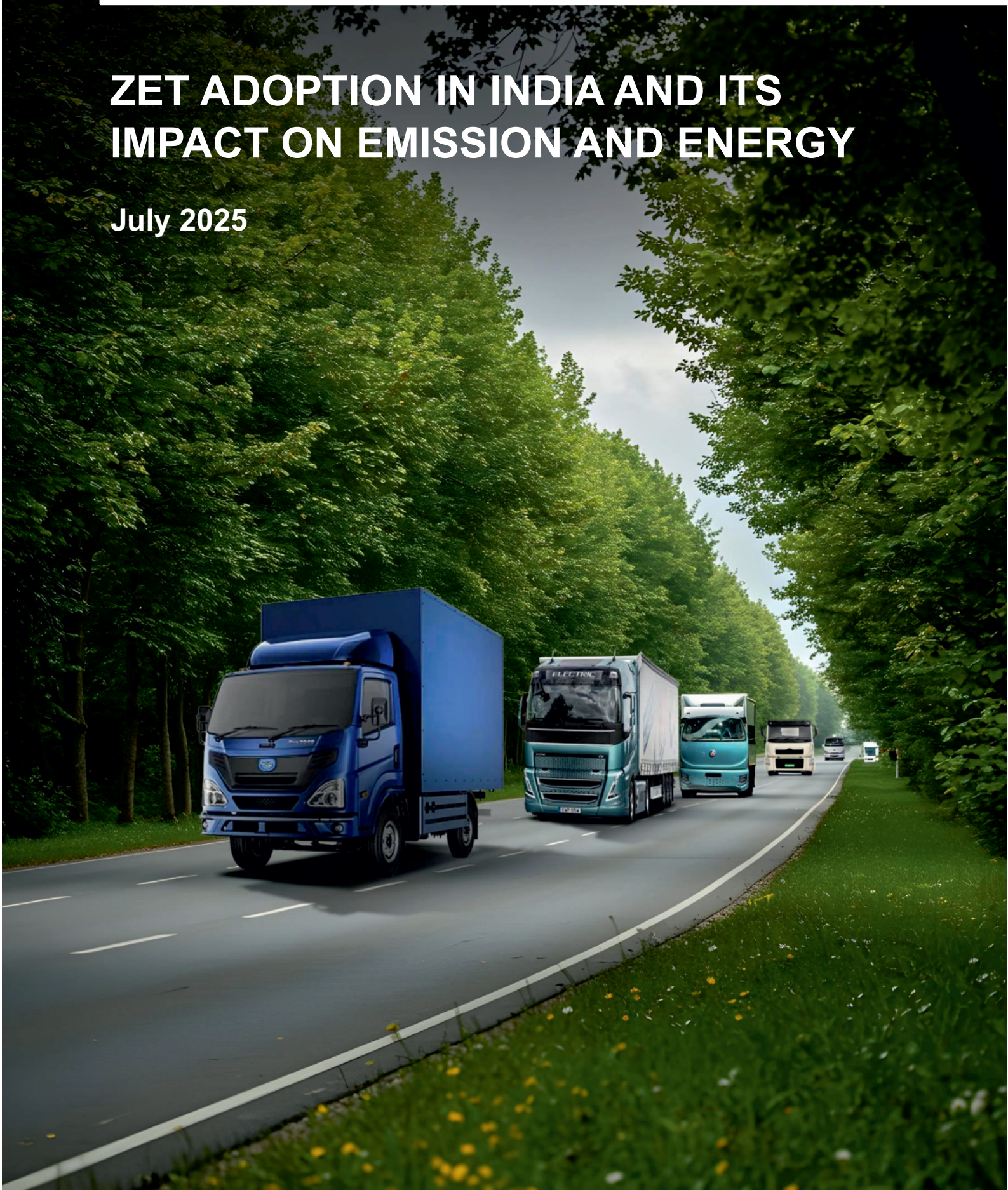




Office of the Principal Scientific Adviser
to the Government of India

ZET ADOPTION IN INDIA AND ITS IMPACT ON EMISSION AND ENERGY

July 2025



अजय के. सूद

भारत सरकार के प्रमुख वैज्ञानिक सलाहकार

Ajay K. Sood

Principal Scientific Adviser to the Govt. of India



सत्यमेव जयते

विज्ञान भवन एनेक्सी

मौलाना आजाद मार्ग, नई दिल्ली-110011

Vigyan Bhawan Annexe

Maulana Azad Road, New Delhi - 110011

Tel. : +91-11-23022112

Fax: +91-11-23022113

E-mail : sood.ajay@gov.in

office-psa@nic.in

Website : www.psa.gov.in



FOREWORD

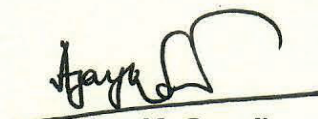
India is experiencing a rapid shift towards sustainable mobility, with its transition towards zero-emission transportation. The adoption of Zero Emission Trucks (ZETs) is a crucial step in reducing greenhouse gas emissions, improving air quality, and enhancing energy security. As a nation committed to achieving Net Zero by 2070, the electrification of freight transport will play a transformative role in shaping a cleaner and more efficient logistics ecosystem.

The impact of ZET adoption is far-reaching: (a) A significant decrease in carbon emissions from the freight sector, contributing to India's climate commitments; (b) Reduced dependence on fossil fuels, fostering a resilient and sustainable energy ecosystem; (c) Investments in ZET infrastructure and manufacturing will create new opportunities for innovation and employment.

The Office of the Principal Scientific Adviser (PSA) released Technical Roadmaps for Deployment of Zero-Emission Trucking in India to provide actionable steps for addressing technological challenges and optimize energy efficiency in freight movement. Subsequently office of PSA has released Bharat Zero Emission Trucking (ZET) Policy Advisory, which outline a structured approach to accelerate ZET adoption. This includes targeted incentives, regulatory frameworks, infrastructure development, and financing mechanisms to support industry stakeholders in making this transition.

To support this transition, the Office of PSA is proud to present the report on "ZET Adoption in India and its Impact on Emissions and Energy". The report is an outcome of a year-long exercise for in-depth data collection, data analysis and scenario evaluation in consultation with industry, subject matter experts and important stakeholders. The document is intended to facilitate relevant policy formulation by providing requisite inputs and estimated ZET demand projections.

I extend my deepest appreciation to all those who contributed to this work, and I invite all industry leaders, financiers, innovators, and citizens to come together in shaping a freight eco-system that is aligned with the aspirations of a cleaner, stronger India.


(Ajay K. Sood)

Dated: 23rd June, 2025



डॉ. (श्रीमती) परविन्दर मैना
वैज्ञानिक सचिव

Dr. (Mrs) Parvinder Maini
Scientific Secretary

भारत सरकार के
प्रमुख वैज्ञानिक सलाहकार के कार्यालय
विज्ञान भवन एनेक्सी
मौलाना आजाद मार्ग, नई दिल्ली - 110011
Office of the Principal Scientific Adviser
to the Government of India
Vigyan Bhawan Annexe
Maulana Azad Road, New Delhi-110011

New Delhi
Dated : 20th June, 2025

MESSAGE

The Office of the Principal Scientific Adviser to the Government of India, through its various missions and programs, has consistently played a pivotal role in advancing Science and Technology in areas of strategic national importance. Recognizing the vital contribution of freight transportation to India's economic growth, and its concurrent implications for environmental sustainability and energy security, the Office of PSA has prioritized efforts to enable a transition towards electrification in this sector.

In support of this transition, a "Consultative Group on e-Mobility (CGeM)" was established with the mandate to develop a robust technical framework for the effective deployment of Zero-Emission Trucks (ZETs) in the country. Several reports and studies have already been published as part of this initiative, and the current report serves as a significant advancement in this ongoing endeavour.

The report on **"ZET Adoption in India and its Impact on Emissions and Energy"** presents a detailed study providing projections on Battery Electric Trucks (BETs) adoption, emission savings, savings in fuel and electricity demand. The analysis is based on in-depth input from experts in the truck industry who have a comprehensive understanding of the market, its use cases, and the relevant technologies. The report also underscores the importance of targeted early-stage interventions such as enhanced fiscal incentives, specialized product offerings, and robust charging solutions to accelerate market confidence in BETs. By laying out these projections and identifying potential catalysts, the report aims to assist policymakers, industry stakeholders, and investors in making informed decisions that will foster a sustainable and economically viable transition to Zero-emission trucking in India.

I extend my appreciation to all contributors, CGeM members and stakeholders whose contributions made this report a reality. I trust that this document will be used as a reference document by all stakeholders in policy formulation and in planning commercial deployment of Zero Emission Trucks in India.



(Parvinder Maini)

Table of Contents

1. Executive Summary	Page 5
2. Technical Introduction	Page 7
3. BET Adoption	Page 8
3.1 Truck Sales Projections	Page 8
3.2 Electrification Requirements	Page 9
- Scenario 1: Business As Usual (BAU)	Page 11
- Scenario 2: Business with Support (BWS)	Page 12
4. Emissions	Page 15
4.1 Understanding GHG Emissions	Page 15
4.2 Carbon dioxide Emission	Page 15
4.3 Emission calculation methodology	Page 16
4.4 Impact of Electrification on Emissions	Page 19
4.5 Cumulative CO₂ Emission	Page 21
5. Fuel Consumption and Savings	Page 22
6. Energy Consumption by BETs	Page 24
6.1 India's Power Generation Landscape	Page 24
6.2 Electricity Demand Growth for e-M&HDTs	Page 25
7. Conclusion	Page 27
Annexures	Page 28

List of Figures

1. Annual Sales Projection of M&HDT Trucks till FY50 (CAGR Based)	Page 8
2. Cumulative M&HDT Stock Projections till FY50 (Vehicle Stock-Based)	Page 9
3. M&HDT ZET Projections: Business As Usual (BAU)	Page 12
4. M&HDT ZET Projections: Business with Support (BWS)	Page 14
5. Emission factor ICE vs BEV	Page 16
6. CO ₂ Emission factor projection	Page 17
7. Segment-Wise CO ₂ Emission Share mix in FY24	Page 18
8. Application-Wise CO ₂ Emission Share mix in FY50 – No electrification scenario	Page 19
9. CO ₂ Emissions in No Electrification, BAU, and BWS Scenarios	Page 19
10. GHG Emissions: No electrification, BAU and BWS scenarios	Page 21
11. Annual Diesel Consumption: No Electrification, BAU, and BWS Scenarios	Page 22
12. Projected Growth and Contribution of Renewable Energy in India's Power Sector (FY24–FY50)	Page 24
13. Projected e-M&HDT Stock Growth and Power Generation Capacity (FY22–FY50) : Renewable vs Conventional Energy contribution - BAU	Page 25
14. Projected e-M&HDT Stock Growth and Power Generation Capacity (FY22–FY50) : Renewable vs Conventional Energy contribution - BWS	Page 26

Chapter 1: Executive Summary

India's freight sector—driven primarily by Medium and Heavy-Duty Trucks (M&HDTs)—accounts for nearly 70%¹ of the nation's logistics operations, playing a critical role in economic growth and industrial development. However, this sector is also a significant contributor to petroleum fuel consumption (approximately 40%)² and the resulting pollution. As freight demand continues to rise, initiatives to transition toward sustainable transport solutions have commenced. Given the current trends in green hydrogen (H₂) production costs³ and limited infrastructure availability, this report assumes that Battery Electric Trucks (BETs) will be the primary zero-emission technology (ZET) for M&HDTs.

Against this background, this detailed study provides projections on BET adoption, emission savings, savings in fuel and electricity demand that are as accurate as possible. The analysis is based on in-depth input from experts in the truck industry who have a comprehensive understanding of the market, its use cases, and the relevant technologies. Historical data from sources such as SIAM, Vahan portal, MoRTH, MoPNG, and MoP, combined with interviews of stakeholders from across the value chain in various regions of the country, underpin the projections. Interviews were conducted with representatives from major OEMs (e.g., Ashok Leyland, Tata Motors), operators of different use cases, experts from end-use industries (e.g., Flipkart, JSW, Waycool), and other related sectors.

The Medium and Heavy-Duty Trucks (M&HDTs) market is growing at approximately 7% per annum over the past 12 years⁴. Annual sales volumes are expected to triple from 2.7 lakh trucks in FY24 to 8.5 lakh trucks in FY50, while the on-road vehicle stock is projected to increase from 5.5 million to 12.5 million during this period.

India's truck market is unique compared to Europe and the US. In India, tractor trailers constitute only about 20% of truck sales & about 5% stock as of FY24, with a significant amount of haulage carried out by multi-axle vehicles (MAVs) and rigidids. Moreover, the majority of buyers are small operators—fewer than 25%⁵ of sales are to fleets of 20 trucks or more.

Unlike the period from 2015 to 2022, battery costs and other eTruck powertrain costs have fallen drastically, altering the viability equation compared to diesel trucks. Currently, a truck that consumes diesel worth Rs. 30 lakhs per year becomes financially more viable when electrified—although operational and infrastructure considerations still pose challenges for roughly 20% of the market⁶.

The analysis and projections covered in this study indicate that while BET adoption will remain very low in the near term (during the first decade), it will then increase rapidly in the following decade due to a combination of falling costs, improved infrastructure availability and growing acceptance among buyers. Under a business-as-usual (BAU) scenario, BET adoption is expected to be about 2% by FY35, roughly 55% by FY45, and reach 100% by FY55. However, with proper support measures (the BWS – Business with Support scenario), BET adoption could rise to about 18% by FY35 and achieve 100% penetration by FY46.

¹ <https://www.niti.gov.in/sites/default/files/2023-02/ZETReport09092022.pdf>

² https://theicct.org/wp-content/uploads/2021/06/ICCT_India-HDV-fuel-consumption_policy-update_20171207.pdf

³ CoEZET estimate

⁴ SIAM Data

⁵ CoEZET's assumption after consulting industry experts.

⁶ Analysis by CoEZET

With such an adoption of BETs, there is significant reduction in diesel use leading to substantial reduction in fossil fuel dependency and consequent forex saving and huge reduction in GHG emissions.

Electricity consumption by BETs is projected to be a small portion of overall generation capacity, peaking at about 8% in FY50. This level is manageable within the context of the projected capacity expansions, even as a significant number of diesel trucks remain on the roads.

It is important to note that these projections are based on certain assumptions regarding policy support, total cost of ownership evolution, technology maturity, and infrastructure development. The analysis was conducted by experts with a deep understanding of the Indian trucking market.

In this regard, the report underscores the importance of targeted early-stage interventions—such as enhanced fiscal incentives, specialized product offerings, and robust charging solutions—to accelerate market confidence in BETs. By laying out these projections and identifying potential catalysts, the report aims to assist policymakers, industry stakeholders, and investors in making informed decisions that will foster a sustainable and economically viable transition to electric trucking in India.

Chapter 2: Technical Introduction

India's freight sector, driven by Medium and Heavy-Duty Trucks (M&HDTs), accounts for nearly 70% of the nation's logistics operations, playing a critical role in economic growth and industrial development. However, this sector is also a significant contributor to greenhouse gas (GHG) emissions, including CO₂, NO_x, SO_x, and particulate matter (PM), posing substantial environmental and public health challenges. As freight demand continues to rise, there is an urgent need to transition toward sustainable transport solutions. Given the current trends in Green Hydrogen (H₂) production costs and limited infrastructure availability, this report assumes Battery Electric Trucks (BETs) to be the primary Zero-Emission Technology (ZET) for M&HDTs. Projections indicate that advancements in battery technology over the coming decades will ensure BETs remain competitive against emerging alternatives like Hydrogen Internal Combustion Engines (H₂ ICE) and Fuel Cell Electric Trucks (FCETs).

This report evaluates the transformative potential of electrifying M&HDTs through the adoption of BETs. Two scenarios are explored, Business As Usual (BAU), which follows current trends, and Business with Support (BWS), which includes targeted policy interventions, financial incentives, and infrastructure development. While the BAU scenario results in incremental progress, the BWS scenario demonstrates the accelerated impact of proactive measures, including substantial reductions in emissions and enhanced adoption of zero-emission technologies. The analysis assumes continuous improvements in battery energy density, charging speeds, and lifecycle costs, which are projected to enhance BET viability and operational feasibility by FY50. For instance, advancements such as solid-state batteries and ultra-fast charging infrastructure are expected to address current limitations like range anxiety and downtime, further solidifying BETs as the optimal ZET choice.

The analysis further examines the implications of BET adoption on fuel consumption, energy security, and electricity demand. By reducing diesel consumption in a big way, electrification offers a significant opportunity to mitigate India's dependence on fossil fuels. Moreover, the modest increase in electricity demand—projected to account for only minor portion of total generation by FY50—aligns seamlessly with India's expanding renewable energy capacity, ensuring a sustainable transition without overburdening the power grid.

Through detailed projections and scenario-based analysis, this report underscores the critical need for immediate action to accelerate M&HDT electrification. By adopting a strategic approach to policy, infrastructure, and technology development, India can achieve its decarbonization goals, bolster energy resilience, and establish itself as a global leader in sustainable freight transport.

Chapter 3: BET Adoption

India's trucking sector handles nearly **70% of the country's freight movement**, with **Medium and Heavy-Duty Trucks (M&HDT)**, having a **Gross Vehicle Weight (GVW) above 12 T**, dominating long-haul transport. M&HDTs are essential for bulk cargo movement, supporting industries like construction, manufacturing, and agriculture. In comparison, **Light and Intermediate Duty Trucks (L&IDT)**, with GVW between **3.5 T and 12 T**, primarily serve short-haul and urban logistics.

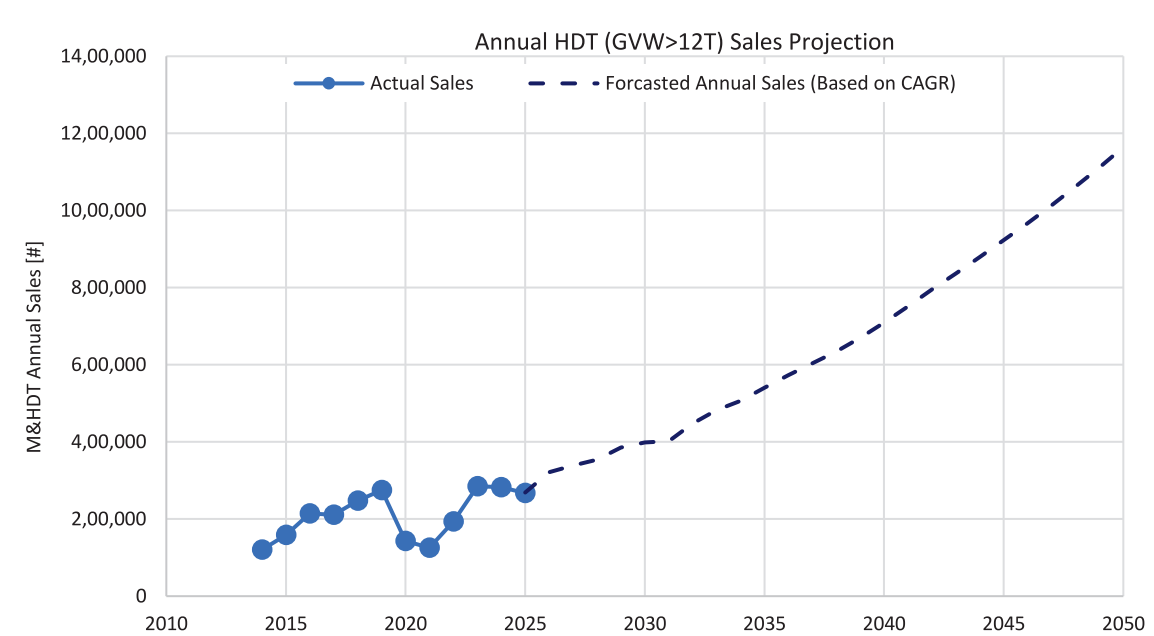
Driven by economic growth and infrastructure expansion, the demand for M&HDTs is increasing rapidly. The following section explores **sales projections** for M&HDTs, showcasing their critical role in India's freight ecosystem and their electrification potential.

3.1 Truck sales projection

The projections for Medium and Heavy-Duty Trucks (M&HDT) in India have been made using two steps to provide a comprehensive outlook on sales and stock growth trends:

1. **CAGR-Based Sales Projections:** This step calculates annual sales for Medium and Heavy-Duty Trucks (M&HDT) using the Compound Annual Growth Rate (CAGR), reflecting a steady increase over time. The baseline CAGR is based on historical data from the Society of Indian Automobile Manufacturers (SIAM) up to FY24, with future growth rates projected by extrapolating this trend. The accompanying chart illustrates annual sales from FY14 to FY50, combining historical data and future forecasts, calculated as a 12-year moving average. The dashed line represents the growth in annual sales, which also accounts for vehicle replacements in the overall sales projections.

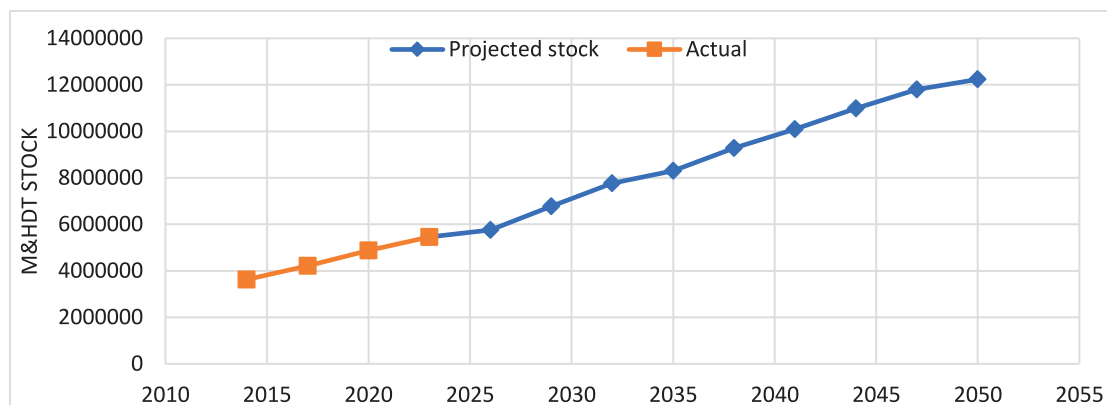
Fig 1: Annual Sales Projection of M&HDT Trucks till FY50 (CAGR Based)



Tonnage wise truck sales and applications wise projections given in Annexure 2-Source:

2. **Vehicle Stock Projections:** In this step, the stock projections are calculated using the actual truck stock data from Vahan portal and incorporating both new additions and replacements over the years.

Fig 2: Cumulative M&HDT Stocks Projections till FY50 (Vahan portal Stock-based)



The chart illustrates the cumulative stock projections of Medium and Heavy-Duty Trucks (M&HDTs) in India up to the year FY50. It compares historical stock data with projected growth trends, providing insights into the total number of trucks expected to be operational over time. The cumulative stock projection is calculated as the sum of the current vehicle stock, annual vehicle sales, and adjustments for vehicles scrapped during the same period [Total vehicle stock at the end of a particular year 'x' = Vehicle stock at the end of the previous year ('x-1') + Annual sale in that year ('x') - number of vehicles scrapped in that year ('x') (assumed to be equal to the sales 15 years ago (year 'x'-15))]. This comprehensive approach highlights the dynamic changes in the M&HDT fleet, driven by market trends and lifecycle considerations. Total stock of M&HDTs on road is expected to grow from current 5.5 million level in FY24 to 12.5 million by FY50.

3.2 Factors influencing BET Adoption: An assessment of factors and BET adoption trends were done based on primary consultation with Industry senior executives/experts, leading operators in various applications/use cases, Logistics Service Providers (LSPs), etc.

- **TCO Parity/Advantage:** Trucks, being commercial vehicles bought for profits, better TCO is the basic hygiene factor to consider for estimating BET adoption. As per experts, considering uncertainties & potential risks, a 10% TCO benefit over diesel trucks would be required to consider initial trial of BET. Year of achievement of 10% advantage in BET TCO over ICE TCO for specific application/use case is given in the table below. Earlier achievement of this TCO advantage through support like subsidies, toll waiver, etc. will help in earlier trial which are critical to generate success stories for subsequent faster adoption of BETs.
- **Operational Suitability/Support:** Assessment of operational suitability of BETs for each application – routes, distance covered, charging needs, stoppages, etc. As per this study, around 20% of vehicles can work with end-to-end charging, around 60% will require electrification of many major corridors and last 20% will require spread of charging facilities at interior locations/range extension technologies. Hence the dominant application in the first 20% are likely to try BETs early. Policy & Financial support for upstream & downstream infrastructure in establishing public & private charging facilities would accelerate BET adoption after initial trial.

