SJIF Impact Factor (2026): 8.863| ISI I.F. Value: 1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 11 | Issue: 4 | April 2026 - Peer Reviewed Journal

DYNAMIC ELECTRIC CHARGING SYSTEM FOR ELECTRIC BUSES ON BRT ROUTES

Prof. A. H. Patil, Prem, Bhupendra, Tanmay
Patil A.H, Head of Civil Engineering Department, Y.B. Patil Polytechnic, Akurdi, Pune-411044.

ABSTRACT

The electrification of transportation is driving a need for innovative charging infrastructure capable of supporting widespread electric vehicle (EV) adoption. Conductive charging tracks represent an advanced solution, enabling dynamic in-motion charging through embedded insulated metal rails installed in roadways. Vehicles equipped with specialized pickup shoes can actively draw power while traveling, minimizing downtime and eliminating range anxiety. This project investigates the interdisciplinary design, material selection, and civil engineering integration needed to construct such tracks, focusing on copper and aluminum rails, insulation requirements, and real-world operating conditions. The study includes conceptual diagrams, prototype testing, and an analysis of operational benefits such as reduced battery size, increased operational efficiency, and environmental sustainability. By merging civil engineering principles with electrical technology, conductive charging tracks offer a practical pathway towards smarter, cleaner, and more resilient urban transport systems.

1. INTRODUCTION

A conductive charging track for electric vehicles (EVs) represents a groundbreaking innovation in transport infrastructure, enabling vehicles to recharge their batteries while driving, rather than relying solely on stationary charging stations. The core principle involves embedding highly conductive metal rails, usually made from copper or aluminium, directly into the road surface. These rails are protected with durable insulation to prevent accidental contact and ensure safety for both vehicles and pedestrians. As an EV travels over the designated conductive lane, a special "pickup shoe" or contact arm mounted underneath the vehicle glides along the metal rails, maintaining a steady connection. This direct contact allows electrical energy to flow efficiently from the conductive rails to the vehicle's battery system. Advanced systems the road segments directly beneath a vehicle, optimizing safety and reducing electromagnetic interference. The conductive charging system can supply either AC or DC power, depending on vehicle and infrastructure requirements, and can be integrated with existing roadways, bus lanes, or dedicated transport corridors.

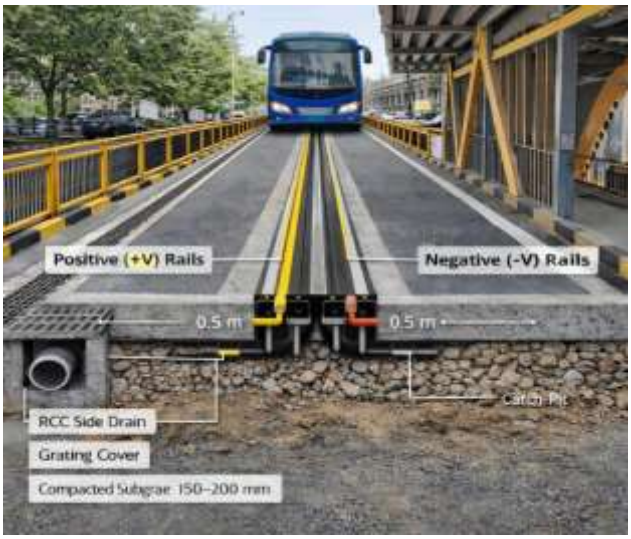


Fig. 1.1 SECTION OF ROAD

2. PROBLEM

2.1 Efficiency Problem: Current electric bus systems require frequent and time-consuming charging stops, leading to delays and reduced service efficiency in high-traffic urban corridors.

2.2 Infrastructure Problem: The need for large and dedicated charging stations creates space constraints and high installation costs in densely populated cities.

2.3 Range & Reliability Problem: Limited battery capacity and lack of continuous charging solutions restrict the operational range and reliability of electric buses.

2.4 Environmental & Energy Problem: Although electric buses reduce emissions, inefficient charging methods increase energy losses and reduce overall system sustainability**.**

2.5 Safety Problem (Advanced): Existing charging systems are not fully optimized for safe operation under varying environmental conditions such as heavy rainfall and waterlogging.

SJIF Impact Factor (2026): 8.863| ISI I.F. Value: 1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 11 | Issue: 4 | April 2026 - Peer Reviewed Journal

3. SOLUTION

3.1 Proposed Solution

To overcome the limitations of conventional charging systems, a self-charging electric bus system using an embedded conductive charging track in the Bus Rapid Transit (BRT) corridor is proposed."

3.2 Explanation of Solution

The proposed system consists of a charging rail embedded within the road surface and a collector (pantograph) mounted beneath the bus. When the bus moves along the BRT corridor or stops at stations, electrical energy is transferred from the track to the bus battery.

3.3 Working Principle

3.3.1 The bus enters the BRT charging zone.
3.3.2 Sensors detect the presence of the bus.
3.3.3 Only the required track segment is activated.
3.3.4 The collector connects with the charging rail.
3.3.5 Power flows from the track to the battery.
3.3.6 Battery level increases (real-time monitoring).
3.3.7 System automatically disconnects when the bus leaves.

3.4 Safety Features (Very Important)

3.4.1 Insulated and covered charging rails.
3.4.2 Segmented power supply (only active under bus).
3.4.3 Waterproof and drainage system (for heavy rain).
3.4.4 Automatic shut-off using sensors.
3.4.5 Proper earthing and short-circuit protection

3.5 Key Advantages of Solution

3.5.1 Eliminates long charging stops.
3.5.2 Enables opportunity charging (while moving or stopping).
3.5.3 Reduces battery size requirement.
3.5.4 Suitable for smart cities and BRT corridors.
3.5.5 Improves efficiency and reduces downtime.

