A Proposal for Future:

H.Hirabayashi

1. Greenhouse effect

- history and future

2. Fuel Cells

- Vehicles
- Households
- Fuel Cells for Mobile Phones

3.Electric Power System (EPS) and Hydrogen energy System (HES)

- EPS --- Practical ---- Could not store
- HES --- Under Development ---- Large Scale Storage with LH_2, Clean
- Compensative in Future

4. Convergence of SC and Liquid Hydrogen Technology

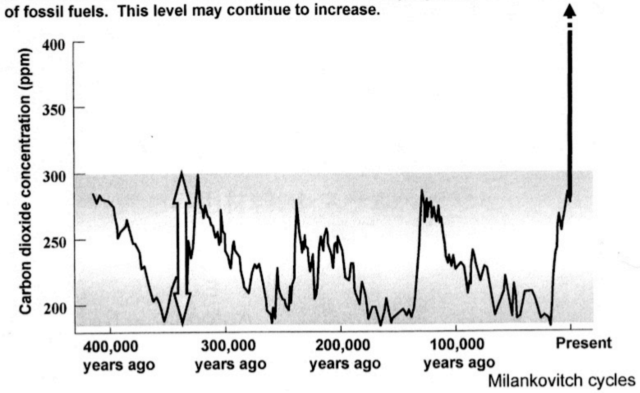
SC + LH_2 = Energy Grid,

HTS, MgB_2

Changes in carbon dioxide concentration

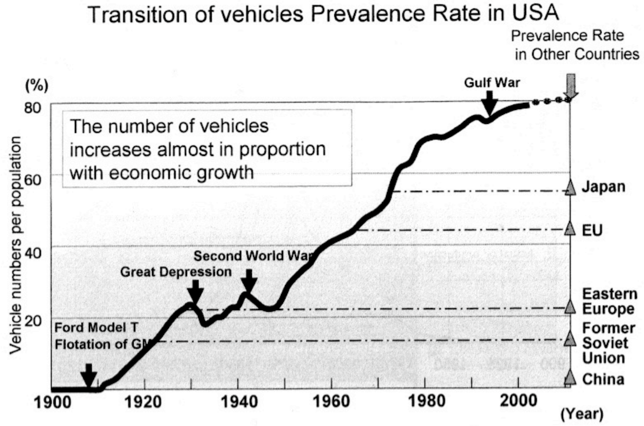
The Power of Dreams

During the history of the earth, the concentration of carbon dioxide had remained steady at between 200 and 300 ppm. Since the Industrial Revolution, however, the level of carbon dioxide in the atmosphere has been rapidly rising due to the use of fossil fuels. This level may continue to increase.



Prevalence Rate of Vehicles

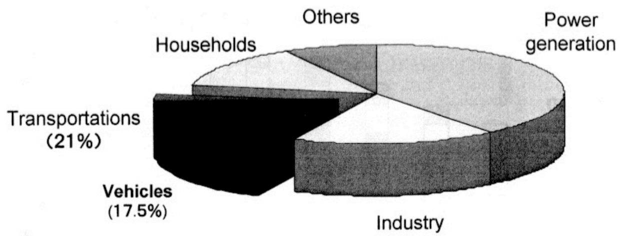
The Power of Dreams



Effects of vehicles on the carbon dioxide emission

The Power of Dreams

Transportation accounts for about 21%, of which 17.5% comes from vehicles. Therefore, it is imperative to reduce carbon dioxide emissions from vehicles.

