Document 4

Provisional Translation

Next-generation Technologies and Innovation for Decarbonization

February 27, 2018

Agency for Natural Resources and Energy
Ministry of Economy, Trade and Industry

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*Reference slides are available in Japanese version

Images of innovation toward 2050

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Requirements toward 2050

- **Energy Security: Pursuit of all technologies and options**
- **Paris Agreement: Significant reduction of GHG emissions**
- **Adapting to digitization: Toward Society 5.0**

Demand-side innovation

1. Transport: Consumption reduced through automatization and design optimization
Electrification (EVs, FCVs, etc.)

2. Industry: Efficiency improved through robotization, AI, etc.
Electrification, use of hydrogen, and increased use of non-fossil materials

3. Buildings: Increased efficiency through IoT and popularized ZEBs and ZEHs
Electrification and methanation

Supply-side innovation

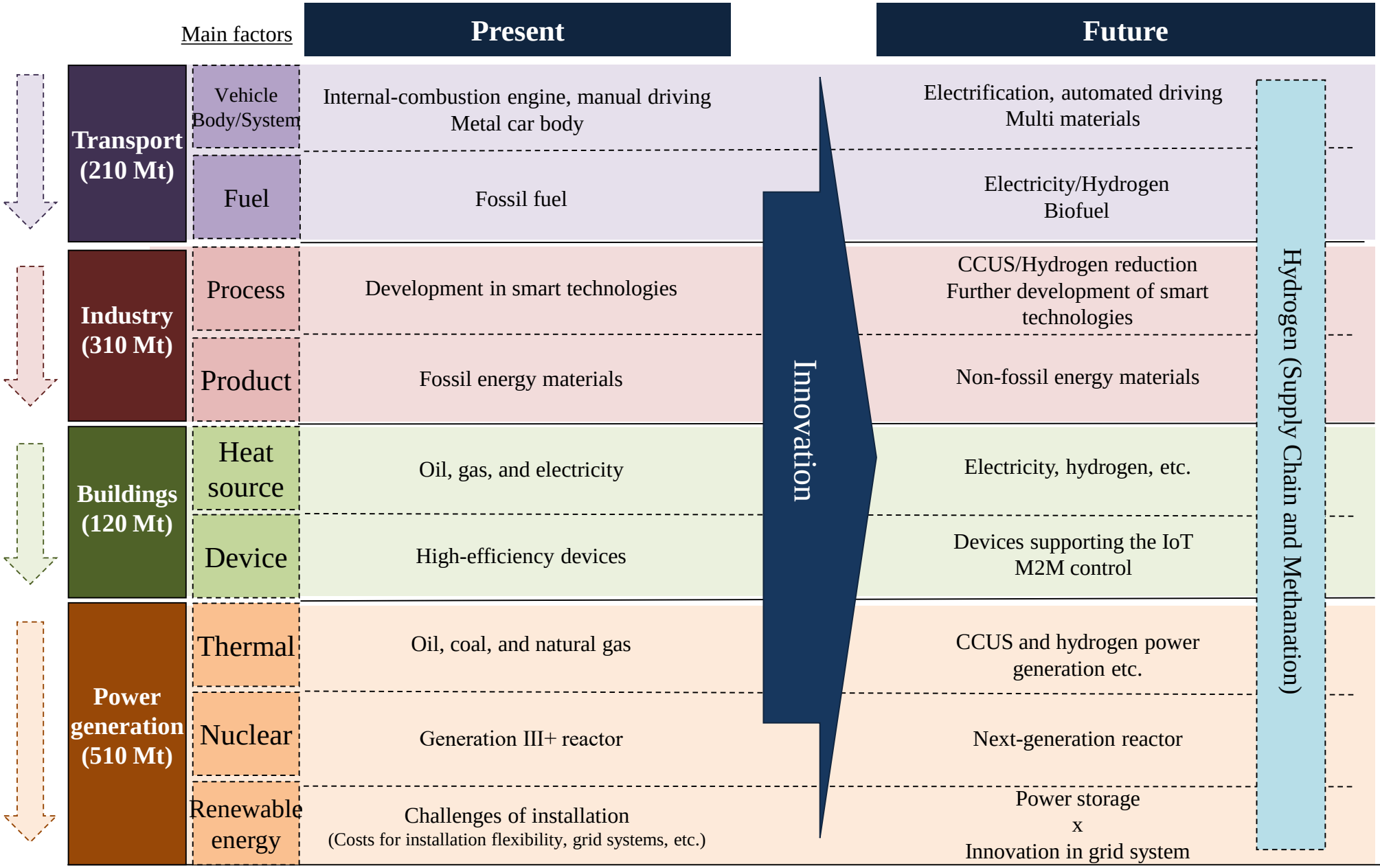
1. Electricity: Increased efficiency through data utilization
Innovation in the technology of zero emission power

2. Hydrogen: Zero emission sources of supply, cost reduction, and establishing supply chains

Innovation to be globally extended to reduce CO_2 emissions at a global level

1. Leading the world in innovation ⇒ Enhanced international competitiveness
2. Establishing a system that can compete with conglomerates in China, US, and Europe etc.

CO_2 Emissions by sector and corresponding mitigation technologies



* The figures inside ( ) are the amounts of CO2 emissions in FY 2015.

