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

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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

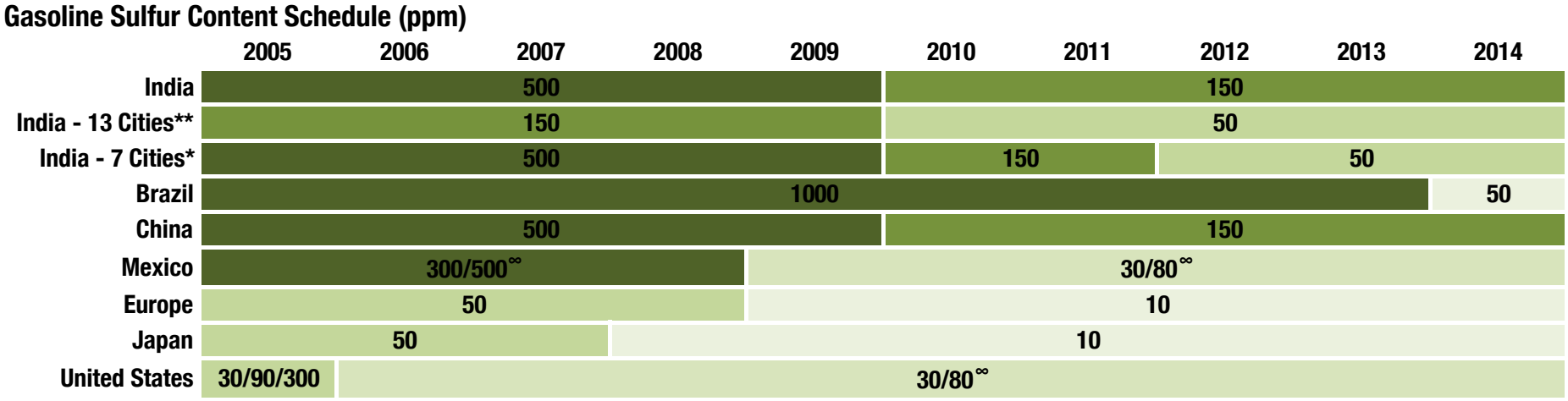
ULSFs are needed to get the most out of emission after-treatment systems

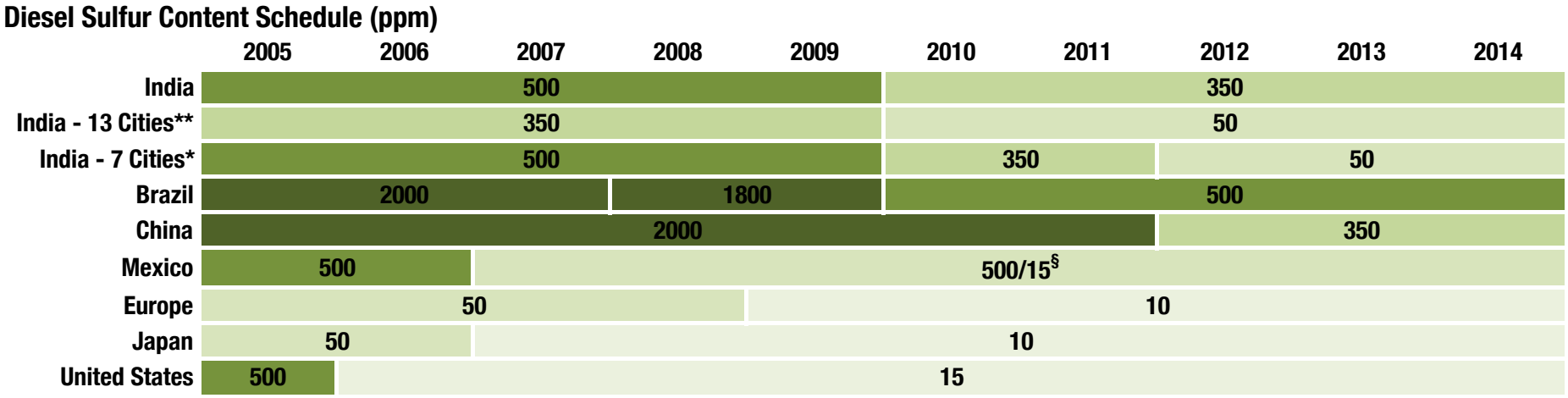
- On gasoline vehicles, lower sulfur content in fuel is helpful in reducing emissions, although the effect of higher sulfur content in fuels is reversible.

