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Intra-city EV charging optimization based on vehicle usage pattern and traffic congestion analysis

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Major Drivers for E-Mobility

15 of world's top 20 polluted cities in India

High dependence on oil imports

India's Second Biennial Update Report to the UNFCCC recognizes the path forward

"**Transport is the second largest contributor** to the country's CO_2 emission and a major cause of air pollution"

"As vehicle ownership in India is set to rise substantially, an opportunity exists to **diversify the transportation fuel mix** to the benefit of the broader economy"

India is on-track to meet its emissions targets

India's Nationally Determined Contribution (NDC)

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

2005		2030
0.47	33 - 35% ↓	0.31
MT CO_2 / \$1000 GDP	**Reduction in Emissions Intensity**	MT CO_2 / \$1000 GDP

Already reduced emissions intensity by 21% from 2005 -14

(India makes up 7% of the global CO_2 emissions as per a 2017 study)

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Policies are being put in place to address Transport emissions

National Mission on Electric Mobility Plan

FAME I

FAME II

2020 Targets	6 - 7M elec. / hybrid vehicles 400K passenger BEVs

National E-Mobility Programme

2030 Ambition	> 30% electric vehicles

Niti Aayog Targets

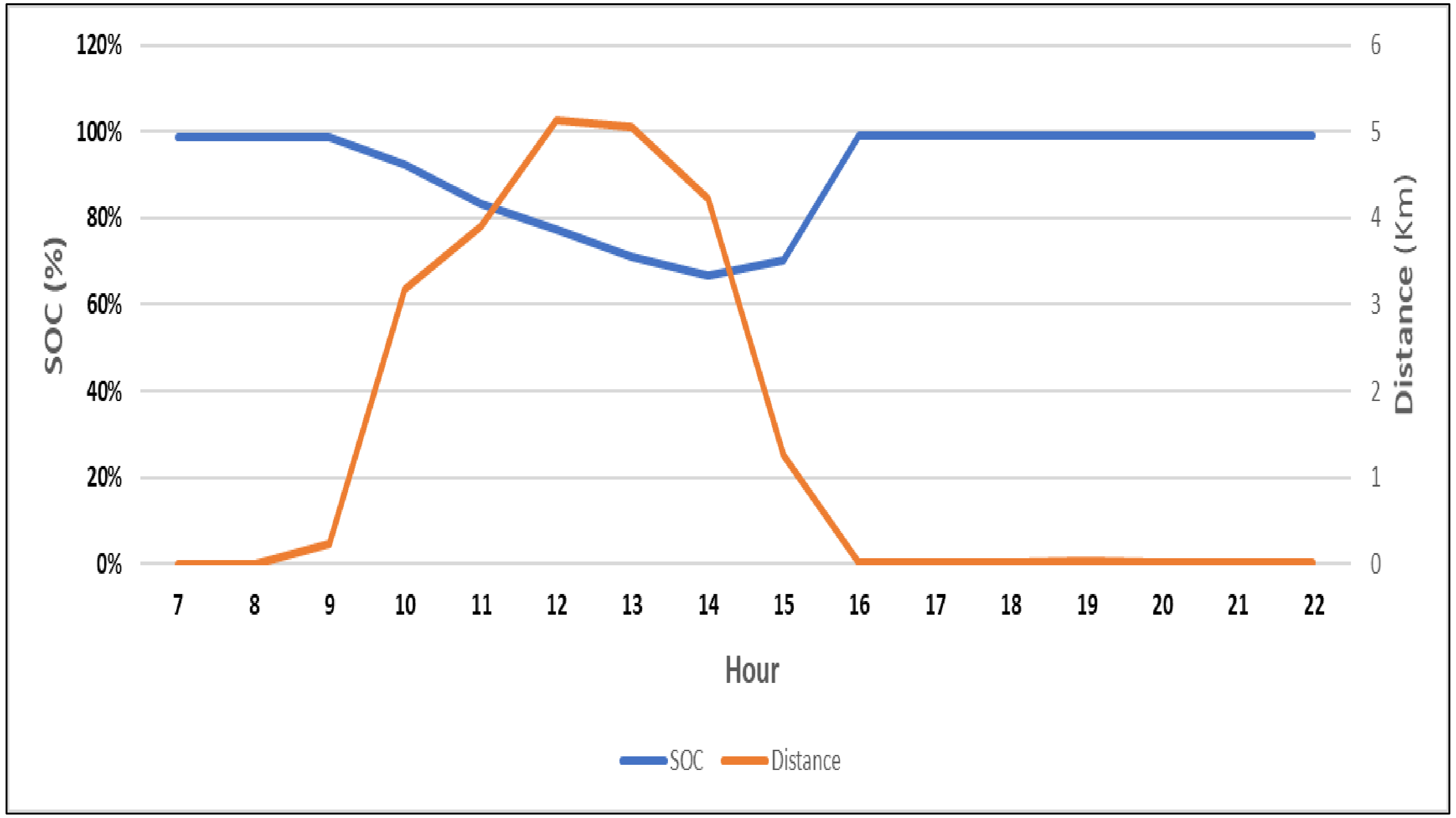
Goals	100% 3W by 2023 100% 2W <150cc by 2025 100% 4W by 2030

