Challenges and Opportunities for Green Car Industry

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K. S. Lee
Senior Vice President in R&D Division
Hyundai–Kia Motor Company, Korea
1. Necessities for Green Car

2. Overview of Green Car Industry

3. Hyundai–Kia’s Green car Strategy

4. Conclusion
Environmental Issues related to Car Industry

Depletion of Oil Resources

- Peak Oil time comes around 2025

  THE GROWING GAP
  Regular Conventional Oil: Discovery & Production

  - The amount of oil discovery passed its peak point 40 years ago
  - No more large oil field discovery is expected
  - To prepare for oil shortage, alternative fuel development is necessary
  - Auto industry depends on oil resources almost 100%

Global Warming By GHG*

- Global warming changes ecological system

  1941
  - Changes of Muir glacier Alaska, in August -
  
  2004
  
  ▪ GHG ↑ → Global Temp ↑ → Sea Level ↑
  - water shortage, flood & extermination of species
  ▪ Kyoto Protocol in 2005
  - CO2 regulation in vehicles is inevitable
  ▪ CO2 reduction technology in automotive vehicle
  - Efficiency improvement and Alternative fuel use

* Green House Gas
Many Governments are Considering **Strengthened** CO2 Emission Regulations

### Europe’s CO2 regulation
- **2007** (Industry Avg.): 158 g/km
- **2012**: 130 g/km (18% Decrease)
- **2020** (Estimated): 95 g/km (40% Decrease)

- • Impose penalties for regulation violations: voluntary (current) → obligatory (modified)

### US CAFE (Corporate Average Fuel Economy)
- **2007** (Estimated): 25 mpg
- **2015**: 31.6 mpg
- **2020**: 35 mpg

- • **35mpg Mandate** (2007.12)
  - Extend E85 credit benefits (2014→2019)
### Types of Green Car

Green Cars reduce petroleum consumption or drive with renewable energy

<table>
<thead>
<tr>
<th>Types</th>
<th>Hybrid</th>
<th>Plug-in Hybrid</th>
<th>Electric Vehicle</th>
<th>Fuel Cell Electric Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine + Motor</td>
<td>Motor drive</td>
<td>Motor drive only</td>
<td>Powered by Fuel Cell</td>
<td></td>
</tr>
<tr>
<td>Battery 0.9 ~ 1.8 kwh</td>
<td>Battery 4 ~ 16 kwh</td>
<td>Battery 10 ~ 30 kwh</td>
<td>Battery 0.9 ~ 8 kwh</td>
<td></td>
</tr>
</tbody>
</table>

**structure**
- Improve fuel economy using electric power in inefficient engine operation area
- Re Charge form external power source
- Hybrid + EV

- Drive by electric energy (No engine operation)
- Drive by the electricity from chemical reaction of H2 and O2 in fuel cell
Battery, Motor and Inverter are common core parts of eco friendly vehicles.

Core Technologies of Green Car

Battery/Motor/Inverter → Common Core parts
Challenges in Green Car

The key challenges for Green Car expansion → Cost reduction + Infrastructure

- Battery cost reduction & Performance Improvement
- Electric part cost reduction
- Recharging Infrastructure

- Development of Next gen Battery
- H₂ refueling infrastructure
- FCV cost reduction

Vehicle Cost
+ $4,000

Vehicle Cost
+ $20,000

Vehicle Cost
+ $40,000

Vehicle Cost
+ $100,000

Hybrid

Plug-in

EV

FCEV
# Green Car Preference Analysis

<table>
<thead>
<tr>
<th>Types</th>
<th>Forecasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Combustion Engine</td>
<td>• Oil price rise (\rightarrow) Acceptance fall</td>
</tr>
<tr>
<td>Hybrid</td>
<td>• Oil price rise and vehicle cost down (\rightarrow) Acceptance increase</td>
</tr>
<tr>
<td>Plug-in / Electric Vehicle</td>
<td>• Initial expansion by policy assistance (\rightarrow) Massive acceptance increase when battery technology innovation occurs</td>
</tr>
<tr>
<td>Fuel Cell Electric Vehicle</td>
<td>• Acceptance increase by depletion of oil resources (\rightarrow) More expansion when hydrogen infra-structure is build</td>
</tr>
</tbody>
</table>

![Graph showing preference over time for various types of green cars](image-url)
Forecasts shows that hybrid sales will reach 8million to 12million in 2020.

