SUSTAINABLE URBAN FREIGHT INITIATIVE

A COLLABORATIVE APPROACH

Decarbonizing Urban Freight in Surat and Bengaluru

Phase I Project Report

EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

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Creating Innovative Solutions for a Sustainable Future

Sustainable Urban Freight Initiative: A Collaborative Approach

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Sustainable Urban Freight Coalition

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PUBLISHED BY

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENT

TERI would like to express its deep gratitude to Environmental defense Fund (EDF) for supporting this study. In particular, we would like to thank Mr Hisham Mundol, Mr Parthaa Bosu, Mr Kaushik Raj Hazarika for their constant support, valuable and insightful inputs at various stages of the study. We also thank Mr Sudhir Gota for his feedback and guidance.

TERI acknowledges the support of the stakeholders, including sector experts, government agencies, private sector stakeholders, think tanks, tempo owners association, fleet operators, Original Equipment Manufacturers (OEMs), and transport service providers for their valuable inputs for the study. In particular, TERI would like to express its gratitude to the following organizations for sparing their valuable time and providing constructive inputs that were helpful in writing the report:

- Directorate of Urban and Land Transport DULT
- Surat Municipal Corporation
- Small Tempo Owners Association, Surat
- Big Tempo Owners Association, Surat
- Surat Bakers' Association
- Kinetic Greens
- Tata Motors Ltd
- Piaggio Private Ltd
- Mahindra Electric
- Ashok Leyland
- Volvo Eicher
- Gayam Motor Works (GMW) Private Ltd

The project team would also like to thank TERI's Southern Regional Centre at Bengaluru for all their help and support provided to the project team for Bengaluru case study. We would also extend our thanks to Mr Kamlesh Yagnik and Mr Mehul Patel for their guidance and support in Surat for stakeholder engagements. The project team is also thankful to the entire TERI Press and Design team for helping with the publication of this report.

LIST OF ABBREVIATIONS

CMP	Comprehensive Mobility Plans
CNG	Compressed Natural Gas
EV	Electric Vehicle
FAME	Faster Adoption and Manufacture of Electric Vehicles
FMCG	Fast Moving Consumer Goods
EDF	Environment Defense Fund
HCV	Heavy Commercial Vehicles
ICE	Internal Combustion Engine
LCV	Large Commercial Vehicles
MCV	Medium Commercial Vehicles
OEM	Original Equipment Manufacturer
OWC	Organic Waste Management Companies
ROW	Right of Way
SCV	Small Commercial Vehicles
SMC	Surat Municipal Corporation
SWM	Solid Waste Management
TCO	Total Cost of Operation
TOD	Transit Oriented Development
UF	Urban Freight
UNDESA	United Nations Department of Economic and Social Affairs

1. INTRODUCTION

1.1 The need and background of the study

Urban freight plays an essential role in both social and economic development at the city level. With an increasing urban population and growing e-commerce, the demand for freight movement in cities has increased rapidly. As per the United Nations Department of Economic and Social Affairs (UNDESA) 2014, India will witness an addition of 404 million urban population by 2050. This implies more commercial centres, more consumer demand, and higher movement of goods within cities.

In India, intra-urban freight movement is happening mostly by road, though inward, outward and through movement could be by rail and road. About 67% of the total generating freight traffic in India is carried by road.[1] The urban freight movement by road is generally covered by commercial vehicles, which are categorized into light or small commercial vehicles (LCV/SCVs), and heavy and medium commercial vehicles (HCVs/MCVs). The road freight in India, which constitutes around 60% of the total freight movement, is carried by 5.5 million MHCVs and 0.6 million LCVs covering length and breadth of country's road network transporting about 2,700 billion tonne km of load annually (MoRTH, 2021). As per TERI estimates, about 60% of the total emission from the transport sector is on account of the MHCV and LCV segments. Of which, it is estimated that 10% emission is from urban freight sector.

Urban freight sector is often a neglected area when it comes to planning a city transport system. The higher potential of this sector in the areas of sustainability and economic savings has recently grabbed attention of policy-makers and other stakeholders, and the discussions for efficient planning of freight systems are initiated.

1.2 Objectives of the study

Project Objectives and Goals

Setting up an urban freight cost and emission reduction guidance facility, to promote and demonstrate innovative ways to improve sustainability of urban freight transport and logistics in India, through partnerships and experience sharing.

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[1] Road Transport Yearbook 2016-17
https://morth.nic.in/sites/default/files/Road%20Transport%20Year%20Book%202016-17.pdf

Tasks:

- Engagement with public/private stakeholders at local/state/national levels
- Creation of an urban freight knowledge-sharing platform
- Facilitation of pilots in new applications and new geographies
- Capacity building of public/private stakeholders

Pilot goals

Goal 1: Pilot for New Applications

Identify and test specific-use-cases in urban freight where low-carbon technologies such as CNG/EVs can be applied to reduce user costs.

The first goal of the pilot studies in this project is to identify the use-cases where application of low-carbon technologies, especially EVs, can bring down the transportation costs for the users along with the positive impact on environment. Phase I of the project tests the application of EVs, where there are high economic and technological potentials based on the type of vehicle and usage pattern. Key reason for selecting EVs for pilot project is the universal availability of electricity, unlike skewed availability of CNG in Indian states. Successful application through the pilot studies will pave the way for further adoption of EVs in the respective urban freight segment.

Goal 2: Pilot in New Geographies

Increase the geographical scope of identified successful applications of sustainable urban freight practices.

The concept of sustainable urban freight is very new to Indian cities and there is a huge scope of regulatory and technological interventions to facilitate sustainable and low carbon freight systems. Limited number of cities in India have incorporated urban freight/logistics in their policy measures, including Cochin and Hyderabad. The current study aimed to develop sustainable urban freight plans for other cities as well. Low-carbon technologies such as EVs and CNG have been applied successfully in urban freight sectors, including e-commerce delivery. However, the use of EVs in these sectors, although increasing, is limited to certain metro cities, owing to various factors concerning the user, manufacturer, and the city in general. The second goal of the pilot studies under this project is to initiate conversations regarding achieving sustainability in urban freight and adopting low-carbon technologies in new cities. This would aim to bring in vehicle manufacturers to the selected cities and improve the geographical scale of EVs in identified applications.

Goal 3: Pilot Study of New Policies

Identify local policy interventions for facilitating sustainable urban freight systems along with increasing adoption of low-carbon technologies in urban freight

Policy interventions can play a significant role in regulating and streamlining freight movement in cities. Detailed study of current freight movement patterns can help to formulate robust logistic plans. Such plans can regulate the freight movement and increase the efficiency of the system.

Accordingly, policies could be framed to promote faster adoption of low-carbon technologies in urban freight. The interventions can be in terms of infrastructural support, regulations, capacity building and awareness, and monetary/non-monetary incentive schemes.

The third goal of the pilot studies in this project is to identify such policy interventions that encourage sustainable interventions for urban freight. For example, aid or push adoption of new low-carbon and low-cost technologies in urban freight. On successful pilot of EVs in solid waste collection, the Surat Municipal Corporation can promote and induct EVs in the waste collection fleet. The pilot study aims to identify and promote local policy interventions for facilitating sustainable urban freight systems.

With these three goals aligned, the pilot studies under this project was able to forecast the viability of low-carbon and low-cost technology applications in other sectors of urban freight, using a roadmap approach.

1.3 Methodology

Selection of the cities

In order to shortlist cities under the study, potential sectors eligible for electrification and overall benefits from electrification in the city were considered. Goods transport demand in a city is heavily dependent on the total population (Temjanovski, 2020); and therefore, the first level of stratification was done based on city population. The 10 most populated cities (considering metropolitan area) in India were considered for further analysis. Table 1 contains the basic parameters considered for the selected cities. For these cities a wide range of relevant parameters were considered to identify the two most appropriate cities.

Table 1: Demographic Parameters of Selected Cities

#	City	State	Population of the City	Metropolitan Population
1	Mumbai	Maharashtra	1,24,42,373	1,84,14,288
2	Delhi	Delhi	1,10,34,555	1,63,14,838
3	Bengaluru	Karnataka	84,43,675	84,99,399
4	Hyderabad	Andhra Pradesh	67,31,790	77,49,334
5	Ahmedabad	Gujarat	55,77,940	63,52,254
6	Chennai	Tamil Nadu	46,46,732	86,96,010
7	Kolkata	West Bengal	44,96,694	1,41,12,536
8	Surat	Gujarat	44,67,797	45,85,367
9	Pune	Maharashtra	31,24,458	50,49,968
10	Jaipur	Rajasthan	30,46,163	30,46,163

Source: Census 2011, compiled by TERI

Macroeconomic indicators

Macroeconomic indicators give us an insight into the overall level of economic activity in a particular region. There is a direct correlation between growth in the transportation sector and the level of activities in the economy (Lahiri, 2006). The specific parameters considered for selecting cities were identified based on the availability of city-specific information and relevance to freight demand.

Population growth rate: When the decadal growth rate between 2001 and 2011 census is considered, increase in population is associated with increased goods demand and subsequent increase in volume of freight required to be transported.

State per capita GDP: Higher GDP per capita contributes positively to the goods transport demand in a city (Lindholm, 2010). State GDP per capita was considered as specific city estimates were not available for all the cities.

Average household income: The average household income indicates the level of consumption. Cities with higher income levels are likely to have higher spending on goods. This higher spending indirectly translates into increased demand for urban freight movement through increased pressure on supply chains.

Industrial profile

Macroeconomic indicators provide a good overview of economic activity but the actual freight demand also depends on the nature of the activity. Industries are a major source of demand for urban freight and the level of industrial production is an important indicator of the freight demand (Brunel, 2005). The type of industries is also important, as each industry has a different effect on the inflow/outflow of freight in a city. Material-intensive industries, which produce high-volume commodities, will lead to more freight demand than less intensive ones.

Existing vehicle population

The existing population and growth rate of LCVs indicate the existing level of freight movement in the city. Cities with higher number of registered LCVs will be the ones that can benefit the most from electrification of these vehicles. The pollution levels existing in the city are also considered here as cities with large concentration of vehicles running on conventional fuels are likely to have poor air quality.

Policy Push from Government

Apart from the freight demand in a city, potential for electrification also depends on the policy push and proactiveness of the state government/city authorities. Certain states have already introduced EV policy with a focus on reducing cost of ownership as well as creating appropriate EV ecosystem, including charging infrastructure.

The final two cities were shortlisted based on an aggregate of the parameters stated above. Additionally, for effective engagement with private and government stakeholders, TERI's resource capacity and experience in these cities were also critical.

Based on the secondary analysis of the above variables, Surat and Bengaluru were selected as two cities for Phase I of the study. Surat was specifically selected for the objective of facilitating clean technology pilot. The reason for selection of Surat is further explained in the following section.

Surat was selected as the city for pilot deployment in this project for the following reasons:

- **Negligible penetration of EVs:** Surat has no EVs applied in freight movement except for a few early adoptions on cargo e-rickshaws. TERI's previous interactions with local stakeholders revealed a negative experience of e-rickshaws deployed in freight. Due to this, a negative perception of technological potential of EVs to replace conventional ICE vehicles was observed among the users. There is no visibility of competitive, high speed and high power EVs in Surat.
- **Willingness by private stakeholders to adopt new technologies:** Despite negative perception towards cargo e-rickshaws, TERI observed willingness of private stakeholders to adopt EVs during earlier interactions, provided right vehicles with appropriate financing option and government support for charging infrastructure were available. Moreover, private stakeholders, including traders and tempo associations, indicated their willingness to support charging needs of EVs if and when they come up.
- **Proactiveness of the city government:** The city government (Mayor and Municipal Commissioner) expressed the desire to make Surat city the leader in EV adoption in Gujarat. The city administration also expressed interest in supporting charging infrastructure for EV pilots in textile and waste management sectors.
- **Limited alternative fuels:** Most urban freight vehicles in Surat operate with diesel as the primary fuel. Hence, there are high environmental and economic opportunity costs associated with conventional fuel technology.

Key factors for selection of **Bengaluru** for the study are listed below:

- **Primary Logistic Hub for E-Commerce:** Bengaluru is a key logistics hub for the largest e-commerce companies like Flipkart and Amazon, and other major FMCG companies.
- **Rising Freight Demand:** The continuous expansion of the city and growth in young working population of the city has increased the demand of e-commerce and last mile deliveries. This demand contributes to the issue of traffic congestion in the city and demands attention.
- **EV Friendly Environment:** Karnataka is the first state to implement EV policy. Along with that, Bengaluru is more adaptive to new vehicle technology and systems.
- Other factors for selection of Bengaluru include proactiveness of the city government, large population, and limited availability of alternate fuel.

1.4 Chapter Scheme

The first chapter talks about the need of study along with major objectives of the study. It also talks about methodology adopted under the study. The second chapter gives an overview of the status of urban transport in India, including policy development, and the scope of sustainability. The third chapter talks about the activities carried out under the pilot project in Surat. The fourth chapter lays an outline for proposed pilot project in Bengaluru. The following chapter discusses the potential cost and emission savings from the pilot project in Surat, including deployment of EVs for solid waste management. Chapter 6 talks in details about the 'Sustainable Urban Freight Coalition' platform developed by TERI to expand the knowledge in the field of sustainable urban freight.

The learnings from the pilot project in Surat and a blueprint of actions for electrification of solid waste collection for Indian cities is discussed in the seventh chapter. The last chapter summarises the SUF initiative and discusses the way forward.

2. BACKGROUND

2.1 Urban Freight in India

According to UNHABITAT (2013) report, goods transport accounts for 10% to 15% of vehicle equivalent kilometer travelled in urban areas, 2% to 5% of the employed urban workforce, and 3% to 5% of urban land use. A typical city not only receives goods but also ships them; about 20% to 25% of truck-kilometers in urban areas are outgoing freight, 40% to 50% are incoming freight, and the rest comprises both originated and delivered within the city. However, each city represents a different freight movement pattern, which are unique in nature.

The key industries driving urban freight transport in Indian cities are fast moving consumer goods (FMCG), pharmaceuticals, retails, E-commerce, food, and parcel services. Parameters such as infrastructure, industry, networks, stakeholders affect the urban freight movement. The urban freight sector impacts several parameters such as city congestion, air and vehicle pollution, livelihoods, etc. Therefore, this function of interdependency also plays a crucial role for the understanding of urban freight concepts in Indian cities.

2.2 Inefficiencies in Urban Freight

Increasing urbanization has led to significant increase in consumer demand. The increased usage of internet and digital transactions are also critical factors for the rapidly growing demand of e-commerce market. Along with the e-commerce, conventional operations like SWM, parcels and logistic operations of industrial units significantly contribute to the city logistics.

Urban freight activities in India are primarily carried out by small commercial vehicles (SCVs). The increase in urban freight demand translates into increase of SCV movement in the city and leads to negative externalities such as increased congestion, accidents and fatalities, ambient air and noise pollution. As per Road Transport Yearbook 2018 (MoRTH, 2021), LDVs along with cars, vans, and taxis are the second highest contributor to road accidents (persons killed category), with a relatively high share involving SCVs and MHCVs.

The issue of increasing congestion and pollution is due to the inadequate planning. The intracity travel pattern of urban freight includes the multiple stops and congested routes. Logistics operators manage the consignment loading whereas they neglect the aspect of route optimization and planning with respect to city geography. This results in a larger fleets, increased congestion and carbon emissions.

In India, most of the SCV's ply on diesel and have higher rate of emissions as compared to other vehicles. While some cities have realised the air pollution caused by diesel operated SCVs and have shifted to CNG vehicles, but no significant reduction in the emissions is observed as the carbon dioxide emitted by current SCV operation annually is 4378.10 g/km in India (Bedi & Chauhan, 2017).

In recent years, there have been several policies and discussions to mitigate negative externalities from passenger transport at city and national levels, but there is limited intervention, vision, or strategy towards reducing emissions from the freight sector. Interventions for sustainable urban freight have both economic and environmental benefits. There is a lack of integrated model of stakeholders, which could support in aligning their vision and motive in managing the logistics industry. Public stakeholders focus on reducing pollution and congestion while private stakeholders such as distributors or retailers are concerned about controlling costs, along with maintaining optimum service levels. Hence, the inefficiencies in the urban freight sector mainly revolve around three key factors:

- High costs of transport and logistics
- Lack of adequate planning
- Fragmented nature of the logistics industry

In India, the share of transportation cost in supply chain management is approximately 62%, inventory cost is around 34%, and administrative cost is 4% (NITI Aayog, 2021). This makes a significant portion of expenses in the entire supply chain. For instance, in e-commerce supply chain, the final mile accounts for approximately 53% of the total logistics costs (KPMG, 2016). It is high time for India to switch to environmentally as well as economically sustainable means of freight transportation.