- 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





*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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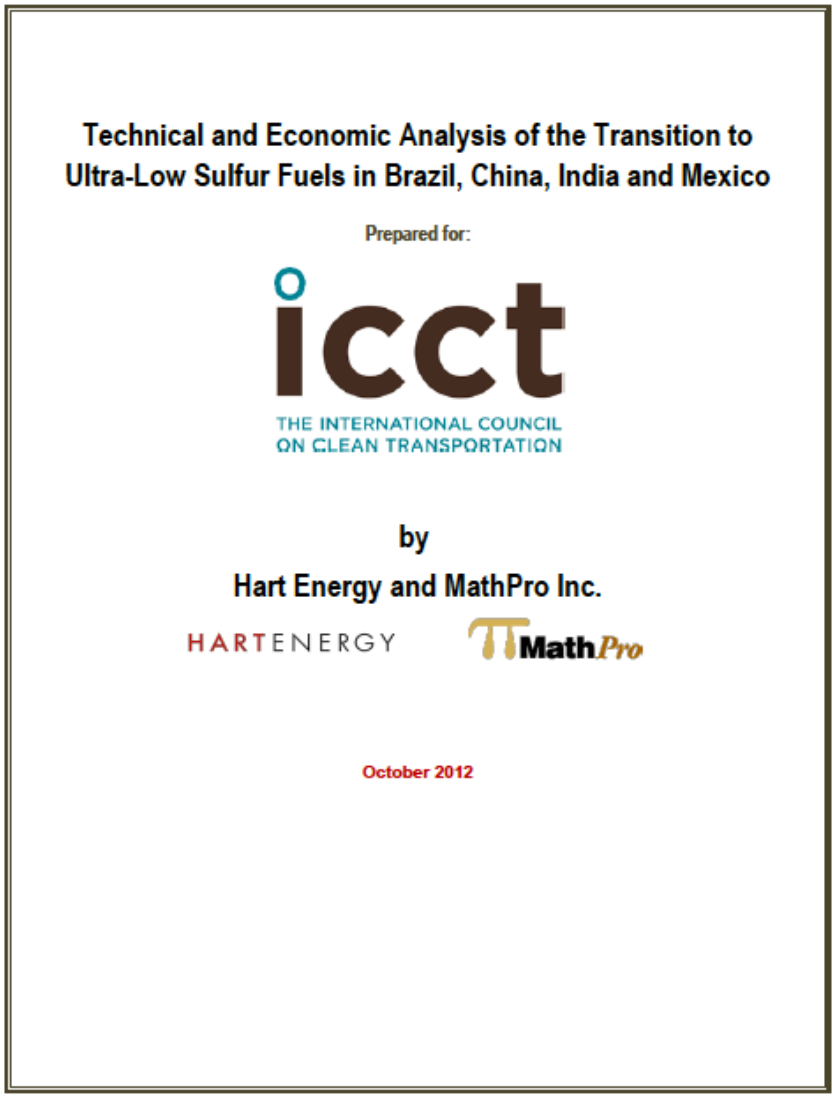
Today's webinar focuses on the costs of transitioning to ULSF in India


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

Prepared for:

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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

by

Hart Energy and MathPro Inc.

