Technology Collaboration Programme
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International Energy Agency
Photovoltaic Power Systems Programme

Task 1 Strategic PV Analysis and Outreach

PVPS

National Survey Report of PV Power Applications in JAPAN 2020

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What is IEA PVPS TCP?

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The Technology Collaboration Programme (TCP) was created with a belief that the future of energy security and sustainability starts with global collaboration. The programme is made up of 6.000 experts across government, academia, and industry dedicated to advancing common research and the application of specific energy technologies.

The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the TCP's within the IEA and was established in 1993. The mission of the programme is to "enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems." In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas.

The IEA PVPS participating countries are Australia, Austria, Belgium, Canada, Chile, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United States of America. The European Commission, Solar Power Europe, the Smart Electric Power Alliance (SEPA), the Solar Energy Industries Association and the Cop- per Alliance are also members.

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What is IEA PVPS Task 1?

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual "Trends in photovoltaic applications" report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2020. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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COVER PICTURE: Roof and Window Glass-integrated PV System at JR Station Platform (Takanawa Gateway Station PV System) with output capacity of 43.8 kW
Photo by RTS Corporation

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1 INSTALLATION DATA

The PV power systems market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries. Other applications such as small mobile devices are not considered in this report.

For the purposes of this report, PV installations are included in the 2020 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2020, although commissioning may have taken place at a later date.

1.1 Applications for Photovoltaics

In 2020, as in the previous year, the majority of PV systems were installed under the Feed-in Tariff (FIT) program. As for the utility-scale applications, the majority are ground-mounted systems, but the floating PV (FPV) systems and agricultural PV systems are also growing. Regarding building-applied PV (BAPV) systems, the main applications are residential, commercial and industrial. For building-integrated PV (BIPV) systems, roof tile-integrated PV modules are installed in some residential applications. While some commercial installations have been reported, BAPV accounts for the majority of installations.

1.2 Total photovoltaic power installed

Annual installed capacity in Japan in 2020 reached 8 676 MW (DC), an approximately 23,4 % increase from 7 031 MW (DC) in 2019.

Table 1: Annual PV power installed during calendar year 2020

		Installed PV capacity in 2020 [MW]	**AC or DC**
PV capacity	Off-grid	0,8	DC
	Decentralized	3 818	DC
	Centralized	4 857	DC
	Total	8 676	DC

Table 2: PV power installed during calendar year 2020

			Installed PV capacity in 2020 [MW] DC value
Grid-connected	BAPV	(1) Residential (< 10 kW)	708
		(2) Commercial (< 50 kW, including ground-mounted)	1 925
		(3) Industrial (50 kW - 1 MW, including ground-mounted)	1 142
		(4) Total of BAPV	3 775
	BIPV	(5) Residential (< 10 kW)	23
		(6) Commercial (10 - 250 kW)	20
		(7) Industrial (> 250 kW)	
		(8) Total of BIPV	43
	Utility-scale	(9) Ground-mounted (1 MW ~)	4 611
		(10) Floating PV systems	46
		(11) Agricultural PV systems	200 (including small-scale systems)
		(12) Total of utility-scale	4 857
Off-grid		(13) Residential	NA
		(14) Other	
		(15) Hybrid systems	NA
		(16) Total of off-grid	0,805
Total		**(17) Total ((4) + (8) + (12) + (16))**	8 675,805

Table 3: Data collection process

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	AC: Figures announcement by the Ministry of Economy, Trade and Industry (METI) DC: Estimated value (DC/AC ratio: based on the overpanelling ratio announced by the Procurement Price Calculation Committee)
Is the collection process done by an official body or a private company/Association?	- Figures for installation volume outside of the FIT program, BIPV, floating PV (FPV) systems, and PV systems on farmland are estimates by RTS Corporation based on hearings, etc. - Installation volume of off-grid systems is based on shipment statistics from the Japan Photovoltaic Energy Association (JPEA)
Link to official statistics (if this exists)	https://www.fit-portal.go.jp/PublicInfoSummary
Other issues to be noted	DC capacity was estimated in consideration of over-panelling of PV modules

The cumulative PV installed capacify in Japan as of the end of 2020 reached 71 868 MW (DC). The cumulative PV installed capacity by application is; 176 MW for off-grid and 71 692 MW for grid-connected applications.

Table 4: The cumulative installed PV power in 4 sub-markets

Year	Off-grid [MW] (Including large hybrids)	Grid-connected distributed [MW] (BAPV, BIPV)	Grid-connected centralized [MW] (Ground, floating, agricultural…)	Total [MW]
1992	15	1	2	19
1993	19	2	3	24
1994	24	5	3	31
1995	30	11	3	43
1996	36	21	3	60
1997	45	43	3	91
1998	53	78	3	133
1999	57	149	3	209
2000	64	264	3	330
2001	67	383	3	453
2002	73	561	3	637
2003	79	778	3	860
2004	84	1 045	3	1 132
2005	87	1 332	3	1 422
2006	89	1 617	3	1 708
2007	90	1 823	6	1 919
2008	91	2 044	9	2 144
2009	95	2 522	11	2 627
2010	99	3 496	23	3 618
2011	103	4 741	69	4 914
2012	109	6 522		6 632
2013	123	13 476		13 599
2014	125	23 214		23 339
2015	127	34 023		34 150
2016	161	41 879		42 040
2017	171	49 329		49 500
2018	173	55 989		56 162
2019	175	63 017		63 192
2020	176	71 692		71 868

Table 5: Other PV market information

	2020
Number of PV systems in operation in Japan	N.A.
Decommissioned PV systems during the year	< 150 MW
Repowered PV systems during the year	N.A.
Total capacity connected to the low voltage distribution grid	~ 59 741 MW
Total capacity connected to the medium voltage distribution grid	
Total capacity connected to the high voltage transmission grid	~ 16 353 MW

Table 6: PV power and the broader national energy market

	2019	2020
Total power generation capacities	265 GW_{AC} [1]	270 GW_{AC} [1]
Total renewable power generation capacities (including hydropower)	112 GW_{AC} [2]	120 GW_{AC} [2]
Total electricity demand	888 TWh [3]	858 TWh [3]
Total energy demand	12 942 PJ [5] (FY 2019)	N.A. [5]
New power generation capacities installed	-5,9 GW_{AC} [4]	5,0 GW_{AC}
New renewable power generation capacities (including hydropower)	6,5 GW_{AC}	8,0 GW_{AC}
Estimated total PV electricity production	63 192 GWh	71 868 GWh
Total PV electricity production as a % of total electricity consumption [1]	7,1 %	8,4 %

[1] : METI's Survey of Electric Power Statistics (Total power generation capacities of electricity retailers, general power transmission and distribution operators, power transmission operators, designated power transmission and distribution operators and power producers) (Distributed systems are NOT included.)

[2] : Total of hydro capacity + Cumulative installed capacity under FIT program + Total of renewable energy facilities by ten electric power companies (EPCOs)

[3] : Statistics on actual electricity demand by METI (Total of electricity demand from Jan. to Dec. each year)

[4] : Oil, other gases, nuclear, geothermal and biomass power generation capacities recorded negative figures

[5] : METI statistics. Statistics for FY 2020 are not available at the time of writing this report. Preliminary figures are expected to be released in October or November 2021 and final figures in April 2022.

1.3 Key enablers of PV development

Table 7 shows the information on key enablers contributing to PV development. The information available at the time of writing this report is listed in the table, since official statistics in Japan are released by fiscal year (April to March).

The shipment data of stationary lithium-ion battery storage systems include not only distributed applications but also other applications such as grid-connected applications. However, applications for transportation (electric motorcycles, those related to vehicles, construction equipment and automated carrier machines, etc.) and industrial applications (robots, uninterruptible power system (UPS)) are not included. It is assumed that around 80 % of the reported figures are for residential applications.

A typical heat pump for residential application is “Eco Cute” highly efficient water heater which uses CO_2 as refrigerant. The subsidy program conducted between FY 2002 and FY 2010 encouraged the installation of this heat pump system, and total 7,27 million units of Eco Cute heat pump systems have been installed in houses as of the end of FY 2020.

