Global Passenger Car Powertrain and Electric Vehicle Market: 2015 Outlook

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- Mobility Integration
- New Mobility business models like car sharing
- Corporate Mobility
- New mobility products and services

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- Powertrain
- Chassis
- Safety & ADAS
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- Aftermarket & Distribution
- Vehicle Interior systems for passenger, commercial & off-road vehicles

- Rolling Stock (Light Rail, Metro, MainLine, High Speed Rail)
- Infrastructure (signaling, track, station)
- Bus & BRT solutions
- Advanced technologies

- Urban Logistics
- Intermodal
- New Business Models
- High Speed Logistics
- Courier, Express and Parcel
- 3PL & 4PL
- Connected Logistics

- Intelligent Transport System (V2X, traffic mgt, congestion charging, tolling, parking, etc.)
- IT Integration
- Rail Infrastructure
- Road Infrastructure
- Sea Ports
Presentation Agenda

Global Passenger Car Powertrain Outlook
1. Global Powertrain Fuel Mix
2. Analysis: Diesel vs Gasoline → Focus on India, Europe
3. Impact of Air Quality Concerns on Powertrain
4. Powertrain Report → China, India and Brazil

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Global Powertrain Mix—Unit Shipment by Region Snapshot
European powertrains will be seen receding from diesels, while developing markets like India will continue to witness increasing diesel engine uptake to meet higher fuel economy requirements.

Powertrain Market: Expected Light Vehicle* Unit Shipment by Region and Powertrain Mix, Global, 2015

- Gasoline
- Diesel
- Alt. Fuels
- Mild Hybrids
- Full Hybrids
- EVs

Key: Light vehicles include personal vehicles (PVs) and light commercial vehicles (LCVs). The powertrain mix in China and Japan consider only PVs. The mild and full hybrids in Japan are shown under the "full hybrid" legend. Mild and full hybrids are shown as a part of gasoline and diesel in China, India, South America, and Korea. Total for 2015 represents the sum of regions shown. *Others in 2015 goalpost include mild hybrids, full hybrids and EVs.

Note: All figures are rounded. The base year is 2014. Source: LMC Automotive; Frost & Sullivan
European Powertrain Market—Unit Shipment, Diesel vs. Gasoline Trend

Higher degree penalization for diesel cars and LEZ strategies by major markets led to a marginal decline of diesel share in 2014; this trend is expected to continue through 2015.


![Graph showing annual share comparison of gasoline and diesel vehicles in European countries from 2013 to 2014.](image)

**Belgium**
- Gasoline: 64.8% in 2013, 64.0% in 2014
- Diesel: 35.2% in 2013, 36.0% in 2014

**Finland**
- Gasoline: 52.1% in 2013, 51.7% in 2014
- Diesel: 47.9% in 2013, 48.3% in 2014

**France**
- Gasoline: 37.6% in 2013, 37.4% in 2014
- Diesel: 62.4% in 2013, 62.6% in 2014

**Germany**
- Gasoline: 52.1% in 2013, 51.7% in 2014
- Diesel: 47.9% in 2013, 48.3% in 2014

**Italy**
- Gasoline: 64.8% in 2013, 64.0% in 2014
- Diesel: 35.2% in 2013, 36.0% in 2014

**NL**
- Gasoline: 52.1% in 2013, 51.7% in 2014
- Diesel: 47.9% in 2013, 48.3% in 2014

**Spain**
- Gasoline: 64.8% in 2013, 64.0% in 2014
- Diesel: 35.2% in 2013, 36.0% in 2014

**Sweden**
- Gasoline: 52.1% in 2013, 51.7% in 2014
- Diesel: 47.9% in 2013, 48.3% in 2014

**UK**
- Gasoline: 64.8% in 2013, 64.0% in 2014
- Diesel: 35.2% in 2013, 36.0% in 2014

**YoY Diesel Change (‘13–14)**
- Belgium: (0.4%) decrease
- Finland: 1.7% increase
- France: (3.0%) decrease
- Germany: 0.5% increase
- Italy: 1.1% increase
- NL: 2.3% increase
- Spain: (0.5%) decrease
- Sweden: (2.2%) decrease
- UK: (0.5%) decrease


**2013**
- Gasoline: 37.4% in 2013
- Diesel: 52.1% in 2013

**2014**
- Gasoline: 37.6% in 2014
- Diesel: 51.7% in 2014

**2015**
- Gasoline: 37.7% in 2015
- Diesel: 51.3% in 2015

Note: All figures are rounded. Source: Respective national automotive agencies; Frost & Sullivan

*Frost Estimate based on latest data available
Higher pollution levels in UK, France and Germany and the tougher targets to be met will essentially result in tougher targets for Automakers too; calling for increased power train optimization and alternative propulsion.

**United Kingdom:** Central London to have highest NOx levels by 2020. 40% of EURO VI compliant vehicles in central London will be targeted by 2020.

