ESMAP Approach and FEAT Overview

November 17 2019
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

- Targeting of poor-performing buses
- Targeting of poor-performing drivers
- Employee recognition
- Financial incentives

Dedicated staff
- 1 trainer, 1 mechanic, 1 helper per depot
APSRTC Results

26% improvement (4.09 to 5.16)

21% reduction FY 2015 consumption

9% savings in FY 2015 total costs
# 16-Point Action Plan Based on Five Principles

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

<table>
<thead>
<tr>
<th>PRINCIPLES</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Management Commitment and Ownership</td>
<td></td>
</tr>
<tr>
<td>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.</td>
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<tr>
<td>2. Benchmark and set appropriate fuel economy goals by bus type for each year.</td>
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<tr>
<td>3. Communicate the fuel economy results achieved each year to both employees and the public.</td>
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</tr>
<tr>
<td>II. Data Collection and Analysis</td>
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</tr>
<tr>
<td>4. Automate data collection to the extent feasible and use analysis software to support maintenance.</td>
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</tr>
<tr>
<td>5. Set up data QA/QC procedures.</td>
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</tr>
<tr>
<td>6. Analyze the data for separating the effects of driver, route and bus related effects on fuel economy.</td>
<td></td>
</tr>
<tr>
<td>7. Use data to refine periodic maintenance.</td>
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</tr>
<tr>
<td>III. Maintenance of Low Fuel Efficient Buses</td>
<td></td>
</tr>
<tr>
<td>8A. Select 10 percent of the fleet showing the lowest fuel economy and conduct simple checks at depot.</td>
<td></td>
</tr>
<tr>
<td>8B. Conduct detailed checks at central facility if bus passes step 8A.</td>
<td></td>
</tr>
<tr>
<td>8C. Compare pre-repair and post-repair fuel economy data on these buses to estimate program benefits.</td>
<td></td>
</tr>
<tr>
<td>9. Check repair quality on a random and periodic basis.</td>
<td></td>
</tr>
<tr>
<td>10. Obtain mechanic sign-off on repairs for traceability.</td>
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</tr>
<tr>
<td>11. Require independent team audit of repairs across depots.</td>
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</tr>
<tr>
<td>12. Retrain mechanics and update repair procedures periodically.</td>
<td></td>
</tr>
<tr>
<td>IV. Training of Low-Performing Drivers</td>
<td></td>
</tr>
<tr>
<td>13. Train drivers in fuel-efficient driving techniques and periodically retrain them.</td>
<td></td>
</tr>
<tr>
<td>14. Select the 10 percent of drivers with the lowest fuel efficiency and conduct special additional training.</td>
<td></td>
</tr>
<tr>
<td>V. Employee Communications and Rewards</td>
<td></td>
</tr>
<tr>
<td>15. Publicly display the fuel economy performance by driver and bus depot to employees.</td>
<td></td>
</tr>
<tr>
<td>16. Reward mechanics at the depot level and drivers individually for exceeding targets.</td>
<td></td>
</tr>
</tbody>
</table>
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

Target Low Performers

- 5% drivers with lowest relative fuel economy
- 10% buses with lowest relative fuel economy

Apply Protocols

- Classroom, on-road driver training
- Tier 1 and 2 bus maintenance protocols
- Local personnel apply approach with support from Consultant
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

<table>
<thead>
<tr>
<th>Bus</th>
<th>Route</th>
<th>Bus Type</th>
<th>KM</th>
<th>Liters</th>
<th>(Step 1) Average KMPL</th>
<th>(Step 2) Route/Bus Type Average KMPL</th>
<th>(Step 3) Relative Fuel Economy (KMPL)</th>
<th>Rank (1=Lowest)</th>
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<tr>
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<td>3.62</td>
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</table>
### Example Driver Targeting Calculation

<table>
<thead>
<tr>
<th>Driver</th>
<th>Route</th>
<th>Bus Type</th>
<th>KM</th>
<th>Liters</th>
<th>KMPL</th>
<th>(Step 2) Route/Bus Type Average (KMPL)</th>
<th>(Step 3) Relative Fuel Economy (KMPL)</th>
<th>Rank (1=Lowest)</th>
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<td>3.62</td>
<td>-0.28</td>
<td>2</td>
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<tr>
<td>Average</td>
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<td>1</td>
<td>14,164</td>
<td>3,912</td>
<td>3.62</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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
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**

<table>
<thead>
<tr>
<th>Description</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMPL of Driver during previous month (in kmpl)</td>
<td>Yes (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name of the Driver: ____________________________________ Driver ID No. ____________</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Route Number: ______________ Bus Number: ______________</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BUS STARTING PROCESS**

1. Did the driver check before starting the ignition whether the pressure in both the “AIR METER” are correct? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)
2. Did the driver keep the FEET ON THE FOOT REST NEAR ACCELERATOR? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)
3. Did the driver start the bus in “IDLING” condition without pressing the accelerator? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)

**MONITORING OF GEAR AND ACCELERATOR usage:**

4. Did the driver set the bus in motion using FIRST GEAR WITHOUT ACCELERATOR? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)
5. Did the driver use SECOND GEAR for driving up to a speed of 20kmph and keep the ACCELERATOR at 1/4th position? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)
6. Did the driver use THIRD GEAR for driving up to a speed of 30kmph and keep the ACCELERATOR at 1/2 position? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)
7. Did the driver use FOURTH GEAR for driving up to a speed of 40kmph and keep the ACCELERATOR at 3/4 position? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)
8. Did the driver use FIFTH GEAR for driving at TOP SPEED and keep the ACCELERATOR in FULL position? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)

Depending upon road or traffic condition, did the driver use the POWERPOINT POSITION on the ACCELERATOR when driving at maximum speed? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)

Did the driver keep his / her TOES for PESSING THE ACCELERATOR? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)

Did the driver remove the FEET FROM THE ACCELERATOR 100 meters before the stoppage points such as bus stops, traffic signals etc. and for slowing down at speed breakers and turnings? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)

Did the driver drive without pressure and with concentration? (✓) No (✗) Yes (✓) No (✗) Yes (✓) No (✗)

**KMPL Achieved (kmpl) ____________**

**Additional Comments of Trainer:**

**Name of the Trainer:** __________________________  **Name of the Driver:** __________________________

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**Weekly checks made for 3 weeks after training**
Second India Pilot (2016)

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

Good

- Fueling data routinely recorded in all cities in both pilots

Data Validation

Data Analysis

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