2.2.1 Previous studies: Findings and Research Gaps

TERI carried out a detailed study on Roadmap for Electrification of Urban Freight in India[2] to understand the opportunities of electrification for different applications of urban freight. The freight operations of Bengaluru, Surat and Delhi were studied to gain in-depth understanding of the nature of goods and freight movement along with the availability of electric vehicles in the market.

The study revealed that the electrification of small commercial vehicles will be beneficial in both economic and environmental terms. As the payload of certain freight operations like e-commerce deliveries, solid waste management and bakeries is much lesser; the loading capacity of ICE vehicles is not fully utilised and cost of operation is relatively higher. Whereas the loading capacity of electric three-wheeler perfectly suits the requirements of such operations and results in better cost efficiency. The TCO analysis also ensured a higher cost savings for electrification of SCVs.

The report suggested to carry out pilot studies for mentioned operations to understand on-ground feasibility and savings from EVs. To understand the application, feasibility and potential challenges in detail, TERI decided to take up a pilot study in Surat with the support from EDF.

2.3 Recent Initiatives by the Government

The discussions regarding transportation planning started from 2006 with the launch of **National Urban Transport Policy**, where development of CMPs was encouraged. But all the Indian policies related to transportation were mainly focused on the provision of passenger mobility like public and non-motorised transport and on transit-oriented development. Focus on urban freight in city mobility plan is a relatively new phenomenon.

[2] https://www.teriin.org/project/roadmap-electrification-urban-freight-india

The **National Electric Mobility Mission Plan** (NEMMP), launched by Department of Heavy Industries (DHI) in 2013, has shown a roadmap to electrify the transport sector in India. The major aim of the mission is to promote adoption of hybrid/EVs in order to reduce the emissions from the transport sector. The policy had set an ambitious target of deploying 6-7 million EV by 2020. The Central government has also rolled out fiscal incentives to support vehicle purchase by the customers and develop charging infrastructure.

Under NEMMP, DHI launched the **Faster Adoption and Manufacture of Electric** (FAME) vehicle scheme. The scheme aims to encourage progressive induction of reliable, affordable and efficient electric/hybrid vehicles (xEV). FAME subsidies promote the use of electric SCVs by the means of incentivisation. The ongoing second phase of the FAME scheme (FAME-II) aims to accelerate the adoption of electric vehicles for urban freight activities by incentivising around 5 lakh e-3w including commercial and passenger vehicles. FAME has set the targets for minimum technical requirements to ensure the efficient operation of EVs. Various state EV policies also give special attention to the electrification of SCVs.

The Ministry of Commerce, Logistics Division launched the concept of **Freight Smart Cities** in July 2021 with an objective of making freight movements in Indian cities more sustainable and resource efficient. As a part of the initiative the Logistic Division has identified 75 freight smart cities and launched a handbook on 'Enhancing Urban Freight Systems'. The handbook aims to guide the cities to plan various short-term and long-term measures to streamline freight movement in cities.

Certain city and state governments have also come up with **freight/logistic committees** to provide efficient urban freight movement. The Kochi Metropolitan Transport Authority, Kerala has set up a special urban freight committee in 2021 to facilitate efficient freight transportation in Kochi. The committee has equal representation of stakeholders from government and planning authorities as well as freight operators in Kochi. Further, the state of Telangana has launched the Logistics Policy in July 2021 to develop better logistics infrastructure and enhance efficiency of freight activities along with special focus on e-commerce sector.

2.4 Technology solutions for Urban Freight

Diesel is the most prevalent fuel type for commercial vehicles, this is due to the easy availability of various freight vehicle models and availability of fuel. Three-wheelers, passenger and commercial, accounts for 6.4% share in total diesel consumption in India, which is about 10% of the transport sector.[3] The share of CNG vehicles in urban freight is still lower as majority of the states do not have adequate CNG supply infrastructure. States such as Delhi, Maharashtra, Gujarat and Uttar Pradesh lead in the adoption of CNG as they have better infrastructure.[4] The adoption of CNG vehicles not only reduces carcinogenic emissions but also reduces the cost of operation.

EVs are being introduced in the commercial segment in the past few years. Electric vehicles offer great cost savings in terms of lower fuel and maintenance costs. However, it is yet to be widely accepted by the stakeholders in the logistics sector primarily due to high upfront cost and limited

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3 All India Study on Sectoral Demand of Diesel and Petrol, Petroleum Planning and Analysis Cell (2014). https://www.ppac.gov.in/WriteReadData/Reports/20141111032945006974OAllIndiaStudyonSectoralDemandofDiesel.pdf

4 https://www.statista.com/statistics/941227/india-number-of-cng-stations-by-state/#:~:text=In%20all%2C%20the%20country%20had%203%2C180%20CNG%20stations.

financing option. As discussed, FAME and other state policies on EVs are promoting e-3Ws in the urban freight sector through financial incentives, to bring the cost of e-3Ws at par with 3W based on conventional fuel technology.

Potential EV buyers are also concerned about technical feasibility and availability of charging infrastructure. FAME has set a minimum bar of technical specifications to enable potential EV buyers to avail subsidy under the scheme. Several OEMs and start-ups are working to develop efficient and sturdier EVs for the Indian commercial market.

2.5 Electrification of UF in India

Decarbonization objective of urban freight requires a shift from fossil fuel-based powertrain vehicles to electric vehicles, which are the cleanest form of commercially available vehicles. Due to high utilization rates, electric vehicles have a huge potential to reduce costs and emissions from urban freight. EVs have been adopted by several companies globally, while several countries have come up with dedicated policies to push deployment of EVs in the urban freight sector.

In India, there are several applications of EVs in the urban freight sector. The adoption of EVs has picked up significantly in the last 2-3 years. Table 2 categorizes the same.

Table 2: Current applications of EVs in urban freight use-cases

	Sector	Example	Vehicle Ownership	Type of EV
Last Mile Delivery	Traditional Retail Delivery	GATI (logistics provider)-IKEA (furniture retailer) partnership for furniture retail delivery	GATI–IKEA partnership	3W
	E-commerce Delivery	LetsTransport, Avaan, Delhivery, Euler, GoGreen, etc. act as third-party logistics for e-commerce like Amazon, Flipkart, BigBasket, Grofers, etc.	Logistics service provider	2W, 3W and retrofitted 4W
	Food Delivery	Jubiliant Food Works (Domino's Pizza)	Company	2W
Utility Services	Waste Management	Municipal solid waste door-to-door collection	Local Government	3W
Wholesale to Retail	Agriculture	Fruits and vegetables	Driver	E-rickshaw

Source: Multiple Sources, compiled by TERI

Note: The list is non-exhaustive

Business models for pilot deployment of EVs

As of now, mainly e-2Ws and e-3Ws are used in urban freight operations in India. There are three identified business models of deploying EVs in urban freight:

- **Direct ownership of EVs by the company (CAPEX model):** This model is being used by Domino's Pizza, who have purchased e-2W fleet for their own operation. Another example is the Municipal Corporation of Vijayawada purchasing e-3Ws from Gayam Electric Motors for door-to-door waste collection.
- **Service contract to third party (OPEX model):** EVs can be deployed by organizations through service contracts or similar partnerships with logistics companies. For example, e-commerce firms like Flipkart or Amazon use services of logistics firms like Avaan and Euler Motors.
- **Driver owned:** In this case, EV is owned and operated by the drivers. Most observed application of EVs through this model have been of e-rickshaws. There has been limited adoption of e3Ws by individual drivers due to factors like availability of finance and associated risks.

E-Rickshaws for Urban Freight in India

E-rickshaws have been the frontrunner in EV transition in India, showing early and rapid adoption. Currently, 55% of the vehicle models that are eligible for subsidies under FAME-II are e-3Ws. The wide presence of e-rickshaws is due to greater compatibility for different uses.

Many e-rickshaws are being used for logistic applications for various sectors like textile, bakery and FMCG. It is largely promoted by wide dealership network of e-rickshaw manufacturers and relatively low costs.

Figure 1: Popular e-rickshaw model being adopted in Surat

E-rickshaw models appear lucrative option in economic terms. It is evident from the rise of e-rickshaws for last mile connectivity in many Indian cities. E-rickshaws have also been adopted in freight applications like movement of fruits and vegetable in Indian cities (TERI 2020). However, long-term performance of e-rickshaw models for cargo applications is yet to be understood. Figure 1 shows the popular models of e-rickshaw adopted in Surat. Figure 2 summarizes the positives and negatives of e-rickshaw adoption in urban freight use-cases.

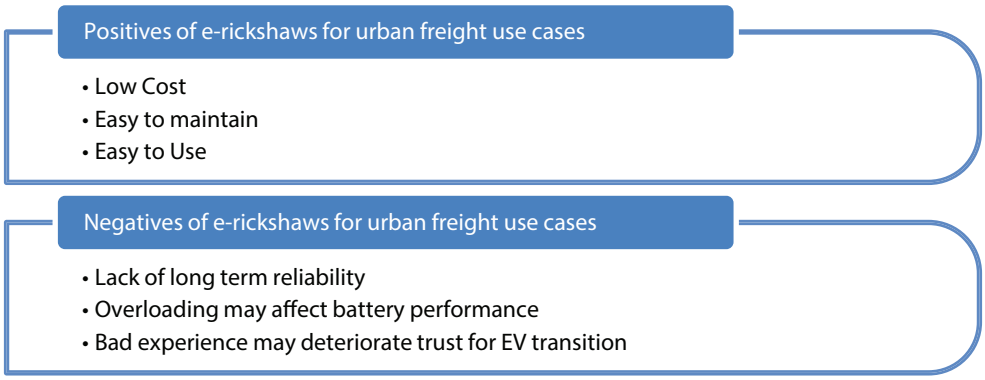

Figure 2: Positives and negatives of e-rickshaw adoption in urban freight use cases

3. PILOT IN SURAT: ACTIVITIES AND OUTCOMES

3.1 Background and Scope

Identified Potential Use Cases

Surat was selected for pilot deployment in Phase I of the project. The identified sectors in the city for EV pilot were **solid waste collection (SWM), textile supply chain operations, bakery supply chain, and raw material movement of organic waste convertor companies.**

The textile industry has been selected because it accounts for 44% of urban freight trips in the city. Application of EVs in this segment can bring a large transition in the overall urban freight in the city. Solid waste collection is selected due to the government's interest in electrifying transport in utility services. Similarly, Duro Green – an organic waste convertor company – joined as it was interested in electrifying its raw material collection. Bakery supply chain was taken up as use-case because its payload requirement is low and its current ICE vehicles were being unutilized.

Table 3: Transport business models of identified use-cases in Surat

	Sector in Surat	Current Transport Business Model	EVs Considered
1	Solid Waste Collection	Service contract with third party agencies	e-3W
2	Textile	Driver/Logistic company/Factory owned	e-3W, e-rickshaw cargo
3	Bakery Supply Chain	Bakery-owned fleets	e-3W, e-rickshaw cargo
4	Organic Waste Companies	OWC company/third party owned fleet	e-3W

Source: TERI

Table 3 summarizes the four selected sectors selected in this project for pilot deployment. The aim is to facilitate deployment of e-3W or e-4W in at least one of these sectors.

Approach for Pilot Deployment in Surat

Steps Taken

We used a workshop-based approach for facilitating EV pilots in each of the four identified use-cases in Surat. First, all public/private stakeholders in Surat were mapped with respect to their roles in criticality to success, their levels of influence, and the current perception regarding EVs for cost and emission reduction from urban freight.

Based on stakeholder meetings and secondary research, four use-cases were identified. Following this, workshops were held separately for each application.[5] The workshops linked the users with

[5] Bakeries and organic waste stakeholder workshops were combined

OEMs and potential of EVs for that particular use-case was discussed. After the completion of the workshop, working groups were formed with potential EV buyers and OEM partners. OEM partners planned demonstration for each set of users. TERI also aided the users to assess techno-economic feasibility of EVs for their application. The users made their decisions in terms of outright purchase in the case of individuals or tender processing in the case of government. Figure 3 summarizes the approach adopted for pilot deployment in Surat in Phase I of pilot study

Stakeholder Mapping

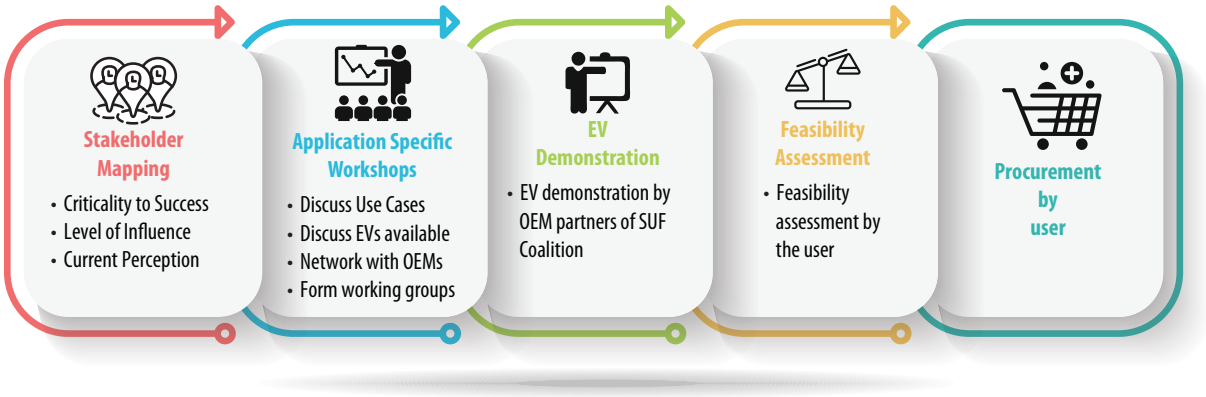

Figure 3: Approach for facilitating EV pilots in Surat's urban freight use-cases

Figure 4 shows the classification of Surat stakeholders in primary and secondary levels based on on their level of interest and influence for EV pilot in urban freight.

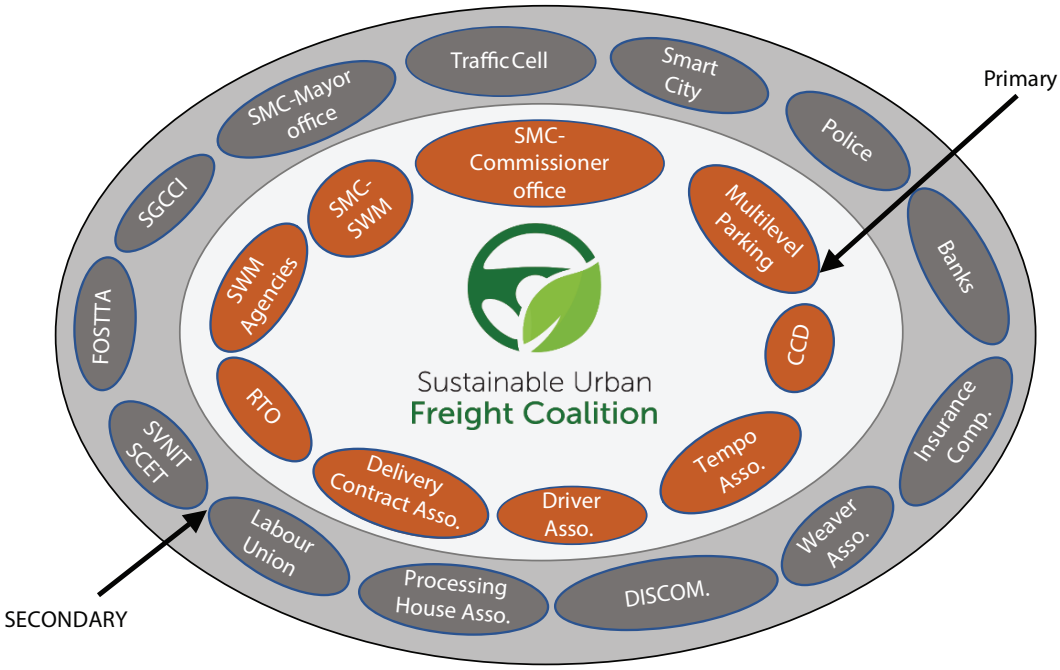

Figure 4: Primary and secondary stakeholders for facilitating pilot in Surat

Primary Stakeholders are those who are directly involved in the pilot project implementation or support with infrastructure development or policy or financial support. For example, the tempo association will be directly involved in pilot deployment, operation, monitoring. Similarly, Surat Municipal Corporation's Municipal Commissioner's office will help in charging infrastructure support required for the pilot and will be directly involved. Hence, they are included as primary stakeholder for pilot implementation. The most important primary stakeholder is the Heath Department of Surat Municipal Corporation as it handles the functioning of Solid Waste Management Operations.