- **Operators' Profile:** Assessment based on profile of operators for the application (Large fleet and captive operators expected to try earlier while small operators will take much longer time). Applications like Market Load which are dominated by small operators are likely to adopt BET slowly as compared to Parcel Load/FMCG, Cement transportation, etc.
- **Stakeholders' Readiness:** Availability of products from OEMs, readiness of Financiers & other stakeholders are other critical factors that influence speed of adoption of BETs.
- **Technical favorability & Other Electrification Constraints**

Results from the TCO study (year at which BETs will have 10% advantage over ICET for various applications with and without support (Scenarios BAU & BWS) given below:

Table 1

Application	Representative Segment (GVW)	BET having 10% advantage over Diesel by year	
		BAU	BWS
Market Load	28	FY30	FY25
Parcel Load/FMCG	19	FY28	FY25
Perishables	19	FY28	FY25
Coal & Minerals	55	NA	FY25
Steel & Metals	55	NA	FY25
Fish	19	FY27	FY25
Petroleum Product	28	FY35	FY25
Water and Municipality applications	19	FY33	FY25
Edible Oil	28	FY31	FY25
Milk	28	FY31	FY25
LPG	40	NA	FY25
Cement Bags	28	FY31	FY25

To assess its impact, two scenarios have been formulated:

Scenario 1: Business As Usual (BAU)

Under this scenario, electrification follows the current market trends and policies (Exemptions from motor vehicle tax, registration certificate fees, and renewal charges) without any additional interventions. Infrastructure development, including HD charging facilities, grows organically based on market viability, with no planned installations in advance.

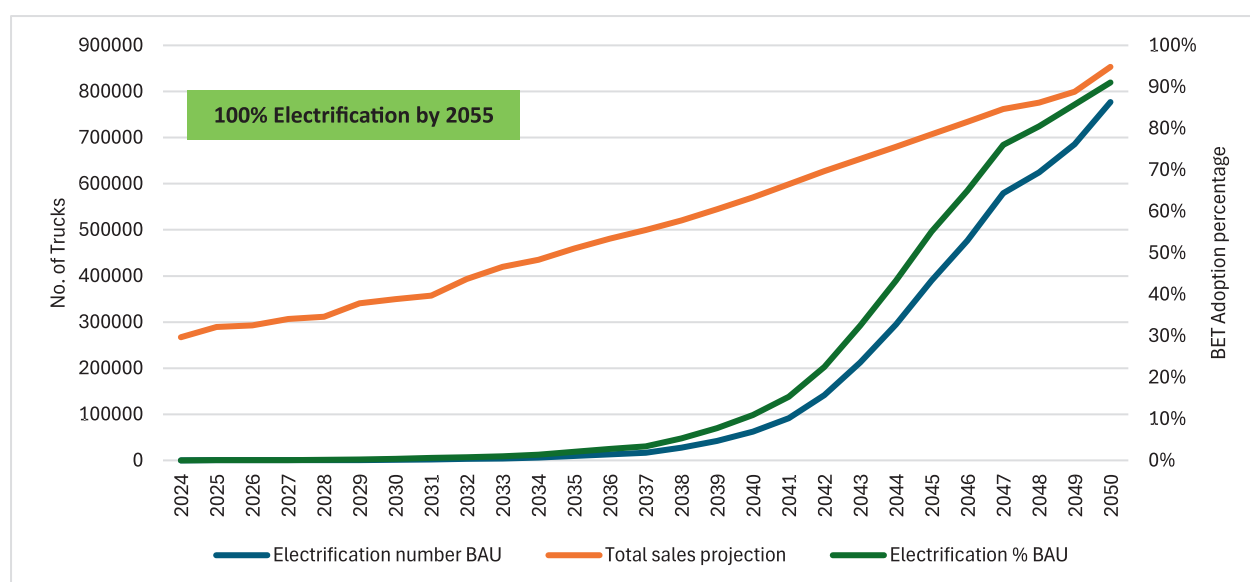
- **Assumptions:**
 - No additional policy or financial support for M&HDT electrification.
 - Infrastructure development driven solely by market demand.
- **Impact:**
 - Limited GHG reductions due to slow adoption of electric trucks.
 - Missed opportunities to meet decarbonization and sustainability targets.

These scenarios highlight the critical need for proactive measures to expedite M&HDT electrification and effectively reduce emissions.

Based on the TCO study results & other factors above, the applications have been classified into four categories – Slow adoption, medium, fast & superfast. Adoption rate for each of these categories has been estimated and the summary below:

Table 2

Rate	Applications	Start year	1% Year	5% Year	20% Year	100% Year
Super-fast	Parcel/FMCG, Municipality Applications & Cement	FY26	FY31	FY37	FY41	FY47
Fast	Perishables, Minerals, Fish, Petroleum, Edible Oil & Milk	FY28	FY32	FY38	FY42	FY50
Medium	LPG & Market Load	FY29	FY34	FY40	FY44	FY52
Slow	Steel & other metals	FY31	FY35	FY41	FY45	FY55

Fig 3: M&HDT ZET Projections BAU

Table 3

Year	Sales Projections	BET Adoption- Business as Usual Scenario	
	(nos.)	(nos.)	%
FY25	267,331	242	0.09
FY30	349,982	1,181	0.34
FY35	459,479	9,476	2.1
FY40	570,444	62,705	11.0
FY45	707,146	389,693	55.1
FY46	733,906	476,930	65.0
FY50	853,377	777,084	91.1

Year wise data provided In Annexure 1

- Under BAU, electrification progresses gradually with current policies, achieving **100% BET adoption by FY55**. The pace is slow, with significant progress only after FY40, reflecting the limitations of unassisted market trends.

Scenario 2: Business with Support (BWS)

This scenario envisions an accelerated transition towards Heavy-Duty Truck (HDT) electrification through a comprehensive policy framework and financial incentives aimed at ensuring infrastructure readiness. The strategy emphasizes aggressive policy support to rapidly develop a robust EV charging network, particularly for high-utilization freight corridors.

Key Policy Interventions:

1. Toll Waivers:

- 100% waiver for the first five years.
- 50% waiver for the subsequent five years.

2. Financial Incentives for Vehicle Adoption:

- A subsidy of ₹10,000 per kWh (capped at ₹30 lakh per vehicle) is proposed to be provided for the first 10,000 HDTs, applicable until FY30.

3. Subsidy for Charging Infrastructure:

- Up to 80% subsidy on upstream infrastructure (behind-the-meter infrastructure), covering costs such as site preparation, grid interconnection, and charging equipment installation.
- 25% subsidy on downstream EVSE (meter and before-the-meter costs), covering expenses related to grid upgrades, transformer installations, and power distribution enhancements.
- In addition to the above, a State level subsidy of 25% for the charging stations subject to a maximum of Rs. 1 million per station for public charging stations.
- A subsidy to waive the minimum demand charges for public charging stations by DISCOMs.

Based on the TCO study results & other factors as mentioned above, the applications have been classified into four categories – Slow adoption, medium, fast & superfast. Adoption rate for each of these categories has been estimated and the summary below:

Table 4

Rate	Applications	Start year	1% Year	5% Year	20% Year	100% Year
Super-fast	Parcel/FMCG, Municipality Applications & Cement	FY26	FY27	FY30	FY35	FY42
Fast	Perishables, Minerals, Fish, Petroleum, Edible Oil & Milk	FY27	FY28	FY31	FY36	FY43
Medium	LPG & Market Load	FY29	FY30	FY33	FY38	FY45
Slow	Steel & other metals	FY30	FY31	FY34	FY39	FY46

Fig 4: M&HDT ZET Projections BWS

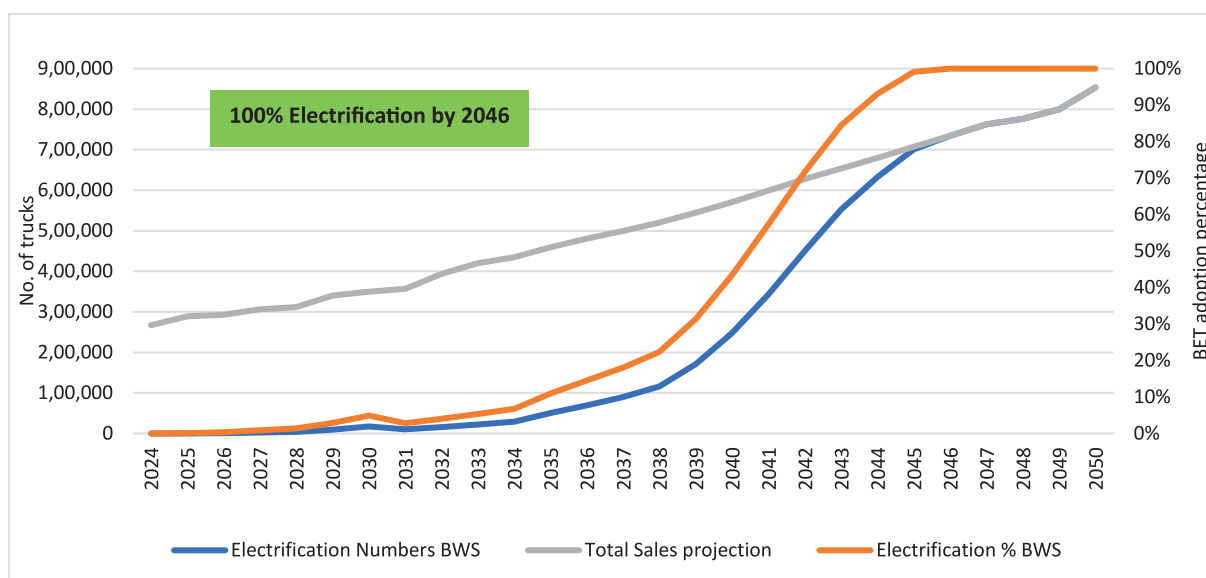


Table 5

Year	Sales Projections	BET Adoption (BWS Scenario)	
	(nos.)	(nos.)	%
FY25	267,331	242	0.09
FY30	349,982	10,015	2.9
FY35	459,479	81,222	17.7
FY40	570,444	323,442	56.7
FY45	707,146	701,063	99.1
FY46	733,906	733,906	100.00
FY50	853,377	853,376	100.00

In the BWS scenario, targeted policies and infrastructure investment accelerate electrification, achieving **100% BET adoption by FY46, nearly a decade earlier than BAU**. The adoption curve steepens after FY35, demonstrating the impact of proactive interventions.

Application wise and tonnage wise electrification penetration for No electrification, BAU and BWS given In Annexure 4 and Annexure 5 respectively

Chapter 4: Emissions

4.1 Understanding GHG Emissions

Greenhouse gases (GHGs) such as **Carbon Dioxide (CO₂)**, **Nitrogen Oxides (NO_x)**, and **Particulate Matter (PM)** trap heat in the atmosphere, contributing to global warming and climate change. In India's freight sector, **Medium and Heavy-Duty Trucks (M&HDTs)** are significant sources of these emissions due to their reliance on diesel fuel.

Sources of GHG Emissions from M&HDTs

- **CO₂ Emissions:** Result from diesel combustion in truck engines, with each litre of diesel producing approximately **2.6 kg of CO₂**⁷. (All emissions calculations in this report utilize this value.)

Diesel fuel contains approximately 86.2% carbon, with 1 litre weighing 0.84 kg. Thus, 1 litre of diesel contains about 0.72 kg of carbon (86.2% of 0.84 kg). During combustion, carbon reacts with oxygen to form CO₂. Given that CO₂ has a molecular weight of 44 (12 for carbon and 32 for oxygen), it is 3.67 times heavier than carbon (44 ÷ 12). Therefore, combusting 1 litre of diesel produces approximately 2.6 kg of CO₂ (3.67 × 0.72 kg). This emission factor is essential for estimating CO₂ emissions and informing strategies to reduce greenhouse gas emissions.

- **NO_x Emissions:** Emerge from high-temperature combustion processes in diesel engines, contributing to smog and respiratory issues.
- **PM Emissions:** Arise from incomplete fuel combustion and wear of vehicle components, leading to air quality degradation
- **SO_x Emissions:** Emitted from diesel combustion, SO_x (mainly SO₂) contribute to acid rain and respiratory issues. Stricter fuel standards reduce these emissions.

4.2 Carbon Dioxide (CO₂) Emissions

Carbon dioxide (CO₂) emissions are a major contributor to climate change, resulting from the combustion of fossil fuels in diesel engines. Medium and Heavy-Duty Trucks (M&HDTs) are responsible for a significant share of CO₂ emissions in the freight sector, driven by their reliance on diesel and high operational demand.

GHG emissions are calculated from **well to wheel**, based on fleet size, segmentation, operational characteristics, and fuel usage, considering both internal combustion engine (ICE) vehicles and scenario-based electric M&HDT (e-M&HDT) adoption. Emission reductions from EVs depend on electricity sources, with cleaner grids and higher renewable energy shares enabling greater reductions. The tank-to-wheel approach focuses on direct emissions from fuel combustion during vehicle operation, excluding upstream processes like fuel production or electricity generation.

⁷ <https://www.mdpi.com/2071-1050/11/9/2690#B30-sustainability-11-02690>

4.3 Emission Calculation Methodology

Well-to-Wheel Carbon Dioxide Emissions: ICE Trucks

The Well-to-Wheel (WtW) CO₂ emissions for internal combustion engine (ICE) trucks are calculated across two phases:

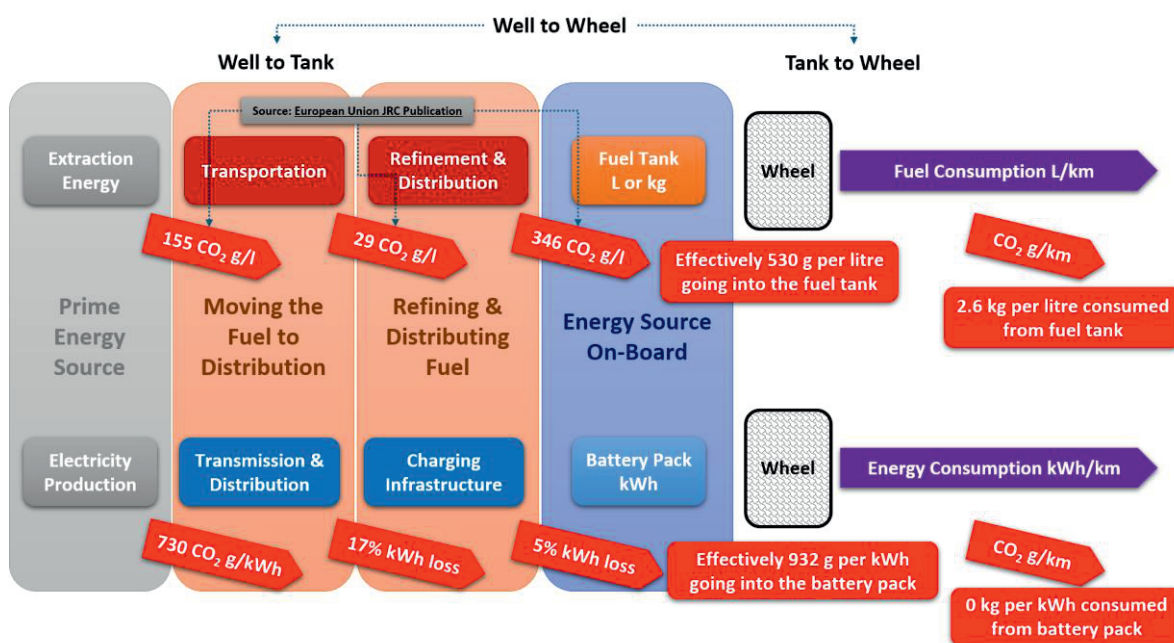
1. Well-to-Tank (WtT):

- Emissions from fuel extraction, refining, and distribution total 530 g CO₂ per litre⁸. This includes energy-intensive upstream processes such as crude oil extraction, transportation, and refining.

2. Tank-to-Wheel (TtW):

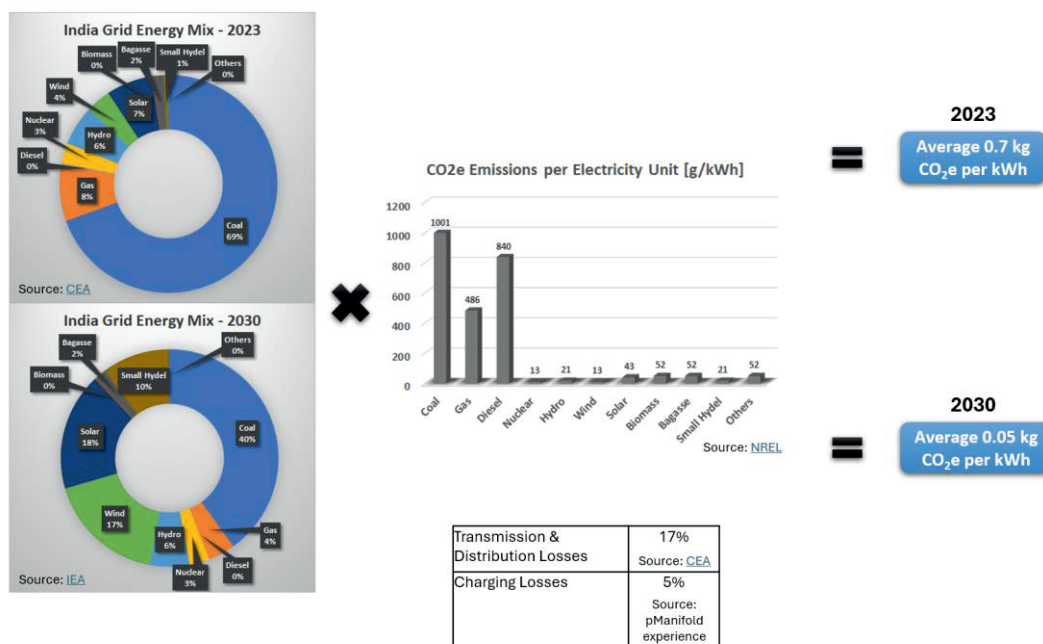
- Direct emissions from diesel combustion amount to 2.6 kg CO₂ per litre, reflecting the carbon intensity of fuel use during vehicle operation.

Fig 5: Emission factor ICE vs BEV



⁸ <https://www.carbonatdelete.eu/en/insights-list/carbon-emission-factors-more-than-just-a-number/#:~:text=Diesel%20has%20direct%20emissions%20or%20tank%2Dto%2Dwheel%20emissions,well%2Dto%2Dwheel%20emissions%20of%203%2C17%20kgCO2e%20per%20litre.>

Fig 6: CO₂ Emission factor projection



Well-to-Wheel Carbon Dioxide Emissions: BETs

The Well-to-Wheel (WtW) emissions BETs are calculated as follows:

1. Well-to-Tank (WtT):

- The current CO₂ footprint of electricity used to charge Battery Electric Trucks (BET) is estimated at 932 g CO₂ per kilowatt-hour⁹ (kWh), which includes generation, transmission, and charging. This figure depends on the energy mix in the grid and will decrease as the share of renewables increases, from 22% in FY22 to an expected 95% by FY50, according to CEA projections. Consequently, the Well-to-Wheel CO₂ emission factor for BET is anticipated to drop significantly, from 932 g in FY23 to as low as 54 g in FY50, reflecting the cleaner energy supply. (Refer Annexure-8 for the calculation and project of CO₂ Emission factor till FY50)

2. Tank-to-Wheel (TtW):

- 0 g CO₂/kWh, as BETs produce zero tailpipe emissions during operation.

⁹ Estimate based on CEA data

Application-Wise Emission Analysis:

For each application, year-wise CO₂ emissions are calculated as explained below:

For ICE trucks,

Total CO₂ emission in a year = Total diesel consumed in that year x CO₂ emitted per litre of diesel (Well to Wheel)

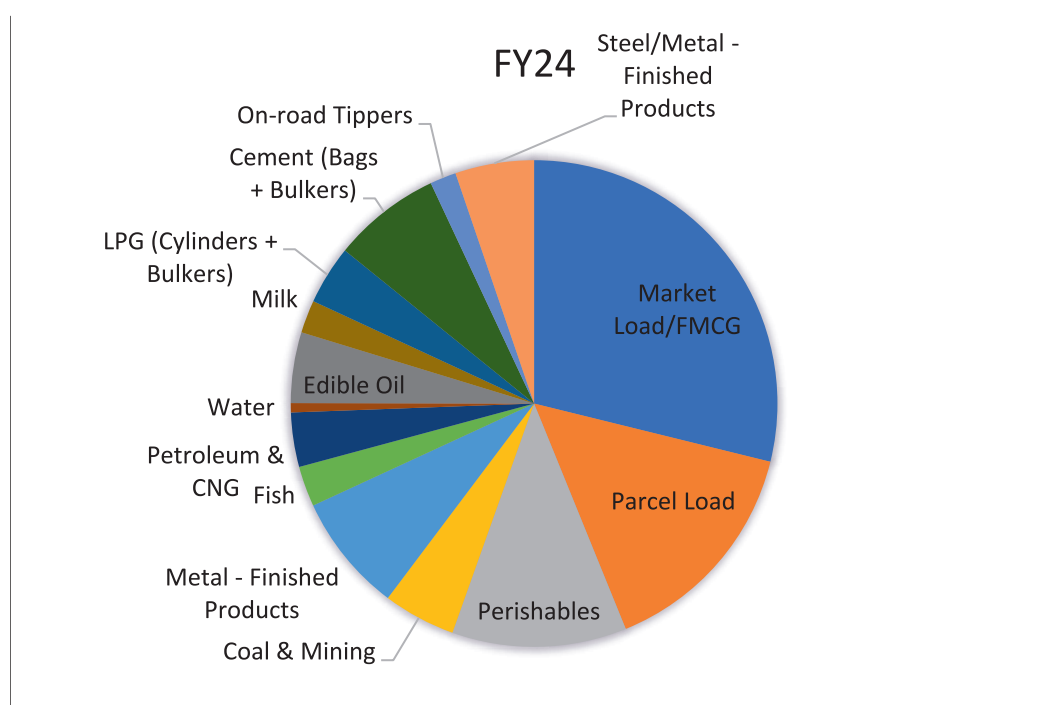
Also, total diesel consumed in a year = Total distance travelled / Fuel efficiency (in kmpl)

For BETs,

Total CO₂ emission in a year = Total electricity consumed ('x' kWh) in a year x CO₂ Emission factor¹⁰ (The amount of CO₂ emitted to generate and transmit 1 kWh of electricity to BET)

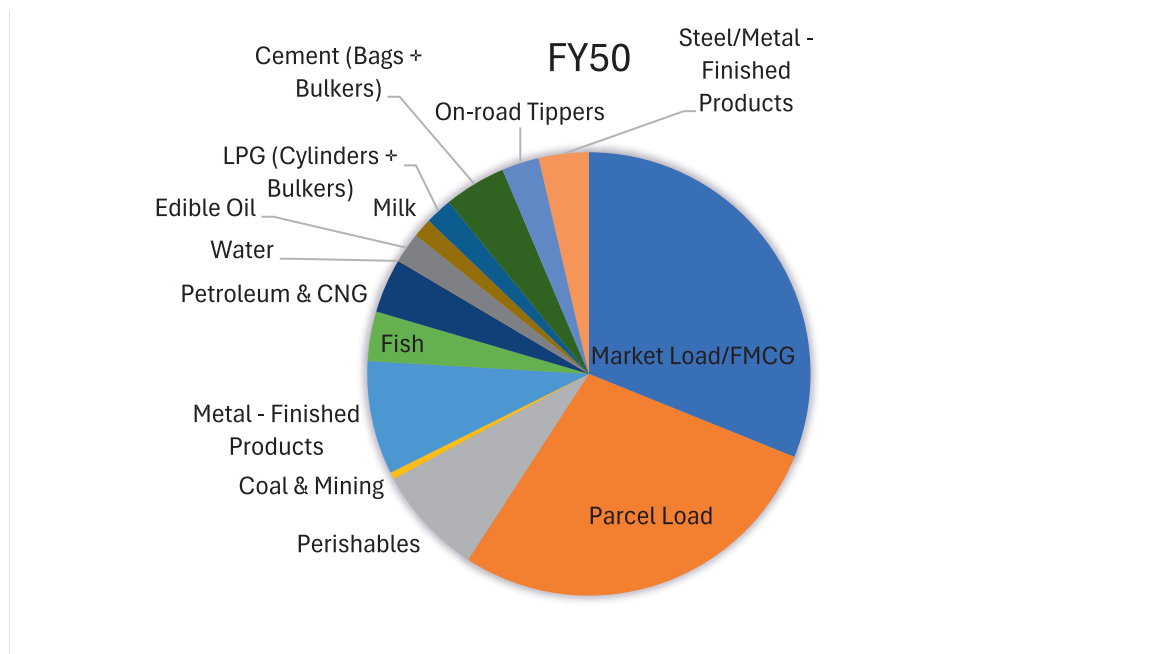
Also, total electricity consumed ('x' kWh) in a year = Total distance travelled/Specific Energy consumption (in kWh/km)

Fig 7: Segment wise CO₂ Emission Share Mix in FY24 - No electrification Scenario



¹⁰ Refer Annexure-8 of this report for CO₂ Emission factor calculation and projection till FY50

Fig 8: Application-wise CO₂ Emission Share Mix in the year FY50 – No Electrification Scenario



By FY50, Parcel Load and FMCG emissions surge from 15% to 38%, driven by e-commerce growth and fossil-fuel-dependent logistics, making it the largest emitter. Market Load remains high (42%), while industrial emissions (Cement, Coal, LPG) decline, indicating a shift toward cleaner technologies. Perishables (12% → 7%) and small goods (Edible Oil, Milk) reduce, reflecting improved cold-chain efficiency. However, fishery emissions remain unchanged (3%), showing no progress in marine transport decarbonization

No electrification, BAU and BWS Application wise share mix from FY24-FY50 given in Annexure 7

4.4 Impact of Electrification on Emissions:

This chart shows projected emissions for Medium and Heavy-Duty Trucks (M&HDTs) in India (FY24-FY50) across three scenarios: **No Electrification**, **Business as Usual (BAU)**, and **Business with Support (BWS)**.

