



# ESMAP Approach and FEAT Overview

November 17 2019



**The World Bank**



# ESMAP: Supporting Efforts to Maximize Fuel Economy



## What is ESMAP?

- Energy Sector Management Assistance Program
- Technical assistance trust fund
- Administered by the World Bank

## Mission

- Increase *know how* and *technical capacity* to achieve *environmentally sustainable energy solutions* for poverty reduction and economic growth

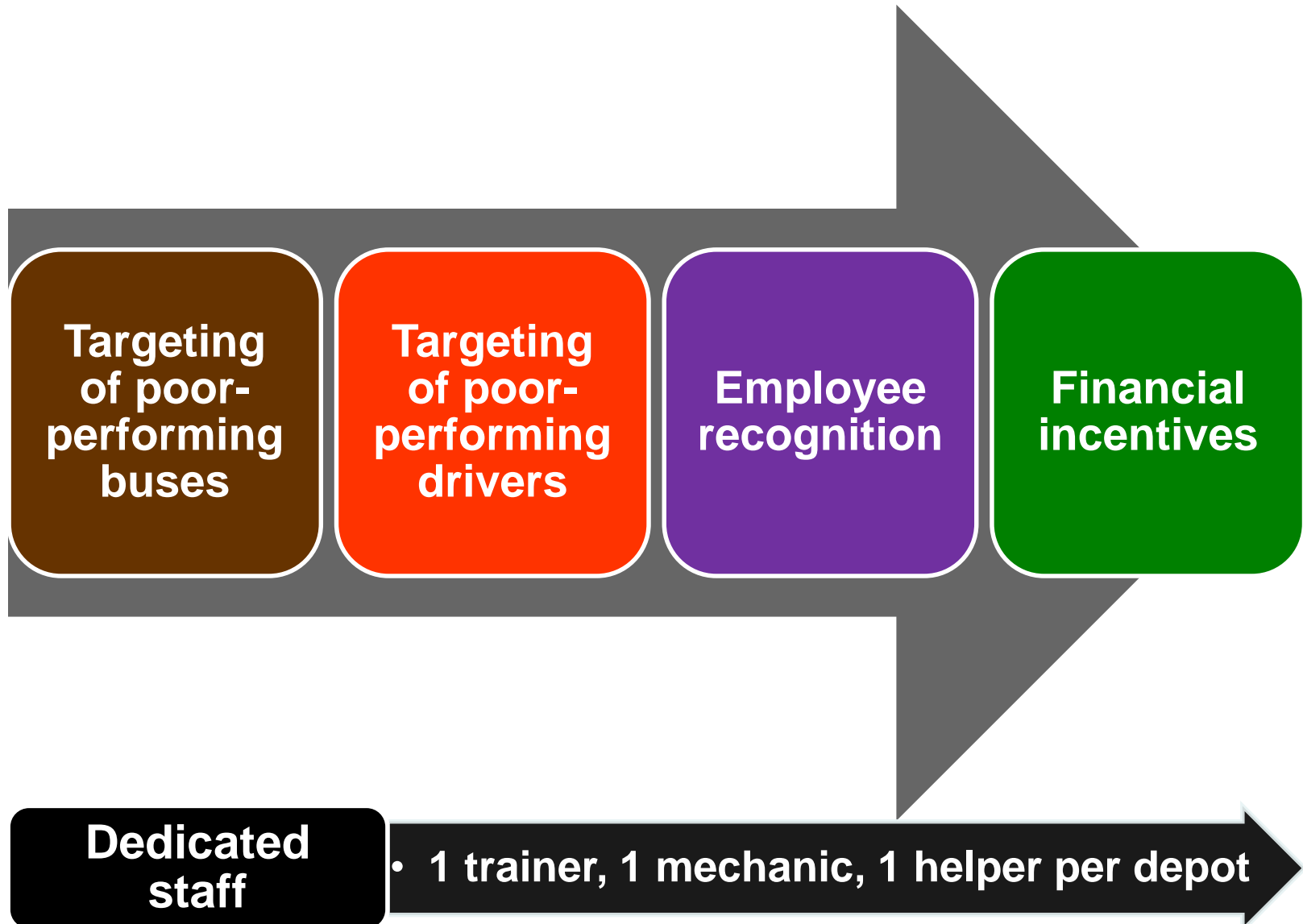
# Why Focus on Bus Fuel Efficiency?



