Policy Plan on Fuel Cell Vehicle & Market Activation

Dec 15. 2016

Ministry of Environment

Content

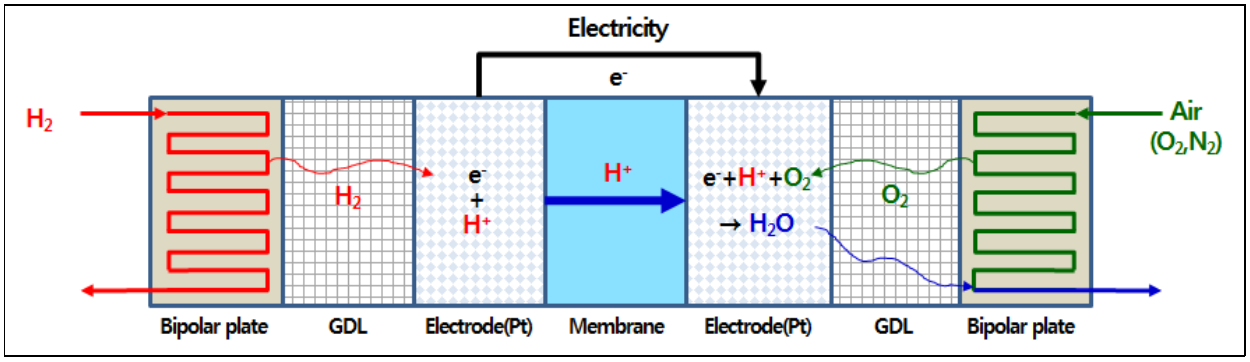
I. FCV Performance Property & Market Condition

1. FCV Performance Property

☐ **(Hydrogen Fuel Cell)** generates electricity using the reverse reaction of electrolysis of water, where water(H_2O)is dissociated into hydrogen(H_2) and oxygen(O_2) by applying electricity.

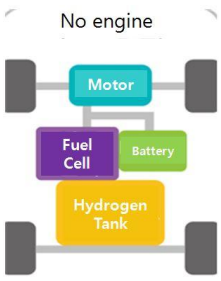
❍ After hydrogen(fuel supply) is divided into electron and hydrogen ion, it is electrochemically reacted with oxygen(air influx) to be converted into water and electricity($H_2 + 1/2O_2 \rightarrow H_2O$ + electricity).

< Hydrogen Fuel Cell Principle >



☐ **(Hydrogen Vehicle Features)** Hydrogen Fuel Cell Vehicle (Hereafter referred to as 'Fuel Cell Vehicle' or 'FCV') is different from internal combustion vehicles as it does not have an engine. Also unlike Electric Vehicle, it does not need external power supply to recharge, but generates electricity internally using hydrogen filled in tank and oxygen taken from air.

< Hydrogen Fuel Cell Vehicle Composition >

	·Hydrogen Tank : hydrogen is stored in high pressure(700bar) ·Fuel Cell: H_2 and O_2 are electrochemically reacted to generate electricity ·Battery : stores electricity generated by Fuel Cell and regenerated during braking ·Motor : drives wheel with electricity generated by Fuel Cell and stored in Battery

☐ (**FCV Environmental Effect**) FCV is an eco-friendly car that discharges only water and no air pollutant or GHG emission.

❍ Countermeasure for ‘GHG emission standard’* and ‘Compulsory sales of Zero-Emission Vehicle’.**

* Standard(g/㎞) : KOREA 140('15) → 97('21), US 140('15) → 113('20), EU 130('15) → 91('21), JAPAN 117('15) → 100('20)

** US imposes 20,000$ fine(per car) for the breach of ‘Hydrogen Vehicle sales quota’ (2018 – 2%, 2020 – 6%, 2025 – 16%)

2. Market Condition

☐ **Hydrogen supply is favorable and mass production technology for FCV has been achieved.**

❍ **(Hydrogen Supply)** Annual hydrogen production is 2.1M tons with byproduct hydrogen account for 1.4M tons. FCVs are expected to consume 0.1M tons per year.

