



Innovation

Challenges and Opportunities for Green Car Industry

2010. 3. 4

K. S. Lee

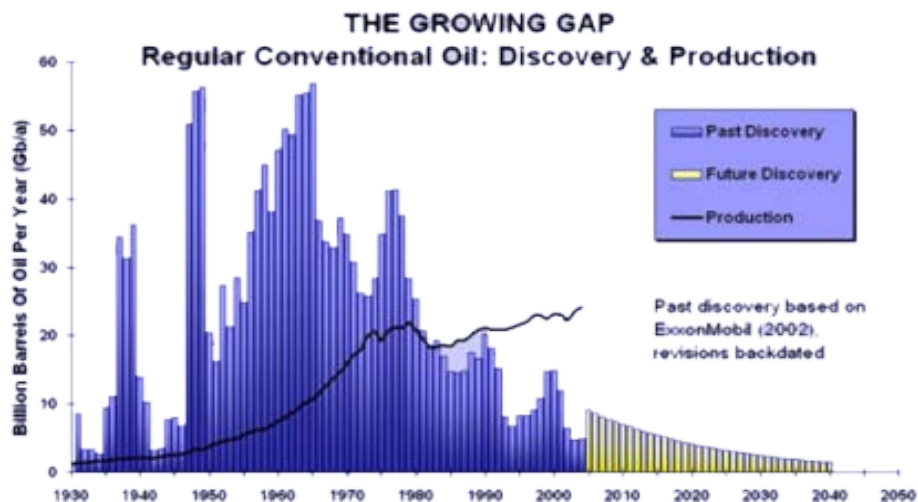
**Senior Vice President in R&D Division
Hyundai-Kia Motor Company, Korea**

- 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 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



2004

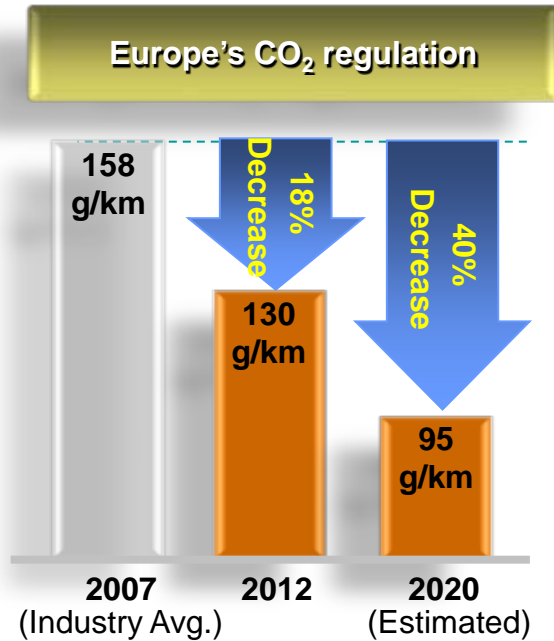
- Changes of Muir glacier Alaska, in August -

