G20 Global Summit on Financing Energy Efficiency, Innovative and Clean Technologies

Roundtable A: Financing innovative technologies
~From an automotive company’s perspective~

12th June 2019, Tokyo, Japan

Takao AIBA
Environmental Affairs Division
Toyota Motor Corporation
For children, who are our future, we need new challenges that will shape Toyota’s future in the decades ahead.
### Toyota Environmental Challenge 2050

#### Three “Zero CO2 Challenges” and three “Net Positive Impact Challenges”

<table>
<thead>
<tr>
<th>Challenge of achieving zero CO2</th>
<th>Description</th>
<th>Challenge of net positive impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) New vehicle zero CO2 emissions challenge</td>
<td>90% reduction by 2050</td>
<td>Develop and accelerate widespread use of electrified vehicles</td>
</tr>
<tr>
<td>(2) Lifecycle zero CO2 emissions challenge</td>
<td></td>
<td>Environment-friendly design, from materials to disposal</td>
</tr>
<tr>
<td>(3) Plant zero CO2 emissions challenge</td>
<td>Achieving zero by 2050</td>
<td>Advanced technologies of low CO2-emitting production</td>
</tr>
<tr>
<td>(4) Challenge of minimizing and optimizing water usage</td>
<td>Throughly reduce usage</td>
<td>Clean thoroughly and return</td>
</tr>
<tr>
<td>(5) Challenge of establishing a recycling-based society and systems</td>
<td></td>
<td>Deploy resource recycling systems globally</td>
</tr>
<tr>
<td>(6) Challenge of establishing a future society in harmony with nature</td>
<td></td>
<td>All-Toyota group activities Connecting society and the world</td>
</tr>
</tbody>
</table>
New Vehicle Zero CO₂ Emissions Challenge
-Electrified vehicles go mainstream

Technology Neutral Approach is Essential

Engine-powered vehicle

HEV; Hybrid Electric Vehicle

PHEV; Plug-in Hybrid Electric Vehicle

FCEV; Fuel Cell Electric Vehicle

BEV; Battery Electric Vehicle

2010  2020  2050
Advantage of FCEVs

- ZERO Emissions
- Large power supply capacity
- Fun to drive
- Starting and driving performance under cold conditions
- Long cruising range
- Fast refueling time
HEVs are the mainstay solution in the short to mid term.
Other “xEVs” (BEVs, PHEVs, FCVs) will be the mainstay solution in the mid to long term.
Environment-friendly vehicles will only contribute to the environment if they come into widespread use.

Cumulative sales and annual sales over the years with a significant increase from 2010 onwards. The chart shows a cumulative sales growth from 1997 to 2017 and annual sales starting from 2005.

The CO₂ reduction amount is shown both cumulatively and per year, with a significant drop from 2017 onwards.

Reduction of about 100 million tons of CO₂ emissions by 2017.
Toyota’s Electrification Technology Meets Various Needs

**Toyota’s Core Technology for Electrified Vehicles**
- Motor
- Battery
- Power Control Unit

- FC Stack
- High-pressure Hydrogen Tank
- Charger
- Engine

**Types of Vehicles**
- FCEV
- BEV
- PHEV
- HEV
HEVs are the mainstay solution in the short to mid term.
Other “xEVs” (BEVs, PHEVs, FCVs) will be the mainstay solution in the mid to long term.

Source: JAMA (Japan Automobile Manufacturers Association, Inc.)
European situation

Figure 3.23 Distance to 2017 target by individual manufacturers registering more than 100,000 vehicles per year

Note: The size of a bubble is proportional to the number of vehicles registered in the EU-28.

Strategy to meet the CAFE standard

CO₂ (fuel economy) and electrified vehicles (ZEV / NEV)

In order to achieve CAFE: 35% less ZEV: 20% share

CAFE: Corporate Average Fuel Economy

ZEV only: Unable to meet CAFE standards

In addition to introducing ZEV, popularization of HEV helps achieving CAFE standards
For market expansion of BEVs and FCVs, resolution of the following issues is necessary.