As for electric vehicles (EVs), the number of units sold in FY 2019 and the number of units owned as of the end of March 2020 (end of FY 2019) (equivalent to cumulative number of units sold) are listed in Table 7.

Table 7: Information on key enablers

	Description	Annual volume	Total volume	Source
Shipment data of lithium-ion battery storage systems	Integrated lithium-ion battery storage system consisting of li-ion battery, power conversion devices such as inverter and converter	FY 2020: 126 925 units (885 MWh)	As of end of FY 2020: 490 792 units (3 453 MWh)	The Japan Electrical Manufacturers' Association (JEMA)
Residential heat pumps	Residential heat pump water heater with natural refrigerant (Eco Cute)	Shipment volume in 2020: 524 859 units	7 271 964 units (cumulative shipments since 2003)	The Japan Refrigeration and Air Conditioning Industry Association, Heat Pump & Thermal Storage Technology Center of Japan
Electric vehicles (EVs) (number of units)	Passenger car (PC), Light car (LC)	FY 2019: PC: 19 774 LC: 802	As of end of FY 2019 PC: 117 315 LC: 4 839	Next Generation Vehicle Promotion Center (Numbers of sales and ownership of EV, etc.)
Electric buses and trucks (number of units)	EVs other than passenger car or light car, which are categorized as "Other" in the statistics	FY 2019: 248	As of end of FY 2019: 1 563	Same as above

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Table 8 shows typical PV module prices for a number of years for residential applications. These are end-user prices. There is a large price gap between residential PV systems and utility-scale PV power plants.

Table 8: Typical residential PV module prices for a number of years (end-user prices)

Year	Average price (JPY/W)	Best price (JPY/W)
1992	996	
1993	950	
1994	927	
1995	764	
1996	646	
1997	652	
1998	674	
1999	598	
2000	542	
2001	481	
2002	462	
2003	451	
2004	441	
2005	428	
2006	433	
2007	436	
2008	447	386
2009	393	347
2010	366	343
2011	327	306
2012	280	269
2013	252	242
2014	197	130
2015	190	N.A.
2016	189	N.A.
2017	150	N.A.
2018	139	56
2019	133	74
2020	127	73

2.2 System prices

Table 9 shows typical applications and prices of PV systems by category. Table 10 shows the trends in system prices. The standardization of grid-connected PV systems has progressed with the growth of the PV market in Japan, and the prices have been decreasing. On the other hand, off-grid system prices are determined on a case-by-case basis, because there are various types of applications, and the size of each market is small.

Table 9: Turnkey PV system prices of different typical PV systems

Category/Size	Typical applications and brief details	Current prices (JPY/W)
Off-grid < 1 kW	Telecommunications, lighting, traffic and road signs, ventilating fans, pumps, remote monitoring, navigation signs, clock towers, etc.	N.A.
Off-grid ≥ 1 kW	Agricultural facilities, communication facilities, disaster prevention facilities, mountain cottages, park facilities, housing in remote areas, lighthouses, etc.	N.A.
Grid-connected roof-mounted, distributed PV systems < 10 kW	Residential	286
Grid-connected commercial and industrial 10 kW- < 1 MW	Commercial and industrial	204
Grid-connected ≥ 1 MW	Power generation business (mainly ground-mounted)	196
Other category (hybrid diesel-PV, hybrid with battery…)		N.A.

Table 10: National trends in system prices for different applications (JPY/W)

Year	Residential PV systems (< 10 kW)	Commercial and industrial (10 kW - 1 MW)	Ground-mounted (≥ 1 MW)
1994	1,920		
1995	1,510		
1996	1,090		
1997	1,062		
1998	1,074		
1999	939		
2000	844		
2001	758		
2002	710		
2003	690		
2004	675		
2005	661		
2006	683		
2007	696		
2008	723		
2009	605		
2010	559		
2011	513		
2012	451	372	280
2013	413	342	275
2014	385	290	263
2015	379	256	240
2016	365	245	236
2017	360	244	221
2018	334	222	213
2019	306	205	204
2020	286	204	196

2.3 Cost breakdown of PV installations

Cost breakdown of PV installations is the typical value analysed from the results of hearing survey. Hearing survey was conducted on major suppliers of PV system, installers, and EPCs.

Table 11: Cost breakdown of Residential PV System < 10 kW

Cost category	Typical value (JPY/W)
Hardware	
Module	174
Inverter	44
Mounting structure	23
Other (electric equipment/ materials of electric equipment, etc.)	2
Soft costs	
Installation	60
Other (promotion/ administration cost, etc.)	
Total (excluding consumption tax)	286

Table 12: Cost breakdown of utility-scale PV systems > 1 MW (extra-high voltage)

Cost category	Typical value (JPY/W)
Hardware	
Module	69
Inverter	15
Mounting structure	19
Measurement/ monitoring instrument, etc.	19
Other (electric equipment/ transformer/ materials of electric equipment, etc.)	
Soft costs	
Installation	53.4
Site development	14
Contribution for grid connection	6
Designing/ development	0.6
Fund raising	
Other (administration cost, etc.)	
Total (excluding consumption tax)	**196**

2.4 Financial Parameters and specific financing programs

Since the FIT program started, a number of commercial PV power plants have been constructed one after another. Following this trend, financing institutions and project developers are now financing through a variety of measures. Corporate finance, project finance, financing via the Infrastructure Fund Market which was established by the Tokyo Stock Exchange (TSE) as well as issuance of green bonds have been conducted. The following are the general financing measures in Japan.

- Corporate finance: Financing is available at very low cost in case own credit line or collateral such as real estate, etc. can be prepared. However, it requires holding of assets directly for a long time and the available assets for holding can reach the limit in many cases.

- Project finance: All the assets and rights of the project are set as collateral to finance the sponsor with non-recourse or limited recourse loans.

- Asset-based lending (ABL): Facilities are set as collateral for assignment of collective movable assets and power sales are set as collateral for assignment of power sales claims to execute loans.

- Institutional loans by local governments and municipalities (start-up loan): Local governments and municipalities, credit guarantee associations and financial institutions share the risk for the loans by financial institutions at relatively low interest.

- Leasing (sale and leaseback): Leasing companies own the facilities and operating companies pay the lease fee. Sometimes, after transferring one's PV assets to leasing companies, etc., operating companies lease back the PV assets to carry out its business without owning large-scale assets. It is used by combining with other loans at times.

- Infrastructure Fund Market: The Infrastructure Fund Market was established by the Tokyo Stock Exchange (TSE). This is the market where funds investing in infrastructure facilities are listed. Dividends are paid to investors, sourced from the usage fee of infrastructure facilities which are expected to gain stable income. For PV systems, the dividends are funded by the income from selling generated electricity. In parallel, activities on private placement funds are also making progress, targeting only institutional investors.

- Green bonds: Bonds which are issued for the purpose of raising funds to be allocated to the projects which are effective to improve the environment (green projects). The raised fund is used for development of PV power plants, etc.

- Sustainability bonds: Bonds whose purpose of use of raised funds is limited to the projects that contribute to the environmental and social sustainability. The raised funds may be used for investment in PV facilities.

In addition to financial institutions, private companies are actively issuing green bonds to promote the development of PV power plants. There were also moves to establish funds through collaboration between major electric companies and developers of PV and other renewable energy sources. Tokyo Metro issued sustainability bonds to invest in the introduction of new railcars and PV facilities. The "Green Growth Strategy towards 2050 Carbon Neutrality" announced in December 2020 outlines a policy to finance innovation towards decarbonization, to work on transition finance towards steady low-carbonization, and to develop a finance system towards carbon neutrality.