PHEV and EV are making markets and FCV is expected to be commercialized after 2020.

### Green Car Market Forecast

#### HEV Sales

- **Global Insight (G.I)**
  - 70k (2012) → 120k (2018)
- **Yano Research**

#### Plug-in hybrid Forecast ('09)


### HEV Sales

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global</strong></td>
<td>50.1</td>
<td>75</td>
</tr>
<tr>
<td><strong>US</strong></td>
<td>31.6</td>
<td>29</td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>8.6</td>
<td>35</td>
</tr>
<tr>
<td><strong>Europe</strong></td>
<td>6.7</td>
<td>11</td>
</tr>
</tbody>
</table>

(10,000 Vehicles)

### FCEV (US Market)

- **DOE (‘06)**
  - Optimistic: 2.5 Mil
  - Pessimistic: 0.5 Mil

### Global Insight (‘08)

- 2.37 Mil
- 3.0 Mil
- 5,000-50,000
- 50,000-300,000
- 9.62 Mil
- 5.5 Mil
- 5,000-50,000
- 50,000-300,000
- 8.5 Mil

### Yano Research (‘07)

- 9.62 Mil
- 5.4 Mil
- 3.48 Mil
- 4.06 Mil
- 8.5 Mil

### JP Morgan (‘08.11)

- 2.57 Mil
- 3.0 Mil
- 5,000-50,000
- 50,000-300,000
- 9.62 Mil
- 5.5 Mil
- 5,000-50,000
- 50,000-300,000
- 8.5 Mil

### Notes

- Forecast for Electric Vehicle

- Forecast for Plug-in hybrid (‘09)


- Forecast for Electric Vehicle
  - Optimistic: 70k (2012) → 120k (2018)

- Forecast for Plug-in hybrid
Hyundai-Kia’s Green Car Strategy

Fuel economy Improvement and eco-friendly vehicle development
→ Global Leader as Reducing GHG emission & Protecting environment

Power train

- Fuel Economy Improvement
  - Gasoline/Diesel
- Bio Fuel and CNG
  - Bio Fuel
- Dual power sources, fuel and electricity
  - Engine+Motor
- Electric Power source, Eco driving
  - Battery+Motor
- Hydrogen, Eco driving
  - Fuel Cell+Motor

Strategy

- Continuous FE Improvement
  - Smart Green Car (Improve FE 30%)
- Regional diversification
  - US: Bio Ethanol
  - EU: Bio Diesel
  - India: CNG
- Expanded HEV Line-ups
  - Elantra HEV('09)
  - Sonata HEV('10)
- Gov. Sponsored Fleet Demo
  - PlugIn HEV('12)
  - EV (End of 2010)
- Small-Scale Mass Production
  - 2012

→ Fuel economy Improvement and eco-friendly vehicle development
Hyundai–Kia’s Green Car Roadmap

Core Technology Development

- 1995
  SantaFe EV (Hawaii, Jeju Demonstration)

- 2000
  Concept

- 2004
  Verna/Pride (Demonstration)

- 2006
  Elantra/Forte LPi

Phase 2 (2005~2009)
Hybrid Mass production

- 2009
  Hyundai-Kia’s Green Car Roadmap
- 2010
  Sonata/Lotze

- 2012
  HE/Plug-in

Phase 3 (2010 ~)
Expansion Green Car Line-up

- 2012
  Small Production

Hyundai/Kia has been developing Eco–Technology since 1995 and will establish full green car line–up by 2012
Elantra L Pi Hybrid

- Elantra L Pi HEV (SOP: ’09.7), Forte L Pi HEV (SOP: ’09.8)
  - First to adopt advanced Lithium Polymer batteries / Powered by LPG
  - 12.7 tons of less CO2 emission throughout the lifecycle (based on 150,000km mileage)