<table>
<thead>
<tr>
<th>BEVs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Battery</td>
<td>Development of a low-cost, high-performance battery</td>
</tr>
<tr>
<td>2. Charging stations</td>
<td>Establishment of comprehensive charging station networks</td>
</tr>
<tr>
<td>3. Vehicle price</td>
<td>BEV prices comparable to those of conventional vehicles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FCVs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduced supply costs</td>
<td>Achievement of low-cost hydrogen use on the basis of reduced hydrogen procurement and supply costs</td>
</tr>
<tr>
<td>3. Vehicle price</td>
<td>FCV prices comparable to those of hybrid vehicles</td>
</tr>
</tbody>
</table>

Source: JAMA (Japan Automobile Manufacturers Association, Inc.)
New Initiative of royalty-free patents and technical support

Vehicle electrification technology patents: Licenses to approximately 23,740 royalty-free patents to be granted

Electrification technology in general: Until end of 2030
Fuel cell-related patents: Extended to end of 2030

System Control
- Approx. 7,550 patents
  - BEV
  - PHEV
  - HEV

Motor
- Approx. 2,590 patents

Charger
- Approx. 2,200 patents

Power Control Unit
- Approx. 2,020 patents

FC Stack
- Approx. 2,840 patents

High-pressure Hydrogen Tank
- Approx. 680 patents

Engine and Transaxle
- Approx. 1,320 patents

Extended to end of 2030

Number of patents: As of end of March 2019
Enhance eco-design
Achieve zero CO2 emissions in the product life cycle in collaboration with suppliers and stakeholders

CO2 emissions from materials and parts will increase due to diffusion of electrified vehicles

Life cycle zero CO2 emissions by eco-friendly design and materials

Zero in the future

Gasoline vehicles
HEV
FCEV

Designated parts for electrified vehicles emit more CO2
## Well to Wheel consideration is important

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>CO2 Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline vehicle</td>
<td>2015年</td>
<td>25</td>
</tr>
<tr>
<td>HEV</td>
<td>2015年</td>
<td>13</td>
</tr>
<tr>
<td>Japan</td>
<td>2015年 (32%)</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>2010年震災前 (26%)</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>2030年ミックス (26%)</td>
<td>41</td>
</tr>
<tr>
<td>U.S.</td>
<td>2015年 (34%)</td>
<td>49</td>
</tr>
<tr>
<td>EU</td>
<td>2015年 (26%)</td>
<td>34</td>
</tr>
<tr>
<td>Germany</td>
<td>2015年 (44%)</td>
<td>49</td>
</tr>
<tr>
<td>France</td>
<td>2015年 (2%)</td>
<td>5</td>
</tr>
<tr>
<td>U.K.</td>
<td>2015年 (23%)</td>
<td>37</td>
</tr>
<tr>
<td>Norway</td>
<td>2015年 (2%)</td>
<td>1</td>
</tr>
<tr>
<td>China</td>
<td>2015年 (70%)</td>
<td>82</td>
</tr>
<tr>
<td>India</td>
<td>2015年 (75%)</td>
<td>96</td>
</tr>
<tr>
<td>Thailand</td>
<td>2015年 (19%)</td>
<td>67</td>
</tr>
</tbody>
</table>

Source: Ministry of Economy, Trade and Industry; Government of Japan
CO₂ reduction in road transport is achievable through the adoption of measures in four core areas, in an integrated approach.

The Integrated Approach to CO₂ Reduction in Road Transport

- Further reductions in vehicle emissions
- Improved traffic flow (congestion mitigation)
- Diversified fuel/energy supply
- More efficient vehicle use

Source: JAMA (Japan Automobile Manufacturers Association, Inc.)
Towards the realization of truly sustainable society, we would like to conserve the global environment in cooperation with people in society and stakeholders.

Thank you very much for your attention!