- **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

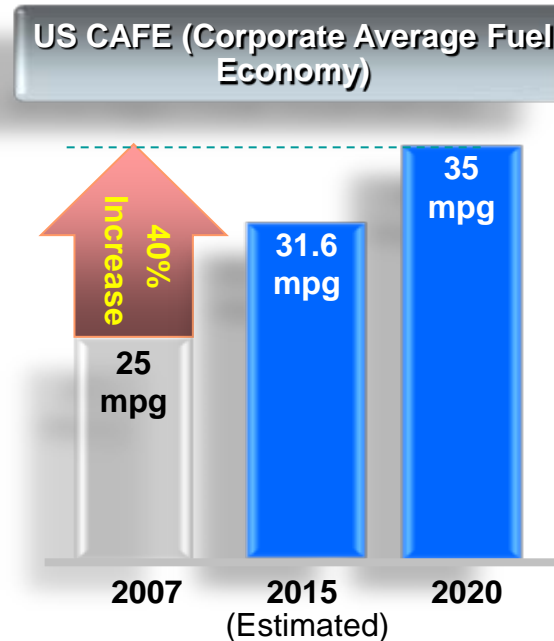
* Green House Gas

Toughening Regulations

Many Governments are Considering **Strengthened** CO₂ Emission Regulations



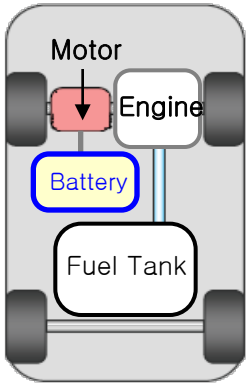
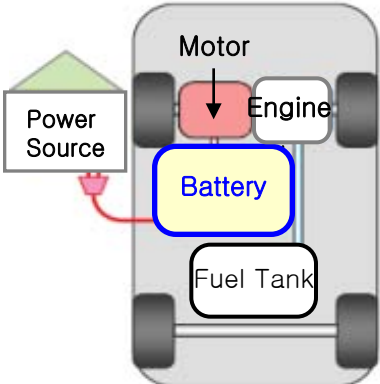
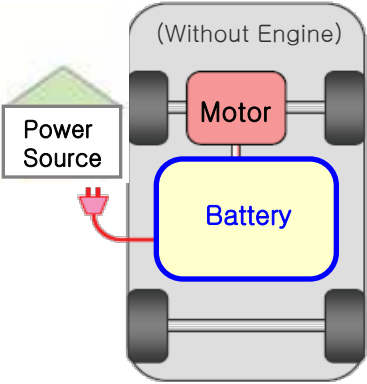
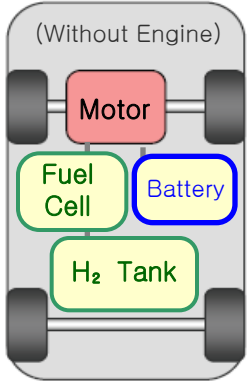
- **Impose penalties for regulation violations :**
voluntary (current)
→ obligatory (modified)



- **35mpg Mandate (2007.12)**
- Extend E85 credit benefits (2014→2019)