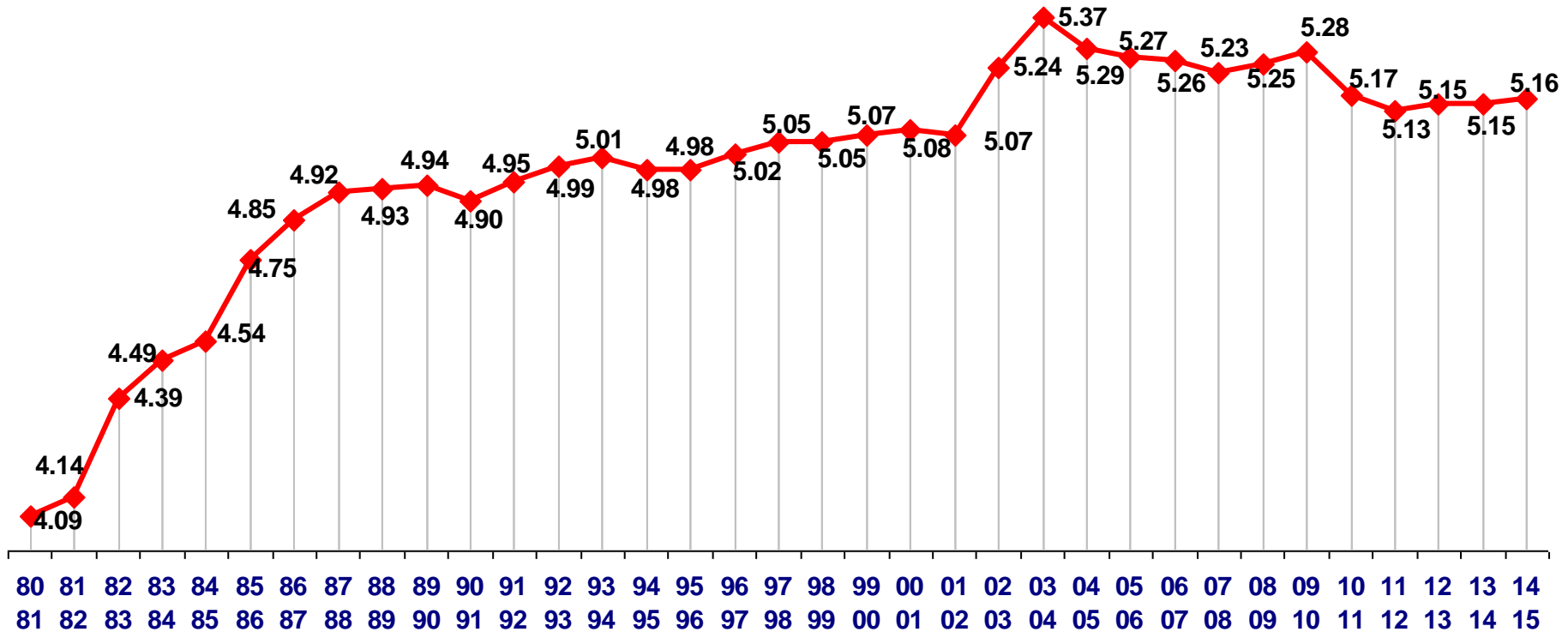
## Fuel is the largest cost item

- Typically 35-45% of operating and maintenance cost
- Cost changes can dramatically affect budgets

