Hydrogen Energy toward high value-added Industry for Ulsan

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Main Industry of Ulsan

Petro-chemistry

SK innovation

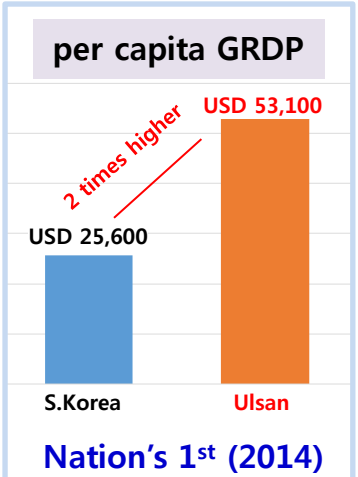
S-OIL

Automobile

HYUNDAI
Drive your way™

Marine shipbuilding

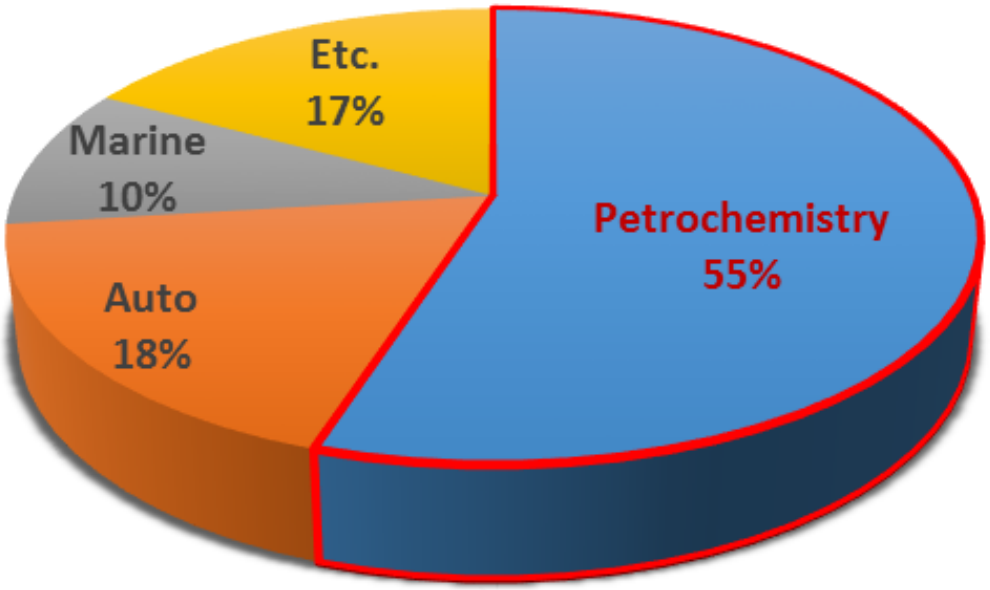
HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

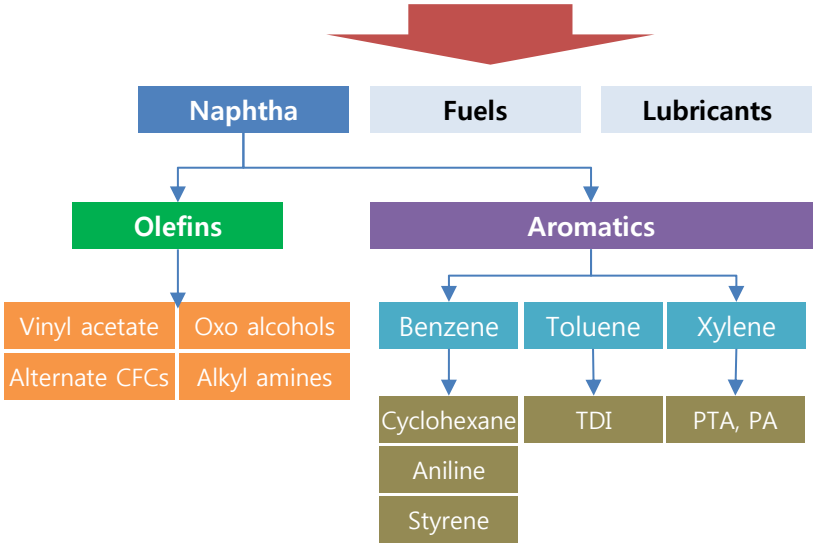


Ulsan is the industrial powerhouse of South Korea.