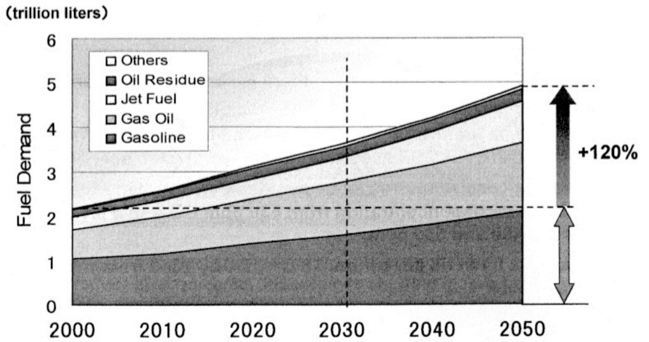


Source: IEA CO2 Emissions from Combustion (2004)

Energy Consumption in the Transport Sector

The Power of Dreams

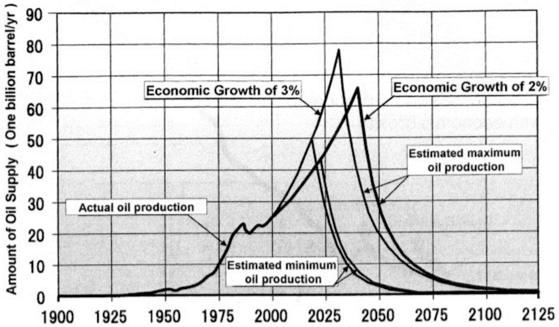
Energy consumption is estimated to increase more drastically due to the increased number of vehicles and the expanded personal transport activity.



Source: Honda estimation based on IEA/ETP data

Issue Related to Energy Demand

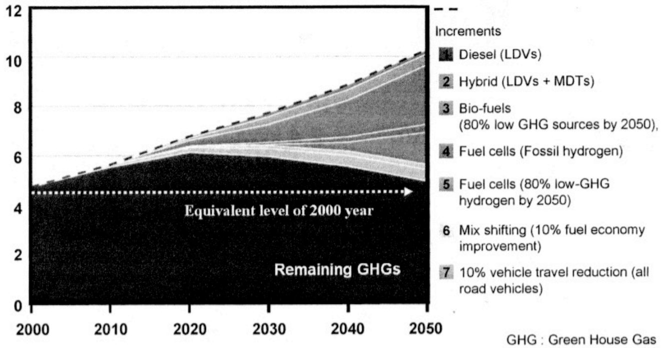
Supply of crude oil will come to a limit in the future.



Source: Honda estimation based on IEA/ETP data

Modeling of CO2 Reduction by vehicles

Only the use of carbon-neutral hydrogen or advanced biofuels can offset the impact of continued growth in greenhouse gases



GHG : Green House Gas

Source: WBC-SD SMP

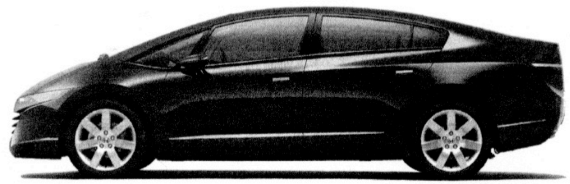
Risks of meteorological changes

Stern Review
October 2006

- **Climate changes adversely affect economic growth and development.**
- **If people take immediate action, there is some time left for avoiding these adverse effects.**
- **Losses to be incurred if no action is taken may account for more than 20% of GDP according to the worst-case scenario.**
- **The worst-case scenario can be avoided by controlling the current level of concentration from 430 ppm CO_2e to a level between 450 and 550 ppm.**
- **Emissions must be cut by more than 25% by 2050 from the current level.**

Society's needs for FCV

- **Low carbon dioxide characteristics (production / driving)**
- **Alternative to petrol**



Developing products that are sufficiently responsive to reduce environmental impact while allowing mobile freedom