# APSRTC Approach



# APSRTC Results

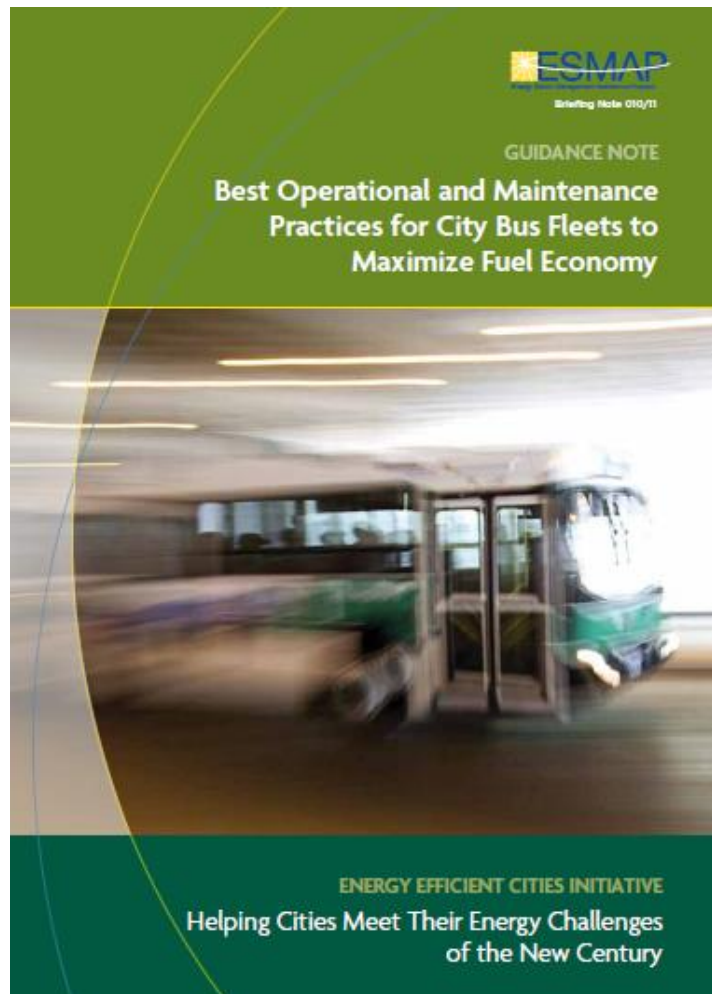


**26% improvement  
(4.09 to 5.16)**

**21% reduction  
FY 2015  
consumption**

**9% savings in FY  
2015 total costs**

# ESMAP 2011 Guidance Note



**Interviewed managers**

**8 cities in Brazil, China, India, US**



**Performed literature review**



**Developed action plan for improving fuel economy**



**Field tested action plan**

**APSRTC (Hyderabad, Vijayawada)**

**KSRTC (Mysore)**

*Report can be downloaded at: <http://documents.worldbank.org/curated/en/2011/01/16259489/best-operational-maintenance-practices-city-bus-fleets-maximize-fuel-economy-energy-efficient-cities-initiative>*