- The world's largest automobile assembly plant(Hyundai Motor), shipyard(Hyundai Heavy Industries), oil refinery(SK Energy).

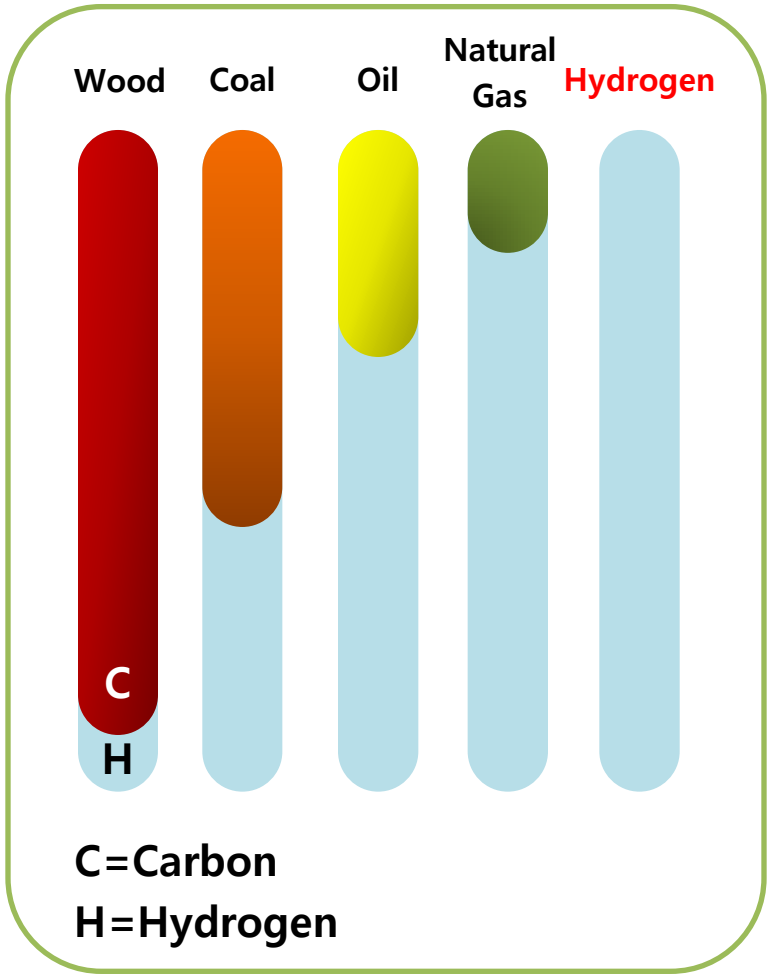
Petrochemical Industry in Ulsan

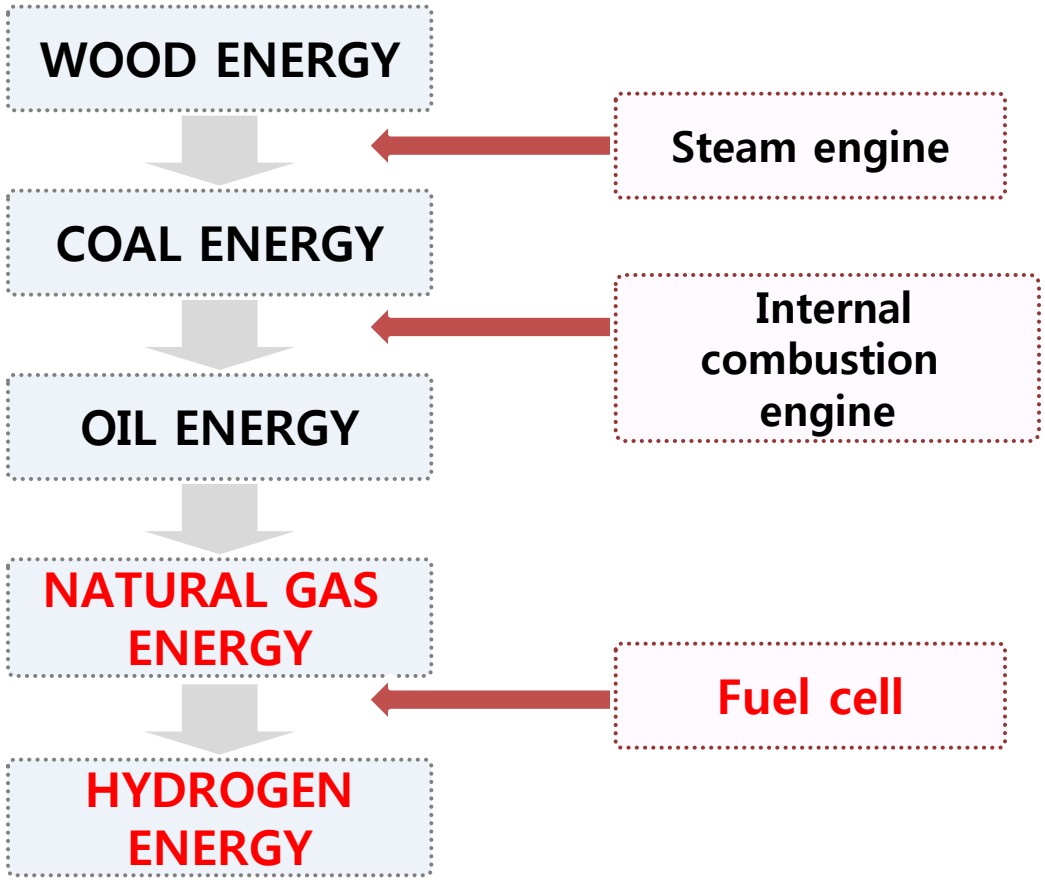




Especially, petrochemical industry covers 55% of the total industrial output in Ulsan.

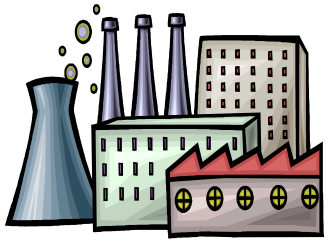
Paradigm shift in Energy Industry





Energy paradigm shift toward hydrogen has been the needs of times.

New Industries from by-product Gases



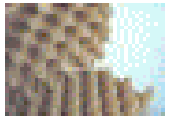
Petrochemical complex

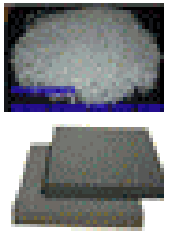
By-product gas

- Collection
- Purification
- Transfer

Green Polymers

CO_2 → Amorphous Polymer → Eco-friendly Polymers





SK innovation

DAELIM chemical

Green Energy

H_2 → Fuel Cell → Power plant / Residential / Transportation / Portable

DOOSAN

S-Fuelcell

Ulsan is supporting green industries by utilizing by-product gases(CO_2, H_2) from petrochemical complex to renewable sources.

Why H_2 energy is valuable in Ulsan?

General aspect

○ Global warming

- CO_2 concentration in air : 280 ppm (before industrialization) → 379 ppm (present) → Temp. increase 2~4.5 °C
- Climate Change & Natural Disaster : Water shortage, flood & extinction of species

○ Oil Depletion

- Expected Peak Oil : Future limitations on oil discovery and production
- Oil consumption annual growth rate ('00~'20) : China 4.1%, India 3.8%

Environmental & Energy issues

Ulsan's new growth engine

○ Limitation in economic growth from current industrial system

- The growth strategy of relying solely on current manufacturing and exporting goods has reached its limit on all fronts.
- Ulsan is searching an alternative development model based on "**Hydrogen energy**".

○ Ideal conditions for hydrogen industry siting

- Ulsan covers 60 % of 1.5 million tons of H_2 produced within the country.
- "Green Hydrogen Town" : a community of 140 families using fuel cells.
- The world first mass-production model FCEV of Hyundai Motor is manufactured in Ulsan since 2013.

