22nd EFA-Roundtable 12/13-10-2023 Brussels

12 Years after Fukushima: The Japanese Energy Policy – Energy Transition with a different approach?

Japan's Proclamation of a „Hydrogen Society"

Dipl.-Ing. Kurt K. Heinz
„TÜV emeritus", Tokyo

Heinz2-O Stiftung Foundation 財団法人
hin zur Wasserstoffgesellschaft
towards the Hydrogen Society
水素社会へ
クルト ケイ ハインツ
Dipl.-Ing. Kurt K. Heinz
President 取締役社長
Office Germany TEL +49 173-452-0731
Office Japan TEL +81 90-3086-0444
kurtkheinz@gmail.com Heinz2-O Foundation

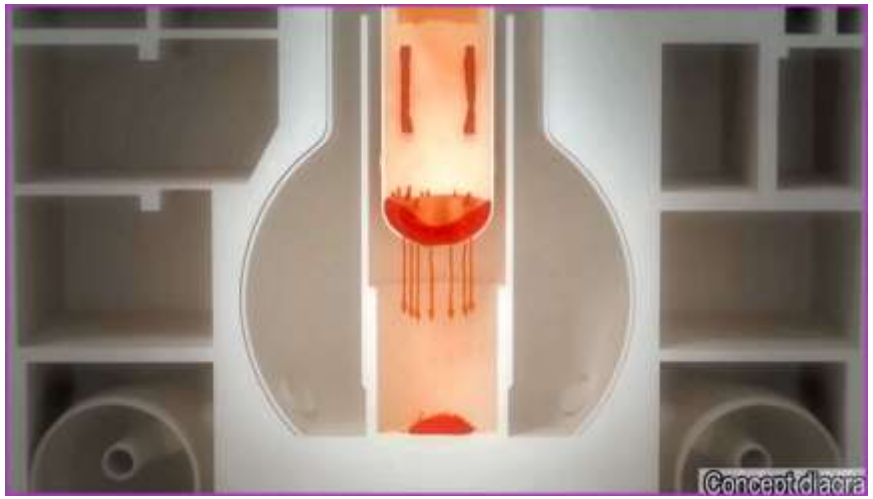
想定外

sō tei gai

thinking - permanent - outside of

unimaginable

Die japanische Energiepolitik - Ist Wasserstoff die Lösung?



Melted dreams
or
Nightmare for 200 years?

Hydrogen Society

- *METI Program*
- *Current status of the energy transition in Japan*

1000 huge water tanks

Fukushima Daiichi, June 2018

Countless bags full of contaminated soil

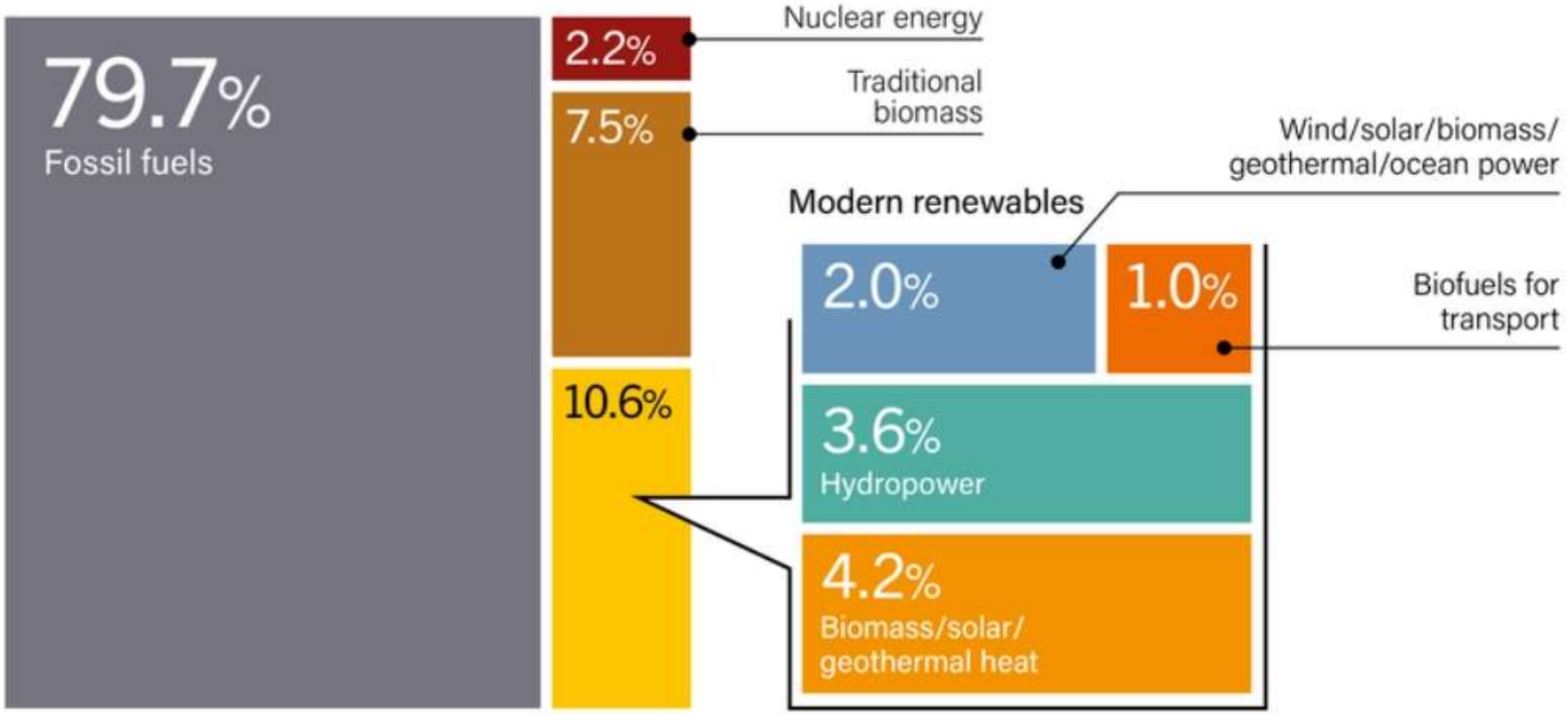
Japan's aging nuclear power infrastructure

(reactors used for at least 30 years)

	REACTOR *(PREFECTURE)*	POWER OUTPUT *(IN MILLIONS OF KILOWATTS)*	YEARS OF USE
Kansai Electric Power	**Oi No. 1** *(Fukui)* → To be scrapped	1.18	38
	Oi No. 2 → To be scrapped	1.18	37
	Takahama No. 1 *(Fukui)* → Life to be prolonged	0.83	42
	Takahama No. 2 → Life to be prolonged	0.83	41
	Takahama No. 3	0.87	32
	Takahama No. 4	0.87	32
	Mihama No. 3 *(Fukui)* → Life to be prolonged	0.83	40
Other utilities	**Japan Atomic Power** Tokai No. 2 *(Ibaraki)*	1.10	38
	Kyushu Electric Power Genkai No. 2 *(Saga)*	0.56	36
	Shikoku Electric Power Ikata No. 2 *(Ehime)*	0.57	35
	Tokyo Electric Power Fukushima Daini No. 1 *(Fukushima)*	1.10	35
	Tokyo Electric Power Fukushima Daini No. 2	1.10	33
	Tohoku Electric Power Onagawa No. 1 *(Miyagi)*	0.52	33
	Kyushu Electric Power Sendai No. 1 *(Kagoshima)*	0.89	33
	Tokyo Electric Power Fukushima Daini No. 3	1.10	32
	Tokyo Electric Power Kashiwazaki-Kariwa No. 1 *(Niigata)*	1.10	32
	Kyushu Electric Power Sendai No. 2	0.89	31
	Japan Atomic Power Tsuruga No. 2 *(Fukui)*	1.16	30
	Tokyo Electric Power Fukushima Daini No. 4	1.10	30
	Chubu Electric Power Hamaoka No. 3 *(Shizuoka)*	1.10	30

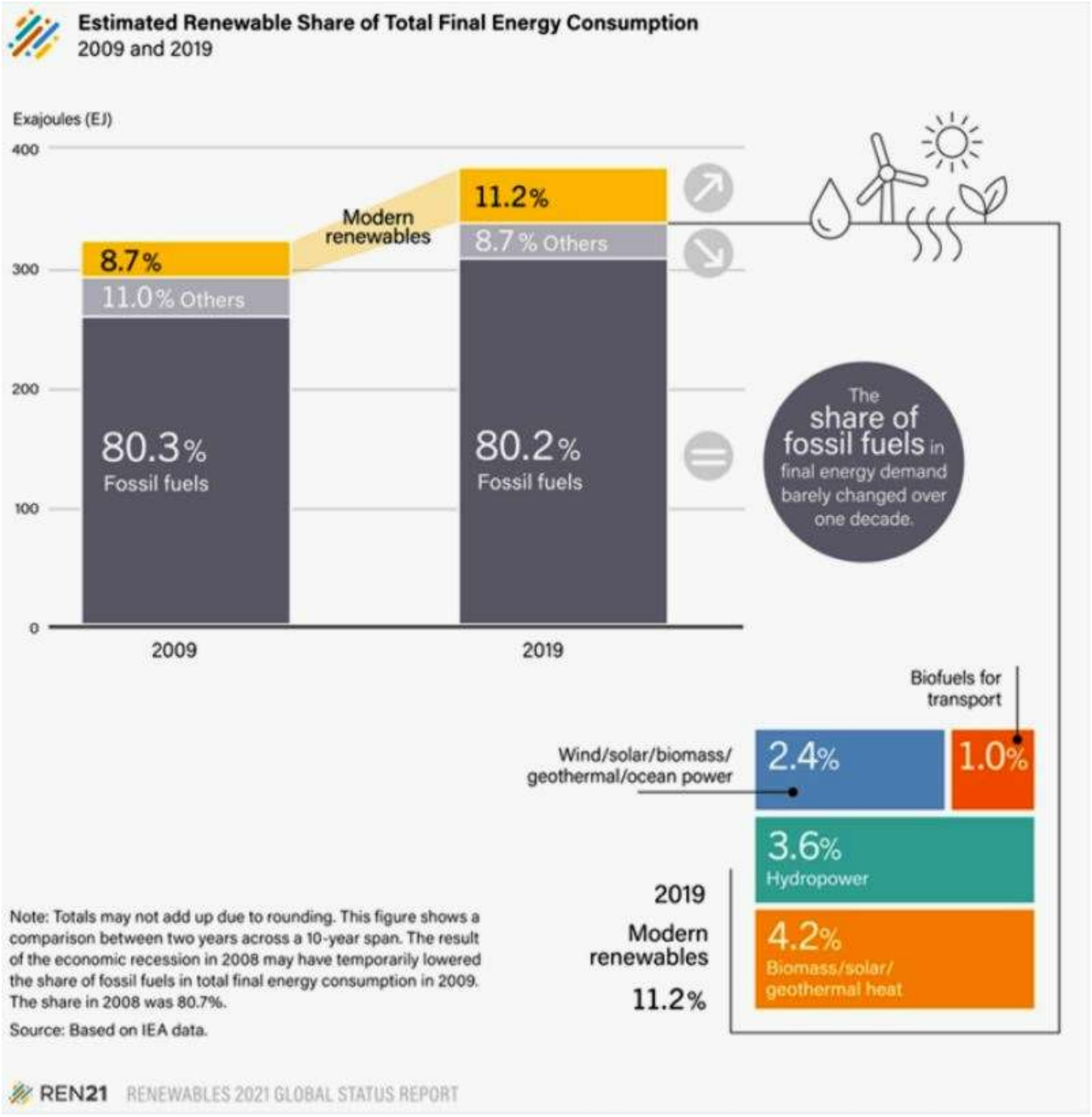
As of October 2017

Estimated Renewable Share of Total Final Energy Consumption, 2017



Note: Data should not be compared with previous years because of revisions due to improved or adjusted data or methodology. Totals may not add up due to rounding.