* Annual fuel consumption/FCV is 200㎏(15,000㎞ mileage) × 0.5M cars = 0.1M tons

- Currently, the cheapest hydrogen fuel is byproduct hydrogen available from Petrochemical Complex(Ulsan, Yeochun, Daesan, KRW 2,000/1㎏, 76.8㎞/1㎏).

❍ **(FCV Production Technology) Achieved** advanced technology with **over 95% localization rate,** established the world’s 1st mass production system (Feb. '13, Tucson ix, 1,000 cars p.a.).

- Related industries such as petrochemical, semi-conductor, and power generation can grow together.

* Some fuel cell components (‘electrolyte membrane’ , ‘gas diffusion layer’)are currently dependent on foreign technology (scheduled to be localized within 2~5 years)

☐ **For Fuel Cell vehicle price, technology on parts for hydrogen refueling station(HRS), support system need to be improved.**

❍ **(Price) Expensive price of Fuel Cell Vehicle**(KRW 85M), with no supportive tax system is a burden for the consumers.

- Currently subsidizing 50% of Incremental cost(KRW 27.5M) for choosing over internal combustion vehicle(MRW 30M).

  * Hydrogen fuel cell vehicle markdown: KRW 150M → 85M(Feb. '15). Apart from technological development, further price reduction required with financial support scheme.

❍ **(Technology)** Insufficient localization rate(40~60%) for HRS.

- Need for development of unsolved refueling parts technology: Storage tank, rapid cooling device, refueling dispenser.

  * 'Hydrogen Fuel Cell Project Group' (MOTIE, '04~'09) is leading technological development on refueling parts.

❍ **(Legal Framework)** Building HRS in **urban area is difficult**, related regulations are incomplete.

- Need to ease the regulation and make new standards to allow colocation with existing stations.

❍ **(Financial Support)** Need to expand government support for the construction of hydrogen refueling station.

II. Support System & Market Status

1. Support System

☐ **(Domestic)** Support for FCV **purchase** and **HRS construction since 2013. ***

* 「Purchase support : Article 10 of **'Act on the Development and Promotion of Environmentally Friendly Automobiles'**」, Support for Low Emission Vehicle and Refueling Stations : Clause 3 of Article 58 of **'Clean Air Conservation Act'**

❍ **(Fuel Cell Vehicle)** Purchase subsidy provided up to 5**0% of price differential*** from internal combustion vehicle.

- National Taxes(Individual Consumption Tax, Education Tax) are fully imposed. Government organizations and local governments are exempt from Local Taxes(Acquisition Tax).

* '13~'14 : KRW 120M(Hydrogen Vehicle 150M / internal combustion vehicle 30M), '15~ : KRW 55M(Hydrogen Vehicle 85M / internal combustion vehicle 30M)

❍ (**Hydrogen Refueling Station**) Government support for construction(KRW 1.5 B/station, '13 & '14 : 1 station per each year).

☐ **(Foreign)** Applying **various supportive policy** depending on the condition : Purchase Subsidy, Tax Reduction, etc.

❍ **(Fuel Cell Vehicle)** Purchase subsidy in California(US) : max. USD 13,000(KRW 15M), China : max. CNY 0.2M(KRW 36M), Japan : JPY 2.02M(KRW 19M, some municipalities support 1M in addition).

- Germany provides incentives such as parking fee exemption, bus-only lane access for Hydrogen Vehicles.
- China applies purchase tax exemption(10% of the vehicle price) and issues exclusive license plates.

❍ **(Hydrogen Refueling Station)** US : 70~90%, Germany : 50%, Japan : JPY 0.15B~0.28B(KRW 1.4 B~2.6B) of the construction cost is supported.