Roadmap for technical development for fuel cell vehicles

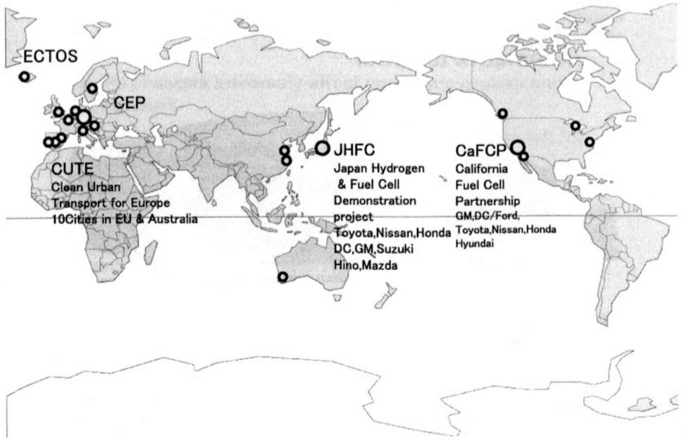
	Demonstration stage	Introduction to commercialization stage	Mass production stage
	Present	until 2010	until 2020
Vehicle efficiency	About 50%	→	60%
Output density (stack)	>1.4 kW/L	2.4 kW/L	>2.4 kW/L
Durability	About 1,000 hrs. 10,000 startups and stops	3,000 hrs. 30,000 startups and stops	5,000 hrs. 60,000 startups and stops
Cost (stack)	Tens of thousands of yen/kW	50,000 to 60,000 yen/kW **(100,000 units/year)**	4,000 yen/kW **(1 million units/year)**

Source: Excerpts from NEDO's Fuel Cell Roadmap Version 2

Issues to be addressed for FCV commercialization

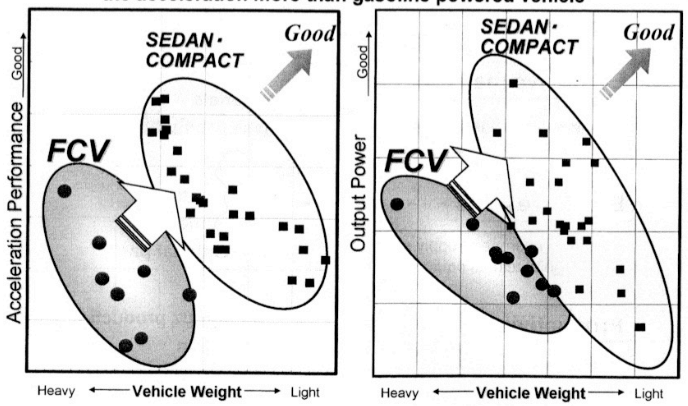
- **Improvement of vehicle output density**
- **Improvement of fuel economy and driving range**
- **Cost Reduction**
- **Improvement of durability and reliability**

Fuel Cell Fleet program in the world

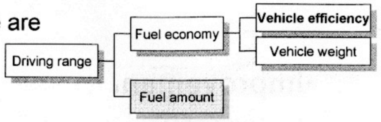


Improvement of vehicle output density

Performance improvement and weight reduction require to achieve the acceleration more than gasoline powered vehicle



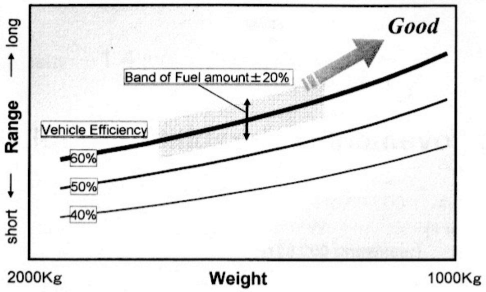
Improvement of fuel economy and driving range



The factor of driving range are

1. Vehicle efficiency
2. Vehicle weight
3. Fuel amount

Improvement each factor make spread driving range



Improvement of the durability and the reliability

Cyclic durability →
- Improvement of membrane and MEA strength
- Replacement of vehicle dynamic mode on the testing stand

Startup and stop degradation →
- Improvement of membrane and MEA strength
- Fuel gas control

Cold/hot degradation →
- Improvement of membrane toughness for cold and hot temperature
- Thermal capacity reduction

Cost reduction

Cost-reduction process

Expensive materials →
- Replacement to popular materials
- Mass production

(e.g., membranes, electrodes, separators)