Source: Based on OECD/IEA and IEA SHC.


Estimated Renewable Share of Total Final Energy Consumption
2009 and 2019
Exajoules (EJ)
400
300
200
100
0
8.7%
11.0% Others
80.3%
Fossil fuels
2009
Modern renewables
11.2%
8.7% Others
80.2%
Fossil fuels
2019
The share of fossil fuels in final energy demand barely changed over one decade.
Biofuels for transport
1.0%
Wind/solar/biomass/ geothermal/ocean power
2.4%
3.6%
Hydropower
2019
Modern renewables
11.2%
4.2%
Biomass/solar/ geothermal heat
Note: Totals may not add up due to rounding. This figure shows a comparison between two years across a 10-year span. The result of the economic recession in 2008 may have temporarily lowered the share of fossil fuels in total final energy consumption in 2009. The share in 2008 was 80.7%.
Source: Based on IEA data.
REN21
RENEWABLES 2021 GLOBAL STATUS REPORT

(1 ton of Hydrogen ~ 33,33MWh energy)

H_2 Demand

12Mio. tons	**~ 400TWh**	**Japan**	**2040**
	1200TWh	**EU + GB**	**2040**

H_2 in Germany:

Planning as of 2022:	**100 – 200TWh**	**2040**
new since July 25, 2023:	**95 – 130 TWh**	**2030**
	400 – 500TWh	**2045**

Primary energy consumption in 2020

(**Peta** (P) for 1 Billiard = 1,000,000,000,000,000 = 10^{15})

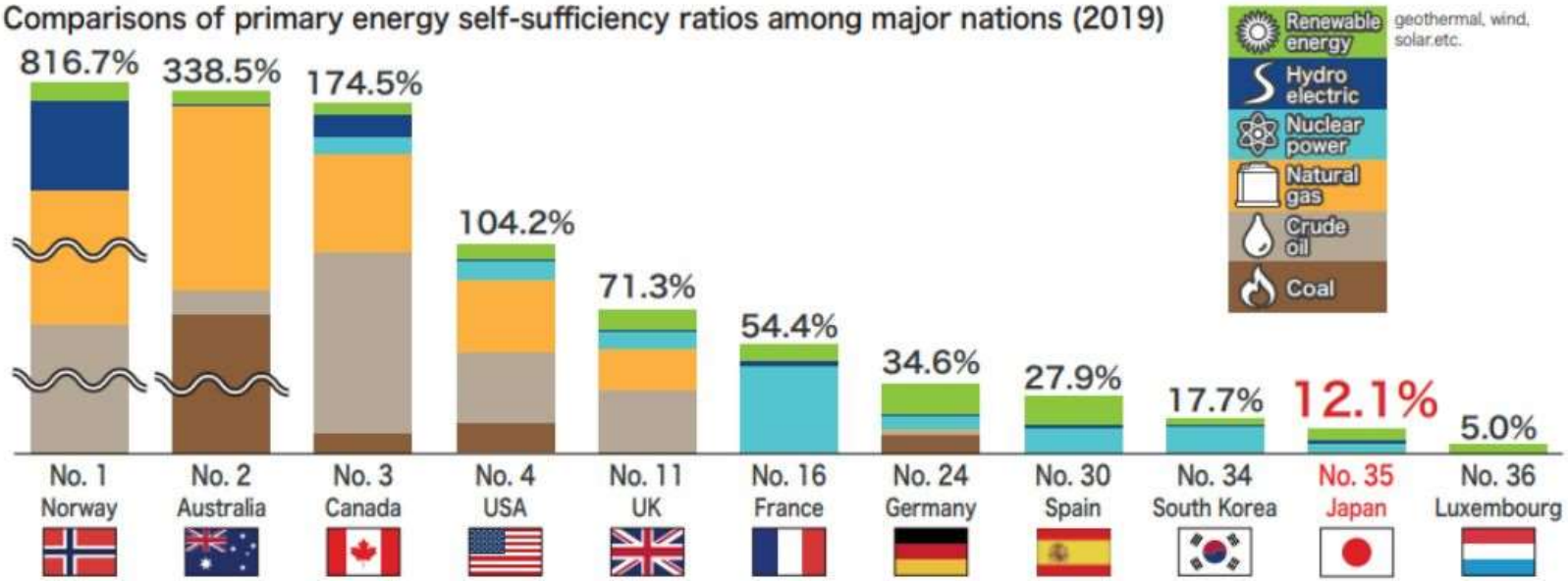
World:	**160PWh**	
Germany:	**3.5PWh**	(2,2% of World consumption)
Japan:	**4.7PWh**	(2,9% of World consumption)

In comparison:

German Electrical Energy consumption in 2021: 0.49PWh (15%)

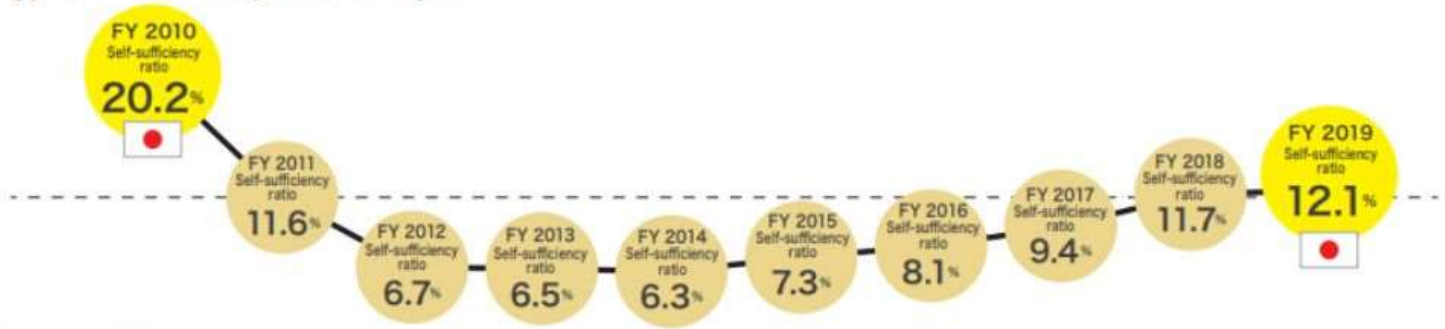
METI
Agency for Natural Resources and Energy

Comparisons of primary energy self-sufficiency ratios among major nations (2019)



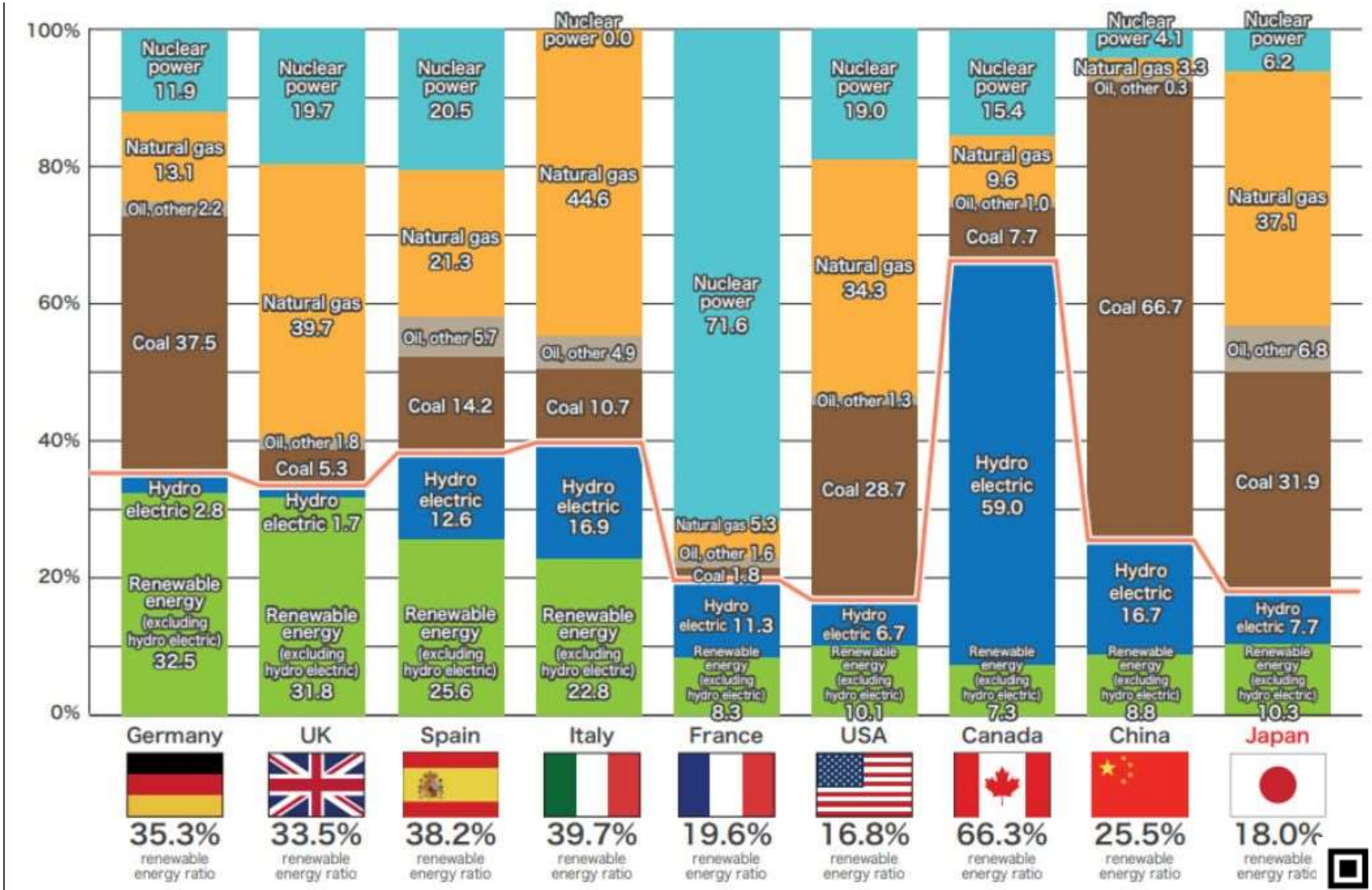
Source: Estimates for 2019 from IEA "World Energy Balances 2020", except for data for Japan, which are confirmed values of FY 2019, derived from "Comprehensive energy statistics of Japan", Agency for Natural Resources and Energy. ＊ The ranks in the table are those of the 36 OECD member countries.