**Specification**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Speed</td>
<td>182 km/h</td>
</tr>
<tr>
<td>Fuel Economy</td>
<td>17.8 km/ℓ (CO₂: 99g/km)</td>
</tr>
<tr>
<td>Acceleration</td>
<td>11.7 sec (0→100 KPH)</td>
</tr>
<tr>
<td>Emission</td>
<td>SULEV</td>
</tr>
<tr>
<td>Powertrain</td>
<td>Gamma 1.6ℓ L Pi + 15kW motor + CVT</td>
</tr>
<tr>
<td>Battery</td>
<td>Li-ion polymer (180 V)</td>
</tr>
</tbody>
</table>
Sonata Hybrid

- Sonata HEV ('10.9), Lotze HEV ('11.3)
  - Proprietary Hybrid System different from Toyota and Honda
  - Competitiveness by exclusive controller and integrated system design

<table>
<thead>
<tr>
<th>Specification</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Speed</td>
<td>195 km/h</td>
</tr>
<tr>
<td>Fuel Economy</td>
<td>More than 20 km/ℓ</td>
</tr>
<tr>
<td>Acceleration</td>
<td>Better than gasoline vehicle (0→100 KPH)</td>
</tr>
<tr>
<td>Emission</td>
<td>SULEV</td>
</tr>
<tr>
<td>Powertrain</td>
<td>Theta 2.4ℓ + 30kW motor + 6-speed A/T</td>
</tr>
<tr>
<td>Battery</td>
<td>Li-ion polymer (270 V)</td>
</tr>
</tbody>
</table>
Fuel Cell Electric Vehicle

- **Global Top Fuel Cell System Efficiency**: 62%
  - Acceleration: 12.8 sec, Fuel Economy: 21.5 km/ℓ
- The Longest Driving Range: 753 km
  - Single Charge: San Francisco → LA 633 km
- 2009 Demonstration Project (4 vehicles are in operation)

**Tucson / Sportage**
- Similar Performance to ICE: 0-100 km/h → 11.9 sec, F+E → 30.7 km/ℓ
- 2007. 8 Michelin Challenge Bibendum All Grade “A”
- 2008. 8 US Traverse: 3,945 km (Portland → LA)

**US Fleet Program**
- Period: '04. 9 ~ '10. 8 (6 years)
- Scale: 32 SUVs (Tucson 16, Sportage 16)

**Domestic Monitoring**
- Period: '06. 8 ~ '10. 7 (4 years)
- Scale: 30 SUVs (Tucson 18, Sportage 12), 4 Buses

**Mohave**
- Similar Performance to ICE: 0-100 km/h → 11.9 sec, F+E → 30.7 km/ℓ
- The Longest Driving Range: 753 km
  - Single Charge: San Francisco → LA 633 km
- 2009 Demonstration Project (4 vehicles are in operation)
**Electric Vehicle**

- Provide compact EV for government fleet program (\`10.8~)
  - MOU with KEPCO for EV and charge infrastructure development (\`09.10)
  - Fleet program in metropolitan area and Jeju island

### Specification

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>i-10 EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive range</td>
<td>160 km</td>
</tr>
<tr>
<td>Charging time</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>7hrs</td>
</tr>
<tr>
<td>Fast</td>
<td>0.5hr</td>
</tr>
<tr>
<td>Max. Speed</td>
<td>130 km/h</td>
</tr>
<tr>
<td>Motor</td>
<td>50kW AC Induction</td>
</tr>
<tr>
<td>Battery</td>
<td>LiPB</td>
</tr>
</tbody>
</table>

**Primary Core Part Devel. Tech.**

- High Performance Battery
- Charger
- Nor. Charging (7hr)
- Rap. Charging (30Min)

**Infra**

- Nor. Charging (7hr)
- Rap. Charging (30Min)
Paradigm Shift in Automotive Industry

- Green car Technology → change of dominance in auto industry
  - Early market domination provides great economic value
- Green car development is necessary for National Energy Security

- Toughening Regulations
  - EU CO₂ Regulation
  - US CAFÉ standard and ZEV regulation

- Government Support
  - Tax credit and Subsidization
  - R&D support
Strategy for competitiveness of Green Car Industry

- Global competitiveness through university – industry cooperation and Green partnership with supplies

Government
- Infrastructure
- Green Car distribution
- R&D support

Industry
- Leading R&D
- Part’s competitiveness
- Cost Reduction

Competitive Green Car Industry
- HR Development
- Base Tech. Development

Univ / Institute