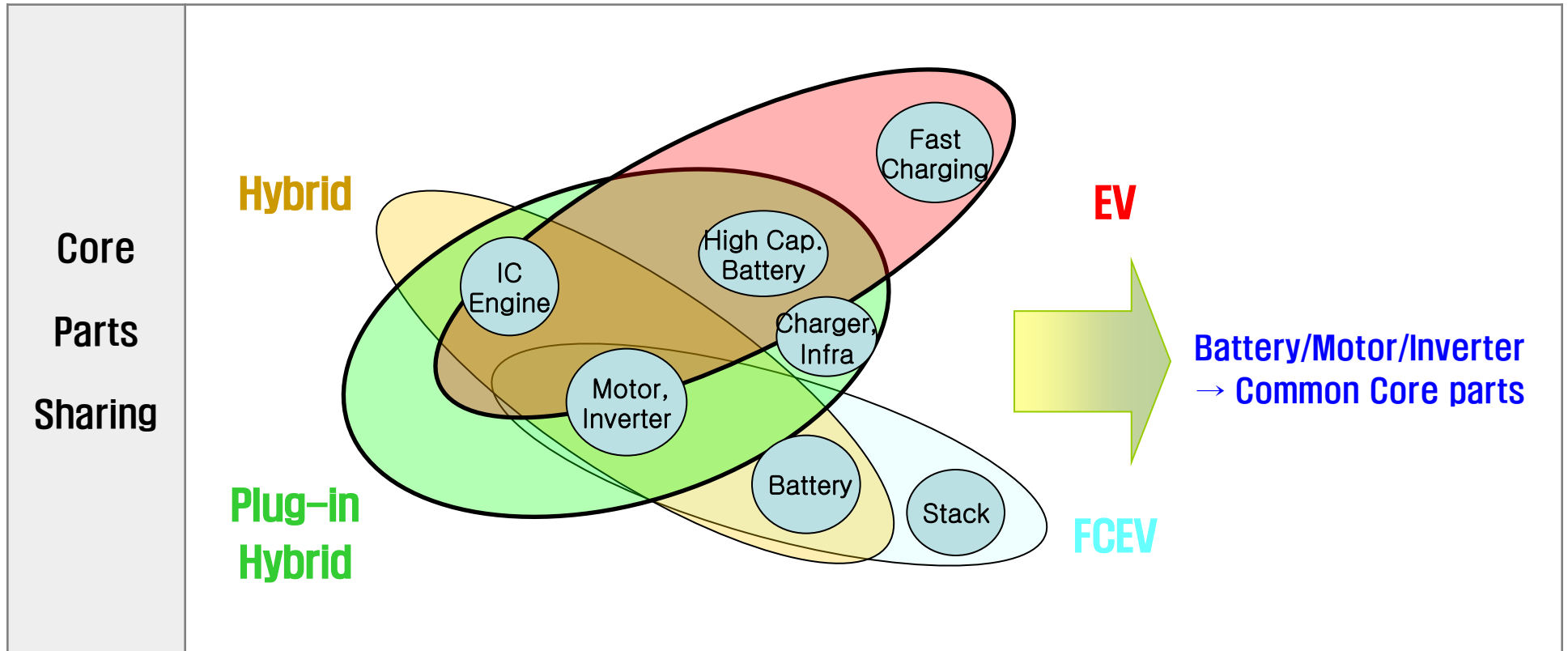
Types of Green Car

Green Cars reduce petroleum consumption or drive with renewable energy

	Hybrid	Plug-in Hybrid	Electric Vehicle	Fuel Cell Electric Vehicle
Types	<p>Engine + Motor</p>  <p>Battery 0.9 ~ 1.8 kwh</p>	<p>Motor drive</p>  <p>Battery 4 ~ 16 kwh</p>	<p>Motor drive only</p> <p>(Without Engine)</p>  <p>Battery 10 ~ 30 kwh</p>	<p>Powered by Fuel Cell</p> <p>(Without Engine)</p>  <p>Battery 0.9 ~ 8 kwh</p>
structure	<ul style="list-style-type: none"> Improve fuel economy using electric power in inefficient engine operation area 	<ul style="list-style-type: none"> Re Charge form external power source Hybrid + EV 	<ul style="list-style-type: none"> Drive by electric energy (No engine operation) 	<ul style="list-style-type: none"> Drive by the electricity from chemical reaction of H₂ and O₂ in fuel cell

