



Fuel Cells & Hydrogen in the Economy: Global Developments and Opportunities



International Partnership
for Hydrogen and Fuel Cells
in the Economy

IPHE Outreach and Education Event Gwangju Institute of Science & Technology

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Presentation Outline

Brief Introduction to the IPHE

International Trends and Drivers

Views on the Paths Ahead




















Caveat: Views expressed today are those of the Executive Director of the IPHE and are not those of any specific IPHE member country or organisation.



What is the IPHE?

An inter-governmental partnership that provides a policy oriented forum to share information and collaborate on initiatives to accelerate the cost-effective transition to clean energy and transportation systems that includes using fuel cell and hydrogen (FCHs).

Member partners are doing research, demonstrations and/or implementing policies to increase the use of FCHs in the economy.

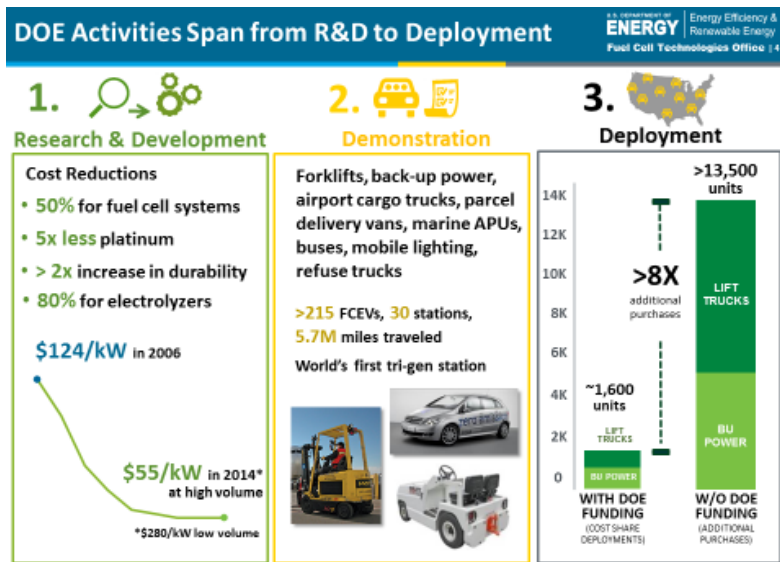
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|--|----------------------------|---|--------------------------|---|---------------------------|
|  | Australia |  | Germany |  | Netherlands |
|  | Austria |  | Iceland |  | Norway |
|  | Brazil |  | India |  | Russian Federation |
|  | Canada |  | Italy |  | South Africa |
|  | China |  | Japan |  | United Kingdom |
|  | European Commission |  | Republic of Korea |  | United States |
|  | France | | | | |



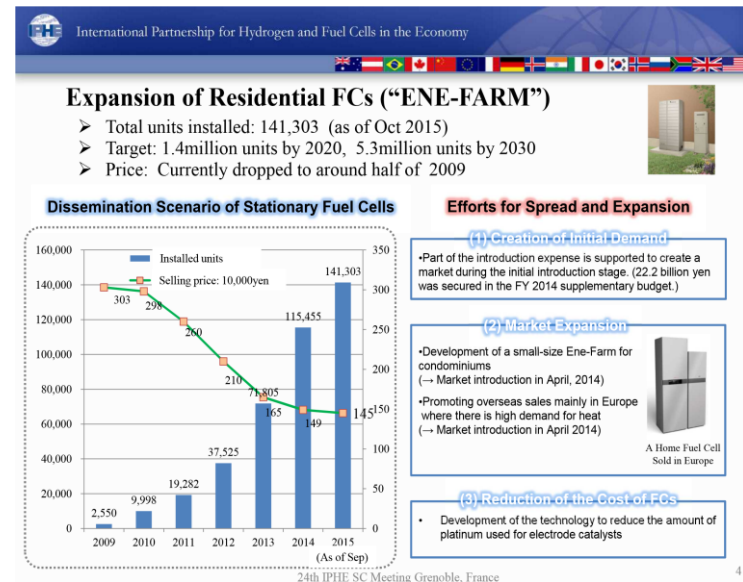
Trends: Significant Cost Reductions

Sustained global research, development, and demonstrations by industry and government have led to a significant level of technology maturity and early market deployment:

- In Japan, more than 180,000 FC-based Combine Heat and Power units are installed;
- Back-up telecom power systems - over 7,800 units shipped or on order in the U.S.;
- In US, over 11,600 warehouse material handling units in operation or on order.