- US subsidizes max. USD 0.1M p.a. until station's operation rate reaches 70%(60~100% of 3-year operating cost). Germany supports over 50% of operating cost

〈 **Implication** 〉

◈ In the context of **automobile industry promotion, air quality improvement and GHG reduction, each country is implementing strategic increase of Hydrogen Vehicles,** utilizing **policy and financial tools.**

◈ **Med-long term roadmap setting** is required for the systematic promotion of domestic Hydrogen Fuel Cell Vehicle, and further **to lead the world market.**

2. Market Status

☐ **(Domestic)** Condition is at the stage of pilot program, supply of hydrogen vehicle and refueling station is weak

❍ **(Fuel Cell Vehicle)** Since the first introduction of FCV(Hyundai Tucson ix, Feb. '13), 42 cars has been supplied to the market with govt. support('13~Sep. '15).

- Daegu 2, Gwangju 13, Ulsan 9, Chungnam 17, Gyeongbuk 1

* 「Green Car Industry Development Strategy & Task(Dec. '10)」, target achievement ratio is 0.4%(42 out of '15 target of 10,100).

❍ **(Hydrogen Refueling station)** 10 stations operating in and around Petrochemical Complex and metropolitan area(「Ministry of Environment」 : 2, Demo. project of 「Ministry of Trade, Industry and Energy」 : 8).

- Metropolitan area 6(Seoul 2, Incheon 1, Gyunggi 3), Daegu 1, Ulsan 1, Gwangju 1, Naepo of Chungnam 1

< Domestic Fuel Cell Vehicles & Hydrogen Refueling Stations Status >

Category	~ '13		~ '15	
	FCV	HRS	FCV	HRS
Target[1)]	50	18	10,100	43
Status[2)]	5	8	42	10

1) 「Green Car Industry Development Strategy & Task」 (Dec. 6. '10, Green Growth Committee) confirmed promotion target.
2) Poor result is due to low profitability at the stations, lack of HRS infra. in the early stage, weak financial support, etc.

☐ **(Foreign)** Some countries set up **roadmap** for strategic market expansion of FCV and are pushing forward supply promotion, yet still **in the early stage** as at '15*.

* Market status(1st half of '15) : US·Europe(250 cars, Hyundai), Japan(200, Toyota)

❍ **(Fuel Cell Vehicle)** New model introduction(Toyota Mirai, Nov. '14), R&D is on-going for price markdown, competitive models(US, Japan, Germany).

* Global market share forecast by IEA('12) : 1.8%(2.4M) by '30, 17.7%(35.3M) by '50

❍ **(Hydrogen Refueling Station)** Infra. construction for hydrogen vehicle is expanding (321 completed, 208 in operation)

< Major Countries Fuel Cell Vehicles & Hydrogen Refueling Stations Roadmap >

Country	~ '25		~ '30	
	FCV	HRS	FCV	HRS
US(California)	0.03M~0.06M('23)	123('23)	–	–
Germany	0.65M('25)	400('23)	1.80M	1,000
UK	0.28M	300	1.60M	1,000
Japan	2M	1,000	7M	3,000

III. Further Promotion Plan

1. Basic Direction

Vision (Strategy)	◈ 「2030, Fuel Cell Vehicle 10% Era」 (10% of new car sales, 0.18M/1.67M) ○ Hydrogen-based coexisting ecology of environment and economy ※ On achieving the 10% target, FCV is expected to become viable without financial support

(HRS : 1 unit, FCV : 1,000 units)

Target

Category	~'16	'17	'18	'19	'20	~'25	~'30	~'50
FCV	0.2 (0.1)	0.5 (0.3)	2.5 (2.0)	5.1 (2.6)	9.0 (3.9)	100 (91)	630 (530)	7,000 (6,370)
HRS	13 (3)	20 (7)	30 (10)	50 (20)	80 (30)	210 (130)	520 (310)	1,500 (980)

※ YOY target on FCV & HRS is to be confirmed through discussion with budget authority

Main Tasks	Core Technology Development	Expansion of Refueling Infra.	System Revision	Private Sector Expansion	Incentives
	▸Station parts localization ▸FCBUS Development & Performance upgrade ▸Tube trailer development	▸Support for construction and extension of HRS ▸Diversification of hydrogen refueling method – byproduct hydrogen – CNG reformation – use electricity from aerogenerator	▸Mitigation of separation distance of protective facilities ▸new regulation on integrated ·complex station ▸new regulation on high-pressure hydrogen storage	▸Purchase subsidy ▸Tax cut ▸Reasonable hydrogen price setting	▸Promotion program for priority city ▸Hydrogen purchase and management of public agencies ▸FCV purchase support from municipalities

2. Specific Tasks

(1) Core Technology Development ⇒ Performance enhancement & price reduction

☐ FCV performance enhancement & development of fuel cell bus(MOTIE).

