Costs of Transitioning to Ultra-low Sulfur Fuels (ULSFs) in India

Gaurav Bansal / Anup Bandivadekar
November 7th, 2012
Purpose of this webinar series is to initiate a dialogue around Auto Fuel Policy in India

ICCT is conducting a study to evaluate the past successes and future prospects of India’s vehicle emission control program
  - New vehicle emission standards
  - Fuel quality standards
  - Vehicle compliance and enforcement program
  - Fuel inspection and compliance program
  - Alternative fuels and new energy vehicle policies
  - Fuel efficiency standards and labeling

- First webinar (April 26) focused on vehicle emission standards and compliance programs
- Second webinar (May 24) focused on fuel quality standards and compliance programs
- Third Webinar (October 10) focused on two- and three-wheeler emissions
ULSFs are needed to get the most out of emission after-treatment systems

- On gasoline vehicles, lower sulfur content in fuel is helpful in reducing emissions, although the effect of higher sulfur content in fuels is reversible.

- Diesel sulfur content > 50 ppm inhibits performance of aftertreatment systems
  - Diesel particulate filter (DPF)
  - Selective catalytic reduction (SCR)
  - Lean NOx trap (LNT)

- < 10 ppm sulfur fuel ideal to maximize the efficiency of aftertreatment systems
### Indian standards 5-8 years behind the world’s best

#### Gasoline Sulfur Content Schedule (ppm)

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#### Diesel Sulfur Content Schedule (ppm)

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*Puducherry, Mathura, Vapi, Jamnagar, Ankleshwar, Hissar, Bharatpur

**Delhi, Mumbai, Kolkata, Chennai, Bangalore, Surat, Agra, Hyderabad, Pune, Ahmedabad, Kanpur, Lucknow, Solapur

§ Gradual implementation to 15 ppm nationwide

∞ First number is average, second number is maximum

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*ICCT - The International Council on Clean Transportation*
Today’s webinar focuses on the costs of transitioning to ULSF in India

Technical and Economic Analysis of the Transition to Ultra-Low Sulfur Fuels in Brazil, China, India and Mexico

Prepared for:

icct
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

by
Hart Energy and MathPro Inc.

October 2012

*http://www.theicct.org/transition-to-ulsf-brazil-china-india-mexico
Study assumptions

- ULSFs to be produced for on-road vehicles only
- Same crude sourcing pattern in 2015 as in 2010
  - No crude switching to lower sulfur
- New refineries not built expressly to produce ULSF
  - Thrust on upgrading of refineries
- Upgrades using only technologies already in commerce
ULSF production technologies

- **Hydrotreating – optimal in India**
  - Removes heterogeneous atoms such as sulfur
  - FCC feed hydrotreating (pre-FCC) for yield
  - FCC naphtha hydrotreating (post-FCC for gasoline)
  - Distillate hydrotreating (post-FCC for diesel)

- **Hydrocracking – costlier than hydrotreating**
  - Breaks down heavier crude fractions into lighter fractions suitable for transportation fuels
  - Removes sulfur
  - In lieu of fluid catalytic conversion (FCC)
  - More expensive than FCC

- **Fuel quality and yield restoration processes**
  - Maintaining gasoline octane number
  - Increase in crude input due to losses
## Refinery groupings in India

<table>
<thead>
<tr>
<th>Refinery Group</th>
<th>Count</th>
<th>Crude Capacity (K Bbl/day)</th>
<th>Characteristics</th>
<th>Crude Type</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>A: Modern Export</td>
<td>3</td>
<td>1520</td>
<td>State of the art</td>
<td>4%</td>
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<td>96%</td>
</tr>
<tr>
<td>B: High Distillate Yield Conversion</td>
<td>6</td>
<td>1120</td>
<td>Existing Cracking and hydroprocessing capacity</td>
<td>14%</td>
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<td></td>
<td></td>
<td>86%</td>
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<tr>
<td>C: Small Sweet Crude</td>
<td>4</td>
<td>98.6</td>
<td>Basic in configuration</td>
<td>100%</td>
</tr>
<tr>
<td>D: Other Conversion</td>
<td>6</td>
<td>976.3</td>
<td>Moderate complexity</td>
<td>19%</td>
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<td>81%</td>
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<tr>
<td>E: Transition Year Capacity</td>
<td>8</td>
<td>1234</td>
<td>Planned and under construction</td>
<td>40%</td>
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<td>60%</td>
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</table>
Costs for ULSF production

- **Operating Costs**
  - Cost of additional hydrogen supply
  - Cost of replacing lost product yield
  - Cost of maintaining other aspects of fuel quality such as gasoline octane
  - Incremental direct operational costs

