Hydrail in Korea and Asia: The Current Direction

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Motive

- Air pollution
  → Fuel cell
- Traffic congestion
  → Rail system
- Oil crisis
  → Alternative Energy
Korea’s national vision

- **Low-carbon and Green-growth**
  - How to turn a low-carbon growth strategy into the machine that can create quality green jobs in the future.
  - South Korea will spend more than 4.2 trillion won (about $3.38 billion) over the next five years to develop green technology solutions in electronics products and communications services to reduce energy consumption, lower costs and boost manufacturing productivity,
  - It is expect that this project will create 52,000 new jobs by 2013 and reduce the country's carbon emissions by 18 million tons of CO₂.
‘A national vision of the hydrogen economy and the action plan’

Continuous Upgrading toward low-cost, high-efficiency, long-duration hydrogen

**Use (Fuel cell)**
- **2020 Target**
  - Fuel Cell Vehicle 1,950,000
  - Fuel Cell Power Plant 2GW
  - Residential Fuel Cell 750,000
- **2040 Target**
  - Fuel Cell Vehicle 12,500,000
  - Fuel Cell Power Plant 17GW
  - Residential Fuel Cell 3,500,000

**Production**
- **2020 Target**
  - NRE Share in Total Production : 22%
- **2040 Target**
  - NRE Share in Total Production : 60%

**Storage & Supply**
- Early Applicable Tech. Dev.
  - (High pressure compressed Storage)
- Tech. Dev.
  - (Liquefied Storage)
  - (Carbon Nano Tube)

Enlarge On-site & Off-site Stations
[2020 : 2,800 Stations → 2040 : 9,500 Stations]

*Source: Ministry of Commerce, Industry and Energ(MOCIE), 2005*
‘A national vision of the hydrogen economy and the action plan’

- 207 trillion won (about $153 billion) should be invested to increase the portion of hydrogen energy in the final energy demand up to 15% by 2040.
- Select the transportation sector as the main target, more than 50% of vehicles on the road will be replaced with fuel cell vehicles.
- 20~30% of electricity demand in the residential and commercial sectors might be replaced with power generation by fuel cells.
- Primary energy demand would be reduced by 9%, resulting in improved energy mix in which fossil fuel consumption is greatly reduced whereas renewable energy increases by 47%.
- CO₂ emissions will be reduced by 20% and self-sufficiency in energy is enhanced up to 23%.
Barriers

- Lower life cycle
- High manufacturing and maintenance cost
- Infrastructure construction
- Safety and reliability
- Air, water and thermal management
- Energy storage and power conditioning
Expected effects

- Environment-friendly railway:
  - completely emission-free
  - reduce the impact on greenhouse effect

- High quality service of public transportation
  - safe and comfortable rail service
  - avoid the unexpected trouble from high voltage transmission
  - remove overhead wire
  - on-time performance
Expected effects

- **Energy-efficient economy:**
  - reuse the regenerative energy from electric braking performance of trains
  - reduce the dependency of imported energy in Korea

- **Lead the practical use for fuel cell transportation:**
  - make the best use of the existing facilities for automatic drive, safety and verification
Korea’s R&D on Fuel Cell

- **The Ministry of Education, Science and Technology**
  
  21st century Frontier Project: Study on hydrogen production, storage and utilization at Hydrogen Energy Center since 2003 (www.h2.re.kr)

- **The Ministry of Knowledge and Economy**
  
  Next Generation Growth Engine Project: Study on the manufacture of fuel cell stack, BOP and Demonstration program ☞ The development of 80 kW and 200 kW fuel cell stack is underway for the use in transportation. The test drive of the onboard vehicle is also underway.