❍ Increase fuel efficiency by 10%* and durability improvement **(0.**1M→0.18M km, `16~`20)

* Increase fuel efficiency : 76.8km/kg('15, world best) → 85km/kg('20)

❍ Development of hydrogen bus(~'20), performance improvement (`19~`25), market introduction from '26.

* Improvement of durability performance through demonstration program : mileage 0.12M km('09~'15) → 0.5M km('21) → 0.8M km('25)

☐ Development of heavy loading tube trailer tank(MOTIE).

❍ Development of 500bar Type3(metal+glass/carbon fiber) or Type4 (plastic+glass/carbon fiber) tanks that can transfer more hydrogen than Type1(steel, 200bar) tank.

☐ Development of hydrogen refueling station parts(MOTIE).

❍ Increase parts localization rate from 40%* to 80%('16~'20) : hydrogen concentration sensor, storage tank, rapid cooling device, dispenser

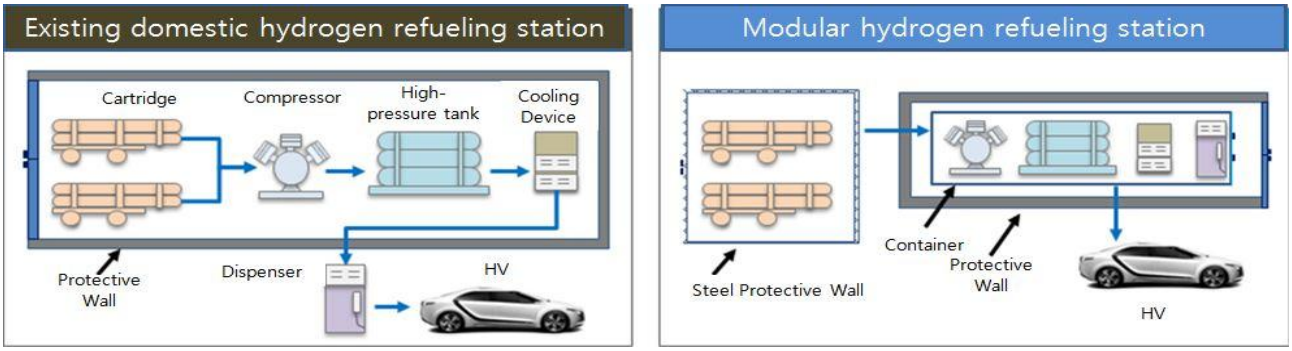
* Localization rate is low due to immaturity of the HRS market.

❍ Development of modular hydrogen refueling station technology(~'18)

- Shorten construction period by integrating compression/storage/refueling components*

* Components required for all types of refueling facilities : tube trailer, LPG/CNG reformation, electrolysis of water, etc.

< Existing vs. Modular hydrogen refueling station >



(2) Expansion of Refueling Station ⇒ Foundation for FCV Promotion

◈ **Expansion of Hydrogen Refueling Stations in and around the hydrogen production base.**

- Induce refueling infra expansion, price reduction, diversification of production method

◈ Considering **immature** FCV market, increase **govt. support for HRS construction.**

☐ Diversification of hydrogen refueling method

① Additional installation of ongoing byproduct hydrogen station(MOE)

❍ **(Type) Expansion of stations** which provide **byproduct hydrogen delivered by tube trailer.**

* Operating stations(10) : byproduct hydrogen 7, electrolysis of water 1, NG reform 1, land fill gas reform 1

❍ **(Location)** Within max. 200km from hydrogen production base.

* Hydrogen price is higher as a station gets farther from production base such as Petrochemical Complex.