# 16-Point Action Plan Based on Five Principles

**TABLE 1 | Summary of Actions for Instituting Transit Bus Maintenance Practices for Fuel Economy**

PRINCIPLES	ACTION
<b>I. Management Commitment and Ownership</b>	<ol style="list-style-type: none"> <li>1. Appoint a senior executive to be in charge of fleet fuel economy and tie some part of his/her bonus to meeting fuel economy goals.</li> <li>2. Benchmark and set appropriate fuel economy goals by bus type for each year.</li> <li>3. Communicate the fuel economy results achieved each year to both employees and the public.</li> </ol>
<b>II. Data Collection and Analysis</b>	<ol style="list-style-type: none"> <li>4. Automate data collection to the extent feasible and use analysis software to support maintenance.</li> <li>5. Set up data QA/QC procedures.</li> <li>6. Analyze the data for separating the effects of driver, route and bus related effects on fuel economy.</li> <li>7. Use data to refine periodic maintenance.</li> </ol>
<b>III. Maintenance of Low Fuel Efficient Buses</b>	<ol style="list-style-type: none"> <li>8A. Select 10 percent<sup>a</sup> of the fleet showing the lowest fuel economy and conduct simple checks at depot.</li> <li>8B. Conduct detailed checks at central facility if bus passes step 8A.</li> <li>8C. Compare pre-repair and post-repair fuel economy data on these buses to estimate program benefits.</li> <li>9. Check repair quality on a random and periodic basis.</li> <li>10. Obtain mechanic sign-off on repairs for traceability.</li> <li>11. Require independent team audit of repairs across depots.</li> <li>12. Retrain mechanics and update repair procedures periodically.</li> </ol>
<b>IV. Training of Low-Performing Drivers</b>	<ol style="list-style-type: none"> <li>13. Train drivers in fuel-efficient driving techniques and periodically retrain them.</li> <li>14. Select the 10 percent<sup>a</sup> of drivers with the lowest fuel efficiency and conduct special additional training.</li> </ol>
<b>V. Employee Communications and Rewards</b>	<ol style="list-style-type: none"> <li>15. Publicly display the fuel economy performance by driver and bus depot to employees.</li> <li>16. Reward mechanics at the depot level and drivers individually for exceeding targets.</li> </ol>

MANAGEMENT

TECHNICAL

MANAGEMENT





# Principles are Combination of Technical & Management Actions

## Technical

- II. Data Collection and Analysis
- III. Maintenance Low Fuel Efficient Buses
- IV. Training of Low-Performing Drivers