Fig 9: CO₂ emissions in No electrification, BAU and BWS Scenarios

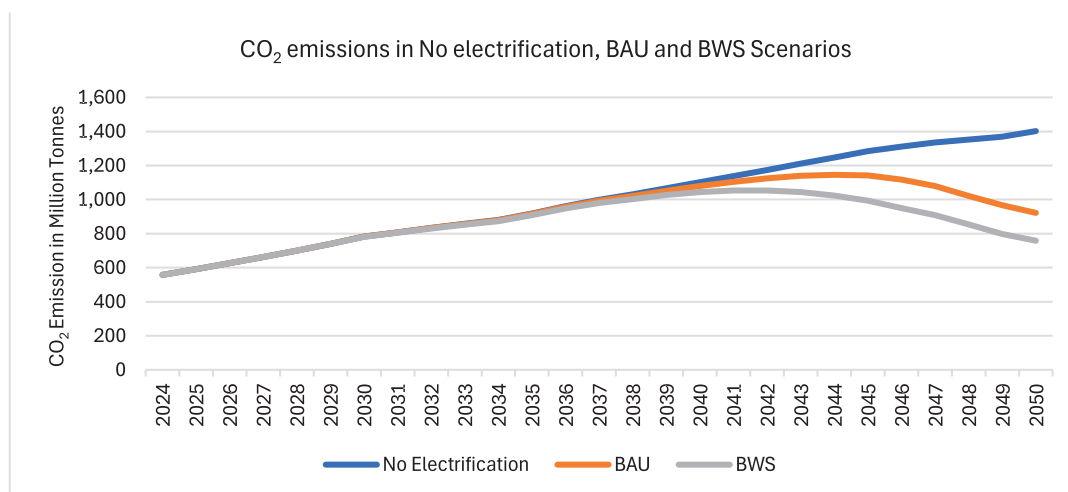


Table 6

Annual CO2 [Million T]	FY24	FY30	FY35	FY40	FY45	FY50
No Electrification	558	783	918	1,102	1,285	1,402
BAU	558	782	916	1,080	1,141	922
BWS	558	782	909	1,043	994	758

Full data available at Annexure 6

- **No Electrification:**

Emissions grow unabated from 558 MT in FY24 to 1,402 MT in FY50, reflecting a 151% increase due to rising freight demand and reliance on diesel. This baseline underscores the environmental cost of inaction.

- **Business-as-Usual (BAU):**

Moderate mitigation efforts result in emissions peaking at 1,141 MT in FY45 before declining to 922 MT in FY50, about 34% reduction as compared to the No Electrification scenario by FY50. The gradual adoption of Battery Electric Trucks (BETs) delays full electrification to FY55, with zero emission from vehicles will be achieved by FY70 after retiring the final diesel fleet sold in FY55.

- **Business with Support (BWS):**

Aggressive policy interventions drive emissions to peak earlier & lesser at 1,043 MT in FY40, declining to 758 MT in FY50, about 46% reduction as compared to the No Electrification scenario in FY50. Full electrification is achieved by FY46, enabling zero emission from vehicles by FY61 as the last diesel cohort (sold in FY46) is phased out by FY61.

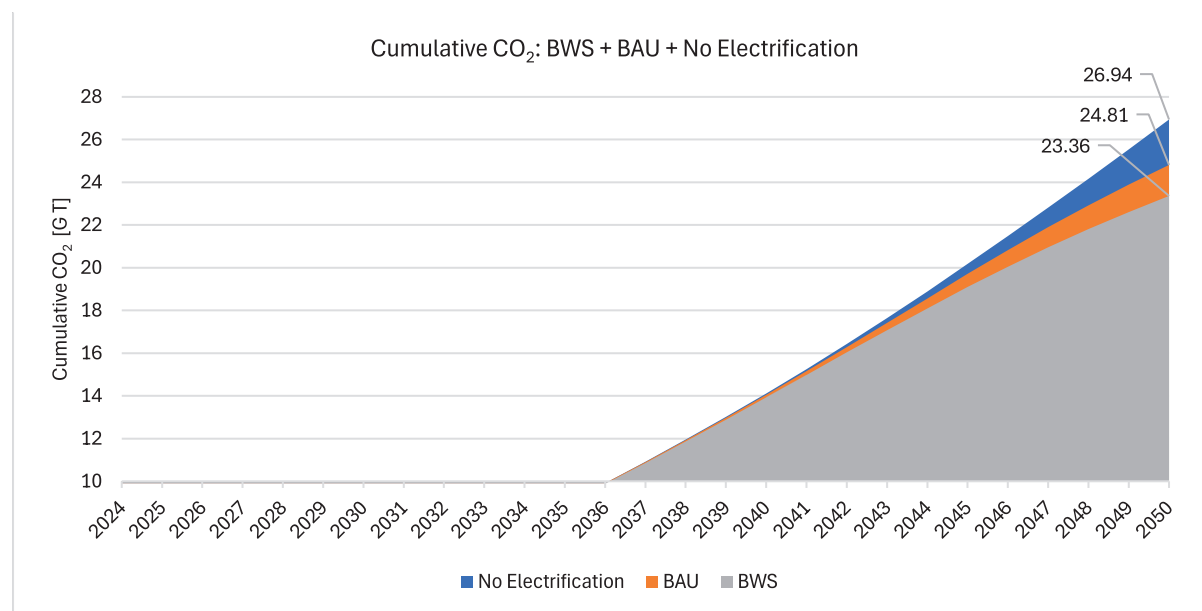
Alignment with Net-Zero Targets

- **BAU:** The 15-year operational lifespan of diesel vehicles necessitates selling the final fleet in FY55, with retirement by FY70. Emissions post-FY55 stem from legacy fleets, declining as they exit service.
- **BWS:** Accelerated BET adoption under supportive policies ensures the last diesel vehicles are sold in FY46 and retired by FY61, avoiding 9 years of residual emissions compared to BAU. As per projections and estimates, there will be about 3.5 million diesel trucks on road by 2050 which is about 30% of total population of trucks on road. These diesel trucks would go off-road progressively and retire fully by FY61 assuming that 15 years life span for trucks will be mandated by then.

4.5 Cumulative CO₂ Emissions

The electrification of Medium and Heavy-Duty Trucks (M&HDTs) is a transformative solution to reduce CO₂ emissions. The transition to Zero Emission Trucks (ZETs) significantly mitigates the environmental impact of the freight sector.

Fig 10: CO₂ Emissions: No electrification, BAU and BWS scenarios



The chart delineates annual CO₂ savings (in GTCO₂e) across three key comparisons:

1. Cumulative emission with No Electrification is estimated to be 26.94 GTCO₂e.
2. With BAU there is about 7.9% Savings (2.13 GTCO₂e) as compared to No Electrification.
3. In BWS scenario, savings in cumulative emission is about 13.3% (3.58 GTCO₂e) as compared to No Electrification.

Table 7

Financial Year	FY24 (act.)	FY30	FY40	FY50
Cum CO ₂ Emissions (from M&HDT Stock with No Electrification in Giga Tons)	0.56	4.66	14.11	26.94
Cum CO ₂ Emissions (from M&HDT Stock with BAU Scenario in Giga Tons)	0.56	4.66	14.05	24.81
Cum CO ₂ Emissions (from M&HDT Stock with BWS Scenario in Giga Tons)	0.56	4.66	13.93	23.36

Chapter 5: Fuel consumption and Savings

India's road freight sector, dominated by Medium and Heavy-Duty Trucks (M&HDTs), consumes over **25% of annual crude oil imports¹¹**, with demand projected to quadruple by FY50 (*Refer Annexure 9*). Electrifying the fleet through **Battery Electric Trucks (BETs)** offers a transformative solution to reduce diesel consumption, enhance energy security, and lower costs.

Fig 11: Annual Diesel Consumption: No electrification, BAU and BWS scenarios

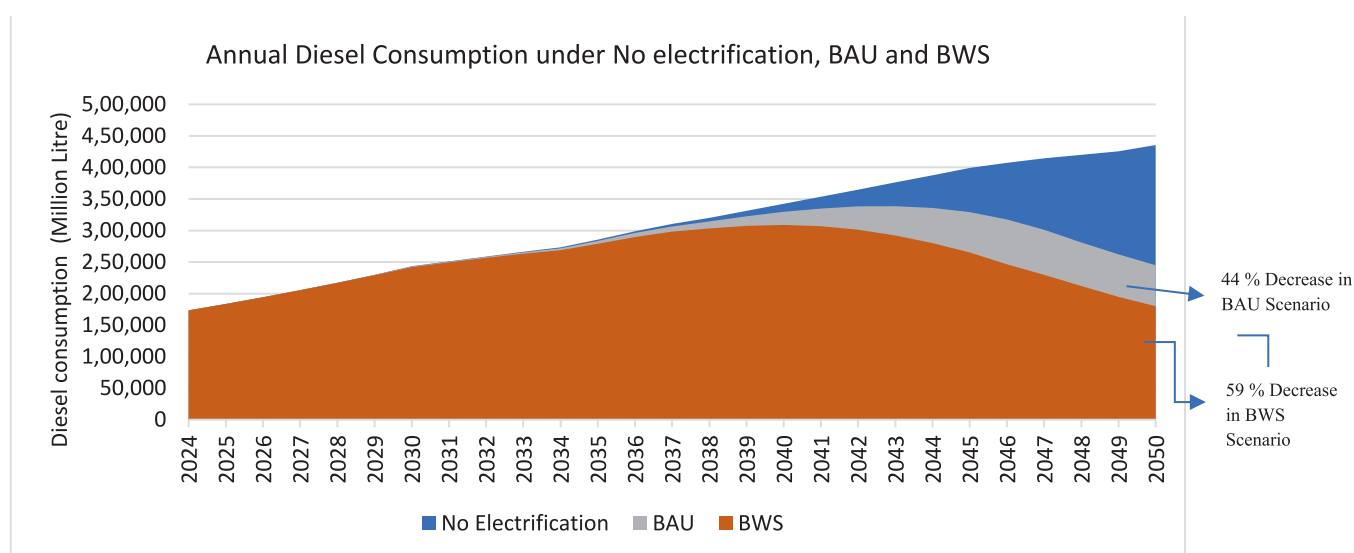


Table 8

Financial Year	FY24 (act.)	FY30	FY40	FY50
Diesel Consumption (from M&HDT Stock with No Electrification in Million Litres)	173,291	243,198	342,332	435,564
Diesel Consumption (from M&HDT Stock with BAU Scenario Million Litres)	173,291	242,917	329,716	245,025
Diesel Consumption (from M&HDT Stock with BWS Scenario Million Litres)	173,291	242,163	308,877	179,829

Impact of BET on Fuel Consumption

The chart highlights fuel consumption trends under three scenarios:

The adoption of Zero Emission Trucks (ZETs) significantly reduces fuel demand, with substantial savings observed under electrification scenarios.

¹¹ <https://www.niti.gov.in/sites/default/files/2023-02/ZETReport09092022.pdf>

BAU Scenario:

- Fuel consumption in FY51 decreases to **245,025 million litres**, saving **190,539 million litres** compared to the **No Electrification scenario** (4,35,564 million litres).
- This represents a **44% reduction**, highlighting moderate fuel savings through partial electrification and efficiency improvements.

BWS Scenario:

- Fuel consumption in FY50 drops to **179,829 million litres**, saving **255,735 million litres** compared to the **No Electrification scenario**.
- This translates to a **59% reduction**, demonstrating significant savings due to widespread electrification and advanced measures.

Reduced Fuel Cost & Import Dependency:

- Lower diesel consumption directly reduces crude oil imports, enhancing India's energy resilience and trade balance. It saves huge fuel costs for the country.
- The freight sector's efficiency gains position India as a global leader in sustainable logistics.

Electrifying the Medium and Heavy-Duty Truck (M&HDT) sector is pivotal for advancing energy independence by reducing diesel reliance, promoting domestic energy use, and ensuring long-term sustainability. By cutting diesel demand, India minimizes its exposure to global oil market fluctuations, enhancing economic stability and resilience. Zero Emission Trucks (ZETs) encourage the adoption of renewable electricity, aligning with India's clean energy objectives and reducing dependency on fossil fuels. Furthermore, lower emissions and fuel consumption directly support net-zero targets and global climate commitments, making electrification a cornerstone of sustainable energy policy.

Chapter 6: Energy Consumption by BETS

6.1 India's Power Generation Landscape

In FY24, India's power generation relies heavily on coal, with **452 GW** installed capacity, of which **46%** comes from renewable energy (RE). Total electricity generation stands at **1,828 TWh**¹², with only **21%** from RE, highlighting a coal-dominated energy mix.

Fig 12: Projected Growth and Contribution of Renewable Energy in India's Power Sector (FY24–FY50)

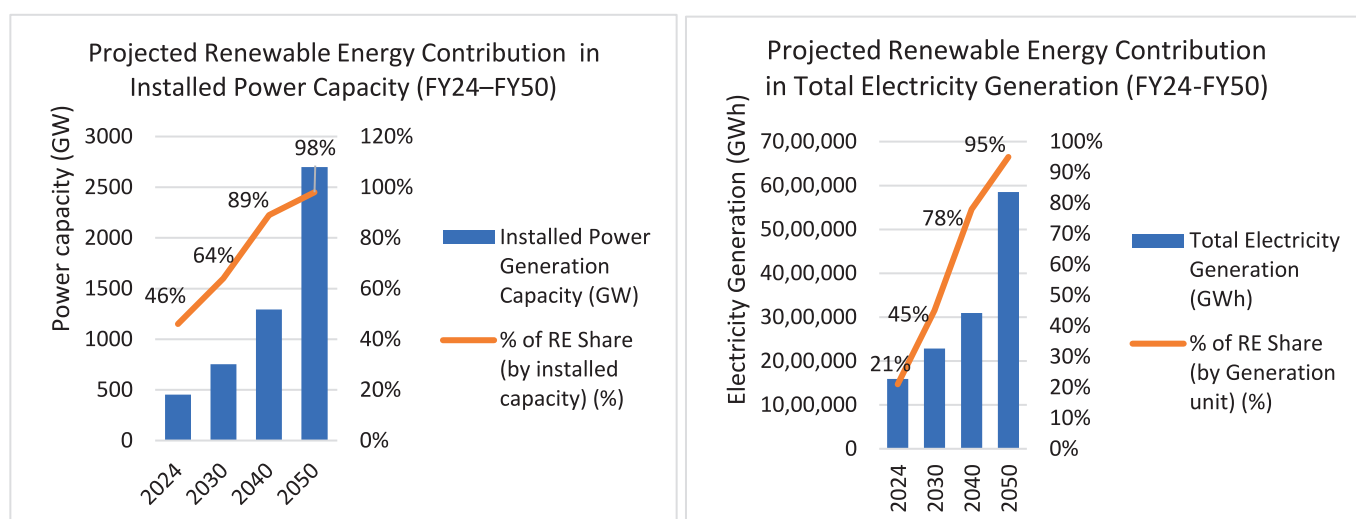


Table 9

Financial Year	Year	FY24	FY30	FY40	FY50
Installed Power Generation Capacity	GW	452	754	1,292	2,698
% of RE Share (by installed capacity)	%	46%	64%	89%	98%
Total Electricity Generation	TWh	1,828	2,365	3,601	5,330
% of RE Share (by Generation unit)	%	21%	45%	78%	95%

By FY50, India's power sector will transition to a renewable-dominated system with **2,698 GW** of installed capacity, **98%** from renewables, replacing coal. Electricity generation will rise to **5330 TWh**, with **95%** from renewables, driven by investments in solar, wind, hydro, storage, and grid advancements.

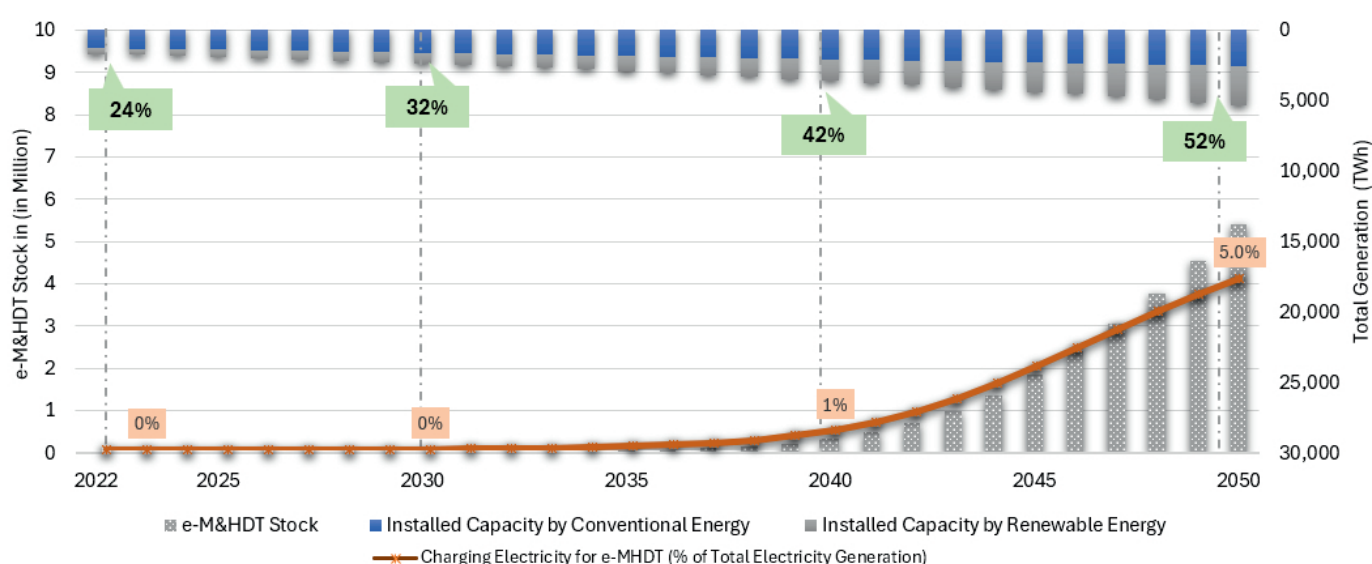
¹² [All India Electricity Statistics, 2022 published by Ministry of Power, GoI](#)

6.2 Electricity Demand Growth for e-M&HDTs

The transition to electric Medium- and Heavy-Duty Trucks (e-M&HDTs) is expected to drive a substantial increase in electricity demand. However, even under an accelerated adoption scenario, e-M&HDTs will constitute a relatively small proportion of India's overall electricity generation. This analysis examines two possible trajectories: the **BAU** scenario and the **BWS** Scenario

BAU Scenario

Fig 13: Projected e-M&HDT Stock Growth and Power Generation Capacity (FY22–FY50): Renewable vs Conventional Energy Contribution-BAU

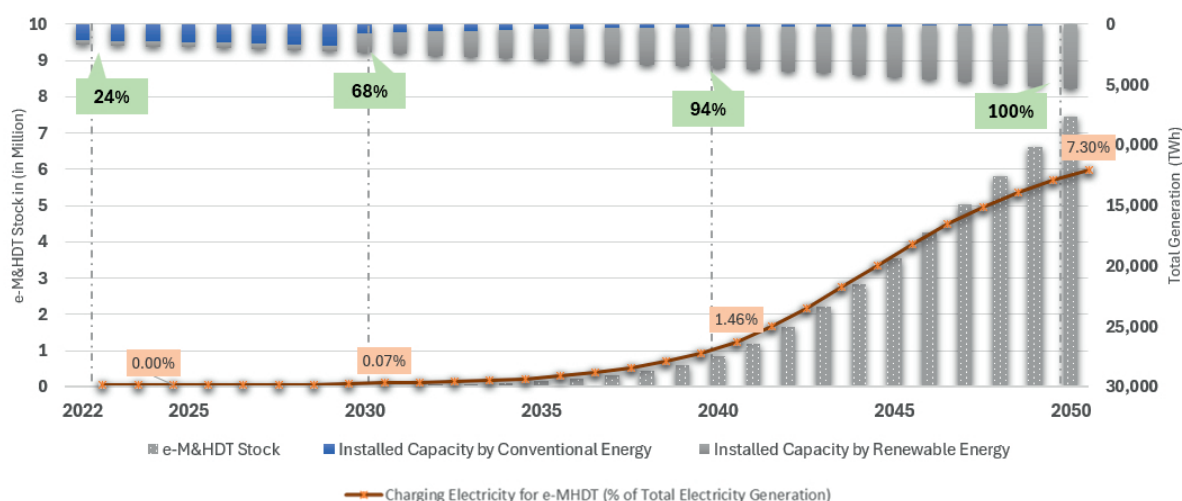


Year wise estimates and Total power generation % given in Annexure 9

- **By FY30:** The electricity demand from e-M&HDTs is projected to reach 469 GWh per year, accounting for 0.02% of total electricity generation. At this stage, market penetration remains minimal.
- **By FY40:** Demand increases to 17,576 GWh, equivalent to 1% of total electricity generation. Despite an expanding fleet, the overall share remains moderate.
- **By FY50:** The estimated demand reaches 292,717 GWh, representing 5% of total power generation. Even at peak adoption, e-M&HDTs exert a limited impact on national electricity consumption, implying manageable grid integration.

BWS Scenario

Chart 12: Projected e-M&HDT Stock Growth and Power Generation Capacity (FY22–FY50): Renewable vs Conventional Energy Contribution-BWS



Year wise estimates and Total power generation % given in Annexure 10

- **By FY30:** Demand rises to 1,533 GWh, constituting 0.07% of total electricity generation. This reflects a more rapid adoption trajectory.
- **By FY40:** e-M&HDT demand reaches 45,293 GWh, or 1.46% of total electricity generation, highlighting an accelerated electrification pace.
- **By FY50:** Demand surges to 426,711 GWh, contributing 7.3% of total electricity generation. This scenario underscores the necessity of strategic investments in renewable energy infrastructure to accommodate growing electrification needs.

Even under an ambitious electrification scenario, Battery Electric Trucks (BETs) will consume only **7.3% of India's total electricity generation by FY50**. This proportion suggests that large-scale BET integration can be effectively managed within the existing and planned energy infrastructure. As renewable energy capacity expands, e-M&HDT electrification will complement national sustainability goals without overburdening the grid, ensuring a balanced and resilient energy transition.

Chapter 7: Conclusion

The adoption of Battery Electric Trucks (BETs) presents a transformative opportunity for India's freight sector, aligning with national decarbonization goals, energy security priorities, and economic competitiveness. This report provides a comprehensive assessment of BET adoption across various truck segments, evaluating the economic, environmental, and infrastructural implications under two primary scenarios—Business As Usual (BAU) and Business with Support (BWS). The findings underscore that while organic market trends under BAU lead to a gradual transition, proactive policy interventions in the BWS scenario significantly accelerate adoption, achieving full electrification nearly a decade earlier. **To maximize these benefits, policy support under the BWS scenario should be expedited, ensuring rapid infrastructure development, cost reductions, and industry-wide adaptation.**

A key takeaway is that electrification will not only reduce India's greenhouse gas (GHG) emissions but also drive significant fuel cost savings and decrease reliance on imported crude oil. Under the BWS scenario, cumulative diesel savings by FY50 are projected to reach 255,735 million litres, translating into fuel cost reductions exceeding ₹116 lakh crore. Moreover, electrification will contribute to improved urban air quality by mitigating emissions of NO_x, SO_x, and particulate matter (PM), thereby addressing critical public health concerns.

From an energy perspective, the incremental power demand due to BET adoption remains well within the capacity expansion trajectory of India's renewable energy sector. Even under an accelerated electrification pathway, BETs are estimated to account for only 8% of total electricity demand by FY50. Given India's ambitious renewable energy deployment targets, this additional demand can be sustainably met without overburdening the national grid, reinforcing the feasibility of large-scale truck electrification.

