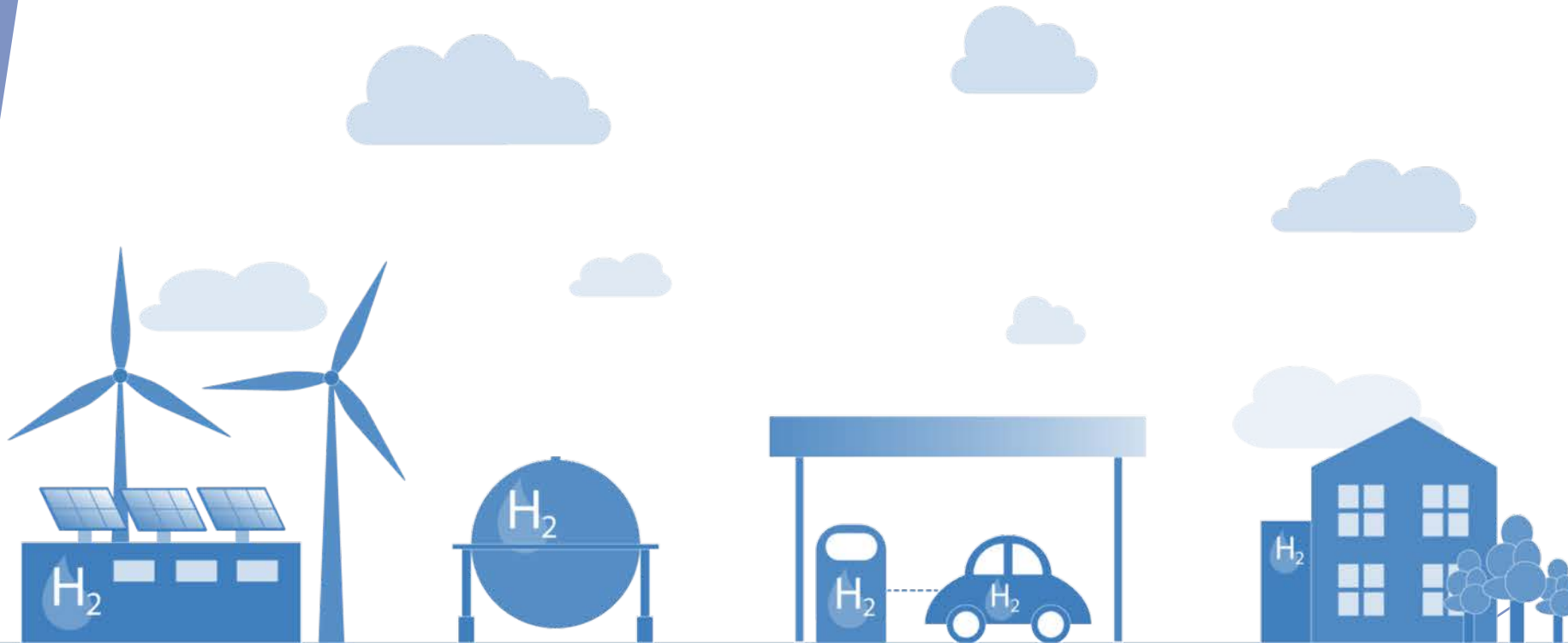


BERGEN ENERGY LAB - 18.09.2019

THE RACE TOWARDS THE HYDROGEN SOCIETY IN JAPAN



Renewable Energy Institute

- ▶ Summer intern at Renewable Energy Institute (REI)
 - ▶ GFI scholarship
 - ▶ Greenstat scholarship



Why hydrogen?

Energy resource scarcity (geography)

The least self-sufficient among
the developed economies

Strong dependency on fossil fuel
imports:

Largest importer of LNG

Second-largest importer of coal

Third-largest net crude oil
importer

Economic competitiveness

High energy prices

Low-emission society

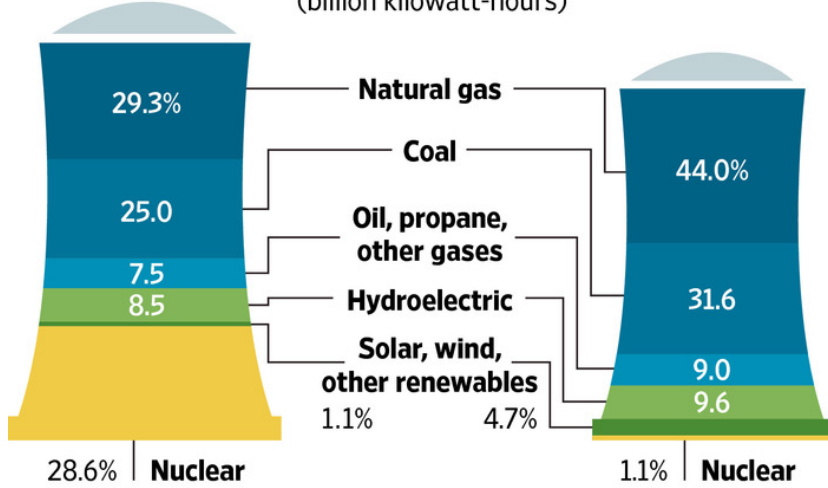


2010

1,007 << TOTAL POWER GENERATED >> 885

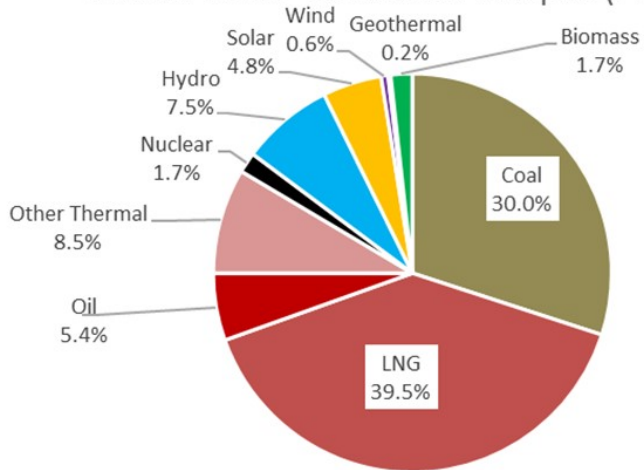
(billion kilowatt-hours)

2015



Source: Federation of Electric Power Companies of Japan THE WALL STREET JOURNAL.

Annual Power Generation in Japan (FY2016)



Source: Estimated by ISEP using METI data

2011 Fukushima disaster: New energy strategy

Nuclear power capacity shut down:

Pre-2011: 30%

Post-2011: 1%

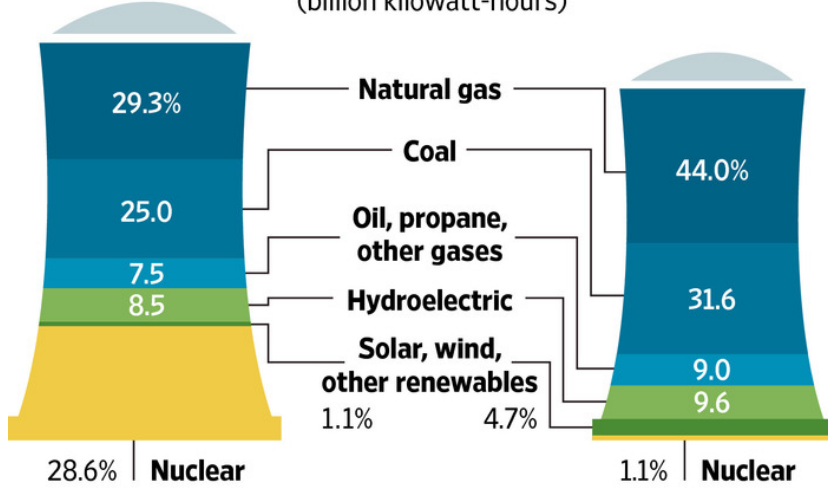
Now increasing: 20-22% by 2030

Self-sufficiency: 6% in 2012

Today: 89% import to cover primary energy demand - oil, gas and coal

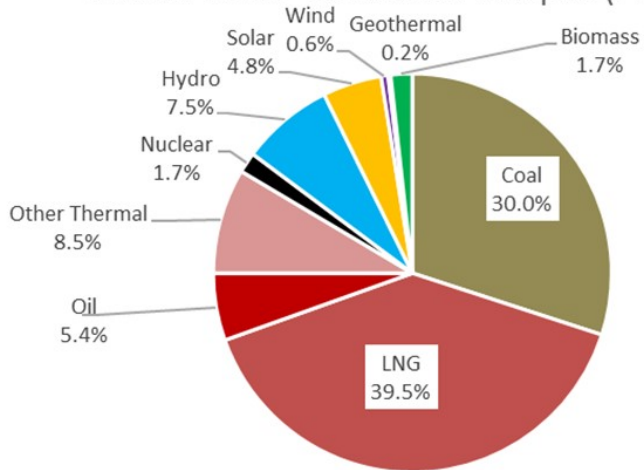
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Annual Power Generation in Japan (FY2016)