Energy self-sufficiency ratio in Japan



Primary energy sources: Primary forms of energy, including oil, natural gas, coal, nuclear power, solar power, and wind power.
Energy self-sufficiency rate: The percentage of the primary energy resources required for people's daily life and economic activities which can be produced or acquired in their own country.

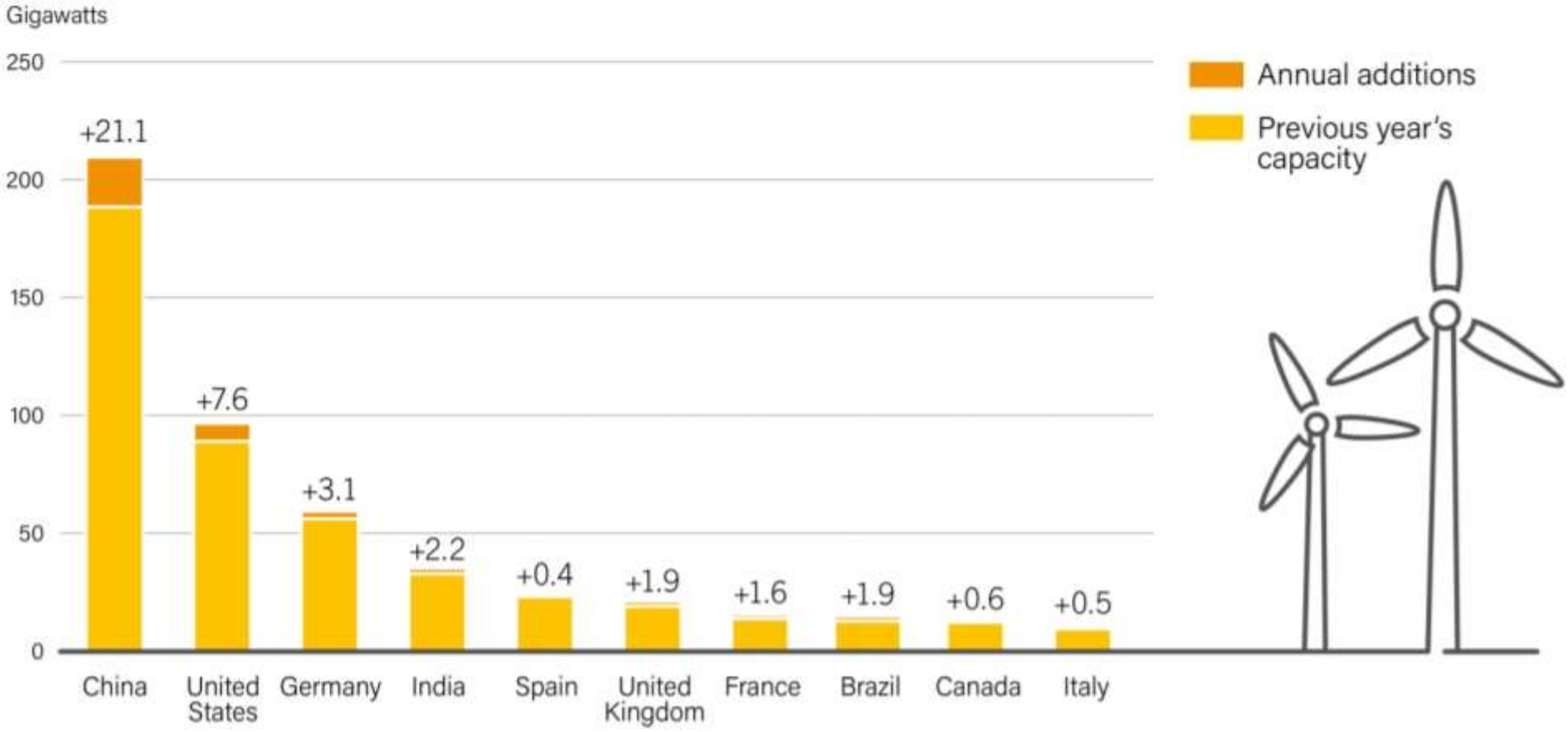
Comparison of percentages of renewable energy in total electric power generation in major nations (Percentage of total generated power), 2020



Source: Created by the Agency for Natural Resources and Energy based on IEA Data Services and other data published by respective countries

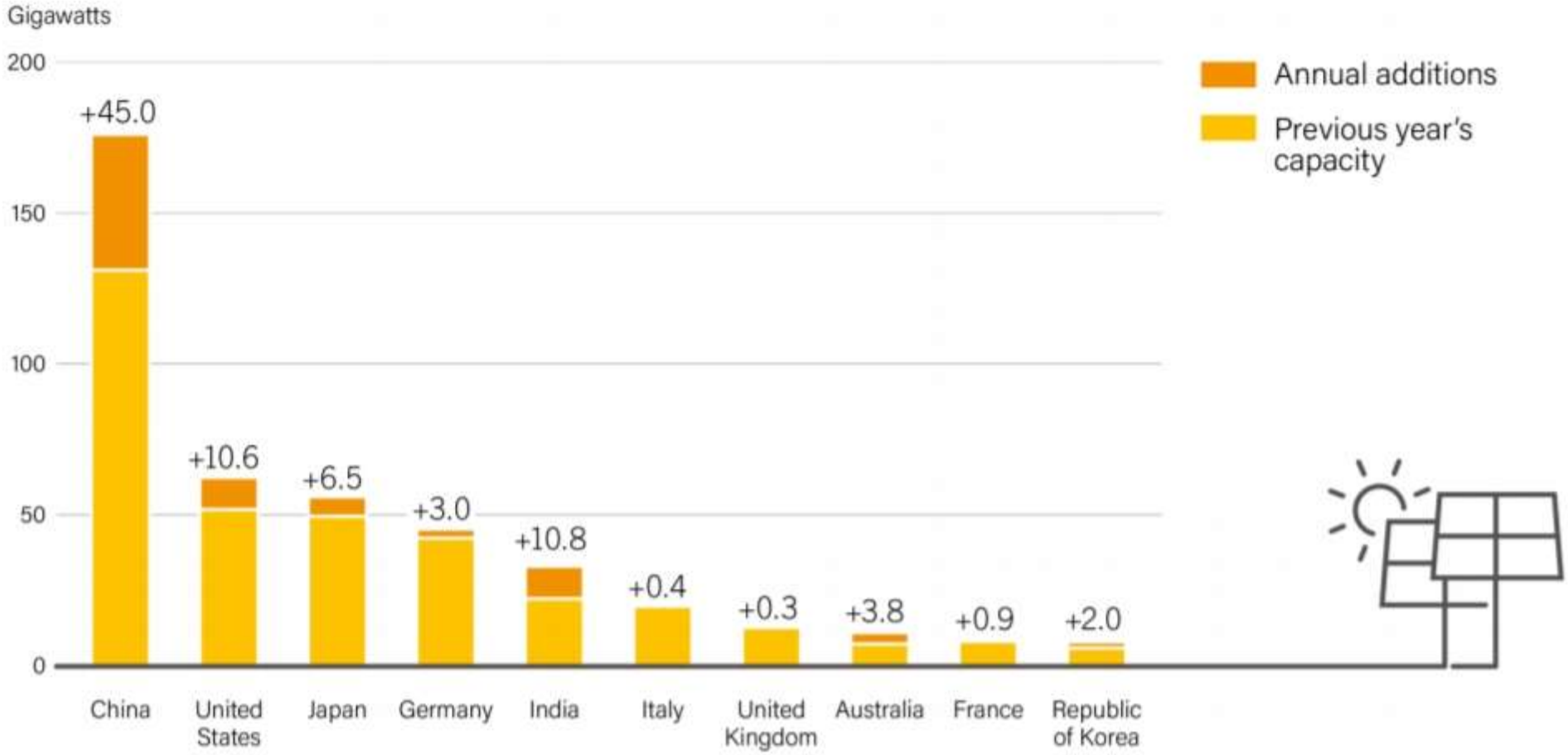
https://www.enecho.meti.go.jp/en/category/special/article/detail_172.html

Wind Power Capacity and Additions, Top 10 Countries, 2018



Note: Additions are net of decommissioning.

Solar PV Capacity and Additions, Top 10 Countries, 2018



Note: Data are provided in direct current (DC).
Data for India are highly uncertain.

