

# Korea Green Car Fuel Economy Schemes; Status and Prospect

18 Oct. 2013

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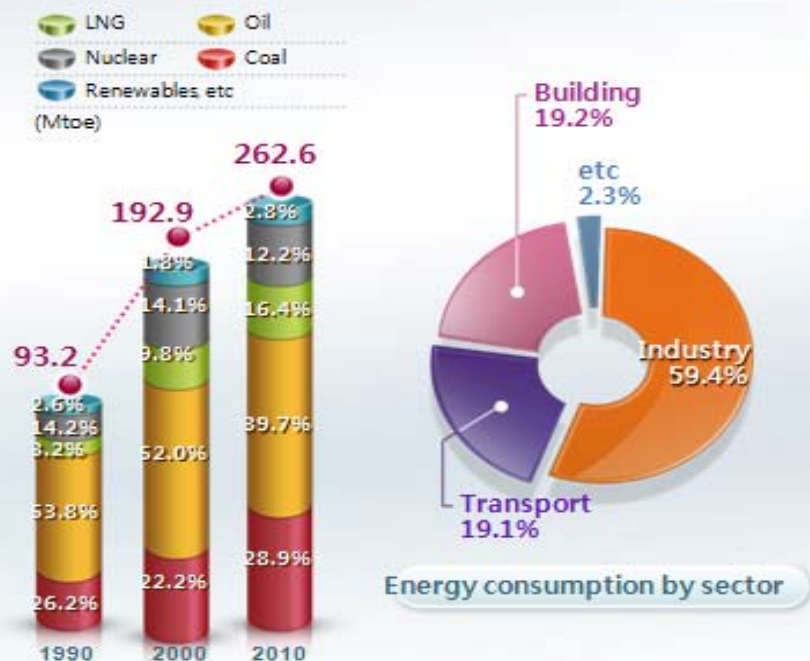
**KOREA ENERGY  
MANAGEMENT CORPORATION**

- I. Overview of Korea Fuel Economy Scheme**
- II. Green Car Policy & Tax Incentive**
- III. Study on Reform of Tax Incentive Criteria**
- IV. 5-cycle Test Results of HEV, EV & PHEV**

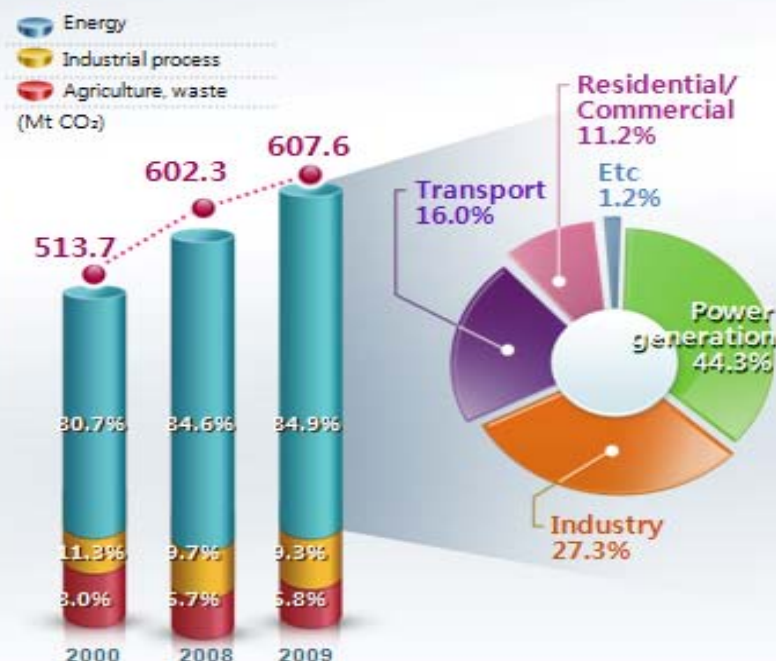
# I. Energy Consumption in Korea

- In 2010, 96.2% of total primary energy supply was imported
- Transport sector accounts for nearly 20% of total final energy consumption
- Vehicle stock has increased dramatically
  - Production volume was 4.56M in 2012, increased by 19.1% compared to 2008
  - Domestic sales volume amounted to 1.41M in 2012, increased by 22.2%
  - Registered vehicles accounted for 18.87M in 2012, increased by 12.4%

## Primary & final energy consumption



## CO<sub>2</sub> emissions

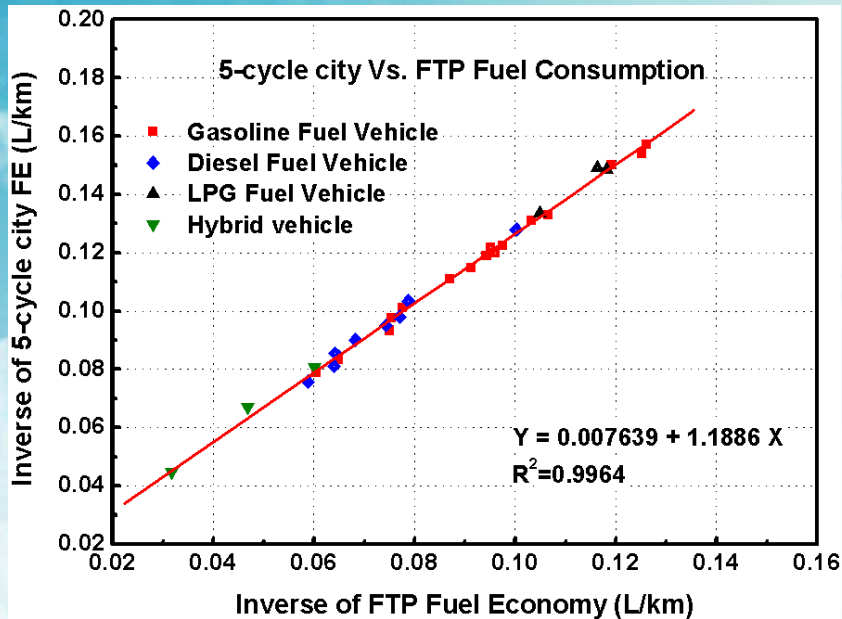


- The Energy Use Rationalization Act of 1989 mandated:
  - Labeling scheme encourages consumers to purchase fuel efficient vehicles
  - Auto companies must put fuel economy information on new vehicles (labels)
- Scope of vehicles
  - All PCs, buses with 15 seats or less, and trucks with GVW of 3.5 tons or less
- Approval of label value
  - Fuel economy of a new vehicle must be approved by KEMCO, before being entered into market
  - KEMCO annually issues about 300 approvals for new vehicle models
- Test methods to determine label value
  - MOTIE-KEMCO must develop test procedures for measuring fuel economy
  - Prior to 2012, only the City test (FTP-75) was used
  - After 2012, use the adjusted 5-cycle test formula by the results of City test (FTP-75) and Highway test (HWFET) to reflect the real world

# I. Adjusted 5-cycle Formula

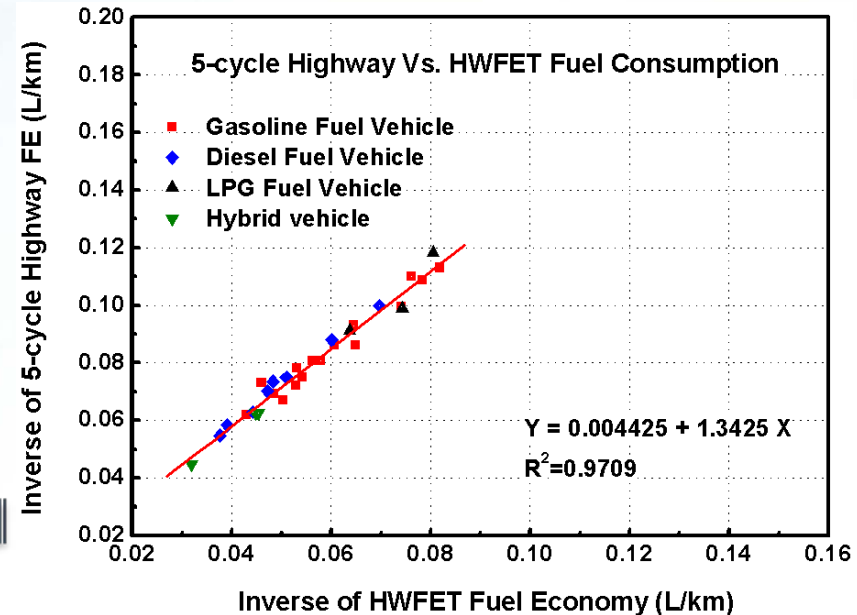
## ◆ Calculation of combined fuel economy

$$\text{Combined FE} = \frac{1}{\frac{0.55}{5\text{-cycle City FE}} + \frac{0.45}{5\text{-cycle Highway FE}}}$$



$$5\text{ cycle City FE} = \frac{1}{0.007639 + \frac{1.1886}{\text{FTP FE}}}$$

$$5\text{ cycle Highway FE} = \frac{1}{0.004425 + \frac{1.3425}{\text{HWFET FE}}}$$



# I. New Fuel Economy Labeling

- New fuel economy label
  - Beginning from 2012
  - Grade, City, Highway and combined F.E.
  - CO<sub>2</sub>, QR code and Legal basis
  - Fuel economy data are also posted on [http://bpms.kemco.or.kr/transport\\_2012](http://bpms.kemco.or.kr/transport_2012) website



- Grade system of fuel economy value (unit: km/L)

Grade	1	2	3	4	5
~2011 (FTP-75 result)	≥ 15	14.9~12.8	12.7~10.6	10.5~8.4	≤ 8.3
2012~ (Adjusted US Combined result)	≥ 16	15.9~13.8	13.7~11.6	11.5~9.4	≤ 9.3
Label					

# I. Fuel Economy Website

에너지관리공단 수송에너지<자동차 연비 등급제도 운영>에 오신 것을 환영합니다. - Windows Internet Explorer

http://bpms.kemco.or.kr/transport\_2012/car/car\_choice.aspx?system

에너지관리공단 수송에너지 <자동차 연비 등급...>

## 에너지관리공단 수송에너지

자동차 표시연비 | 자동차CO<sub>2</sub>배출량 | 평균에너지소비효율

Energy Saving is the life.  
**자동차 표시연비**

수송부문의 에너지사용량을 줄이기 위하여 고효율 그린카의 종류, 특징에 대한 각종정보를 제공하고 있습니다.