HARTENERGY MathPro

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*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

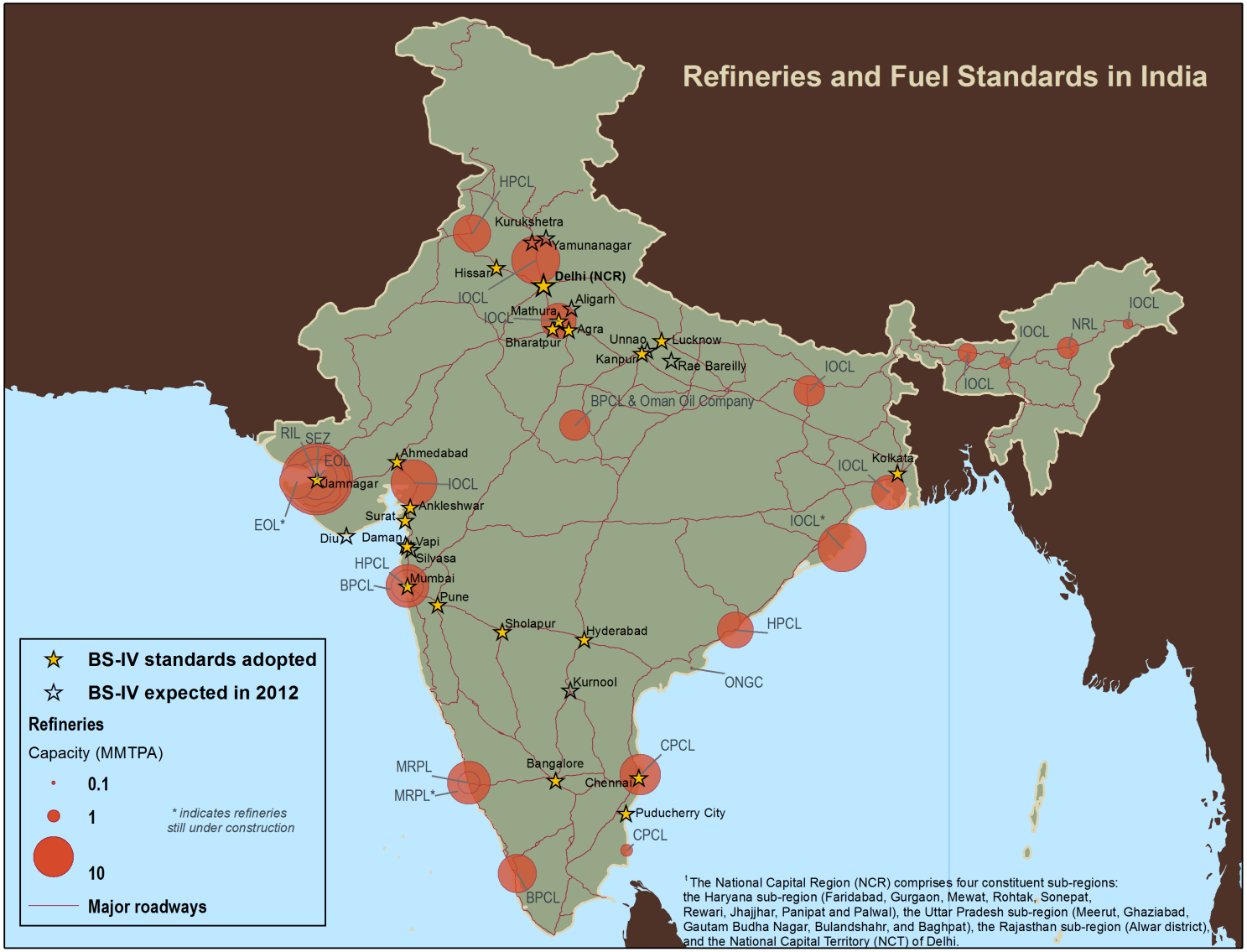
- Hydrotreating – optimal in India
  - Removes heterogeneous atoms such as sulfur
  - FCC feed hydrotreating (pre-FCC) for yield
  - FCC naphtha hydrotreating (post-FCC for gasoline)
  - Distillate hydrotreating (post-FCC for diesel)