Core Technologies of Green Car

Battery, Motor and Inverter are common core parts of eco friendly vehicles




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

Hybrid

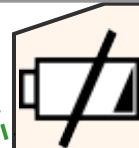


Home Charging Infrastructure

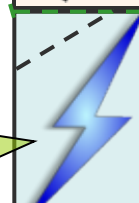
Vehicle Cost
+ \$20,000

Plug-in


Short Driving Range



Battery Technology Development




Fast charging Infrastructure




Vehicle Cost
+ \$40,000


EV



FC Technology Development



H₂ refueling infrastructure

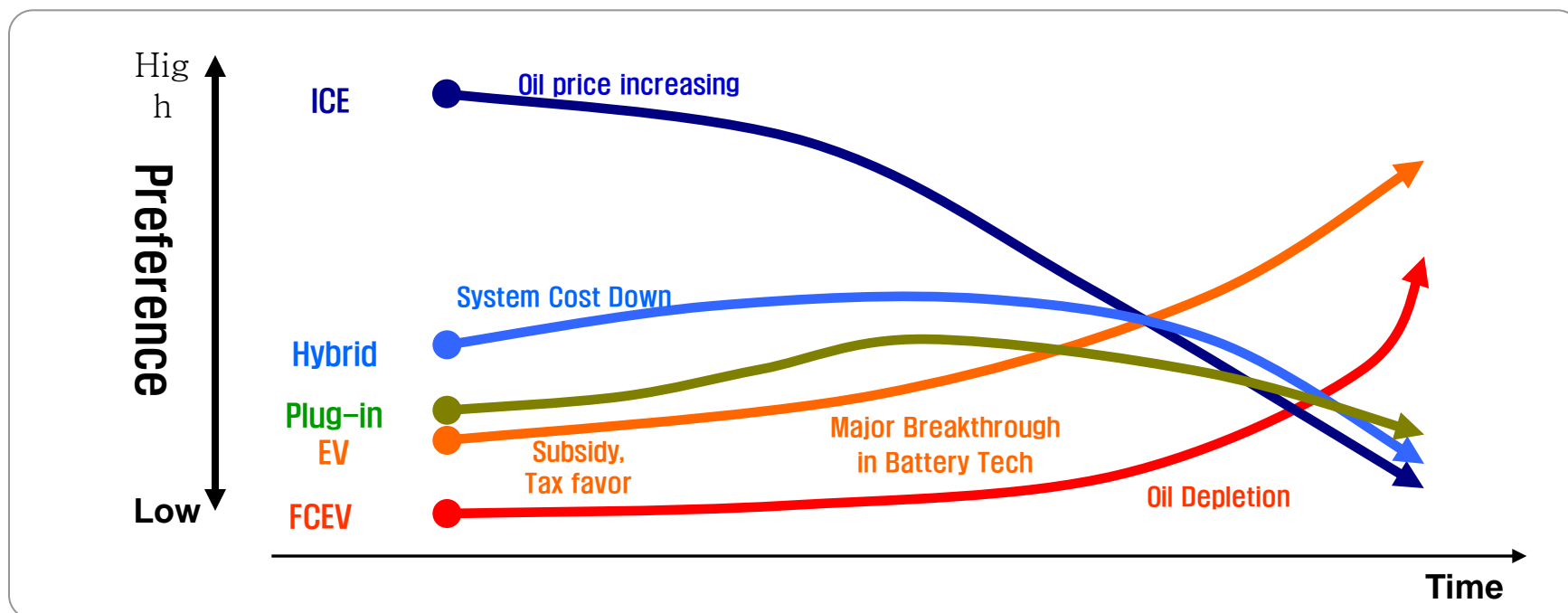