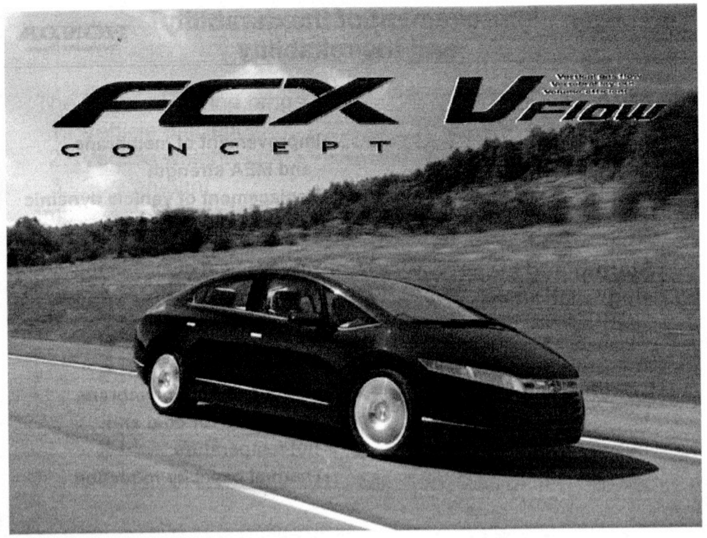
Exclusive parts →
- Simplification
- Replacement to conventional parts

(e.g., tanks, hydrogen supply systems, high-voltage electrical equipment)

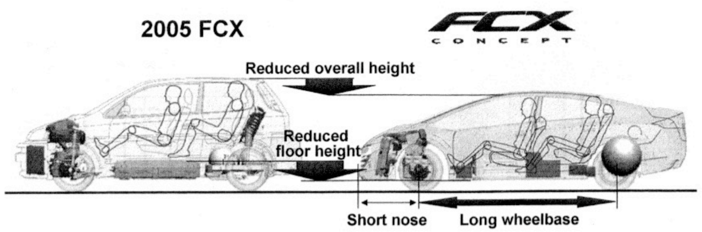
Productivity →
- Continuous production and automation
- Yield improvement

(e.g., MEA/stack)

development of fuel cell vehicles



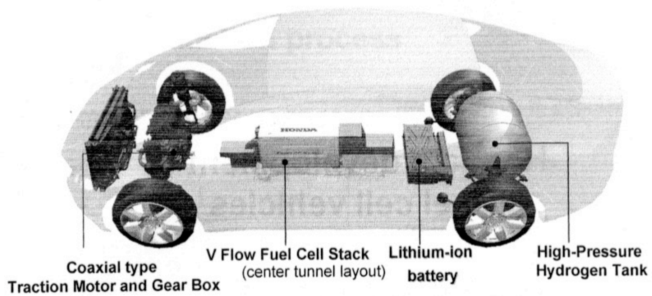
FCV Development
Advanced Packaging



- Very short front overhang
- Large cabin in relation to vehicle length
- Reduced floor/overall height

Advanced packaging made possible by the V Flow fuel cell platform

FCV Development

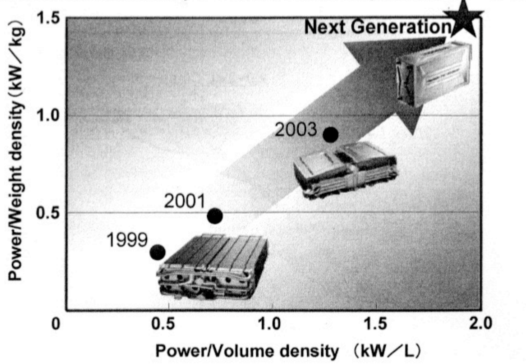


Maximum Speed	160 km/h	Maximum Motor Output	95 kW (129PS)
Driving Range	570 km (355 miles) *1	Maximum Motor Torque	256 Nm (26.1kgm)
		Energy Storage	Lithium-ion battery
Fuel Cell Stack Output	100 kW	Hydrogen Tank	171 L/5000psi (35 Mpa)

*1 City mode(LA4-H/H, Honda estimation)