Nation's largest H_2 production region

World's 1st mass-production of FCEV

World's largest H_2 town

Value-chains of Hydrogen Industry

Production

By-product hydrogen

Renewable Energy

Reforming

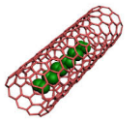
Transfer

Trailer

Pipeline

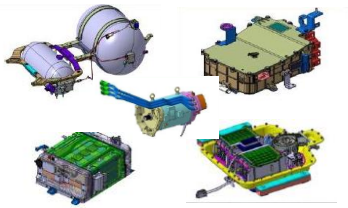
Storage

Tank

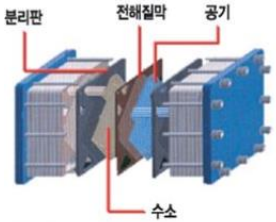


Solid materials

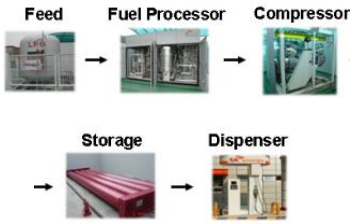
FCEV, H_2 refueling station



Mechanical components



Fuel cell stack



H2 refueling station

Fuel cell power plant

Smart grid

Conformity of by-product H_2 Industry

Recycling

- Reutilization of by-product H_2 as Eco-friendly Energy source
- Transformation of by-product CO_2 to Eco-friendly product

CO_2 reduction

- Innovative and ultimate route to reduce CO_2
- Profits as CERs(certified emission reductions)

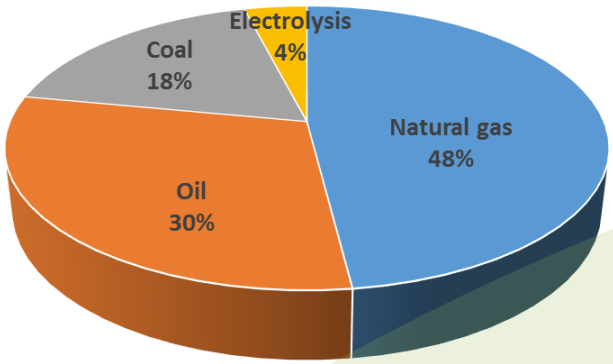
Conformity (Policy)

- Compatibility to Nation's policy "Low carbon & green growth"
- Achievement of original technology based on by-product gases
- Upgrade chemical industry by a higher value-added technologies

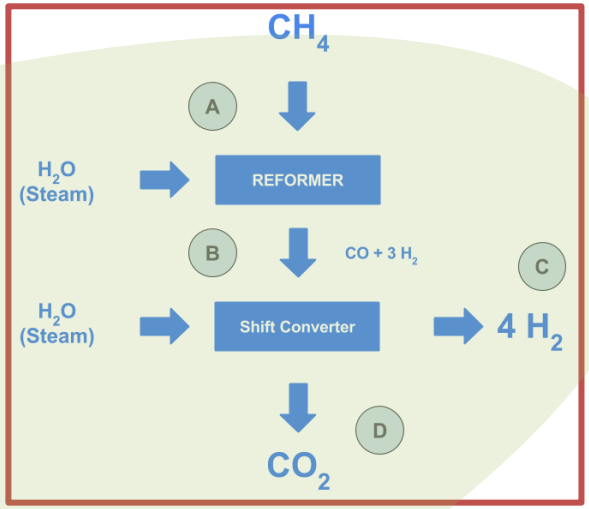
Ulsan's condition

- Hub of petro-chemistry and transportation industries
- Regional merits to get by-product gases with large industrial complex
- Representative city to lead nation's new energy and high value industries

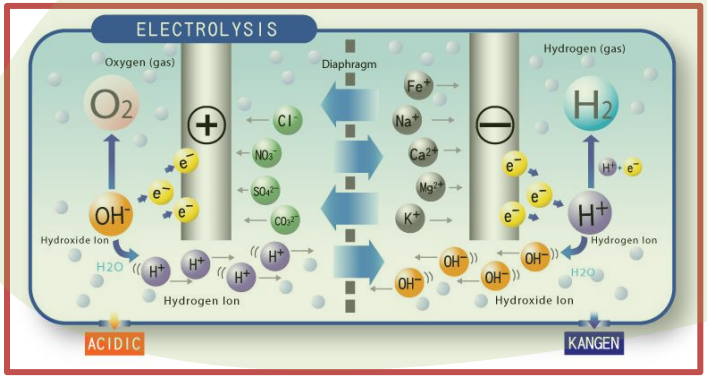
How to produce H_2?