Source: Estimated by ISEP using METI data

Fukushima disaster: New energy strategy

Modest growth in hydropower and renewables

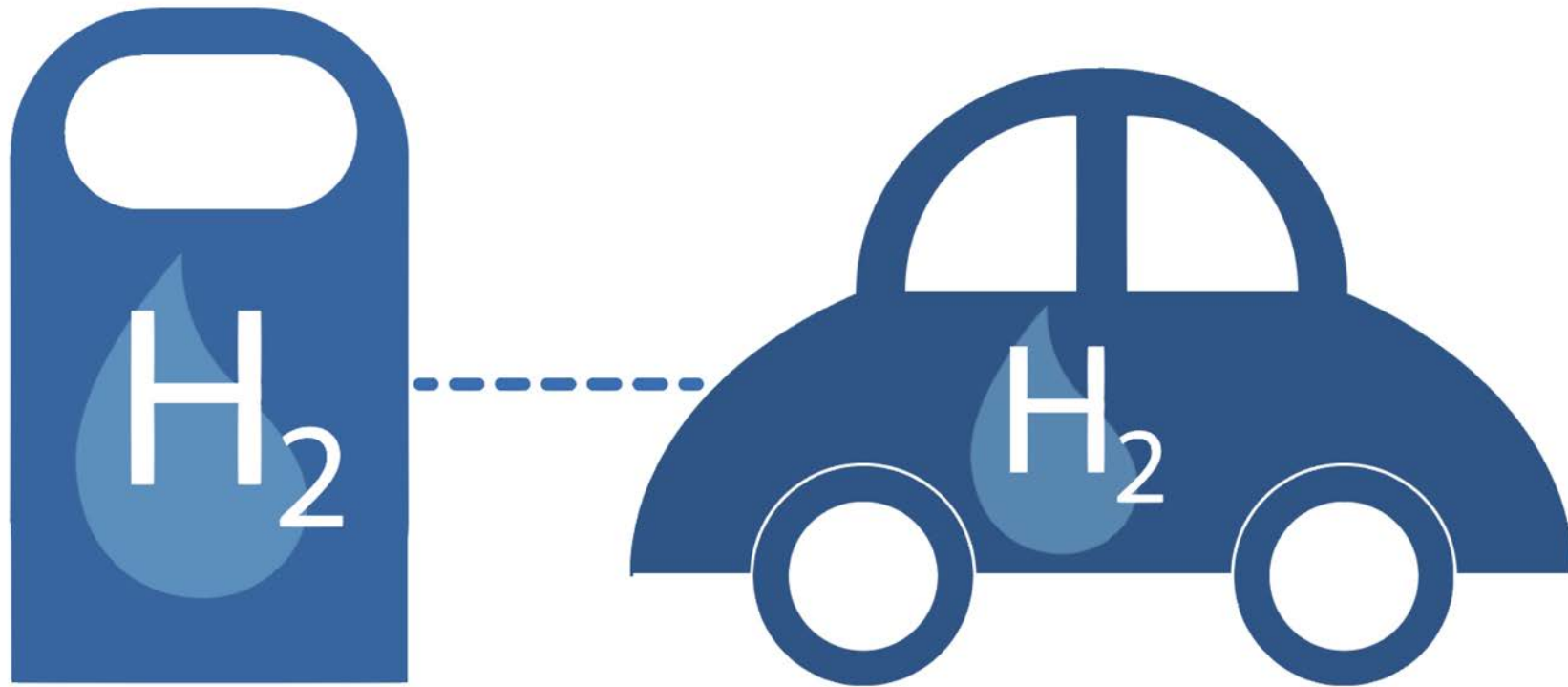
2012 FiT system: increase in renewables (solar)