② Introduction of city gas reforming station, expansion and diversification of supply capacity(MOE, MOTIE)

❍ **(Type)** Construct stations that produce hydrogen through **reformer*** or **stationary fuel cell**** using CNG as raw material.

* produce hydrogen by installing reformers at existing CNG stations

** able to offset GHG by producing hydrogen concomitantly in the process of power generation

❍ **(Location)** Construct preferentially in and around the area where byproduct hydrogen use is not convenient compared to others*.

- Can serve as a multipurpose station as both **CNG** and **hydrogen** are available for **FCV, CNG bus,** H-CNG bus, EV(stationary fuel cell station)

* Implementation of integrated station demo project and city gas reform, etc.('16~, MOTIE)

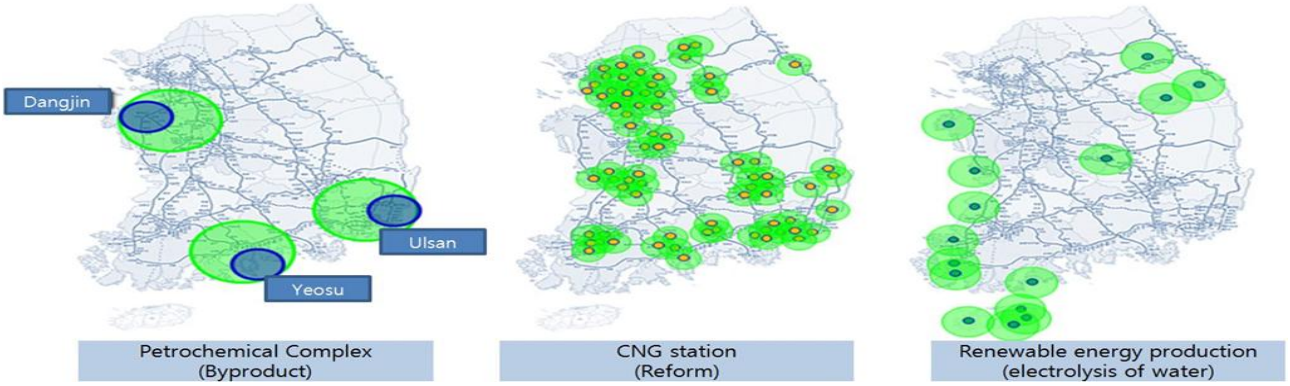
③ Implementation of renewable energy hydrogen refueling station(MOE, MOTIE)

❍ **(Type) Examining the adoption of station** where hydrogen is produced & delivered using electricity generated by **wind/solar power plant.**

- National research institute will start demo project and develop core technology('16~'20).

❍ **(Location)** Construct near wind/solar power plant

< Major location for hydrogen production & refueling station >



☐ Support for hydrogen refueling station construction/operation and facility extension(MOE)

❍ To boost construction and secure profitability of hydrogen refueling station

- Support construction in early stage, convert to **loan** in the long term
- Operation support to be determined after examining real operating examples

❍ **Review of support for capacity extension cost**

- When stations built in early stage of FCV promotion(~'20) are to have facility extension, support for the part of extension cost will be reviewed

< Hydrogen refueling station construction plan >

Category	'16~'20	'21~'25	'26~'30	'31~'50
HRS(Accum.)	70(80)	130(210)	310(520)	980(1,500)

※ Expand station infra. to meet FCV promotion plan : 9,000('20)→ 0.63M('30)

(3) Revision of Regulations for FCV & HRS ⇒ Achievement of Safety & Rationalization of Safety Regulations

☐ Supplementation of FCV Safety Regulation(MOLIT)

❍ Develop FCV **safety evaluation skill** and **newly establish safety standard** for FCV over 4.5 ton('17~'20)* to further lead the amendment of international standard('20~'25).

* Currently there is no safety standard for FCV over 4.6 ton.

☐ Mitigation of separation distance for protected facility near FCV station(MOTIE)

❍ Resetting of separation distance from protected facility* when reinforced concrete wall is installed in modular hydrogen refueling station('20)

* Class 1 protected facility : School, daycare center, senior citizen center, hospital, etc. Class 2 protected facility : detached house, apartment house, etc.