Production method/source



Reforming : Oil, Coal, Gas, Alcohol



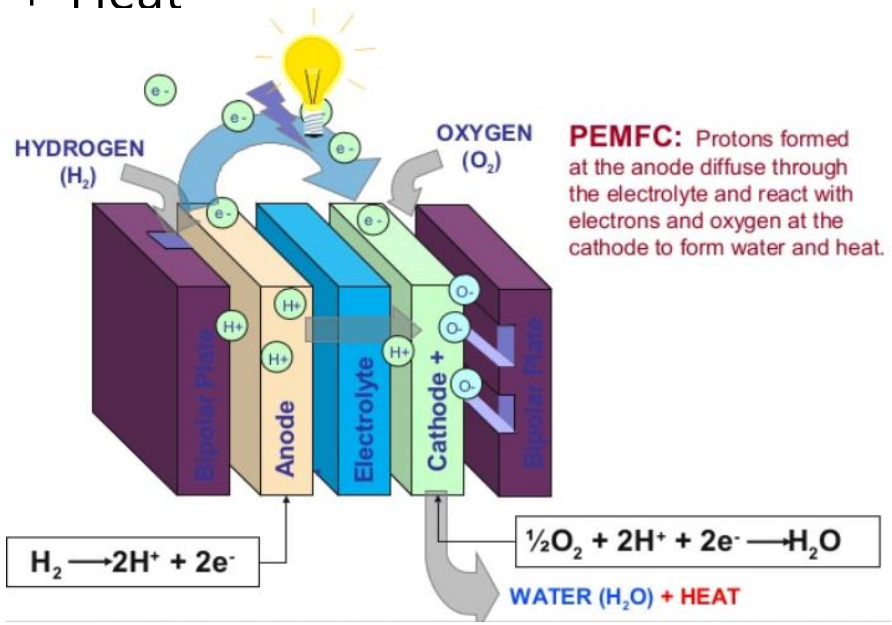
Water Electrolysis

Most of H_2 produced in the world is from oil, natural gas and coal.
Technological advance will lead to increase the portion of water electrolysis.

What is a Fuel cell?

Fuel cells are electrochemical devices that convert chemical energy of reaction directly into electrical energy.

- $H_2 + 1/2O_2 \rightarrow H_2O$ + Electricity + Heat
- Output: DC Voltage
- Potential: ≈ 1 volt/cell
- Anode ≡ the electrode that emits electrons (negative)
- Cathode ≡ the electrode that receives electrons (positive)

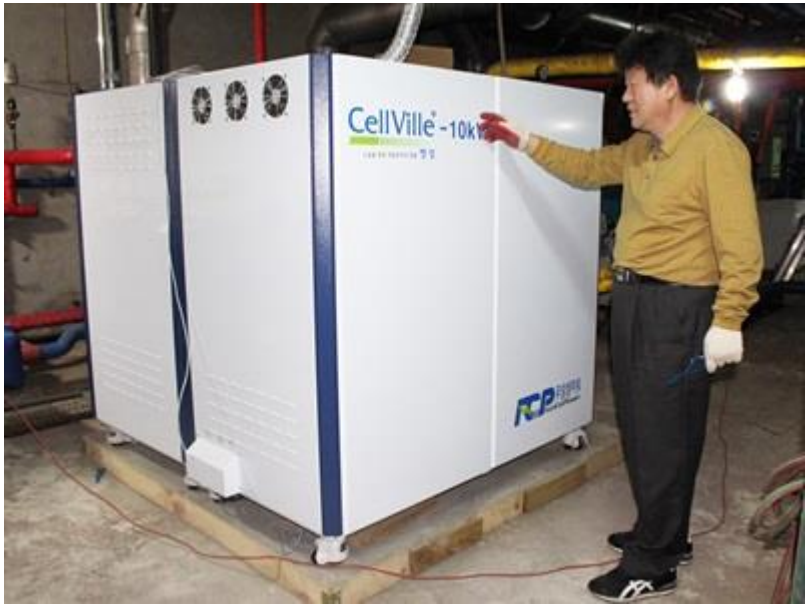


Fuel Cell for stationary application

Large-scale fuel cell power plant is constructed for supplying electricity and heat to local area.

Small-scale fuel cells are used for individual houses and buildings to provide independent electricity and heat with better energy efficiency.