Secondary Stakeholders are those whose support to the project is expected indirectly through policy development or implementation support or motivational support to investor or operator. For example, Surat Municipal Corporation's Mayor's office will not be involved directly in the pilot implementation but will pass the proposal for charging infrastructure provided to EVs and also insist primary stakeholders like Tempo association to participate in the pilot project.

List of all stakeholders is enclosed in Annexure-I.

Influence and support for EV pilot

The stakeholders were classified based on their level of influence for EV adoption in urban freight. The stakeholders mapped were also simultaneously classified as potential investor/operator, infrastructure provider, policy developer, and general supporter. The same was determined based on initial feedback on EV transition from stakeholders in Surat. In investor category, the major stakeholders were identified as tempo association, driver association, and the Solid Waste Management Agency in Surat. Similarly, the major stakeholders for infrastructure support for the pilot were identified as multiple departments of the Surat Municipal Corporation based on the sector. Figure 5 illustrates mapping of stakeholders by their level of influence and criticality to success.

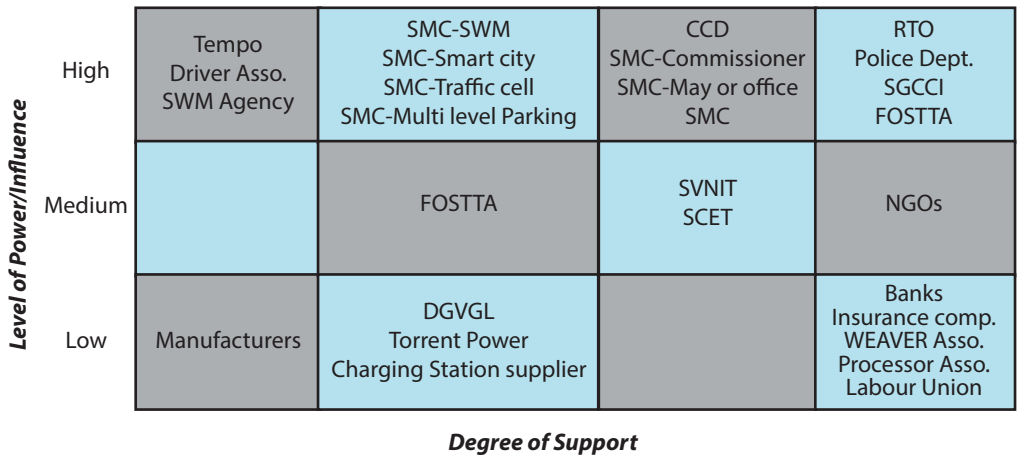

Figure 5: Level of influence and degree of support for EV pilot in Surat

Current perception and criticality to success

Based on initial feedback from local stakeholders in Surat, stakeholders were mapped based on their criticality to success of a pilot and their current perception about EVs. It was observed that critical stakeholders such as Tempo Association, Surat Chamber of Commerce and Industries, Solid Waste Management Department at Surat Municipal Corporation supported trying EVs as an alternative to their current respective use-cases. Figure 6 illustrates TERI's understanding of stakeholders' current perception based on their initial feedback.

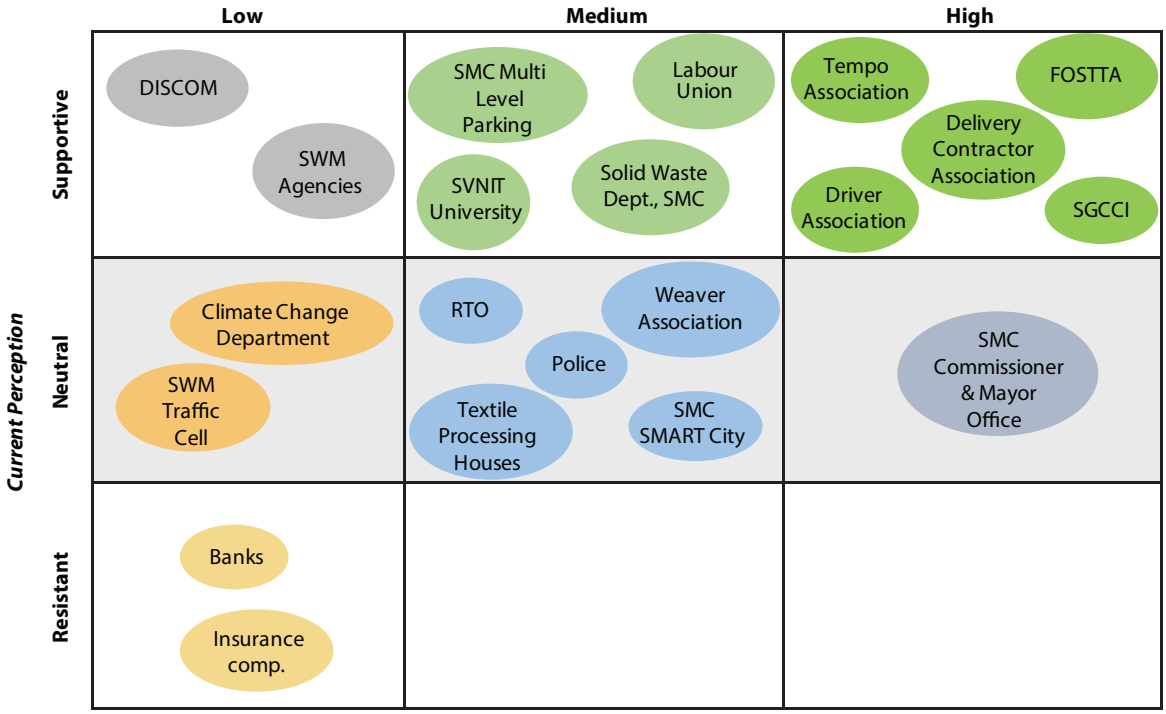

Figure 6: Surat stakeholders' current perception and criticality to success of EV pilot

3.2 The Pilot Study on Electrification of Solid Waste Management in Surat

In order to cope with the increased generation of solid waste and comply with the MSW Rules 2006, the Solid Waste Management (SWM) practices in Surat have seen a drastic overhaul in the recent past. As of March 2021, 4,900 TM of waste is generated and 97% of that is collected and transported. Primary collection involves day-time sweeping, door-to-door collection, scraping and brushing activity, hotel–kitchen waste management, and society ANUDAN programme. By adopting a PPP model, the entire door-to-door collection operation was leveraged through private agencies. The city has been divided into eight zones and the door-to-door garbage collection operation in each zone is managed by a particular agency. The waste collected through primary collection is transported to the transfer station assigned to each zone.

From the transfer station, the waste is then taken to the disposal site at Khajod.

Baseline Study and Details

State of SWM Transportation

As on March 2021, there were 908 vehicles deployed by Surat Municipal Corporation for door-to-door waste collection, litter bins and street sweeping, commercial waste collection as well as secondary transportation to landfill sites. Figure 7 shows the growth of freight vehicles in Surat SWM.

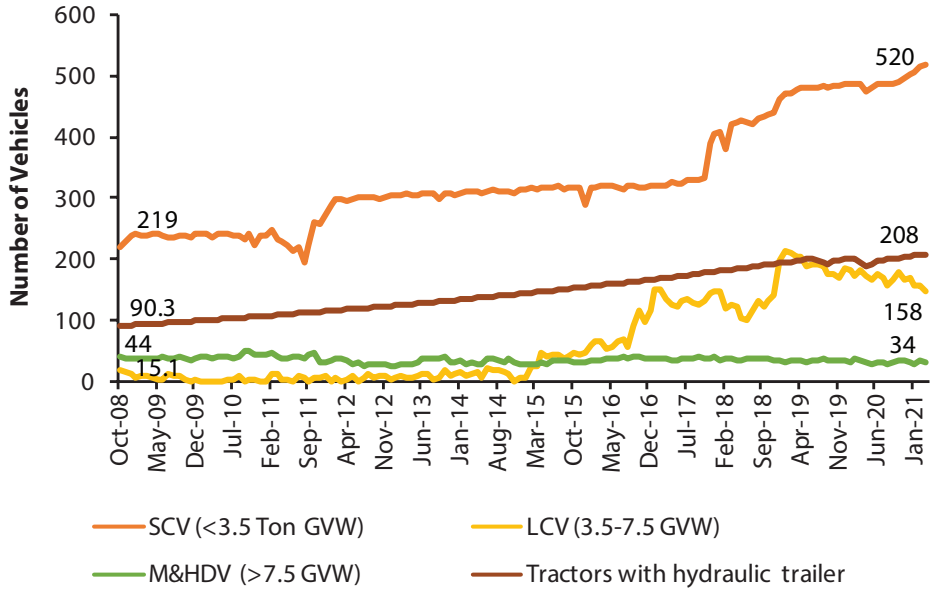

Figure 7: Growth of vehicles in Surat SWM fleet

Source: TERI analysis

Current Emissions and Cost from SWM Operation

Current GHG Emission from SWM Fleet: According to Surat Municipal Corporation, as on March 2021, SWM operations in Surat utilized 908 vehicles including small and light commercial vehicles (GVW < 3.5 tonne), and medium and heavy-duty vehicles (>3.5 tonne GVW), and agricultural tractors fitted with hydraulic trailers. These vehicles are involved in various activities including door-to-door waste collection, night scraping waste collection, collection from litter bins and commercial establishments as well as for secondary transportation.

These vehicles transport about 4900 tonne of waste per day. The calculations by TERI show that, Surat's waste transportation exercise leads to **16 tonnes of GHG emissions,** every day. Annually, this sector alone accounts for more than **5800 tonne** of carbon dioxide equivalent GHG emissions. All vehicles deployed presently use diesel as the primary fuel. This paints a grim picture on the impact of this sector on Surat's air pollution.

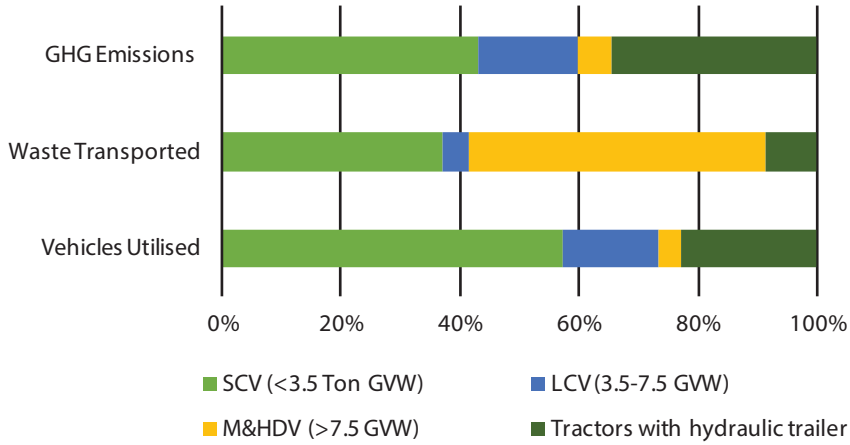

Figure 8: Vehicle segment-wise GHG emissions, vehicle utilization, and waste transported in Surat

Source: TERI analysis

As can be noticed in Figure 8, a significant proportion of GHG emissions from Surat SWM comes from SCVs and tractors. The tractors especially are the most polluting in terms of transport emission per unit of waste carried. They account for more than 30% of GHG emissions from Surat SWM but are responsible for less than 10% of the waste transportation. TERI's emissions modelling reveals that transitioning tractors will be the most-effective strategy for reducing costs and emissions from Surat SWM. This was indicated to Surat Municipal Corporation officials during its initial interaction with TERI. In fact, eventually Surat Municipal Corporation decided tractors to be replaced for first phase of EV pilot in Surat SWM.

Cost of SWM Operation

Current fleet of SWM vehicles in Surat is diesel based. Higher cost of diesel and frequent maintenance requirements increase the operating cost of diesel vehicles. Based on the stakeholder consultation, fuel requirement for the SWM vehicles was found out. The calculations show that SWM operation in Surat consumes around 6,000 litres of Diesel, which costs around Rs 5-6 lakhs per day as of July 2021.

Activities Related to Pilot

Workshop with Solid Waste Management Department, SMC and Outcomes

A workshop was organized by TERI and Surat Municipal Corporation with a specific objective to Facilitate electrification of municipal solid waste collection in Surat.

At the workshop, Surat Municipal Corporation envisioned pilot deployment by March 2021. The OEMs will then have 1.5 to 2 months to deploy, once their proposal is selected and order is placed by Surat Municipal Corporation. Subsequently, Surat Municipal Corporation and TERI planned to monitor and study the deployment. Based on the observation on successful economic benefits from deploying EVs, adequate provisions will be made in Surat Municipal Corporation's **SWM policy** to plan transition of the entire fleet (800–1000 vehicles) into electric. Through incentives and mandates, the provisions in the SWM policy will nudge the third-party contractors to transition the entire waste collection in Surat by 2022.

e-Vehicle deployment

Selection of suitable operation for Electrification

The first step for pilot deployment was the selection of the most suitable operation to be replaced by electric vehicles. The small commercial electric vehicles have the most competitive technology and cost as compared to ICE vehicles. The loading capacity of small electric three-wheelers is more suitable to door-to-door collection of solid waste and the operation of small trucks for garbage collection. The pilot project is focused on the electrification of the mentioned operations for the city of Surat.

Procedure for Tendering at SMC

The majority of interactions of TERI are with Solid Waste Management Department as it deals with the vehicles involved for SWM operation. However, for transitioning the conventional diesel vehicles to electric vehicles a long procedure including tendering is required.

The request for tender is first sent to the Health Department and the requirement of tender is then discussed with Municipal Commissioner. Once the tender is prepared from the commissioner office, it gets discussed in the meeting with Mayor and Standing Committee to assess the need of work. Once the tender is passed by the Standing Committee it is floated on websites for bidding.

Figure 9: Flow of Tendering Process

Benefits of EV transition: Cost and Emission Savings

Current Fleet

TERI prepared an RfP for Phase I of pilot adoption in Surat. Phase I of the pilot would involve replacing in Surat's central zone waste collected by 21 tractors that are fitted with hydraulic trailers. The letter from Surat Municipal Corporation to TERI is attached in Annexure-II. Table 4 gives the summary operations that is intended to be replaced by EVs in Phase I.

Table 4: Summary operations that is intended to be replaced by EVs in Phase I

Parameters	Details
Type of Vehicles	Tractors with hydraulic trailers
Number of Vehicles	21 tractors
Trips per Tractor per Day	2–3
Total Distance per Tractor per Day	41 km
Total Diesel Consumption per Day	10 liters/ tractor
Total Waste Collected per Day	42 MT (Approx.)
Waste Carried per Tractor per Trip	800–1500 kg (derived from secondary SWM data and stated by SMC)
Type of Waste	Street sweeping and litter bins
Number of Persons Utilized per Tractor	Driver + two helpers for collection

Source: Stakeholder consultation by TERI

Based on this request, TERI prepared a Request for Quotations and collected quotations from five OEMs. All OEMs were 3W EV manufacturers. Due to COVID-19-related emergencies, Surat Municipal Corporation has been unable to come up with a public tender.

Phase-wise EV Transition

Solid Waste Management operations in Surat are outsourced to third party contractors. SWM vehicle ownership is also private, yet SMC has envisioned the transition of conventional SWM vehicles to EV and will help the third-party vendors to shift to 100% electric fleet. As discussed earlier in Phase I of the pilot, 21 tractors will be replaced. Surat Municipal Corporation envisions to transition its entire fleet of 800 vehicles in 2-3 years. Although heavy duty EVs may not be available in the market in that timeline, Surat Municipal Corporation can certainly transition its SCVs and tractor fleets. As tractors are the most polluting per unit of waste carried, transitioning tractors to EVs would be the most cost and emission cost and emission effective transition. This plan has been clearly expressed to TERI by Surat Municipal Corporation.

