LEADING BY INNOVATION
World CE Market

‘Shifting Leaders of Global Economic Growth’

- BRIC: 53.3%
- Europe: 14.6%
- USA: 14.6%
- ROW: 17.3%

Market Size in million units

Source: World Market Analysis
India CE Market

Industry Volume & Growth Rate

28,239 41,240 37,089 33,607 48,974 62,685 56,194 47,114 39,797 41,006 45,962 54,060 64,812 70,637

39% 46% -10% -11% 48% 28% -10% -16% -16% 4% 12% 18% 20% 8%

Strong Long Term Potential
Global CO₂ emissions expected to increase by 1.9% annually between 2001 & 2025 that may result in more than 5°C temperature rise.

Developing countries’ emissions are expected to grow above the world average at 2.7%

31% of petroleum oils consumed by CEV & tractors and second to Transport sector.

Each gallon of fuel CEV burns adds 20 pounds of CO₂ in the environment

This means we are adding ~4 Tonnes of CO₂/vehicle/year

*Source: Petrofed and Indian Oil corp. Limited*
2020 Estimated Fuel Demand

<table>
<thead>
<tr>
<th>Year</th>
<th>Liters in million</th>
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</thead>
<tbody>
<tr>
<td>2013</td>
<td>6.20 bn</td>
</tr>
<tr>
<td>2020</td>
<td>15.30bn</td>
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Emission: ~40 bn Tons of CO₂
Fuel Efficiency as an Opportunity

30% Fuel Efficiency gain by 2020 would translate:

- ~5.0 billion Litres of Fuel Saved / Year
- 11.5 bn tonnes of CO2
- Savings on the subsidy

There is a case to therefore incentivize the Innovations driving fuel efficiency programs in industry
BS IV : Implications

• Step changes needed on engine platforms.

• Significant investments and lead times:
  • OEM Readiness
  • FIE Manufacturing capacity readiness
  • After Treatment technology viability / footprint

• Customer Impact: Initial Price and After-market, equipment serviceability and maintenance.

• Fuel quality, availability and infrastructure pan India.
Technology Shift (In Cylinder)

Combustion System

- Optimized Nozzle Spray Pattern, Zero sac vol.
- Re-entrant Piston Bowl
- 4 Valves per cylinder
- Hydraulic Lash Adjuster
- Better Swirl Ratio

Fuel Injection Equipment (FIE)

- Common Rail System Third generation (2200 bar)
- Rotary Pump
- Inline Pump
- Fuel Injection Equipment (FIE)
Air Management

Turbocharger, TCIC, WG TC

Variable Geometry Turbocharger
- Controls exhaust pressure to drive EGR flow
- Variable position vanes allow tailored performance
- Customer Value - Faster Response - More Torque - Improved Fuel Economy

Two Stage TC

EGR with controller (Pneumatic/ Electrical)
High Pressure / Low Pressure

Cooled EGR

Exhaust Gas Recirculation
**Aftertreatment Technology Strategy**

**Diesel Oxidation Catalyst (DOC)**
- Additional Transformation of No to NO₂.
- PM reduction with SoF oxidation.
- Low Maintenance and cost

**Diesel Particulate Filter (DPF)**
- Consists of particle collecting and the regeneration device
- Reduction of Ultra fine particle
- Filter Efficiency >99%

**Particulate Oxidation Catalyst (POC)**
- Filter Efficiency of 60-80% (Less than DPF)
- Passive regeneration (Typically)
- Less sensitive to ash accumulation

**Challenges:**
- Thermal & Chemical stability
- Formation of sulfuric acid
- Regeneration
- Thermal failure
- Low Sulfur Diesel
Selective Catalytic Reduction (SCR)

- Urea – Aqueous solution, Freezing at -11°C
- Catalyst
  - Urea injection and control system
  - Optimized for good fuel efficiency

Challenges
- Infrastructure & Cost
- Sulfur poisoning / desulfurization
- Low temperature range.

Nox absorber Catalyst (NAC)
Lean NOx Trap (LNT)

- NOx conversion efficiency 10%-25%
- Option for retrofit/Easy to install and integrate

Challenges
- Sulfur poisoning / desulfurization
- Long-term stability / thermal aging
- Limited DeNOx regen operation area.
**Key Challenges**

**T4f Compliance**

**Challenges** related to T4final development:

- **Packaging** and **sign-off** of exhaust after-treatment installation including:
  - SCR (catalyst)
  - DEF (diesel exhaust fluid) injection system and
  - **On board diagnostic** to monitor and control the NOx content in the exhaust

- **Complex technology** for after market support & End user

- Fuel Quality and Adulteration would pose challenge to system reliability.

- Cost to end Customer.

2021/22

**Huge Investment**

**Price Increase**
Alternate Energy

Fuel Efficiency up by 40%
Carbon footprints reduction by 30 %
Efficiency Improvement

- Exhaust Energy
- WHR
- Turbo Compounding
- Turbocharger
- Cost
- Electrical vehicles
- Hybrid
- Macro Hybrid
- Start Stop
- Heavy Duty Cycle
- Light Duty Cycle
NRMM industry is on a cross road where it needs to preparing for next level of Challenges.

BS IV significant impact on powertrain footprint (technology, manufacturing, FIE, supply chain, after-sales as well as the Customer).

No. of Potential solutions for BS IV possible, but key lies in well Integrated Solution that meets end Customer requirement and Aftermarket support.

Industry is ready with technology, however the lead times high to establish the footprint.
NRMM Industry population would rise by 2020, pressure on fuel demand and environment impact esp. CO2 emissions.

Fuel Efficiency is the big opportunity, need for Innovations to generate at least 30% reduction.

Opportunity areas: Efficiency Innovations, Hybrid Technologies, Alternate Fuels, FE Labeling, Incentivization etc.
Thank You