Hydrogen Society / 水素社会
or End of the “fossil fuel culture“

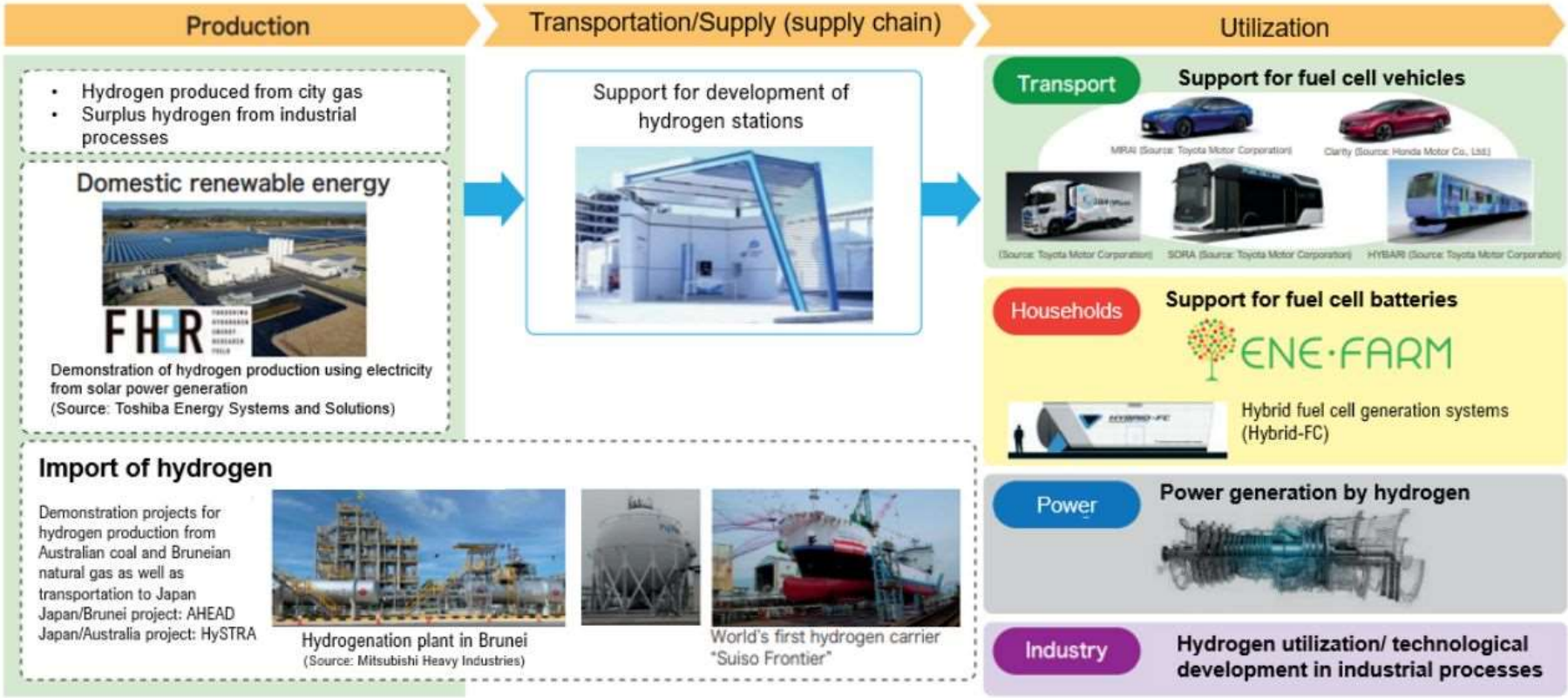
The government acts (Japan Times/Kyodo News)

Prime Minister Shinzo Abe asked ministers on Tuesday (April 11, 2017) to formulate by the end of the year a fundamental strategy for creating a zero-emissions "hydrogen society", while making greater efforts to increase the use of renewable energy.

METI: Efforts toward realizing a hydrogen-based society

„Hydrogen Society“

(as of 2020)



https://www.enecho.meti.go.jp/en/category/special/article/detail_172.html

2019

Challenges for Japan's Energy Transition

- Basic Hydrogen Strategy -

June 24

Masana Ezawa
Director, Hydrogen and Fuel Cell Strategy Office,
Ministry of Economy, Trade and Industry (METI), Japan

Mission/ Background

METI
Ministry of Economy, Trade and Industry

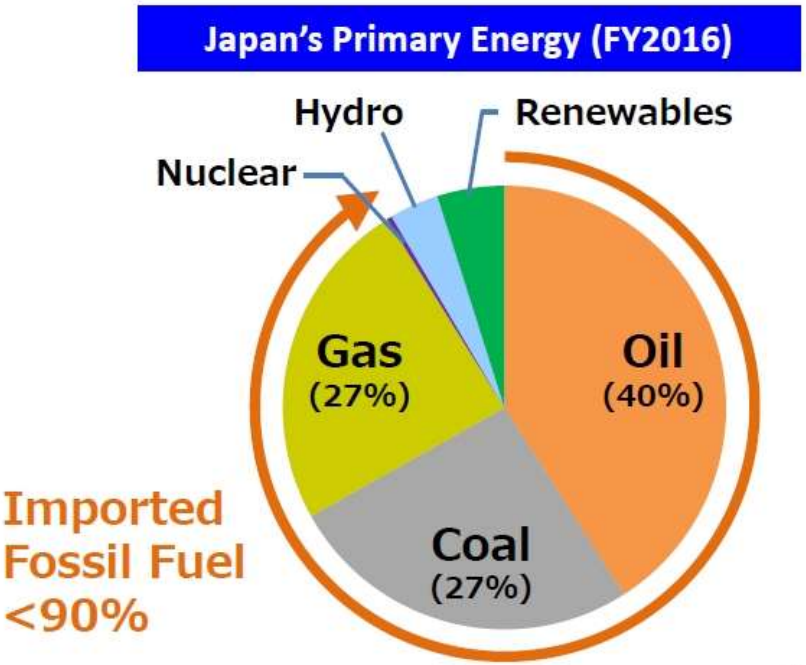
- **Japan's Responsibility for Energy Transition**

  ⇔ **Energy trilemma**

  - ✓ **E**nergy security
  - ✓ **E**nvironment (Sustainability)
  - ✓ **E**conomic affordability (Cost)

  } **3"E"** + **S**afety

- **Measures;**
  - ✓ Energy saving
  - ✓ Renewable energy
  - ✓ Nuclear energy
  - ✓ CCS + Fossil fuels
  - ✓ **Hydrogen**



Strategy

- **"Basic Hydrogen Strategy" (Prime Minister Abe's Initiative)**
  - ✓ **World's first national strategy**
  - ✓ **2050 Vision: position H_2 as a new energy option** (following Renewables)
  - ✓ **Target: make H_2 affordable** ($3/kg by 2030 ⇒ $2/kg by 2050)

3 conditions for realizing affordable hydrogen

【Supply】 ① **Inexpensive feedstock** (unused resources, renewables)
② **Large scale H_2 supply chains**
【Demand】 ··· ③ **Mass usage** (Mobility ⇒ Power Generation ⇒ Industry)

- **Key Technologies to be Developed**

Production	Transportation	Use
• Electrolysis System • Gasification + CCS	• Energy Carrier (LH_2, MCH, NH_3, etc.)	• Fuel Cells (Mobility, Generation) • H_2-fired Generation

Direction of Activities to Realize a "Hydrogen Society"

Production

Domestic fossil fuels
- City gas
- LP gas
- Reforming
- Byproduct hydrogen

Future

Overseas unused energy
- Brown coal → Gasification → CCS
- Byproduct hydrogen
- Overseas renewable energy → Water electrolysis

Renewable energy
- Solar power
- Wind power
- Water electrolysis

*Use hydrogen as a means of energy storage (absorb fluctuations in intermittent RES)

- Demonstration of large-scale power-to-gas @Fukushima/aiming for use in the 2020 Tokyo Olympic and Paralympic Games

Transportation and supply (supply chain)

- City gas pipeline/LPG supply network
- Liquefied hydrogen lorry
- Hydrogen pipeline

- Installation of 113 stations nationwide
- Promotion of regulatory reform for cost reduction

Hydrogen station

- Demonstration of the world's first international hydrogen supply chain in 2020

Large-scale hydrogen ocean Transportation network

Use

Transportation

- 2,900 vehicles installed
- 40,000 vehicles by 2020

Fuel cell vehicles (FCV, FC bus, etc.)

- Entered service in Tokyo in March 2017
- 100 buses by 2020

Power generation

- Over 270,000 units installed

Fuel cell cogeneration (e.g. Ene-Farm)

Reforming

- For Business and Industry use, some models have already been launched in 2017

Future

Hydrogen power generation (CO_2-free thermal power plants)

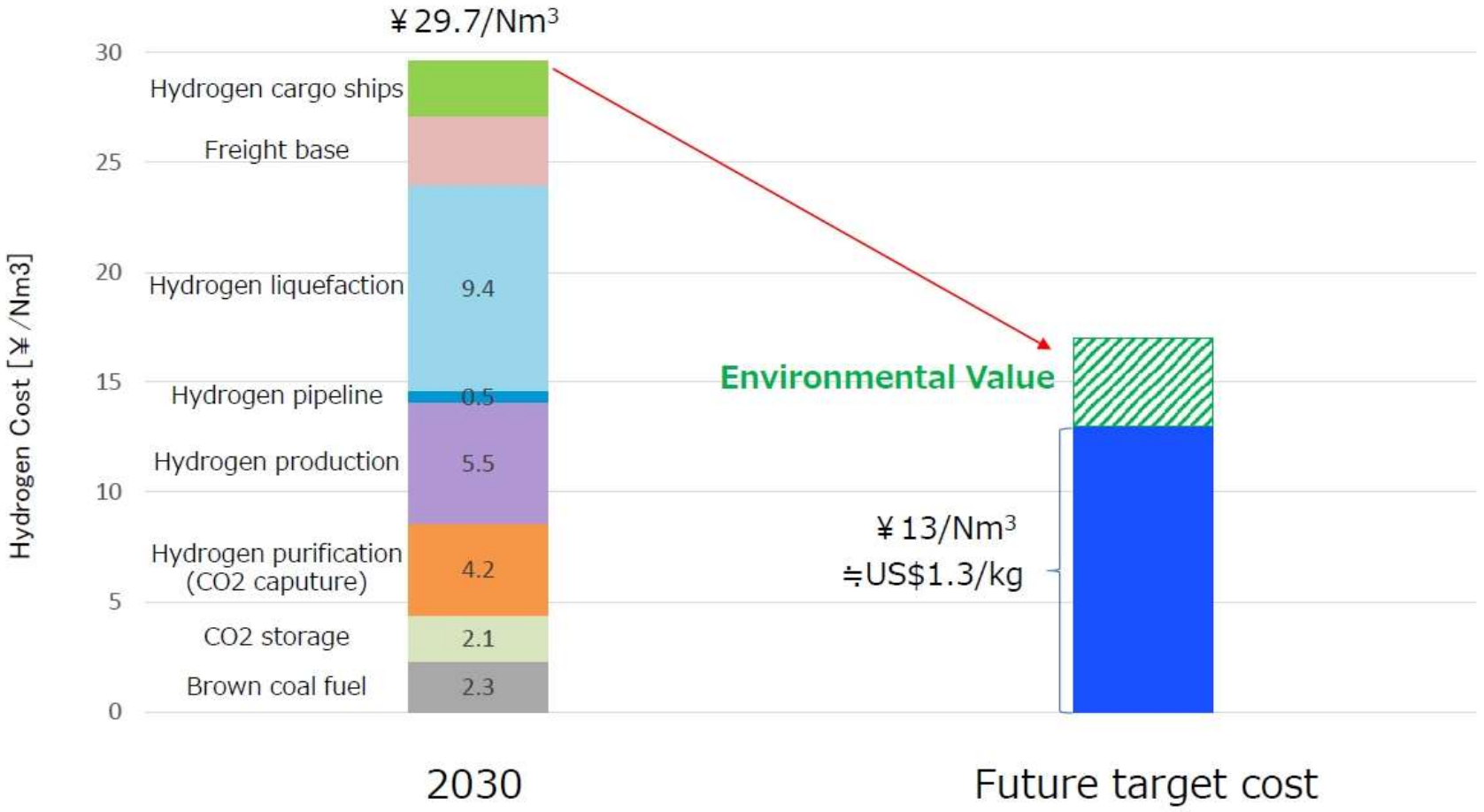
- Combined heat and power supply using hydrogen cogeneration in Kobe in early 2018

Other

Use in the industrial sector (Power-to-X)

Hydrogen Cost Perspective of the Supply Chain Project

- Target cost of hydrogen supply in 2030 is ¥30/Nm^3.
- Natural gas price is unpredictable, however further cost reduction is needed.