FCV Development
Honda FC Stack evolution

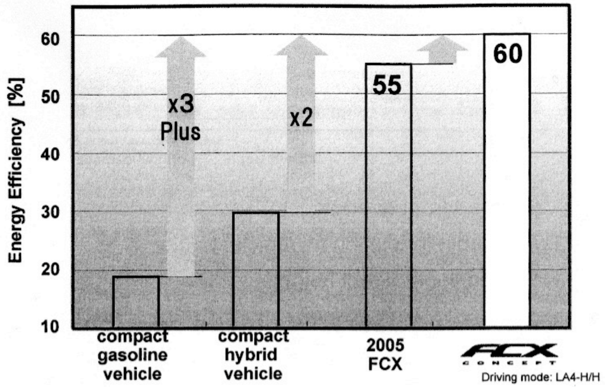
Significant improvements compare to previous model
Power/Volume density : +50% , Power/Weight density : +67%



FCV Development: Energy Efficiency

HONDA
The Power of Dreams

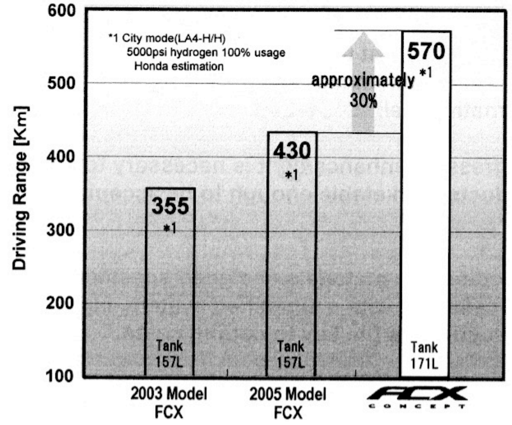
Energy efficiency of FCX CONCEPT
- twice that of hybrid-electric vehicle!
- three times that of gasoline vehicle!



FCV Development Driving Range

HONDA
The Power of Dreams

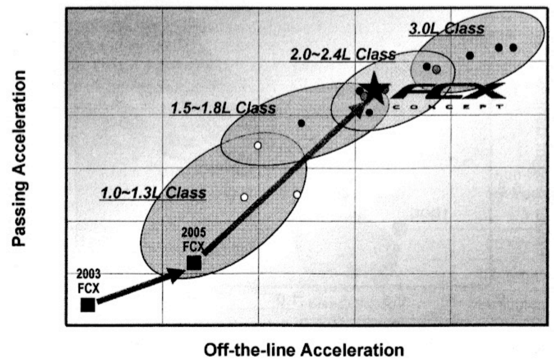
Driving range improved by approximately 30% over 2005 FCX to 570Km.



FCV Development Driving Performance

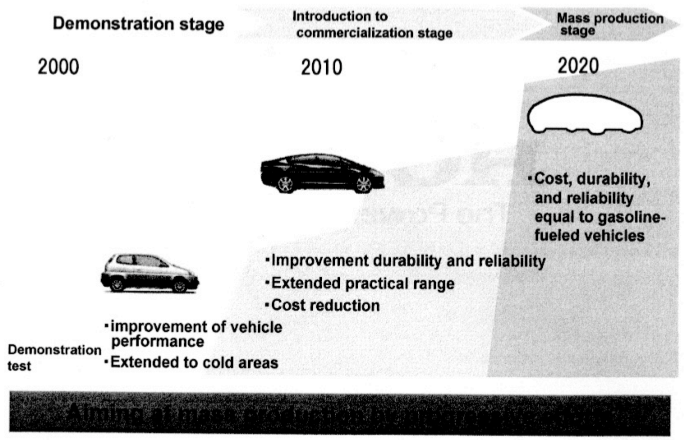
HONDA
The Power of Dreams

- Significantly improved mid-to-high-speed acceleration in addition to already superior off-the-line acceleration
- Uniquely quiet and linear acceleration feel



Prospects of FCV commercialization

HONDA
The Power of Dreams



Why Fuel Cells and Why Now?

