Toyota’s Initiatives for Realizing Sustainable Mobility

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Toyota Motor Corporation
Toyota’s Actions
Focused on Rapid Changes Today
Advanced Gasoline Engine Technology

Complete upgrading all of engine series from L3 (1.0 Л) through V8

- L3
  - 1.0 Л

- Newly-developed L4
  - 1.3 Л
  - New Start & Stop system

- Newly-developed L4
  - 2.5 Л
  - 2.7 Л

- L4
  - 1.8 Л
  - 2.0 Л
  - Valvematic system

- V6
  - 2.5 Л
  - 3.0 Л
  - 3.5 Л
  - 4.0 Л

- V8
  - 4.6 Л
  - 5.0 Л
  - 5.7 Л

Add variations of fuel-efficient engines
Advanced Gasoline Engine Technology

< Improvement of fuel efficiency >

Achieved improvement in fuel efficiency by introducing new engines

Fuel efficiency comparison (former-new)

<table>
<thead>
<tr>
<th>Engine</th>
<th>Former</th>
<th>New</th>
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</thead>
<tbody>
<tr>
<td>Corolla</td>
<td></td>
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<tr>
<td>Camry(V6)</td>
<td></td>
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<tr>
<td>Lexus GS</td>
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<tr>
<td>Lexus LS</td>
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</tbody>
</table>

< Weight reduction >

Reduced weight by using aluminum material, and modularized parts.

Weight comparison by output (kg/kW)

< Improvement of performance >

Performance improved by introducing D-4S, high compression ratio, and lowering friction.

Output comparison (kW)

Achieved improvement in weight reduction, fuel efficiency, and in performance at the same time

TOYOTA
Annual sales of Toyota HV (worldwide)

Accelerate promoting hybrid models to satisfy market demand
Actions Focused on Mid-Long Term
Recognizing Challenges

1. Reducing Oil Consumption and Promoting Wide Use of Alternative Energies

2. Reducing CO₂ (for preventing global warming)

3. Prevention of Air Pollution
Size and weight reduction is crucial to energy conservation and lower CO₂ emissions

### Initiatives for Reducing Size and Weight of Vehicles

**Six methods by which world’s most compact vehicle was achieved**

<table>
<thead>
<tr>
<th>Method</th>
<th>Image</th>
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</thead>
<tbody>
<tr>
<td>Differential gear reverse placement</td>
<td><img src="image" alt="Differential gear reverse placement" /></td>
</tr>
<tr>
<td>Center take-off gearbox</td>
<td><img src="image" alt="Center take-off gearbox" /></td>
</tr>
<tr>
<td>Placement of ultra-thin fuel tank under floor</td>
<td><img src="image" alt="Placement of ultra-thin fuel tank under floor" /></td>
</tr>
<tr>
<td>Slimmed seat backs</td>
<td><img src="image" alt="Slimmed seat backs" /></td>
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<tr>
<td>Compact air conditioning unit</td>
<td><img src="image" alt="Compact air conditioning unit" /></td>
</tr>
<tr>
<td>Asymmetric installment panel</td>
<td><img src="image" alt="Asymmetric installment panel" /></td>
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</tbody>
</table>
HVVs contribute to reduced CO₂ emissions
Evolution of Electric Motors for HV

- '97 Prius: 33 kW
- '03 Prius: 50 kW
- '05 RX400h: 123 kW
- '06 GS450h: 147 kW
- '07 LS600h: 165 kW

Output density ratio

- Reducing size and weight by increasing output density

Permanent Magnet Motor

- Increasing voltage
- Increasing speed
- Two-stage motor speed reduction gear

Reducing size and weight by increasing output density
Evolution of Batteries for HV

Reducing size and weight by increasing output density

TOYOTA
- Toyota overcomes other car makers in HV sales
- Toyota HV superiors other makers’ HV in fuel efficiency
Plug-In Hybrid Vehicle

Recharging battery using an external power source
Short distance: EV, Long distance: HV
What is Plug-In Hybrid Vehicle?

Short distance: EV

Electricity

Long distance: HV

Hybrid
Verification testing is underway in Japan, Europe and the USA for confirmation of improved fuel efficiency for plug-in hybrid vehicles.
Challenges for EV:
1) Cruising range, 2) cost, 3) charging time, 4) dedicated charging infrastructure

For the time being, a realistic option as compact commuter vehicles
Alternative Fuels Initiatives (Bio Fuels, Natural Gas, Hydrogen)

**Bio Fuels**
- Research for manufacturing cellulose ethanol
- Completed all models to adopted to E10
- Development of vehicles like FFV or BDF-vehicles to satisfy regional demand

**Natural Gas**
- Introducing CNG vehicle

**Hydrogen**
- Steady advances in FCV technology

Place HV and PHV as core technologies, Toyota develops and offers items based on the concept “right vehicle for the right place at the right time.”
New battery research department to be established as part of efforts to accelerate R&D for a next generation battery

TOYOTA
North America Research Institute (TRI-NA) is newly-organized.
TODAY for TOMORROW