Source: IPHE Workshop *Getting to 2020 & Beyond*, Grenoble France 2015



24th IPHE SC Meeting Grenoble, France



Trends: Role of Demonstrations

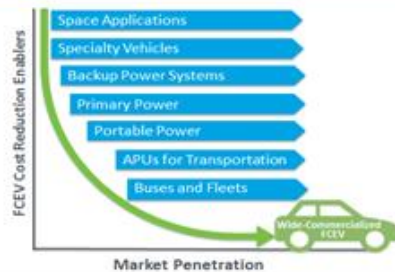
Early market demonstrations from specialty vehicles to backup power systems to fleet applications is crucial in developing the systems and supply chains necessary for broader deployments.

Early Market Strategies Increase Volume

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy
Fuel Cell Technologies Office | 10

Early Markets enable:

- Fuel cell **cost reduction**
- Robust **supply base**
- Emerging **infrastructure**
- Customer **acceptance**



Early Markets Applications Recently Deployed in the U.S.



Fuel Cell Tow Trucks

Fuel Cell Bus Fleets

Forklifts

Backup Power

Source: IPHE Workshop *Getting to 2020 & Beyond*, Grenoble France 2015

International Partnership for Hydrogen and Fuel Cells in the Economy



Country Update China

- A prototype tram powered by hydrogen fuel cells was unveiled at the CSR Sifang factory in Qingdao on March 19, 2015.



- ✓ A three-car tram capable of carrying as many as 380 passengers; Run for 100 km at speeds up to 70 km/h;
- ✓ Additional testing is being completed at CSR Sifang's facility in Qingdao;
- ✓ Foshan city is going to be the first customer, a fuel cell tram line and hydrogen refueling stations are in design.

23rd IPHE SC Meeting Wuhlan, China

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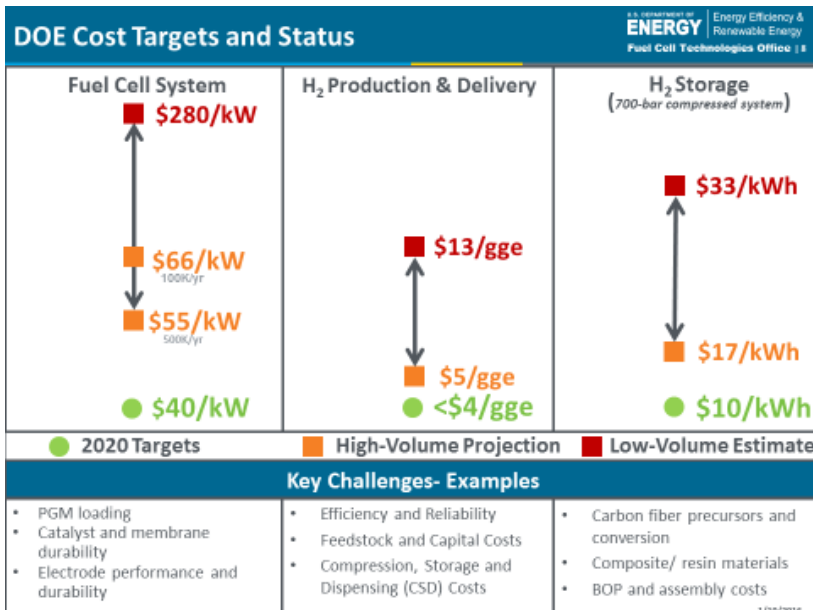


Trends: More Cost Reductions & Market Focus

Need more work across the innovation spectrum

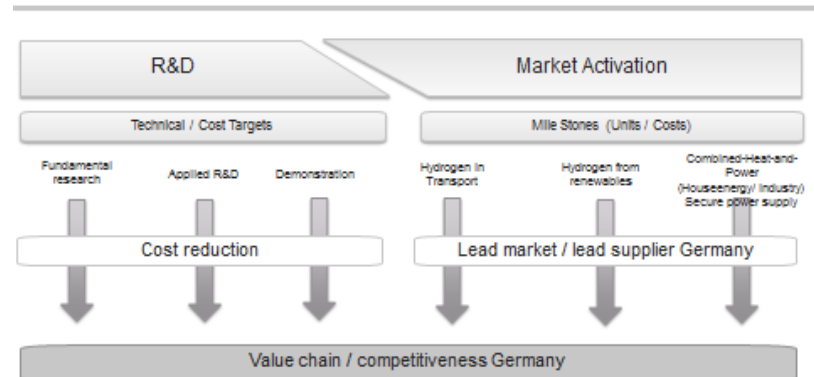
- Cost reductions in the FC system and Hydrogen management

Need internationally consistent market framework structures such as robust technical Codes, Standards and Regulations.