Table 13: PV financing information in 2020

Residential (solar loan/ sales on credit)	Long-term prime rate + approx. 1,5 % (low-interest rate financing is available by combining with home mortgage). Preferential interest rate is available depending on financial institute.
Small to medium size (corporate loan/ sales on credit/ lease)	Long-term prime rate + approx. 1,5 - 2,0 % Guarantor or collateral are required in many cases. Even though the interest rate is high, loan without collateral is available in some cases using sales on credit. In case of the scheme of lease, the facilities are owned by the leasing companies, etc.
Large-scale PV (project finance)	LIBOR or TIBOR + approx. 1,0 - 1,5 % + up-front fee (approx. 1 % of the amount financed) which is paid to financial institutes at the time of financing
Asset-based lending (ABL)	ABL is a financing scheme in which loan is secured with collateral of assets of the power generation business such as power generation facilities, guarantee agreement, electric power selling agreement and insurance, etc.
Infrastructure Fund Market	Raising capital from private investors who seek for long-term stable dividend through listing of stocks on the Infrastructure Fund Market which was established by the Tokyo Stock Exchange (TSE). Raised capital is used for development and operation of power plants and the revenue from sales of electric power is distributed to the investors as dividend.
Green bonds	Bond which is issued for the purpose of raising funds to be allocated to the projects which are effective to improve the environment (green projects).
Sustainability bonds	Bonds whose purpose of use of raised funds is limited to the projects that contribute to the environmental and social sustainability.
Loan for solar sharing	Loan which is provided by Norinchukin Bank aiming to increase income of Japan Agricultural Cooperatives (JA) and revitalize regional economy

2.5 Specific investments programs

Under the Feed-in Tariff (FIT) program, a wide variety of business models have been introduced by taking advantage of the long-term and stable revenues from selling electricity generated by PV systems fixed for the period of 20 years under the FIT program. Basically, typical business models for investment are loan and lease programs. Other business models include the following:

Regarding the TPO model of PV systems, local governments are conducting public tenders for the lease of the roofs of public facilities such as elementary and junior high schools. Since the risks of collapse of business of the owner or removal of facilities are low compared with the lease of the roofs of private facilities, the tenders are actively responded. Also, the service for self-consumption started, which directly supplies electricity generated from PV systems installed on the rooftops of these facilities. Major electric companies, gas companies and Power Producer and Supplier (PPS) are promoting a service to install PV systems for self-consumption at no initial cost.

A tax system to support small- and medium-sized enterprises (SMEs) is utilized and a preferential tax treatment under the Act for Facilitating New Business Activities of Small and Medium-sized Enterprises was continued in FY 2020, which offers immediate depreciation of corporate tax or tax reduction, reduction of fixed property tax for PV systems for self-consumption (selling surplus electricity).

Table 14: Summary of existing investment schemes

Investment Schemes	Introduced in Japan
Third Party Ownership (TPO) (no investment)	“Roof lease model” is available, which leases only the right of use of roofs. However, this business model has legal restrictions. Long-term power purchase agreements (PPAs) to supply PV-generated electricity on-site are being promoted.
Renting	There are some cases where land is rented.
Leasing	It is easier for leasing to secure credit line than bank loans and the procedures are easier. It is not necessary to own excessive asset for a long time. The leasing model has been actively used for these reasons. Leasing is also utilized to support PV systems on farmland while continuing agricultural activities.
Utilization of taxation system	Taxation system which supports investment by small- and medium-sized enterprises (SMEs), mainly dealing with 10 - 50 kW small-scale projects for self-consumption

2.6 **Additional Country information**

Table 15: Country information

Retail electricity prices for a household (Low voltage 100 V or 200 V) (TEPCO Energy Partner)	Base rate: 286 JPY/ 10 A (1 kVA) Charge for the volume of usage: < 120 kWh/month 19,88 JPY/kWh, 120 - 300 kWh/month 26,48 JPY/kWh, > 300 kWh/month 30,57 JPY/kWh (TEPCO Energy Partner, type B, typical ampere for general household: 10 - 60 A, three-phase pricing system with prices varying depending on the volume of usage) *1: "Surcharge to promote renewable energy power generation (2,95 JPY/kWh (May 2019 - April 2020), 2,98 JPY/kWh (May 2020 - April 2021))" will be added on top of the above-mentioned charge, depending on the electricity usage. *2: Fuel regulatory costs will be added or reduced depending on the import prices of crude oil, LNG and coal as well as currency exchange (fuel regulatory cost of low-voltage supply in Kanto Area as of December 2020: -5,01 JPY/kWh). *3: There are various price plans depending on time zones. *4: Electric Power Companies (EPCO) announced various price plans of their own following the full liberalization of electric power including retail electricity prices for households from April 1, 2016. (Source: TEPCO Energy Partner's website)
Retail electricity prices for a commercial company (High voltage: ≤ 6,6 kV) (TEPCO Energy Partner)	Base rate: 1 716 JPY x (185 - power factor)/ 100 per kW Charge for the volume of usage: 17,54 JPY/kWh (summer), 16,38 JPY/kWh (other seasons) (TEPCO Energy Partner, commercial use, from October 1, 2019) *1: Contract electricity volume will be fixed according to annual maximum electricity demand. *2: Surcharge to promote renewable energy power generation will be added in the same way as the one for households. Fuel regulatory costs will be added or reduced (fuel regulatory cost as of December 2020: -4,84 JPY/kWh). *3: There are various price plans depending on time zones and seasons. (Source: TEPCO Energy Partner's website)
Retail electricity prices for an industrial company (High voltage: ≤ 6,6 kV) (TEPCO Energy Partner)	Base rate: 1 815 JPY x (185 - power factor)/ 100 per kW Charge for the volume of usage: 16,16 JPY/kWh (summer), 15,15 JPY/kWh (other seasons) (TEPCO Energy Partner, high voltage electricity (≥ 500 kW), from October 1, 2019) Base rate: 1 292,5 JPY/kW x (185 - power factor)/ 100 per kW Charge for the volume of usage: 17,37 JPY/kWh (summer), 16,24 JPY/kWh (other seasons) (TEPCO Energy Partner, high voltage electricity A (< 500 kW), from October 1, 2019)

	*1: Contract electricity volume will be fixed according to annual maximum electricity demand. *2: Surcharge to promote renewable energy power generation will be added in the same way as the one for households. Fuel regulatory costs will be added or reduced (fuel regulatory cost as of December 2020: -4,84 JPY/kWh). *3: There are various price plans depending on time zones and seasons. (Source: TEPCO Energy Partner's website)
Population	123,288 million (Statistics Bureau, Ministry of Internal Affairs and Communications (MIC), as of September 1, 2020)
Country size	377 975 km^2 (Statistics Bureau, MIC) (as of January 1, 2021)
Average PV yield in kWh/kW	1 000 - 1 100 kWh/kW/yr
Name and market share of major EPCOs (based on electricity demand of December 2020)	1 TEPCO Energy Partner 28,8 % 2 Chubu Electric Power Miraiz 16,2 % 3 Kansai Electric 14,7 % 4 Tohoku Electric 10,6 % 5 Kyushu Electric 10,2 % 6 Chugoku Electric 7,1 % 7 Hokuriku Electric 4,2 % 8 Hokkaido Electric 3,8 % 9 Shikoku Electric 3,3 % 10 Okinawa Electric 0,9 % (Source: Survey of Electric Power Statistics, METI)
Name and market share of electric utilities (based on electricity demand of December 2020)	1 Former General Electricity Utilities (10 EPCOs from Hokkaido to Okinawa) 80,1 % 2 Power Producers and Suppliers (PPS) 19,9 % (Source: Survey of Electric Power Statistics, METI)