3.6 Advanced Feature (For High-Level Paper)

The system is designed to operate safely under extreme weather conditions by incorporating waterproof enclosures, drainage channels, and real-time monitoring systems.

4. METHODOLOGY

4.1 System Overview

The proposed system is based on a conductive charging mechanism integrated into the Bus Rapid Transit (BRT) corridor. It includes an embedded charging track, an underbody collector (pantograph), a power supply unit, and a control system for safe and efficient energy transfer.

4.2 System Components

a) Embedded Charging Track

i. Conductive rails are installed within the road surface.
ii. Proper insulation and protective covering are provided.
iii. Track is divided into small segments for safety

b) Bus Collector Mechanism

i. A pantograph/collector is mounted beneath the bus.
ii. It maintains contact with the charging rail
iii. Designed for smooth sliding contact.

c) Power Supply Unit

i. Electricity is supplied from grid power.
ii. Includes transformer, rectifier, and control panel.
iii. Provides controlled voltage and current.

SJIF Impact Factor (2026): 8.863| ISI I.F. Value: 1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 11 | Issue: 4 | April 2026 - Peer Reviewed Journal

d) Control & Sensor System

i. Sensors detect bus presence.
ii. Microcontroller (Arduino)controls ON/OFF operation.
iii. LCD display shows charging status.

4.3 Working Procedure

i. The bus enters the BRT charging corridor.
ii. Sensors detect the bus position.
iii. The corresponding track segment is activated.
iv. The collector connects with the charging rail.
v. Electrical power flows to the bus battery.
vi. Battery charging is monitored in real time.
vii. When the bus leaves, the segment is deactivated.

4.4 Safety Mechanism

i. Insulated rails to prevent electric shock.
ii. Waterproof design with drainage system.
iii. Segmented power supply (only active under bus).
iv. Automatic shutdown in case of fault or water detection.
v. Proper earthing system.

4.5 Working Model Implementation

For the prototype model:

i. A small DC motor vehicle represents the bus.
ii. Copper strips act as charging rails.
iii. A metal contact acts as collector.
iv. Arduino is used for automation.
v. LED/LCD displays charging status.

4.6 Performance Evaluation

The system performance is evaluated based on:

i. Charging efficiency.
ii. Time required for charging.
iii. Energy transfer rate.
iv. Safety under different conditions.

5. CALCULATION & RESULT

5.1 Basic Formula (Charging Power)

Charging power formula

Power (kW) = Voltage (V) × Current (A) / 1000

Example:

Voltage = 750 V

Current = 400 A

Power = 750 × 400 / 1000 = 300 kW

- Meaning the charging track is providing 300 kW of power to the bus.

5.2 Charging Energy Calculation

Energy formula

Energy (kWh) = Power (kW) × Time (hours)

Example:

Bus runs for 10 minutes on 300kw track.

10 min = 10/60 = 0.167 hour

Energy = 300 × 0.167 ≈ 50 kWh

- Meaning in 10 minutes The bus gets approximately 50 kWh charge

5.3 Bus Range Increase Calculation

Average electric bus consumption:

1.2 – 1.4 kWh per km

Example:

SJIF Impact Factor (2026): 8.863| ISI I.F. Value: 1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 11 | Issue: 4 | April 2026 - Peer Reviewed Journal

50 kWh / 1.3 kWh per km
≈ 38 km extra range

- This means that 10 minutes of charging can give a extra range of 35 to 40 km..

5.4 Moving Charging Track Calculation

If the bus is running at a speed of 40 km per hour and the charging track length is 3 km.
Time on charging track:
Time = Distance / Speed
3 km / 40 km/h
= 0.075 hour (4.5 minutes)
Energy:
300 kW × 0.075 = 22.5 kWh

- The bus will get 22.5 kWh of charge from 3 km charging tracks.

5.5 Real Design Parameters

Self-charging BRT road design usually:

Parameter	Typical Value
Voltage	600–750 V
Current	300–600 A
Charging power	200–450 kW
Bus consumption	1.2–1.5 kWh/km



Fig 5.1 BRT ROUTE



Fig 5.2 MEAREMENT ON BRT

6.CONCLUSION

The development and implementation of conductive charging tracks for electric vehicles demonstrate a visionary advancement at the intersection of civil engineering and sustainable transport technology. By embedding insulated metal rails in the roadway and enabling dynamic, in-motion charging through vehicle pickup shoes, this system directly addresses the limitations of conventional charging infrastructure—such as range anxiety, frequent charging stops, and the need for large batteries. It represents a practical solution for continuous mobility, especially in urban corridors, public transport sectors, and long-distance freight routes.

From a civil engineering perspective, careful material selection, robust pavement integration, and effective insulation strategies are essential for ensuring safety, durability, and reliability under diverse traffic and environmental conditions. The technology supports

SJIF Impact Factor (2026): 8.863| ISI I.F. Value: 1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 11 | Issue: 4 | April 2026 - Peer Reviewed Journal

the transition to cleaner, greener mobility by reducing emissions, optimizing energy use, and promoting more widespread adoption of electric vehicles.

In conclusion, conductive charging tracks are poised to play a significant role in shaping future transportation networks. Their integration into infrastructure will help realize the goals of smart cities, lower carbon footprints, and efficient urban planning, making them a cornerstone for next-generation sustainable mobility. With continued innovation, collaboration, and real-world testing, conductive charging technology can accelerate the move towards a cleaner and more connected world.