제도안내 > | 자동차연비·등급리벨 >

### 자동차 표시연비 검색

선택비교 | 업체명

- 포드 Fusion Hyb
- 혼다 CIVIC HYB
- 폭스바겐 Polo 1.6 TD
- BMW BMW 520d
- 기아 K5 2.0하이브리드
- 현대 쏘나타 2.0E (연비)
- 토요타 렉서스 CT200h
- 토요타 토요타 PRIUS
- 쉐보레 쉐보레
- 폭스바겐 Golf 1.6 TDI Blue Motion





제조사 :	현대	공급업체 :	현대자동차(주)
모델명 :	액센트 1.6디젤_신연비	출시(예정)일 :	2013-01-01
국산/수입 :	국산	자동차종류 :	승용차
자동차형식 :	내연기관	자동차유형 :	일반형
공차중량(kg) :	1155	승차정원(인) :	5
엔진형식 :	D4FB	배기량(cc) :	1,582
최고출력(ps/rpm) :	128/4000	최고토크(kgm/rpm) :	26.5/1900~2750
연료 :	경유	연료공급방식 :	CRD
변속형식 :	수동6	구동방식 :	FF
타이어사이즈(전) :	P175/70R14	타이어사이즈(후) :	P175/70R14
연료탱크용량(ℓ) :	43.0		
표시연비 및 CO <sub>2</sub> 배출량(연방)	표시연비(lm/ℓ) : 19.2	CO <sub>2</sub> 배출량(g/km) : 99	
	연비등급 : 1등급		

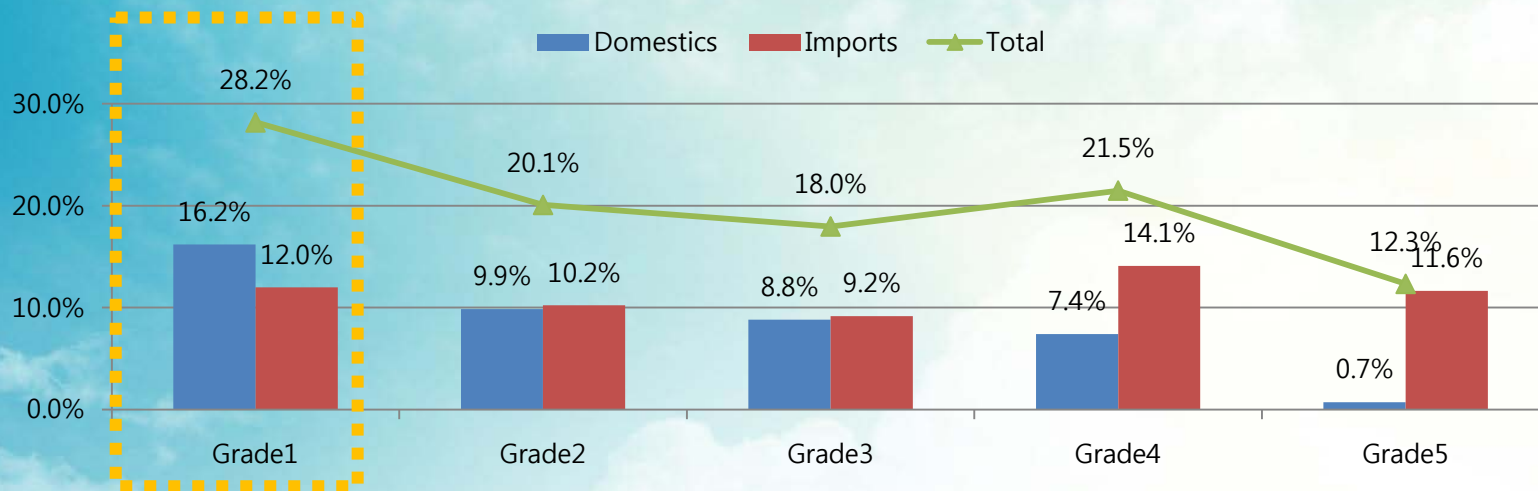
1 2 3 4 5 6 7 8 9 10 >>

신뢰할 수 있는 사이트

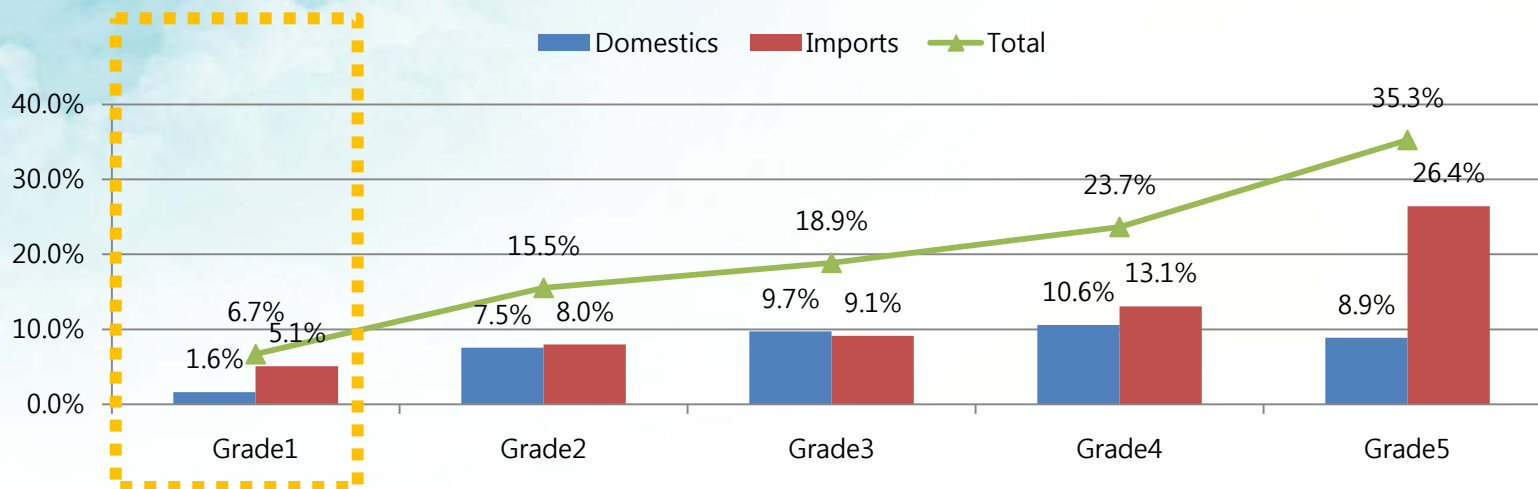


# I. Outcome of New Fuel Economy Labeling

## ● The grade ratio of vehicles approved in 2011



## ● The grade ratio of vehicles approved in 2012





- The Energy Use Rationalization Act of 2006 mandated:
  - CAFE promotes more fuel efficient vehicles in domestic market
  - Auto companies must comply with CAFE standard every year
- Scope of vehicles
  - All passenger cars with 10 seats or less and with GVW of 3.5 tons or less
- Test methods to determine fuel economy
  - Prior to 2012, only the City test (FTP-75) was used
  - In 2012, the combined results are used by 55% of City (FTP-75) and 45% of Highway test (HWFET) results
- Korea CAFE standards

	≤ 1,600cc	> more than 1,600cc
2006 ~ 2011 (FTP-75)	12.4 km/L	9.6 km/L
2012 ~ 2015 (US Combined Mode not adjusted)	17 km/L or 140g/km (application of different standard for each automaker according to their vehicle curb weight)	