Ongoing Projects (Supply-side)

METI
Ministry of Economy, Trade and Industry

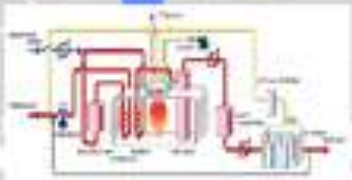
International H_2 Supply Chain

Japan-Brunai Pilot Project

2020~ AHEAD

Off-gas

Steam Methane Reforming



Hydro-genation*
(TOL→MCH)

Chemical Tanker

Dehydro-genation*
(MCH→TOL)

* Image

Toluene → Metylcyclohexane

Japan-Australia Pilot Project

2020~ HySTRA

Brown Coal +CCS

Gasification

Liquefied H_2 Carrier*

Loading Facility*

Power-to-gas

Fukushima Renewable H_2 Project

2020~ FH2R

Power-to-Gas Plant*

Electrolysis System (Alkaline)

TOKYO 2020

TOKYO 2020

Ongoing Projects (Demand-side)

METI
Ministry of Economy, Trade and Industry

H_2 Mobility

H_2 Station Network

2013～

*113 Stations
by November 2018

H_2 Applications

2016～

FC Bus

× 100 in 2020

FC Truck Demo

H_2 Power Generation

H_2 Co-generation Demonstration Project

Hydrogen Gas
Turbine (1MW class)

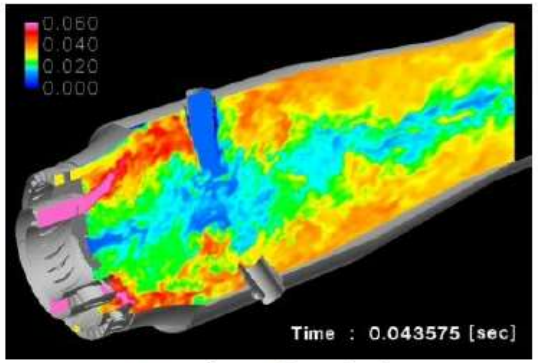
2018～

Joint Venture for H_2 Infrastructure Development

2018～

R&D of H_2 Burner Systems

For Power
Generation
<500MW



Burning Simulation
(H_2 + CH_4)

Japan reverses nuclear energy phase-out policy amid global fuel shortages, climate change

Posted Thu 22 Dec 2022 at 11:07am

https://www.abc.net.au/news/2022-12-22/japan-nuclear-energy-phase-out-reversal/101803800

Key point:

Push nuclear energy

Japan plans to maximize the use of its existing nuclear reactors by restarting as many as possible. Reversing previous policy, it is argued that nuclear energy delivers stable performance and plays "an important role".

After the Fukushima disaster, Japan swore to phase out nuclear power. But not anymore

December 22, 2022 · 11:12 AM ET

By The Associated Press

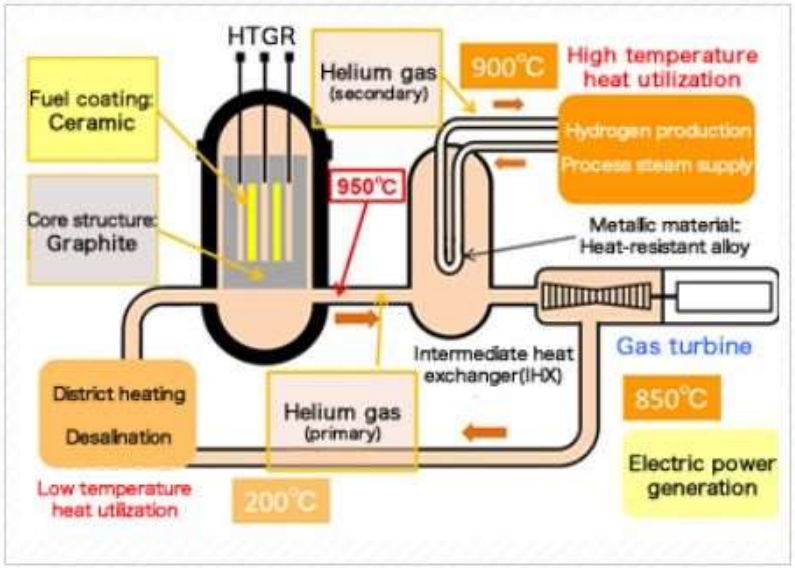
https://www.npr.org/2022/12/22/1144990722/japan-nuclear-power-change-fukushima

TOKYO

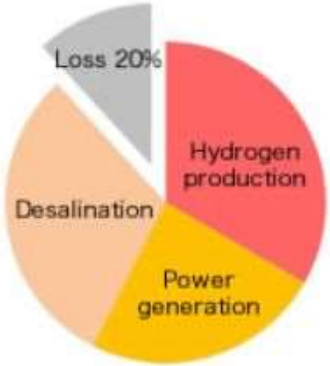
- Japan approved a plan Thursday [12/22/2022] to extend the life of nuclear reactors, replace the old ones and even build new ones, a major shift in a country scarred by the Fukushima disaster and once phased out from nuclear energy.
- Facing global fuel shortages, rising prices and pressure to reduce carbon emissions, Japan's leaders have begun to turn back to nuclear energy.
- Under the new policy, Japan will maximize the use of existing reactors by restarting as many of them as possible and extending the operating life of older reactors beyond a limit of 60 years.

Urgent need for commercialization of accident-free, high-temperature gas-cooled reactors. In HTGR technology Japan is a world leader.

What is High Temperature Gas-cooled Reactor (HTGR) ?



- Helium gas cooled reactor with outlet coolant temperature of 950°C.
- 80% of reactor thermal power can be utilized by a cascade energy system for hydrogen production, power generation and desalination.



JAEA *Japan Atomic Energy Agency*
Oarai Research & Development Institute

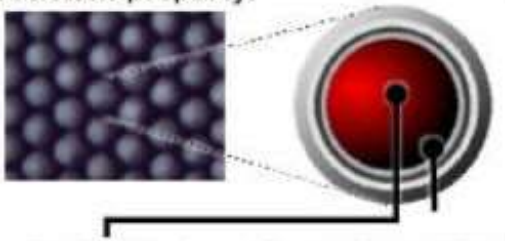
Superior inherent safety

Japan Atomic Energy Agency
Oarai Research & Development Institute

Superior inherent safety

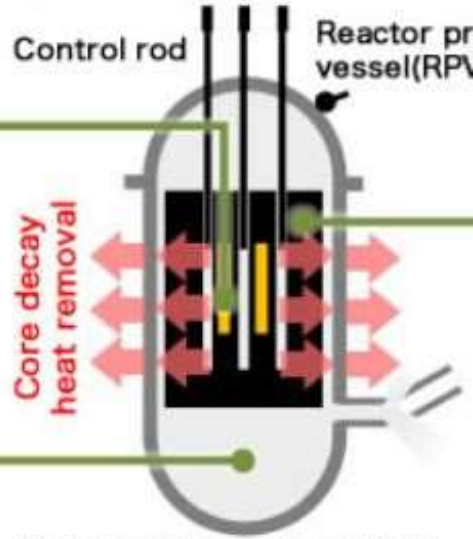
Ceramic coated particle fuel

Hard to melt due to extremely heat-resistant property.



Helium coolant

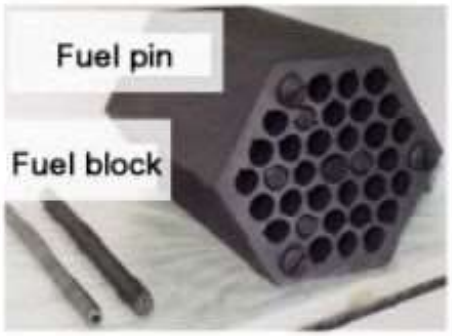
No hydrogen/vapor explosion due to chemical inertness and absence of phase change of helium.



Radionuclides can be retained within the plant by inherent reactor shutdown and core cooling without any equipment or operator action in case of loss of coolant accident or station blackout.

Graphite moderator

Capable to keep the fuel temperature below the allowable limit due to high heat capacity and large thermal conductivity of graphite.