- **Capital Costs**
  - Annual capital charges (ACC) associated with investments
Investment parameters for annual capital charges

\[ \text{ACC} = \text{Investment}_{\text{US}} \times \text{Location Factor} \times \text{ACC Ratio} \]

<table>
<thead>
<tr>
<th>ACC Ratio Parameter</th>
<th>Baseline Value</th>
<th>Sensitivity Case for India</th>
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<tbody>
<tr>
<td>Construction Period</td>
<td>3 years</td>
<td>2 years</td>
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<tr>
<td>Economic Project Life</td>
<td>15 years</td>
<td>20 years</td>
</tr>
<tr>
<td>Depreciation Period</td>
<td>10 years</td>
<td>10 years</td>
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<tr>
<td>Cost of Capital (after tax)</td>
<td>10%</td>
<td>5%</td>
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<tr>
<td>Marginal Tax Rate</td>
<td>30%</td>
<td>30%</td>
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<tr>
<td>Inflation Rate</td>
<td>2% per year</td>
<td>7% per year</td>
</tr>
<tr>
<td>Annual Fixed Costs</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Other Costs</td>
<td>0.4%</td>
<td>0.4%</td>
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</table>

Location Factor for India: 0.98
ULSF production investments

- **Total Investment:**
  - $4.1 billion (Rs. 21,000 crore)
    - LSF investment (current standards → 50 ppm sulfur):
      - $1.9 billion (Rs. 9,500 crore)
    - Extra ULSF investment (50 ppm sulfur → 10 ppm sulfur):
      - $2.26 billion (Rs. 11,300 crore)

- **12th 5-year plan (2013-2017) public sector refinery investments:**
  - $31 billion (Rs. 1,55,000 crore)
    - Much of LSF investment included in 12th five-year plan

- Some LSF and ULSF investment from private sector as well
ULSF production per liter costs – investments & operating costs

- Current refineries (Groups A-D)
  - Gasoline: 0.90-1.10¢ (Rs. 0.45-0.55)
  - Diesel: 0.80-1.10¢ (Rs. 0.40-0.55)

- Transition year refineries (Group E)
  - Gasoline: 0.20-0.30¢ (Rs. 0.10-0.15)
  - Diesel: 0.30-0.40¢ (Rs. 0.15-0.20)

- Combining both (Groups A-E)
  - Gasoline: 0.70-0.87¢ (Rs. 0.35-0.44)
  - Diesel: 0.64-0.88¢ (Rs. 0.30-0.44)
ULSF costs in other countries

- China
  - Investments: $6.9 billion (Rs. 34,500 crore)
  - Per liter costs
    - Gasoline: 0.66-0.78¢ (Rs. 0.33-0.39)
    - Diesel: 1.42-1.83¢ (Rs. 0.71-0.91)

- Mexico
  - Investments: $3.3 billion (Rs. 16,500 crore)
  - Per liter costs
    - Gasoline: 1.10-1.40¢ (Rs. 0.55-0.70)
    - Diesel: 2.50-3.20¢ (Rs. 1.25-1.60)

- Brazil
  - Investments: $6.3 billion (Rs. 31,500 crore)
  - Per liter costs
    - Gasoline: 1.64-1.96¢ (Rs. 0.82-0.98)
    - Diesel: 1.55-1.96¢ (Rs. 0.77-1.04)
Benefits of ULSF far outweigh costs!

- ULSF enables much cleaner vehicles

- Large long-term gain -- *four to seven times the cost* -- by implementing cleaner vehicle and fuel policies:
  - Gains continue well beyond 2030
  - Costs stabilize over time
    - Economies of scale & learning

- Additional benefits would be substantial
  - Reduced morbidity
  - Global warming mitigation
  - Increased agricultural output

- More stringent regulations will make auto and oil industry more competitive internationally

- Details to be discussed in the next webinar!
Pipelines becoming increasingly important

Challenge is designing growing pipeline network to handle all fuels regardless of fuel quality
Growth of pipeline capacity in India

- Product Pipeline Capacity (MMT)


- Capacities: 1.82, 7.32, 11.02, 15.31, 26.49, 33.99, 61.72, 54.99, 62.59, 76.23
Recommendations for discussion

- Transition to <50 ppm sulfur fuel nationwide immediately
  - Not just a few more cities or state capital, but nationwide adoption of one fuel quality standard is critical

- Transition to <10 ppm sulfur fuel nationwide as soon as possible

- Enable oil companies to recover costs
  - Commitment to increase fuel price by Rs. 0.50-0.60 per liter to help recover costs of ULSFs
For more information…

- ICCT India website: [http://theicct.org/india](http://theicct.org/india)
- Blog on vehicle and fuel taxes in India: [http://theicct.org/blogs/staff/india-2012-budget](http://theicct.org/blogs/staff/india-2012-budget)

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