Vehicle Usage Pattern

Vehicle and Battery Specifications

Battery Capacity	280 Ah
Technology	Lithium-ion
Battery on-board power	15.4 kWh
Driving Range	140 Km

Vehicle Driving and Energy Consumption pattern



Key Points:

- Start the day of operation with 100% SoC
- Plug-in for charging at the end of operation
- Need to set SoC_{min}
- Traffic congestion an important factor in deriving the vehicle range

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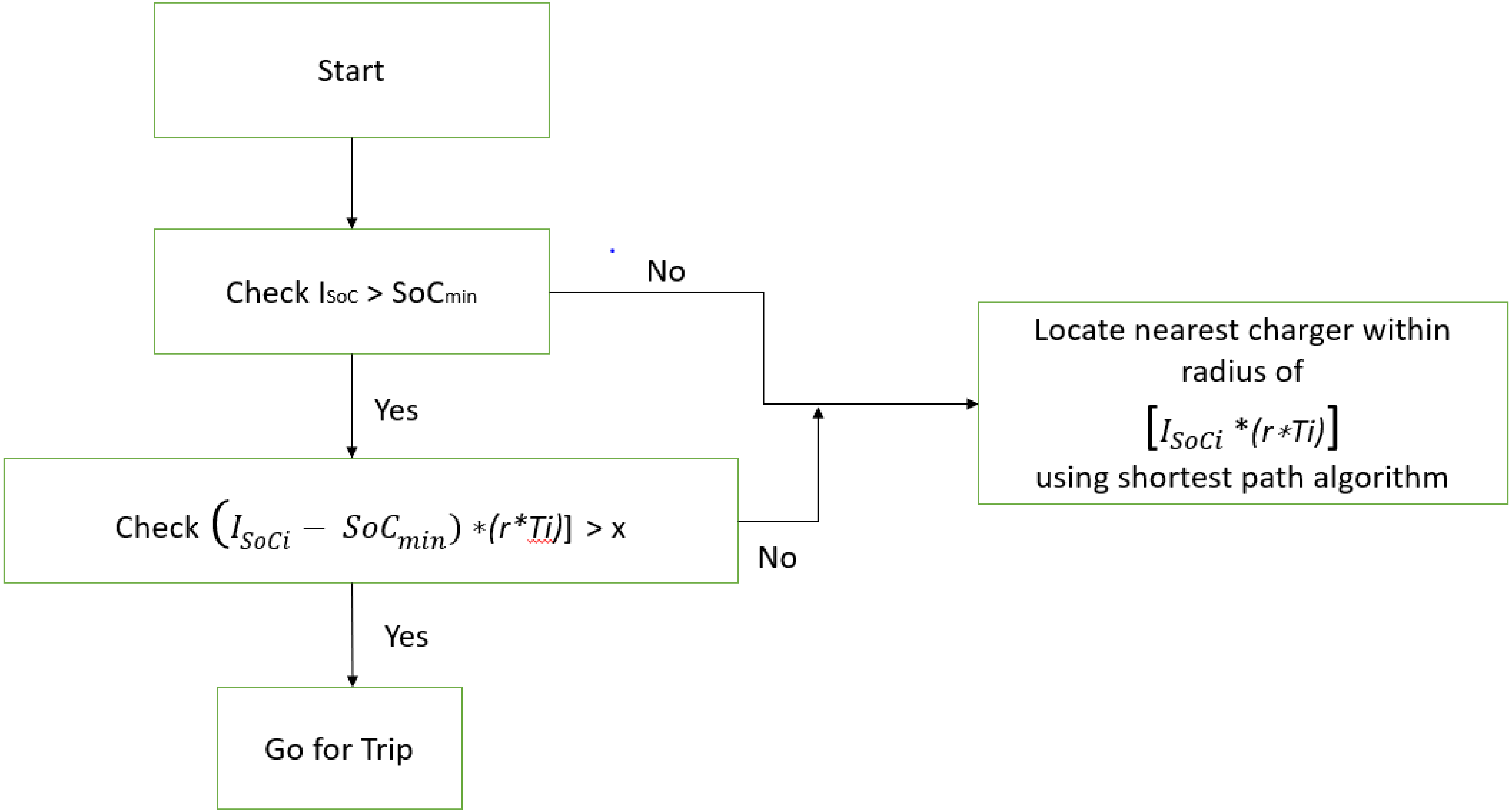
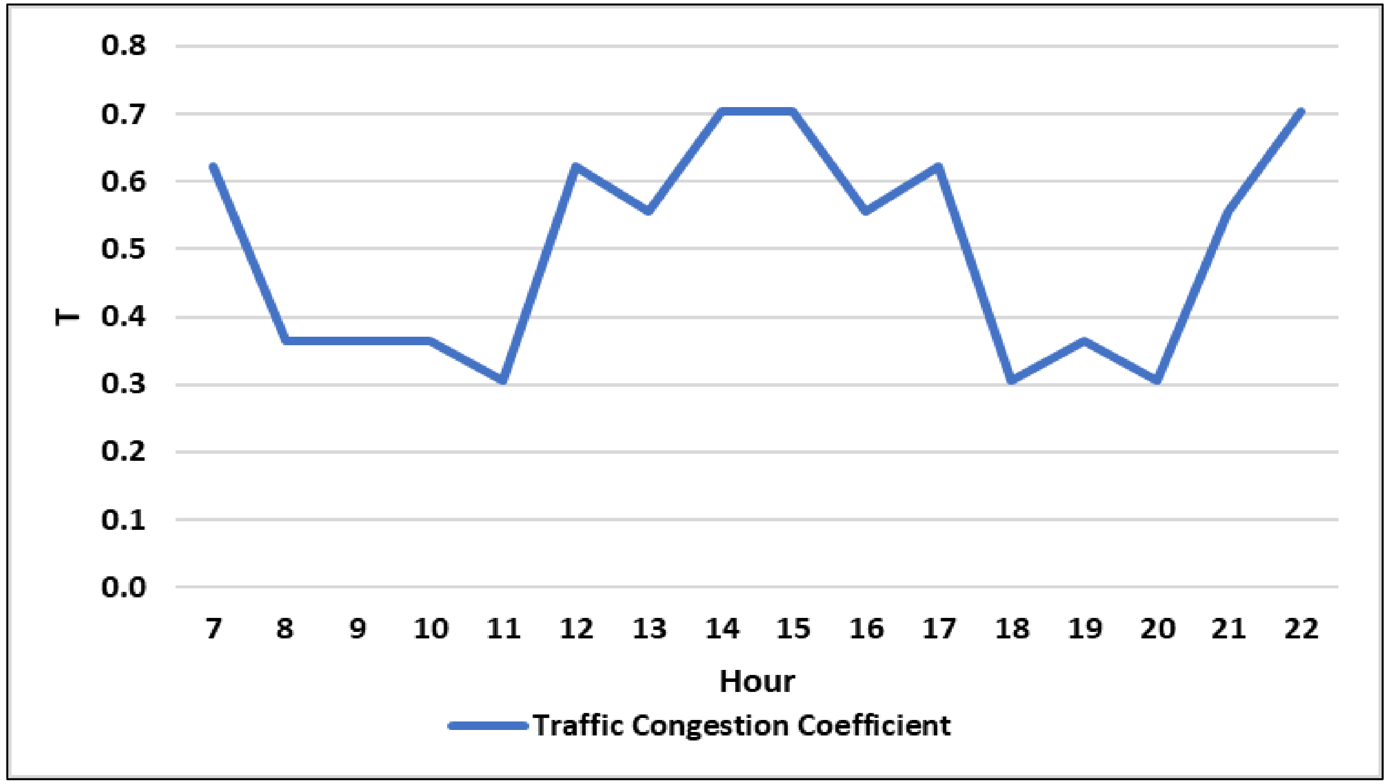
Decision Tree