- Korea CAFE and GHG standards

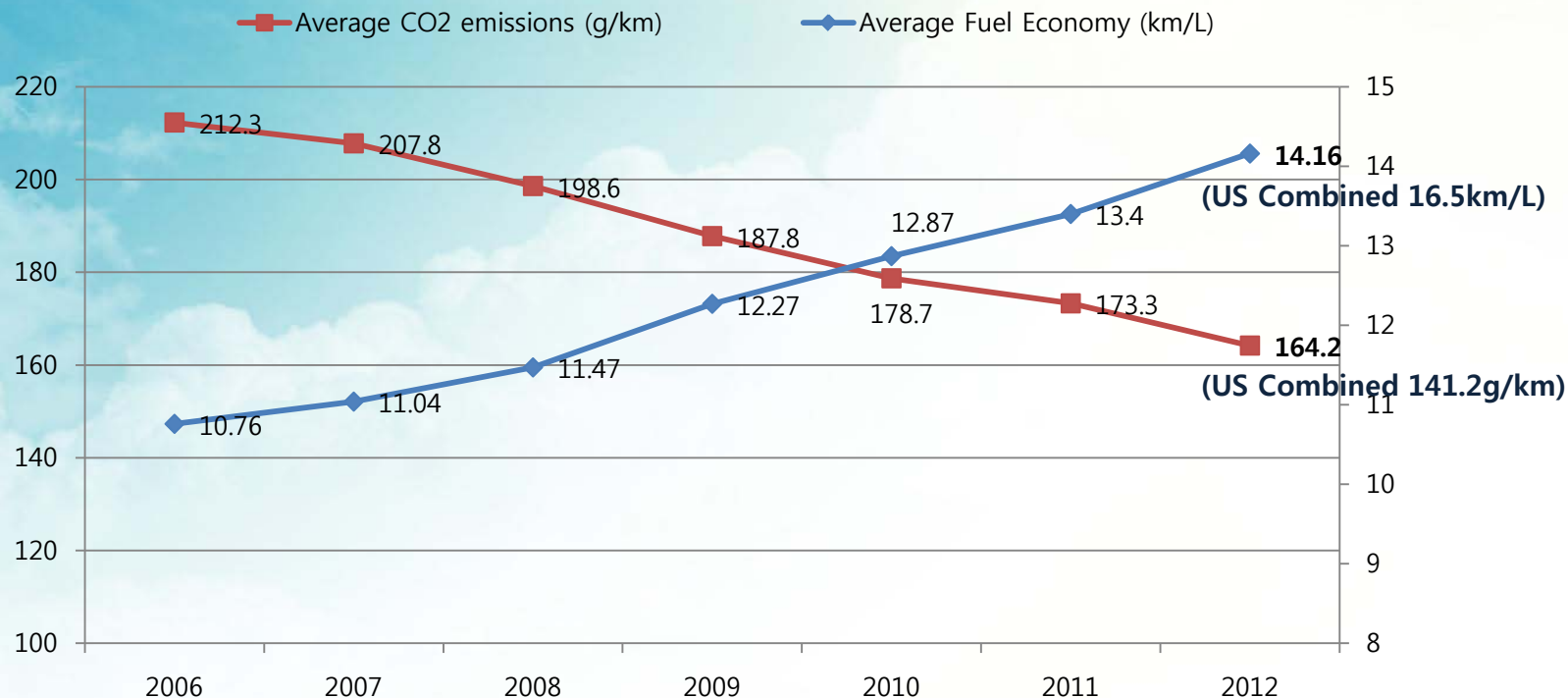
- Automakers can select either CAFE or GHG standard every year
- MOTIE takes charge of CAFE standard and ME of GHG standard
- Automakers must comply with 30% of total sales volume in 2012, 60% in 2013, 80% in 2014 and 100% in 2015

	Equation of Standards
<b>CAFE (MOTIE)</b>	<p>- <b>CAFE standard = Total sales volume of vehicles / <math>\sum</math>(Sales volume of each model / FE standard of each model)</b></p> <p>* FE standard of each model = <math>28.4577 - 0.007813 \times m</math></p> <p>* <math>m</math> = vehicle curb weight of each model</p>
<b>GHG (ME)</b>	<p>- <b>GHG standard = <math>140 + a \times (M - 1423.2)</math></b></p> <p>* <math>a = 0.0484</math> for makers with 4,500 units of sales volume in 2009, 0.0588 for others</p> <p>* <math>M</math> = sales volume weighted average VCW of each automaker</p>

# I. Results of Korea CAFE

## ● Results of CAFE and GHG emissions

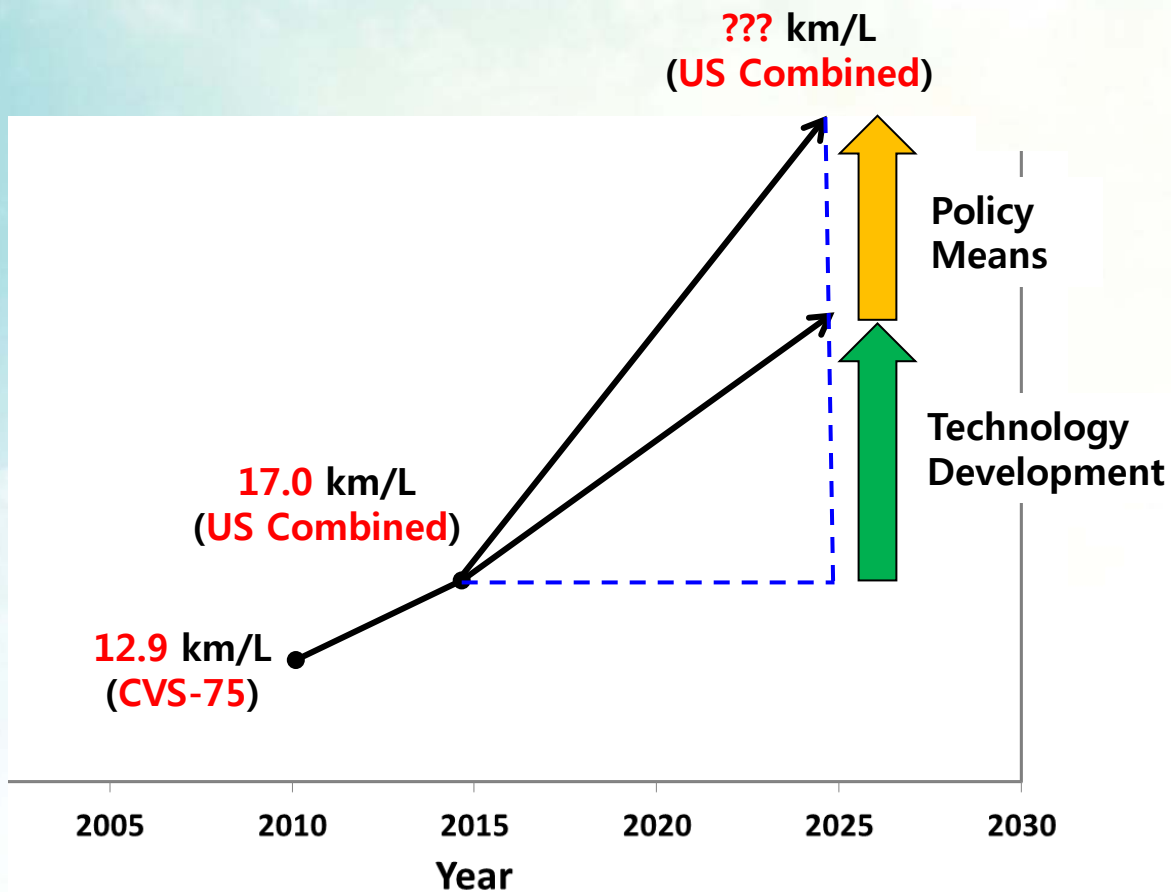
- The average fuel economy of passenger cars has increased an average of 5.6% every year since 2006, and the average CO2 emissions has decreased an average of 5.3% annually



\* Test Cycle: FTP-75

## ● New CAFE standards

- MOTIE will introduce the new CAFE standards for passenger cars and light trucks which will be applied from 2016 to 2020 or 2025
- Target values have not been decided yet, but the new standards will require the auto companies to improve their fuel economy as high as that of Japan (23.3km/L in 2020) or EU (27.6km/L in 2020)



- Korean Government has launched **the program of Future Car Development** as a part of new growth engines in 2004

Government has established “**Act on the Promotion of Development and Distribution of Environmental-friendly Automobiles**” in 2004

\* **Environmental-friendly Automobiles** : EV, PHEV, FCEV, HEV, CDV, NGV, etc.

- **The five year plan for environmental-friendly automobiles** has been established for the first time in 2006
- **Government announced Green Car Roadmap in Dec. 2010**
  - **[Production]** 1.2M units in domestic and 0.9M units for overseas by 2015
  - **[Promotion]** 21% of domestic market share(3.3M tCO<sub>2</sub> reduction) by 2015
  - **[Investment]** KRW 1.7 trillion(USD 1.4 billion) from government by 2015

# II. Green Car Tax Incentives

- The Environmental-friendly Automobiles Act of 2004 mandated:
  - To develop and promote green cars in domestic market
  - Auto companies must comply with the criteria of green cars if they want to get tax incentives(max. USD 2,600 for HEV and max. USD 3,500 for EV)

## ● Eligibility criteria for HEV

- Only the City test (FTP-75) are used

Engine Displacement	Gasoline	Diesel	LPG
Under 1,000cc	25.5 km/L	-	20.6 km/L
1,000 ~ under 1,600cc	20.6 km/L	27.2 km/L	16.5 km/L
1,600 ~ under 2,000cc	16.8 km/L	19.1 km/L	13.5 km/L
More than 2,000cc	14.0 km/L	16.8 km/L	11.1 km/L

- Nominal voltage of Traction Battery must meet over 60V

## ● Eligibility criteria for EV

- Combined Fuel Economy must meet over 5.0km/kWh
- Combined Range of NEV must be over 27km, and EV must meet over 82km



- **Defects of Eligibility criteria for HEV**

- No reform of the eligibility criteria for HEV since 2009
- Causing the customer confusion because of using the FTP-75 mode results without the derived 5-cycle adjustment

