

## **REGENERATIVE BRAKING SYSTEM: SCIENCE & TECHNOLOGY**

**NEWS:** Siemens delivers India's first 9000 HP electric locomotive for long-haul freight trains

### **WHAT'S IN THE NEWS?**

India launched its first 9000 HP electric freight locomotive with regenerative braking in Dahod, Gujarat, marking a major step in sustainable rail logistics. The engine can recover braking energy as electricity, boosting energy efficiency, reducing emissions, and lowering operational costs.

### **India's First 9000 HP Electric Freight Locomotive**

#### **Launch Details:**

- **Location:** Dahod, Gujarat
- **Collaboration:** Built in partnership with **German engineering giant Siemens**
- **Significance:** Represents a **technological milestone** in India's rail freight infrastructure

#### **Key Features of the Dahod-9000 Electric Engine:**

- **Horsepower:** 9000 HP – one of the most powerful electric freight locomotives in India
- **Haulage Capacity:** Can haul up to **5800 tonnes**
- **Regenerative Braking:** Capable of **converting braking energy into usable electricity**
- **Design Configuration:** Six-axle locomotive
- **Speed:**
  - **Average speed:** 75 km/h
  - **Maximum speed:** 120 km/h
- **Noise and Vibration:** Designed for **silent operation** with **minimal vibrations**
- **Environmental Impact:**
  - **Zero emissions** during operation
  - Supports India's goals of **sustainable and green transport**

#### **Advantages:**

- **Cost-effective and high-quality engineering**
- **Boosts export potential** of Indian rail technology
- **Promotes efficient freight logistics**
- **Reduces dependence on diesel engines**

- **Lowers carbon footprint and enhances energy efficiency**

## **What is a Regenerative Braking System (RBS)?**

### **Definition:**

- A **braking technology** used in **electric and hybrid vehicles/locomotives** that recovers the vehicle's **kinetic energy** during braking.
- Converts energy that is normally lost as **heat** into **electrical energy**, which is then **stored and reused**.

### **How Regenerative Braking Works:**

#### **1. Kinetic Energy Conversion**

- As the vehicle moves, it accumulates **kinetic energy**.
- When brakes are applied, this energy needs to be reduced to slow the vehicle.

#### **2. Motor Acts as Generator**

- The **electric motor reverses its function**, working as a **generator**.
- It **slows down the wheels** while converting kinetic energy into **electrical energy**.

#### **3. Energy Storage**

- The generated electricity is sent to:
  - The vehicle's **battery**, or
  - A **supercapacitor**.
- This energy is stored for **later reuse**.

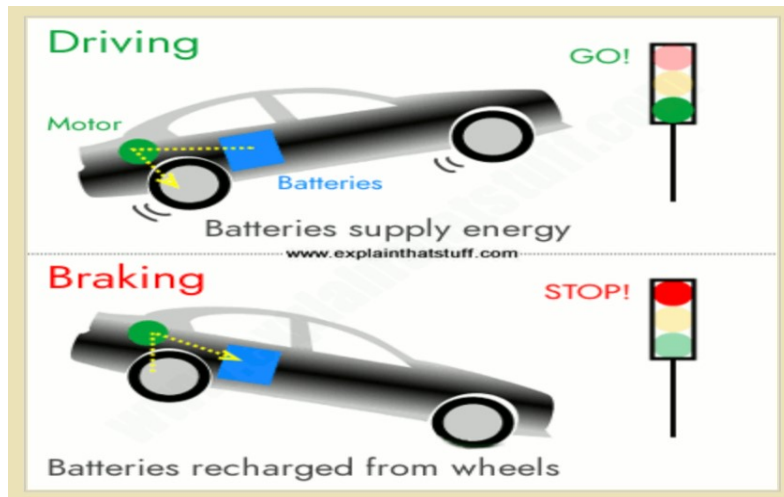
#### **4. Energy Reuse**

- The stored energy can be used to:
  - **Power the vehicle** again during acceleration
  - **Reduce external electricity draw**, increasing overall efficiency.

## **Benefits of Regenerative Braking**

## 1. Improved Energy Efficiency

- Reduces energy loss during braking.



- Enhances the vehicle's **overall efficiency and performance**.

## 2. Lower Emissions

- Promotes **eco-friendly transport** by **minimising energy wastage**.
- Useful in reducing the **railway sector's carbon emissions**.

## 3. Reduced Brake Wear

- Decreases reliance on **friction-based braking systems**.
- Leads to **lower maintenance costs** and **longer brake life**.

## Limitations of Regenerative Braking

### 1. Reduced Effectiveness at Low Speeds

- As **vehicle speed drops**, so does **kinetic energy**, reducing the amount of recoverable energy.
- Energy recovery is **least effective at very low speeds**.

### 2. Incomplete Braking Capability

- RBS **cannot fully stop the vehicle** in most cases.
- Must be used in **conjunction with traditional friction brakes** for complete halts and emergencies.

## Conclusion

The **Dahod 9000 HP electric locomotive** marks a significant advancement in India's journey towards **modern, efficient, and green transportation systems**. Equipped with **regenerative braking**, it sets a benchmark in combining **heavy-duty haulage** with **energy conservation**, contributing to **sustainable rail logistics**.

Source: <https://www.thehindu.com/business/siemens-delivers-indias-first-9000-hp-electric-locomotive-for-long-haul-freight-trains/article69621439.ece>