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Agenda

• Fuel Freedom Foundation
• Methanol for LDVs
• Research Program
• Summary
Fuel Freedom Foundation

• Non-partisan initiative dedicated to reducing U.S. dependence on petroleum

• Initiate changes necessary for gasoline, diesel, natural gas, ethanol, methanol, and electricity to compete on equal footing
  – Overcome the regulatory, commercial, and practical barriers that impede innovation in fuel production, consumption, and true market competition
Decoupling of Natural Gas and Oil Prices

- **Upward Price Pressure from** Demand from Developing Countries
- **Downward Price Pressure from** U.S. Shale Gas Production
A Variety of Fuel Options Possible from Natural Gas

- Battery Electric Vehicles
- Plug-in Hybrid Electric Vehicles
- Internal Combustion Engine Vehicles
- Electric Vehicles
- Methanol
- Ethanol
- Synthetic Gasoline
- Compressed NG
- Natural Gas
- Liquified NG
- Hydrogen
- Fuel Cell Vehicles
Methanol as Transportation Fuel

• Focus on existing light duty vehicle fleet
  – Fuel demand large
  – Existing fleet of FFVs
  – Possible conversions
  – Provides business case for investing in production, distribution and retailing

• Methanol can be marketed at prices to provide a value proposition to consumers
  – Low cost of FFV technology and conversions
Existing Fleet of FFVs and Potentially Larger Population with Vehicle Conversions

- Engine control system reprogrammed
- Fuel tank and fuel line from material compatible with alcohol
- Fuel pump and injectors designed for more fuel throughput
- Active oxygen sensor connected to engine control

Total incremental production cost $\sim 100$
# Methanol Research Needs

## Supply Chain & Vehicles

<table>
<thead>
<tr>
<th>Fuel Production</th>
<th>Methanol</th>
<th>Research Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Production</td>
<td>Chemical methanol only</td>
<td></td>
</tr>
<tr>
<td>Fuel Specification</td>
<td>ASTM D5797 under revision</td>
<td></td>
</tr>
<tr>
<td>Natural Gas Feedstock</td>
<td>Commercial</td>
<td></td>
</tr>
<tr>
<td>US Production facilities</td>
<td>No but coming back</td>
<td></td>
</tr>
<tr>
<td>RBOB</td>
<td>No (RVP increase)</td>
<td>1,2</td>
</tr>
</tbody>
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## Transportation and Blending Equipment

| Pipeline | No |
| Rail tanker cars | No but possible to use methanol |
| Terminal Storage | No |
| Blending Facilities | No |
| Tanker Truck | No but possible gasoline |

## Fuel Station Equipment

| Storage Tank & Piping | Methanol should be ok |
| Dispenser (UL approved) | No | 2 |
| Stage II vapor recovery | No | 2 |

## Market

| US Stations | none |
| Market Penetration | none |

## Vehicle

| 15% blends | No, but China, Australia, Israel investigating |
| FFVs | Maybe M56 | 1 |
| Existing Vehicles | No (materials) & possible pumps, injectors, sensors | 1 |
| Conversions | None on market | 1 |
Methanol Research Program

• Vehicle Testing
  – Test several FFVs on varying methanol blends for emissions, driveability, and performance
  • Determine methanol blend limit if any on FTP, HWFET
  • On highest blend assess full load performance, SC03, Cold CO, SRC, and SHED tests

• Engine Testing
  – Baseline on E10 and E85
  – Optimize for best BSFC, emissions, and performance on methanol

• Conversion of non FFVs to methanol
Methanol Research Program

• Materials Compatibility
  – ORNL research on effects of high level methanol gasoline blends
  – Collaborate with work on M15 blends being performed in Israel, China, and Australia
  – Contact Tier 1 OEM suppliers
    • Fuel pumps, sensors, injectors
Methanol Research Program

• Related Studies
  – Resources for the Future, “Cheaper Fuels for the Light-duty Vehicle Sector: Opportunities and Barriers,
    • http://www.rff.org/Publications/Pages/PublicationDetails.aspx?PublicationID=22250
  – MIT, Advanced ICE Technologies with Methanol
Summary

• Natural gas supply in U.S. opens opportunity to introduce less expensive natural gas derived fuels like methanol and ethanol
• Current U.S. fleet of FFVs coupled with conversions creates demand to justify production
• Possible tailpipe emission benefits with existing fleet
• Methanol and ethanol fuels will enable more efficient newer vehicles—lowering GHG impact
• Much work needed to overcome barriers to fuels competition
Summary

• Thank you for your attention

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