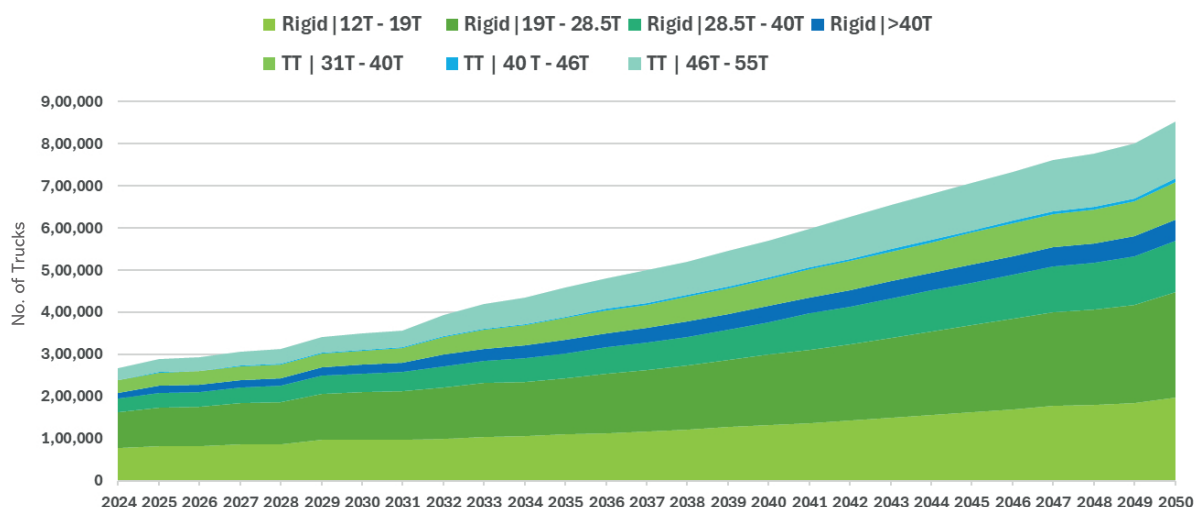
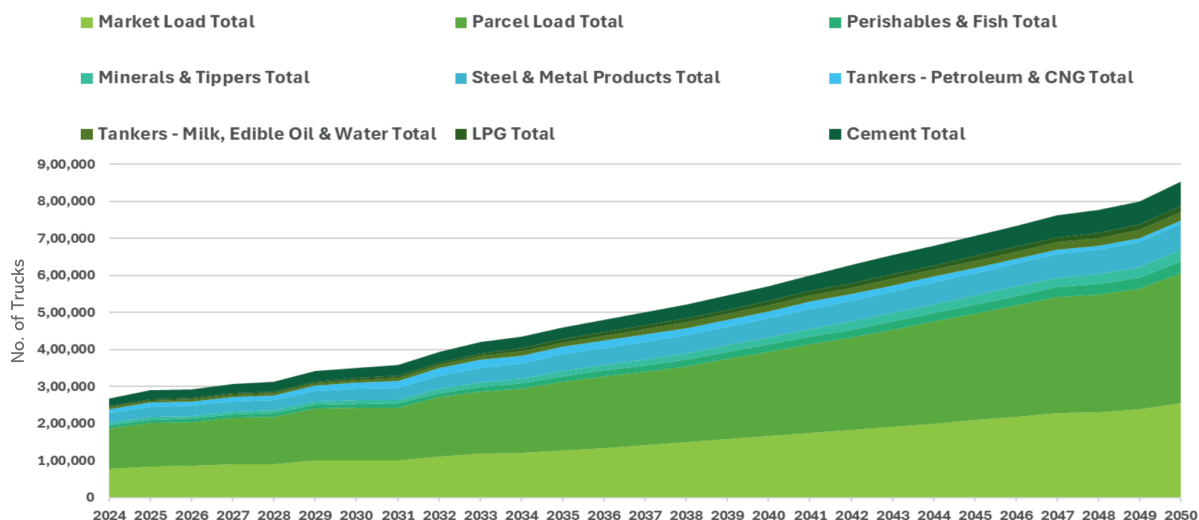
The strategic implications of these findings are clear. While technological advancements such as improvements in battery energy density and ultra-fast charging infrastructure will naturally enhance BET feasibility, policy support will be instrumental in ensuring early adoption. Key interventions such as targeted financial incentives, charging infrastructure investments, and regulatory enablers (e.g., toll waivers and fleet electrification mandates) can bridge the cost and operational barriers that currently inhibit widespread deployment.

In conclusion, transitioning to BETs is not merely an option but an imperative for India's freight transport sector. By embracing a forward-looking policy framework that supports fleet electrification, India can unlock substantial economic and environmental benefits while reinforcing its position as a global leader in sustainable logistics. This report serves as a crucial reference for policymakers, industry stakeholders, and researchers in charting a pathway toward a zero-emission trucking ecosystem, ensuring that India's freight transport sector remains resilient, cost-effective, and environmentally responsible in the decades to come.

Annexure 1 – BAU and BWS electrification year wise data

Year	Annual Sales	Electrification Numbers BAU	Electrification % BAU	Electrification Numbers BWS	Electrification % BWS
FY25	2,67,331	242	0.10%	242	0.10%
FY26	2,92,755	312	0.10%	779	0.30%
FY27	3,06,587	280	0.10%	1,503	0.50%
FY28	3,11,588	284	0.10%	2,188	0.70%
FY29	3,40,622	602	0.20%	4,210	1.20%
FY30	3,49,982	837	0.20%	7,043	2.00%
FY31	3,57,129	1,623	0.50%	15,717	4.40%
FY32	3,93,723	2,416	0.60%	26,013	6.60%
FY33	4,19,882	3,292	0.80%	37,787	9.00%
FY34	4,35,091	4,638	1.10%	52,214	12.00%
FY35	4,59,479	8,193	1.80%	74,711	16.30%
FY36	4,80,530	11,416	2.40%	1,01,420	21.10%
FY37	4,99,924	14,321	2.90%	1,27,598	25.50%
FY38	5,20,454	21,571	4.10%	1,59,261	30.60%
FY39	5,44,900	33,234	6.10%	2,13,673	39.20%
FY40	5,70,444	48,133	8.40%	2,80,287	49.10%
FY41	5,98,993	71,373	11.90%	3,67,496	61.40%
FY42	6,27,362	1,05,324	16.80%	4,56,352	72.70%
FY43	6,53,881	1,55,299	23.80%	5,53,144	84.60%
FY44	6,79,846	2,17,187	31.90%	6,32,690	93.10%
FY45	7,07,146	2,94,581	41.70%	7,01,065	99.10%
FY46	7,33,915	3,40,234	46.40%	7,33,905	100.00%
FY47	7,62,284	4,16,427	54.60%	7,62,289	100.00%
FY48	7,75,640	4,80,089	61.90%	7,75,647	100.00%
FY49	7,99,520	5,72,530	71.60%	7,99,528	100.00%
FY50	8,53,298	7,22,858	84.70%	8,53,290	100.00%

Annexure 2 – Annual sales segment mix-tonnage & Application Wise



Annexure 3 – M&HDT Application profiling:

Use cases	Characteristics	MDT 1 12 < GVW ≤ 18.5 T Rigid	MDT 2 18.5 < GVW ≤ 25 T Rigid	MDT 2 18.5 < GVW ≤ 31 T Tractor - Trailer	HDT 1 25 < GVW ≤ 40 T Rigid	HDT 2 >40 T GVW Rigid	HDT 1 31 < GTW ≤ 40 T Tractor – Trailer	HDT 2 >40 T GVW Tractor - Trailer
Market load Trucks/Parcel/FMC G (Fast moving consumer goods) 	- Carries regular/irregular shapes of goods - Performs long haul trips - Includes a mixed density payload - Has a Moderate overloading propensity - Travels at a medium speed of 40-60 kmph - Requires High Govt. Influence	✓	✓	✓	✓	✓		
Perishable Goods Trucks (including Fish and Milk) 	- Goods Deteriorate over a short-time - Have a mixed payload - Have a lower overloading propensity - Goods are Perishable & fragile - Travel at a high speed of 50-60 kmph - Require negligible Govt. Influence	✓	✓	✓				
Water Tankers 	- Designed specifically with Permanently mounted tank for transporting water - Have a greater overloading propensity - Travel at a low speed of 20-35 kmph - Require negligible Corporate / Govt. Influence - Require negligible Corporate / Govt. Influence		✓	✓	✓	✓		

Use cases	Characteristics	MDT 1 12 < GVW ≤ 18.5 T Rigid	MDT 2 18.5 < GVW ≤ 25 T Rigid	MDT 2 18.5 < GVW ≤ 31 T Tractor - Trailer	HDT 1 25 < GVW ≤ 40 T Rigid	HDT 2 >40 T GVW Rigid	HDT 1 31 < GTW ≤ 40 T Tractor – Trailer	HDT 2 >40 T GVW Tractor - Trailer
Petroleum Tankers 	- Designed specifically to transport petroleum products in bulk - Highly regulated, hazardous, and hence no overloading is allowed. Can perform always only one-way empty trips. - Travel at a medium speed of 45-55 kmph - Require high Govt. Influence		✓	✓	✓	✓		
Milk/Edible Oil Tankers 	- Mobile bulk container designed specifically to transport bulk liquid goods. - Highly regulated and hence no overloading is allowed. - Travel at a medium speed of 45-55 kmph - Require medium Corporate / Govt. Influence		✓	✓				
LPG Cylinders & Cement Bags Trucks 	- Used to transport goods from distributor to end-user (Short & Medium Haul trips) - Have a greater overloading propensity - Travel at a medium speed of 45-60 kmph - Require high Corporate / Govt. Influence	✓	✓	✓	✓	✓		

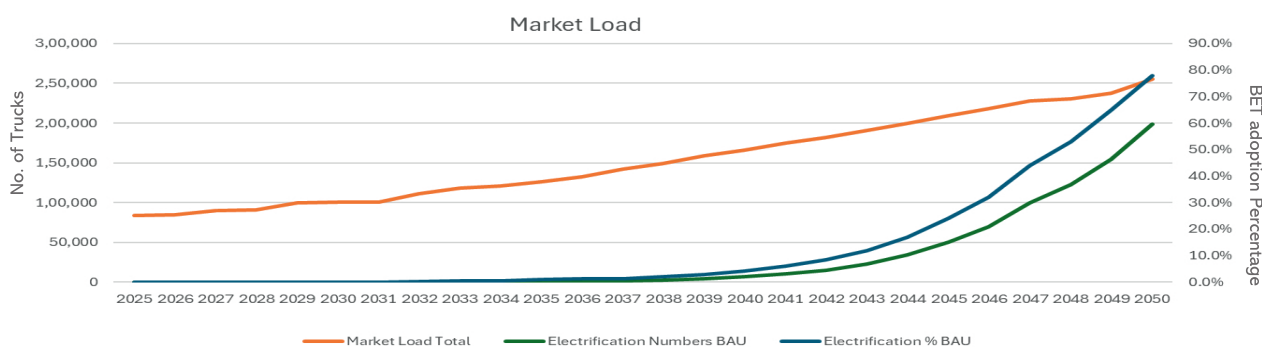
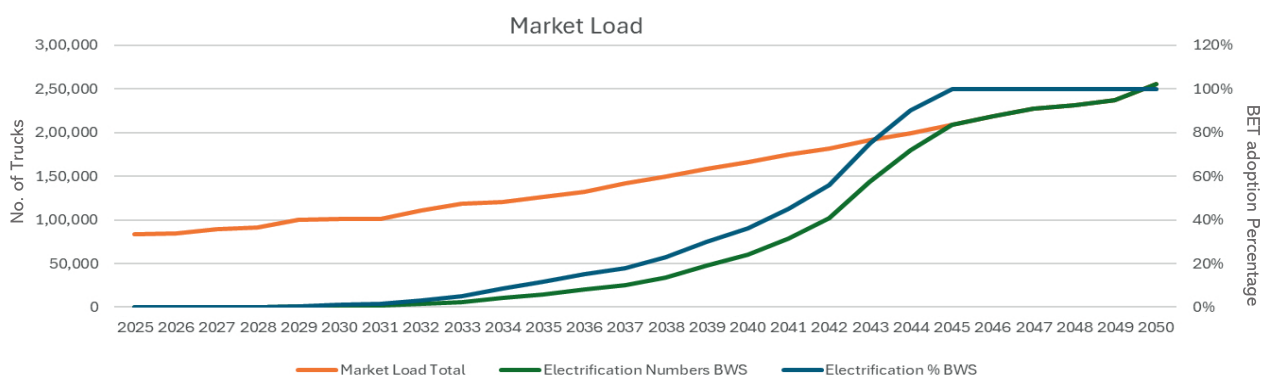
Use cases	Characteristics	MDT 1 12 < GVW ≤ 18.5 T Rigid	MDT 2 18.5 < GVW ≤ 25 T Rigid	MDT 2 18.5 < GVW ≤ 31 T Tractor - Trailer	HDT 1 25 < GVW ≤ 40 T Rigid	HDT 2 >40 T GVW Rigid	HDT 1 31 < GTW ≤ 40 T Tractor – Trailer	HDT 2 >40 T GVW Tractor - Trailer
Construction Material (steel, sand, stone, etc.) Trucks 	- Specifically used between mines/quarries to bulk transportation centres - Make Short Haul trips - Have a low propensity of overloading - Travel at a low speed of 20-30 kmph - Require low Corporate / Govt. Influence	✓	✓	✓	✓	✓		
Steel (sheet-rolls, etc.) Trucks 	- Carry Steel rolls, plates, sections & finished products (Less volume, more weight) - Make medium to long haul trips generally. - Have a greater overloading propensity - Travel at a low speed of 20-30 kmph - Require medium Govt. Influence	✓	✓	✓	✓	✓	✓	✓
LPG Bulk & Cement Bulk Trucks 	- Transport goods from factory outlets to distributors (Medium & Long-Haul trips) - NO Overloading - Carry bulk goods - Travel at a low speed of 35-45 kmph - Require medium Corporate / Govt. Influence	✓	✓	✓	✓	✓		

Use cases	Characteristics	MDT 1 12 < GVW ≤ 18.5 T Rigid	MDT 2 18.5 < GVW ≤ 25 T Rigid	MDT 2 18.5 < GVW ≤ 31 T Tractor - Trailer	HDT 1 25 < GVW ≤ 40 T Rigid	HDT 2 >40 T GVW Rigid	HDT 1 31 < GTW ≤ 40 T Tractor – Trailer	HDT 2 >40 T GVW Tractor - Trailer
Coal & Minerals Trucks 	- Specifically used between mines/quarries to bulk transportation centers - Make Short Haul trips - Have a low propensity of overloading - Travel at a low speed of 20-25 kmph - Require medium Govt. Influence	☑	☑	☑	☑	☑	☑	☑
Miscellaneous Applications 	- Transport Construction material/waste handling - Make Short Haul trips generally - Have a low propensity of overloading - Travel at a Low speed of 20-30 kmph - Require Low Corporate / Govt. Influence	☑	☑	☑	☑	☑		

Annexure 4 – Application wise Truck electrification penetration projections

1. Market Load

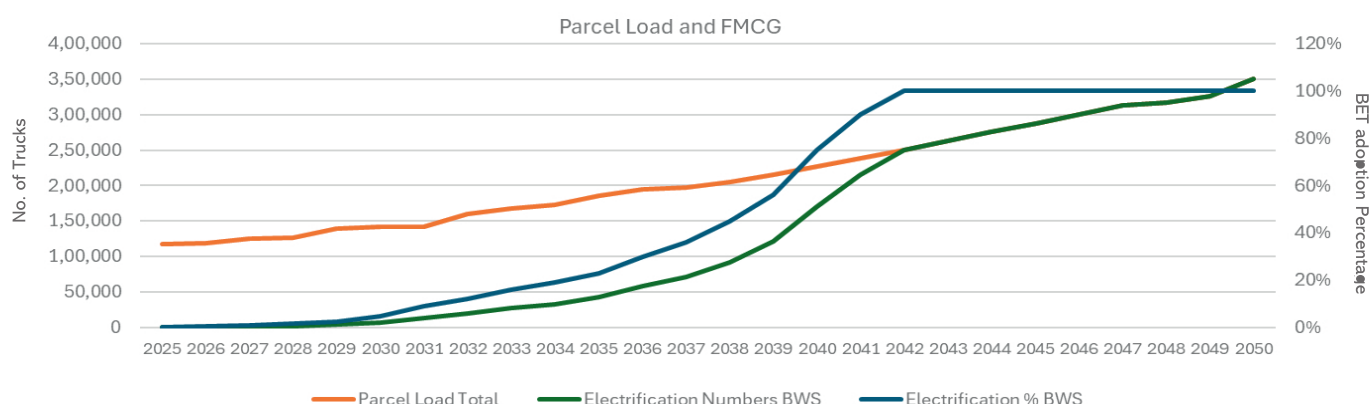
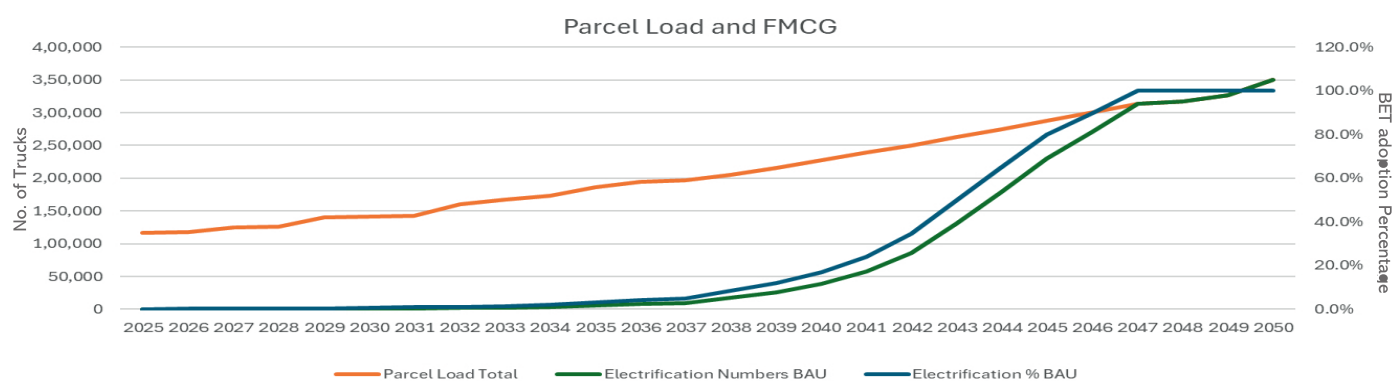
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Sales	83,506	84,913	89,581	90,830	99,813	1,00,774	1,00,882	1,11,096	1,18,193	1,20,648	1,26,555	1,32,200	1,42,190	1,49,439	1,58,773	1,66,261	1,74,404	1,81,729	1,90,988	1,99,596	2,08,874	2,18,320	2,27,548	2,30,794	2,37,358	2,55,204
Electrification Numbers BAU	74	0	0	0	0	0	102	222	473	724	1,265	1,587	1,991	2,987	4,762	6,817	10,463	15,265	22,920	33,933	50,547	69,863	1,00,121	1,22,318	1,54,309	1,98,059
Electrification % BAU	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.4%	0.6%	1.0%	1.2%	1.4%	2.0%	3.0%	4.1%	6.0%	8.4%	12.0%	17.0%	24.2%	32.0%	44.0%	53.0%	65.0%	78.0%
Electrification Numbers BSW	74	0	0	0	499	1,008	1,716	3,334	5,911	10,256	14,555	19,831	25,595	34,371	47,631	59,854	78,481	1,01,768	1,43,249	1,79,636	2,08,873	2,18,320	2,27,548	2,30,794	2,37,397	2,55,203
Electrification % BSW	0.1%	0.0%	0.0%	0.0%	0.5%	1.0%	1.7%	3.0%	5.0%	8.5%	11.5%	15.0%	18.0%	23.0%	30.0%	36.0%	45.0%	56.0%	75.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



BET adoption of Market load vehicles shows exponential growth from the year FY40 in the BAU scenario and it only reaches to 75% by FY50. While in the BWS scenario, the electrification penetration growth trend escalates from the year FY33 and reaches 100% by FY45 itself.

2. Parcel Load and FMCG

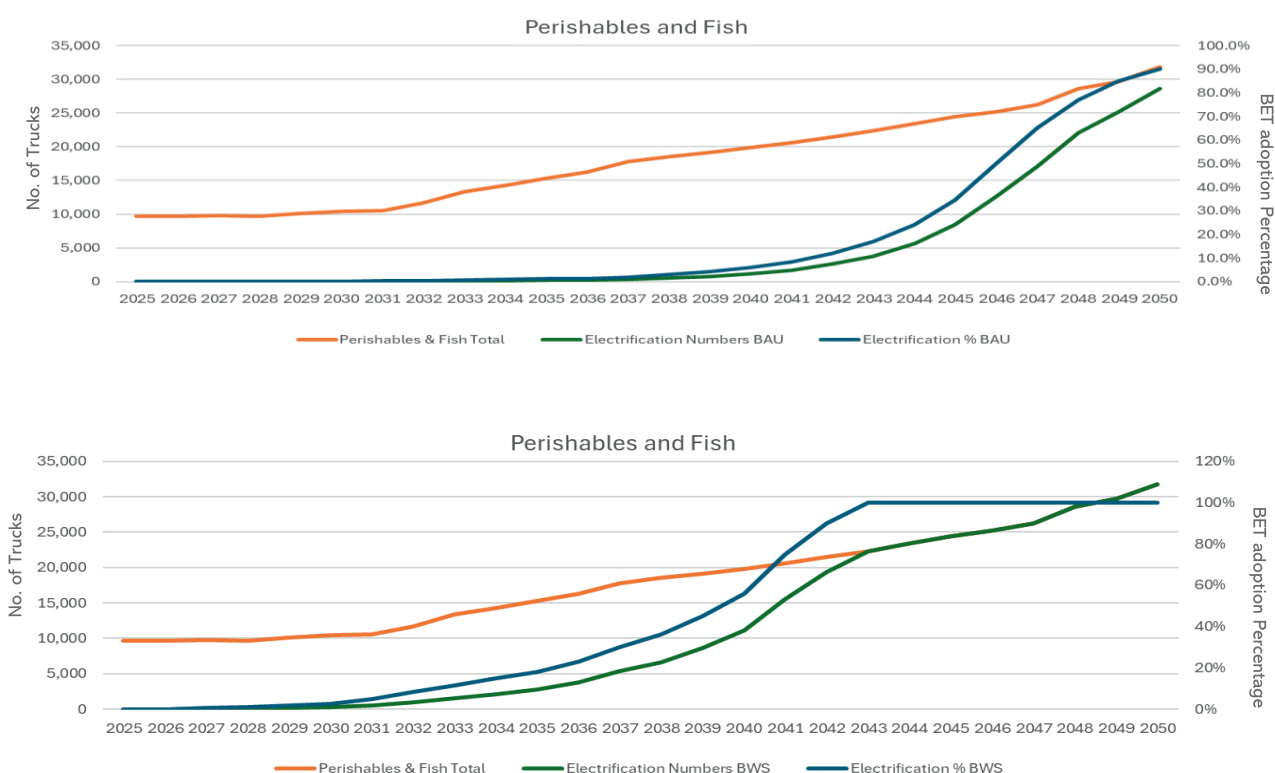
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Sales	1,17,163	1,18,181	1,25,303	1,26,724	1,39,767	1,41,910	1,42,377	1,59,824	1,67,463	1,72,962	1,85,994	1,94,268	1,96,788	2,05,055	2,15,549	2,27,192	2,38,899	2,50,260	2,62,729	2,75,238	2,87,847	3,00,885	3,13,770	3,17,518	3,26,185	3,50,365
Electrification Numbers BAU	139	236	251	253	560	851	1,424	1,919	2,345	3,460	5,581	7,966	9,839	17,224	25,867	38,622	57,814	86,589	1,31,364	1,78,904	2,30,277	2,70,797	3,13,771	3,17,519	3,26,186	3,50,365
Electrification % BAU	0.1%	0.2%	0.2%	0.2%	0.4%	0.6%	1.0%	1.2%	1.4%	2.0%	3.0%	4.1%	5.0%	8.4%	12.0%	17.0%	24.2%	34.6%	50.0%	65.0%	80.0%	90.0%	100.0%	100.0%	100.0%	100.0%
Electrification Numbers BSW	139	590	1,252	1,901	3,494	6,386	12,813	19,180	26,794	32,862	42,778	58,281	70,844	92,276	1,20,706	1,70,394	2,15,010	2,50,261	2,62,730	2,75,236	2,87,848	3,00,885	3,13,771	3,17,519	3,26,186	3,50,365
Electrification % BWS	0.1%	0.5%	1.0%	1.5%	2.5%	4.5%	9.0%	12.0%	16.0%	19.0%	23.0%	30.0%	36.0%	45.0%	56.0%	75.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



The projected electrification of Parcel Load and FMCG, being the most dominant application shows 100% electrification in the BAU Scenario in the year FY47, with its exponential growth starting in the year FY37. While that in the BWS Scenario, this major application is expected to be completely electrified in the year FY42.