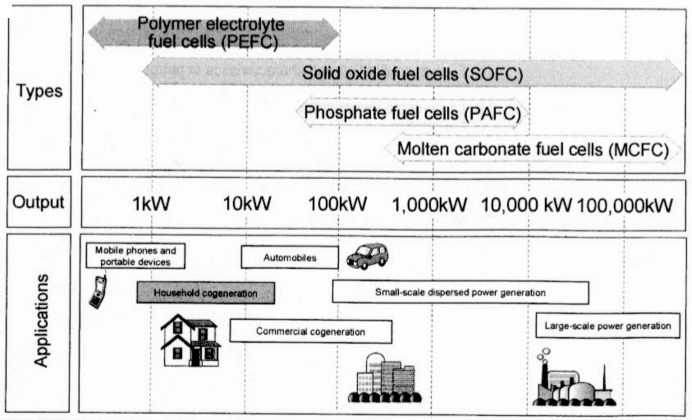
- The first successful demonstration of fuel cell power generation was conducted in 1839.
  (By Sir William Grove of the UK.)

- The first practical application was developed in 1965.
  (Carried onboard the NASA's Gemini 5 manned space shuttle)

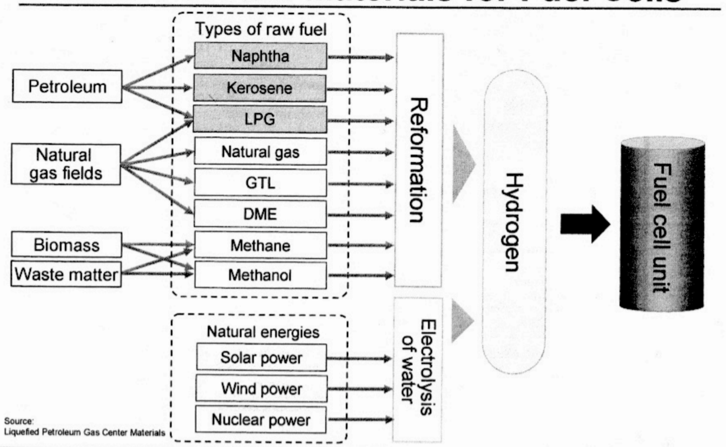
So why are fuel cells in the limelight now?

- They offer good heat utilization efficiency which helps to reduce carbon dioxide emission.
- They have smaller environmental impact than oil, as they emit smaller harmful gasses.
- They use a variety of energy supply sources, such as petroleum fuel, natural gas, and biomass fuel, etc.
- They are a step towards the future hydrogen energy use.
- Fuel cell performance has improved to the point where their output per unit volume is in line with that of car engines.
- They will lead to create new industries and strengthen Japan's industrial competitiveness.

Types of Fuel Cells and Respective Power Generation Capacities and Applications



Choice of Raw Materials for Fuel Cells



Source:
Liquefied Petroleum Gas Center Materials

Merits of Petroleum Fuels

- High energy density, perfect for storage and transportation.

- Existing production and distribution facilities can be used to supply petroleum fuels.

- Installation possible anywhere in Japan.

- Fuel reserves can be kept to secure energy supplies in case of emergency.

Future Directions of Mobile Fuel Cells

Diversification and Multi-Functionality of Mobile Phones

↓

High Function Mobile Phones Always-On

Standby mode
: approx. 3mW
Talking
: approx. 0.9W
Packet communication (email, imode)
: approx. 1.0W
(incl. LCD (backlight) operation)

↓

Need to Increase Mobile Phone Battery Capacity

Provisional Measures

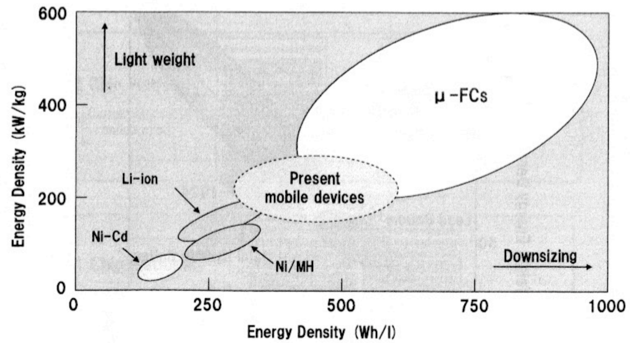
- Active use of 2nd generation lithium-ion batteries