- 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

Chapter 2 of the study contains a tutorial on refining and production of ULSFs

Refineries & BS IV cities in India



Refinery groupings in India

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

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

$$ACC = Investment_{US} \times Location\ Factor \times ACC\ Ratio$$

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

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

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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

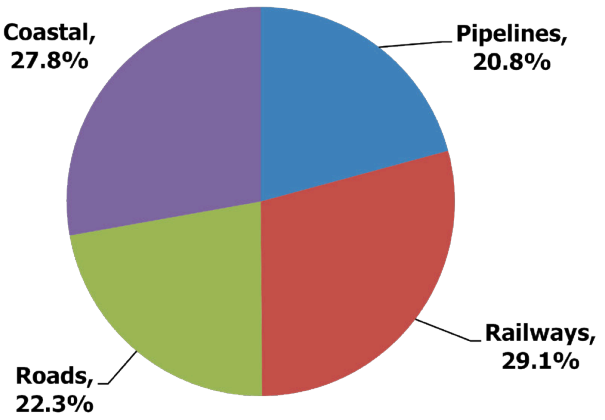
- China
  - Investments: **$6.9 billion (Rs. 34,500 crore)**
  - Per liter costs
    - Gasoline: **0.66-0.78¢ (Rs. 0.33-0.39)**
    - Diesel: **1.42-1.83¢ (Rs. 0.71-0.91)**
- Mexico
  - Investments: **$3.3 billion (Rs. 16,500 crore)**
  - Per liter costs
    - Gasoline: **1.10-1.40¢ (Rs. 0.55-0.70)**
    - 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!

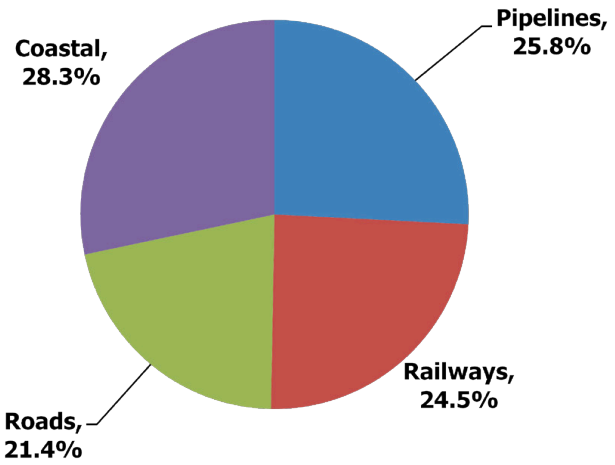
- ULSF enables much cleaner vehicles
- Large long-term gain -- *four to seven times the cost* -- by implementing cleaner vehicle and fuel policies:
  - Gains continue well beyond 2030
  - Costs stabilize over time
    - Economies of scale & learning
- Additional benefits would be substantial
  - Reduced 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!