3. Perishables and Fish

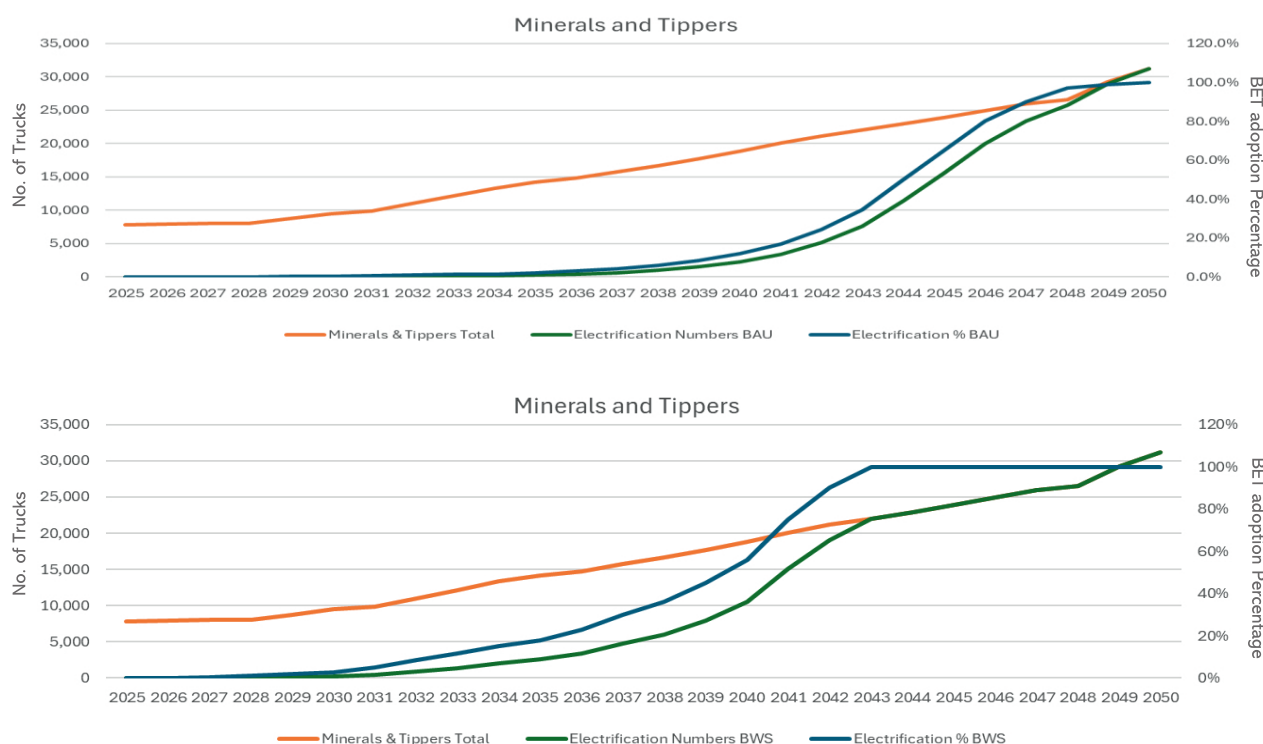
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Sales	9,674	9,695	9,759	9,699	10,128	10,421	10,516	11,680	13,352	14,249	15,331	16,287	17,763	18,506	19,098	19,833	20,621	21,470	22,333	23,417	24,446	25,211	26,261	28,606	29,668	31,798
Electrification Numbers BAU	0	0	0	0	11	21	42	47	80	144	184	228	355	556	782	1,190	1,732	2,577	3,796	5,667	8,458	12,604	17,069	22,027	25,217	28,619
Electrification % BAU	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.4%	0.4%	0.6%	1.0%	1.2%	1.4%	2.0%	3.0%	4.1%	6.0%	8.4%	12.0%	17.0%	24.2%	34.6%	50.0%	65.0%	77.0%	85.0%	90.0%
Electrification Numbers BSW	0	0	48	97	172	261	526	993	1,535	2,138	2,760	3,746	5,329	6,662	8,594	11,107	15,466	19,323	22,333	23,417	24,446	25,211	26,261	28,606	29,668	31,798
Electrification % BWS	0.0%	0.0%	0.5%	1.0%	1.7%	2.5%	5.0%	8.5%	11.5%	15.0%	18.0%	23.0%	30.0%	36.0%	45.0%	56.0%	75.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



The electrification of this application is projected to reach 100% in the year FY49, and under subsidy and Incentives implication, the electrification projection growth starts much earlier and reaches 100% by FY43.

4. Minerals and Tippers

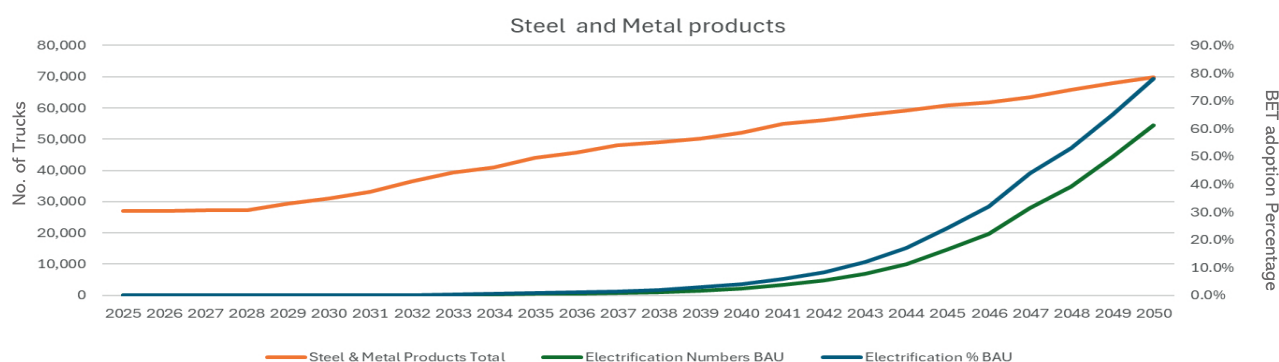
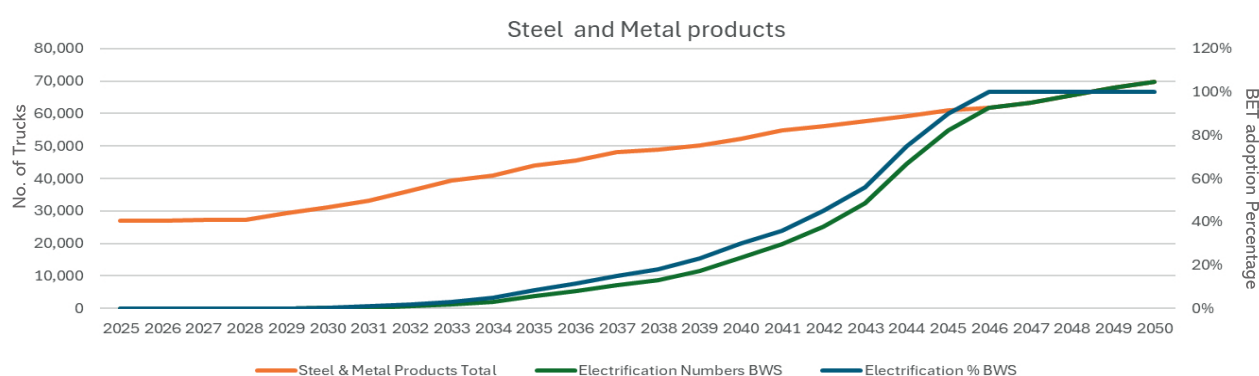
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Sales	7,809	7,908	8,006	8,032	8,762	9,496	9,848	11,027	12,159	13,313	14,198	14,783	15,707	16,663	17,676	18,801	20,095	21,138	22,040	22,943	23,877	24,925	26,002	26,537	29,216	31,164
Electrification Numbers BAU	0	0	0	8	18	39	58	111	147	186	285	444	643	1,000	1,486	2,256	3,416	5,114	7,626	11,472	15,520	19,941	23,402	25,742	28,925	31,163
Electrification % BAU	0.0%	0.0%	0.0%	0.1%	0.2%	0.4%	0.6%	1.0%	1.2%	1.4%	2.0%	3.0%	4.1%	6.0%	8.4%	12.0%	17.0%	24.2%	34.6%	50.0%	65.0%	80.0%	90.0%	97.0%	99.0%	100.0%
Electrification Numbers BSW	0	0	40	79	150	239	493	938	1,399	1,998	2,556	3,400	4,712	5,999	7,954	10,529	15,072	19,023	22,040	22,942	23,877	24,924	26,002	26,537	29,217	31,163
Electrification % BWS	0.0%	0.0%	0.5%	1.0%	1.7%	2.5%	5.0%	8.5%	11.5%	15.0%	18.0%	23.0%	30.0%	36.0%	45.0%	56.0%	75.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



The combined applications Minerals and On-Road Tippers show 100% electrification projection in the year FY50. To bring this year earlier, a BWS scenario is created with additional incentives. With government policies and subsidies, the electrification is projected to be 100% in the year FY43.

5. Steel and Metal Finished Products

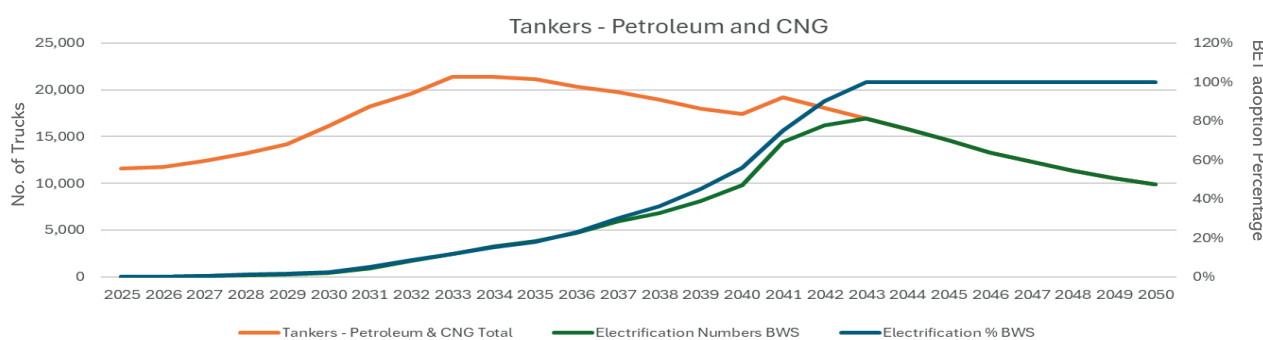
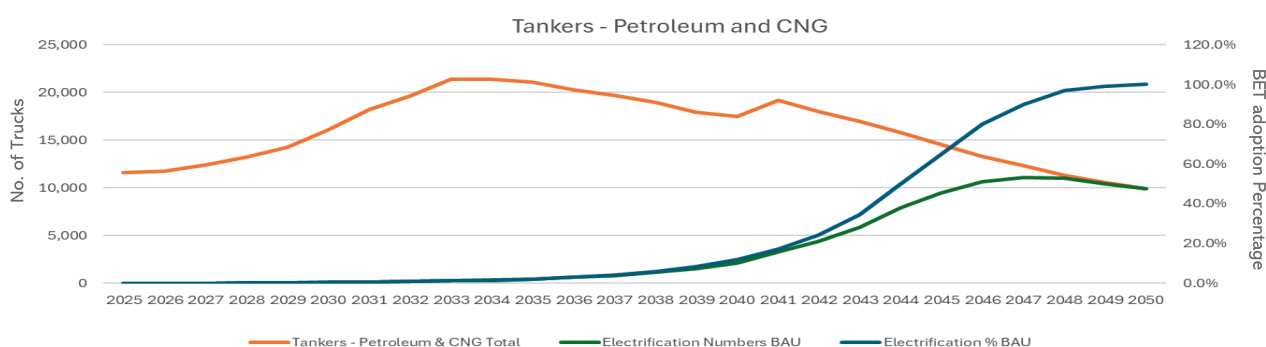
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Sales	27,050	27,062	27,139	27,262	29,312	31,139	33,178	36,386	39,286	41,039	43,966	45,622	48,159	48,899	50,213	52,180	54,838	56,129	57,661	59,237	60,892	61,784	63,415	65,726	68,033	69,851
Electrification Numbers BAU	7	0	0	0	0	0	33	73	157	246	439	548	675	976	1,507	2,140	3,290	4,714	6,919	10,070	14,736	19,771	27,901	34,836	44,222	54,483
Electrification % BAU	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.4%	0.6%	1.0%	1.2%	1.4%	2.0%	3.0%	4.1%	6.0%	8.4%	12.0%	17.0%	24.2%	32.0%	44.0%	53.0%	65.0%	78.0%
Electrification Numbers BSW	7	0	0	0	0	156	331	619	1,179	2,051	3,738	5,247	7,224	8,802	11,548	15,655	19,742	25,259	32,290	44,428	54,803	61,785	63,415	65,726	68,033	69,851
Electrification % BWS	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	1.0%	1.7%	3.0%	5.0%	8.5%	11.5%	15.0%	18.0%	23.0%	30.0%	36.0%	45.0%	56.0%	75.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%



The Steel and Metal Finished Products typically are Heavy Duty Vehicles and hence the electrification needs to be achieved early. But in the BAU scenario, it only reaches 78% electrification by the year FY50. And in the BWS scenario, the electrification condition looks better by reaching 100% in the year FY46.

6. Tankers Petroleum and CNG

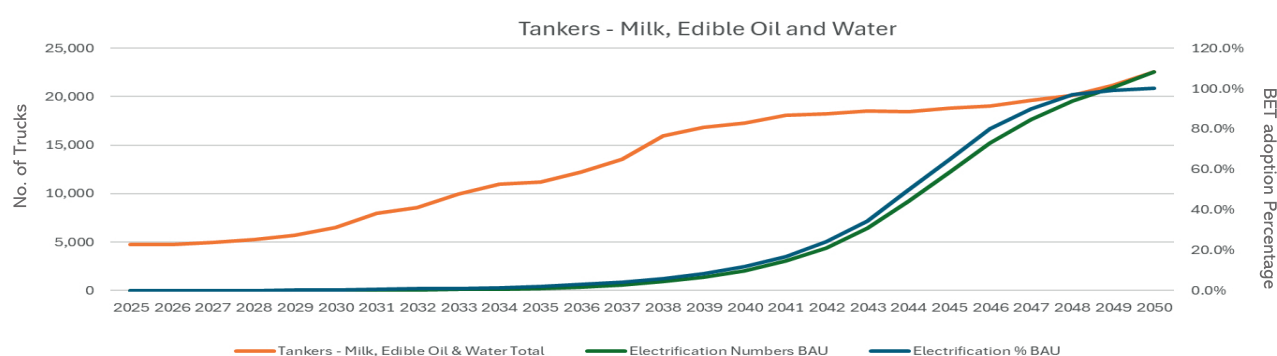
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Sales	11,574	11,719	12,369	13,231	14,210	16,090	18,189	19,585	21,408	21,360	21,128	20,306	19,729	18,928	17,955	17,448	19,168	18,033	16,947	15,763	14,549	13,253	12,342	11,329	10,554	9,880
Electrification Numbers BAU	0	0	0	13	29	64	109	196	257	298	422	609	809	1,134	1,508	2,094	3,259	4,363	5,864	7,881	9,457	10,604	11,108	10,989	10,448	9,880
Electrification % BAU	0.0%	0.0%	0.0%	0.1%	0.2%	0.4%	0.6%	1.0%	1.2%	1.4%	2.0%	3.0%	4.1%	6.0%	8.4%	12.0%	17.0%	24.2%	34.6%	50.0%	65.0%	80.0%	90.0%	97.0%	99.0%	100.0%
Electrification Numbers BSW	0	0	63	132	242	404	910	1,666	2,461	3,204	3,802	4,670	5,920	6,813	8,080	9,771	14,377	16,229	16,947	15,764	14,549	13,253	12,342	11,330	10,554	9,880
Electrification % BWS	0.0%	0.0%	0.5%	1.0%	1.7%	2.5%	5.0%	8.5%	11.5%	15.0%	18.0%	23.0%	30.0%	36.0%	45.0%	56.0%	75.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



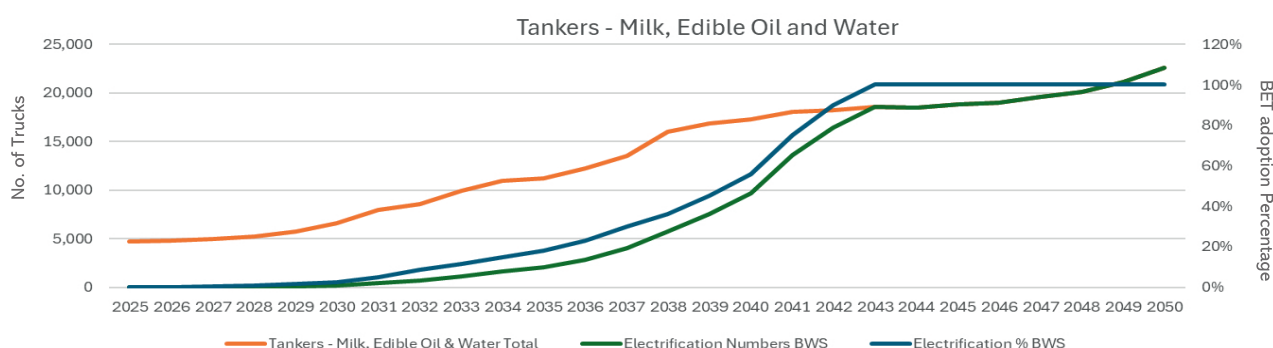
The Petroleum and CNG Tankers show a decline in sales, but it reaches electrification in the year FY50 in BAU scenario. But in the BWS scenario, it reaches 100% electrification in the year FY43.

7. Tankers – Milk, Edible Oil and Water

Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Sales	4,730	4,785	4,945	5,235	5,720	6,550	7,977	8,563	9,941	10,989	11,215	12,205	13,546	15,962	16,814	17,261	18,080	18,249	18,531	18,484	18,814	19,023	19,624	20,141	21,155	22,572
Electrification Numbers BAU	0	0	0	7	11	27	48	85	119	154	225	366	555	957	1,414	2,072	3,074	4,416	6,412	9,242	12,229	15,218	17,661	19,535	20,943	22,572
Electrification % BAU	0.0%	0.0%	0.0%	0.1%	0.2%	0.4%	0.6%	1.0%	1.2%	1.4%	2.0%	3.0%	4.1%	6.0%	8.4%	12.0%	17.0%	24.2%	34.6%	50.0%	65.0%	80.0%	90.0%	97.0%	99.0%	100.0%
Electrification Numbers BSW	0	0	24	52	97	163	398	728	1,142	1,648	2,019	2,808	4,064	5,747	7,566	9,666	13,560	16,423	18,531	18,483	18,814	19,022	19,626	20,141	21,155	22,572
Electrification % BWS	0.0%	0.0%	0.5%	1.0%	1.7%	2.5%	5.0%	8.5%	11.5%	15.0%	18.0%	23.0%	30.0%	36.0%	45.0%	56.0%	75.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



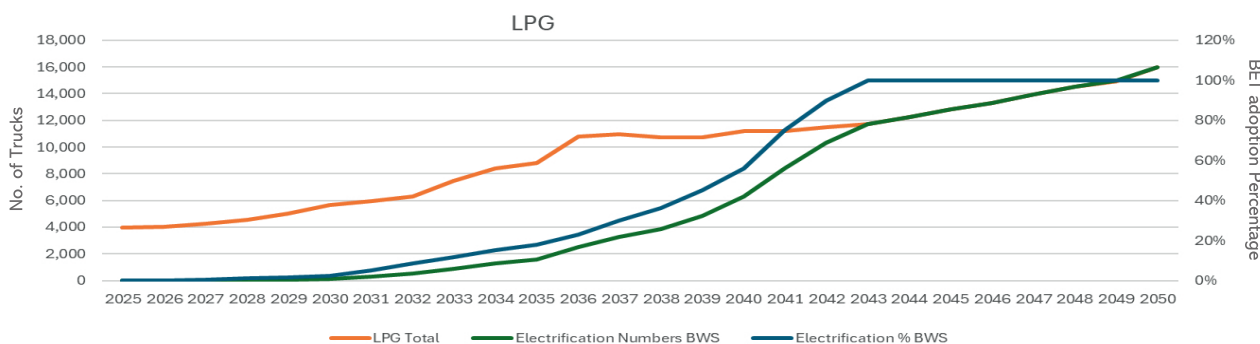
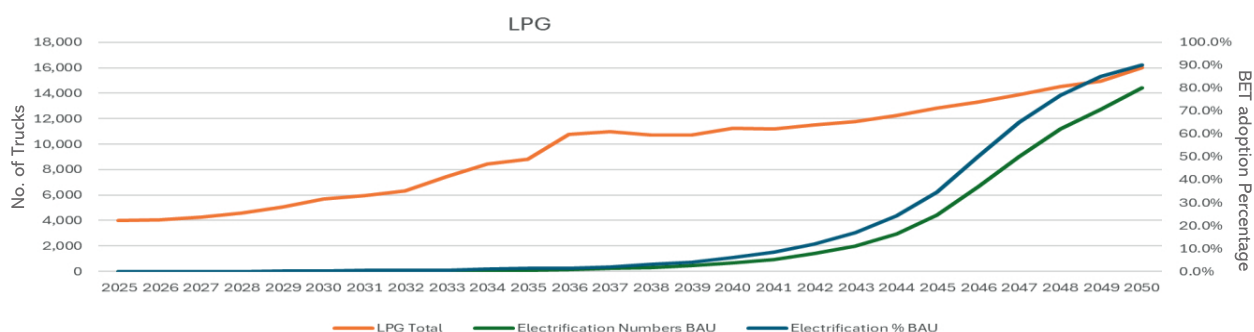
The Milk, Edible Oil and Water Tankers slowly increases the electrification penetration from the year FY39,



and is fully electrified by the year FY50 in the BAU scenario. But after application of incentives and subsidies, the electrification is projected to start in FY30 and reaches 100% in the year FY43.

8. LPG

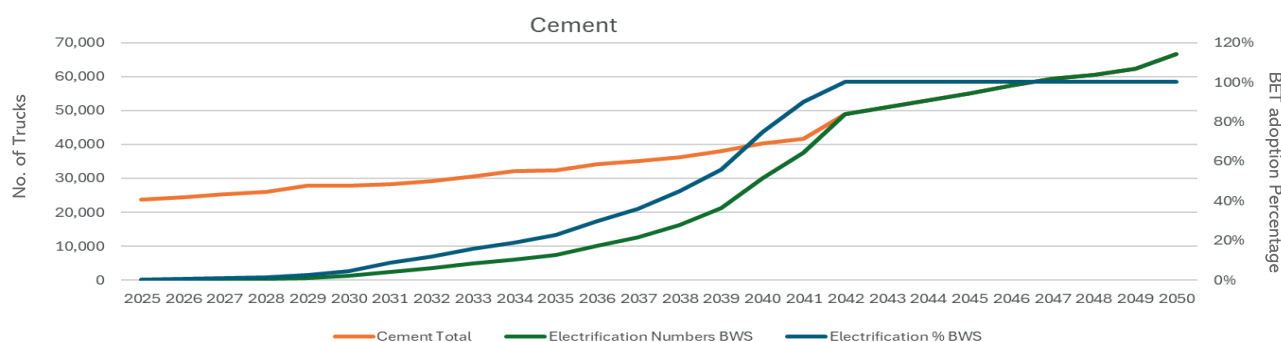
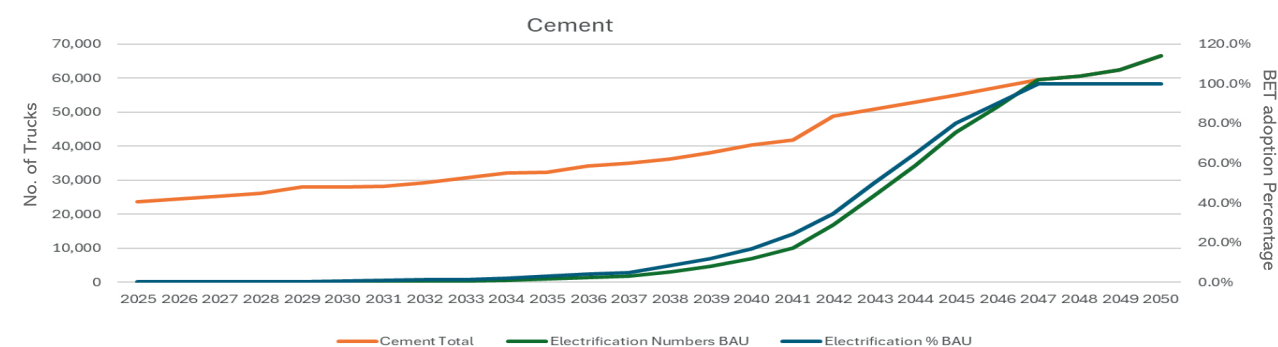
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Sales	3,985	4,042	4,245	4,570	5,040	5,680	5,964	6,308	7,460	8,415	8,834	10,787	10,978	10,724	10,737	11,223	11,192	11,499	11,749	12,235	12,802	13,307	13,908	14,507	14,957	16,003
Electrification Numbers BAU	0	0	0	0	4	11	23	25	43	84	107	152	219	321	440	674	942	1,380	1,998	2,961	4,429	6,654	9,040	11,169	12,714	14,402
Electrification % BAU	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.4%	0.4%	0.6%	1.0%	1.2%	1.4%	2.0%	3.0%	4.1%	6.0%	8.4%	12.0%	17.0%	24.2%	34.6%	50.0%	65.0%	77.0%	85.0%	90.0%
Electrification Numbers BSW	0	0	20	46	86	142	299	536	858	1,264	1,591	2,481	3,294	3,860	4,831	6,286	8,394	10,347	11,749	12,235	12,802	13,307	13,908	14,507	14,957	16,003
Electrification % BWS	0.0%	0.0%	0.5%	1.0%	1.7%	2.5%	5.0%	8.5%	11.5%	15.0%	18.0%	23.0%	30.0%	36.0%	45.0%	56.0%	75.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



The LPG application is slower when it comes to electrification adoption as projected in the BAU scenario. But with the BWS scenario, the initial costs are lowered down, bringing the electrification feasibility earlier and faster. The Electrification shows an exponential growth from the year FY33 and reaches 100% in the year FY43.