- **The Ministry of Land, Transportation and Maritime Affairs**

  National Transportation Key Technology R&D project: Develop hybrid bimodal tram with hybrid propulsion system of fuel cell and battery/super capacitor

  Plan: Hydrogen based public transportation system, the related infrastructure and regulation, hydrogen supply system
Fuel cell bimodal tram

Project I (2009)
- Modular composite body
- Virtual rail
- Automated operation
- Hybrid system

Project II (2011)
- System engineering
- Infrastructure standard
- Operation system
- Maintenance based on railway system

Project III
- Fuel cell propulsion
- Hydrogen infrastructure
- Regulation
- Standardization

Prototype Tram

Hydrogen Public Transportation

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Project I (Bimodal Tram)

- CNG Hybrid Bimodal Tram
  - Series hybrid propulsion system
  - CNG engine (Cummins B Gas Plus, 230hp)
  - Li-polymer battery (Kokam, 80Ah)
Test track
Project III (Hydrogen Bimodal Tram)

- Series hybrid power supply will be replaced by fuel cell stack, BOP and DC/DC converter.
- Fuel cell stack and BOP: 1) R&D prototype in Korea
  2) Best one in the world

CNG engine – generator – PWM converter + Motor drivers – Motors

Battery pack +

Fuel cell + DC/DC converter + Motor drivers - Motors

BOP + Supercapacitor +
Project III (Hydrogen Bimodal Tram)

- Development of hydrogen propulsion system
  - propulsion control equipment, BOP for fuel cell stack, supercapacitor/battery
  - maximum speed 80km/h
  - commercial speed over 30km/h
  - 116 passengers/car
  - 200kW fuel cell stack.
  - 200kW supercapacitor or battery

- Development of infrastructure for hydrogen Tram
  - hydrogen supply and storage system
  - establish the safety standard, code and regulation
Fuel cell train in Japan

- **Railway Technology Research Institute**

✓ A 100 kW fuel cell system that can be mounted on a train in 2007.
✓ The first running test of an actual railway car driven by a fuel cell system.
  - Test track: up to 40km/h, max 90kW
  - Test platform: up to 105km/h, max 105kW
✓ Test results the FC energy efficiency and fuel consumption under the condition of commercial lines by the running simulation on WCRR 2008.

<source: WCRR 2008, Energy efficiency and fuel cells powered test railway vehicle>
Fuel cell train in Japan

- **JR East**
  
  - The first diesel hybrid railcars, which were developed as the first stage in the development of a diesel hybrid system, were introduced on the Koumi Line in July, 2007.
  
  - Currently developing the world’s first “fuel cell hybrid railcars” as the second stage, and have been making trial runs with the prototype railcars since April, 2007
Fuel cell train in India

- India estimates it needs to sustain economic growth at nearly 10% per year for at least 25 years to end poverty and meet the demands of a population expected to reach 1.6 billion by 2050.

- Indian Railway (IR) is one of the largest railroad systems in the world (India imports 2 million barrels of oil per day).

- To handle its vast freight and passenger traffic, it operates as many as 4,000 diesel-powered and an equal number of electric locomotives.

- These locomotives consume 2,000 million liters of diesel & 9,000 million units of electricity annually. <source: www.indianrail.gov.in/abri.html>
Fuel cell train in India

- A huge opportunity for hydrogen to replace oil in transport in the next few decades and help meet the goals of sustainability and energy security.
- Plans for coal gasification and hydrogen production from photovoltaic electrolysis of water. In the long term, hydrogen could come from biomass or bio-alcohols.
- Indian Railway is currently building a FC powered shunting locomotive using a 500kW PEM stack and battery bank for research purpose. No date has yet been set for its unveiling.<Source : Fuelcell Today>
Fuel cell train in Taiwan

- The National Science and Technology Museum of Taiwan successfully tested a mini-train using power generated by a hydrogen fuel cell on April 11, 2007. The train is one of the first of its kind in the world. <Source: Fuelcell Today>

- More than 400 million New Taiwan dollars developing and building the train fuel cell power system, track and hydrogen stations to promote green energy education.

- The hydrogen fuel electric train will run in the park outside the Taiwan Science and Technology Museum every Saturday, Sunday and holidays.
Thank you

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for your attention