- **Defects of Eligibility criteria for EV**

- Determined the criteria of EV with the prototype vehicles in 2011
- Causing the customer confusion because of using the combined mode results without the derived 5-cycle adjustment



- **Improvement direction of Eligibility criteria**

- Protecting the customer confusion by using the derived 5-cycle adjustment
- Reflecting the development level of HEV since 2009
- Considering the energy efficiency of the mass product EV in the market
- Adding the tax incentive criteria for PHEV

## ● Research Process

1. Analysis of Technology and Policy of Green Cars in Domestic & Overseas Market
2. Layout of Technical Items of HEV, EV and PHEV respectively
3. Technical Analysis of HEV, EV and PHEV with the 5- cycle test
4. Selection of Criteria Items of HEV, EV and PHEV from Technical Items
5. Development of various Scenarios to determine Eligibility Criteria
6. Proposal of the final Criteria for HEV, EV and PHEV to Government

## ● Scenarios to reform the criteria of HEV, EV and PHEV

- Application of the 2012 Korea CAFE result
- Application of the average of the submitted fuel economy in 2012
- Application of the ranked vehicles in the top 10% in terms of Fuel Economy
- Application of the 2020 Korea CAFE target
- Application of the technical level of HEV and EV in the USA
- Application of the tax incentive criteria for Green Car in the Europe



# III. Technical Items of HEV

HEV Technical Items			
Battery	Nominal Voltage(V)		
	Capacity(kWh)		
	Weight(kg)		
	Cycle Life(times)		
Motor	Power(kW)		
	Torque(N-m)		
	Life(years)		
Vehicle	Curb Weight(kg)		
	Footprint(m <sup>2</sup> )		
	Warranty(year)		
	Fuel Economy(km/L)	Adjusted Combined	
		Combined Mode	
		FTP-75	
		HWFET	
		US06	
		SC03	
		Cold FTP	

**[Considerations]**

- Related Energy Efficiency
- Need of Advanced Technology
- Easy to measure
- Easy to verify
- Technical Weight

# III. Technical Items of EV

## EV Technical Items

Battery	Nominal Voltage(V)		<p><b>[Considerations]</b></p> <ul style="list-style-type: none"> <li>- Related Energy Efficiency</li> <li>- Need of Advanced Technology</li> <li>- Easy to measure</li> <li>- Easy to verify</li> <li>- Technical Weight</li> </ul>	
	Capacity(kWh)			
	Weight(kg)			
	Cycle Life(times)			
Motor	Power(kW)			
	Torque(N-m)			
	Life(years)			
Vehicle	Curb Weight(kg)			
	Footprint(m <sup>2</sup> )			
	Warranty(year)			
	Charging Time(hrs)			
	Easy to Plug - standard			
	Fuel Economy(km/L)	Adjusted Combined		
		Combined Mode		
	Range(km)	FTP-75		
		HWFET		
		US06		
SC03				
	Cold FTP			



# III. Technical Items of PHEV

## PHEV Technical Items

Battery	Nominal Voltage(V)		<p><b>[Considerations]</b></p> <ul style="list-style-type: none"> <li>- Related Energy Efficiency</li> <li>- Need of Advanced Technology</li> <li>- Easy to measure</li> <li>- Easy to verify</li> <li>- Technical Weight</li> </ul>
	Capacity(kWh)		
	Weight(kg)		
	Cycle Life(times)		
Motor	Power(kW)		
	Torque(N-m)		
	Life(years)		
Vehicle	Curb Weight(kg)		
	Footprint(m <sup>2</sup> )		
	Warranty(year)		
	Charging Time(hrs)		
	Easy to Plug - standard		
	Fuel Economy(km/L) - CD+CS - CD	Adjusted Combined	
		Combined Mode	
		FTP-75	
		HWFET	
		US06	
SC03			
Range(km)	Cold FTP		



# IV. Test Vehicles for 5-cycle Test

## ● Vehicle Technical Items Analysis

- 5-cycle test to check Fuel Economy and Range under the various environment
- [HEV] HMC YF Sonata, Lexus GS450h
- [EV] Kia Ray EV, GM Spark EV
- [PHEV] Toyota Prius PHEV, GM Chevy Volt