想定外

sō tei gai

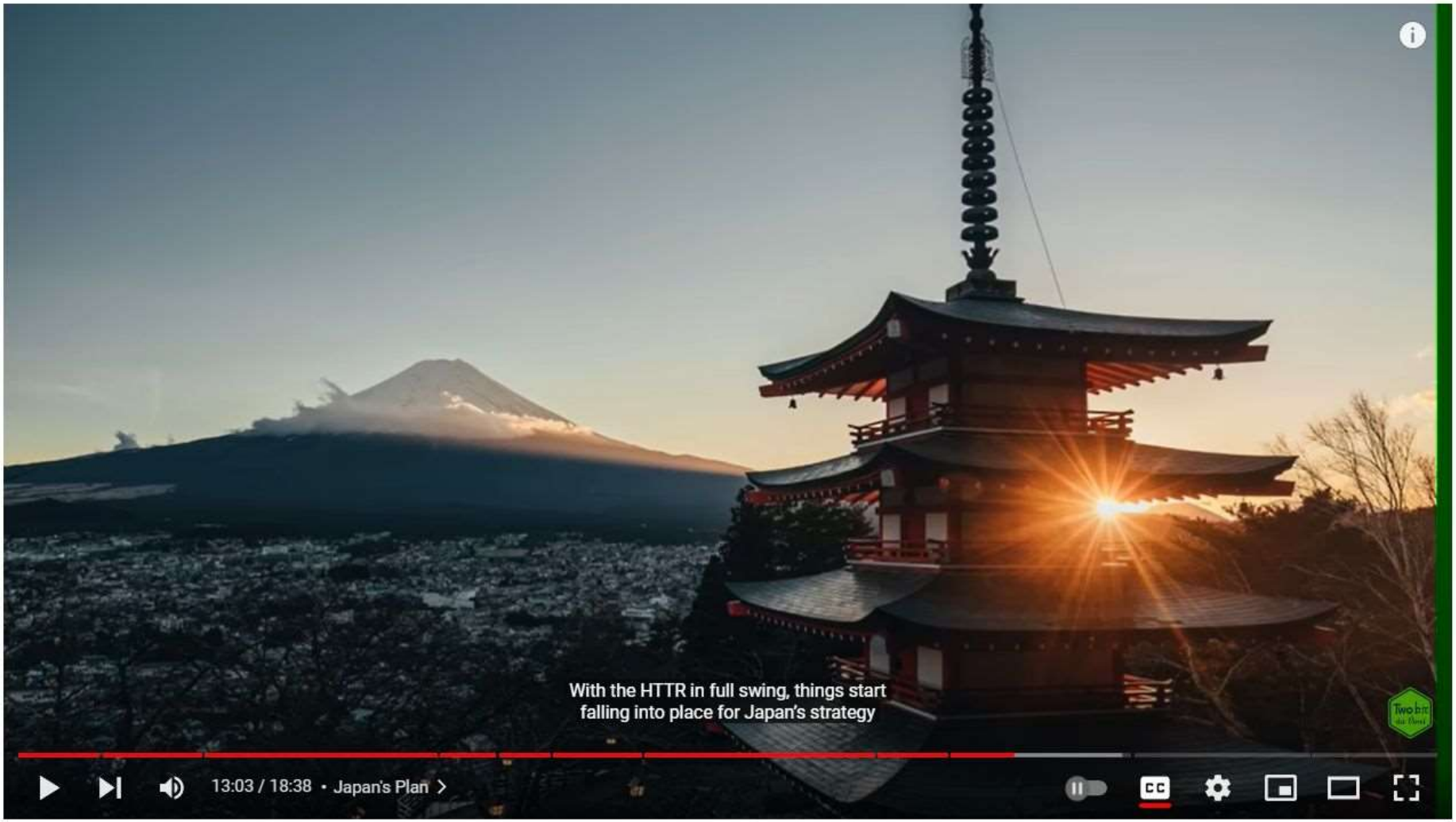
thinking - permanent - outside of

unimaginable

Advanced HTGR

- "High Temperature Engineering Test Research Reactor" (HTTR, Oarai, Ibaraki Prefecture) basically free from the risk of a core meltdown.
- 950 degrees Celsius, three times higher than that of ordinary pressurized water reactors.
- Gas turbine for electricity generation, but more importantly: IS (iodine-sulfur) process through cyclic thermochemical decomposition of water to produce hydrogen.
- Industrialization of IS (iodine-sulfur) process difficult, but already two years ago continuous hydrogen production of 150 hours, which is standard for long-term operation.

https://www.sankei.com/article/20210203-3EICBGIMXVPHTNBS35GRHPEGZU
2021-02-03



Japanese RED Hydrogen Breakthrough Will DESTROY Oil & Gas!

https://www.youtube.com/watch?v=_uTZWaJU6ho

Japan to update hydrogen energy strategy in push for carbon neutrality

Tuesday, April 4, 3:45

(1000kg Hydrogen ~ 33,33MWh energy)

H_2 Demand

12Mio. tonnes	~ 400TWh	Japan	2040
	1200TWh	EU + GB	2040

H_2 in Germany:

Planning as of 2022:	100 – 200TWh	2040
new since July 25, 2023:	95 – 130 TWh	2030
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Primary energy consumption in 2020

(Peta (P) for 1 Billiard = 1,000,000,000,000,000 = 10^{15})

World:	**160PWh**	
Germany:	**3.5PWh**	(2,2% of World consumption)
Japan:	**4.7PWh**	(2,9% of World consumption)

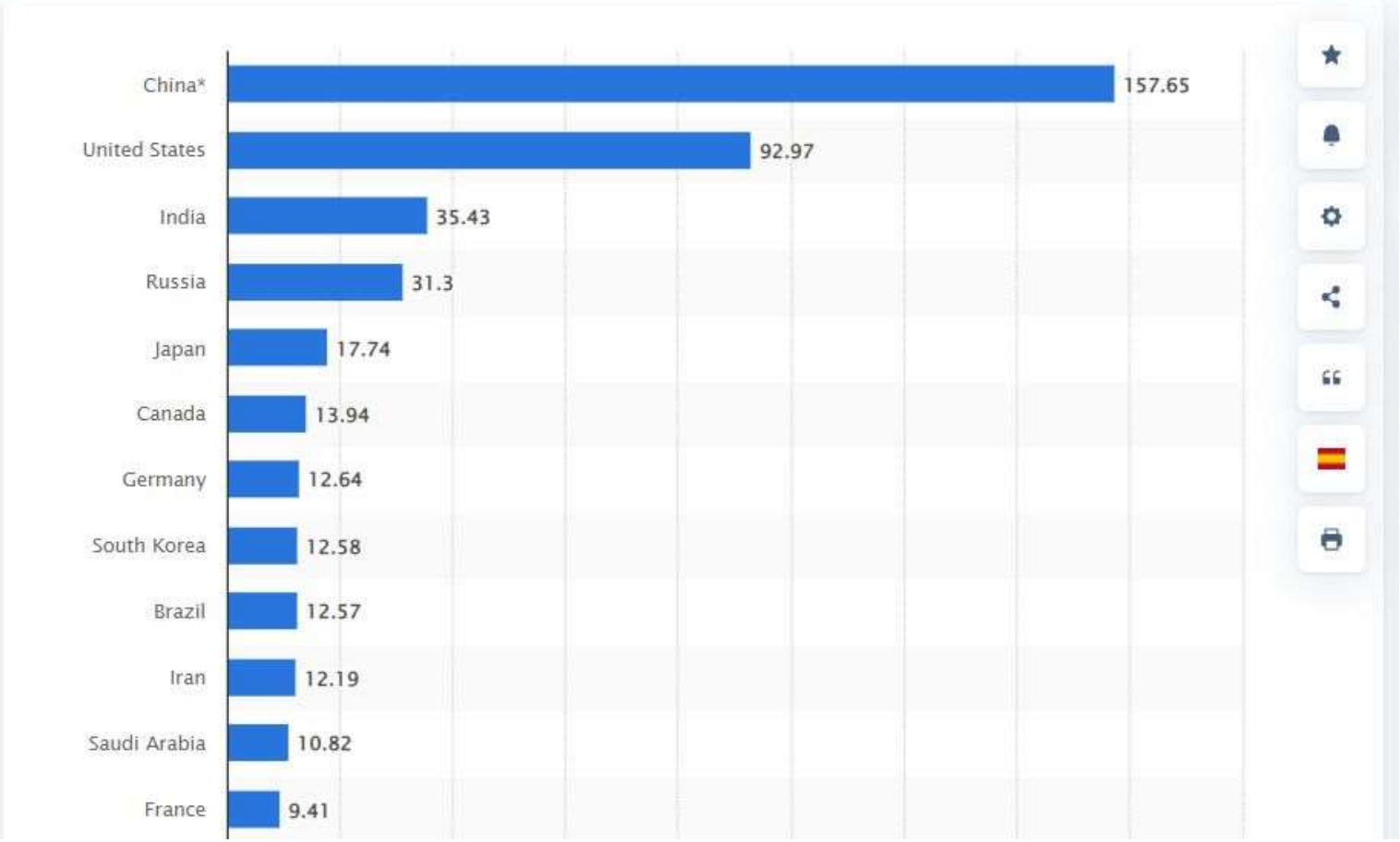
In comparison:

German Electrical Energy consumption in 2021: 0.49PWh (15%)

Energy & Environment › Energy

Primary energy consumption worldwide in 2021, by country

(in exajoules)



10Exajoule = 2,7PWh
https://www.statista.com/statistics/263455/primary-energy-consumption-of-selected-countries/

Why a clean energy transition is so important to G7 chair Japan

G7 Meeting in Hiroshima May 19 – 21, 2023

WHY DOES HYDROGEN AND ITS DEFINITION MATTER FOR JAPAN?

- Japan wants to change the definition of hydrogen to two types - clean or not clean.

WHAT IS THE ROLE OF AMMONIA?

- Japan aims to extend the lifespan of its coal-fired power plants in an ambitious project to add ammonia, a toxic gas made of nitrogen and hydrogen, to its fuel mix

HOW CAN JAPAN CUT POWER SECTOR EMISSIONS?

- Japan, the world's fifth-biggest emitter, gets around one-quarter of its electricity from clean sources including generation from solar, wind, hydropower, biomass and nuclear.

DOES JAPAN HAVE A CARBON PRICING SCHEME?

- Japan is introducing a carbon pricing scheme in stages starting this month that combines emissions trading and a carbon levy to encourage companies to curb pollution.

https://www.channelnewsasia.com/sustainability/explainer-why-clean-energy-transition-so-important-g7-chair-japan-3412141

Hydrogen filling stations

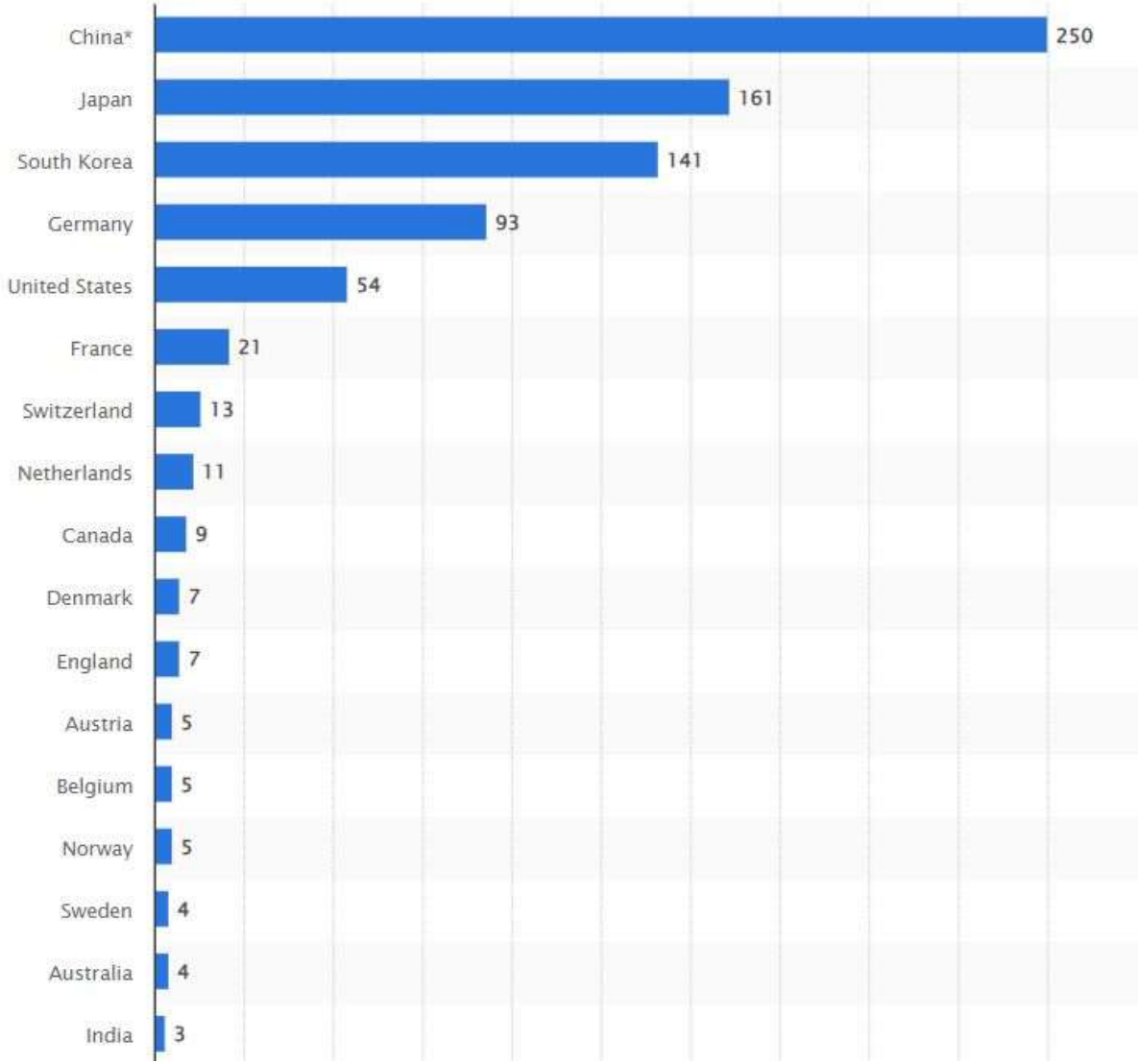
Number in Japan (including in Tokyo): *164 (23)* *planned: 1000 by 2030*
(2023)