Vehicle Cost
+ \$100,000

FCEV

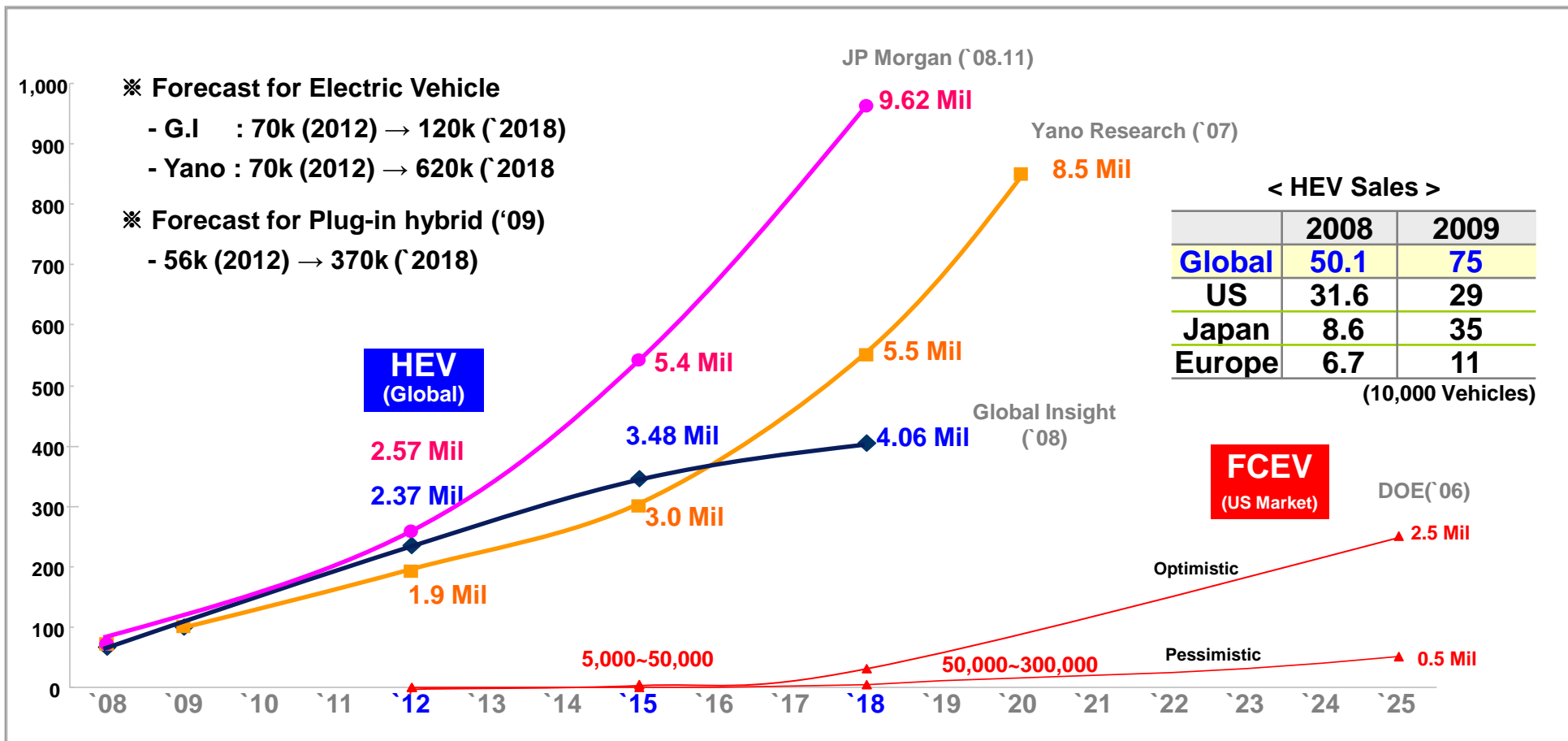
Green Car Preference Analysis

Types	Forecasts
Internal Combustion Engine	• Oil price rise → Acceptance fall
Hybrid	• Oil price rise and vehicle cost down → Acceptance increase
Plug-in / Electric Vehicle	• Initial expansion by policy assistance → Massive acceptance increase when battery technology innovation occurs
Fuel Cell Electric Vehicle	• Acceptance increase by depletion of oil resources → More expansion when hydrogen infra-structure is build