Renewable electricity generation in Japan: 18% → 22-24% by 2030

World frontrunner in energy efficiency:

One of the lowest energy-intensive economies

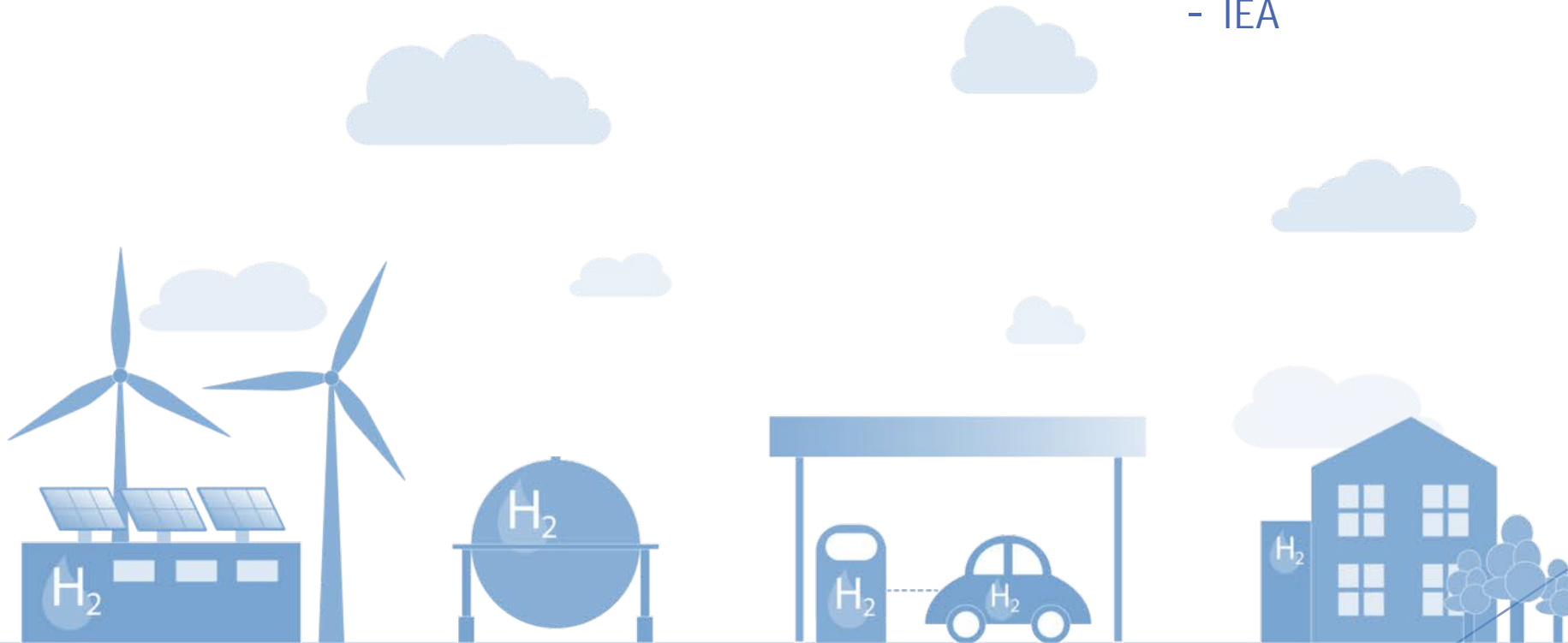
Energy-conscious population



Hydrogen society - can it be done?