Table 4 shows the plan for EV transition in Surat's SWM fleet along with the estimated emission and cost savings.

3.3 Specific Use Cases

Along with the operations under Solid Waste Management of Surat Municipal Corporation, other key use cases considered under the study are Textile, Bakery, Organic Waste Management, which have greater potential of electrification of their fleet. As part of the study, workshops were conducted to sensitize the stakeholders regarding the benefits and potential of EVs. This section discusses in detail the outcomes of the activities undertaken by TERI in Surat. The detailed information regarding the workshops is attached in the annexure as workshop proceedings.

Textile Supply Chain

Textile-related freight movement in Surat

The textile industry is selected because it accounts for 44% of the urban freight trips in Surat. Application of EVs in this segment can bring a large transition in the overall urban freight in the city. As per Figure 14, the textile industry accounts for 96% of Surat's industrial units, 34% of the daily freight tonnage leaving Surat, and 44% of daily freight vehicle trips within Surat. Limited data is available regarding the exact number of vehicles utilized for textile freight in the city. However, the sheer production volumes of textile finished and semi-finished goods clearly indicate the stake of this industry in the overall urban freight in the city.

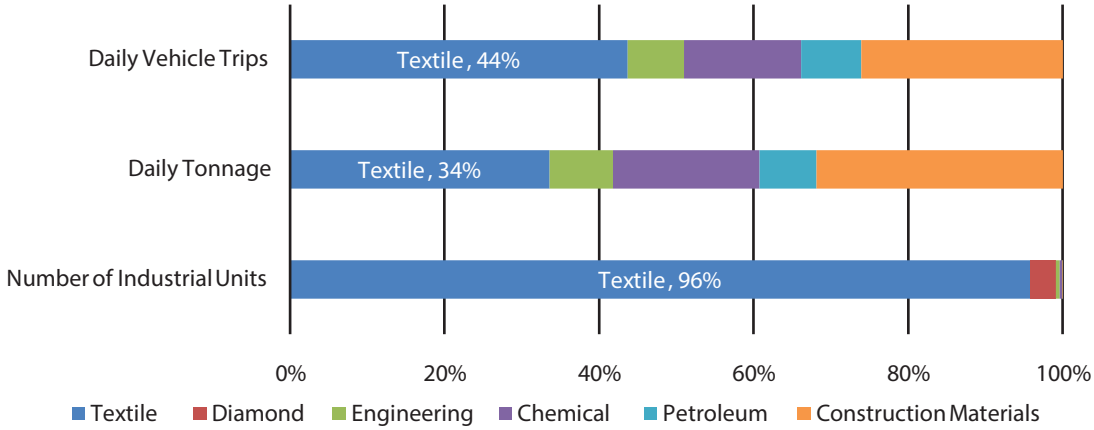

Figure 10: Share of industries in Surat freight movement

Source: TERI analysis

Members of Surat's Small Tempo Owner's Association own more than 2000 SCVs, deployed primarily for textile-related freight movement. The Small Tempo Owner's Association were the primary stakeholders targeted for EV pilot-related workshop.

Workshop with Tempo Owners and Outcomes

TERI in collaboration with Surat Municipal Corporation and Tempo Owner's Association in Surat conducted a close-door workshop aimed at facilitating EV pilots in textile freight. At the workshop, many tempo owners, including president of the association, expressed interest in trying out EV for their operations. However, they expressed apprehension regarding loss of vehicle performance during overloading. Nevertheless, they were willing to test and purchase vehicles if available in Surat. Their main demand was that the EV demonstration event be organized in Surat. They were keen on test driving the vehicles presented by OEM partners at the workshop. But the EV demonstration from the OEM partners got delayed due to COVID-19 spikes in the city and related mobility restrictions. Despite this, some keen tempo owners went ahead and purchased low-cost e-rickshaw cargo vehicles for their operation. We documented the operations and their experience. The following section briefly describes the same.

EV adoption by tempo owners

We were able to capture data from EV adoption by two stakeholders who attended SUF Coalition workshop in December 2020. The workshop ensured the tempo owners regarding the efficiency of EVs and encouraged them to deploy EVs for their operation. These users purchased their EVs in January 2021. Table 5 shows characteristics of adoption of 22 EVs by two tempo owners in Surat.

Figure 11: Purchased EVs in textile related operations

Table 5: Pilot outcome with Surat tempo association (As of July 2021)

Name of the User	Manish Godhani	Jaysukh Bhai
EVs Purchased	10	12
ICEs Replaced	0	8
Primary Use-Case	Textile	Textile
Secondary Use-Case	None	FMCG delivery
Primary Trip Type	Shop to Distribution	Shop to Distribution
Daily Trips	6–7 trips	4–5 trips
Daily Total Distance	80 km	90-130 km
Average Load Carried	500 kg	800 kg to 1 Tonne
EV Model Purchased	City Life Heavy Capacity	City Life Heavy Capacity
Claimed Load Capacity of Purchased EV	850–1000 kg	1050 kg
Charging Location	Shop or Home	Shop
Reason for Not Purchasing EVs Presented at the Workshop	**Economical, user friendly, easy to maintain, dealer available in Surat**	

Source: Stakeholder consultation by TERI

Bakery Supply Chain

The bakery supply chain was considered as target area as the stakeholders had expressed keen interest in shifting to EVs for their fleet used for raw material movement and final goods distribution. The users themselves indicated underutilization of their current ICE vehicles and emphasized on the potential of EVs for their operations. Figure 16 lists the reasons for high potential of EVs in bakery supply chain.

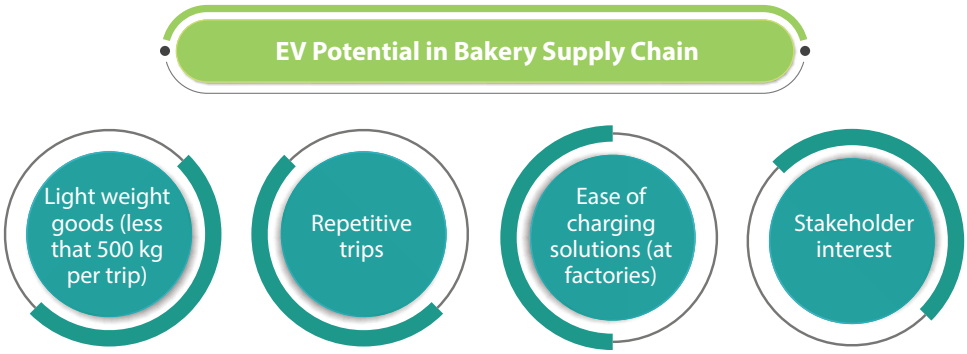

Figure 12: EV potential in bakery supply chain

Surat Bakers Association has more than 100 bakeries as its members. This association was selected as the primary partner for organizing the workshop with bakers in Surat.

Workshop with Surat Bakers Association and Outcomes

TERI in collaboration with Bakery Association of Surat conducted the third workshop for electrification of urban freight aimed at facilitating the EVs to manage the supply chain of bakeries and organic waste converter companies. Several stakeholders from Surat Bakers Association expressed their interest in purchasing EVs. Some users expressed requirement of refrigerated closed bodies in potential EVs. The baker's association also requested EV demonstration event to be organized in Surat. All the three OEMs agreed upon organizing demonstration of EVs in the city for better understanding of stakeholders. However, like tempo owners, some keen bakers went ahead and purchased EVs. These stakeholders purchased e-rickshaw cargo models too for their freight requirements. The following section summarizes the details of adoption.

EV adoption by bakeries

We were able to collect data of EV adoption by three stakeholders who attended SUF coalition workshop in December 2020. These users purchased their EVs in April 2021. All e-rickshaw cargo vehicles procured are engaged solely for bakery supply chain-related movement in Surat. Table 6 summarizes adoption of 5 EVs by 3 members of Surat Bakers Association.

Table 6: Pilot outcome with Surat Bakers Association (as of July 2021)

Name of the User	Aatawala	Kamil Bhai	Chand Bhai
Name of the Bakery	Modi Bakers	Royal Traders	National Sales
EVs Purchased	2	2	1
ICEs Replaced	2	2	First vehicle
Primary Use-Case	Bakery supply chain	Bakery Supply Chain	Bakery Supply Chain
Secondary Use-Case	None	None	None
Primary Trip Type	Factory to Shop, Shop to Distribution	Shop to Distribution	Warehouse to Shop
Daily Trips	2–3 trips	Max. 3 trips	2 trips
Daily Total Distance	80–90 km	80–100 km	60–70 km
Average Load Carried	700 kg	600–700 kg	600 kg
EV Model Purchased	City Life Heavy Capacity	City Life Heavy Capacity	E-rickshaw model
Claimed Load Capacity of Purchased EV	850 kg	850 kg	850 kg
Charging Location	Shop Shop or home		Warehouse or shop
Reason for Purchasing EVs	**Economical, user friendly, easy to maintain, dealer available, better performance, suitable for user requirement**		

Source: Stakeholder consultation by TERI

Organic Waste Collection

Workshop with Duro Green and Outcomes

Duro Green is an organization providing waste management-related solutions to multiple cities in India. TERI involved Duro Green in the workshop with Surat Bakers Association in March 2021. Before and after the workshop, Duro Green clearly expressed its interest in purchasing EVs for its operations in Surat. With TERI's assistance, Duro Green also conducted the economic feasibility of deploying EVs. Duro Green plans to add at least two EVs in its fleet in 2021.

3.4 Outcomes of the Pilot in Surat

In Phase I of this project, TERI targeted four use-cases and had some outcome in each of the cases. The major win for the pilot project is the commitment by SMC to electrify the whole SWM fleet. The positive responses from other stakeholders also suggest the increasing faith in EVs and innovation. Table 7 shows the progress towards the goals of Urban Freight Cost and Emission Reduction Facility, while Table 8 summarizes the stakeholder response from the workshops, the pilot-related outcomes, and the timeline of the same for each use-case targeted under this project.

Table 7: Status of Goals

Goal	Status of Completion	Activities Done
Goal 1: Pilot for New Application	Achieved	4 specific use-cases for EV transition identified and consulted (SWM, textile, bakery and organic waste management) As of May 2021, 22 EVs are purchased by tempo owners and 5 EVs by bakers.
Goal 2: Pilot in New Geographies	Ongoing	MoU with DULT has been signed for work related to urban freight. Discussions for Pilot Project for Bengaluru to be taken up. (Refer to annexure for MoU)
Goal 3: Pilot Study of New Policy	Committed by SMC	Agreed for transition to electric vehicles (Refer to annexure for the request letter by SMC)

Table 8: Overall timeline of pilot outcomes in Phase I Pilot Project

	Surat UF Use-Case	Stakeholder	Stakeholder Response	Outcome in Phase I	Timeline
1	Solid Waste Management	Surat Municipal Corporation	Positive, concerned about EV performance with overloading and elevation, need demonstration	Workshop	Nov-20
				Request for quotations raised for 21 tractors in Central Zone	Feb-21
				Preparation of RfP document by TERI	Feb-21
				Preparation of quotation comparison and recommendation document by TERI	Mar-21
				Feasibility assessment by SMC	Apr-21
				Tender Release	Tender for 81 e3Ws to be released in 2021

Table 8: Overall timeline of pilot outcomes in Phase I Pilot Project

	Surat UF Use-Case	Stakeholder	Stakeholder Response	Outcome in Phase I	Timeline
2	Textile Supply Chain	Surat Small Tempo Owner's Association	Positive, need demonstration, concerned about overloading	Workshop	Dec-20
				Demonstration in Surat	Postponed due to COVID-19
				Purchase of EVs by users independently	Jan-21
3	Bakery Supply Chain	Surat Baker's Association	Positive, need demonstration, need closed body with refrigeration	Workshop	Mar-21
				Demonstration	Postponed due to COVID-19
				Purchase of EVs by users independently	Apr-21
4	Organic Waste Collection	Duro Green, OWC Company	Positive, need demonstration	Workshop	Mar-21
				Demonstration organized in Ahmedabad	Apr-21
				Feasibility assessment by DG	Apr-21
				Purchase of EVs by Duro Green	Aug-21

Delays due to COVID-19 Pandemic

The delay in the release of tender to purchase EVs for SWM was delayed by the SMC on account of COVID-19. SMC has clearly established the need for transitioning its EV fleet and the specific pilot of replacing tractors in Phase-I of the transition and has committed to float the tender for purchasing 81 e3Ws to replace the tractors as soon as the situation improves in Surat.

4. PILOT IN BENGALURU: ACTIVITIES AND OUTCOME

4.1 Background and Scope

Bengaluru (old name Bangalore and also known as "Silicon Valley of India" for having a higher number of ICT based industries[6]), a capital city in state of Karnataka, is located centrally in Southern India and well connected with other locations in the region. It is the fifth largest metropolis in India. The total population of Bengaluru Urban Agglomeration is 8.5 million (Census, 2011).

Bengaluru has a vibrant ecosystem for professional, scientific, technical and research sectors. This also include information technology and startup opportunities. For the state of Karnataka, the city accounts for almost 36% of the Gross State Domestic Product. Bengaluru has the highest contribution in secondary and tertiary sector's GSDP due to high concentration of major industries and infrastructure facilities.

It is one of the progressive states in rolling out clean energy-related policies. Karnataka was also the first Indian state to introduce Electric Vehicle and Energy Storage (EVES) Policy during 2017. The aim of the EV policy is to promote manufacturing and use of battery-run green vehicles.

City Urban Freight

Bengaluru experiences the need to upgrade its transportation, infrastructure and public facilities and in the view of current situation and due to the increasing pace of city growth it is essential too. Mobility issues such as increasing road and traffic congestion, vehicular population, longer commuting interval, lesser road space is few of concerning factors for city's economic and cultural growth.

Considering Bengaluru's urban freight, this section of a report provides an overview of goods movement at intercity and intra-city level in Bengaluru. It also reviews the existing urban freight scenario of Bengaluru and also discuss the stakeholder mapping and their respective roles in the sector.

Types of Sectors, Commodities and Vehicles in Bengaluru

As Bengaluru is one of the major production hubs in south India. Few significant sectors, which are driving the demand of urban freight are listed in Figure 13.

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6 ICT: Information and Communication Technology

Figure 13: Sectors driving demand for urban freight

Some of key **consumption** sectors in Bengaluru are listed in Figure 14.

Figure 14: Key consumption sectors in Bengaluru

Also, due the increasing demand in real-estate there is higher consumption of construction material in the city.

Types of Goods and Vehicles

Mostly commercial vehicles plying in the city carry the following types of goods (BDA, 2017):

- Perishables (dairy products, food grains, vegetables, fruits etc)
- Industrial materials
- Tankers
- Manufactured goods

Industrial material depicts a higher percentage of the flow of material from within or outside the city. Regarding the broad types of freight vehicles used in Bengaluru are – multi-axled trucks, LCVs, and trucks & lorries. Out of all, LCVs are more in number. There are few major goods terminals in the city, which provide services for goods movement. These facilities also have a higher percentage of trucks, entering or exiting the city, originating from these terminals.

Figure 15 shows the major freight terminals in Bengaluru's map. One of the major transportation centers created by the state government, Karnataka Goods Transporters Association (KGTA), plays an important role in city's urban freight movement. The role of KGTA is to organize all transport operators, agents, owners, whether individuals, partners or companies or similar associations into one central corporate body for the whole state of Karnataka. City also has a number of terminals and warehouses, which are mainly located in the outskirts. Several large retails, FMCG and e-commerce players have already set up a number of fulfillment and distribution centers, and logistics parks within and outside the city.

The above facilities provide the management of services which include - inbound services, warehousing services, and outbound services. The freight vehicles, which account for almost 34% of the total commercial vehicles operating in the city, are responsible for congestion and pollution in the city (Government of Karnataka, 2019). Amongst the freight vehicles, multi-axle trucks were estimated to be 19%, trucks and lorries to be 26%, while LCVs accounted for 55% of the share in 2019.