Number in Germany: *93* *planned: 100 by 2025*
(2022)

Note:

- *SAE J2600 (Society of Automotive Engineers) and its ISO equivalent for the hydrogen nozzle and FCEV vehicle intake are essentially identical and harmonized worldwide for 35MPa and 70MPa.*

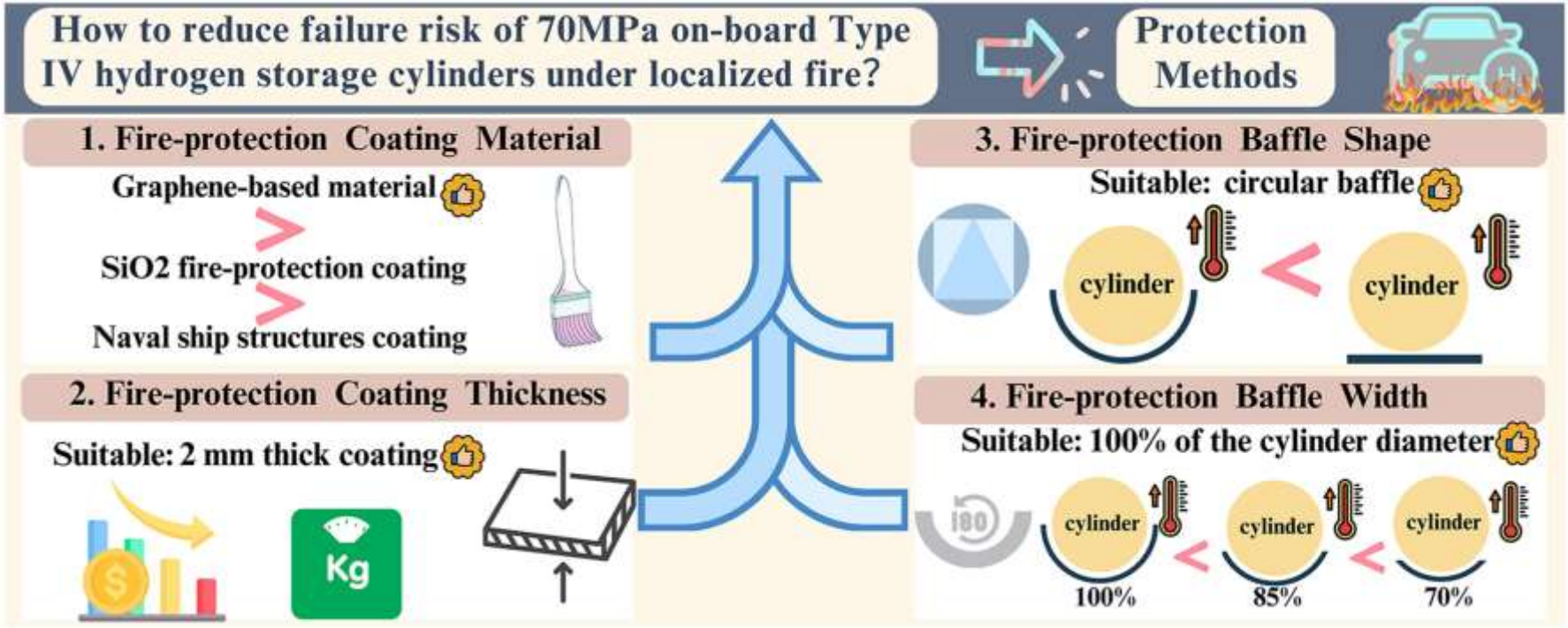
Number of hydrogen fueling stations for road vehicles worldwide as of 2022, by country



https://www.statista.com/statistics/1026719/number-of-hydrogen-fuel-stations-by-country/

International Journal of Hydrogen Energy
Available online 23 August 2023

Research on protection methods for 70 MPa on-board Type IV hydrogen storage cylinders under localized fire conditions



FDMA 住民とともに

Fire and Disaster Management Agency

of the Ministry of Internal Affairs and Communications

総務省消防庁

Chapter 1 消防・防災

Fire and disaster prevention

国民の安心・安全を確

的確に対応できる消防力の確保をめざし、

The world's leading fire and disaster protection

Reviewing and maintaining an ideal firefighting service with the aim of

変化する災害に対応し、進化する消防防災行政

Advanced fire services administration to respond to the ever changing face of disasters

Chapter 2 救助・救急

Rescue operations, First-aid

救える命を、救いたい

各種の災害に即応し、「救える命を確実に

Saving anyone and anything that can be saved

Reviewing, improving and enhancing systems, and organizing equipment to

全国各地から駆けつけてくる精鋭部隊

Elite teams coming to your assistance from across the country

Chapter 3

火災予防

Fire prevention

未然に防ぐ！何よりも

火災等による「被害を最小限に抑える」た

Preventing the unexpected! The most important

Implementing various fire safety measures to "minimize damage by all

社会情勢の変化に対応した防火安全対策

Elite teams coming to your assistance from across the country

Chapter 4

国民保護

People Protection

あらゆる事態に備え、

武力攻撃や大規模テロなどから国民を保

Protecting the public from any situation

Taking all steps necessary to protect the public from armed attacks and large-

有事に揺るがない体制の確立

Establishing reliable systems for emergencies

国際協力
International cooperation

確かな技術と経験
国際消防救助隊の海外派遣や技術援助を
Contributing to the international community with proven technology
Cooperating with and contributing to the international society by sending international

世界に貢献する国際消防救助隊
International Rescue Team of Japanese Fire-service contributing to international affairs

組織・所掌事務
Outlines, organizations and responsibilities

私たちは『総務省消防庁』です。

消防庁は、国民の一人ひとりが自ら地域の安心・安全について強く意識を持ってもらえるよう心がけ、災害に決して揺るぐことのない社会の実現に向け邁進しています。常に人命優先の立場から、火災、地震、風水害など各種災害による死傷者の発生が皆無となるよう努力を続けています。

We are the Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications.
The FDMA is committed to the construction of a society where each and every inhabitant has a strong sense of fire defense and disaster prevention, unyielding to any type of disaster. We will continue to make every effort possible to minimize the loss of life and injury in various disasters including fires, earthquakes, storms and floods, with the top priority always given to the lives of people.

消防庁の組織および所掌事務
Fire and Disaster Management Agency Organizational and Jurisdiction

METI
Ministry of Economy, Trade and Industry

https://www.meti.go.jp/english/policy/safety_security/industrial_safety/index.html#hydrogen

Safety of Hydrogen and Its Derivatives

- Hydrogen is one of the important energy sources to achieve carbon neutrality in 2050.
- METI will establish a rational and appropriate safety system that meets the characteristics of hydrogen for safe and secure large-scale use of hydrogen.
- In addition, METI will promote initiatives such as human resource development and risk communication with each stakeholder in order to build a safe and secure hydrogen use environment.

Related News Releases and Information

Hydrogen Safety Portal Website Launched (June 30, 2023) News Release

Interim Report for the Hydrogen Safety Strategy Released (March 13, 2023) News Release

Contact:

Industrial Safety Division, Industrial and Product Safety Policy Group
TEL +81-3-3501-8628

Division in Charge

Industrial Safety Division, Industrial and Product Safety Policy Group

Hydrogen Safety Portal Website Launched

June 30, 2023

https://www.meti.go.jp/english/press/2023/0630_002.html

▶ Safety and Security

On June 30, 2023, the Ministry of Economy, Trade and Industry (METI) launched a portal website that provides well-organized information on hydrogen safety under the Interim Report for the Hydrogen Safety Strategy.

1. Outline of the Hydrogen Safety Strategy

The internal and external environments surrounding Japan's hydrogen safety is changing drastically, with demands for response to climate change issues, advances in hydrogen utilization technology, the integration of different types of businesses, the involvement of various actors, demands for safe use, and other issues.

Against this backdrop, the Study Group of a Hydrogen Safety Strategy (Chaired by Professor Miyake Atsumi, Executive Director and Vice President of Yokohama National University) was launched in August 2022. Since then, the group has held six discussions to build an environment that facilitates the use of hydrogen with a view toward creating a hydrogen society in each step of the hydrogen supply chain, including i) organizing current situations of and issues on hydrogen safety regulations; and ii) rationalizing and optimizing regulations on the use of hydrogen with the premise of ensuring safety. The results of the discussions were compiled in an interim report and METI released it in March 2023.