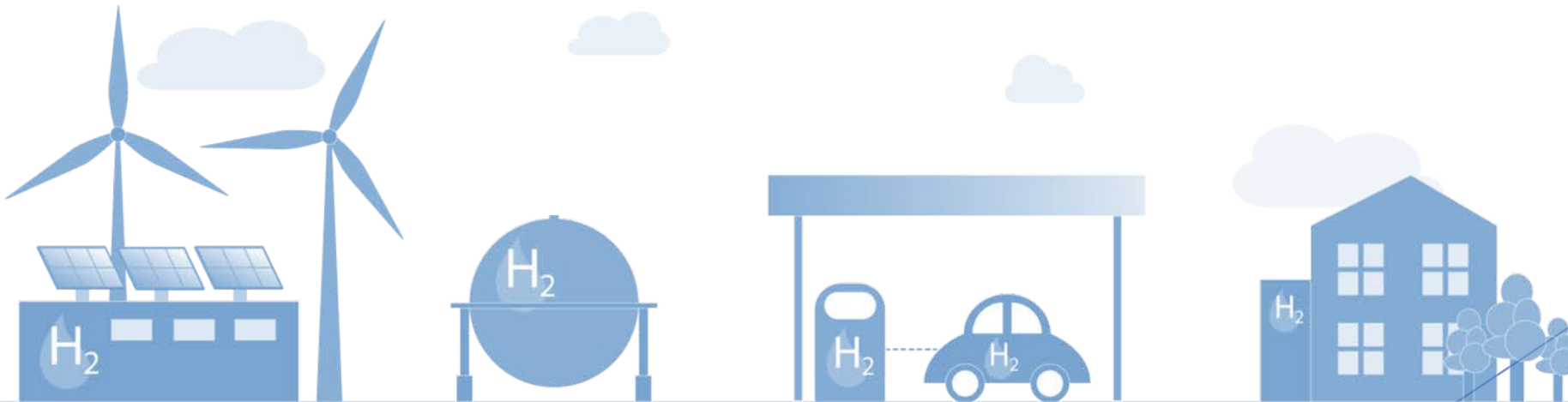
«Hydrogen with a low-carbon footprint has the potential to facilitate significant reductions in energy-related CO₂ emissions and to contribute to limiting global temperature rise to 2°C»

- IEA



Benefits of hydrogen

- ▶ Flexible energy carrier
 - ▶ Can be produced locally from renewables - solution for intermittency issues
 - ▶ Can effectively be transformed into energy forms for diverse end-use applications
- ▶ Green hydrogen (no carbon footprint): electrolysis of water driven by renewables
- ▶ Use: Energy storage, long distance transport and clean energy generation



«The most
successful fuel cell
commercialization
program in the
world»



ENE-FARM:

Residential fuel cell cogeneration system

- ▶ Hydrogen is extracted from natural gas and reacts with oxygen to generate electricity
- ▶ Surplus heat used for heating water
- ▶ System energy efficiency: 95%
 - ▶ Power grid: 35-40%



- ▶ Collaboration between Panasonic and Tokyo gas

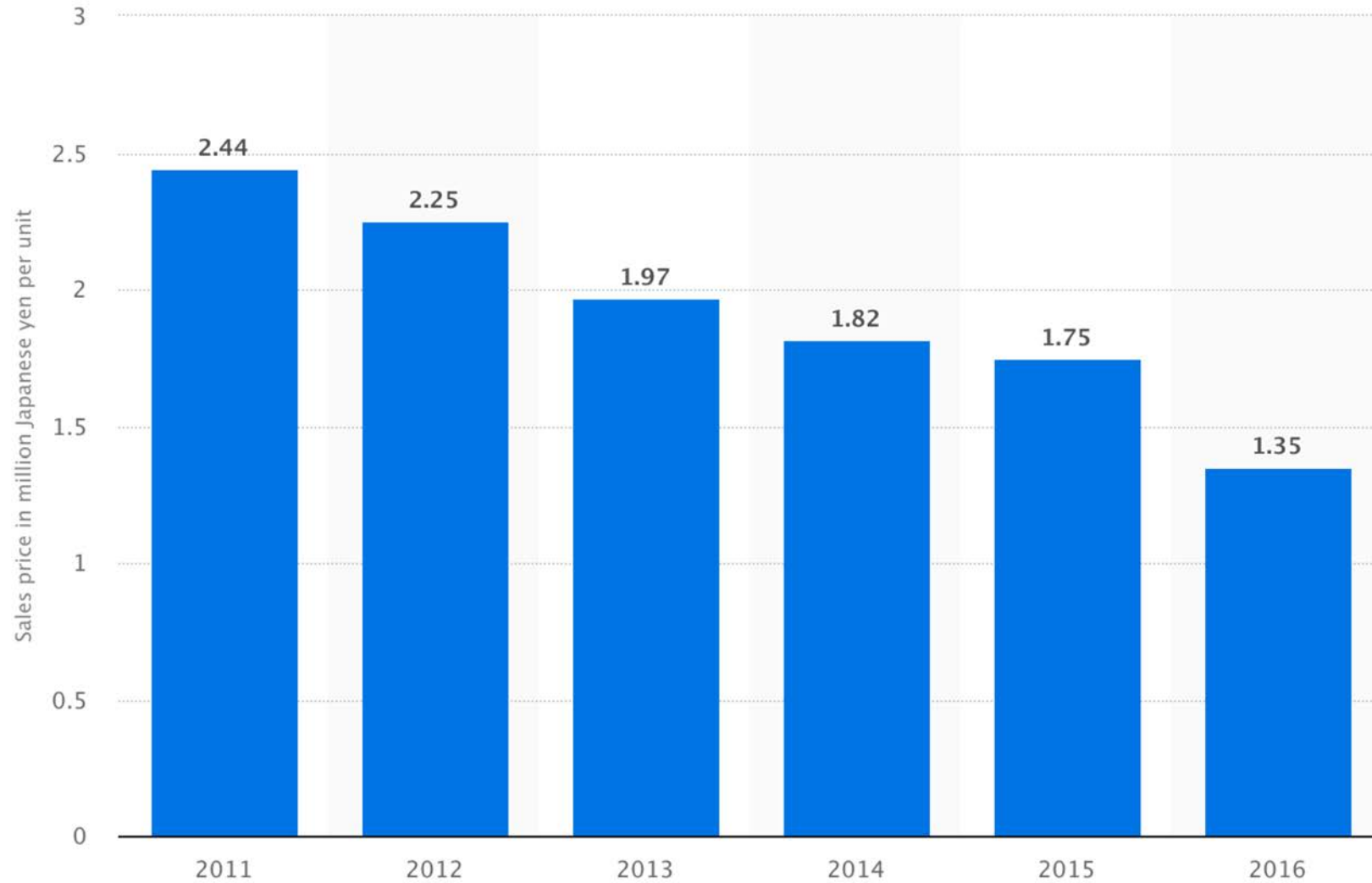
- ▶ 1999: funding for fuel cell research
- ▶ 2005: Launch of demonstration program of 3,300 ENE-FARM units