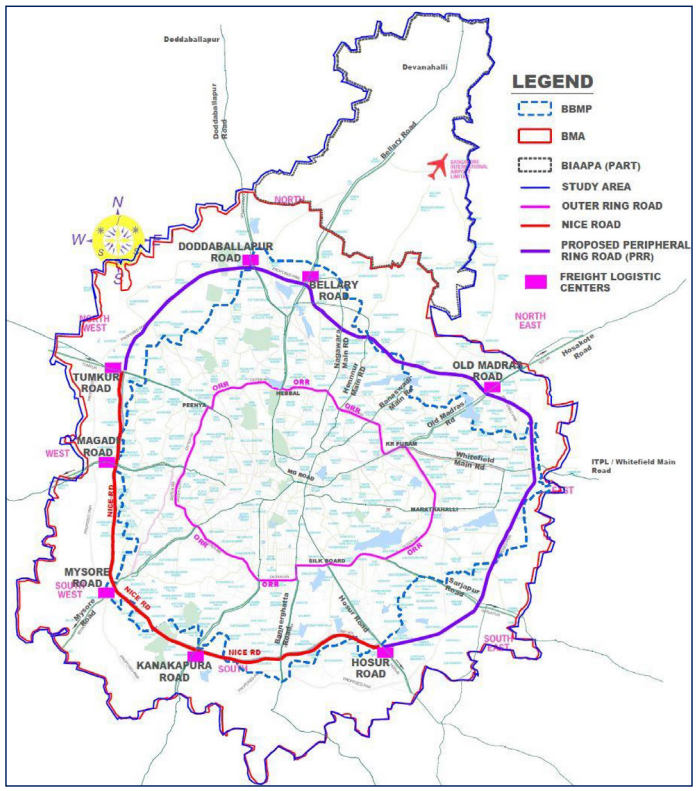

Figure 15: Major freight terminals in Bengaluru

Source: Comprehensive Mobility Plan

4.2 Engagement with DULT

The Directorate of Urban Land Transport (DULT), which is a state level organization established under the Urban Development Department (UDD) in 2007, aims to promote sustainable mobility in urban areas in the state.

In collaboration with DULT, TERI initiated dialogue on sustainable urban freight in Bengaluru. The MoU focuses on carrying out capacity building activities and initiate clean technology pilots in the city. It also aims at developing urban freight policy framework for Karnataka along with comprehensive urban logistics plans. TERI has also conducted a stakeholder workshop to discuss pathways for decarbonizing urban freight in Bengaluru.

4.2.1 Workshop with Stakeholders

The workshop was jointly organized by TERI and DULT in April 2021 with the specific objective to discuss solutions for sustainable urban freight in Bengaluru. The workshop aimed to bring all the city stakeholders on one platform and discuss the potential of sustainability in urban freight in Bengaluru.

It was concluded that along with data collection for freight behaviour, sensitizing the stakeholders about the available alternate technology and their benefits will help to switch to sustainable freight activities.

4.3 Way forward

TERI aims to carry out the sector specific pilots of the city of Bengaluru. With addition to the pilot projects, TERI along with DULT is looking forward to come up with policy interventions to streamline the urban freight operations of the city.

5. COST AND EMISSION SAVINGS – SWM, SURAT

5.1 Potential GHG Savings

The earlier chapter on Surat had highlighted the current GHG emissions of 16 tonnes daily from SWM vehicles in Surat. These emissions are expected to increase with the increasing population, waste generation, and SWM vehicles in the city. However, transition to EVs can significantly mitigate the present and future emissions from Surat SWM.

To calculate the GHG emissions from solid waste management operations in Surat, data of daily run of different type of vehicle along with their fuel consumption was fetched from primary and secondary sources. The emission factor for SCVs was taken from India Specific Road Transport Emission (GHG program document)[7] and GHG emissions for current SWM operation were identified. The factors used for the calculations are listed in the annexure.

To derive the net savings in emissions, the electricity requirement for EV operation was identified and emissions related to electricity consumption were calculated. Net emission savings were derived from subtracting the emissions from electricity usage from current emissions from SWM operations.

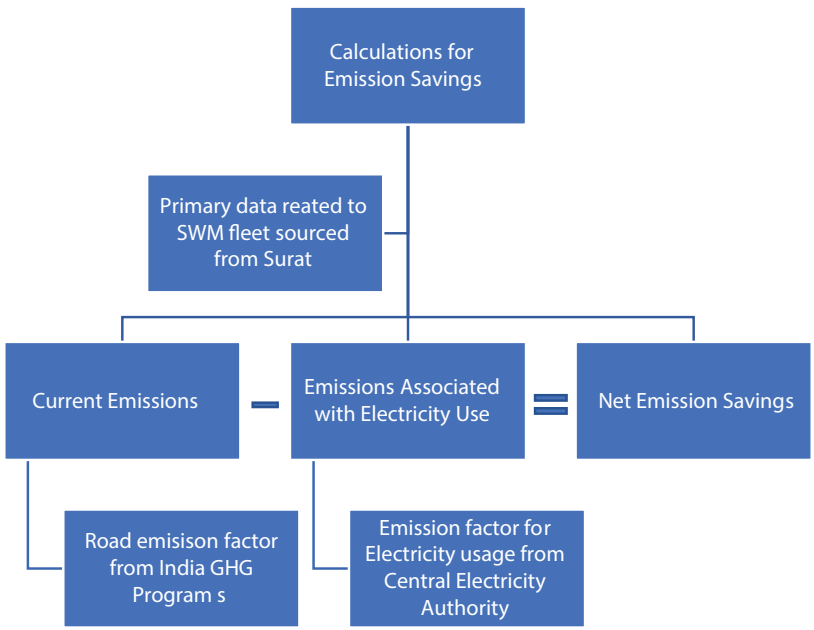

Figure 16: Methodology for Emission Estimation

[7] India Specific Road Transport Emission Factors;
https://shaktifoundation.in/wp-content/uploads/2017/06/WRI-2015-India-Specific-Road-Transport-Emission-Factors.pdf

Table 9 shows a three-phase strategy envisioned by SMC to electrify its SWM fleet. TERI estimated GHG emission reduction potential, with respect to 2021 levels and successful EV transition under the proposed three phases. Figure 10 shows the potential GHG mitigation from the proposed pilot and subsequent scaling up of the experience within Surat.

Table 9: Plan for EV transition in Surat's SWM fleet (July 2021)

EV Transition Phases	Year	Pilot Scales	Predicted Savings in GHG Emissions (tonne/km)	Savings in Fuel Cost (₹/year)
Phase I	2021	Replace 21 tractors with EVs	192	₹52,17,060
Phase II	2022	Replace all tractors with EVs	1,908	₹5,16,73,733
Phase III	2023	Replace all tractors and all SCVs with EVs	4352	₹11,68,35,869

Source: TERI analysis

After converting all SCVs into electric vehicles, Surat will save 4 tonne CO_2 per metric tonne collection of solid waste from the city. Along with the increase in electrification, GHG savings are increased substantially, even with coal-powered electricity generation.

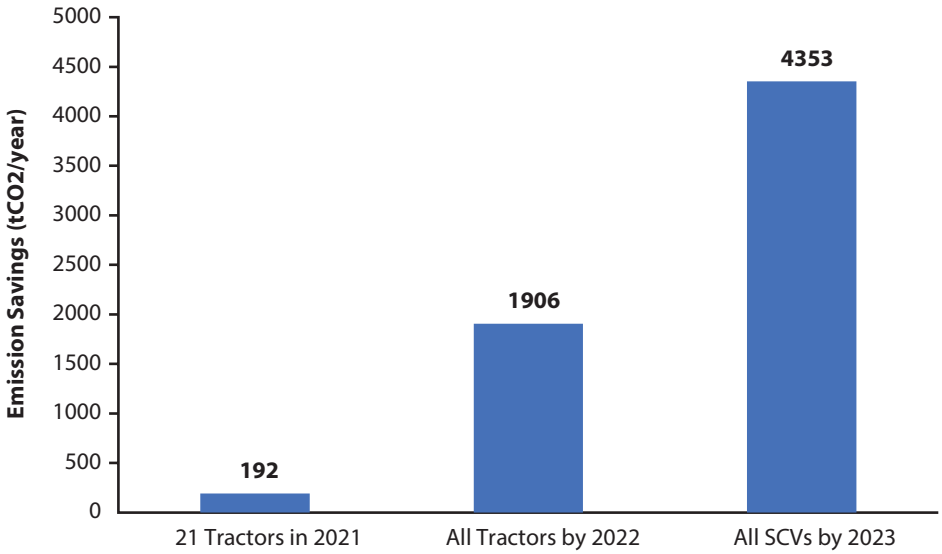

Figure 17: Phase-wise GHG emission mitigation from Surat SWM EV transition

Source: TERI analysis

The phase-wise transition to electric vehicle will lead to gradual increase in emission savings. Figure 18 shows the potential savings from electrification.

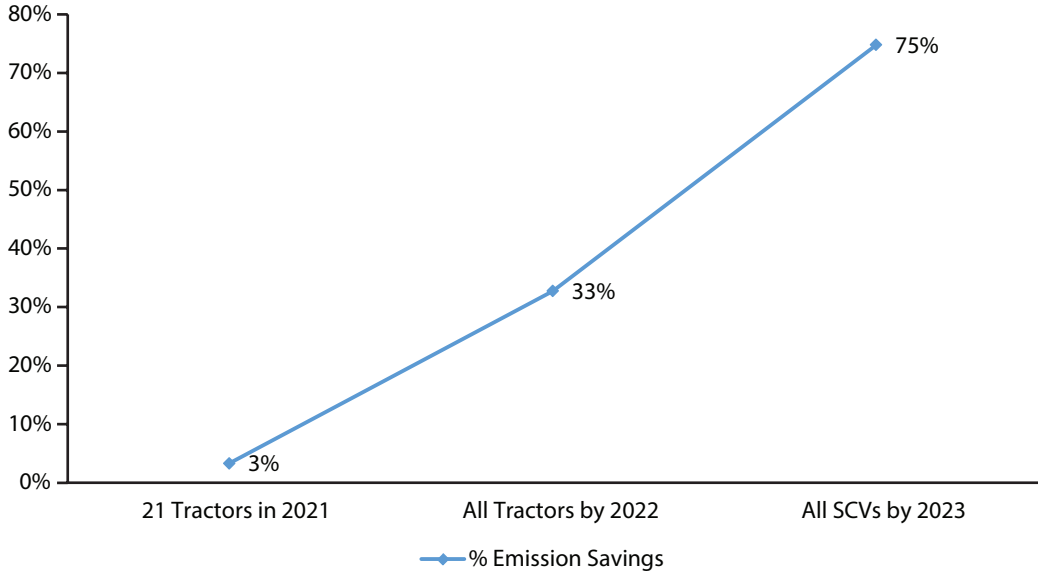

Figure 18: Percentage Emission Savings

Source: TERI analysis

5.2 Potential Cost Savings

The daily fleet of SWM operations covers around 8,000 kilometres and consumes 6,000 litres of diesel. The higher cost of diesel increases the total operating cost of SWM vehicles. Unit cost of electricity is comparatively very low and switch to electric mode of mobility it will result into higher savings.

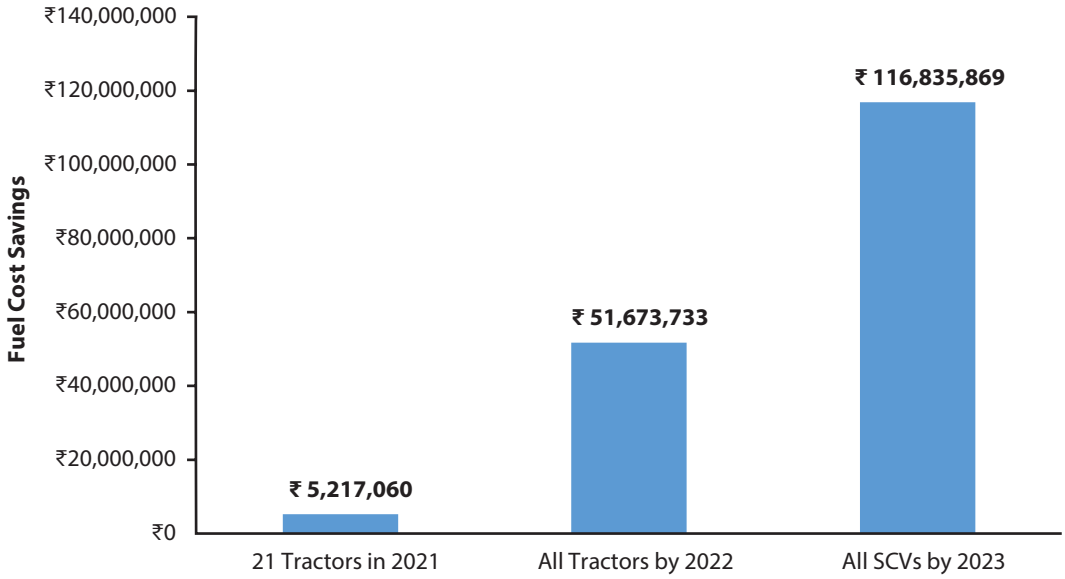

Figure 19: Fuel Cost Savings by EV Adoption

Source: TERI analysis

The dialogue with OEMs and EV users revealed that as solid waste management is more of a volumetric operation, ICE vehicles can be replaced by the same number of electric vehicles. The lower cost and additional benefits from FAME-II and other state subsidies will lower down the capital cost of vehicle significantly. For the specific case of Surat, SMC will save up to 57% of the capital cost at the end of phase-3 of pilot project.

The fuel costs are calculated on the bases of quantity of fuel utilised in both the scenarios. The diesel price and unit cost of electricity for Surat are sourced from the secondary sources. Figure 18 shows the annual fuel cost savings from the electrification of SWM fleet in Surat for the decided transition timeline. It is important to not here that, electrification will save the 98% of the fuel cost of SCVs.

6. NATIONAL SUSTAINABLE URBAN FREIGHT COALITION

6.1 About SUFC

The Sustainable Urban Freight Coalition (SUFC), initiated by TERI, is a consortium of stakeholders of urban freight including central government agencies, state and local governments, vehicle manufacturers, logistics service providers, research and academic institutions, and civil society and industry members. Figure 20 lists the vision and mission this coalition.

Sustainable Urban Freight Coalition

SUFC's Vision

Achieving Sustainablity in Urban Freight Operations in India

SUFC's Mission

SUFC is committed to making freight movements innovative, efficient, climate-friendly and help India be a leader in Green-Freight

Figure 20: SUFC vision and mission

SUF Coalition's aim

- Create, compile and disseminate sustainable urban freight-related knowledge
- Build capacity of government and private stakeholders for interventions to reduce costs and emissions from urban freight
- Facilitate sharing of sustainable urban freight-related experiential knowledge to identify, replicate, and scale best practices
- Facilitate sustainable urban freight policies and clean technology pilots in varied urban freight applications and facilitate regional and national scaling of successful pilots
- Test, promote, and scale innovative solutions for decarbonizing urban freight in India

SUF Coalition's actions

Figure 21 displays the four broad areas of actions to be undertaken by the sustainable urban freight coalition.

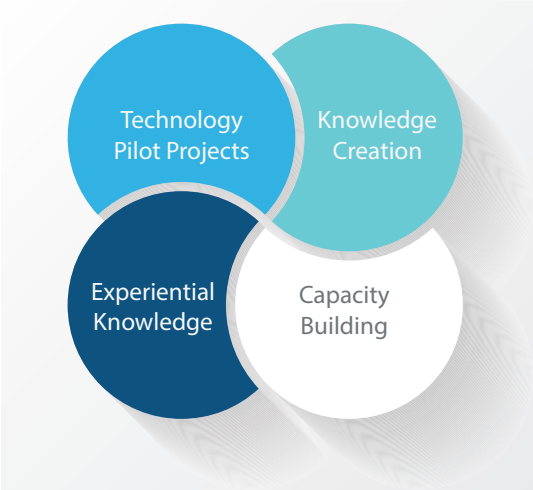

Figure 21: Actions of SUF Coalition

- **Knowledge creation**
  - SUFC will create and maintain a digital platform to facilitate the literature and resources like research papers, case studies, toolkits to help planners and decision makers to leverage efficient and green freight transport systems.
- **Capacity building**
  - The SUFC will conduct online and offline workshops for logistic providers, OEMs, planners and decision makers to sensitize them about economic and environmental benefits of technology transitions along with empowering them to plan better and efficient ecosystems for sustainable urban freight.

- **Clean technology pilot projects**
  - SUFC will facilitate clean technology pilots for varied urban freight use cases and will evaluate, document and publish techno-economic-environmental implications of the pilots. The coalition also aims at scaling successful pilots at regional and national levels.
- **Sharing of experiential knowledge**
  - SUFC's digital platform will facilitate the sharing of experiential knowledge of sustainable interventions related to urban freight with an aim to help interested stakeholders to choose the best suitable technology/method for planning sustainable urban freight.

