Progress and Challenges for TOYOTA’s Fuel Cell Vehicle Development

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Since 1980, oil discoveries in new oil fields have lagged oil consumption, hence ‘Peak Oil’ seems to be inevitable.

Atmospheric CO₂ concentration has dramatically increased since the 20th century.

Prompt countermeasures and significant technology innovation are vital.
Electricity and hydrogen are expected to be alternatives to liquid fuel.
Toyota is actively developing hybrid technology to serve as a core technology applicable to all powertrains.
## TOYOTA FCHV Progress

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Present</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 2002 ~</td>
<td>'02 FCHV (lease model)</td>
<td>-30degC ~</td>
</tr>
<tr>
<td>Jul. 2005 ~</td>
<td>'05 FCHV (lease model)</td>
<td>15 years or more</td>
</tr>
<tr>
<td>‘08 FCHV-adv (lease model)</td>
<td>500km or more</td>
<td></td>
</tr>
</tbody>
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### Technical Challenges

1. **Cold Start / Driving Capability**
   - 0degC ~
   - 0degC ~
   - -30degC ~

2. **Actual Cruising Range**
   - 210km
   - 230km
   - 500km or more

3. **FC Stack Durability**
   - 15 years or more

4. **Cost reduction**
   - 1/10 or less (design / materials)

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- Toyota has significantly improved actual cruising range and cold start / driving capability.
- Toyota continues its efforts especially on FC stack durability and FC system cost reduction, targeting commercialization in 2015.

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The cold-weather performance tests verified that the cold start and driving performance of the TOYOTA FCHV-adv was equivalent to that of gasoline-powered vehicles.
2. Cruising Range
TOYOTA FCHV-adv

The FCHV-adv achieved an actual cruising range of over 500 km with increased fuel cell system efficiency.
3. FC Stack Durability

- Durability has been improved by more than three times.
- Further efforts are being made especially for reduction of MEA deterioration under real-world conditions.
As an initial step, we aim to reduce the cost to 1/10 of the current level by design / manufacturing engineering and materials improvement.
Factors for Successful Commercialization of FCVs

1. Increased societal acceptance of various energy sources
   Global warming, depletion of resources, energy security

2. Vehicle marketability
   Resolving technical challenges, reducing cost, and adding new appeal to the products

   Fine-N
   2003 Tokyo Motor Show

   Fine-X
   2005 Tokyo Motor Show

3. Hydrogen infrastructure development
   \( \text{H}_2 \) production, transport & supply;
   \( \text{CO}_2 \) sequestration technology; Codes & Standards
Challenges of Infrastructure Development, Hydrogen Pathways

H₂ Production

- Excess by-product H₂
- Solar / Biomass
- Electricity
- Coal
- Petroleum
- Natural gas

H₂ Transport / Storage / Supply

- 1. Pipeline
- 2. Liquid H₂ by truck
- 3. Chemical hydrides by truck

Refueling

Station

- High Pressure H₂
- Liquid H₂
- Others?
- Onsite H₂ Production
- Trigeneration Station
  Electricity/Hot water/H₂

What is the optimum pathway?
In terms of right timing, right place, and right technologies.

Today For Tomorrow
Towards Popularization of FC Vehicles

In Japan, FCCJ has agreed that automakers and energy companies promote technology development and codes & standards establishment targeting 2015.

Business phase

FCV Development

1st FCHV, Limited leasing

R&D / Product Development

Manufacturing Engineering

Hydrogen Infrastructure

Government support phase

Business phase

Social Needs

Low emission

CO2 reduction

Energy security

Low emission

2002

2008

2015

2030

FCCJ Target

Initial market penetration

Low volume production

Mass production

Mass production

In Japan, FCCJ has agreed that automakers and energy companies promote technology development and codes & standards establishment targeting 2015.
1. For the diversification of energy sources and CO₂ reduction, early commercialization of FCVs are urgent and vital matters.

2. The popularization of FCV requires:
   1) Increased societal acceptance of various energy sources
   2) Vehicle marketability
   3) Hydrogen infrastructure development

3. Toyota is overcoming the technical challenges of:
   1) Actual cruising range of 500 km or more
   2) Cold start capability at -30degC

   Towards commercialization of FCV, Toyota focuses on improving durability/reliability and reducing costs.

4. Toyota is working together with energy companies and the government towards creating a hydrogen society, including codes & standards development and hydrogen infrastructure preparation.
Hydrogen has lower volumetric energy density than liquid fuels. Li-ion batteries have even lower energy density.
Press release issued by FCCJ (July 4, 2008)
“Commercialization of fuel cell vehicles and hydrogen stations to commence in 2015”

Source: Fuel Cell Commercialization Conference of Japan (FCCJ)