9. Cement

Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Sales	23,681	24,450	25,242	26,004	27,870	27,921	28,188	29,267	30,610	32,103	32,266	34,073	35,061	36,278	38,082	40,241	41,706	48,846	50,898	52,934	55,051	57,198	59,417	60,487	62,362	66,540
Electrification Numbers BAU	22	50	51	51	111	168	282	351	429	642	968	1,397	1,753	3,048	4,569	6,840	10,092	16,901	25,449	34,408	44,040	51,478	59,418	60,488	62,362	66,541
Electrification % BAU	0.1%	0.2%	0.2%	0.2%	0.4%	0.6%	1.0%	1.2%	1.4%	2.0%	3.0%	4.1%	5.0%	8.4%	12.0%	17.0%	24.2%	34.6%	50.0%	65.0%	80.0%	90.0%	100.0%	100.0%	100.0%	100.0%
Electrification Numbers BSW	22	121	253	390	697	1,256	2,538	3,511	4,897	6,099	7,423	10,221	12,622	16,324	21,327	30,180	37,536	48,846	50,897	52,934	55,051	57,198	59,418	60,488	62,362	66,541
Electrification % BWS	0.1%	0.5%	1.0%	1.5%	2.5%	4.5%	9.0%	12.0%	16.0%	19.0%	23.0%	30.0%	36.0%	45.0%	56.0%	75.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

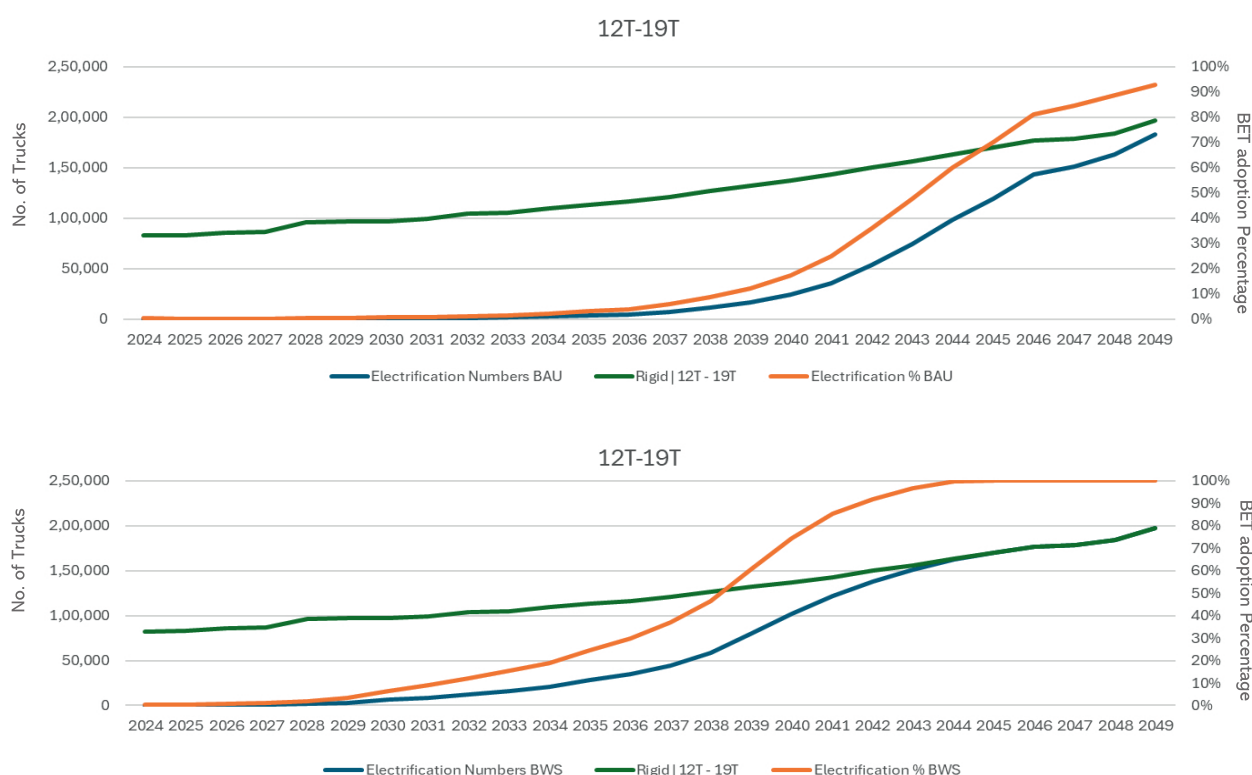


Cement applications, typically heavy duty vehicles have a higher freight on road and higher GHG emissions. The Electrification penetration for BAU scenario is projected in the year FY47.

Annexure 5 – Tonnage wise Truck electrification penetration projections

1. Rigid 12T – 19T

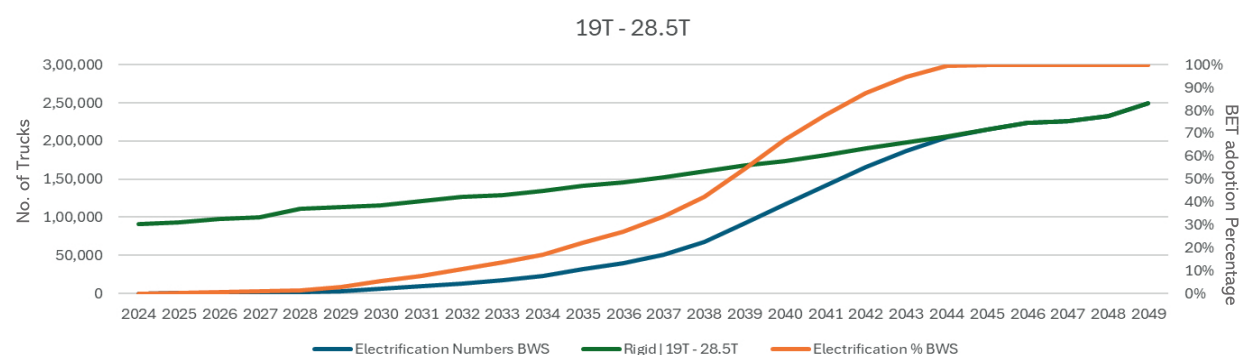
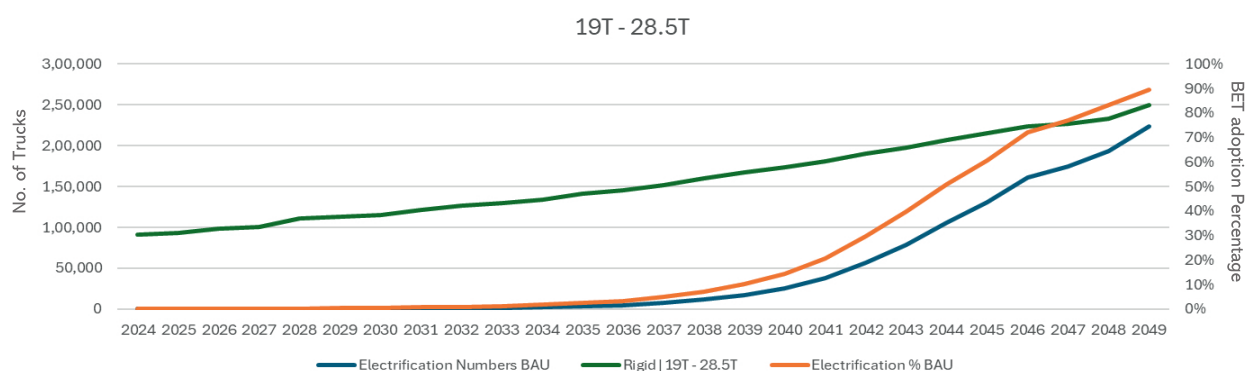
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
	82,492	82,704	85,618	86,459	95,912	96,985	97,053	99,549	1,04,145	1,04,903	1,09,569	1,13,276	1,16,183	1,21,071	1,26,723	1,32,171	1,37,086	1,43,109	1,49,792	1,56,292	1,63,127	1,69,926	1,76,570	1,79,017	1,84,114	1,97,077
Electrification Numbers BAU	180	97	101	108	245	380	655	854	1,093	1,571	2,471	3,433	4,281	7,256	10,900	16,155	23,903	35,661	53,842	74,451	98,007	1,19,017	1,42,949	1,51,411	1,63,276	1,83,076
Electrification % BAU	0.2%	0.1%	0.1%	0.1%	0.3%	0.4%	0.7%	0.9%	1.0%	1.5%	2.3%	3.0%	3.7%	6.0%	8.6%	12.2%	17.4%	24.9%	35.9%	47.6%	60.1%	70.0%	81.0%	84.6%	88.7%	92.9%
Electrification Numbers BWS	180	242	555	864	1,725	3,117	6,126	8,841	12,598	16,077	20,750	27,926	34,564	44,839	58,969	80,382	1,02,091	1,22,205	1,37,791	1,50,983	1,62,689	1,69,926	1,76,570	1,79,017	1,84,114	1,97,076
Electrification % BWS	0.2%	0.3%	0.6%	1.0%	1.8%	3.2%	6.3%	8.9%	12.1%	15.3%	18.9%	24.7%	29.7%	37.0%	46.5%	60.8%	74.5%	85.4%	92.0%	96.6%	99.7%	100.0%	100.0%	100.0%	100.0%	100.0%



In the BAU scenario (top chart), electrification grows steadily, with a moderate increase in both total numbers and percentage penetration. By FY50, electrification reaches around 90% in percentage terms. In the BWS scenario (bottom chart), electrification accelerates faster due to supportive policies and incentives, with penetration reaching 100% by FY46.

2. Rigid 19T – 28.5T

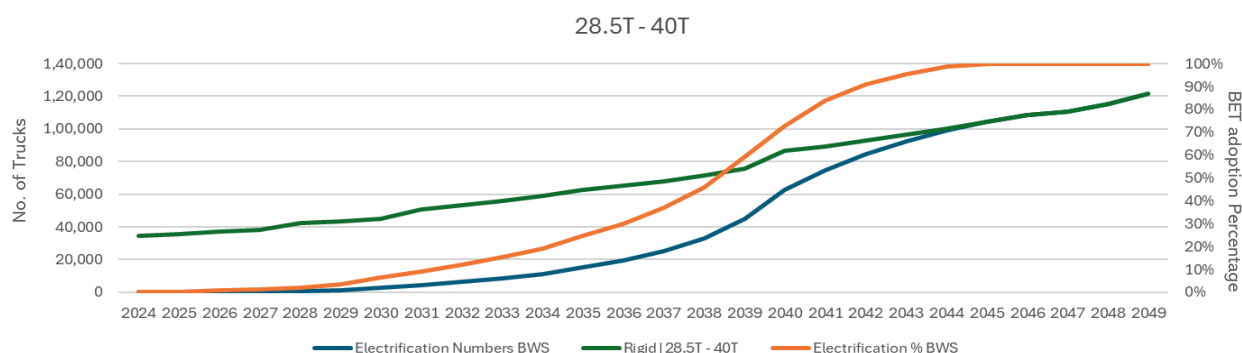
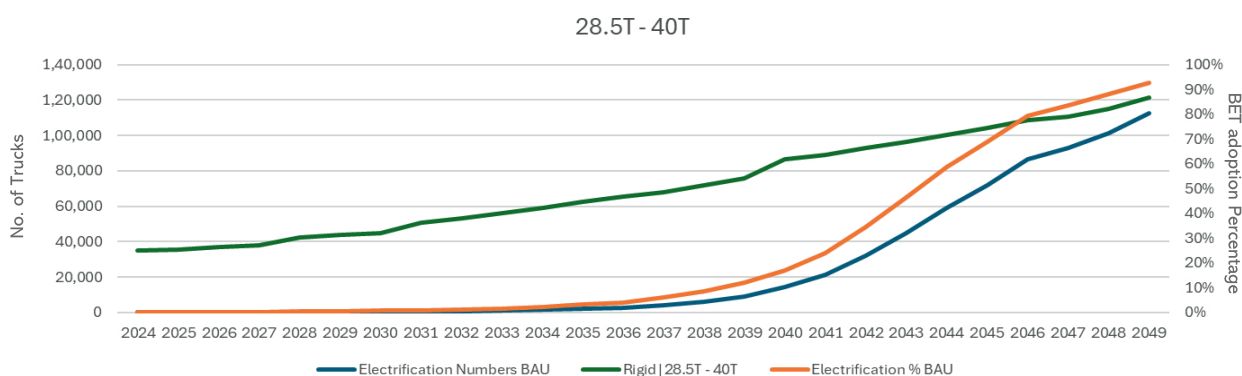
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
	91,486	93,058	98,307	1,00,245	1,10,621	1,13,128	1,15,317	1,21,578	1,27,010	1,29,418	1,34,236	1,40,783	1,45,770	1,52,060	1,59,808	1,67,779	1,73,686	1,81,198	1,89,938	1,98,018	2,06,472	2,14,888	2,23,326	2,26,604	2,32,625	2,50,080
Electrification Numbers BAU	0	86	91	98	217	342	629	864	1,153	1,668	2,615	3,644	4,585	7,636	11,510	17,112	25,196	37,520	56,662	78,982	1,05,323	1,30,409	1,60,689	1,74,732	1,93,478	2,23,580
Electrification % BAU	0.0%	0.1%	0.1%	0.1%	0.2%	0.3%	0.5%	0.7%	0.9%	1.3%	1.9%	2.6%	3.1%	5.0%	7.2%	10.2%	14.5%	20.7%	29.8%	39.9%	51.0%	60.7%	72.0%	77.1%	83.2%	89.4%
Electrification Numbers BWS	0	214	511	812	1,667	3,052	6,070	9,214	13,367	17,737	23,016	31,427	39,296	51,146	67,740	91,715	1,16,612	1,41,604	1,66,130	1,87,227	2,05,225	2,14,888	2,23,326	2,26,604	2,32,625	2,50,080
Electrification % BWS	0.0%	0.2%	0.5%	0.8%	1.5%	2.7%	5.3%	7.6%	10.5%	13.7%	17.1%	22.3%	27.0%	33.6%	42.4%	54.7%	67.1%	78.1%	87.5%	94.5%	99.4%	100.0%	100.0%	100.0%	100.0%	100.0%



In the BAU scenario, electrification numbers and percentages gradually increase, reaching around 90% electrification by FY50. In the BWS scenario, the electrification percentage accelerates more quickly, reaching 100% by FY46. This suggests a significant increase in adoption, especially under the BWS scenario, with faster penetration rates compared to BAU.

3. Rigid 28.5T – 40T

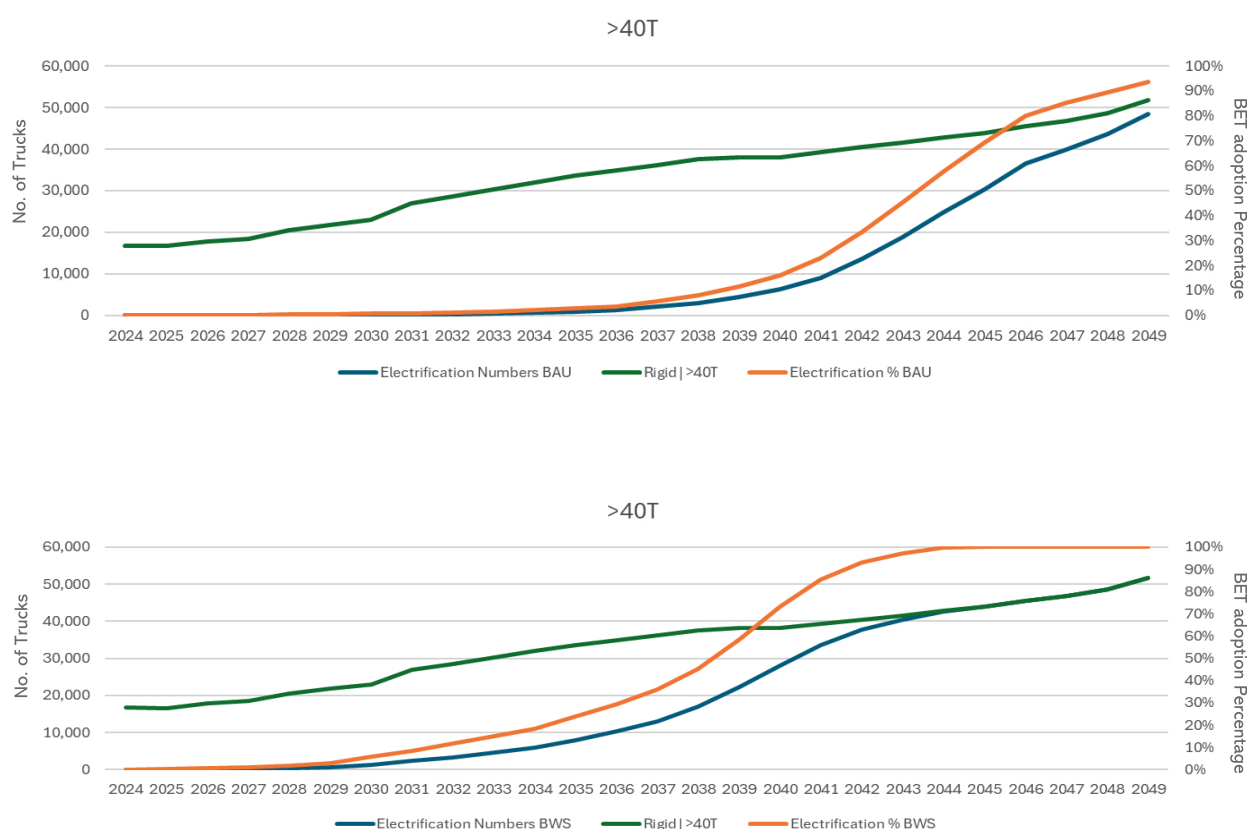
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
	34,813	35,426	37,016	38,104	42,415	43,583	44,869	50,912	53,105	55,870	58,857	62,582	65,512	68,119	71,811	75,915	86,564	89,227	92,925	96,647	1,00,346	1,04,177	1,08,718	1,10,828	1,15,075	1,21,650
Electrification Numbers BAU	0	42	45	53	118	189	325	455	579	847	1,334	1,927	2,486	4,114	6,134	9,068	14,584	21,454	32,152	44,794	58,954	71,916	86,457	92,768	1,01,351	1,12,643
Electrification % BAU	0.0%	0.1%	0.1%	0.1%	0.2%	0.4%	0.7%	0.8%	1.0%	1.4%	2.0%	2.8%	3.5%	5.7%	8.0%	11.0%	14.4%	20.8%	32.4%	43.3%	55.0%	64.8%	74.2%	79.5%	83.7%	84.5%
Electrification Numbers BWS	0	105	265	427	818	1,471	2,959	4,583	6,477	8,579	11,171	15,400	19,662	25,154	33,058	45,034	62,825	74,895	84,382	92,254	99,227	1,04,178	1,08,718	1,10,830	1,15,074	1,21,648
Electrification % BWS	0.0%	0.3%	0.7%	1.1%	1.9%	3.4%	6.6%	9.0%	12.2%	15.4%	19.0%	24.6%	30.0%	36.9%	46.0%	59.3%	72.6%	83.9%	90.8%	95.5%	98.9%	100.0%	100.0%	100.0%	100.0%	100.0%



BAU (Business as Usual) and BWS (Business With Support). In the BAU scenario, both the electrification numbers and percentage steadily increase, with the electrification percentage approaching 85% by FY50. The BWS scenario reflects a faster rate of electrification, with the percentage reaching 100% by FY45. This suggests that the BWS scenario supports more rapid adoption, while the BAU scenario shows a slower but steady increase in electric vehicle penetration within this weight segment.

4. Rigid > 40T

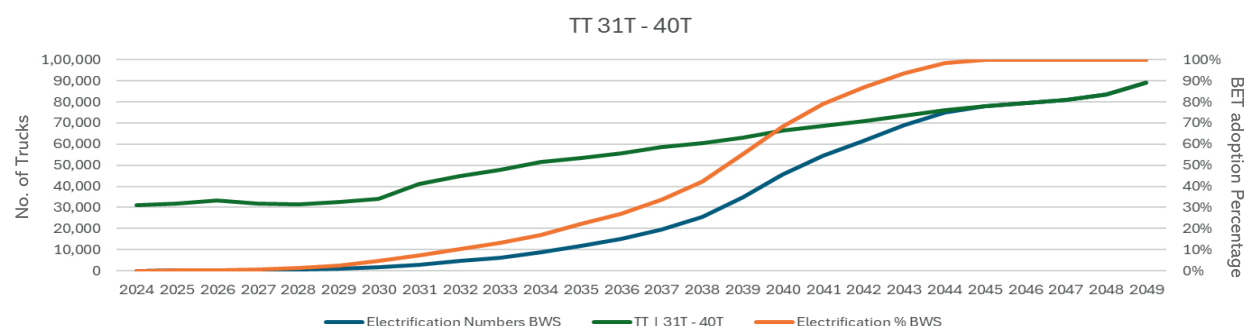
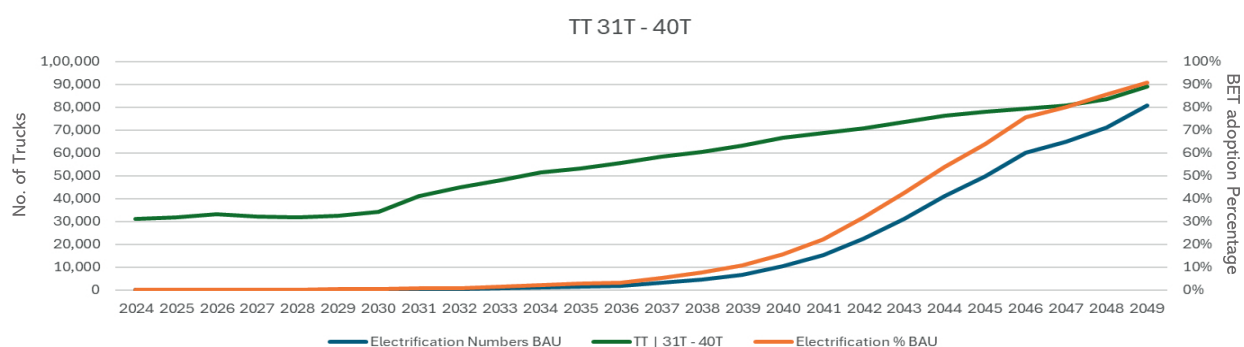
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
	16,697	16,623	17,822	18,472	20,418	21,758	23,031	26,919	28,558	30,230	31,964	33,595	34,953	36,111	37,539	38,101	38,114	39,251	40,453	41,549	42,749	43,925	45,604	46,793	48,658	51,694
Electrification Numbers BAU	0	14	16	22	48	82	145	225	295	425	662	953	1,257	2,035	3,011	4,362	6,174	9,083	13,501	18,820	24,773	30,382	36,537	39,840	43,604	48,376
Electrification % BAU	0.0%	0.1%	0.1%	0.1%	0.2%	0.3%	0.6%	0.7%	0.9%	1.3%	1.9%	2.6%	3.3%	5.3%	7.5%	10.8%	16.0%	22.7%	31.5%	42.8%	54.9%	65.7%	75.5%	80.3%	84.1%	84.7%
Electrification Numbers BWS	0	35	109	183	356	639	1,335	2,292	3,314	4,491	5,837	7,959	10,274	13,026	16,988	22,272	27,946	33,524	37,737	40,336	42,597	43,925	45,604	46,794	48,657	51,695
Electrification % BWS	0.0%	0.2%	0.6%	1.0%	1.7%	2.9%	5.8%	8.5%	11.6%	14.9%	18.3%	23.7%	29.4%	36.1%	45.3%	58.5%	73.3%	85.4%	93.3%	97.1%	99.6%	100.0%	100.0%	100.0%	100.0%	100.0%



The above graphs show significant difference in the BAU and BWS scenarios for electrification penetration. The electrification is slower and reaches 85% in the year FY50 in the BAU scenario. In BWS scenario, the electrification raises earlier and reaches 100% in FY46.