**HEV**



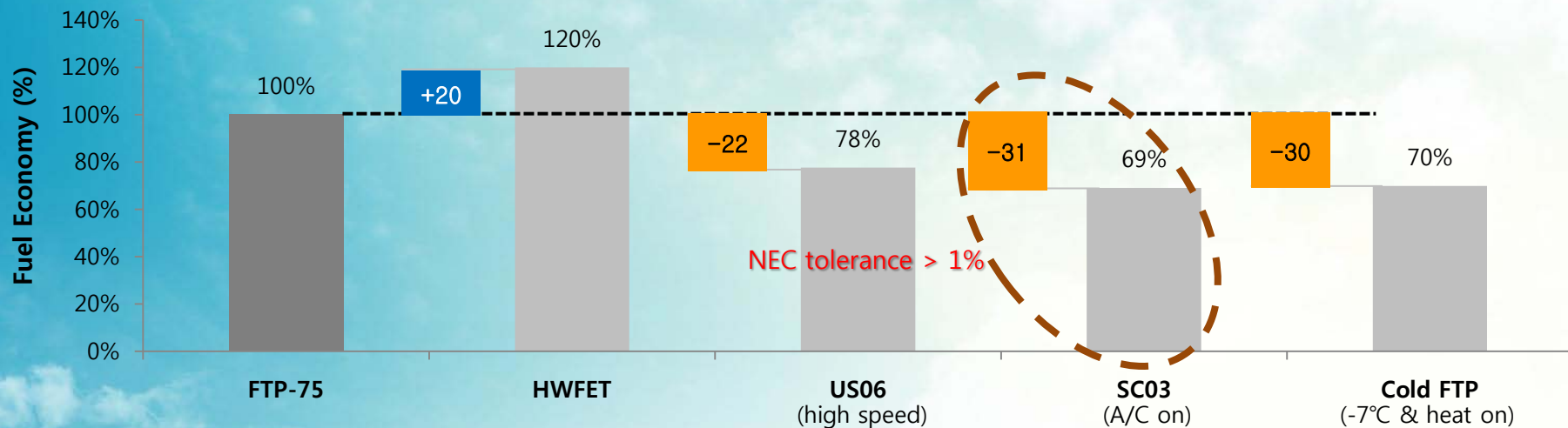
**EV**



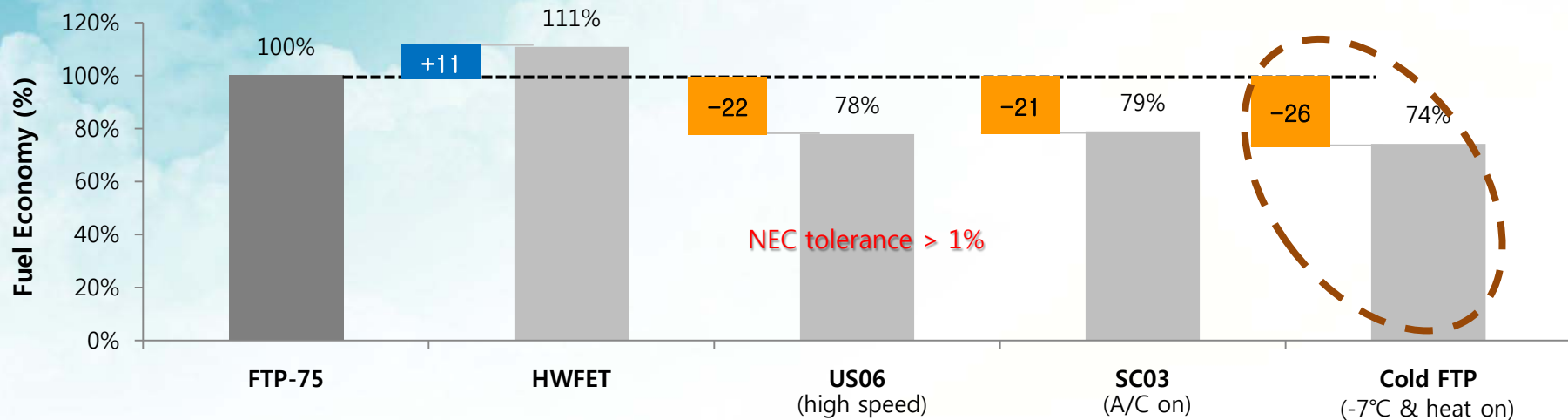
**PHEV**



# IV. HEV 5-cycle Test Results; F.E.



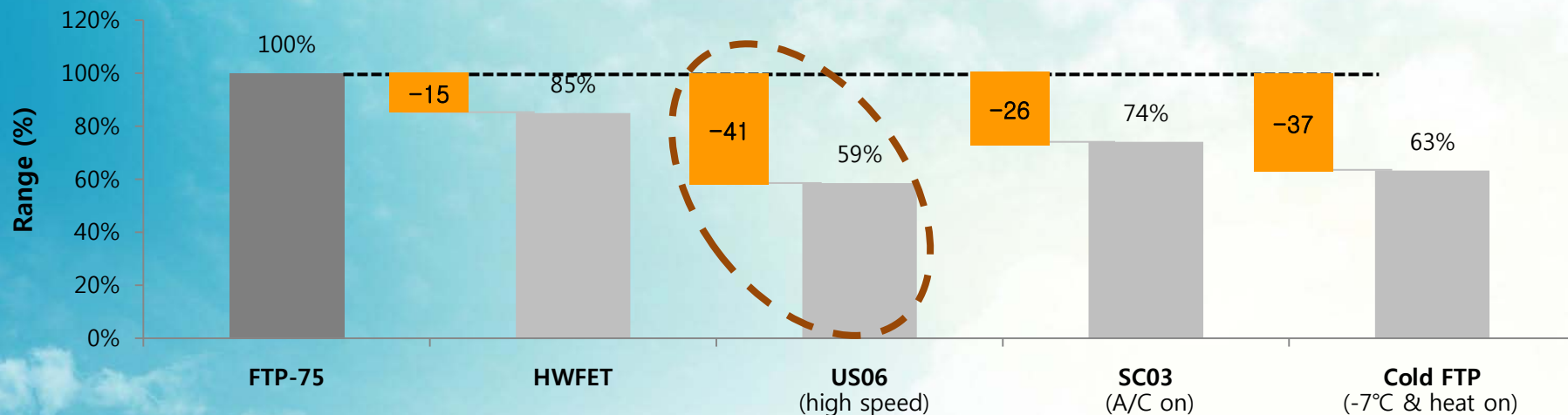
## HMC YF Sonata



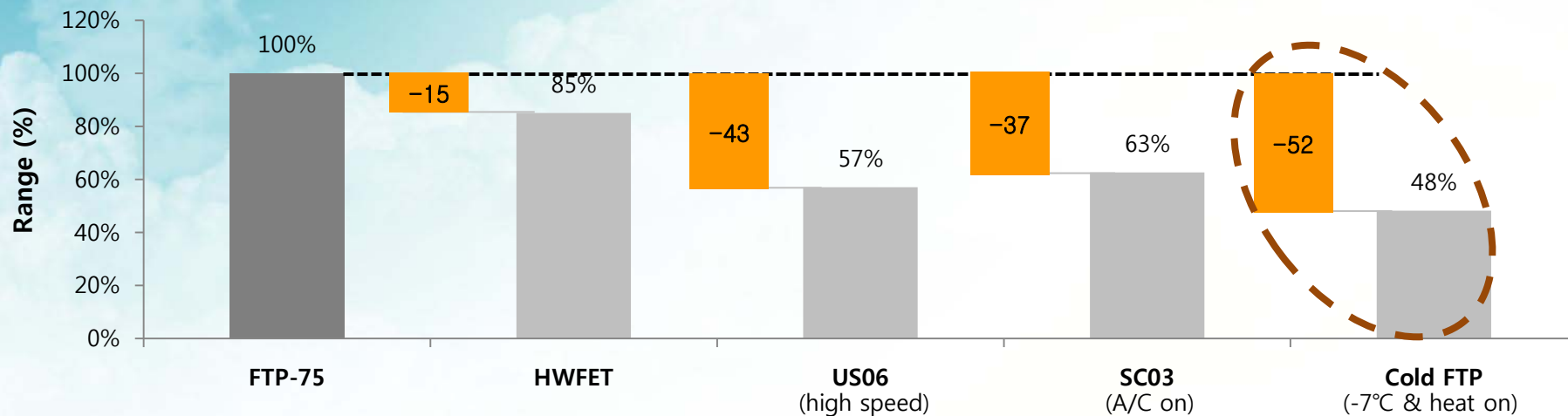
## Lexus GS450h



# IV. EV 5-cycle Test Results; Range



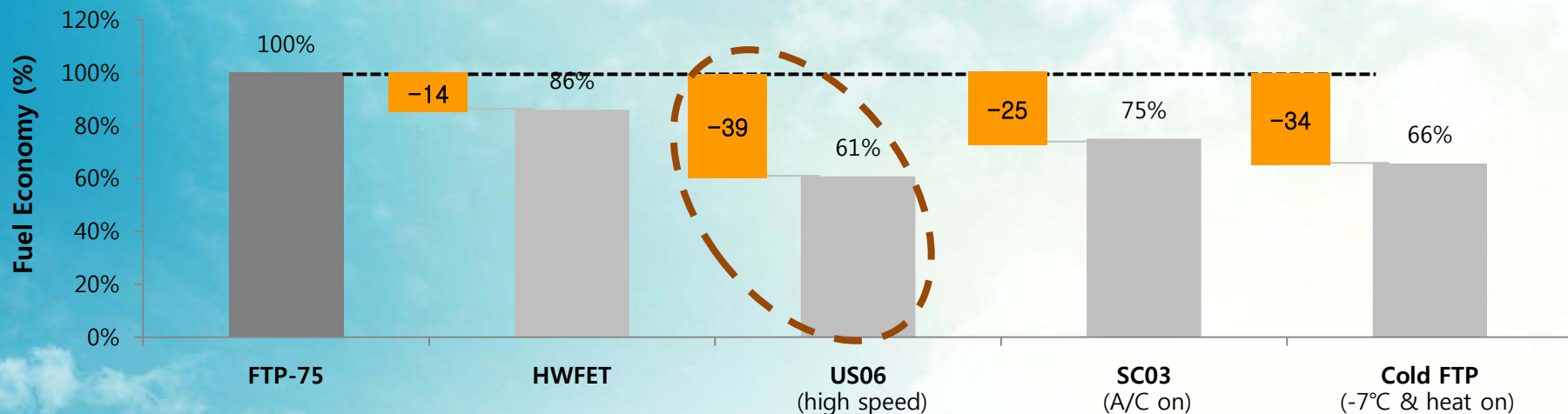