## Management

- I. Management Commitment & Ownership
- V. Employee Communications and Rewards



# Focus of World Bank Pilots

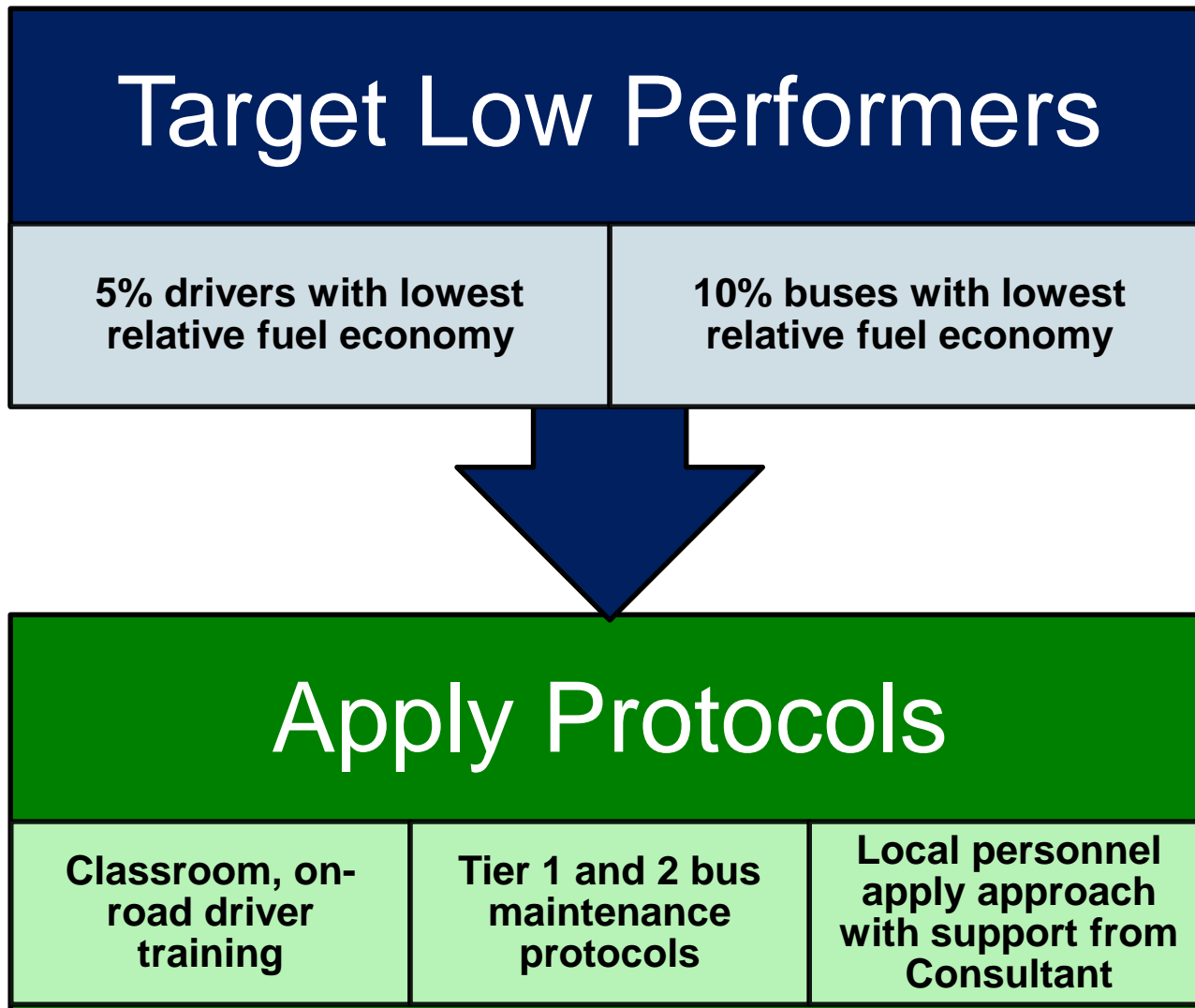
## Apply technical ESMAP elements

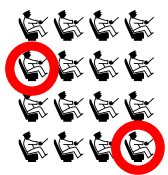
- Data collection
- Targeting analysis
- Maintenance and driver training protocols

## Prepare “How-To” detailed guidance

- ESMAP work good in overall approach, limited in step-by-step procedures

# Technical Approach





# Targeting Approach

**Address  
External  
Factors  
Affecting KMPL**

- Route operated
  - Number stops/KM
  - Traffic congestion
  - Terrain (hilly/flat)
- Bus type
  - Engine horsepower
  - Transmission type,
  - Physical size

**Rank buses,  
drivers using  
relative KMPL**

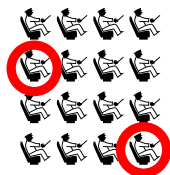
- Compare individual bus (driver) KMPL to average KMPL for its route/bus type average



# Example

## Bus Targeting Calculation

Bus	Route	Bus Type	KM	Liters	(Step 1) Average KMPL	(Step 2) Route/Bus Type Average (KMPL)	(Step 3) Relative Fuel Economy (KMPL)	Rank (1= Lowest)
101	12	1	4,435	1,341	3.31	3.45	-0.14	3
102	12	1	4,689	1,256	3.73	3.45	0.28	9
103	12	1	4,325	1,299	3.33	3.45	-0.12	4
<b>Average</b>	<b>12</b>	<b>1</b>	<b>13,449</b>	<b>3,896</b>	<b>3.45</b>			
104	12	2	4,897	1,404	3.49	3.22	0.26	8
105	12	2	4,478	1,501	2.98	3.22	-0.24	2
106	12	2	4,690	1,459	3.21	3.22	-0.01	5
<b>Average</b>	<b>12</b>	<b>2</b>	<b>14,065</b>	<b>4,364</b>	<b>3.22</b>			
107	14	1	4,890	1,267	3.86	3.62	0.24	7
108	14	1	4,550	1,356	3.36	3.62	-0.27	1
109	14	1	4,724	1,289	3.66	3.62	0.04	6
<b>Average</b>	<b>14</b>	<b>1</b>	<b>14,164</b>	<b>3,912</b>	<b>3.62</b>			