Source: IPHE Workshop *Getting to 2020 & Beyond*, Grenoble France 2015

Continuation of the National Innovation Program Hydrogen and Fuel Cell Technology 2016-2026 Program Structure





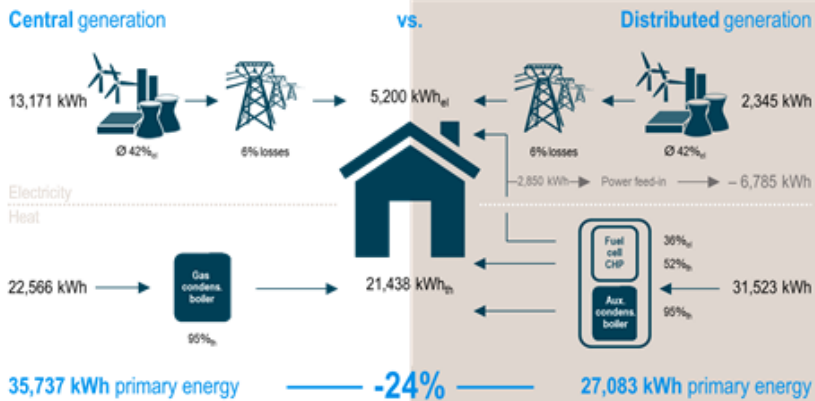
Trends: Increasing Role in Energy Systems

Numerous energy demonstration systems are being implemented to better understand the potential role of hydrogen.

Technical details, efficiency and performance characteristics are being quantified.

Distributed CHP versus central generation

Comparison of central and distributed generation in terms of energy efficiency¹⁾



¹⁾ Exemplary case of a German, partially renovated 1/2-family dwelling in current conditions (2014), total-balance or power-credit methodology
Source: FCH JU Coalition, Roland Berger

Fuel Cell Deployment and the Current Industry Trend

Household/Building

(Household) Forged the FC market through government deployment scheme with a focus on PEMFC (2010-~)

	2010	2011	2012	2013	2014	2015	Total
the number of household	957	292	245	232	207	316	2,249
Deployment capacity (kW)	209	292	245	232	207	313	1,498

(Building) Enlarged the market through government support programs such as, 'Incentive for Building installation', 'Obligation in Public Institutions*', 'Municipal government deployment scheme'

< Incentive for Building installation scheme >

	~2010	2011	2012	2013	2014	2015	Total
the number of Building	14	4	3	10	20	29	80
Deployment capacity (kW)	22	16	53	160	391	278	920

* Obligation of Fuel cell installation scheme (No. of Case/Capacity) : 5 cases/39kW (2014) → 13 cases /168kW (2015)



Trends: Energy & Transport System Integration

Recognition of the longer-term opportunity and need for hydrogen as an integrator.

Significant technical research and economic analysis is necessary to understand the efficient and effective integration of the systems and the business cases to make it happen.



Vast promise, huge challenges

IEA outlines critical steps to advance hydrogen and fuel cells.
30 June 2015

“... In a future energy system largely based on renewable energies, hydrogen could play a pivotal role by connecting different layers of infrastructure to link energy supply and demand. **Hydrogen can enable new energy vectors used to supply transport, buildings and industry by bridging surplus renewable power into the energy demand sectors**”

Source: *Key Point: Energy system today and in the future* IEA



Drivers: National Circumstances

Energy Security

- Security of energy supply with ability to switch sources

Energy Efficiency

- More effective use of variable generation – at grid and at community/facility scale; and,
- A move from centralized to distributed energy generation.

Economic Growth

- Transition of energy and transport systems are leading to new products and supply chains; and,
- Governments (taxpayers) need to realize their R,D&D investments through jobs and economic wealth driven by the private sector.

Environmental Performance

- Climate change goals for energy & transportation systems; and,
- Clean Air obligations (e.g., NO_x, SO_x, Particulates) in Air Sheds.



Drivers: International Policy Commitments

COP 21 Decisions

Universal agreement aiming to keep global temperature rise this century well below 2°C, strive to limit the increase to 1.5°C above pre-industrial levels.

Mission Innovation

Aims to reinvigorate and accelerate global clean energy innovation with the objective to make clean energy widely affordable.

The “Break-through Energy Coalition”

Seeking widely available energy that is reliable, affordable and does not produce carbon by developing new tools to power the world.

Dramatically scaling up public research pipeline linked to patient, flexible investments to developing technologies to create a new energy mix.

Clean Energy Ministerial

Initiatives help reduce emissions, improve energy security, provide energy access, and sustain economic growth.



Paths Ahead

“Stay-the-Course” – Still Need More Fundamentals

- Significant technical developments have been reached but need much more.
- Policy and marketplace frameworks are continuing to evolve with an increasing focus on commercial applications.

“Get-to-Scale” – Niche to Global Markets

- Global events mean a real opportunity to foster momentum to get from demonstrations to real deployment.
- Need for broader engagement and information for decision-makers and stakeholders including building public awareness and understanding.



Questions & Comments

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