Guiding principles of SUF Coalition

As a national support structure for sustainable urban freight, SUFC's vision is aligned with many Sustainable Development Goals (SDGs) as well as towards achieving India's NDC targets.

SUFC's end goal is in synergy with city's aim to tackle air pollution as indicated under the city action plan for air pollution, both of which directly aligns with SDG 3 (Health) and SDG 11 (Sustainable

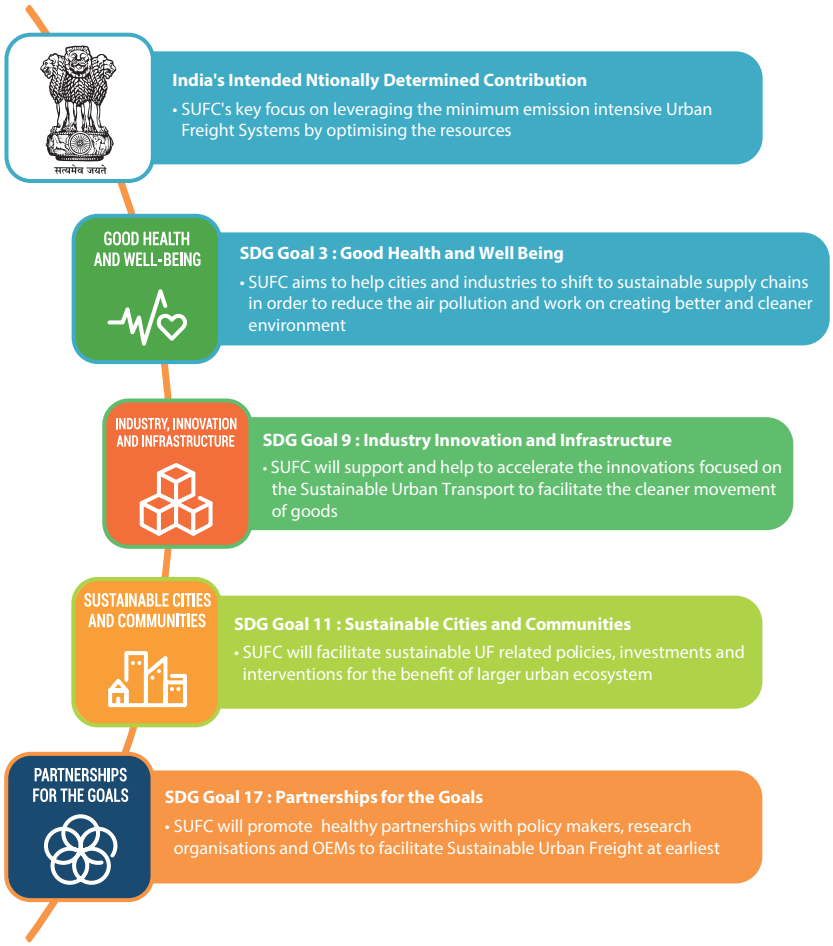

Figure 22: Guiding principles of SUF Coalition

Cities). The coalition is also determined to curate the feasible technological transitions as pilot projects with an aim to reduce cost and emissions from urban freight It envisions and promotes the partnerships between different stakeholders to achieve this goal collectively. SUFC's focus is also aligned with SDG 9 (Innovation and Infrastructure) and SDG 17(Partnerships).

SUFC is committed to achieve India's Nationally Determined Contributions (NDC) target to reduce the emissions intensity of GDP by 33-35% by 2030 below 2005 levels. SUFC aims to achieve this by reducing emission intensity of urban freight in India by the same proportion by 2030 below 2005 levels. To support India's NDC target, SUFC is also committed to achieve India's target of EV30 by 2030 by accelerating adoption of EVs and optimizing the urban freight systems.

Benefits for stakeholders on joining SUF Coalition

The sustainable urban freight coalition is an open platform for researchers, consultants, vehicle manufacturers, service providers, industry bodies as well as government departments to gain latest information and updates about the sustainable urban freight technologies and solutions. Members can also use this platform to showcase their research/ experience in the sustainable urban freight, find appropriate technology solutions, or plan policy interventions for efficient urban freight systems. Figure 23 summarizes the benefits of joining SUFC by stakeholder category of individuals, government agencies, OEMs, and private organizations.

Figure 23: Benefits of SUF coalition for stakeholder groups

Current members of SUF Coalition

Figure 24 lists the stakeholders who have come on board to be SUFC members during the course of activities undertaken under Phase I of pilot study.

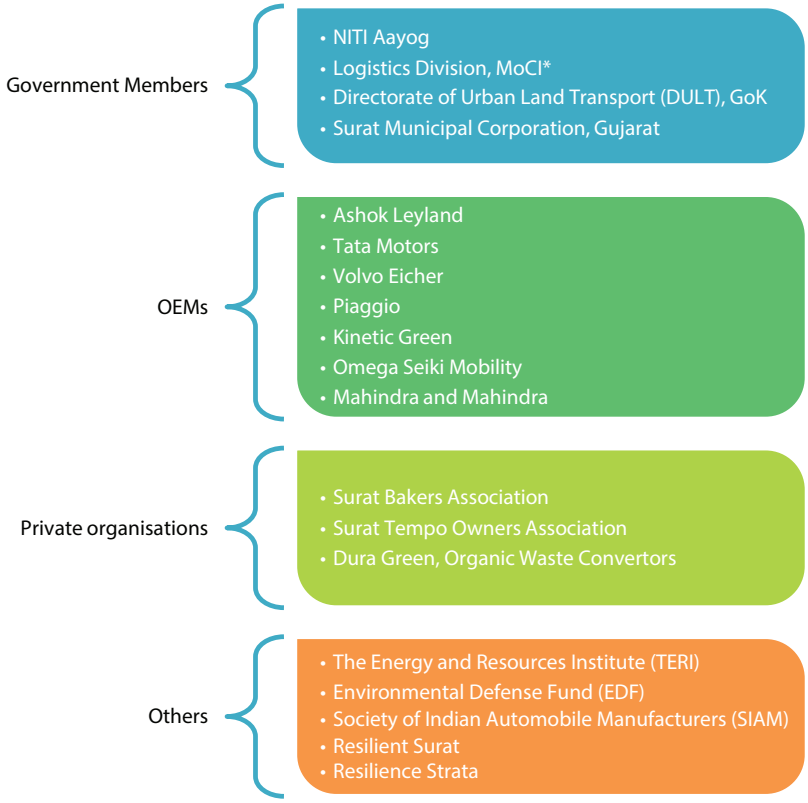

Figure 24: Current members of SUF Coalition

6.2 SUFC Platform

Figure 25 shows a screengrab of the SUFC platform's home page.

Figure 25: Screengrab of SUFC platform homepage

Sustainable Urban Freight Coalition (SUFC) platform

https://sufcoalition.org/public/index.php/#

Aim of SUFC platform

The role of urban freight in the economic and social growth of cities is very crucial. However, the externalities related to the urban freight are often undermined. The knowledge of urban freight as a different subject is often diluted and, therefore, the tailor-made policy solutions are not acknowledged. The policy support required to monitor the reduction in externalities is a requisite to promote sustainable urban freight. For the same, capacity building is required for the policymakers and knowledge support is required for the private stakeholders.

With this platform, we aim to create a knowledge repository including the information about the urban freight, which can be effectively utilized by all the stakeholders working in this domain. The repository will facilitate systematic assimilation and transformation of experiential knowledge of urban freight in evolving future policies and strategies. The repository will be created in the form of an online platform with the objectives listed in Figure 26.

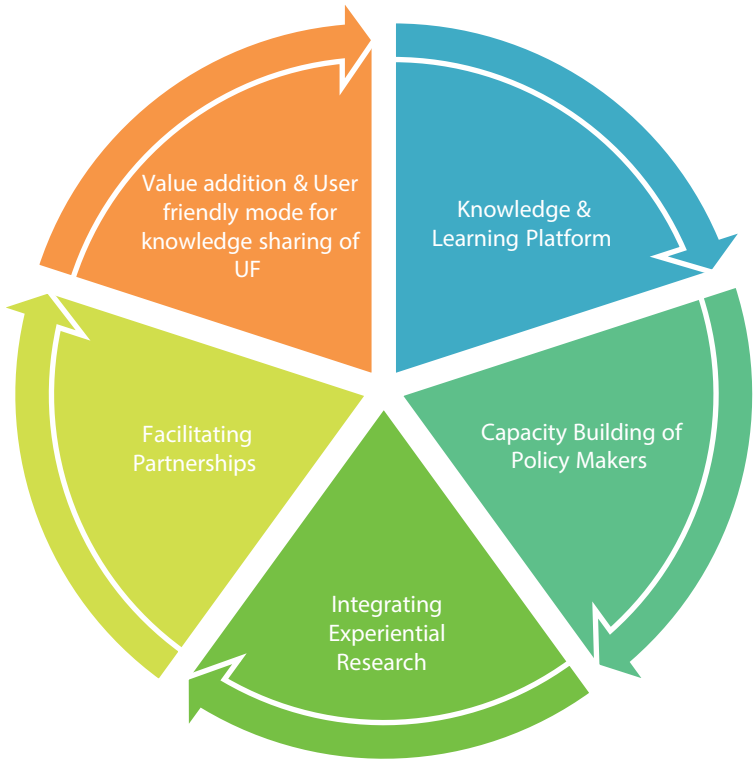

Figure 26: Objectives of SUFC platform

Uniqueness of SUFC platform

The purpose of this website is to improve the existing urban freight system in India thereby providing value addition to current knowledge spectrum of low carbon freight movement. The website will provide value addition to the current urban freight by the following ways:

- Providing knowledge about sustainable urban freight through modules
- Sharing the best practices related to sustainable urban freight both internationally and nationally.
- Bridging the gap thereby integrating the policymakers with the industry-based solution provider
- Fostering partnerships for low carbon urban freight in India

These points are summarized in Figure 27.

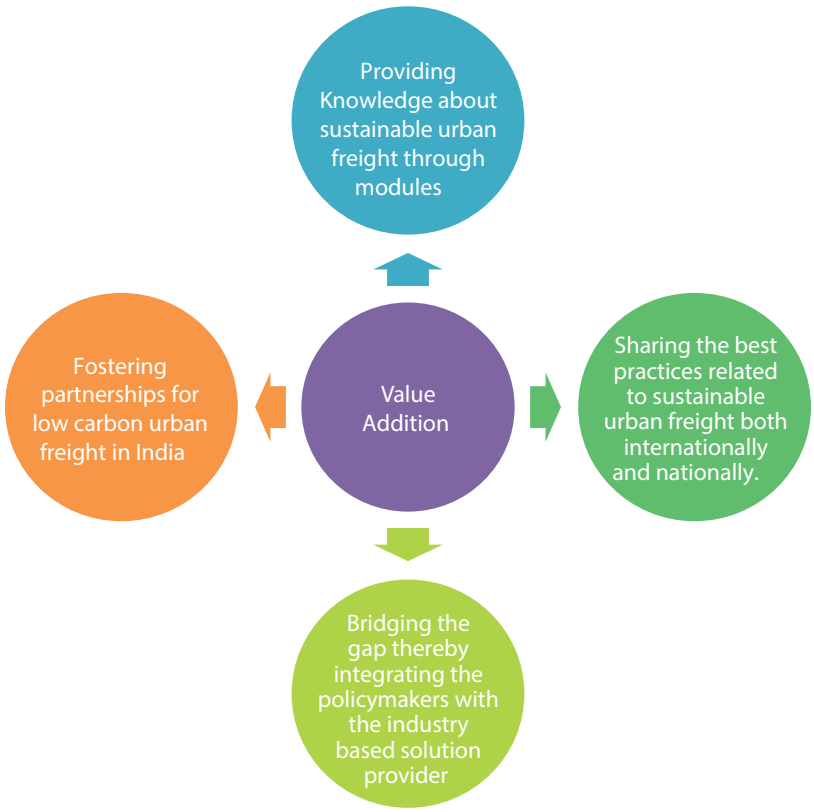

Figure 27: Value addition of SUFC platform

Strategy for knowledge products

The website will be updated on the periodic basis and online interactions and discussions will be encouraged. The update mechanism for the website is as under:

- TERI will be updating latest research, toolkits and innovations in solutions section.
- Monthly reminders will be sent to OEMs to share any updates regarding new vehicles and specifications.
- Periodic call for opinions will be shared to subscribers and on social media to engage stakeholders to share their opinions. Parallelly, fruitful discussions related to sustainable practices related to urban freight will be initiated in discussion section.

Membership and sustainability of the platform

Membership and commercial plans are part of the platform's long-term strategy and not specific deliverables of the current Phase I of the project.

There are two primary objectives of setting up a member sign-in on the website:

Streamlining knowledge inputs

- Through individual and institutional members

Achieving economic sustainability

- Through paid institutional membership from OEMs

To achieve the same, website/platform/portal intends to have two types of memberships: **Individual and partner/institutional membership.**

- The individual members can use sign-in to submit urban freight-related opinion articles, blogs, papers to be published on the website.
- Institutional members like urban local bodies can use the sign-in to share their experiential knowledge of UF initiatives. They can upload articles, videos, images, etc. for dissemination on the website.
- All individual memberships and institutional memberships from government bodies will be free. Whereas, institutional memberships of vehicle manufacturers (OEMs) have the potential to be charged as the platform also serves as an advertising space for their low carbon UF vehicles.
- The vehicle information section of the website has the potential to be developed as a revenue-earning source for sustaining the website. OEMs may also be allotted pages on the platform to advertise their sustainable products/initiatives.
- Similarly, other private stakeholders in the UF space can use the website to advertise sustainable UF products/initiatives to niche visitors of the website.
- Apart from these, TERI will have its own login to access, approve, and update the data and information being uploaded on the website.
- The knowledge products offered on the website will be accessible for free by all. However, downloading of documents would require free registration.

7. LEARNINGS FROM PHASE 1 PILOT PROJECT

7.1 Major Challenges in Electrification of Urban Freight

During the course of activities carried out in Phase-I of the study, there were a few challenges identified which are impeding adoption of EVs in urban freight applications. Following are some general challenges identified.

Lack of urban freight related data

There is no clear classified data regarding urban freight related mobility in Indian cities. Only data set available is regarding registration of light commercial vehicles. There is limited understanding of the applications of those cargo vehicles, their utilisation and trip patterns. This data is crucial for estimating environmental and economic implications of urban freight and gains to be made with low carbon interventions. Although cities have periodic comprehensive mobility plans, urban freight is largely ignored in them. Unavailability of concrete data also impedes freight related policies to come up at state and national levels. For a comprehensive national plan for low carbon transition of urban freight in India these is a need to have application specific utilisation data of cargo vehicles in the country.

Action Points: A city level data repository can be maintained where major important areas for freight movement and nature of goods shall be documented. Partnerships with logistic companies and delivery services can be developed to understand the movement of freight.

Along with the rode side and stakeholder surveys, IoT applications can be used to tract the movement of vehicles in the city. GPS history of freight vehicles can be used to extract the data. The recordings of the CCTV at junctions can also be processed to identify the important routes and stations.

Heterogeneity in vehicle specs requirement

Urban freight applications can be diverse with varied load, distance and performance requirement of vehicles. For instance, some applications like bakery and dairy products may have low load requirement but may need refrigeration technology for their loads. Whereas, applications like SWM and textile may need higher load requirement and may also demand higher performance in gradient terrains. Similarly, distance requirement and idle characteristics during the day may also vastly differ. Hence this is restricting for an overarching policy, plan or strategy for urban freight's low carbon transition. All passenger three wheelers have the same load requirement and have similar distance requirement. This is not so in the case of cargo three wheelers. Current ICE vehicles are made to cope with a diverse set of requirements. Many ICE vehicles may be underutilised as the requirements of the users may be lower.

Action Points: An inventory shall be made for different type of freight operations and their general requirements. Such inventories will help OEMs and start-ups to design the most competent products. A healthy conversations and partnerships between freight operators and OEMs can be developed.

OEMs and Start-ups need to be flexible with the requirements of customers. Through interaction with users, OEMs and Start-ups are already customising and providing solutions for specific requirements of users.