# Example

## Driver Targeting Calculation

Driver	Route	Bus Type	KM	Liters	(Step 1) Average KMPL	(Step 2) Route/Bus Type Average (KMPL)	(Step 3) Relative Fuel Economy (KMPL)	Rank (1= Lowest)
512	12	1	4,456	1,234	3.61	3.45	0.16	6
514	12	1	4,678	1,256	3.72	3.45	0.27	8
583	12	1	4,315	1,406	3.07	3.45	-0.38	1
<b>Average</b>	<b>12</b>	<b>1</b>	<b>13,449</b>	<b>3,896</b>	<b>3.45</b>			
511	12	2	4,987	1,432	3.48	3.22	0.26	7
521	12	2	4,489	1,489	3.01	3.22	-0.21	3
586	12	2	4,589	1,443	3.18	3.22	-0.04	4
<b>Average</b>	<b>12</b>	<b>2</b>	<b>14,065</b>	<b>4,364</b>	<b>3.22</b>			
506	14	1	4,980	1,276	3.90	3.62	0.28	9
567	14	1	4,540	1,245	3.65	3.62	0.03	5
569	14	1	4,644	1,391	3.34	3.62	-0.28	2
<b>Average</b>	<b>12</b>	<b>1</b>	<b>14,164</b>	<b>3,912</b>	<b>3.62</b>			

# FEAT Tool Developed for Analysis

## “Cleans” input data

- Checks for “bad” data
- Groups or splits data as needed

## Calculates relative/ absolute fuel efficiency

- Drivers, buses, routes

## Simple program

- Uses Excel data input
- Now a desktop program

### Fuel Efficiency Analysis Tool - MIRA-BHAYANDAR

This tool requires the folder C:\BusFuelData be created. It imports data from the following Excel file which must be located in C:\BusFuelData

**FuelConsumption.xlsx**

Daily data on fuel consumption by bus and driver

The following Information is included in the program:

- 1- Listing of Routes
- 2- Route Grouping if Necessary
- 3- Route Splitting if Necessary
- 4- Bus Inventory

This information can be changed using the buttons below.

The tool analyzes the data from these files and exports an excel file of the analysis to C:\BusFuelData. The user must provide a name for the Excel output file.