3 POLICY FRAMEWORK

Table 16: Summary of PV support measures

	Residential		Commercial + Industrial		Centralized	
Measures in 2020	**On-going**	**New**	**On-going**	**New**	**On-going**	**New**
Feed-in tariffs	Yes (purchase of surplus electricity)	- Purchase prices for FY 2021 and 2022 were determined	Yes	- Cut in purchase price - Tender scheme (≥ 250 kW)	Yes	- Cut in purchase price - Tender scheme (≥ 250 kW)
Feed-in premium (above market price)	No	Electric companies, etc. set the post-FIT power purchase menu	No	No	No	(Scheduled to start from FY 2022)
Capital subsidies	No	No	There are subsidies for non-FIT applicant		There are subsidies for non-FIT applicant	
Green certificates	Yes		Yes		Yes (rarely used since FIT is more profitable)	
Renewable portfolio standards (RPS) with/without PV requirements	No	No	Transitional measures of the past programs are still valid	No	Transitional measures of the past programs are still valid	No
Income tax credits	Preferential tax treatment under the Act for Facilitating New Business Activities of Small and Medium-sized Enterprises - Intended for companies and individuals who file an income tax return on the blue form - Two options: immediate depreciation (100 %) or 10 % tax credit - Fixed Property Tax is reduced by 50 % for three years as a special measure					
Self-consumption	No	No	There are subsidies intended for PV for self-consumption purpose (FIT is not provided)		No	No
Net-metering	No	No	No	No	No	No
Net-billing	No	No	No	No	No	No
Commercial bank activities e.g., green mortgages promoting PV	There are various financing options as an extension of mortgage and home improvement loans. The interest rate is approx. 1,4 - 2,5 %.		Many financial institutions offer financing options for PV systems with a capacity of 10 kW or more taking advantage of FIT. Green bonds are issued, or funds are established for PV power generation.			
Activities of electricity utility businesses	No	Obligation to equip devices to address output curtailment	- Obligation to equip devices to address output curtailment started in 2015 - Promoting the development of renewable energy, including the establishment of renewable energy power generation companies - Conducting demonstration tests to realize both the introduction of renewable energy and stable management of electric grids in remote islands, etc.			
Sustainable building requirements	Based on the "Act for the Improvement of the Energy Efficiency Performance of Buildings", a gradual change to conformity obligations to energy efficiency standards is promoted. Previous non-binding obligations were changed to conformity obligations for buildings with gross floor area of 2 000 m² or more from FY 2017 onwards. Following the revision of the act in May 2019, buildings with gross floor area of 300 m² or more will be obliged to conform to energy efficiency standards, which will take effect from April 1, 2021. In case of conformity obligations, a building which primary energy consumption falls below standard as a result of assessment in a specific manner cannot be constructed. It is expected that installation of PV on buildings will increase through conformity obligations because PV is assessed as a device to reduce energy consumption.					
BIPV incentives	No	No	No	No	No	No
Other						

3.1 National targets for PV

In the Fourth Strategic Energy Plan which was approved by the Cabinet in 2014, the significance of securing safety was added as the basics of energy policy, in addition to 3E (Energy Security, Economic Efficiency and Environment). In December 2014, the Long-term Energy Supply and Demand Outlook Subcommittee was established and started discussions on the future of the realistic and well-balanced structure of energy supply and demand. The subcommittee compiled a report on July 16, 2015, and the energy mix for FY 2030 was decided. The energy mix for FY 2030 is estimated to be as follows: 22 to 24 % by renewable energy, 20 to 22 % by nuclear power, 27 % by LNG thermal power, 26 % by coal-fired thermal power and 3 % by oil-fired thermal power. The breakdown of renewable energy sources is as follows: 8,8 to 9,2 % by hydro, 7,0 % by PV, 3,7 to 4,6 % by biomass, 1,7 % by wind and 1,0 to 1,1 % by geothermal power. As a national PV target, the cumulative installed capacity of 64 GW in FY 2030 was set. This target was set by capping the surcharge for the FIT program, which is a burden on the nation, at approximately 3 trillion JPY per annum. A review on the Strategic Energy Plan started in July 2020, and discussions are being made in the direction of increasing the ratio of renewable energy. The next Strategic Energy Plan is expected to be formulated around the summer of 2021.

3.2 Direct support policies for PV installations

3.2.1 Description of support measures

- Program to promote autonomous dissemination of renewable energy-based electricity and heat

This program provides subsidy to PV systems, etc. for self-consumption and local production and local consumption of electricity. The FIT program is not applied under the subsidy.

- Project to promote making renewable energy a mainstream power source and enhancing resilience in local communities

The project provides subsidy to the models that deliver necessary dispatching ability on the demand side of existing public facilities, etc., and facilities related to establishing DC power supply systems between buildings that reduce the loss of renewable energy-based electricity.

- Subsidy for project expenses to implement a special scheme for surcharge under the FIT program

For energy-intensive industries, reduction of surcharge payment is eligible. The amount of reduced surcharge is compensated with the national budget.

- Project to support establishment of net zero energy houses (ZEHs) at detached houses

The project provides subsidies to those who build new detached houses (custom-built or ready-built) that meet the ZEH requirements and provides a fixed amount of subsidies for the installation of storage batteries.

- Project to promote decarbonization and enhancement of resilience of buildings, etc.

A certain amount of subsidy is provided for the introduction of net zero energy building (ZEB) in commercial facilities and demonstration, etc. of advanced decarbonized buildings that can supply energy even in times of disaster.

- Project to promote installation of independent and distributed energy facilities which realize disaster prevention and reduction as well as low carbonization of local communities in parallel

The project provides subsidies of a certain amount to businesses that install renewable energy equipment in public or private facilities that are designated as evacuation facilities in the case of disasters, etc. in local disaster-prevention plans, etc.

- Project to demonstrate establishment of virtual power plants (VPPs) utilizing energy resources on the consumer side

This project aims to establish a technology to control VPPs, etc. and promote expansion of renewable energy introduction, enhancement of energy conservation and levelling of the load of electricity, etc.

- Subsidy for project expenses to support promotion of renewable energy introduction in Fukushima Prefecture

This subsidy program supports demonstrative research on introduction of renewable energy-based power generation facilities, establishment and improvement of storage batteries and power transmission lines, and toward commercialization of renewable-energy related technologies in Fukushima Prefecture.

- Subsidy for the expenses of projects for comprehensive utilization of energy using regional grid lines

A certain amount of the necessary costs is subsidized for private businesses, etc. that intend to establish regional microgrids or prepare a master plan.

3.2.2 Description of support measures excluding BIPV and rural electrification

The Ministry of Economy, Trade and Industry (METI) is taking initiative in supporting introduction of PV systems under the Feed-in Tariff (FIT) program. In order to achieve a well-balanced introduction of renewable energy while curbing of national burden, the “Act on Special Measures Concerning Procurement of Renewable Energy Sourced Electricity by Electric Utilities (Renewable Energy Act or FIT Act)” was amended, and the “revised FIT Act” was enacted. Effective from April 2017, the FIT program was fundamentally reviewed and revision of approval scheme, change of method to set FITs, change of entities obliged to purchase FIT electricity, improving transparency of issues related to electric grids and revision of the surcharge reduction system were implemented. In August 2017, from the viewpoint of reducing the national burden, the Ministerial Ordinance which regulates overpanelling of PV modules after approval was revised. In December 2018, the retroactive measures were decided for the first time to deal with the FIT-approved PV projects which have not started operation for a long time. It was planned to make a drastic review on the revised FIT Act by March 31, 2021, and the Acts for Establishing Resilient and Sustainable Electricity Supply Systems were enacted in June 2020, and the name of the special measures act was amended to the Renewable Energy Promotion Act (revised Act on Special Measures Concerning Procurement of Renewable Energy Sourced Electricity by Electric Utilities, or the current FIT Act). Two types of power sources, competitive power source and locally-utilized power source were presented. As for competitive power source, it is planned to be integrated with the electricity market under the Feed-in Premium (FIP) program, as the market-integrated support for installation. As for locally-utilized power source, it is planned to maintain the FIT program after setting the requirements for local utilization. In addition, an approval cancellation system

will be newly established to deal with the FIT-approved projects which have not started operation for a long time.

3.2.3 BIPV development measures

The introduction of PV power generation into buildings is adopted in the demonstration jointly supported and promoted by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), METI and the Ministry of the Environment (MoE), in order to realize net zero energy house (ZEH) and net zero energy building (ZEB) as the measures for energy conservation of houses and buildings.

The New Energy and Industrial Technology Development Organization (NEDO) is promoting Development of Technologies for Wall installed PV Systems under the "Development of Technologies to Promote Photovoltaic Power Generation as a Main Power Source", a new program started in FY 2020. It will develop see-through solar cells and perovskite BIPV modules for aperture area of building walls, formulate guidelines, and conduct system demonstrations.