☐ Amendment of integrated·complex hydrogen station regulation(MOTIE)

❍ Establishment of exemption law for demo construction in existing stations('16)

❍ Establishment of construction standard for integrated*, complex** hydrogen station('20)

* simultaneously operating gas & hydrogen refueling station
** simultaneously operating gas & gas reforming hydrogen refueling station

☐ Establishment of standard for composite tanks for high-pressure gas transportation(MOTIE)

❍ Establishment of standard for high-pressure composite tanks such as Type3(metal+glass/carbon fiber) or Type4 (plastic+glass/carbon fiber) ('16)

☐ Temporary approval for the use of foreign components(MOTIE)

❍ **Temporary lift of local inspection on foreign part factory when using foreign parts due to unavailability of local products***('16)

* Sampling inspection will still hold to secure safety

(4) Private Sector Promotion ⇒ New Market Formation

☐ FCV purchase subsidy and price reduction(MOE)

❍ Purchase subsidy(KRW 27.5M) and inducement to cut price(KRW 85M('15) → 64M('18))

- With mass production and technology development, **reduce** FCV **price** down to **EV level(`20)**, and to **HEV(`25)**, which will lead to phased reduction on subsidy budget.

* FCV price forecast (in Million KRW) : 85('15)→ 64('18)→ 51('20)→ 38('25)

< Hydrogen Fuel Cell Vehicle Promotion Plan >

(unit: 10,000)

Category	'16~'20	'21~'25	'26~'30	'31~'50
FCV (Accum.)	0.9(0.9)	9.1(10)	53(63)	637(700)

※ Achievement of 15% of global FCV market share on the basis of domestic FCV production plan(Korea Automotive Technology Institute, Sep. '15)

☐ Consultation on tax reduction among relevant Ministries upon purchasing/registering of FCV(MOE)

❍ Discuss with relevant Ministries about the need for FCV tax reduction('16~)

- 'FCV' and 'EV' are ZEV(Zero-Emission Vehicle) and designated as Class 1 LEV(Low Emission Vehicle).

☐ Reasonable pricing of hydrogen(MOTIE, MOE)

❍ To invigorate FCV market, hydrogen price need to be set appropriately

- Hydrogen price need to be set at a level(KRW 6,000~8,000/㎏) where economic benefit can be secured for FCV operators in competition with internal combustion cars of the same class.

* Uncompetitive hydrogen fuel price will result in drawbacks in FCV promotion and management of stations.

(5) Provision of other Incentives ⇒ Market Expansion

☐ Operation of specialized cities for FCV and infra promotion(MOE, MOTIE)

❍ Select FCV specialized cities to promote FCV and refueling infra

- The city's hydrogen production/supply conditions and willingness to promote FCV will be considered upon selection

  * Selected cities will be main implementers of hydrogen station demo project(MOTIE)

〈 **FCV promotion conditions of municipalities** 〉

- **(Gwangju)** Excellent conditions for potential supply(Yeosu Industrial Complex), established FCV related 'Creative Economy Innovation Center'(Jan. '15)
- **(Ulsan)** Excellent conditions for potential supply(Ulsan Industrial Complex and many hydrogen production companies)
- **(Changwon)** Many car component factories and excellent willingness of municipality
- **(Naepo, Chungnam)** Excellent conditions for potential supply(Daesan Industrial Complex)

☐ Hydrogen purchase & management by public organizations(MOTIE)

❍ Bulk purchase(tender) from hydrogen supplier to maintain stable supply and price*('17~)

  * KOGAS will exclusively purchase and manage hydrogen. Hydrogen supplier will be in charge of transportation.