- ▶ Government support

- ▶ 2016: subsidies covered half of the ENE-FARM unit costs
- ▶ ENE-FARM installations have doubled annually
 - ▶ 2017: 120,000 units
 - ▶ 2020: 300,000 units
- ▶ Now: cheaper, smaller and more efficient



Sales price of ENE-FARM systems (2011-2016)



ENE-FARM:

success going abroad

- ▶ Panasonic R&D-center in Germany in 2011
 - ▶ Develop fuel cells for the European market
 - ▶ Existing gas infrastructure
- ▶ Clean fuel cells: generate power directly from H₂
 - ▶ Hydrogen infrastructure needed to support the next generation of residential fuel cells



Hydrogen in transport



Hydrogen in transport

- ▶ Ministry of Economy, Trade and Industry (METI): 2040 roadmap towards the hydrogen society
- ▶ Japan H₂ Mobility (JHyM): collaboration between 11 companies, including Toyota, Air Liquide Japan and Development Bank of Japan
 - ▶ Accelerate market uptake of hydrogen vehicles → infrastructure development



Hydrogen economy

▶ Barriers:

- ▶ Cost of hydrogen production
- ▶ Cost of operating fuelling stations
 - ▶ Also seen here in Norway: Hyop closing down 5 stations after 7 years - 2 left in Norway

▶ Drivers

- ▶ Infrastructure: fuelling stations
- ▶ Increase attraction of hydrogen vehicles
- ▶ Increase population knowledge