Knowledge gap for policy and adoption

Economic benefits of EV Transition of SWM have not yet been clearly documented and understood in urban freight segments. Although there has been EV adoption in many urban freight use cases like SWM, e-commerce, last mile delivery etc., the experiential knowledge has not been widely disseminated. There is a need to develop experiential knowledge regarding benefits of low carbon initiatives in urban freight to guide sustainable policy and faster adoption of new technologies. Phase-I pilot studies showed how capacity building workshops can clearly help accelerate EV adoption. In order to maximise impact, the capacity building workshops for low carbon interventions in urban freight must be use-case specific. It was observed that there is a large willingness to shift to EVs by freight operators provided the economics makes sense. There is also capacity building requirement for vehicle users through demonstration of EVs in their local operations.

Action Points: More and more research and pilot implication in the field of urban freight shall be encouraged. Availability of information on successful EV transitions in Indian cities will reduce the hesitance. The awareness campaigns, advertisement shall also include such examples along with the statistics. Along with SUFC platform other platforms and initiatives like Freight Smart Cities will help bridging the knowledge gap.

Limited choice of EVs for cargo applications

During the course of pilot study in Phase-I, on behalf of SMC, TERI invited tentative quotations from all OEMs to replace operations of 21 tractors collecting commercial waste in central zone of Surat. As it was shown in this chapter, the quotations were received from only three-wheeler manufacturers. In fact, there was no four-wheeler cargo electric vehicle available in the market. This was discouraging factor for SMC as all SCVs deployed by them for waste collection presently were four wheelers. Similarly, stakeholders like bakeries in Surat also largely rely on four-wheeler ICEs for their operations. As only three-wheeler cargo vehicles were presented and those too made limited economic sense, some stakeholders went ahead to purchase e-rickshaw versions for their operations. SMC clearly expressed their need for higher load carrying EVs but OEMs were not able respond with such products.

Action Points: OEMs shall be promoted to manufacture the new EVs keeping in mind the particular requirements for freight movement. An interactive mechanism for understanding the requirement shall be developed.

New state EV policies have declared handsome incentives for setting up manufacturing plants for EVs. Such initiatives will certainly boost the vehicular availability.

Optimising vehicle utilisation and charging

The targeted pilot in Surat's SWM focussed on replacing the most inefficient operations. These were heavily underutilised tractors carrying just about 800kgs per trip, while consuming about 10 litres in doing so. While a plan was being made to replace these tractors, SMC initially estimated a large number of EVs needed as each tractor would need to be replaced with more than one EV. This was the case as most EVs presented by OEMs had payload capacity less than 500 kgs. This estimation method was making EVs not a financially viable solution for replacing the target operations. This isn't the case if utilisation of each EV is increased by increasing the number of trips. Optimising for time and charging, in fact, less than one EV will be required for replacing the current operations by the selected pilot area. Hence there is a need to focus on the operations than the vehicles in order to optimise the freight transportation while transitioning into cleaner technologies.

Action Points: The cities must plan the charging infrastructure based on the freight vehicle movement and their major stopping points. Special incentives can be designed to set up the charging stations at potential loading-unloading spaces.

All the OEMs can provide an IoT dashboard to track the remaining battery capacity and indicate the need of charging. Vehicles with swappable batteries shall be encouraged to decrease the charging time.

7.2 Policy Learnings and City Blue Print for EV Transition for SWM

The pilot experience in Surat can be scaled locally, regionally, and nationally. In the subsequent phases of SUF Coalition activities, the pilot exercise for Surat SWM can be replicated in other cities. SUF Coalition can follow a similar format but include multiple municipal bodies together in the capacity-building workshop. The experience TERI gained from developing request for quotations, economic feasibility of pilot, and preparation of municipal tender can be utilized in aiding many other municipal bodies simultaneously. In SUF Coalition's subsequent phases, strategies can be made to electrify waste collection in all the cities in India. Phase-wise strategy document may be prepared by SUF Coalition to act as a guideline for phase-wise transition of waste collection in Surat. The proceeding of Surat SWM workshop already acts as a capacity-building document for other municipal bodies to refer to.

Steps for city governments to electrify SWM fleets

Based on experience gained from activities and engagement conducted for electrifying SWM in Surat, a step-by-step guideline for electrification is prepared as a learning and presented here. This will serve as a blueprint for city governments to electrify their respective solid waste management fleets.

Step 1: Secondary assessment of techno-economic potential of EVs in city's SWM

The initial step in electrifying any fleet is to understand the existing operations and the potential of the same to be replaced by EVs. This would include understanding techno-economic trip details

of primary and secondary waste collection. The following are some of the data points that would help conduct this assessment:

- Types of vehicle models used for primary and secondary transportation
- Number of vehicles (by vehicle type)
- Average distance per trip (by vehicle type)
- Average waste per carried per trip (by vehicle type)
- Number of trips per day (by vehicle type)
- Idle time per day per vehicle
- Parking location of vehicles (by vehicle type)
- Fuel consumed per vehicle per day

Step 2: Workshop with EV OEMs with assessment results

An initial workshop may be conducted with manufacturers of electric vehicles within which the current operational details compiled in Step 1 discussed with the OEMs. The OEMs will give their perspective into potential of EV to replace the operations. The city government can also understand the availability of EVs in the market as well as the willingness of the OEMs to sell in their respective cities. The initial workshop intends to engage the OEMs with the city government and identify working groups for planning pilot intervention.

Step 3: Selection of pilot intervention area

Based on a positive response from OEMs regarding EV transition of the city's SWM, a particular set of waste operations may be selected for intervention. For the initial phase, the areas located near collection facility can be chosen to avoid the need of charging during the operation. Along with the range, other parameters like loading capacity of EV and pollution reduction potential shall also be assessed. In the case of Surat, collection of commercial waste by 21 tractors was selected as the operations.

Step 4: Data collection of current operations in target area

A more detailed dataset like the one mentioned in Step 1 must be prepared to showcase the operations that need to be replaced. So as to optimize transport resources, the focus should be on replacing the operation, not the ICE vehicle by another EV. In the case of SWM, the focus must be the waste collection activity and not the number of vehicles deployed in the same. This will help to take into account and improve on existing inefficiencies while facilitating a technology transition to electric.

Step 5: Float request for tentative quotations for replacing target operations

Once the operations to be replaced in the first pilot is identified and data related to the same is collected, a request for quotation may be floated for the same. Again, the request for quotation must clearly emphasize on the operations to be replaced and not on the number of electric vehicles to be procured. In this way, OEMs will suggest the optimal number of vehicles with optimal utilization in order to replace the targeted operations.

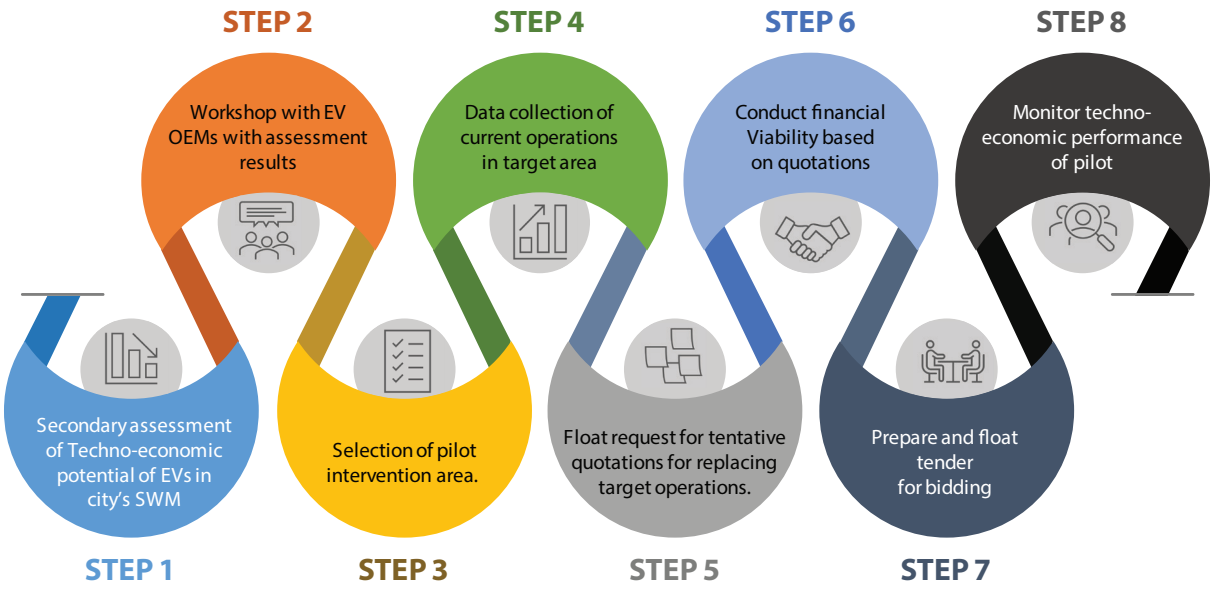

Figure 28: Steps to preparing 100% EV transition timeline for city SWM

Step 6: Conduct financial viability based on quotations

Based on quotations received, economic benefits of transitioning selected operations to electric can be realistically estimated. The difference in TCO and Operation cost for conventional vehicle and EV shall be compared to check the economic feasibility of EV for selected operation. This can help the city government justify the pilot intervention.

Step 7: Prepare and float tender for bidding

Based on financial viability assessment and feedback received from the initial call for tentative quotations, the city government can prepare a tender to attract the best competitive bids from OEMs. Due to multiple interaction with OEMs, the city government will be able to develop a comprehensive and technically strong tender and hence attract bids from a good number of OEMs.

Step 8: Monitor techno-economic performance of pilot

Once the pilot on ground is functional, the city government must monitor the daily operations of EVs to document the real techno-economic benefit of this transition. This monitoring can also help optimize charging for further scaling. Such monitoring is necessary for documenting caveats of EVs in specific use-case of waste collection. In order to optimize deployment of EVs to maximize economic and environmental savings, it is imperative to monitor challenges like performance loss of EVs due to overloading.

Prepare 100% transition timeline

Based on successful monitoring results of the pilot, the city government must prepare an overall transition timeline for electrifying its SWM operations. This can be divided into phases based on vehicle segments of spatial locations in the city. In the case of Surat, the most environmentally and economically inefficient operations of collection like using tractors were targeted first to be

transitioned into EVs. The city may have a procurement strategy for the vehicles either through budgetary plans or by mandates for transition in their respective SWM policy. The EV mandates are ideal for situations where SWM is carried out by third party service contractors. Figure 28 summarizes the steps towards preparing 100% timeline for EV conversion of SWM fleet for any city government.

7.3 Planning for Sustainable Freight Movements: Learnings with DULT

The major issue faced by Bengaluru is the extremely high number of vehicles, resulting in congestion, delays and higher emissions. For this, technological advancement like EVs can only help reduce emissions, however, the issue of congestion cannot be addressed. To derive a holistic solution to the issues related to transport, there is a need to develop comprehensive logistics plan for cities, including Bengaluru.

Need and Scope of City Logistics Plan

A conceptual framework backed by the analysis of growth patterns of freight activities of the city can help solve a range of issues related to urban freight activities. The development of logistics plan will involve a detailed study of freight movement in the city and associated infrastructure, and help identify major routes and hotspots of freight movement.

Based on this analysis, regulatory measures can be implemented on congested routes and alternate routes can also be promoted. The restrictions based on peak-hours can be imposed to regulate freight movement in a city. Incentivisation can be used as an important tool to promote faster transition to clean energy fuels.

The scope of incorporating public transport systems like municipal bus services, sub-urban rail, rail, and metros can be assessed. If these systems are also used to transport freight in a city, issue of traffic congestion along with higher emissions can be resolved.

Logistics plan can also be an important tool to determine location of upcoming warehouses and intermediate delivery centres for efficient movement of urban freight.

In short, a number of measures can be taken along with electrification to solve issues related to freight movement in cities.

8. WAY FORWARD

Under Phase I of the study, TERI engaged with public and private stakeholders in Surat and Bengaluru, facilitated EV pilots in four different use-cases in Surat, conducted workshops, curated a national coalition for sustainable urban freight, and developed an online knowledge-sharing platform dedicated for sustainable urban freight. TERI has laid a foundation for the envisioned national support structure for cost and emission reduction from urban freight. The activities towards facilitating pilots have given crucial learnings that could be replicated and scaled across regional and national levels. TERI envisages various activities along with pilot implementations such as, developing urban freight policy framework, comprehensive urban freight plans and organising capacity building workshops and stakeholder dialogues.

Pilot Projects: Low Carbon Technologies for SWM and other operations

Going forward, EV pilot experience from Surat may be scaled and replicated in the subsequent phases of this project. SUF Coalition will facilitate Surat Municipal Corporation and other similar agencies to scale up the adoption of EVs and other low carbon fuels. SUF Coalition will engage and bring together decision-makers from multiple cities to chart out EV transition plans for their respective SWM fleets. A state-wide approach can be adopted for the same. Through formal engagement with DULT, TERI will initiate discussions with BBMP to replicate or implement learnings from the activities carried out for electrification of Solid Waste Management in Surat. TERI will also adopt a targeted approach in various cities where different use-cases will be identified and low carbon technology will be facilitated.

City Engagement: Capacity building and Policy support

Different use cases for low carbon technologies will be identified and capacity building workshops will be organized at city and regional levels. Many more city governments will be brought on board to the growing sustainable urban freight coalition and discussions related to planning efficient urban freight systems will be initiated. TERI aims to develop blueprints of pilot project implementation for smooth facilitation for similar pilots in other cities. Apart from this, TERI aims to support urban freight-related policy formulation at national level by bringing together stakeholders with central government stakeholders. In addition to that, other policy and regulatory measures for urban freight will be identified and incorporated in pilot implementation. The long-term plan is to prepare a national roadmap for sustainable freight movements in urban centres, which will incorporate policy interventions, restrictions, mandates, logistics plan, and technological upgradation for efficient freight management.

Some of the cities identified by the Logistics Division, MoCI under the 75 Freight Smart Cities will be studied by TERI with the support of relevant stakeholders. Key cities in the state of Karnataka,

Gujarat, Maharashtra and Assam have been identified for expanding the work in the field of sustainable urban freight. It is however subject to change based on feedback from the logistics division and local partners.

Sustainable Urban Freight Coalition

SUFC will continue to develop repository of urban freight-related knowledge and quantitative data to drive informed decision-making in the urban freight sector. The aim is to expand the reach and network of SUF coalition to cover diverse and non-state stakeholders in the sector.

CONCLUSION

Indian freight transport is heavily dependent on the road sector, which accounts for about 60% of total freight activities. With regard to urban areas, freight transport account for 10-15% of vehicle kilometres travelled. With ever increasing urban population and increasing dependency on e-commerce for daily needs, the share of freight activities will increase significantly. It is important to look into the negative externalities of increased freight activities as, it will not only result in increased traffic and congestion, but will also significantly impact the environment due to heavy dependence on diesel. In continuation to the previous report on 'Roadmap for Electrification of Urban Freight in India', TERI tested and implemented the best feasible solutions for urban freight currently available. With the support of EDF, TERI has taken up pilot studies in Surat and Bengaluru to make urban freight operations more sustainable. TERI aims to study the urban freight transport of Indian cities and implement the regulatory and technical measures to bring positive change.

Along with the on-ground implementation of EV technology in the selected cities, TERI has set up 'Sustainable Urban Freight Coalition' to initiate the discussions regarding urban freight and empower stakeholders to plan better urban freight systems. A dedicated website has also been developed to facilitate knowledge and sharing of experience regarding initiatives and measures towards sustainable urban freight.

The first phase of pilot implementation was focused on implementing efficient technologies for urban freight operations in Surat. Capacity building workshops for selected use cases like, solid waste management, textile and bakery supply chain and organic waste collection were carried out and as of July 2021, 27 e-3Ws were already purchased for different applications. Surat Municipal Corporation has also committed to switch to electric vehicles for their SWM operations in three phases. The estimates for cost and emission savings for the SWM operations say that, switching all SCVs to electric vehicle will help to save up to Rs 11 crore and 5000 tonnes of CO_2 emissions annually.

The pilot project for Bengaluru was focused on bringing in regulatory measures to streamline the urban freight systems and reduce the negative externalities. The major outcome from the pilot in Bengaluru will be the 'Logistics Plan' as well as implementation of EV/low-carbon technology solutions for the urban freight sector in the subsequent phases of the study.