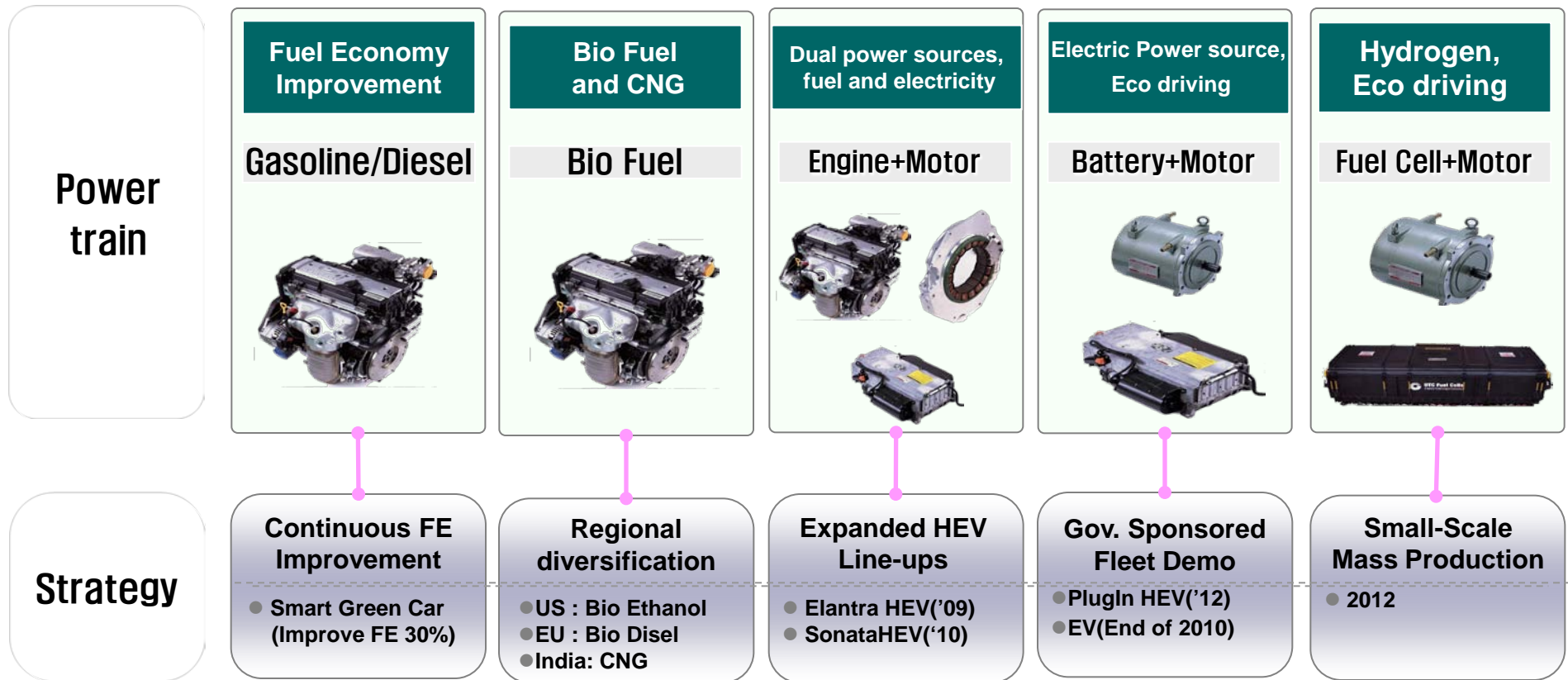
Green Car Market Forecast

- 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

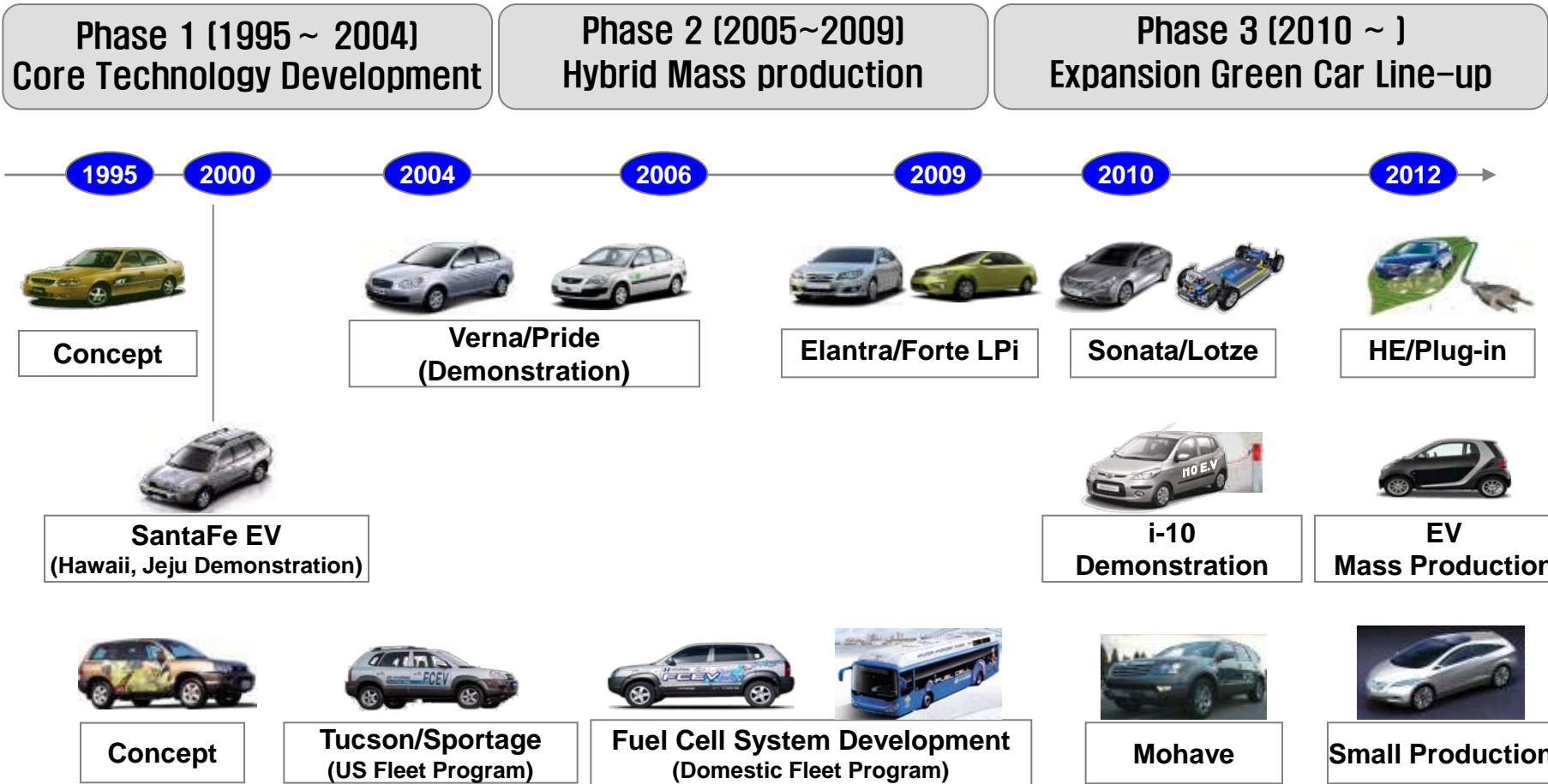


Hyundai-Kia's Green Car Strategy

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



Hyundai-Kia's Green Car Roadmap



Hyundai/Kia has been developing Eco-Technology since 1995 and will establish full green car line-up by 2012

Elantra LPi Hybrid

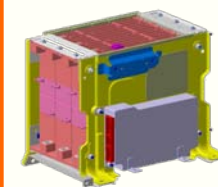
- Elantra LPi HEV (SOP: ' 09.7), Forte LPi HEV (SOP: ' 09.8)
 - First to adopt advanced Lithium Polymer batteries / Powered by LPG
 - 12.7 tons of less CO2 emission throughout the lifecycle (based on 150,000km mileage)

Specification

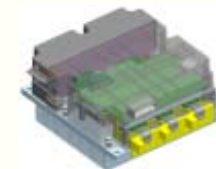
Max Speed	182 km/h
Fuel Economy	17.8 km/ℓ (CO ₂ : 99g/km)
Acceleration	11.7 sec (0→100 KPH)
Emission	SULEV
Powertrain	Gamma 1.6ℓ LPi + 15kW motor + CVT
Battery	Li-ion polymer (180 V)



Motor



Battery



Inverter

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

Specification

Max Speed	195 km/h
Fuel Economy	More than 20 km/ℓ
Acceleration	Better than gasoline vehicle (0→100 KPH)
Emission	SULEV