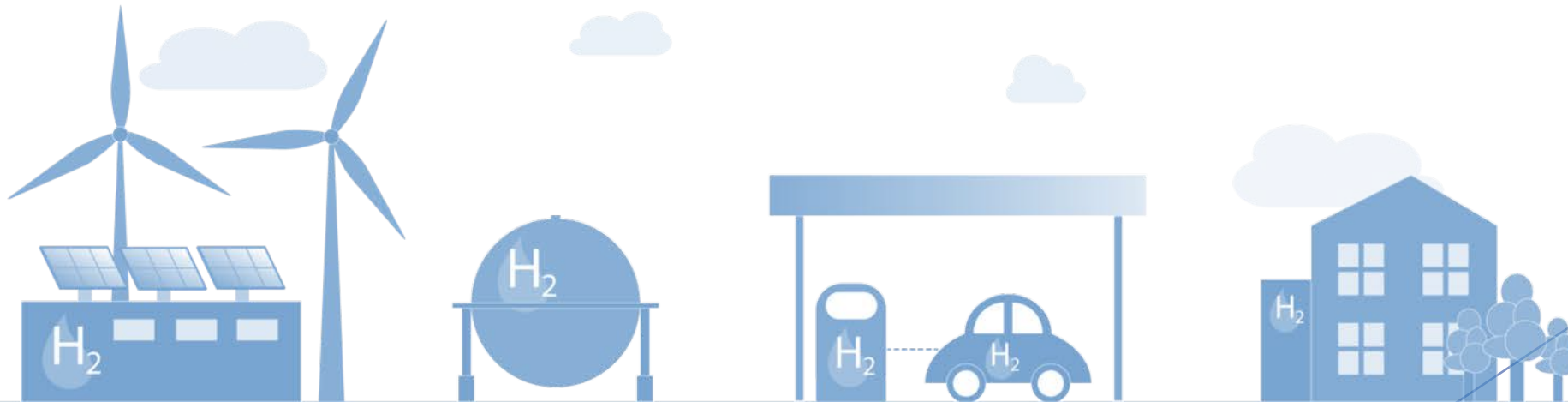


Hydrogen
museum to
educate the
population...



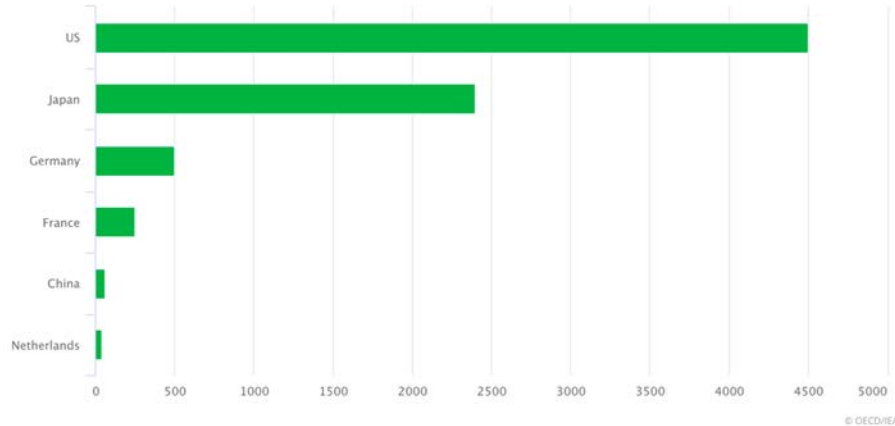
Tokyo 2020 Olympics

- ▶ Tokyo Metropolitan Government: realize hydrogen society for the 2020 Tokyo Olympic games.
- ▶ Tokyo Metropolitan Government: realize hydrogen society for the 2020 Tokyo Olympic games.
- ▶ Olympic villages and means of transportation powered by fuel cell technology



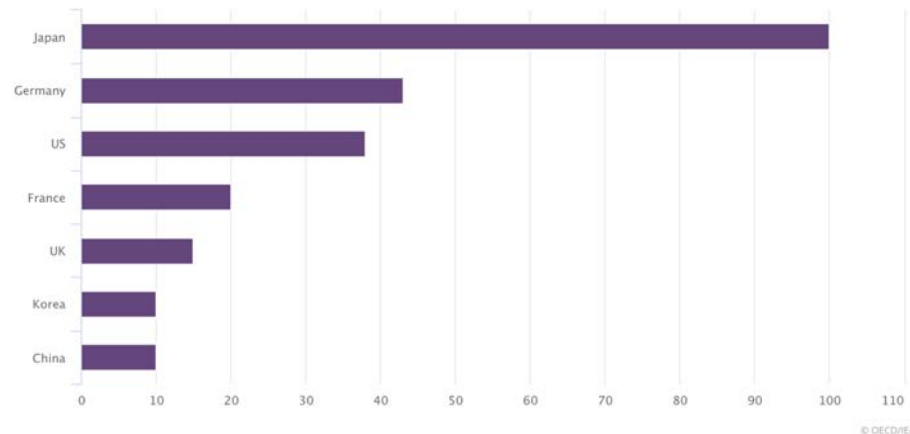
Stock of Fuel Cell Electric Vehicles (FCEVs) in 2017

The US is the world leader in fuel cell vehicle deployment...