Also, METI implemented a three-year program called "International Standardization of Building-Integrated Photovoltaic (BIPV) Modules and Systems" from FY 2018 to FY 2020. As a project consignee, Photovoltaic Generation Technology Research Association (PVTEC) conducted research on standardization, covering the test method of laminate glass for BIPV modules, a new test method regardless of the size of BIPV module, etc.

3.3 **Self-consumption measures**

Table 17: Summary of self-consumption regulations for small private PV systems in 2020

PV self-consumption	1	Right to self-consume	Transfer of environmental value is available through green power certificates, etc. In other cases, the right to self-consume attributes to the consumer.
	2	Revenues from self-consumed PV	Self-consumed electricity is not subject to taxation.
	3	Charges to finance Transmission, Distribution grids & Renewable Levies	The fee will not be charged in case of self-consumption.
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	FIT for surplus electricity is set. For the post-FIT residential PV systems, electricity retailers set the purchase price.
	5	Maximum timeframe for compensation of fluxes	Measured by installing two meters (sale/ purchase) and bill separately on a monthly basis. Therefore, there is no compensation.
	6	Geographical compensation (virtual self-consumption or metering)	There is no compensation.
Other characteristics	7	Regulatory scheme duration	Surplus power purchase periods under FIT program: 10 years for < 10 kW and 20 years for ≥ 10 kW systems.
	8	Third party ownership accepted	So far, the roof-lease business has been conducted using FIT, however, introduction of PPA model in combination with electricity retailing is making progress as the purchase price declines.
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	Except for respecting the regulations set at the time of grid connection and paying the amount required by electric companies, there are no charges intended for renewable energy such as fees that arise out of ancillary service, etc.
	10	Regulations on enablers of self-consumption (storage, DSM…)	For residential PV systems, responses to the mode to promote self-consumption (Green Mode) are being promoted, in preparation for the termination of the FIT purchase period.
	11	PV system size limitations	Purchase of surplus electricity for < 10 kW systems. For ≥ 10 kW systems, there is no size limitation as far as power transmission and distribution operators permit.
	12	Electricity system limitations	There is no major barrier at present
	13	Additional features	Promotion and support measures for self-consumption have been strengthened, aiming for independence from FIT.

3.3.1 Dissemination measures related to self-consumption

From FY 2020, under the FIT program, requirements for approving power sources as locally-used power sources for self-consumption are applied to PV systems with a capacity of 10 kW - < 50 kW. The self-consumption rate of 30 % or more is one of the requirements for approval.

3.3.2 Dissemination measures related to self-consumption

Nothing special to report.

3.4 Collective self-consumption, community solar and similar measures

There is no established scheme for the use of electricity from PV systems by multiple consumers. However, the Ministry of Economy, Trade and Industry (METI) published the list of examples of smart communities, which use energy effectively within communities and is promoting smart communities across Japan through companies and organizations. The New Energy Promotion Council continues to accept applications for the “Project to promote introduction of smart communities” which is designed to contribute to establishing smart energy systems and smart communities that are resistant to disasters in the areas stricken by the Great East Japan Earthquake. In FY 2020, a call for proposals for the "II. Smart Community Development Project" was conducted, and the model project for reconstruction of Katsurao Village through establishing a smart community and other projects were adopted as subsidized projects. The expenses required for systems and equipment to be installed, project management and promotional activities are subsidized.

3.5 Tenders, auctions & similar schemes

There are two types of tenders: tender for grid connection capacity and tender for FIT capacity.

- Tender for grid connection capacity

The “tender process to secure the grid connection capacity” is conducted to bid for grid connection capacity in areas where projects of various power sources such as PV are concentrated into specific power transmission and distribution lines. Under the tender process to secure the grid connection capacity, reduction of the burden of each business operator is aimed to be achieved through cost sharing with neighbouring projects. The cost for enhancement of bulk power system is the general burden which is widely covered by consumers based on the guideline by METI. As for the enhancement cost of power transmission and distribution facilities other than those for bulk power system, the ratios of general burden and burden for business operators (specific burden) are calculated for each tender process. A ceiling price was set for the general burden, at the uniform price of 41 000 JPY/kW for all the power sources.

The Organization for Cross-regional Coordination of Transmission Operators, JAPAN (OCCTO) is the organizer of the tender process, and the tender process can be started when the requirements are satisfied following the application for the start by the business operator. General power transmission and distribution operators are in charge of the procedures, and

they present tender capacity and minimum tender price (minimum unit price of tender burden) per kW for each area. Power producers bid for the planned system capacity and tender price (unit price of tender burden) per kW and the priority for grid connection is decided in descending order according to tender price. The tender process becomes effective when the product (result of multiplication) of unit price of tender burden and capacity exceeds the construction cost for that tender. As of December 2020, a total of 41 tender processes have been started throughout Japan of which 34 processes have been completed. From October 2020, a bulk consideration process to secure the grid connection capacity was introduced to replace the tender process to secure the grid connection capacity. In case the capacity of the grid is insufficient, and construction of grid enhancement is required, the general power transmission and distribution operators formulate measures involving neighbouring projects as well. Effective grid maintenance, etc. will be available through sharing the cost of grid enhancement construction among multiple applicants for grid connection.

- Tender for FIT capacity

Following the incorporation of the tender for FIT capacity in the revision of the Renewable Energy Act which was enacted on May 25, 2016, a tender scheme for 2 MW and larger PV projects was introduced from FY 2017. The scope of PV projects subject to the tender scheme was expanded to include ≥ 500 kW from FY 2019 and ≥ 250 kW from FY 2020. The tender capacity for the sixth tender conducted in FY 2020 was 750 MW. A total of 255 projects with a total capacity of 368,87 MW participated in the tender and a total of 254 projects with a total capacity of 368,37 MW won the tender. The ceiling price which was not disclosed at the time of the tender was set at 12,00 JPY/kWh and the lowest winning price was 10,00 JPY/kWh. The winning projects are required to firstly pay the second deposit (5 000 JPY/kW) and acquire approval, and 237 projects with 354,10 MW paid the deposit. The tender capacity for the seventh tender was 750 MW and a total of 83 projects with 69,4 MW won the tender. The ceiling price which was not disclosed at the time of tender was set at 11,50 JPY/kWh, the lowest winning price was 10,48 JPY/kWh, and the highest winning price was 11,50 JPY/kWh. A total of 81 projects with 68,65 MW paid the second deposit. The results of the sixth and the seventh tenders were verified, and discussions were made on the tenders scheduled to be conducted in FY 2021. The scope of PV projects subject to the tender scheme will be maintained to include ≥ 250 kW. The number of tenders will be increased to four times a year, and the ceiling price will be announced in advance. The ceiling price will be set at 11,00 JPY/kWh for the eighth tender, 10,75 JPY/kWh for the ninth tender, 10,50 JPY/kWh for the tenth tender, and 10,25 JPY/kWh for the eleventh tender. The tender capacity will be set at 208 MW for the eighth tender, and the capacity for the ninth and subsequent tenders will be reviewed based on the results of the previous tenders. Tender capacity of 208 MW is considered as the lower limit, and if the sum of the bids received exceeds the tender capacity, the tender capacity for the next round will be increased. Additionally, the requirements for confiscation of security deposit will be relaxed, and the participation fee will be lowered to stimulate the tender scheme.

Table 18a: Results of the sixth tender for FIT capacity in FY 2020

Item	Description
Subject of the tender scheme	≥ 250 MW PV systems
Tender capacity	750 MW (a uniform tender is conducted nationwide)
Ceiling price	12,00 JPY/kWh (not disclosed at the time of bidding)
Winning bids	254 projects with a total capacity of 368,37 MW
Lowest winning price	10,00 JPY/kWh
Highest winning price	12,00 JPY/kWh
Withdrawal after winning the bid	17 projects with a total capacity of 14,27 MW
Paid the second deposit to acquire approval	237 projects with a total capacity of 354,10 MW

Table 18b: Results of the seventh tender for FIT capacity in FY 2020

Item	Description
Subject of the tender scheme	≥ 250 kW PV systems
Tender capacity	750 MW (a uniform tender is conducted nationwide)
Ceiling price	11,50 JPY/kWh (not disclosed at the time of bidding)
Winning bids	83 projects with a total capacity of 69,40 MW
Lowest winning price	10,48 JPY/kWh
Highest winning price	11,50 JPY/kWh
Withdrawal after winning the bid	2 projects with a total capacity of 0,75 MW
Paid the second deposit to acquire approval	81 projects with a total capacity of 68,65 MW

3.6 Other utility-scale measures including floating and agricultural PV

Although there are no support measures to promote the introduction of floating PV (FPV) systems, the installed capacity of FPV systems in static freshwater such as reservoirs and regulating reservoirs is increasing. There are no examples of installations in coastal and offshore areas. Following the typhoon-induced damage and fire at Japan's largest FPV plant (12,7 MW) in September 2019, the Interpretation of Technical Standards of Electric Facilities was revised to specify requirements, etc for supporting structures of FPV systems. The revision is expected to lead to an increase in the installation of FPV systems with higher safety standards than before.