5. TT 31T – 40T

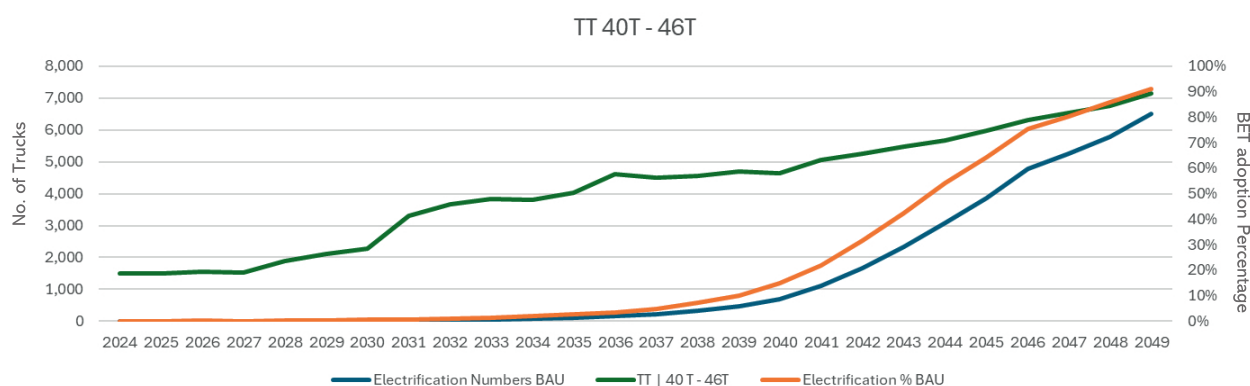
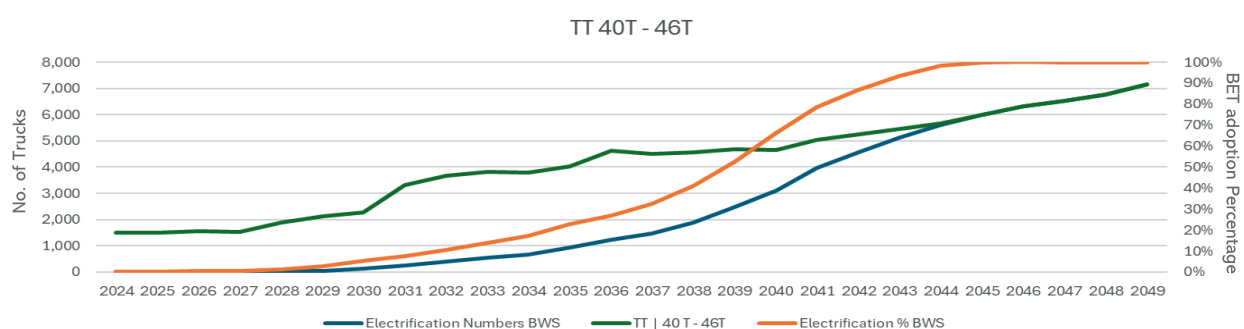
Annual Sales	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
	31,113	31,831	33,316	31,979	31,643	32,540	34,193	41,135	44,884	47,866	51,370	53,339	55,525	58,491	60,464	63,187	66,581	68,795	70,948	73,600	76,262	77,896	79,441	80,865	83,385	89,058
Electrification Numbers BAU	0	24	24	25	56	91	174	290	408	617	1,021	1,419	1,793	3,046	4,541	6,711	10,278	15,170	22,592	31,198	41,177	49,886	60,045	64,824	71,285	80,914
Electrification % BAU	0.0%	0.1%	0.1%	0.1%	0.2%	0.3%	0.5%	0.7%	0.9%	1.3%	2.0%	2.7%	3.2%	5.2%	7.5%	10.6%	15.4%	22.1%	31.8%	42.4%	54.0%	64.0%	75.6%	80.2%	85.5%	90.9%
Electrification Numbers BWS	0	58	129	204	412	802	1,652	2,985	4,553	6,310	8,678	11,775	14,908	19,617	25,580	34,823	45,424	54,371	61,546	68,866	75,107	77,896	79,442	80,866	83,385	89,058
Electrification % BWS	0.0%	0.2%	0.4%	0.6%	1.3%	2.5%	4.8%	7.3%	10.1%	13.2%	16.9%	22.1%	26.8%	33.5%	42.3%	55.1%	68.2%	79.0%	86.7%	93.6%	98.5%	100.0%	100.0%	100.0%	100.0%	100.0%



The electrification of the Tractor Trailers in the GVW segment 31T – 40T grow gradually in the BAU scenario and will reach 91% by year FY50. Whereas in the BWS scenario, Electrification is coming earlier in the year FY46.

6. TT 40T – 46T

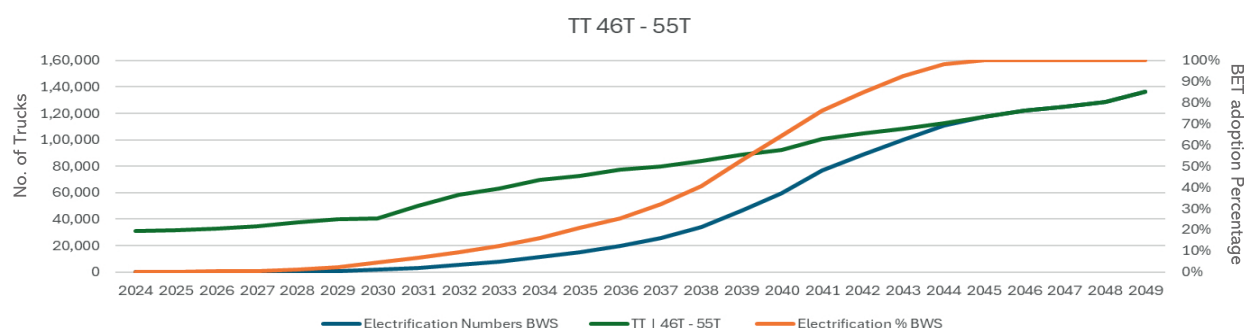
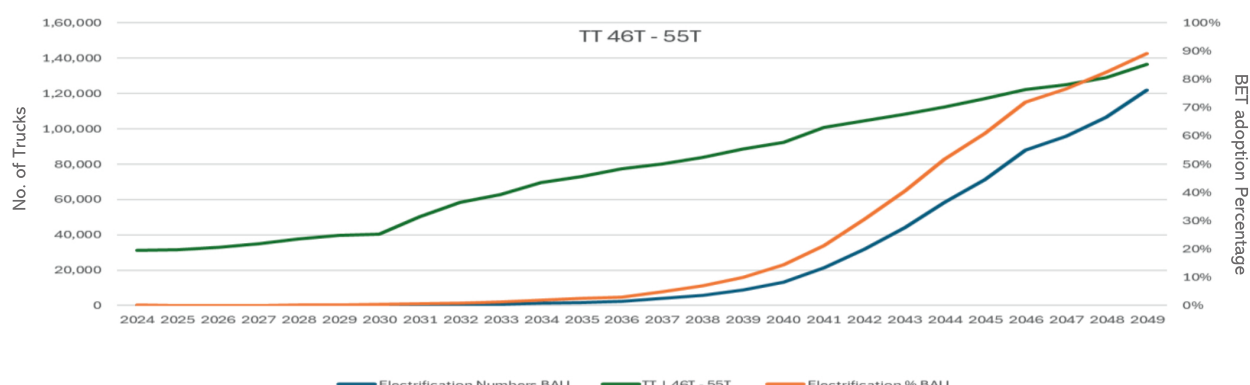
Annual Sales	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Electrification Numbers BAU	0	0	1	2	1	3	6	11	24	35	53	78	115	151	222	325	470	697	1,105	1,659	2,322	3,083	3,854	4,772	5,251	5,791	6,515
Electrification % BAU	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.3%	0.5%	0.7%	1.0%	1.4%	2.0%	2.8%	3.3%	4.9%	7.1%	10.0%	15.0%	21.9%	31.5%	42.5%	54.3%	64.4%	75.4%	80.4%	85.7%	91.2%
Electrification Numbers BWS	0	0	2	7	9	26	54	119	245	386	533	654	921	1,243	1,460	1,871	2,468	3,098	3,972	4,571	5,122	5,594	5,983	6,328	6,530	6,757	7,144
Electrification % BWS	0.0%	0.0%	0.1%	0.5%	0.6%	1.4%	2.6%	5.2%	7.4%	10.5%	13.9%	17.2%	22.8%	26.9%	32.5%	40.9%	52.6%	66.5%	78.6%	86.9%	93.7%	98.5%	100.0%	100.0%	100.0%	100.0%	100.0%



The comparison between the BAU and BWS scenarios help us understand that government incentives are required to bring the electrification earlier. With the subsidy and Toll waiver, the complete electrification adoption is expected to reach in the year FY46 against 91% by FY50 with BAU.

7. TT 46T – 55T

Annual Sales	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
	28,221	31,087	31,620	32,956	34,801	37,740	39,877	40,378	50,337	58,500	62,954	69,686	72,910	77,363	80,109	83,981	88,596	92,317	1,00,721	1,04,571	1,08,271	1,12,518	1,17,109	1,22,302	1,25,007	1,28,916	1,36,675
Electrification Numbers BAU	0	62	22	23	25	57	91	182	317	487	757	1,295	1,806	2,306	3,894	5,914	8,827	13,250	21,326	31,940	43,971	58,376	71,466	88,042	95,797	1,06,561	1,21,980
Electrification % BAU	0.0%	0.2%	0.1%	0.1%	0.1%	0.2%	0.2%	0.5%	0.6%	0.8%	1.2%	1.9%	2.5%	3.0%	4.9%	7.0%	10.0%	14.4%	21.2%	30.5%	40.6%	51.9%	61.0%	72.0%	76.6%	82.7%	89.2%
Electrification Numbers BWS	0	62	55	124	198	433	880	1,763	3,345	5,481	7,793	11,116	15,277	19,657	25,612	34,031	46,738	59,642	76,908	88,609	1,00,287	1,10,624	1,17,108	1,22,303	1,25,008	1,28,916	1,36,675
Electrification % BWS	0.0%	0.2%	0.2%	0.4%	0.6%	1.1%	2.2%	4.4%	6.6%	9.4%	12.4%	16.0%	21.0%	25.4%	32.0%	40.5%	52.8%	64.6%	76.4%	84.7%	92.6%	98.3%	100.0%	100.0%	100.0%	100.0%	100.0%



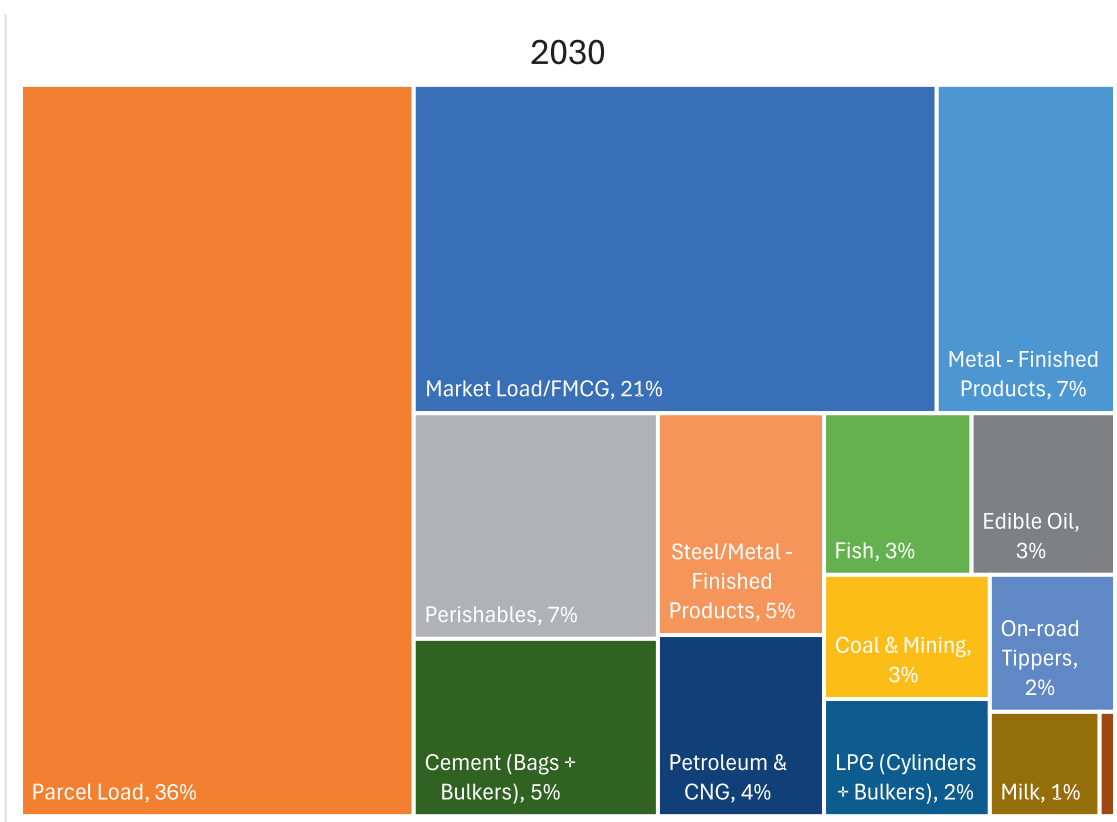
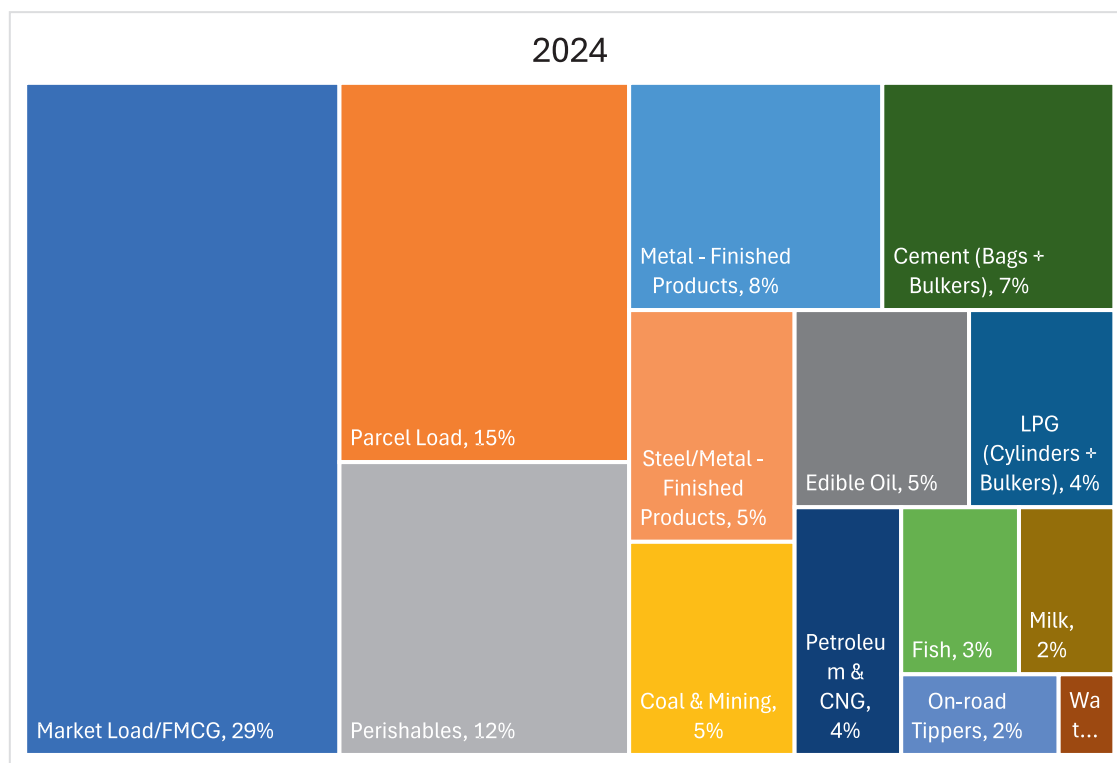
The Electrification adoption in the BAU scenario only reaches 89% by FY50 while it reaches 100% in year FY45 in the BWS scenario.

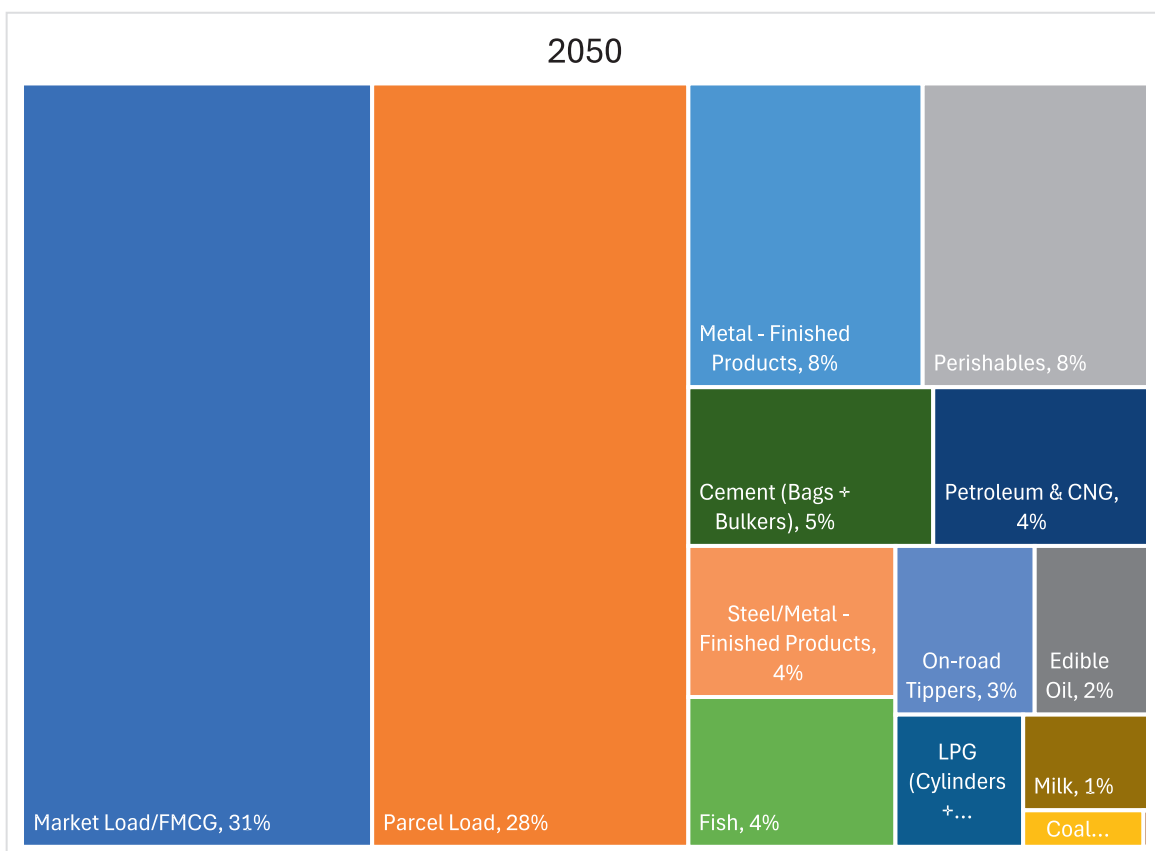
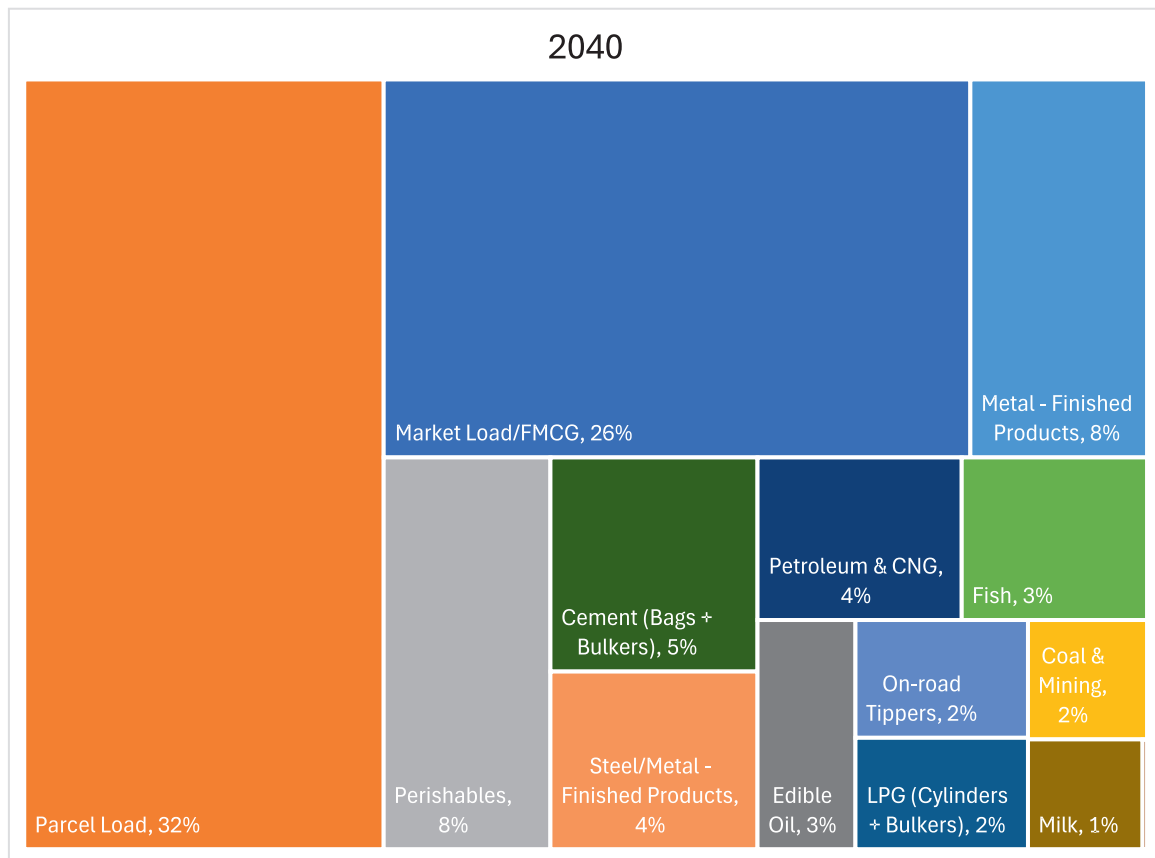
Annexure 6 – CO₂ Emissions -No electrification, BAU and BWS Scenario

Year	No Electrification (Million Tonnes)	BAU (Million Tonnes)	BWS (Million Tonnes)	Year	No Electrification (Million Tonnes)	BAU (Million Tonnes)	BWS (Million Tonnes)
FY24	558	558	558	FY38	1031	1021	1003
FY25	592	592	592	FY39	1066	1052	1026
FY26	626	626	626	FY40	1102	1080	1043
FY27	662	662	662	FY41	1137	1105	1053
FY28	699	699	699	FY42	1174	1125	1053
FY29	740	740	739	FY43	1211	1140	1043
FY30	783	782	782	FY44	1248	1145	1023
FY31	808	807	806	FY45	1285	1141	994
FY32	833	832	830	FY46	1312	1118	950
FY33	857	856	853	FY47	1335	1079	908
FY34	880	878	873	FY48	1353	1021	854
FY35	918	916	909	FY49	1369	966	798
FY36	961	957	948	FY50	1402	922	758
FY37	1000	993	980				