Change in cathode and charging voltage of Li-ion batteries

Long-term Measures

- Use of micro fuel cells (DMFC, PEFC)

Expectations toward Fuel Cells (1)



Expectations toward Fuel Cells (2)

	Phosphoric Acid Fuel Cell (PAFC)	Molten Carbonate Fuel Cell (MCFC)	Solid Oxide Fuel Cell (SOFC)	Polymer Electrolyte Fuel Cell (PEFC)	Direct Methanol Fuel Cell (DMFC)
Fuel	Hydrogen (reformed gas)	Hydrogen, carbon monoxide (reformed gas)	Hydrogen, carbon monoxide	Hydrogen (reformed gas)	Methanol solution
Electrolyte	Phosphoric acid	Lithium carbonate Potassium carbonate	Stabilized zirconia	Ion exchange membrane	Ion exchange membrane
Ion exchange membrane	Proton	Carbonate ion	Oxygen ion	Proton	Proton
Operating temperature	Approx. 200 ℃	Approx. 650℃	Approx.1,000℃	Ambient temp.~ Approx.100℃	Ambient temp.~ Approx.50℃

DoCoMo is now investigating and prototyping these batteries partly through joint development

Introduction of various other fuel cells for mobile terminals under investigation

Expectations toward Fuel Cells (3)

Cable-connected (current example)
Recharge via power outlets

Recharged (prototype example)
By carrying the fuel cell and cartridge, one can continue to use the mobile phone without power outlets

Terminal-embedded (future target)

R&D for embedded fuel cells

- Terminal embedded fuel cells with high fuel concentration technology
- Simple fuel cartridge design
- Hybrid operation of Li-ion battery packs and fuel cells