In accordance with the Act on Promoting Generation of Electricity from Renewable Energy Sources Harmonized with Sound Development of Agriculture, Forestry and Fisheries enacted in 2013, efforts are being made to properly develop renewable energy generation facilities in

agricultural, forestry and fishing villages in coordination with land use, etc., and to contribute to the sound development of the regional agriculture, forestry and fisheries.

PV systems on farmland (solar sharing), in which farming and PV power generation are carried out at the same time by sharing the sunlight are promoted, aiming to expand the size of the farming business and encourage the transition to the sixth industry through income from the sale of agricultural products as well as from the sale of electricity and in-house use of the generated electricity. As shown in Table 19, the Ministry of Agriculture, Forestry and Fisheries (MAFF) issued a notification on the PV systems on farmland in 2013, which clarified the handling of PV systems on farmland, and the installed capacity increased since then. In 2017, the Cabinet of then Prime Minister Shinzo Abe approved a policy to promote PV systems on farmland in the Future Investment Strategy 2017, and in 2020 in the Follow-up on the Growth Strategy. MAFF is encouraging the introduction of PV systems on farmland by publishing guidebooks every year since 2017 and by the regulatory reform to extend the term of permission for conversion of farmland for PV installations from three years to ten years in May 2018. In April 2020, the Ministry of Economy, Trade and Industry (METI) eased the requirements for approving power sources as locally-used power sources for small-scale commercial PV systems on farmland under the FIT program. Cumulative installations of PV systems on farmland in Japan are estimated to be more than 3,000 systems, or more than 600 MW.

Table 19: Policies related to PV systems on farmland (solar sharing)

Period	Responsible organization	Details
March 2013	MAFF[1]	Issuance of agricultural promotion notification No. 2657 (FY 2012) "Handling of PV power generation facilities, etc. under the permission system of farmland conversion, by installing PV systems above farmland with supporting poles and continuing agricultural activities".
June 2017	Cabinet of Prime Minister Shinzo Abe	PV systems for agricultural applications were introduced in the Investments for the Future Strategy 2017
November 2017	MAFF	Release of guidebook by MAFF
April 2018	MoE[2]	PV systems for agricultural applications were introduced in the Fifth Basic Environment Plan
May 2018	MAFF	Revision of the notification (Permission term for temporary farmland conversion was conditionally extended to within 10 years) "Changes in handling permission of farmland conversion for PV power generation facilities for agricultural applications"
April 2020	METI[3]	As part of the revision of the FIT program, requirements for approving power sources as locally-used power sources for self-consumption for small-scale commercial PV systems (low-voltage interconnection) were eased on the condition that the conversion of farmland for PV system installations is allowed for ten years
July 2020	Cabinet of Prime Minister Shinzo Abe	In the Follow-up on the Growth Strategy, PV systems on farmland were positioned to be disseminated nationwide by preparing a guide for farmers who plan to install PV systems on farmland for self-consumption, etc. by FY 2022

1: Ministry of Agriculture, Forestry and Fisheries

2: Ministry of the Environment

3: Ministry of Economy, Trade and Industry

3.7 Social Policies

Although no specific programs are available for low-income families, regional public organizations are supporting the introduction of renewable energy and conducting advanced model projects to establish independent and distributed energy systems at public facilities, etc. and enhance the resilience of the local communities. Under the Program to promote autonomous dissemination of renewable energy-based electricity and heat, a part of costs for consideration of commercialization and facility installation will be subsidized for such cases as follows: 1) Projects which are conducted with active participation and involvement of regional public organizations; 2) Activities on installation of PV systems mainly on farmland on the premise of continuing agricultural activities; 3) Projects to install and utilize energy storage systems, etc. Under the Project to promote installation of independent and distributed energy facilities which realize disaster prevention and reduction as well as low carbonization of local communities in parallel, a part of costs for facility introduction will be subsidized for projects which introduce renewable energy systems such as PV and storage batteries, etc. to public and private facilities that serve as evacuation centers and disaster prevention bases in case of disasters according to local disaster-prevention plans, etc.

3.8 Retrospective measures applied to PV

Since the start of the FIT program in July 2012, installation of ≥ 10 kW commercial PV systems rapidly increased, and the purchase price (FIT) more than halved from 40 JPY/kWh for FY 2012 to 12 JPY/kWh for FY 2020. Under the scheme where FIT is set at the time of approval, there are a large number of FIT-approved PV projects which have not started operation for a long time while keeping the high FIT, which brought up the following issues: 1) Concerns over the future increase in the financial burden of the nation; 2) Stagnation in new development and cost reduction and 3) Occupation of open grid capacity. In order to further increase the installed capacity of renewable energy while curbing the national burden, new measures were decided on December 5, 2018 to handle the FIT-approved PV projects which have not started operation. Among the commercial PV projects which acquired FIT approval between FY 2012 and FY 2014 and have far exceeded three years, which is an indicative period of starting operation after acquisition of approval, the following measures have been taken for the projects for which the deadline for starting operation was not set: 1) FIT responding to the timing of starting operation is applied instead of the higher FIT based on the cost at the time of approval, if the preparations for starting operation have not started by the end of FY 2018 (March 31, 2019) in principle and 2) One-year deadline for starting operation is set in principle, in order to secure the start of operation as early as possible. In FY 2020, the subjects of the measures expanded to include the PV projects which were approved between FY 2012 and FY 2016 and for which the deadline for starting operation is not set. From April 2022, the approval cancellation system will be newly introduced to set the deadline of approval cancellation in addition to the existing COD deadline. For the projects whose COD deadline is March 31, 2022 or earlier, a grace period before cancellation of approval will be granted upon confirmation of submission of an application of construction start for grid connection on April 1, 2023, and if the submission is not confirmed, the approval will be cancelled at that point.

3.9 Indirect policy issues

3.9.1 Rural electrification measures

Since the entire nation is almost 100 % electrified in Japan, there are no rural electrification measures. However, there are support measures for remote islands in order to reduce carbon emissions in remote islands not having grid connection with the mainland. These islands depend on expensive fossil fuel-based energy such as high-cost diesel power generation, therefore, they are susceptible to the changes in fossil fuel prices and have an issue of large amount of CO_2 emissions. Given this, METI and the Ministry of the Environment (MOE) have carried out dissemination measures for renewable energy such as PV and installation of storage batteries in remote islands to reduce fossil fuel usage. Since the feed-in tariff (FIT) program was introduced, installation of PV systems has increased even in the remote islands with idle lands. However, problems such as suspension of responses to applications for grid connection contracts and output curtailment became obvious because of the limit of adjusting power which was caused by limited demand. To address these problems, a number of measures were announced in 2020.

The Ministry of the Environment (MoE) is planning to initiate a demonstration project to supply the necessary electricity from renewable energy at Minami-Tori-shima, an island located at the easternmost tip of Japan, from FY 2021. MoE allocated 350 MJPY for related expenses in its budget request for FY 2021. It is planned to install renewable energy power generation facilities such as PV systems and storage batteries to examine whether it is practical to deploy them on the isolated island 1 800 km away from the mainland Japan.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) published a list of "needs" or local issues which local governments are facing and "seeds", such as new technologies from private companies, with the aim of realizing the "Smart Island" concept. MLIT is aiming to revitalize the remote islands by combining the needs of local governments in fields such as transportation, energy and disaster prevention with the seeds of businesses. In the field of energy, technologies to address output fluctuations, etc. are proposed in anticipation of the large-volume introduction of renewable energy. In conducting the demonstration on the remote islands, it is planned to make an effective use of the storage batteries installed in households while asking for the cooperation of storage battery manufacturers.