## KIA Ray EV



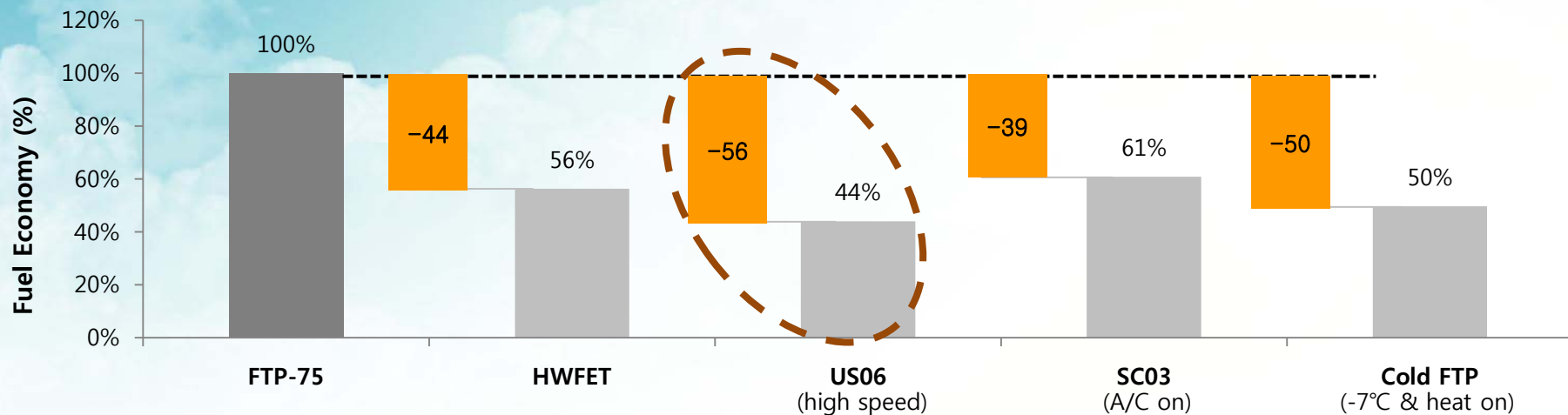
## GM Spark EV



# IV. EV 5-cycle Test Results; F.E.



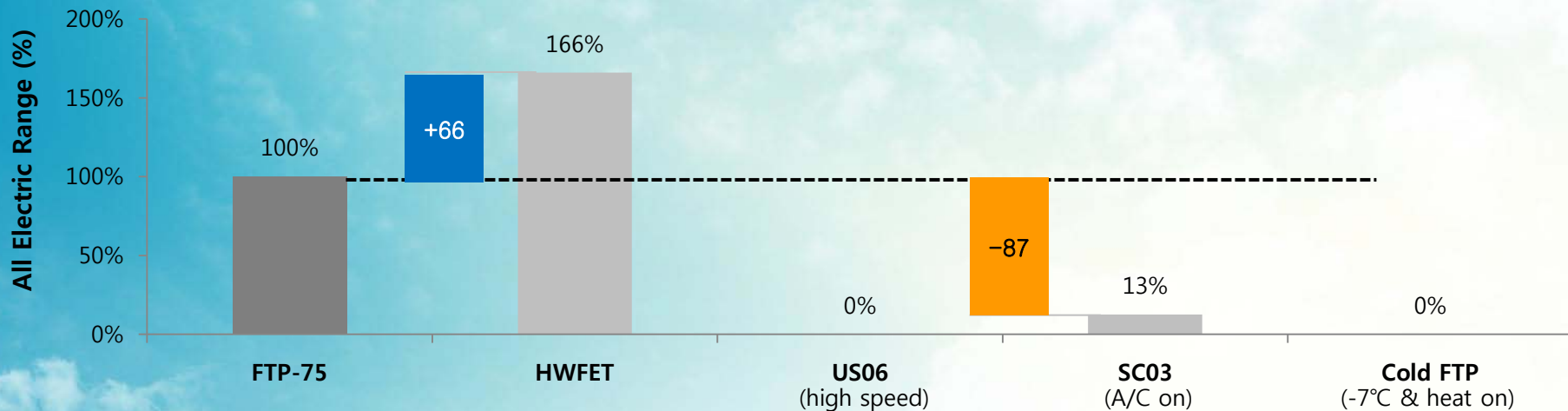
## KIA Ray EV



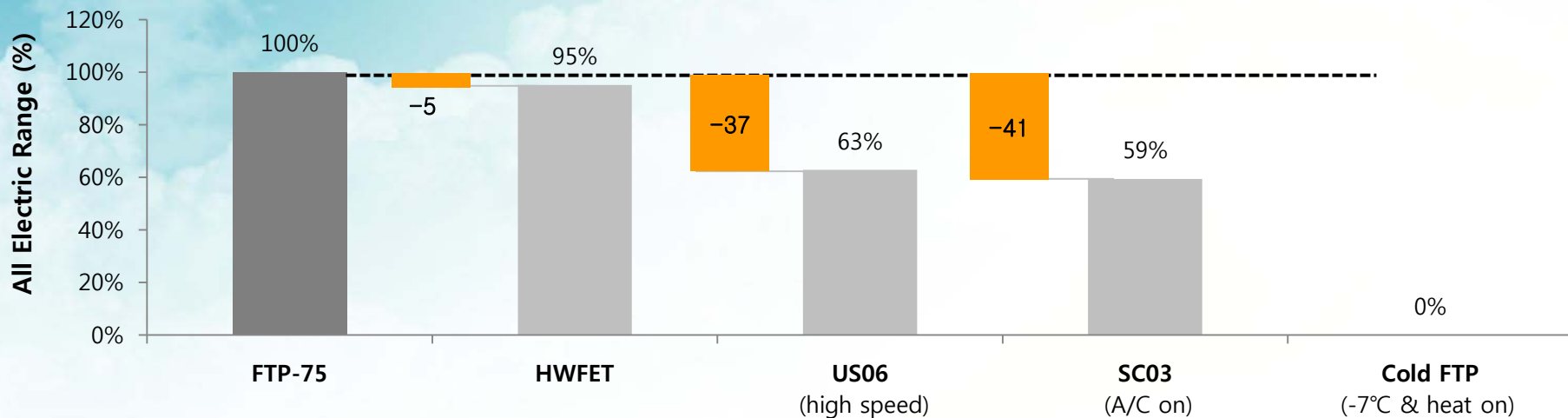
## GM Spark EV



# IV. PHEV 5-cycle Test Results; AER



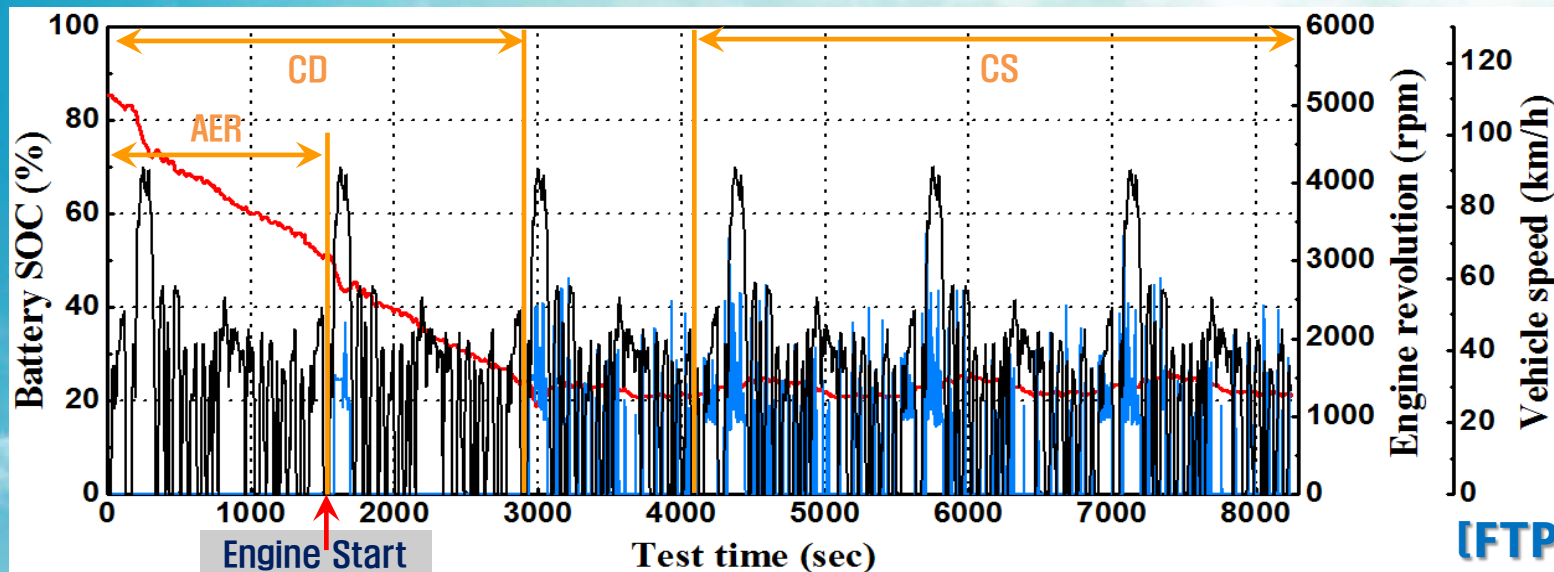