FCHV-BUS

中部国際空港ーセントレアーで お会いしましょう。

中部国際空港への路線バスや 空港内ランプバスとして活躍中。

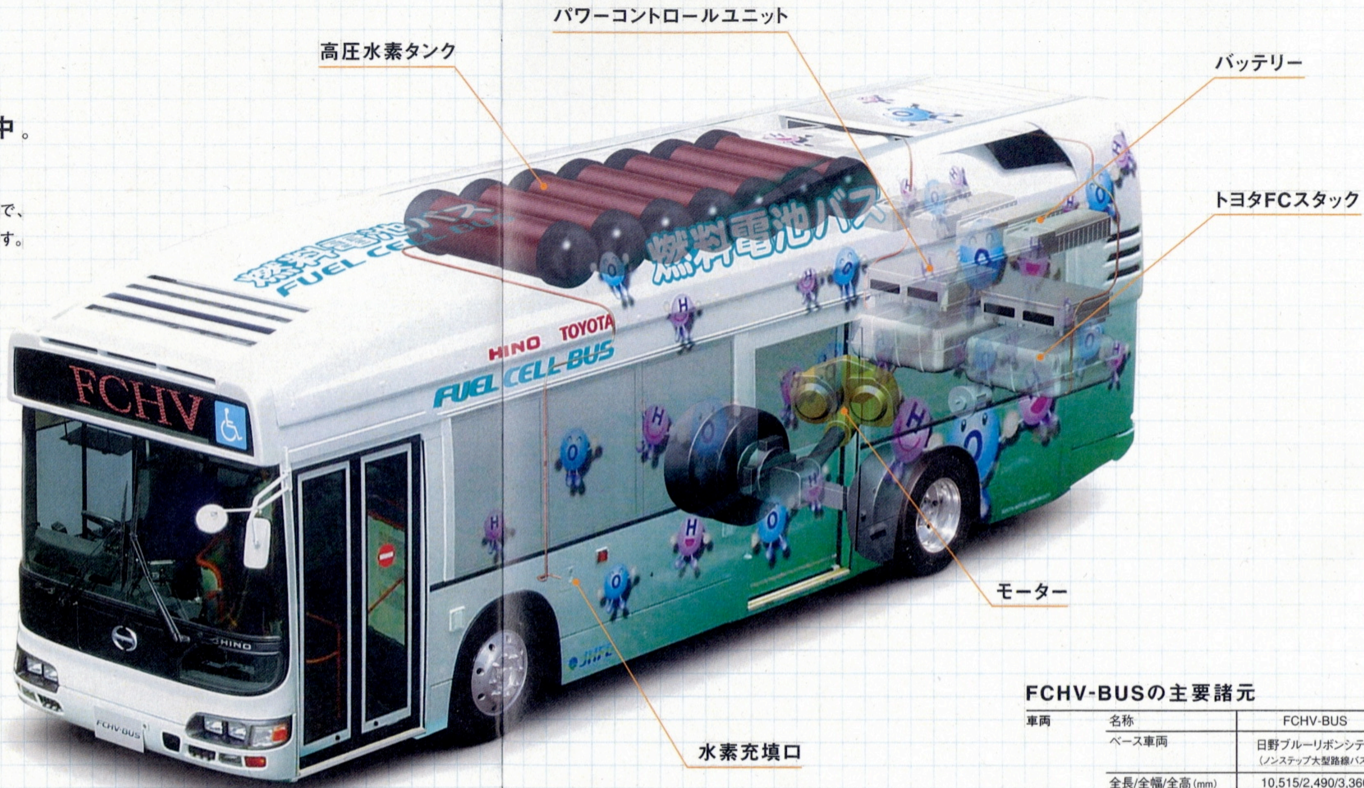
FCHV-BUSは、トヨタと日野自動車が共同で開発した燃料電池ハイブリッド大型バスです。NOxもPMもゼロで、特に、都市の大気環境をクリーン化するねらいがあります。2005年3月から9月まで開催された「愛・地球博」では、会場間の移動手段として、8台のFCHV-BUSが運行。100万人のお客様にご利用いただきました。

FCHV-BUS（万博バス仕様車）

そしてFCHV-BUSは、2006年3月より中部国際空港ーセントレアーへの移動手段として愛知県の知多半田駅から営業運行しています。また空港内では、旅客ターミナルと空港内に駐機する航空機との間で旅客を送迎するランプバスも運行しています。

FCHV-BUS 営業運行路線図

FCHV-BUS（ランプバス仕様車）



ショックの少ない発進と乗り心地が評判です。

FCHV-BUSは、トヨタFCHVと同じ「トヨタFCスタック」を採用しています。その燃料電池を2基搭載しているのですが、バスの大きな車体を見ると、ついつい重たそうに走る姿を想像してしまいます。しかし乗ってみると、予想は見事に裏切られてしまいます。特に発進時は、はじめから大きなパワーを発生するモーターの特性が発揮されて、静かに力強く加速します。

FCHV-BUSの主要諸元

車両	名称	FCHV-BUS
	ベース車両	日野ブルーリボンシティ（ノンステップ大型路線バス）
	全長/全幅/全高（mm）	10,515/2,490/3,360
	乗車定員（人）	62（路線バス）/63（ランプバス）
性能	最高速度（km/h）	80
燃料電池	名称	トヨタFCスタック
	種類	固体高分子形
	出力（kW）	90×2
モーター	種類	交流同期電動機
	最高出力（kW（PS））	80（109）×2
	最大トルク（N･m（kg･m））	260（26.5）×2
燃料	種類	水素
	貯蔵方式	高圧水素タンク
	最高充填圧力（MPa）	35
バッテリー	種類	ニッケル水素電池


604


燃料電池バス
HINO
TOYOTA
FUEL CELL BUS
JHFC


FCHV
10-01
Iwatani
広島332
10-03


New GAS,
New ENERGY
Iwatani
クリーンエネルギー水素
水素ロータリーエンジン車
HYDROGEN RE