#### Instructions

1. Enter a file name for the Excel output file
2. Click on Conduct Analysis

Enter a file name for the Excel output file

Conduct Analysis

Routes, Grouping or  
Splitting

Bus Inventory

# First India Pilot (2013-14)

- Demonstrate at one depot in 4 cities
  - Different operating environments



BHOPAL



MIRA BHAYANDAR



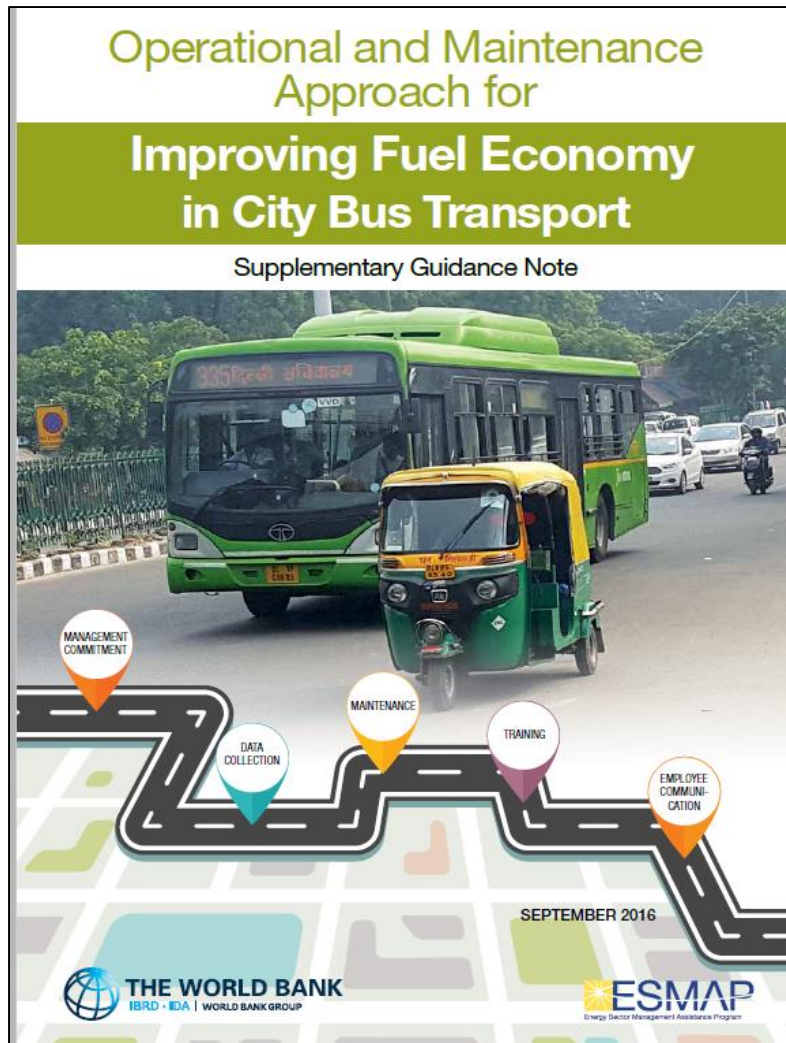
CHANDIGARH



JAIPUR



# Operational & Maintenance Approach - 2016



**Interacted with Bus Operators**

Identified existing practices

**Developed action plan for applying ESMAP Principles**

**Developed FEAT for effective implementation of the ESMAP Pilot**

**Field tested action plan**

**Bhopal, Chandigarh, Jaipur, Mira-Bhayander**

# Follow-up Monitoring

On Route Driver Performance Monitoring - CHECKLIST							
Driver Name: _____		Driver ID No. _____		Bus Number: _____			
		Route Number: _____		Date: _____			
KMPL of Driver during previous month (पिछले महीने के दौरान चालक की KMPL) (for eg. Since monitoring will be done in January 2014, KMPL of driver to be put December 2013. (उदाहरण के लिए: MONITORING जनवरी 2014 में करेंगे, तो चालक की दिसंबर 2013 की KMPL का उल्लेख करें)							
Description	Week 1 Yes (हाँ) / No (नहीं)		Week 2 Yes (हाँ) / No (नहीं)		Week 3 Yes (हाँ) / No (नहीं)		
<b>BUS STARTING PROCESS</b>							
1 Did the driver check BEFORE STARTING THE IGNITION whether the pressure in both the "AIR METERS" are correct? इग्निशन शुरू करने से पहले क्या चालक ने दोनों "एयर मीटर" में दबाव सही है या नहीं इसकी जांच की?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
2 Did the driver keep the FEET ON THE FOOT REST NEAR ACCELERATOR ? चालक ACCELERATOR के पास footrest पर पैर रखा था ?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
3 Did the driver start the bus in "IDLING" condition without pressing the accelerator ? चालक एक्सीलेटर दबाने के बिना IDLING CONDITION में बस शुरू कर दिया?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
<b>Monitoring of GEAR AND ACCELERATOR usage:</b>							
4 Did the driver set the bus in motion using FIRST GEAR WITHOUT ACCELERATOR ? क्या चालक ने बिना ACCELERATOR दबाये पहले गियर में बस को गति में लेकर आया?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
5 Did the driver use SECOND GEAR for driving upto a speed of 20kmph and keep the ACCELERATOR at 1/4th position? क्या ड्राइवर ने 20kmph की रफ्तार तक ड्राइविंग के लिए दूसरे गियर का उपयोग किया और ¼ स्थिति पर ACCELERATOR रखा था ?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
6 Did the driver use THIRD GEAR for driving upto a speed of 30kmph and keep the ACCELERATOR at 1/2 position? क्या ड्राइवर ने 30kmph की रफ्तार तक ड्राइविंग के लिए तीसरे गियर का उपयोग किया और ½ स्थिति पर ACCELERATOR रखा था ?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
7 Did the driver use FOURTH GEAR for driving upto a speed of 40kmph and keep the ACCELERATOR at 3/4 position? क्या ड्राइवर ने 40kmph की रफ्तार तक ड्राइविंग के लिए चौथे गियर का उपयोग किया और ¾ स्थिति पर ACCELERATOR रखा था ?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