Mode-wise transportation of petroleum products

2009-2010

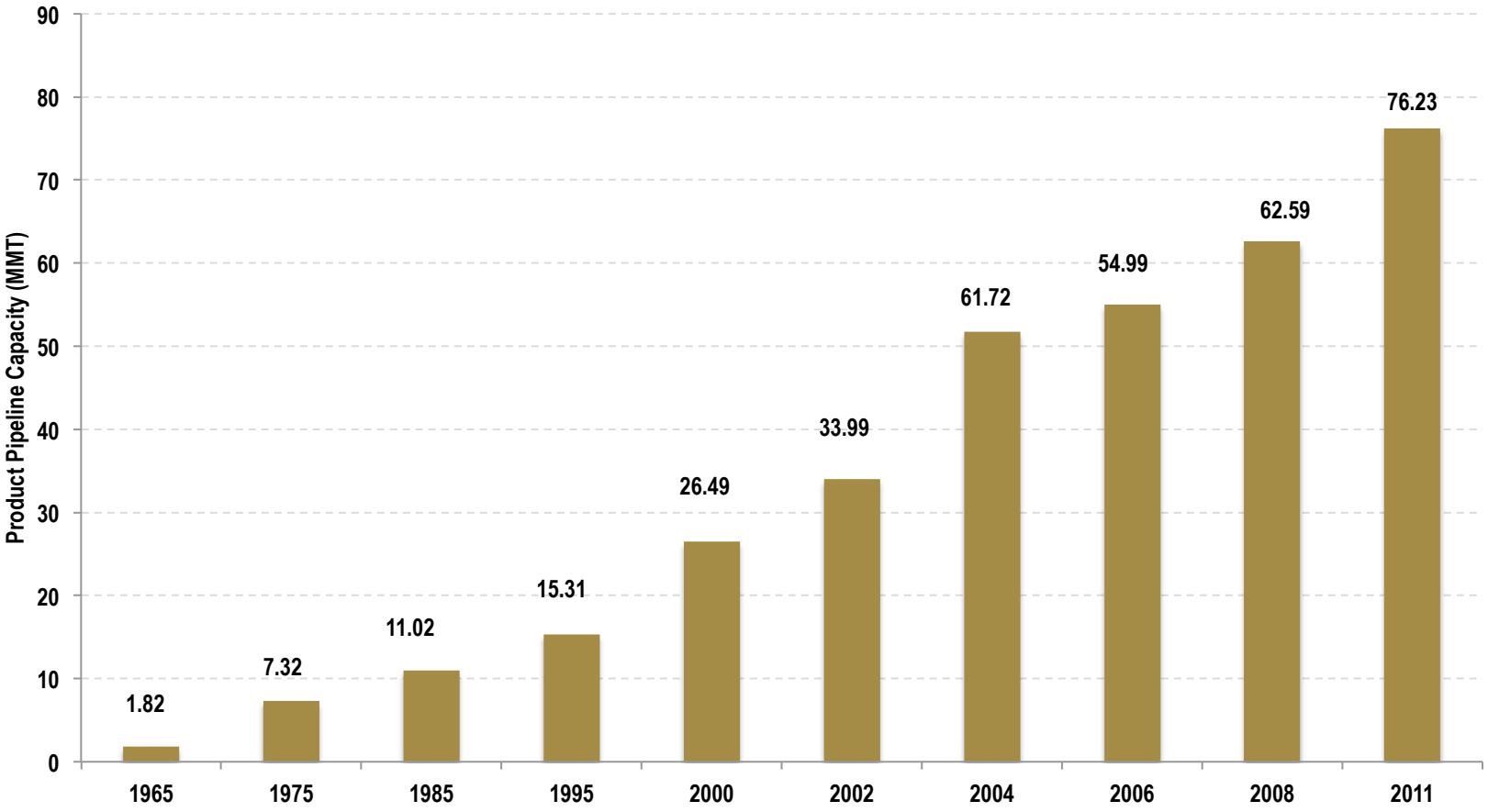


2010-2011



- Pipelines becoming increasingly important
- Challenge is designing growing pipeline network to handle all fuels regardless of fuel quality

Growth of pipeline capacity in India



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
- Transition to ULSF study report: http://theicct.org/transition-to-ulsf-brazil-china-india-mexico
- Webinar on vehicular emissions in India: http://theicct.org/blogs/staff/reducing-vehicular-emissions-india-webinar-notes
- Webinar on fuel quality in India: http://theicct.org/blogs/staff/improving-fuel-quality-india-webinar-notes
- Report on costs of emission reduction technologies: http://theicct.org/estimated-cost-emission-reduction-technologies-ldvs
- Briefing on the benefits of low sulfur fuels in India: http://theicct.org/benefits-low-sulphur-fuels-india
- Briefing on the potential of lower vehicle emission standards in Indian cities: http://theicct.org/potential-lower-vehicular-emissions-indian-cities
- Blog on dieselization in India: http://theicct.org/blogs/staff/harsh-calculus-dieselization-india
- Blog on vehicle and fuel taxes in India: http://theicct.org/blogs/staff/india-2012-budget

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