3.9.2 Support for electricity storage and demand response measures

With regard to demand response, METI announced a public invitation for “Subsidy for project expenses to demonstrate establishment of virtual power plants (VPPs) utilizing energy resources on the consumer side”, carried out by the Sustainable open Innovation Initiative (SII). The public invitation was conducted in the following four categories: A) Projects to establish VPP infrastructure; B-1) VPP aggregator projects; B-2) V2G aggregator projects and C) Projects to promote introduction of VPP/ V2G resources. For the Projects to promote introduction of VPP resources, subsidy is granted to support the equipment cost including storage batteries and the installation cost. In FY 2020, a subsidy program was implemented for storage systems of both residential and industrial applications (storage batteries + inverters). The target price of a storage system was set at 150 000 JPY/kW, and 60 000 JPY per one kW of rated capacity (capped at one third of the price) was subsidized for those below the target price.

As for residential storage batteries, target prices ranging from 60 000 JPY/kWh to 90 000 JPY/kWh were set in the above-mentioned “Subsidy for project expenses to demonstrate establishment of virtual power plants (VPPs) utilizing energy resources on the consumer side”, and storage batteries purchased at the prices below the target price were subsidized at the rate of 20 000 JPY/kWh. As for the industrial electricity storage, etc., the introduction of PV systems for self-consumption and storage batteries, etc., which contribute to the promotion of decarbonization and disaster prevention, was carried out under the "Project to support transition to a decarbonized society viewing supply chain reform and reshoring production bases to Japan", as a subsidy program of MoE.

The MoE also provided subsidies for the installations of net zero energy house (ZEH) and demonstration projects of net zero energy building (ZEB) as a subsidy program. “Project to support net zero energy house (ZEH)” was implemented by the SII as a liaison for this program. In case of introducing a storage system to the eligible ZEH, 20 000 JPY is granted for one kWh of storage capacity with the cap of the subsidy amount of 200 000 JPY.

Following the establishment of negawatt trading market in April 2017, a mechanism in which negawatt can be traded as a supply capacity as is the case with the generated electricity was developed. Following the full liberalization of electricity retailing, general power transmission and distribution operators are conducting public invitation for dispatching ability used for frequency control and adjustment of supply and demand balance within the electricity supply service area. In order to utilize demand response (DR) as a dispatching ability, requirements for participation in public invitations have been improved to make it easier for DR operators to participate in the public invitation.

Dissemination of residential storage batteries for stationary applications is progressing thanks to the subsidies provided by the support projects of ZEH. Many of them were for emergency use at the time of electric outage, etc. or operated in the mode to store electricity in the middle of the night and discharge in the daytime. However, the surplus power purchase under the FIT program started to be terminated for PV systems from November 2019, and the operation in demand response mode started, following the change of the operation mode.

METI held the "Study group for expanding the dissemination of stationary storage batteries" four times between November 2020 and February 2021, and presented the measures for expanding the dissemination of storage batteries until 2030.

3.9.3 Support for electric vehicles (and VIPV)

Since FY 2009, METI has been providing subsidy for the introduction of clean energy vehicles. This scheme has been reviewed following the change of policy, etc. In FY 2020, subsidies were granted through the "Subsidy for project expenses to introduce clean energy vehicles that can be used in times of disaster" which was included in the third supplementary budget. The subsidy is available for individuals who purchase electric vehicles (EVs), plug-in hybrid vehicles (PHVs), and fuel cell vehicles (FCVs). The maximum subsidy amount is 800 000 JPY for EVs, 400 000 JPY for PHVs and 2,5 MJPY for FCVs. In addition, subsidies for charging facilities are also provided to individuals and businesses, covering one half of the cost of the facilities or a maximum of 750 000 JPY. Construction costs are subsidized at a fixed amount, with the maximum amount of 400 000 JPY for individuals or 950 000 JPY for businesses. Aside from government subsidies, local governments also provide subsidies for the introduction of EVs.

While there are no specific subsidies from the government for vehicle-integrated PV (VIPV), NEDO provides public funding support for R&D and demonstration to promote the spread of PV mounted on vehicles, based on the accomplishments of the PV-Powered Vehicle Strategy Committee and the projects to promote the development of innovative and high-performance solar cells. Based on the accomplishments so far, VIPV is expected to be an opportunity to create new markets and solve energy and environmental issues, and the future support measures are anticipated.

3.9.4 Curtailment policies

Power generation amount of renewable energy sources such as PV varies depending on the natural environment. Accordingly, in case the power generation amount within a region exceeds the local electricity demand, output curtailment is conducted to maintain stable supply of electricity. Based on the priority dispatch rules which were stipulated by the Ordinance for Enforcement of the FIT Act and Operational guidelines for the power transmission and distribution business, etc. by the Organization for Cross-regional Coordination of Transmission Operators, JAPAN (OCCTO), curtailment of thermal power generation, operation of pumped storage power generation and utilization of inter-regional interconnection lines will be conducted. In case where the power generation amount remains excessive even with these measures, output curtailment of renewable energy sources will be conducted. In October 2018, the first output curtailment on the mainland was conducted on the Kyushu mainland. Following this, the following efforts have been made to reduce the output curtailment: 1) Further utilization of inter-regional interconnection lines; 2) expansion of online control to enable flexible adjustment; 3) reduction of the minimum output capacity of thermal power generators and 4) economic adjustment of output curtailment to secure fairness among power producers and efficient output curtailment. The economic adjustment of output curtailment is called online proxy curtailment which is under consideration for early introduction. Kyushu Electric reported that it reviewed the operation method of output curtailment in October 2019 and reduced output curtailment capacity by about 20 % through to March 2020. Consideration is also underway regarding the application of non-firm connection, which is scheduled to be applied to the bulk power system from January 2021. As for the local grid, Tokyo Electric Power (TEPCO) and NEDO plan to start a trial project from April 2021. Regarding the method to control congestion in the grid where non-firm connection is applied, it is planned to adopt re-dispatching method by general power transmission and distribution operators.

3.9.5 Other support measures

3.9.5.1 International policies affecting the use of PV Power Systems

In order to achieve the reduction target of greenhouse gas (GHG) emissions which was presented in the Intended Nationally Determined Contributions (INDC) of Japan, which was approved by the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21), the national government formulated the “Plan for Global Warming Countermeasures” in May 2016, in which a mid-term plan for Japan’s global warming prevention measures is indicated. This plan specifies the actions to be addressed by the national government, local governments, business operators and general public and the national measures and draws a path for achieving targeted reduction, as well as establishing a goal to reduce the GHG emissions by 80 % by 2050 as a long-term target. In this plan, it is stated that renewable energy should be “introduced

to the maximum extent possible". In November 2016, the Japanese government approved the accord on the Paris Agreement in the plenary session of the House of Representatives and established goals to reduce the GHG emissions by 26 % by FY 2030 compared to FY 2013 (25,4 % decrease from FY 2005) and by 80 % by 2050. In 2020, a new target to further accelerate this goal was announced. Prime Minister Yoshihide Suga declared in his first Policy Speech at the 203rd extraordinary session of the Diet held on October 26, 2020, that "Japan aims to reduce greenhouse gas emissions to net zero by 2050, achieving carbon neutrality and decarbonized society by 2050. In this speech, he presented the realization of a green society which creates a virtuous circle between the economy and the environment as a pillar of Japan's growth strategy. He also mentioned the maximum introduction of renewable energy as well as the promotion of nuclear power policies with safety as the highest priority and explained the policy to achieve both decarbonization and stable power supply. Furthermore, he indicated his intention of accelerating commercialization of progressive innovation such as the next-generation solar cells and carbon recycling, considering them as the key factors, and announced the drastic conversion of the policies for coal-fired thermal power generation. In response to this decision, the Ministry of Economy, Trade and Industry (METI) announced that it will formulate an action plan in the end of 2020 that will show the way to achieve this goal by 2050. METI will discuss them intensively at the Advisory Committee for Natural Resources and Energy and Green Innovation Strategy Meeting. Meanwhile, the Ministry of the Environment (MoE) announced a policy to revise the Law Concerning the Promotion of the Measures to Cope with Global Warming to promote introduction of renewable energy.