## Toyota Prius PHEV



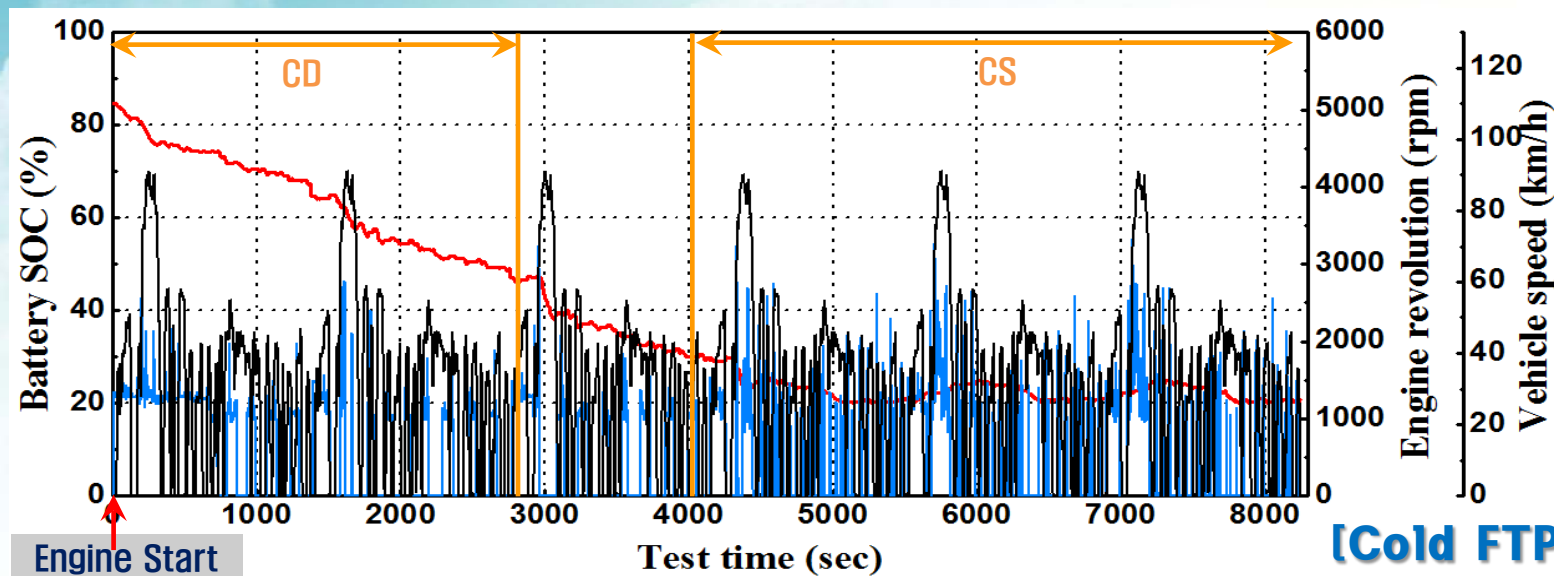
## GM Chevy Volt PHEV



# IV. Toyota Prius PHEV Test Results (I)



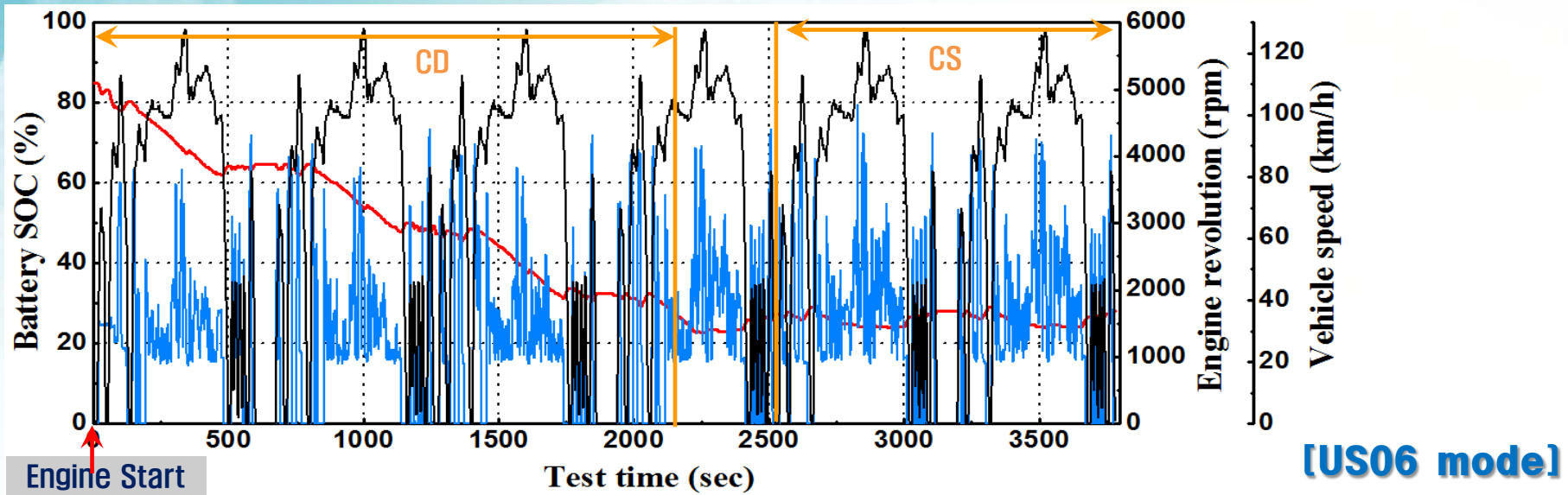
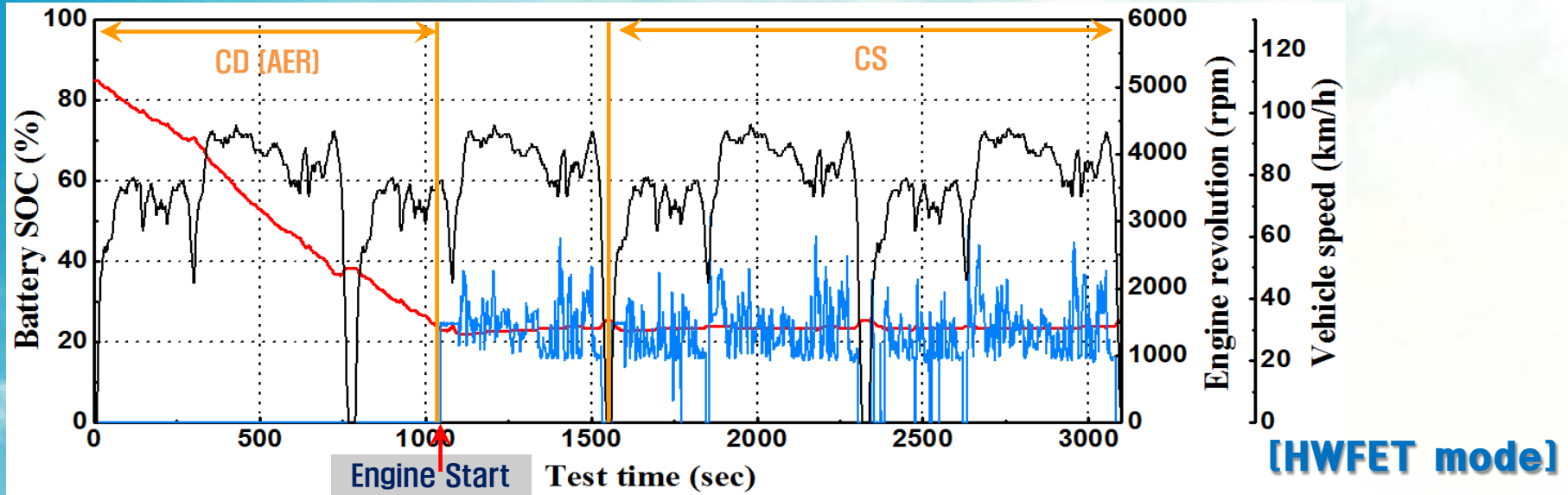
[FTP-75 mode]



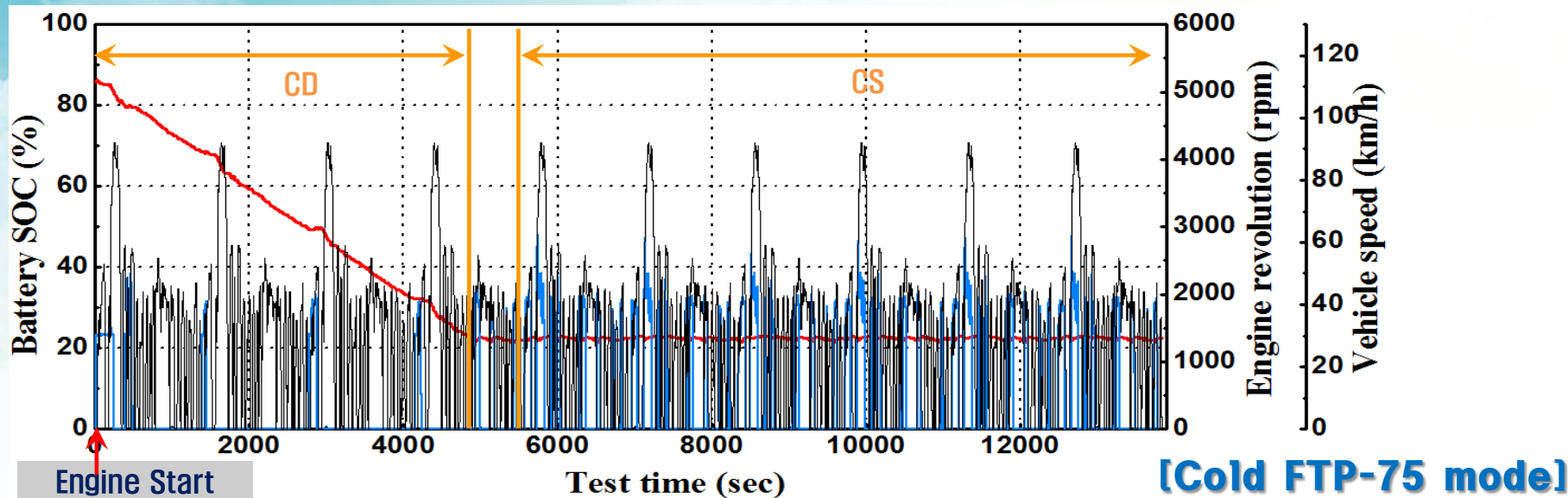
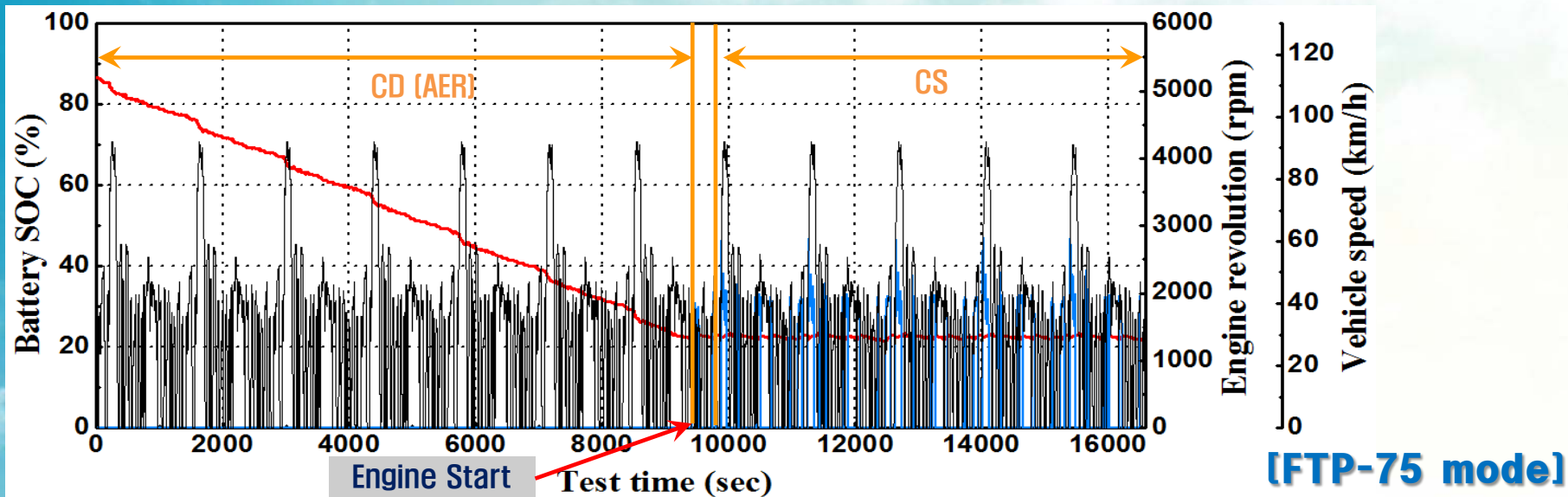
[Cold FTP-75 mode]