Source: Agency for Natural Resources and Energy

(Reference) Review of the Innovation toward 2050

	Demand side	Supply side
Statements from previous sessions	✓ The government's support for promoting innovation is important (Mr. Sieminski and Dr. Stevens) ✓ Diversity should be ensured in both of demand and supply. (Mr. Sieminski). ✓ We should not target a specific technology. Competition among technologies is important. (Prof. Skea). ✓ **EVs** can be effectively used **as a flexible source of power system.** (Dr. Stevens) ✓ **Digitalization** creates new services for consumers. (EDF) ✓ Consumer needs promotes **decentralization**. (ENGIE) ✓ In urban areas, energy saving advances **based on the use of data**. (ENGIE)	✓ It is also important to **develop new types of storage batteries** that are not only based on liquid lithium. (Mr. Sieminski) ✓ The **development of nuclear technology** increases social acceptability. (Mr. Shellenberger) ✓ It is important to use **integrated approaches** including conversion of surplus power into hydrogen (Dr. Kemfert). ✓ **Hydrogen** is potentially an important energy carrier. (Shell)
NESTI 2050 **National Energy & Environment Strategy for Technological Innovation towards 2050**	<Energy system integration technology> ✓ Demand response ✓ Utilization of AI, big data, and IoT <Core technologies that consist systems> ✓ Innovative sensor ✓ Multi-purpose superconductor <Energy saving> ✓ Innovative production process ✓ Ultralight and heat-resistant structure material	<Energy storage> ✓ Next-generation storage battery ✓ Production, storage, and use of hydrogen, etc. <Energy creation> ✓ Next-generation solar power generation ✓ Next-generation geothermal power generation <Fixing and effective utilization of CO_2> ✓ CCUS
Long-term strategies of major countries	✓ **Electrification** in the transport, buildings, and industrial sectors (U.S.A., Canada, France, U.K., and Germany) ✓ Popularization and promotion of **EVs** (France and U.K.) ✓ Utilization of **hydrogen** in transport and industrial processes (U.S.A., Canada, U.K., and Germany) ✓ **CCUS** in heavy industries (Canada, France, and Germany)	✓ **Battery storage and grid system stabilization** that promote installation of renewables (U.S.A. and U.K.) ✓ Investment in and development of **next-generation nuclear power plant** (U.S.A. and U.K.) ✓ Utilization of **thermal power generation with CCS** (Canada and France)

(Reference) Carbon Reduction Targets

CO_2 emission in 2015 (100 million tons)

	World	Developed countries	Emerging countries	Japan
Total	323	124	199	11.5
Electricity	127	45	82	5.1
Transport	77	41	36	2.1
Automobiles (Passenger vehicle, freight automobile,ect)	58	31	27	1.9
Others (Aircraft, ships, etc)	19	10	9	0.2
Industry	83	23	61	3.1
Steal and Iron (Not includes cokes production)	19	3	16	1.3
Petrochemicals (Includes petroleum products)	9	3	6	0.7
Heat (commercial & residential sectors)	35	14	21	1.2

* Developed countries: OECD, Emerging countries: Non-OECD
* Definitions in IEA and METI data may be different.
* CO2 emissions from international marine/aviation bunkers are allocated to OECD and non-OECD

Source: IEA CO2 Emissions from Fuel Combustion, METI statistics

(Reference) Investments by major companies in research and development

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		Transport		Industry		Residential/Commercial	
		Volkswagen (Germany)	Toyota (Japan)	GE (U.S.A.)	Hitachi (Japan)	Google* (U.S.A.) *Alphabet	Panasonic (Japan)
Company overview	Sales amount	28.1 trillion yen	28.4 trillion yen	14.2 trillion yen	10.0 trillion yen	9.0 trillion yen	7.6 trillion yen
	Overseas Ratio	80%	70%	55%	48%	54%	52%
Research and development	Investment amount	1.6 trillion yen	1.1 trillion yen	0.6 trillion yen	0.3 trillion yen	1.5 trillion yen	0.4 trillion yen
	Examples of development fields	Jan. 2018 Expansion in the IT segment and enhancement of development of digital products	Jan. 2018 Automotive battery recycling business	Oct. 2017 Development of IoT applications	Dec. 2017 Development of self-competition learning AI	2017.12 Setup of an AI development base in China	Jun. 2017 Development of AI giving advice according to interests of individuals

Source: SPEEDA, Corporate annual reports etc.

(Reference) Investments by major companies in research and development

		Power		Oil		Gas	
		EDF (France)	TEPCO (Japan)	Shell (Netherlands)	INPEX (Japan)	Engie (France)	Tokyo Gas (Japan)
Company overview	Sales amount	10.1 trillion yen	6.1 trillion yen	25 trillion yen	0.9 trillion yen	9.4 trillion yen	1.9 trillion yen
	Overseas Ratio	47%	2%	64% * The countries outside Europe are regarded as overseas countries.	89%	64%	NA
Research and development	Investment amount	0.09 trillion yen	0.02 trillion yen	0.13 trillion yen	0.001 trillion yen	0.03 trillion yen	0.01 trillion yen
	Examples of development fields	Sep. 2013 Setup of a smart grid research lab.	Mar. 2017 Drone-based automated inspection of power facilities	Oct. 2017 Buyout of an EV recharging service company	Jul. 2017 Survey of the largest gas field in the SE-Asia started	May 2017 Order for a large electricity storage system	May 2017 Development of technology for increasing the efficiency of fuel cells

Source: SPEEDA, Corporate annual reports etc.