Powertrain	Theta 2.4ℓ + 30kW motor + 6-speed A/T
Battery	Li-ion polymer (270 V)



YF Hybrid System

Fuel Cell Electric Vehicle

Tucson /Sportage



Mohave



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

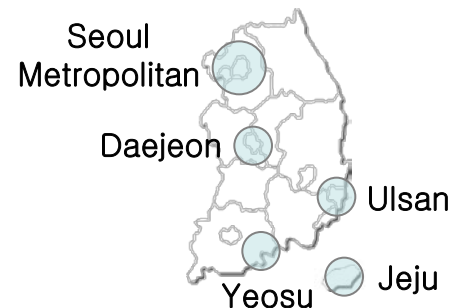
US Fleet Program

- 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



- Global Top Fuel Cell System Efficiency : 62%
 - Acceleration : 12.8sec, Fuel Economy : 21.5 km/ ℓ
- The Longest Driving Range : 753 km
 - Single Charge : San Francisco → LA 633km
- 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

Vehicle		i-10 EV
Drive range		160 km
Charging time	Normal	7hrs
	Fast	0.5hr
Max. Speed		130 km/h
Motor		50kW AC Induction
Battery		LiPB



Primary
Core
Part
Devel.
Tech.

High Performance
Battery



Charger



Infra

Nor. Charging(7hr)
Rap. Charging(30Min)



Paradigm Shift in Automotive Industry




Toughening Regulations

EU CO₂ Regulation
US CAFÉ standard and ZEV regulation

Government Support

Tax credit and Subsidization
R&D support

- 
- 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

Strategy for competitiveness of Green Car Industry

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