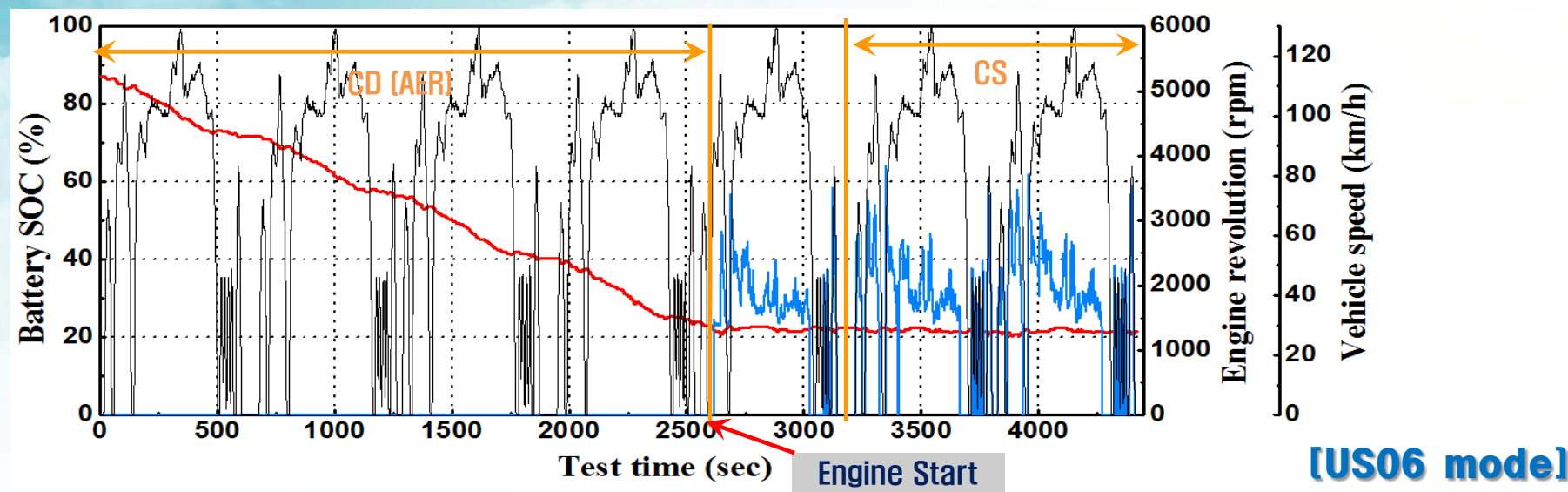
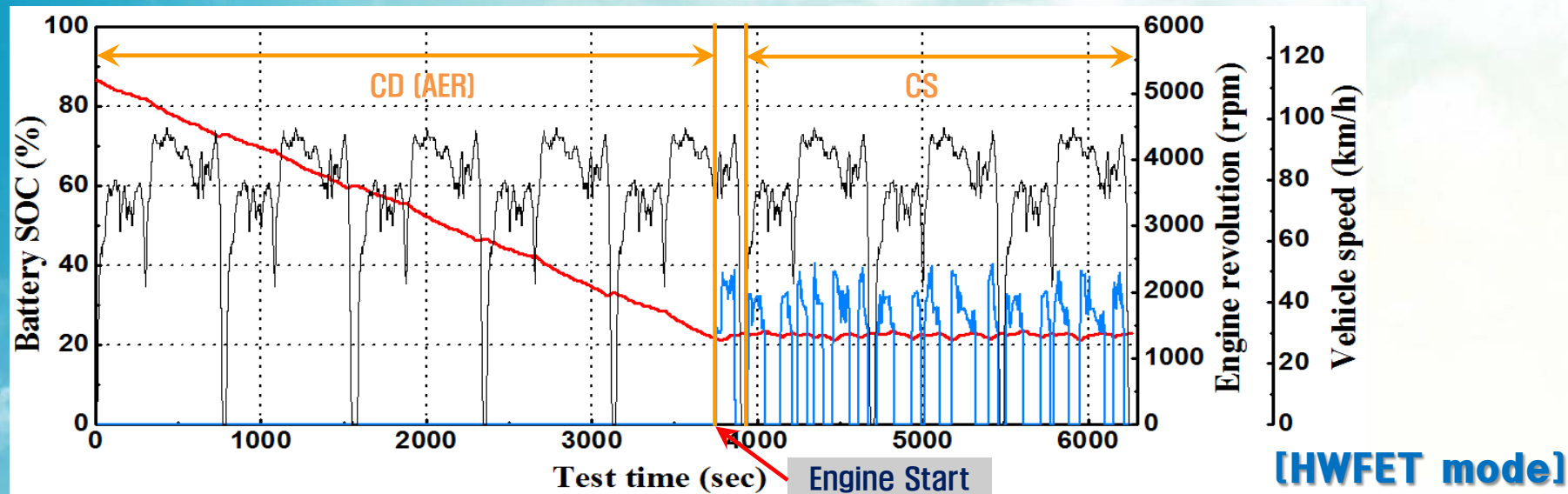
# IV. Toyota Prius PHEV Test Results (II)



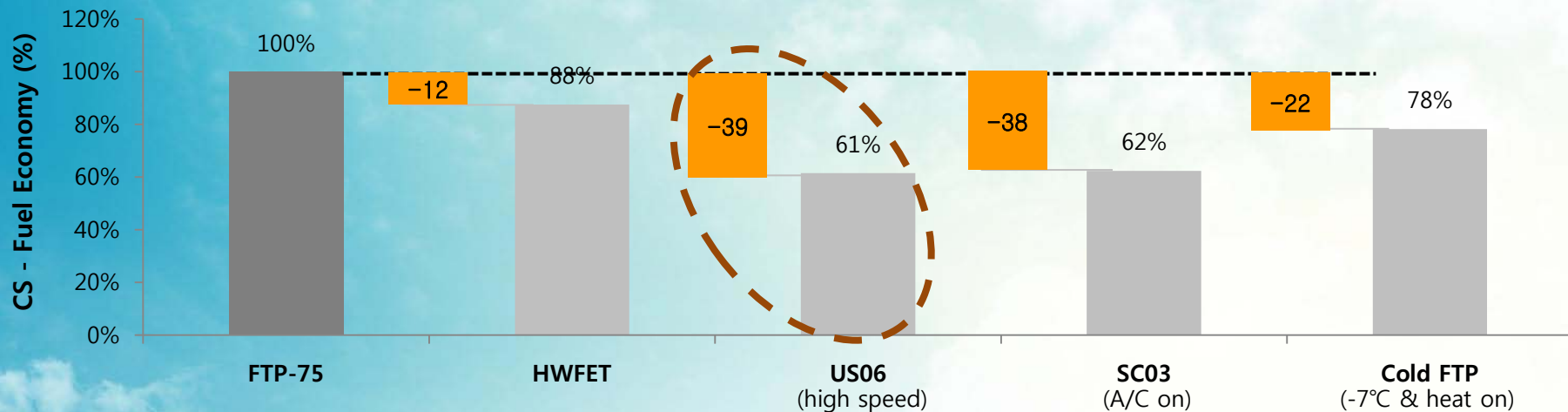
# IV. GM Volt PHEV Test Results (I)



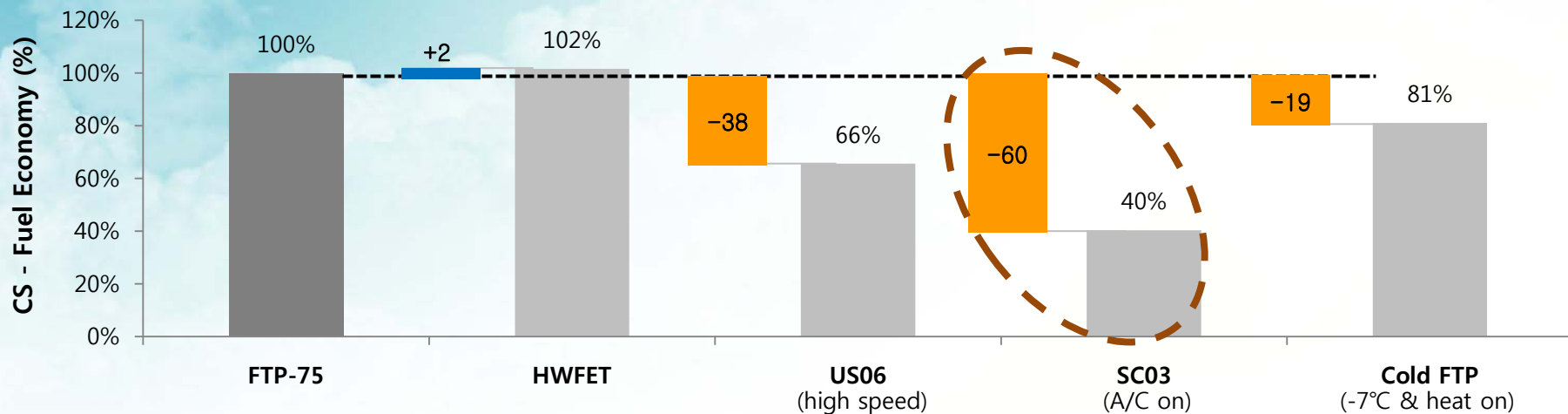
# IV. GM Volt PHEV Test Results (II)



# IV. PHEV 5-cycle Test Results; CS F.E.



## Toyota Prius PHEV



## GM Chevy Volt PHEV

# THANK YOU

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