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ANNEXURE

Annexure-I List of Stakeholders in Surat

Public Stakeholders for Surat Pilot

Name of Organization	Brief Description	Domain
Local and State Government		
Mayor's Office	Mayor's office deals with new policy development in ULB level with the help of other sector-wise committee and councillors.	Policy Support
Municipal Commissioner's Office	The commissioner's office is responsible for implementation of the projects and leads the city administration. This office mainly works on city infrastructure.	Infrastructure Support
Traffic Cell, SMC	It mainly deals with public transport system in the city. It also plans for future city demands in the mobility and connectivity sector.	Infrastructure Support/Policy Support
Solid Waste Management (SWM) Dept., SMC	SWM department is working towards managing municipal solid waste on a day-to-day basis.	Pilot Study
Multilevel Parking Dept., SMC	This department works towards providing and operating parking infrastructure at public places in the city.	Infrastructure Support
Smart City Dept., SMC	This department supports new technologies and innovative ideas for city-level project implementation with various departments.	Infrastructure Support/Policy Support
Road Transport Officer (RTO) Surat	It is entrusted with the responsibility of providing an efficient public transportation system, control of vehicular pollution, registration of vehicles in the district, issuance of driving license, issuance of various permits, collection of road taxes.	Vehicle Registration
Police Department Surat	Traffic Control Branch, Surat Police, is the primary traffic regulatory body in Surat and is responsible for smooth flow of traffic in the city.	Traffic regulation

Name of Organization	Brief Description	Domain
Dakshin Gujarat Vij Com. Ltd.	It has functional responsibilities for generation, transmission, distribution, and trading of electricity with complete autonomous operations in South Gujarat in seven districts.	Charging Station Infra.
Climate Change Department (CCD), Govt. of Gujarat	The State Government Department undertakes actions required for mitigation of and adaptation to climate change.	Policy Development

Private Stakeholders for Surat Pilot

Private Stakeholders and Associations		
Torrent Power	It is an integrated power utility and is one of the largest private sector players in India having interests in power generation, transmission, distribution and manufacturing, and supply of power cables.	Charging Station Infra.
Financial Institutions	Financial institutions in the EV domain like Ujwal Finance Bank and Yes Bank will be engaged.	Financial Support
Insurance Sector	Organizations in vehicle insurance sector will be engaged along with financial institutions.	Loss Security
Southern Gujarat Chamber of Commerce and Industry (SGCCI)	SGCCI is committed to the development and strong evolution to the MSME segment in Southern Gujarat region by way of implementing the various initiatives of the government.	Implement support
Federation of Surat Textile Trader's Association (FOSTTA)	FOSTTA is textile traders-related management body dealing with trading issues of traders, liaising with government, goods delivery issues, etc.	Implement and infrastructure support
Weaver's Associations	Surat has several Weaver Association area-wise to protect their rights regarding the supply–demand, labour issues, and price fluctuations.	Pilot Implement support
South Gujarat Textile Processors Association (SGTPA)	SGTPA addresses common concerns of units in textile and represents them to several ministries, government departments, semi-government institutions, and private companies. SGTPA is a common platform for all the processing units of this area for constructive interaction and mutually beneficial policy making.	Pilot Implement support

Private Stakeholders and Associations		
Tempo Association	It deals with grey fabric delivery and parking issues in the textile market. The association also deals with weaver, processors, and traders for smooth operations of delivery in the textile sector.	Investor/ Operator
Labour Union	It deals with labour welfare-related issues with traders and processors associations. It is primarily concerned with employment, health, and wages of each labour of textile sector.	Pilot Implement support
Driver's Association	It deals with driver welfare-related matters with weaver, traders, and processors associations. It is concerned with employment, wages, and parking-related matter in the textile market.	Pilot Implement support
Sardar Vallabhbhai National Institute of Technology (SVNIT)-Transportation Engineering	This department has immensely contributed in conducting training programmes on 'Road Safety Engineering Measures' and 'Road Safety Audit' in Surat	Policy Development support
Sarvajanik College of Engineering and Technology (SCET)	SCET being one of the prime institutes in Surat city for technical education.	Policy Development support
Solid Waste Management (SWM) agencies	SWM agencies are third parties closely working with SWM department of SMC dealing with door-to-door garbage collection in Surat.	Investor/ Operator
Gray & Finished Delivery Contract Association	It deals with grey and finished fabric transportation inside the city. It deals with issues such as parking, wages and welfare of employees.	Investor/ Operator

Annexure – II Factors Considered for Cost and Emission Calculations

Factors Considered for Calculations		
Parameter	**Value**	**Source**
Diesel Rates in Surat (INR/ Litre)	69.21	https://www.bankbazaar.com/fuel/diesel-price-gujarat.html
Emission Factor (kg/ CO_2 per Litre)	2.64	https://indiaghgp.org/transport-emission-factors
Electricity Requirement (kWh/km)	0.078	Calculated from Battery Capacity of e-3w
Cost of Electricity	7	https://www.bijlibachao.com/news/domestic-electricity-lt-tariff-slabs-and-rates-for-all-states-in-india-in.html#Torrent_Power_For_power_supply_to_Ahmedabad_Surat_and_Dahej
Emission Factor for Electricity (tCO2/MWh)	0.79	https://cea.nic.in/cdm-co2-baseline-database/?lang=en

Annexure – III Review of Other Global Platforms on Sustainable Urban Freight

1. Freight Electric Vehicles in Urban Europe (FREVUE): https://frevue.eu/vehicles-home/	
Objective	The overall objective of FREVUE was to create an evidence base on European best practice which would underpin future uptake of EVs by private logistics operators and justify policy interventions to promote the use of EVs for urban deliveries.
Key Features	⊙ Project information: objective, approach, impact ⊙ City-based pilot information ⊙ Vehicle information ⊙ Logistic provider ⊙ Categorization of partners ⊙ Resources: Documents/reports, event information, links ⊙ Get involved
Purpose	⊙ **Bringing together** a genuine public–private partnership between municipalities and the freight and logistics sector. Key stakeholders include freight operators and fleet managers, public authorities, energy network operators, vehicle manufacturers, and ICT and service providers. ⊙ **Providing evidence** for electric freight vehicles' day-to-day reliability and suitability across a wide range of city layouts, climatic conditions, logistics chains, organizations and models, charging modes and electricity networks, and diverse political and regulatory settings. ⊙ **Disseminating and exchanging** on the project best practice examples, lessons learnt and key recommendations, promoting the further roll-out of innovative city logistics solutions using electric freight vehicles. ⊙ **Designing and implementing** a robust and structured evaluation framework to ensure that the data from each demonstrator is analysed on a common and pan-European basis.
Learning	⊙ The key feature of the website is the vehicle information and pilot information which can be added to the proposed blueprint

2. Electric Urban freight and Logistics (EUFAL): https://www.eufal-project.eu/home	
Objective	The EUFAL platform of exchange, which a consortium of seven partners from five different countries is the user-friendly web-based open-source platform of knowledge exchange providing all available data centrally. It provides support to the more accurate and cost-efficient implementation of EV in commercial vehicle fleets in Europe by offering access to planning tools for optimal fleet composition, planning urban micro-hub solutions, a long-lasting experts network for further consultancy and other. The platform of exchange, policy support documents, and the gained scientific knowledge will provide proven tools for companies and policy at different stages of EV implementation: the early planning of EV use, the implementation of EV use, and finally the optimization of EV implementation.
Key features	⊙ EUFAL Platform- Assess to Charging infrastructure, TCO, policy and regulations, tools, use-cases, vehicle technology ⊙ Scientific Methodology: Planning stages and work packages ⊙ Consortium ⊙ News ⊙ Contact
Purpose	⊙ Analysing and developing tools needed for decision support of companies interested in the implementation of EV in their commercial vehicle fleets ⊙ Developing and implementing a web-based information and knowledge exchange platform which integrates all collected and developed decision support tools for EV implementation in companies. ⊙ Supporting companies with information for EV implementations. ⊙ Demonstrating the use of the platform of exchange, and the integrated tools provided, by selected EV implementations in all participating countries. ⊙ Demonstrating commercial EV fleets at different levels of development. ⊙ Assessing and evaluating the developed platform of exchange, and the integrated tools, to ensure useful project results beyond the project. ⊙ Considering user feedback and expert knowledge in all project developments to guarantee successful EV implementations in commercial vehicle fleets.
Learning	⊙ The learning tools/modules are the unique feature of this website portal

3. Energy efficiency in City Logistics Services for small- and mid-sized European Historic Towns (ENCLOSE): http://www.enclose.eu/content.php?p=home	
Objective	Raising awareness about the challenges of energy-efficient and **sustainable urban logistics in European Small-/Mid-size Historic Towns** (SMHTs) and about the concrete opportunities to achieve highly significant improvements and benefits by implementing and operating suitable and effective measures, schemes, and framework approach specifically targeted to such class of urban environments.
Key Features	⊙ Project-overview, objectives, expected results, actions and deliverables ⊙ Forerunner and Follower towns: Best practices ⊙ Partners ⊙ Sustainable Urban Logistic Plans ⊙ Communications
Purpose	⊙ Sharing knowledge about feasible solutions for the vast number of European small-/mid-size historic towns ⊙ Investigate and demonstrate the transferability of solutions and pave the way for the dissemination and future take-up of energy-efficient and sustainable urban logistics solutions in the largest possible number of small-/mid-size historic centres throughout Europe.
Learning	⊙ The project description stating the objective, expected results, and deliverables and the best practices are the unique feature of this website
4. Alliance for Logistics Innovation through Collaboration in Europe (ALICE): https://www.etp-logistics.eu/	
Objective	ALICE, the European Technology Platform, is set-up to develop a comprehensive strategy for research, innovation, and market deployment of logistics and supply chain management innovation in Europe
Key Features	⊙ About ALICE: mission and vision, structure, documents and publications ⊙ Members ⊙ How to join ⊙ Road maps: Sustainable Logistics Supply Chains, Corridors, Hubs and Synchro modality, Systems & Technologies for Interconnected Logistics, Global supply network coordination and collaboration, Urban Logistics ⊙ Knowledge platform: Projects, funding opportunities, PI companies, documents, videos and papers ⊙ Projects ⊙ News & Events ⊙ Newsletter ⊙ Contact

Purpose	⊙ Define research and innovation strategies, roadmaps and priorities agreed by all stakeholders to achieve the ETP on Logistics vision. ⊙ Foster innovation in logistics and supply chains, stimulating and accelerating innovation adoption to make possible the growth of the European economy through competitive and sustainable logistics. ⊙ Raise the profile and understanding of new logistics technologies and business processes, monitoring progress and adjusting research and innovation roadmaps accordingly. ⊙ Contribute to a better alignment and coordination of European, national, regional innovation programs in logistics. ⊙ Provide a network for interdisciplinary collaborative research involving industry, academia and public institutions.
Learning	⊙ The knowledge platform is the unique feature of the website
5. Cleaner and better transport in cities (CIVITAS): https://civitas.eu/	
Objective	CIVITAS is a network of cities for cities dedicated to cleaner, better transport in Europe and beyond. The knowledge garnered through these practical experiences is complemented, and supported, by several research and innovation projects (ECCENTRIC, PORTIS and DESTINATIONS), also run under CIVITAS. CIVITAS offers practitioners' opportunities to see innovative transport solutions being developed and deployed first-hand and learn from peers and experts working in the field. CIVITAS nurtures political commitment, new marketable solutions, and offers funding and knowledge exchange to create growth and better connected, more sustainable transport modes.
Key Features	⊙ Mobility solutions- Mapping mobility solutions ⊙ Communities- Pilots of cities and thematic groups ⊙ Projects- Labs, research support ⊙ News ⊙ Events ⊙ Resources- Knowledge base, tool inventory, learning centre, forum ⊙ About
Purpose	⊙ One-stop solution provider for low carbon transport projects
Learning	⊙ The mapping of the mobility solution representing localized solution is the key feature of this website.

6. Rail freight Project (FUTURA): http://www.projectfutura.com/project/	
Objective	The main objective of the action is to provide last development steps for the market launch of Divided Rail Freight Brake Disc (DRFB disc). DRFB disc is a revolutionary solution, influencing three key elements in the rail freight transport: 1) safety and security, 2) health and environment and 3) cost-effectiveness with strong horizontal and vertical 'spill-over' effects and crucial social, economic and technical impacts.
Key Features	⊙ Home ⊙ Project - Optimization of drfb disc crown, optimization of drfb disc hub, laboratory testing and UIC standard compliance, testing in real environment and pilot implementation, validation of the business model, communication, dissemination and exploitation, project management ⊙ Consortium ⊙ News and updates ⊙ Deliverables ⊙ Contact us
Purpose	The FUTURA action will improve the quality and safety of life of over 55 million of EU citizens, who live or work near train tracks. The aim of commercializing the innovation is to capture 7% of the market share in the production of brakes for rail freight wagons on the global market.
Learning	The website is focusing on the rail freight project
7. Deploying cooperative logistics (CO-GISTICS): http://cogistics.eu/#	
Objective	CO-GISTICS is a consortium of 33 local authorities, logistics and freight organizations, large private companies and SMEs working towards the deployment of cooperative ITS services for logistics. CO-GISTICS is the first European project fully dedicated to the deployment of cooperative intelligent transport systems (C-ITS) focused on logistics. CO-GISTICS services are deployed in seven European logistics hubs: Arad (Romania), Bordeaux (France), Bilbao (Spain), Frankfurt (Germany), Thessaloniki (Greece), Trieste (Italy) and Vigo (Spain).
Key Features	⊙ About us ⊙ Get involved ⊙ Logistics hubs: Details of services ⊙ News and events ⊙ Media room ⊙ Contact

Purpose	⊙ CO-GISTICS deploys five services: ⊙ Intelligent Truck Parking and Delivery Areas Management ⊙ Cargo Transport Optimization ⊙ CO2 Footprint Monitoring and Estimation ⊙ Priority and Speed Advice ⊙ Eco-Drive Support
Learning	⊙ The CO2 monitoring and estimation tool is the highlight of the website
8. Baltic Sea Region electric (BSR Electric): https://www.bsr-electric.eu/use-cases/urban-logistics	
Objective	The project BSR electric aims to enhance the utilization of e-mobility in urban transport systems around the Baltic Sea Region by demonstrating potential applications of various types of urban e-mobility such as electric city logistics, e-Bikes, e-Buses, e-Scooters and e-Ferries. Transnational pilot activities will outline how different e-mobility applications can be implemented in practice and will guide public authorities, companies, planners, and transport providers in the process of integrating these into urban transport strategies.
Key Features	⊙ Home ⊙ Project ⊙ News ⊙ Events ⊙ Use-cases: Pilots on various segments ⊙ Partners ⊙ Results project findings: road map
Purpose	⊙ Analysis and overview of e-mobility in the Baltic Sea Region ⊙ Demonstration of activities, feasibility studies, and stakeholder analyses ⊙ Development of specific recommendations based on findings and results of piloting activities ⊙ Creation of BSR road map on e-mobility, compiling best practices and specific results ⊙ Dissemination of results and capacity-building programmes ⊙ Capacity building
Learning	⊙ The use-cases giving case study-based information is the unique feature of the website.

9. Transport Decarbonization Alliance (TDA): http://tda-mobility.org/	
Objective	The Transport Decarbonization Alliance (TDA) was launched in 2018 as a unique collaboration to accelerate the worldwide transformation of the transport sector towards a net-zero emission mobility system before 2050. The TDA is a unique collaboration between countries, cities/regions, and companies the '3 C's' to accelerate the worldwide transformation of the transportation sector towards a net-zero emission mobility system before 2050.
Key Features	⊙ Home and About us: About the initiative background, objective and governance ⊙ TDA members ⊙ Supporting organizations ⊙ Communities of interest: Fast Track to Transport Decarbonization, Urban Freight, Executive Education on Transport Decarbonization, Action Group ZEFV ⊙ TDA News ⊙ Contact us
Purpose	⊙ **Substantiated scaled-up ambition for the transport sector:** designing a common vision for 'front-runners' ⊙ **Tangible action:** setting up '3 Cs Communities of Interest' ⊙ **Effective advocacy:** Influencing political decision-makers in key international fora on climate change (e.g. UNFCCC), sustainable development (e.g. UN High-Level Political Forum – SDGs); international political processes (e.g. EU, G7, G20, B20) and through bilateral dialogues.
Learning	⊙ The community interest tab featuring the customized solution for different groups is the key feature of the website