Case study Analysis

General Assumptions	
Average distance travelled over a day	200 Km
Hours of Operation	7 AM to 10 PM
SoC_{min}	5%
SoC_{max}	80%
Electric Peak Load Hours	6 AM to 10 AM & 6 PM to 10 PM

Traffic Congestion Coefficient

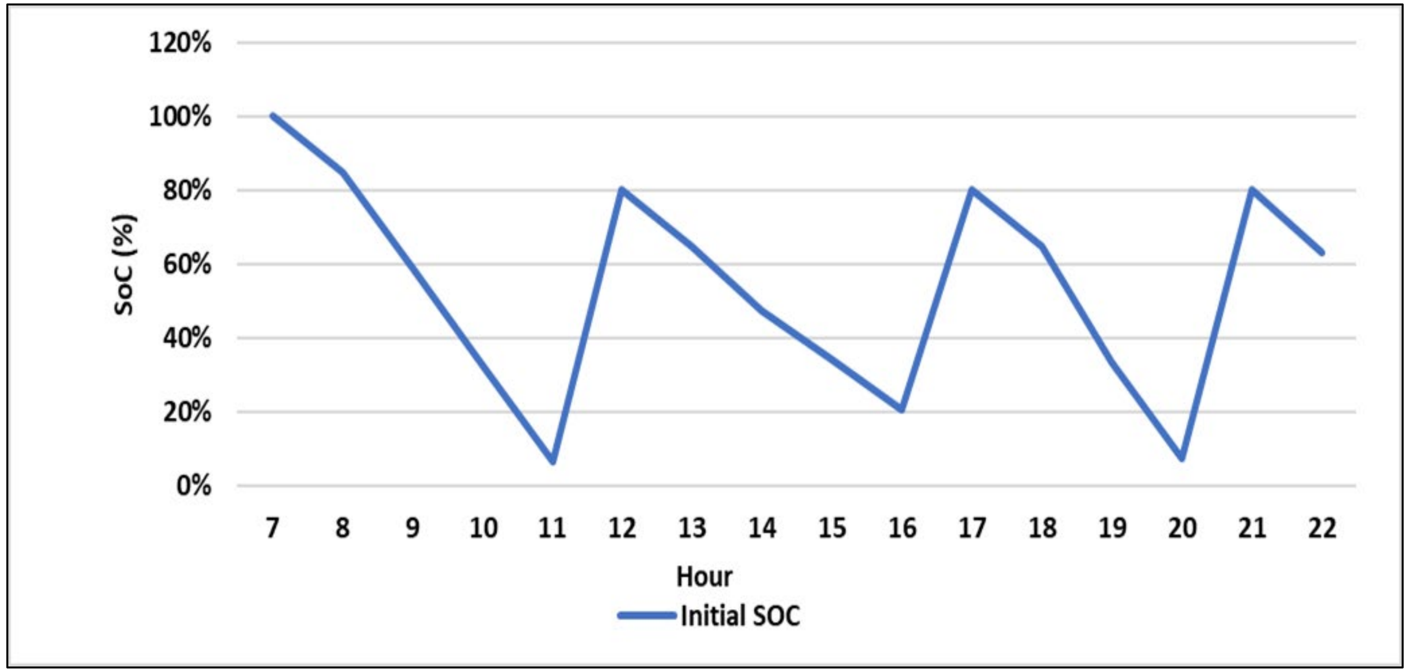


Key Points:

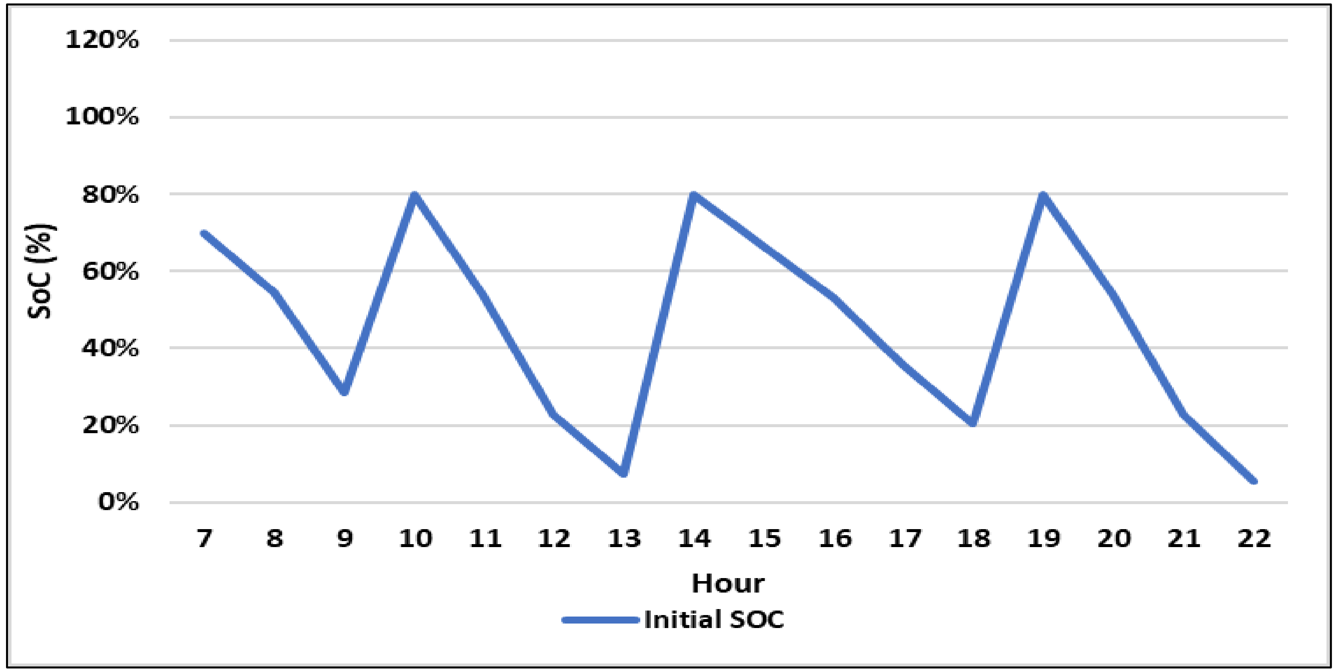
- Study is done for fixed route and flexible route fleet
- Vehicle charging pattern needs to be planned to avoid waiting time at charging station

Fixed Route Fleet

Vehicle Charging pattern with 100% starting SOC



Vehicle Charging pattern with 70% starting S



Key Points:

- Partial number of vehicles in a fleet can start a day with lower SoC levels
- This will lead to non-coincidental charging patterns for vehicles in the fleet
- Trade off between waiting at charging station or losing business opportunity in terms of next trip

Flexible Route Fleet solution and future needs

A connective tissue that enables mobility stakeholders to transition to a connected drive future

EV Drivers
Charging Station Availability
Charge Location
*Eliminate **Range Anxiety***

Car Sharing / Pay for Use
Trip & route planning
Availability of parking

Telematics Platform

OEMs
Vehicle Usage Patterns
Battery Usage & Diagnostics
Vehicle Diagnostics

Charging Point Operator
Billing & Collection
Localized Load Management
Consumption Information

Utilities
Billing & Collection
Demand Forecasting
Dynamic Energy Pricing

Public Transportation
Last mile connectivity to public transport
Single ePass / Ticketing

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Conclusion

- Fixed route EVs can start a day of operation with varying SOC levels
- Trade off between waiting at charging station and having one more charging cycle over the operating day
- Flexible fleets need to have a real time software platform for better fleet management
- Fleet owners need to invest in charging infrastructure rather than relying on public charging stations
- Waiting time at charging stations can be reduced by using combination of battery swapping and plug-in charging models

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