**France:** France has to bring down its GHG emissions by 14% till 2020 (over 2005 levels). Road measures.

**Sweden:** NOx levels to decline at over 2.5% every year to meet 2020 targets.

**Netherlands:** The current network of 13 LEZ will expand covering larger area, as about 30% cut down in NOx levels will be required by 2020, from current levels.

**Italy:** 3% annual decrease in NOx levels is required to meet 2020 targets.

**Germany:** Increasing emissions from power sector will put additional load on transportation. Auto makers need to cut down emissions by 27% by 2020.

**Czech Republic/Slovakia:** Road transport contributing close to 40% of overall NOx emissions.

Source: Government portals for Air quality, Country Pollution Fact sheets, Frost & Sullivan Analysis
Key Powertrain Highlights of 2014 - India, China & Brazil

Light vehicle sales went up in China and Japan, while it declined in Turkey. India witnessed major technology advantages like engine downsizing, GDI and twin scroll turbochargers in the C/D segments.

Sales Outlook:
The combined sales of passenger cars, utility vehicles and vans are expected to reach **about 2.6 million** as the financial year closes in India. Gasoline will have powered about 45-46% of vehicles, while diesel, about 52-53%.

Technology Outlook:
- **Directed injected gasoline** engines came fitted in the B/C segments cars like, VW POLO TSI and VENTO TSI.
- These also feature dual scroll **turbocharger for gasoline engines**, capable of giving 40% higher output than the naturally aspirated, port injected counterparts. TAT also introduced gasoline turbocharging in it’s ‘ZEST’, with a Revotron engine.
- **Engine downsizing** also gained focus, with FORD’s 1L Ecoboost, VW’s 1.5L engines and Hyundai’s 1.1L 3 cylinder CRDi engines gaining popularity.
- Popular models like VW POLO, FORD Ecosport and Fiesta also introduced **DCT versions** targeting city drivers, primarily.

China

Sales Outlook:
Sales of passenger cars reached close to **19.7 million units in 2014** clocking 9.9% growth over 2013 levels. **Chinese car manufacturers increased their sales by 4.1% over previous years.**

Technology Outlook: The share of **direct injected engines was about 14-15%** among gasoline vehicles.

About **16-18%** of gasoline engines were **boosted**.

The production of **8 speed transmissions got a boost** as result of increased adoption from European OEMs;

**Dual clutch** transmissions continued on their growth track with growth rate over **25%**, from 2013 levels.

China sold close to 74,800 New Energy Vehicles(NEV); more than three fold the sales in 2013.

 LATAM Region - Brazil

Sales Outlook:
In the backdrop of weak economy and poor exports vehicle sales totaled about **3.5 Million**, declining by **7.1%** over 2013 levels.

Technology Outlook:
40% of cars sold had displacement below 1L, over 59% were between 1 and 2L, while engines above 2.0L displacement constituted 0.7%.

Diesel and gasoline cars had 5-6% each market share, while **flex fuel cars remained the majority with 88% penetration**.

Electric Vehicle sales reached close to 900 units. In 2013, the figure was less than 500 units.

Source: Respective Country/Regional Automotive Associations, Frost & Sullivan
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GDI Unit Production Forecast by Region
OEMs like VW, FORD and Renault Nissan are expected to embrace GDI technology at an accelerated rate, in the backdrop of EURO VI implementation and tightening CAFÉ/EPA targets.

1. **Europe**: will see 10-11% increase in the number of GDI engines produced primarily to move closer to EURO VI targets, in the context of declining diesel uptake.

2. **NA & APAC**: Gasoline dominated markets like NA and APAC will see significant advancement in DI technology, and hence will be a principal element in all almost OEMs’ strategies. NA and APAC both to witness 15-17% growth in GDI engines over 2014 levels.

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**Key:** The centre graph represents data for 2015 for select OEMs. The goalpost charts represent data for the entire global market, not only for the OEMs in the centre graph.

**Note:** All figures are rounded. The base year is 2014. Source: LMC, Frost & Sullivan
Gasoline Particulate filters will be reach penetration of around 65% in Western Europe.

Western Europe is expected to be the biggest market with 65% of the GDI engines to have fitted with GPF. VW, Daimler and BMW are leading adopters and expected to take up 52% of market share.

Note: The Market share analysis has been based on the Gasoline Particulate Filter production volumes of each OEM. Others include Hyundai, Toyota, Honda, Geely, Fiat-Chrysler and Mazda.
SCR technology adoption is high in North America, Europe, and China due to stringent emission norms. Japan, South Korea, Australia, Latin America, and Russia will show progress if new emission regulations are launched.
High-speed Transmissions—Unit Shipment Forecast by Region and Technology

Transmissions will continue to speed up this year, with 9-speeds increasing their penetration to about 22-23%.