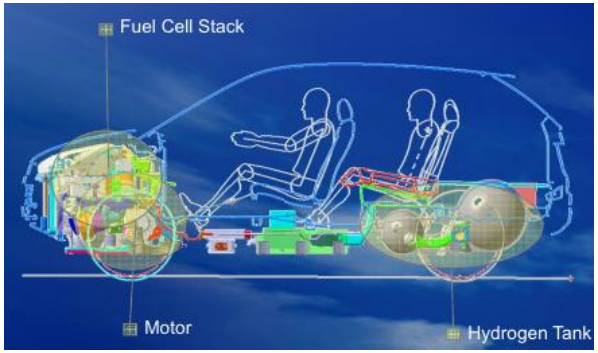
Fuel cell power plant (sub-MW~MW)



Residential and building (1~100kW)

Commercialization of FCEV

Category	Model			
FCEV	MIRAI	CLARITY	-	Tucson ix FCEV
				
Year	2014	2016	2017 예정	2013
Accumulated sales	890 (`16. 05)	-	-	489 (`16. 05)
Manufacturer	Toyota (Japan)	Honda (Japan)	Benz (Germany)	Hyundai (Korea)
Driving range	650km	750km	-	594km
Cost	~$53,000	~$67,000	-	~$70,000



In 2013 Hyundai motor released world's first commercial type FCEV at Ulsan.

Ulan = the hub of Hydrogen industry

Hyundai Motor' FCEV
(World's 1st mass production)

For electric vehicles

Hydrogen Town
(World's Largest magnitute)

For residential scale

Fuel Cell Test Complex
(Demonstration of product)

For building, power plant scale

Leading Hydrogen Energy Industry

Ulsan is the only city to invest on three kind of Hydrogen fuel cell industries in Korea. (Car, residential and larger scale applications)

FCEV demonstration with Hyundai

Ulsan city has made an effort to expand the FCEV infrastructure and commercialize FCEV with Hyundai motor.

- Construction and managing of FCEV monitoring & maintenance system
- Training for experts in FCEV maintenance
- Publicity activities (trial ride)
- Provide driving and maintenance data to Hyundai motor