2. Three action policies and nine concrete means under the strategy

For establishing a rational safety regulation system for the large-scale use of hydrogen ahead of the rest of the world, the strategy sets out—as a set of action policies for the public and private sectors over the next five to ten years—broad directions and visions that the public and private sectors should achieve as ideal approaches and goals that they will aim at looking toward 2050. It also upholds three action policies and nine concrete means that Japan should tackle. Details of the policies and means are as follows:

Example for the non-systemic approach in Japan

Spread and Development Trend of ENE-FARM and Residential Fuel Cells

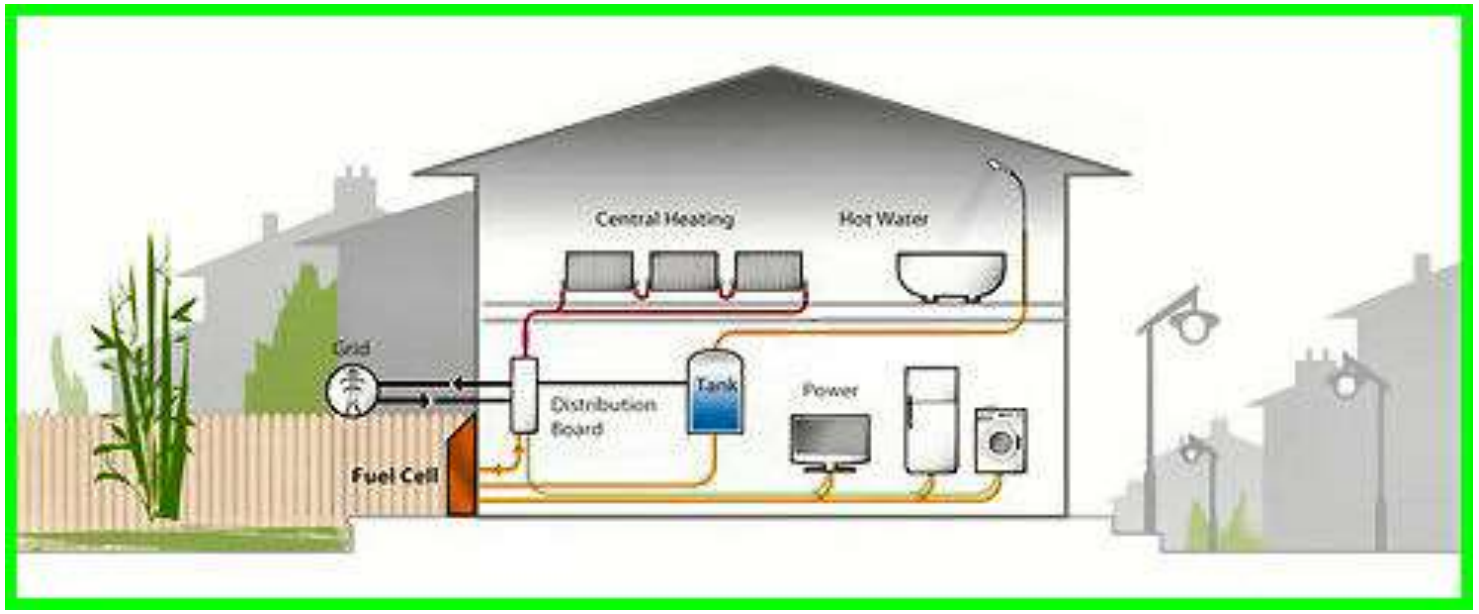
ENE-FARM

ELECTRICITY & HOT WATER

PANASONIC UND TOKYO GAS

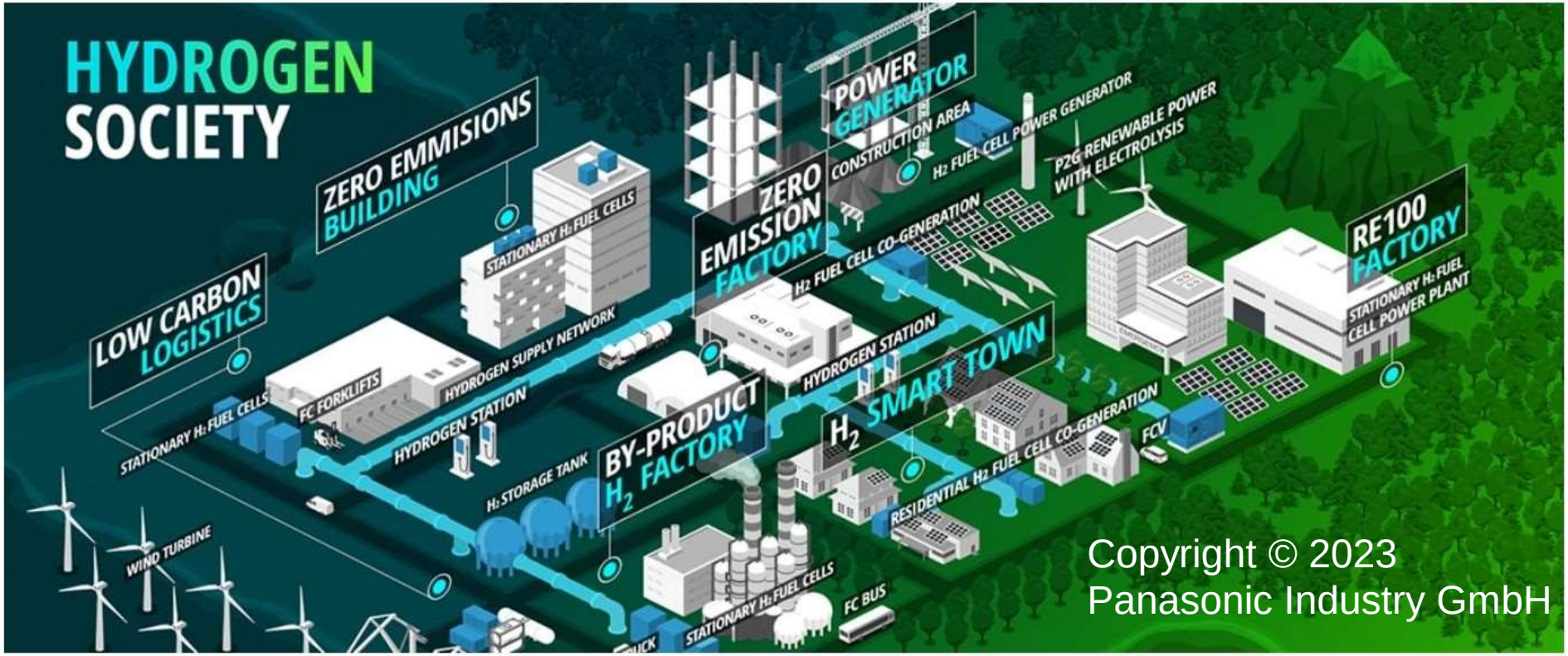
Fuel cell for the home

Cogeneration, “combined heat and power”



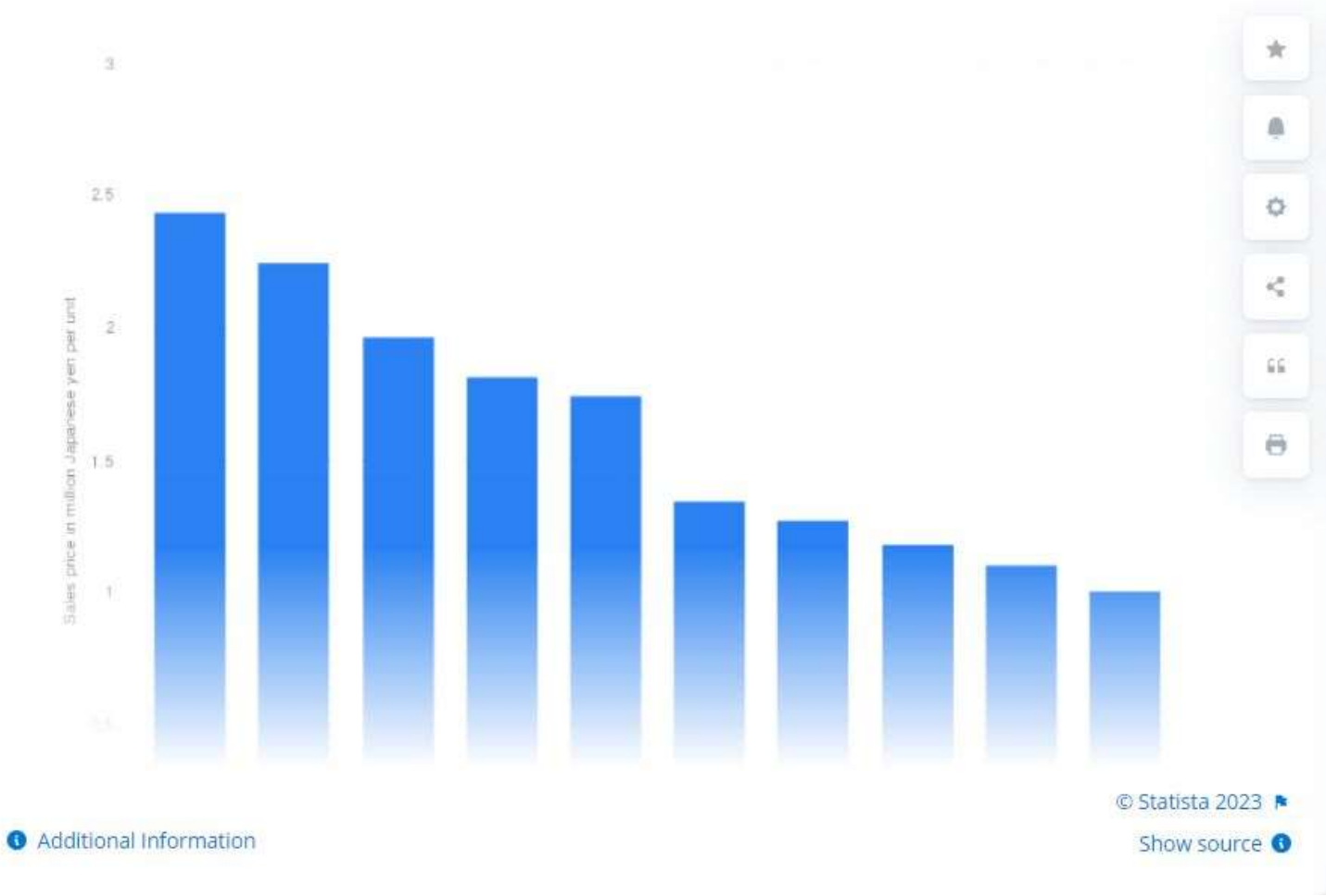
Hydrogen Fuel Cells for Heat and Electricity

Read more **here**.



Sales price of ENE-FARM systems for solid oxide fuel cells (SOFC) in Japan from fiscal year 2011 to 2020

(in million Japanese yen)



World's Smallest High Efficiency Household Fuel Cell Cogeneration System "Ene-Farm Mini" Developed

by FuelCellsWorks, 2019-10-14

International Institute for Carbon-Neutral Energy Research

持続可能な低炭素社会に向けた水素のポテンシャル
世界はPower to Gas からPower To Xへ

Das Potenzial von Wasserstoff für eine nachhaltige Gesellschaft mit geringem Kohlenstoffausstoß

Internationales Forschungsinstitut für CO2-neutrale Energie der Kyushu-Universität

九州大学　カーボンニュートラルエネルギー国際研究所

WPI 招聘教授

Katsuhiko Hirose

KYUSHU UNIVERSITY

wpi World Premier International Research Center Initiative

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

“End of stone age was
not due to the lack of stone”

Die Steinzeit ging nicht zu Ende, weil es keine Steine mehr gab.

The technological innovation and new idea
change the society.

石器時代が終わったのは
石が無くなったわけではない！

技術革新と新しいアイデアが社会を変えるのだ。