Key: Graph in centre represents data for 2015.
Note: All figures are rounded. The base year is 2014. Source: Frost & Sullivan
Honda and VW are expected to increase penetration of DCT primarily in to their midsize/sports segments, while 9/10 speed ATs will penetrate more in to larger segments of Chrysler, FORD and Hyundai.

### Powertrain Market: Expected Transmission Type Introductions in Key Segments, 2015 & 2016

<table>
<thead>
<tr>
<th>Segment</th>
<th>BMW</th>
<th>Daimler</th>
<th>Fiat Chrysler</th>
<th>FORD</th>
<th>GM</th>
<th>Honda</th>
<th>Hyundai</th>
<th>TATA</th>
<th>Toyota</th>
<th>VW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Small</td>
<td>Mini Marquee, Sub 1-Series</td>
<td>Compact CUV, 100, Dart, Compass</td>
<td>MKC, Focus, C-Max, Fusion, Mondeo</td>
<td>Compact CUV, Encore, Cruze, Malibu</td>
<td>Accord, TLX</td>
<td>i40, iX35, C‘eed</td>
<td>Sub XF</td>
<td>Camry, GS Series</td>
<td>A4</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>X1, X2</td>
<td>MKS, Taurus</td>
<td>Impala, LaCrosse</td>
<td>RWD Sedan</td>
<td>LTS</td>
<td>Equus, Genesis, K9</td>
<td></td>
<td></td>
<td>A6, A8</td>
<td></td>
</tr>
<tr>
<td>Exec-Luxury</td>
<td>Coupe Models, CLA class</td>
<td>Mustang</td>
<td></td>
<td></td>
<td>Acura Premium Coupe</td>
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<td></td>
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<tr>
<td>Sports</td>
<td>Durango</td>
<td>Expedition Navigator</td>
<td></td>
<td></td>
<td>Pilot</td>
<td>Mohave, Kia SUV</td>
<td>Freelander / Evoque</td>
<td>Land-cruiser, Highlander</td>
<td>Q5, Q7</td>
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<tr>
<td>SUV</td>
<td>M-Class, GLK, GL Class</td>
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<tr>
<td>MPV/PickUP/Van</td>
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</tbody>
</table>

8 – Speed AT | 9 – Speed AT | 10 – Speed AT | DCT

Source: Frost & Sullivan
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Total EVs are likely to reach 10 million units by 2020. Fuel cell vehicle success depends on Toyota, Hyundai and Honda.
The need for increased fuel economy and the emergence of clean diesel technologies are propelling the growth of diesels in North America and India, at small rates. Hybrids continue to grow globally.

**Vehicle type with maximum growth in 2014**

Note: All figures are rounded. The base year is 2014. Data are based on Frost and Sullivan estimates where unavailable. Source: Respective national automotive agencies; Frost & Sullivan.
Over 480,000 electric vehicles to be sold globally in 2015 with North America accounting for 36% of the market

Total EV Market: Percent Sales Breakdown by Region, Global, 2014

- North America: 39.0%
- Europe: 26.1%
- Japan: 13.9%
- China: 18.8%
- South Korea: 2.3%

Total EV Market: Percent Sales Breakdown by EV Type, Global, 2014

- PHEV: 30.9%
- BEV: 61.0%
- NEV: 1.2%
- eREV: 6.9%

Note: Numbers have been extrapolated for November and December; Source: Frost & Sullivan
### EV Charging Infrastructure in Europe

France and the Netherlands lead the way in establishing EV charging infrastructure; however, the United Kingdom has the maximum DC charging stations at 110 stations.

#### Total EV Market: Charging Station Installation Base, Europe, 2014

<table>
<thead>
<tr>
<th>Country</th>
<th>AC</th>
<th>DC</th>
<th>Key Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>1,500</td>
<td>18</td>
<td>Austrian Mobile Power, Spar</td>
</tr>
<tr>
<td>Belgium</td>
<td>1,530</td>
<td>20</td>
<td>Siemens, Park &amp; Charge, Rittal</td>
</tr>
<tr>
<td>Denmark</td>
<td>1,190</td>
<td>56</td>
<td>EON, Clever</td>
</tr>
<tr>
<td>France</td>
<td>6,050</td>
<td>110</td>
<td>EDF, Park &amp; Charge, Vinci Autoroutes</td>
</tr>
<tr>
<td>Germany</td>
<td>4,340</td>
<td>53</td>
<td>RWE, Bosch</td>
</tr>
<tr>
<td>Netherlands</td>
<td>8,580</td>
<td>80</td>
<td>Epyon, Alfen, ABB</td>
</tr>
<tr>
<td>Norway</td>
<td>5,720</td>
<td>96</td>
<td>Transnova, City of Oslo</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1,020</td>
<td>30</td>
<td>Park &amp; Charge, Alpiq</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>3,780</td>
<td>110</td>
<td>Podpoint, Elektromotive, Chargemaster</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan
For Additional Information

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