☐ Support for FCV purchase and etc.(Municipalities)

❍ Municipalities will additionally support the purchase of FCV depending on their financial conditions

❍ Exemption of FCV public parking fee and traffic congestion fee

☐ Hydrogen refueling station locator and other guidance service(MOE)

❍ Guidance service on the location, availability and open hour of hydrogen refueling stations using smartphone application or car navigation('17~)

Ⅳ. Expected Effect('16~'30)

◈ GHG reduction 4.4M tons(1.4M tons, '30)

◈ Economic benefit from Environmental improvement, hydrogen market activation, etc. measures KRW 84 Trillion
  - Environment : KRW 0.5 T, energy saving : KRW 0.9 T, hydrogen market : KRW 83 T

☐ **(Environment improvement)** Reduction of GHG 4.4 M tons(KRW 50.41 B), air-pollutant 5,480 tons(KRW 37.2 B)

❍ GHG reduction per vehicle : 1.9~2.1 tons p.a.(USD 104.7/t, exchange rate USD:KRW = 1:1,100)

* Annual mileage 15,000km, GHG reduction from vehicle 3% by each year

❍ CO 2,850 tons(KRW 7,074/t), NOx 2,436 tons(KRW 5,460/t), HC 179 tons(KRW 2,730/t), PM 15 tons(KRW 214,500/t)

* Reduction amount is calculated according to 'rules on vehicle total pollutant emission calculation'.

* Cost reduction : 'Social cost estimation and price system rationalization for fossil fuel use' (KEI, '12), etc.

☐ **(Reduction on petrol consumption)** Drop of petrol consumption by 0.63B ℓ(KRW 910B)

❍ Petrol 0.45Bℓ(KRW 600B at KRW 1,511/ℓ), diesel 0.18Bℓ(KRW 210B at KRW 1,263/ℓ)

☐ **(Industry development)** Development of related industry and production increase(Total KRW 83T), job creation(94,000)

❍ **(Market)** FCV KRW 79T(domestic sales 24T, export 55T), HRS KRW 1.4T, hydrogen industry KRW 2.7T

❍ **(Job creation)** FCV 88,000, HRS 2,000, hydrogen industry 4,000

❍ **(Related industry)** Development of renewable energy(wind, solar) production, utilization of natural gas, parts manufacturing, hydrogen energy storage manufacturing, hydrogen pipeline construction related industry

V. Implementation Schedule

Specific Tasks	Timeline							Ministries
	16	17	18	19	20	~25	~30	
1. Core Technology Development → Performance Enhancement								
▪ Parts for hydrogen refueling station(~'20)	■	■	■	■	■			MOTIE
▪ Pressure vessel for tube trailer(~'19)	■	■	■	■				MOTIE
▪ FCV with enhanced performance(~'25)	■	■	■	■	■	■		MOTIE
2. Infrastructure Expansion → Foundation for FCV Promotion								
▪ Construction of byproduct hydrogen stations(~'30)	■	■	■	■	■	■	■	MOE
▪ Core technology for water electrolysis by wind power('16~'20)	■	■	■	■	■			MOTIE, MOE
▪ Support program for hydrogen stations(~'25)	■	■	■	■	■	■		MOE
3. Revision of Regulations for FCV & HRS → Rationalization of Safety Regulations								
▪ Revision of FCV safety regulation('17~'20)		■	■	■	■			MOLIT
▪ Revision of int'l regulation(UN GTR NO.13)('20~'25)					■	■		MOLIT
▪ Reduction of separation distance between HRS and protected facilities(~'20)	■	■	■	■				MOTIE
▪ Amendment for integrated/complex HRS(~'20)	■	■	■	■				MOTIE
▪ Amendment for high-pressure composite tanks('16)	■							MOTIE
4. Private Sector Promotion → New Market Formation								
▪ Subsidy for FCV and price reduction(~'25)	■	■	■	■	■	■		MOE
▪ Consultation on tax reduction for FCV('16~)	■	■	■	■	■	■		MOE
▪ Decision of reasonable hydrogen price(~'25)	■	■	■	■	■	■		MOTIE, MOE
5. Provision of Other Incentives → Market Expansion								
▪ Operation of specialized cities for FCV(~'18)	■	■	■					MOTIE, MOE
▪ Hydrogen purchase by public institutions(~'30)		■	■	■	■	■	■	MOTIE
▪ Locator service for HRS('17~)		■	■	■	■			MOE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