8 Did the driver use FIFTH GEAR for driving at TOP SPEED and keep the ACCELERATOR in FULL position? क्या ड्राइवर ने TOP SPEED पर ड्राइविंग के लिए पांचवें गियर का उपयोग किया और ACCELERATOR को पूरा दबा रहा था?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
9 Depending upon road or traffic condition, did the driver use the POWERPOINT POSITION on the ACCELERATOR when driving at maximum speed? सड़क या यातायात की स्थिति पर निर्भर, क्या ड्राइवर ने अधिकतम गति से गाड़ी चला एक्सीलेटर पर पावरपॉइंट स्थिति का उपयोग किया था?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
10 Did the driver use his / her TOES for PRESSING THE ACCELERATOR ? क्या ड्राइवर ने ACCELERATOR दबाने के लिए पैर की उंगलियों का उपयोग किया?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
11 Did the driver REMOVE THE FEET FROM THE ACCELERATOR 100 meters BEFORE the stoppage point such as bus stops, traffic signals etc. and for slowing down at speed breakers and turnings ? क्या ड्राइवर ने STOPPAGE POINT, जैसे बस स्टॉप, SIGNAL इत्यादी, से 100 मीटर पहले तथा गति-रोधक अथवा मोड़ पर बस की गति को धीमा करने के लिए ACCELERATOR से पैर हटाया ?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
12 Did the driver DRIVE WITHOUT PRESSURE AND WITH CONCENTRATION ? दबाव के बिना और एकाग्रता के साथ ड्राइवर ने ड्राइव किया था?	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	Yes (हाँ)	No (नहीं)	
KMPL Achieved (KMPL हासिल की): _____							
Additional Comments of Trainer (ट्रेनर की अतिरिक्त टिप्पणियाँ): _____ _____ _____ _____ _____							
Signature of Trainer : _____				Signature of Driver: _____			
Name of the Trainer: _____				Name of the Driver: _____			

- Weekly checks made for 3 weeks after training

# Second India Pilot (2016)



Chennai



Jaipur

**Demonstrate at one depot in each city**

- A different depot in Jaipur from first pilot

**New supporting partners**

- Chennai: Petroleum Conservation Research Association (PCRA)
- Jaipur: Safety Circle Private Limited (SCPL)



# Driver Pilot Results

## Average results varied

- About 5%
- Low -2.0% to high 25%

## Maximum results >10%

- Low 4%, high 71%
- Shows potential gains



# Bus Pilot Results

## Average results varied

- About 10%
- Low -2.8% to high 30%

## Maximum results >10%

- Low 10%, high 64%
- Shows potential gains

## Improvement declined by round

- Expected when going from lowest to better performing buses



# Why Varied Results?

**Changing behavior takes time!**

**“Learning curve” for trainers**

**Varied follow-up monitoring**

# Data Management

**Data  
Recording**

**Data  
Validation**

**Data  
Analysis**

**Good**

- **Fueling data routinely recorded in all cities in both pilots**

**Fair**

- **Data error-checking**
  - *Not part of old routine*
- **Limited analysis performed**
  - *“Query” data,*
  - *Perform special analyses*





# Conclusions & Actions

**ESMAP Pilot - Good approach**

**Could be applied by all bus companies**

**Pilot expansion under ESCBS**

# Thank You!

## ESMAP Pilot Team

**Nupur Gupta, Brian McCollom,  
Sudhakararao Uppada, Mohammed Haneef,  
N. S. Srinivas**

**The World Bank Group**