Hydrogen fuelling stations by country, 2017

...but Japan has more than twice as many fuelling stations.



Tokyo 2020 Olympics

- ▶ 2020 targets:
 - ▶ Fuel cell cars
2000 → 40,000
 - ▶ Fuel cell buses
2 → 100
 - ▶ Hydrogen fuelling stations
100 → 160
- ▶ Costs have been ignored
 - ▶ Cost efficient development for several sectors in the long term
 - ▶ Public transportation

Horizon2020: Energy Observer



- ▶ Autonomous hydrogen vessel
- ▶ Emission free
- ▶ Electric-propelled by RE and carbon-free hydrogen made from seawater
- ▶ Tokyo 2020

Tokyo Study Trip, october 2017: Hydrogen boat



- ▶ Hydrogen fuelled boat project led by Dr. Etsuro Shimizu, TUMSAT
- ▶ Technology to be used for tourist sightseeing boats in Tokyo bay for 2020 Olympics

Possibilities for Norway

- ▶ Green hydrogen: too expensive to produce in Japan
- ▶ Race between Norway and Australia to supply hydrogen to Japans energy transition
 - ▶ Australia: coal
 - ▶ Norway: hydropower



Possibilities for Norway

- ▶ Svein Grandum, Innovation Norway: Norwegian companies are attractive partners for Japan
 - ▶ Norwegian suppliers can contribute to infrastructure development and deliver green hydrogen
- ▶ Seiichiro Kimura (REI): good opportunities for foreign companies
 - ▶ Electrolysis technology not efficient enough (NEDO)

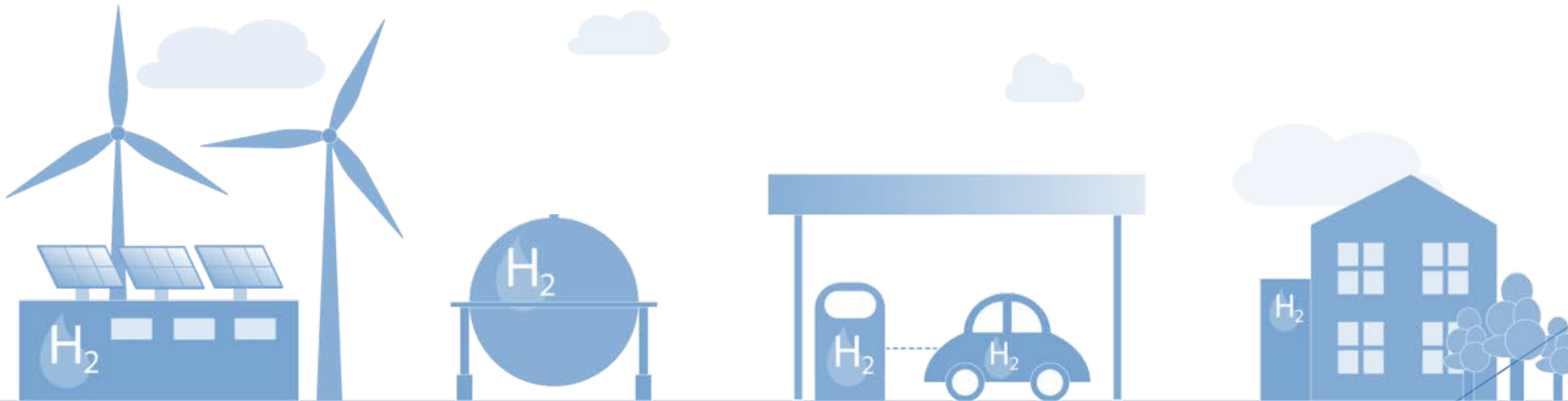


Hydrogen critics are coming around

- ▶ Risk related to the rate of the market uptake of hydrogen vehicles and hydrogen demand
- ▶ The IEA estimates that 150 million hydrogen vehicles will be on the global market by 2050
 - ▶ Infrastructure costs estimated at 900-1900 dollars for each vehicle.

«The government is a strong supporter of the commitment to the hydrogen society- they see it as a key technology for the future»

Takuro Kobashi (REI)



THANK YOU FOR YOUR
ATTENTION!

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