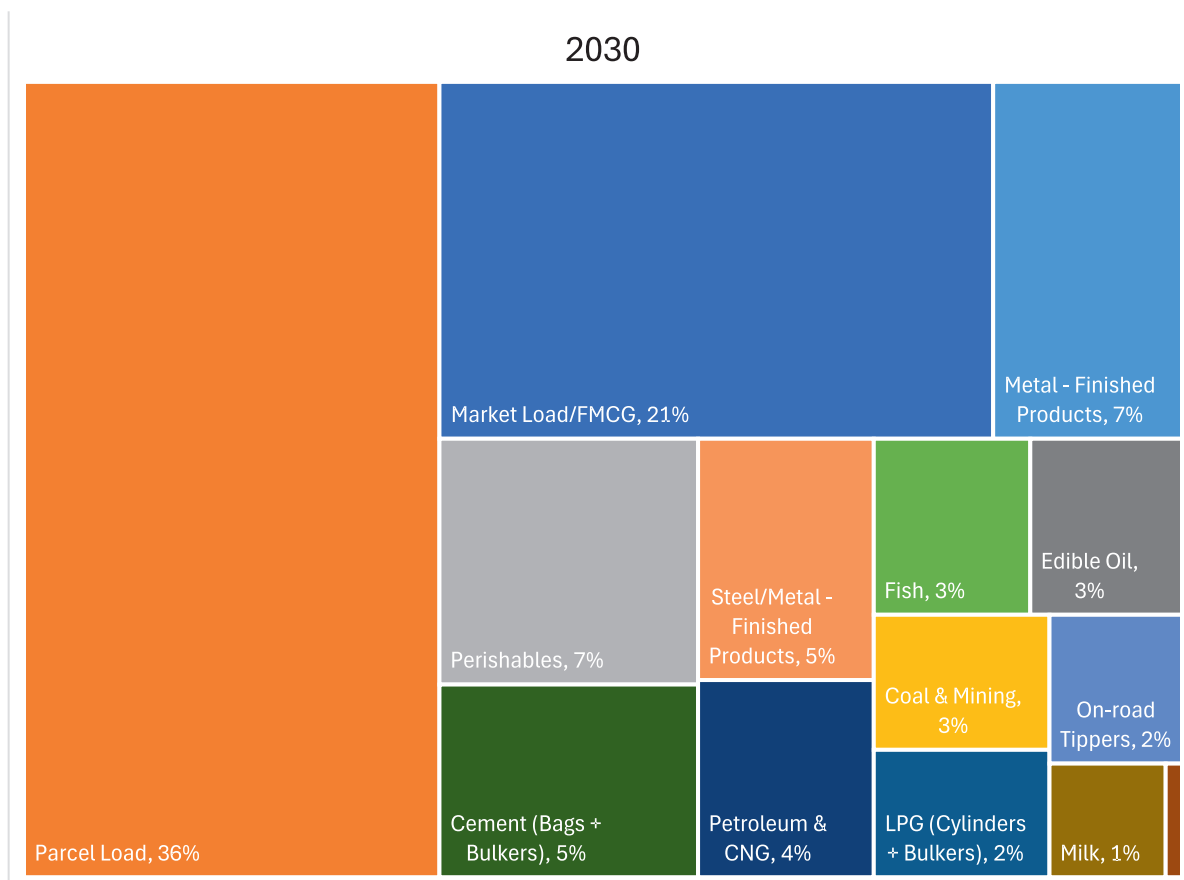
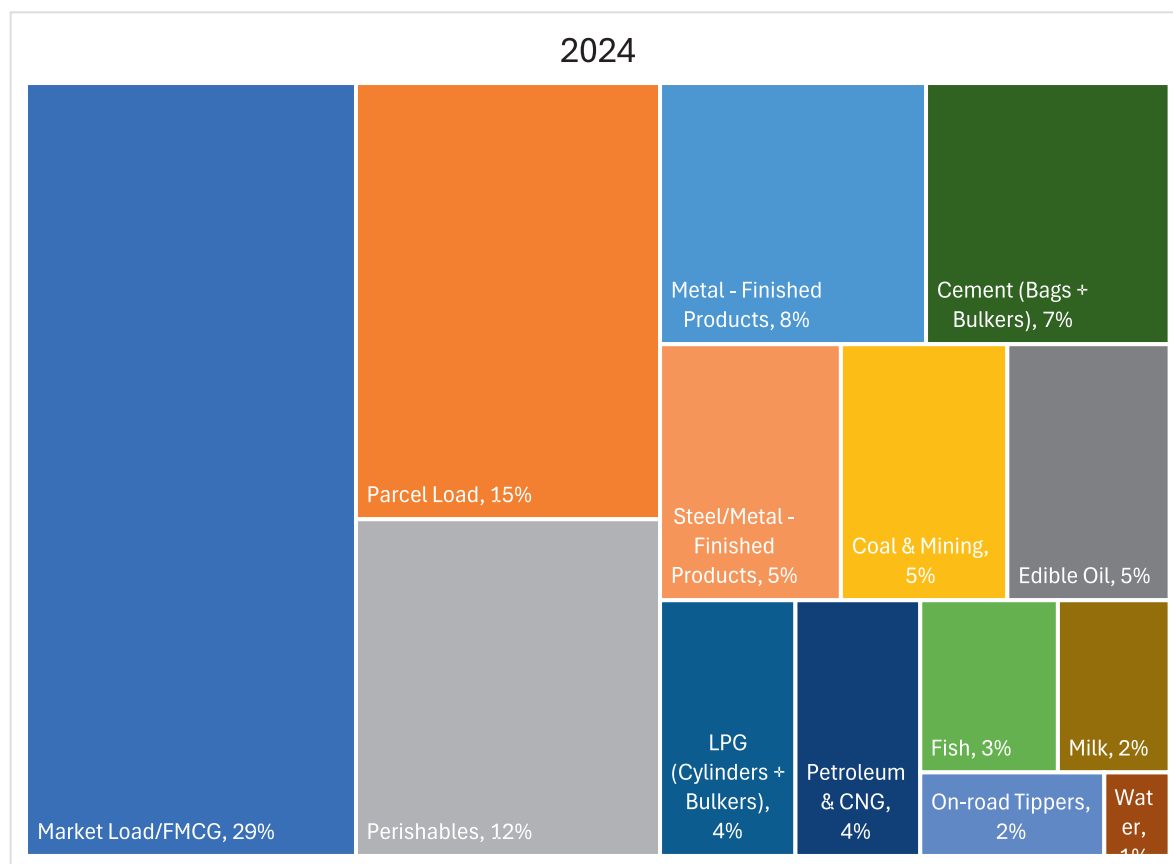
Annexure 7 – CO₂ Emissions Share Mix

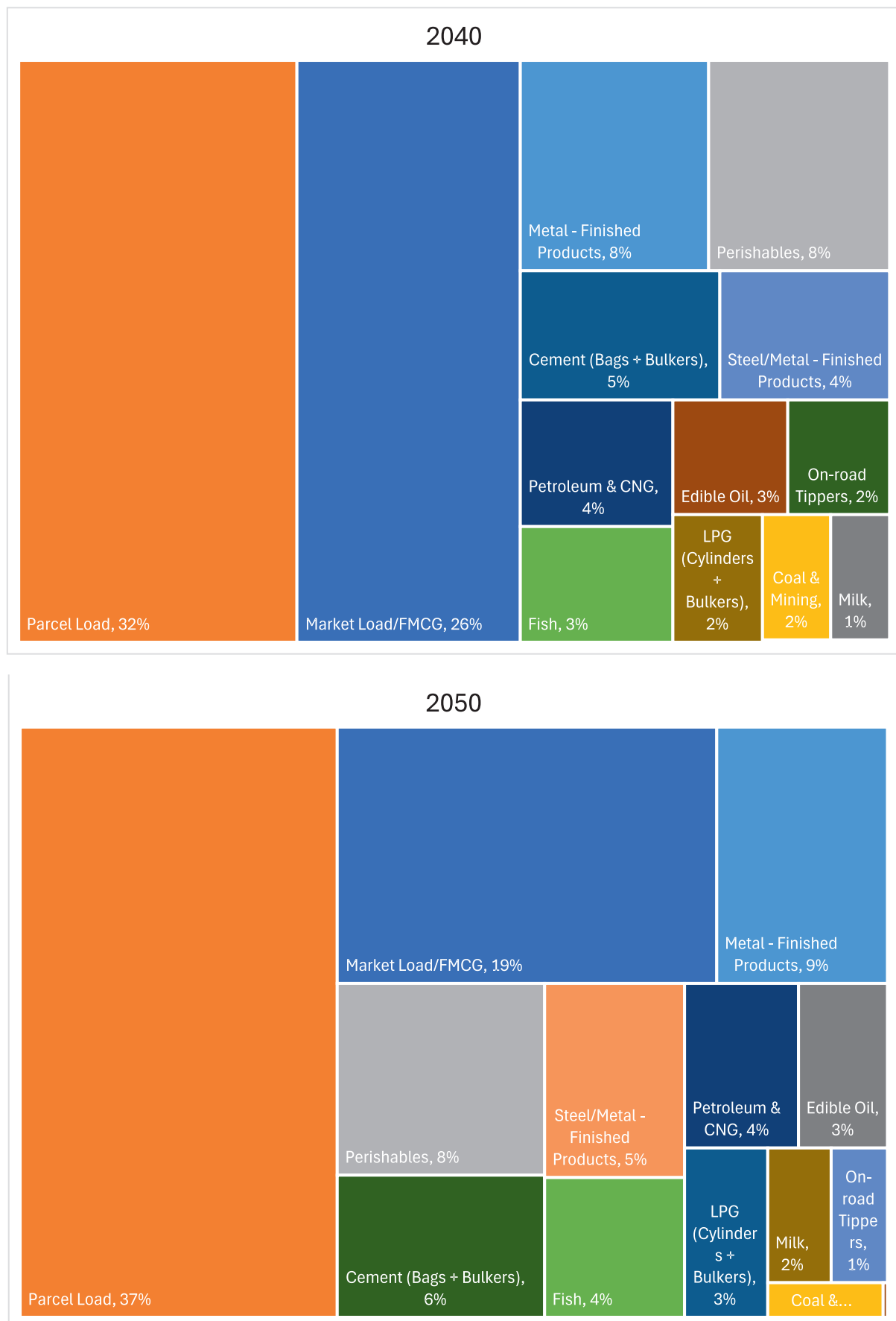
- No electrification:



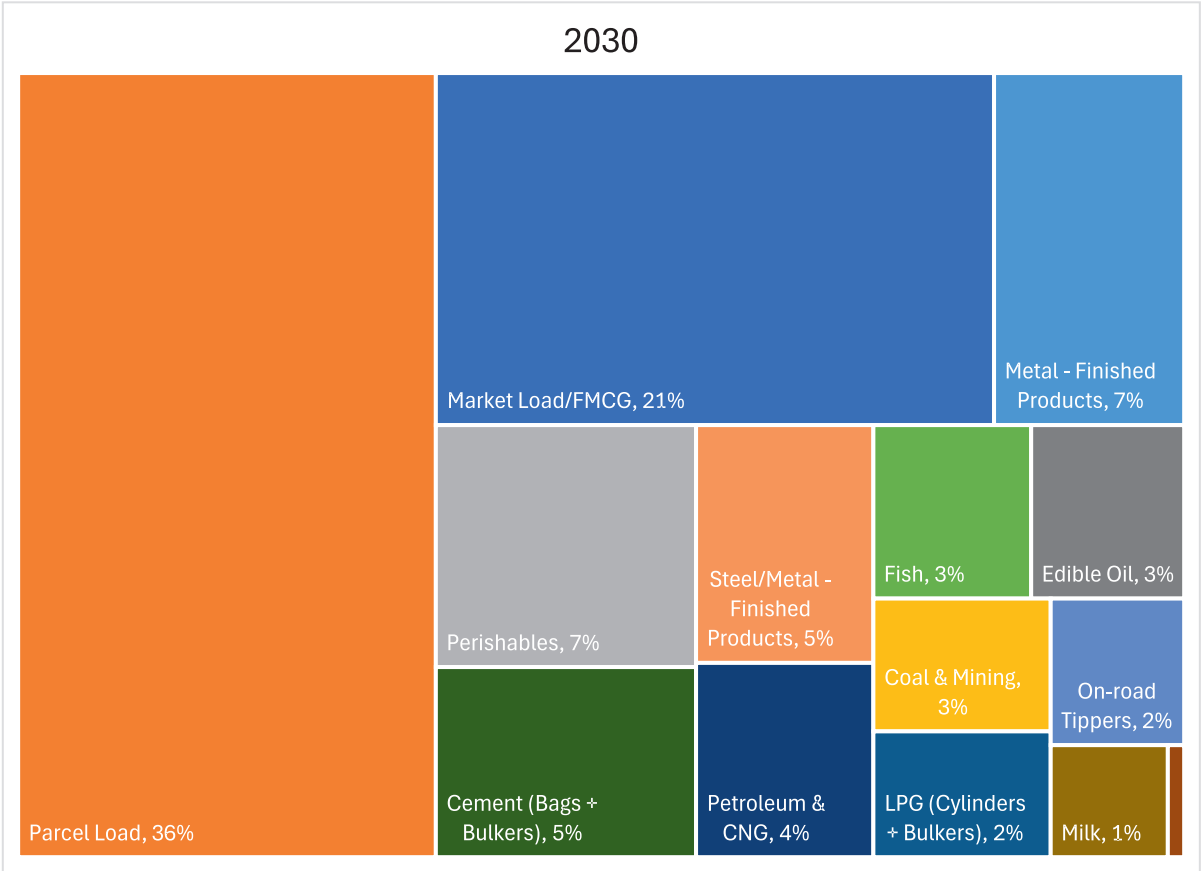
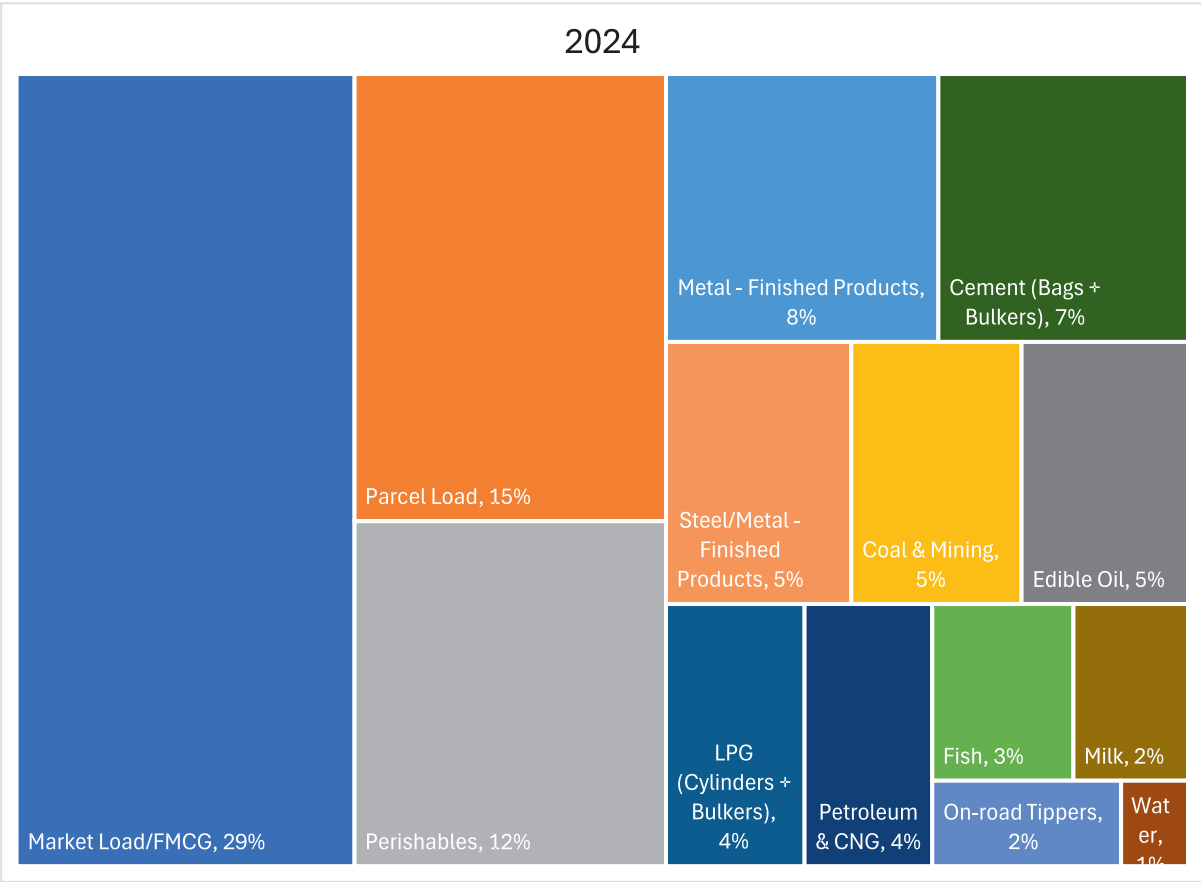


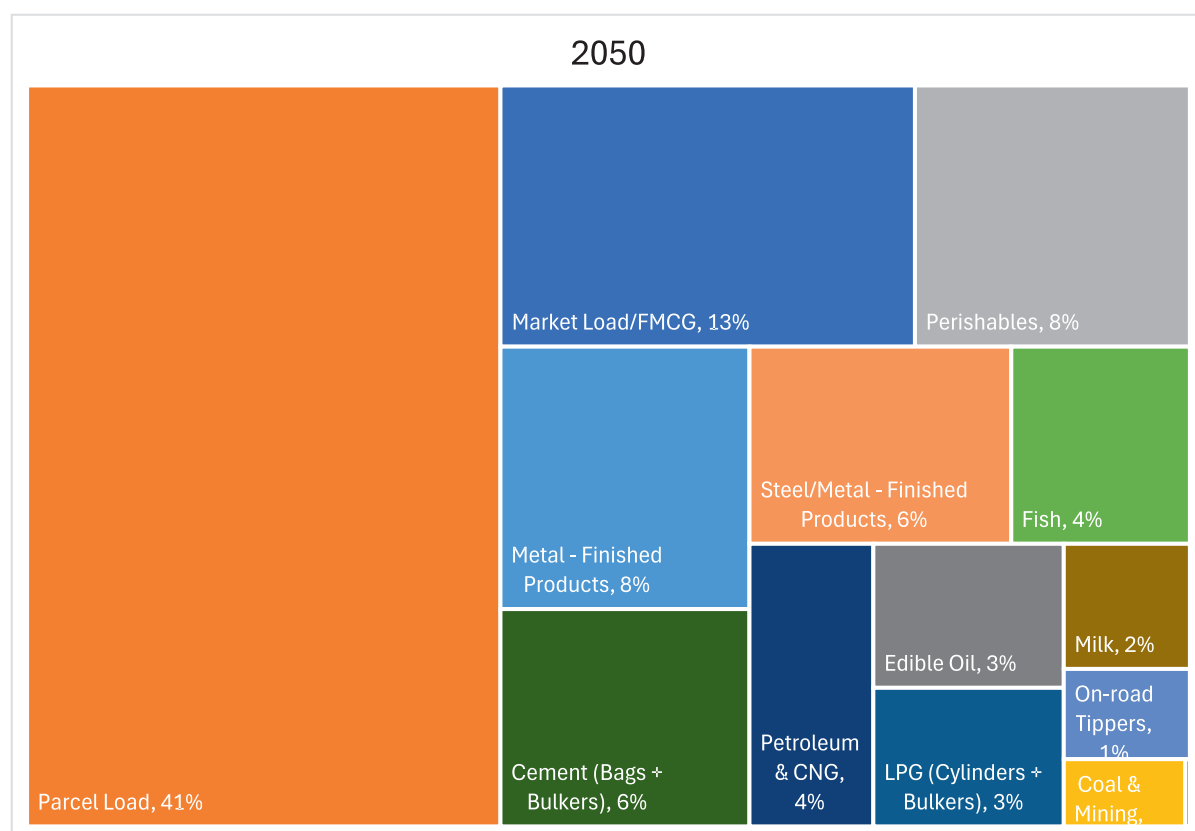
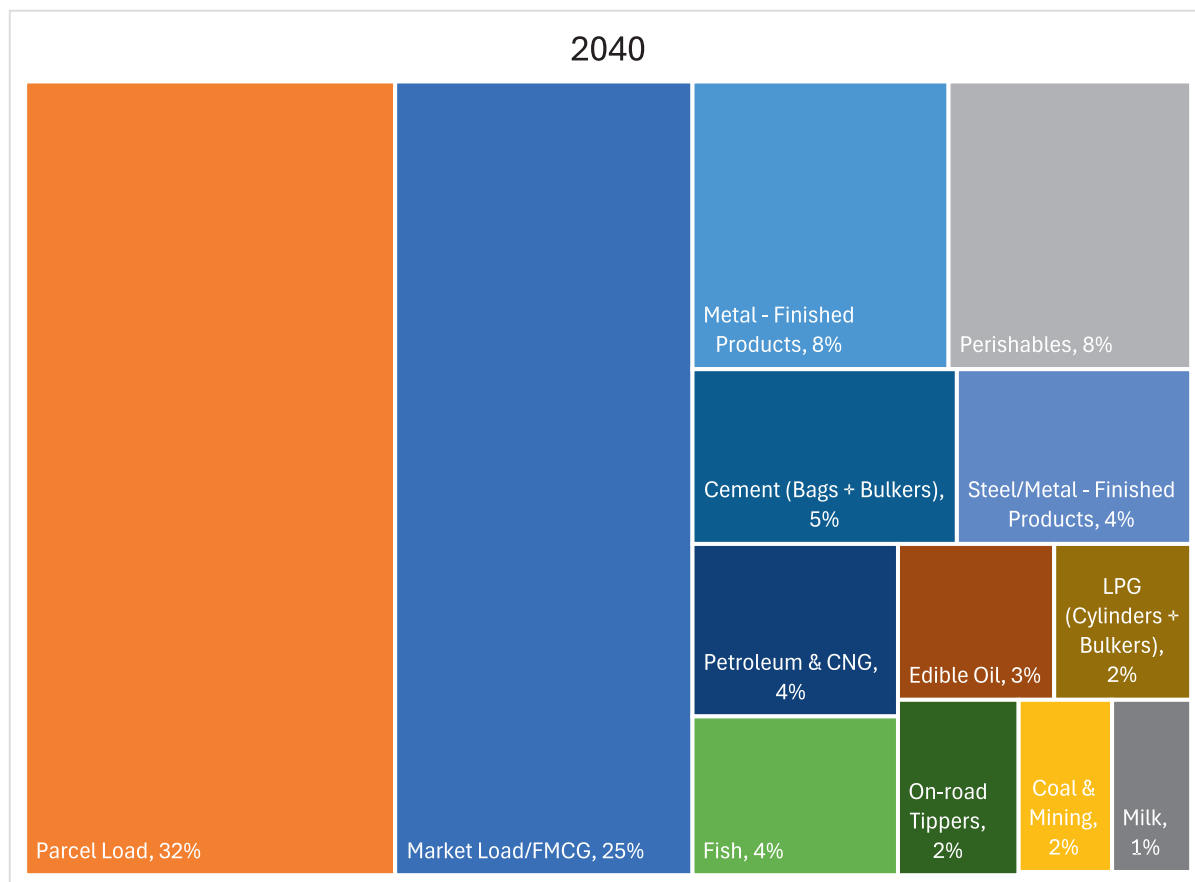
- Business as Usual





● Business with Support





Annexure 8 – CO₂ Emissions Factor Projection till FY50

Electricity Source	% of Grid Electricity in India		CO ₂ e g/kWh by Source		CO ₂ e g/kWh for India	
	2023	2030	Generation	Battery Storage	2023	2030
Coal	67.6%	32.4%	1001	0	676.9	324.1
Gas	8.1%	3.2%	486	0	39.5	15.5
Diesel	0.2%	0.0%	840	0	1.6	0.0
Nuclear	2.8%	2.0%	13	0	0.4	0.3
Hydro	8.1%	6.9%	21	0	1.7	1.5
Wind	4.8%	12.9%	13	33	2.2	5.9
Solar	6.7%	37.7%	43	33	5.1	28.6
Biomass	0.2%	1.9%	52	33	0.2	1.6
Bagasse	0.7%	0.0%	52	33	0.6	0.0
Small Hydel	0.6%	0.7%	21	33	0.3	0.4
Others	0.2%	2.5%	52	33	0.1	2.1
	Source: CEA	Source: CEA	Source: NREL		729	380

Transmission & Distribution Losses	17.7%	Source: CEA
Charging efficiency	95.0%	Source: pManifold Experience
Total Well to Tank	78.2%	

After accounting for transmission and distribution losses as well as charging efficiency, the emission factors are determined to be **932 g** for FY23 and **444 g** for FY30. The emission factors for the years between FY23 and FY30 are calculated using linear interpolation. Beyond FY30 and up to FY50, the emission factors are projected using the Compound Annual Growth Rate (CAGR) method as below.

Years	Emission Factor (CO ₂ g/kWh)
FY23	932
FY24	862
FY25	792
FY26	723
FY27	653
FY28	584
FY29	514
FY30	444
FY31	400
FY32	360
FY33	324
FY34	291
FY35	262
FY36	236
FY37	212
FY38	191
FY39	172
FY40	154
FY41	139
FY42	125
FY43	112
FY44	101
FY45	91
FY46	82
FY47	74
FY48	66
FY49	60
FY50	54

Acknowledgements

S. No.	Name, Designation, and Organisation
1.	Dr. Preeti Banzal, Adviser/Scientist 'G', O/o PSA
2.	Sh. Karthick Athmanathan, Honorary PSA Fellow
3.	Sh. Shankar Ram C S, Principal Investigator, CoEZET, IIT Madras, Chennai
4.	Sh. Rajesh S, Advisor, CoEZET, IIT Madras, Chennai
5.	Sh. Sundaresan S A, (Ex. Head – New Technologies, Ashok Leyland), Professor of Practice, Department of Engineering Design, IIT Madras, Chennai
6.	Sh. Ajithkumar T K, Chief Executive Officer, CoEZET, IIT Madras, Chennai
7.	Sh. Ravi M, Erstwhile Chief Operations Officer, CoEZET, IIT Madras, Chennai
8.	Sh. Selvarajan T, Lead Market Facing Project, CoEZET, IIT Madras, Chennai
9.	Sh. Rahul R, Project Officer, CoEZET, IIT Madras, Chennai
10.	Sh. Vikrant Vaidyanathan, PManifold
11.	Sh. Roopesh Varun. S, Research Intern, CoEZET, IIT Madras, Chennai



**Office of the Principal Scientific Adviser
to the Government of India**

Vigyan Bhavan Annexe, Maulana Azad Road,
New Delhi – 110011

Phone: 011 23022038
Fax: +91 11 2302 2113



/prinsciadvoff/



@prinsciadvoff



/PrinSciAdvOff



/prinsciadvoff



www.psa.gov.in