  ➔ Commercialization of FCEV in 2013

Hydrogen refueling station

Education for FCEV mechanics

Repair shop for FCEV

Publicity event for FCEV

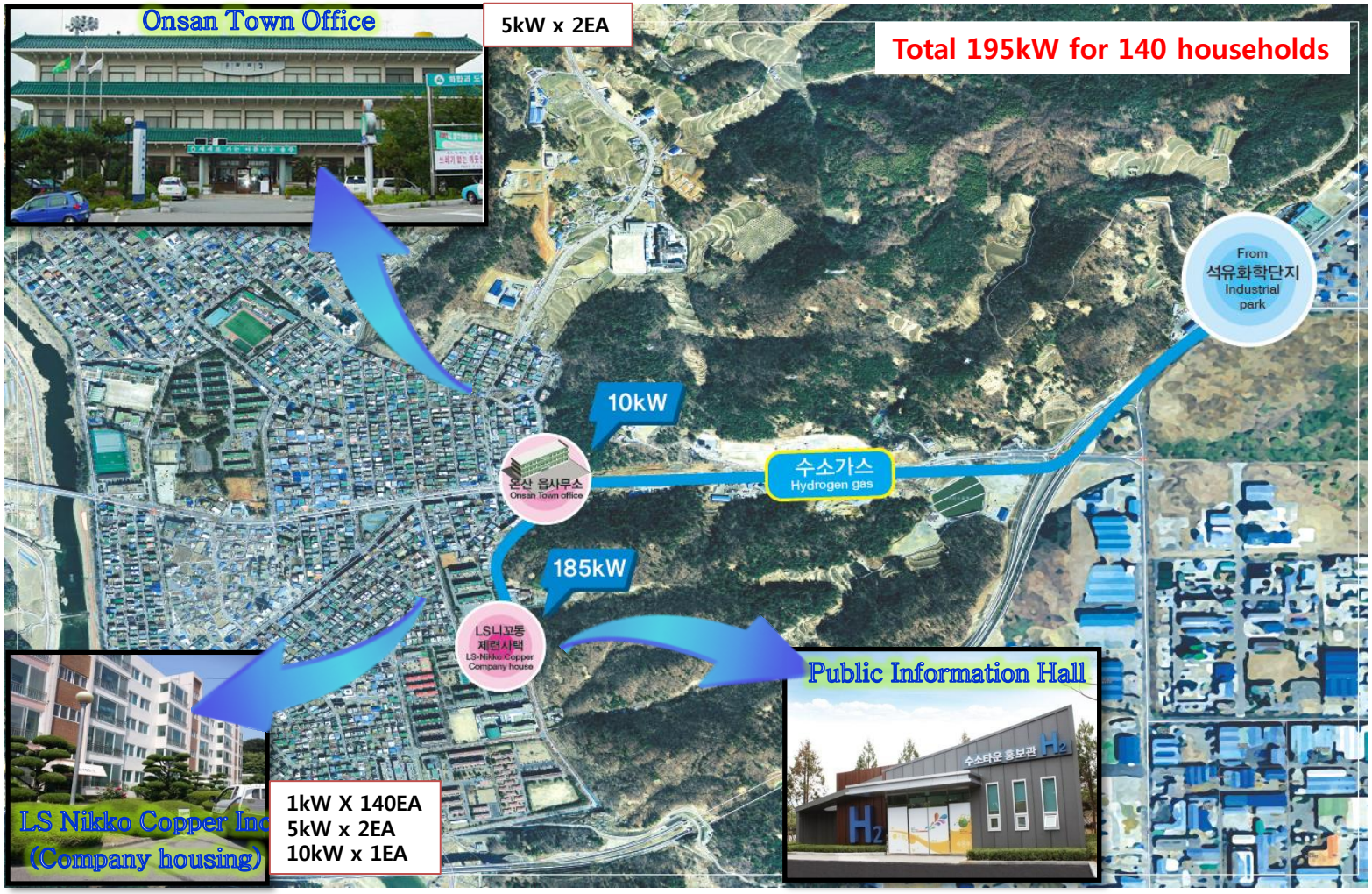
FCEV demonstration with Hyundai

Currently, Ulsan city is running 9 FCEVs as official vehicles. (Tucson : 8EA, Bus : 1EA)

Additional 35 FCEVs will be provided to the corporations located in Ulsan.

Ulsan Hydrogen town

Ulsan is operating the world's largest H_2 town powered by fuel cells.



- **Total budget : $7.3M**
- **Period : `12~`18**
- **Participant**

울산광역시 ULSAN METROPOLITAN CITY
울산테크노파크 Ulsan Technopark
LS-Nikko 동제련
퓨얼셀파워 FuelCellPower
S-FUELCELL New Story Creator
HYUNDAI HYSCO
HYOSUNG

Ulsan Hydrogen town

Installation of Fuel cells by domestic suppliers

1 kW

1 kW

1 kW

5 kW

S-FUELCELL
New Story Creator

10 kW

Ulsan Hydrogen town

- **Advertising Hydrogen technology to the public**

Over 2,000 people have visited Ulsan hydrogen town so far from various organization.

Ulsan Fuel cell demonstration complex

Leading to Global Hydrogen Economy and Hydrogen Industry Hub

Construction of Demonstration complex For research of hydrogen and fuel cells commercialization and PEMFC system demonstration

- Hydrogen & Fuel cell Research Center
- Hydrogen Quality Test Center
- Project management
- 1MW PEMFC system demonstration
- 5MW fuel cell test-bed and Hydrogen Pipeline

Ulsan Fuel cell demonstration complex

Ulsan Fuel cell demonstration complex

Hydrogen pipeline

- Diameter = 100 mm(4 inch)
- Distance = About 4.5 km
- Pressure
  - Petrochemical Complex : 20kg/cm^2
  - Test –bed : < 10kg/cm^2
- Start point
  - Petrochemical Complex exit 3
- Design based on the Korean High Pressure Gas Safety Law

구분	연장(m)	비고
1~2	3,000	울산석유화학단지/산업로
2~3	1,500	테크노산업단지내
계	4,500	

Other actives in preparation

Supply 4,000 FCEVs in Ulsan (~2020)

- Plan of Korean government (Ministry of Environment)

Category	'16~'20	'21~'25	'26~'30	'31~'50
FCEV (thousand EA)	10(10)	91(100)	530 (630)	6,370 (7,000)
Hydrogen station (EA)	80(100)	130(210)	310(520)	980(1,500)

- Plan of Ulsan

Category	'15	'16	'17	'18	'19	`20	Total
FCEV (EA)	8	35	57	100	300	3500	**4,000**
Hydrogen station (EA)	1	2	2	2	2	3	**12**

- Ulsan city has decided to provide the biggest amount of subsidy to FCEV consumers among local governments.
- FCEVs will be used for public transportations (Bus, Taxi) step by step.
- Ulsan city is also trying to build more hydrogen refueling stations yearly.

Other actives in preparation

Hydrogen pipeline toward downtown area

Vision of Ulsan

Ulsan

E- HUB Project
(Energy HUB)

Thank you!