3.9.5.2 The introduction of any favourable environmental regulations

- Establishment of a disaster-resilient distributed power system (the revision of the Electricity Business Act)

Concerning the promulgation of the "Acts for Establishing Resilient and Sustainable Electricity Supply Systems (Act to revise a part of the FIT Act and the Electricity Business Act, in order to promote establishment of the resilient and sustainable electricity supply framework)" in June 2020, the partial revision of the "Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities" has significant direct impacts on PV power generation.

In addition to the above, the partial revision of the Electricity Business Act has led to promoting the enhancement of cooperation at the time of disaster, strengthening the resilience of power transmission and distribution networks and the establishment of the disaster-resilient distributed electricity system. Above all, the partial revision is expected disseminate distributed power sources including PV power generation taking root in local communities by the following approaches, in order to disseminate the disaster-resilient distributed electricity system: 1) the power distribution business is positioned so that its distribution network can be operated as an independent network in case of emergency, 2) the aggregators are positioned as the electricity supplier who aggregate distributed power sources, etc. and supply electricity from them and 3) the rules of the Measurement Act were rationalized to promote utilization of distributed power sources such as storage batteries for residential use. Preparation of the detailed design is underway for the implementation of the revised Act in April 2022.

- Enhancement of energy conservation standards in buildings and the promotion of net zero energy house (ZEH) and net zero energy building (ZEB)

The “Act to revise a part of the Act on the Improvement of Energy Consumption Performance of Buildings (the revised Building Energy Efficiency Act)” was promulgated in May 2019. Under the revised act, non-residential buildings that have a floor area of 300 m^2 or more are required to comply with the energy conservation standards and newly-built houses/buildings that have a floor area of 300 m^2 or more are required to notify the energy conservation plan. Newly-built houses (floor area of less than 300 m^2) are not required to comply with the standards under the revision this time, though they were included in the targets of the obligation in the initial plan. However, the ranges of the target for which the architect’s accountability for the conformity with the energy conservation standards is required and the ranges of the target which must conform to the standards of the Housing Top-Runner Program were expanded (the obligation to notify the energy conservation plan and the Housing Top-Runner Program are already implemented and the rest will take effect in April 2021). Concerning the energy conservation standards (the standards of energy consumption performances), it requires that the design value of the “primary energy consumption”, which is the subtraction of the amount of energy generated by PV, etc. from the accumulated amount of energy consumption such as air conditioning and ventilation, lighting, hot-water supply, etc., is below the standard value which is set for each region.

Three ministries, namely METI, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the MoE, jointly formulated a roadmap of the net zero energy house (ZEH) in December 2015. The roadmap aims to disseminate houses whose primary energy consumption is zero or below by improving energy saving performances such as heat insulation, and strengthening introduction of energy creation. In FY 2018, the roadmap was reviewed, which set targets to make more than half of the newly built custom-built detached houses built by homebuilders ZEH by FY 2020, and to make all the newly-built houses ZEH on average across Japan by FY 2030. The definition of ZEH is subdivided, such as “Nearly ZEH (available in limited regions)”, “ZEH+ (the higher-grade ZEH)”, “ZEH+R (a disaster-response type ZEH)”, “ZEH-Oriented (ZEH for small rooftops, etc., generation of energy is not required)” and “ZEH-M (Ready/Oriented, ZEH for condominiums with multiple dwelling units called “Mansion” in Japanese)”.

Similarly, net zero energy building (ZEB) is a building which aims to make the balance of annual primary energy used by the building zero, while realizing the comfortable interior environment. The roadmap proclaims the goals to realize ZEB for newly-built public buildings, etc. by the scale/use of the buildings by FY 2020 and to realize ZEB for all newly-built buildings on average by FY 2030. In addition to “Nearly ZEB” and “ZEB Ready (50 % or more reduction of primary energy consumption by energy conservation and generation)” which have been popular, the government established “ZEB Oriented (energy generation is not required)” for the rapid dissemination of ZEB, since it is difficult to make commercial buildings completely zero-energy buildings.

Homebuilders, mainly the major ones as well as major construction companies, have been enhancing activities on ZEH and ZEB and proposing houses and buildings equipped with PV systems, home energy management systems (HEMS) and storage batteries. Some homebuilders achieved their targets for FY 2020 ahead of schedule. The Tokyo Metropolitan Government (TMG) declared its commitment to realize "Zero Emission Tokyo," contributing to net zero CO_2 emissions by 2050, and set the goal of converting all buildings in Tokyo to ZEB in its "Zero Emission Tokyo Strategy," which outlines specific initiatives and roadmaps.

3.9.5.3 Policies relating to externalities of conventional energy

While the operation of nuclear power plants is suspended after the Great East Japan Earthquake, electricity supply capacity has been secured by increasing the operation of thermal power generation facilities as shown in Figure 1. The share of thermal power generation in the generation mix was approximately 65 % in FY 2010, before the earthquake, which increased to around 84 % in FY 2015. In FY 2019, it slightly decreased to approximately 76 %. While the share of fossil fuels decreased, the share of nuclear power and renewable energy increased to about 6 % and about 18 %, respectively.

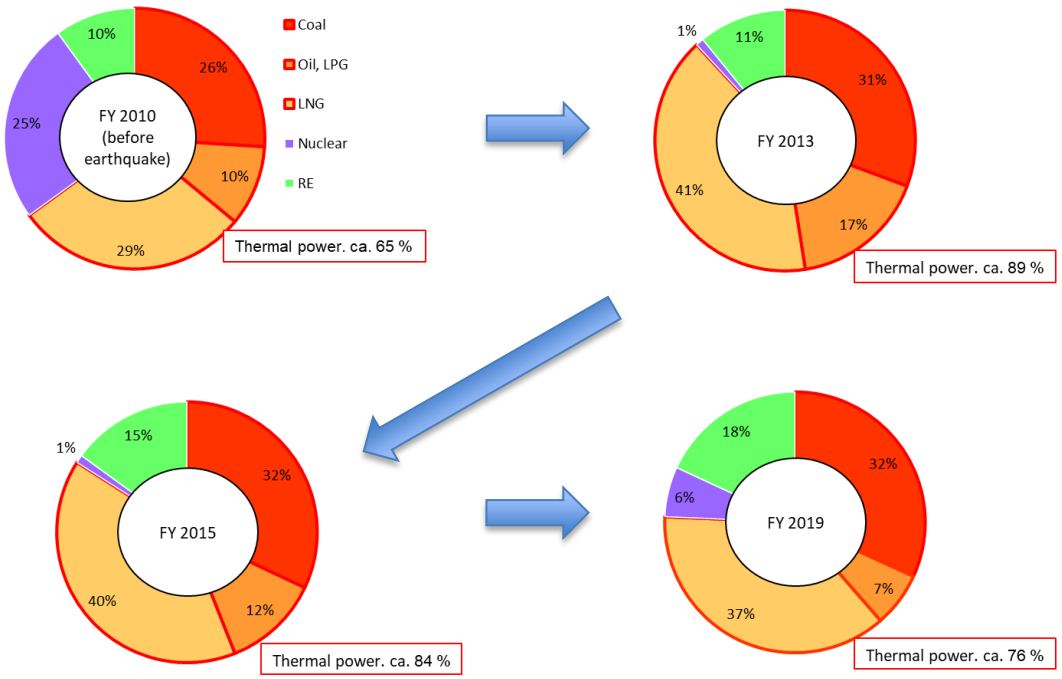

Figure 1 Generation mix of the electric companies

Source: Report on electricity supply-demand verification (October 2017) and White Paper on Energy 2021

Following the increased operation of thermal power generation facilities, greenhouse gas emissions in the electricity sector has increased to 573 million t-CO_2/year in FY 2013 from 438 million t-CO_2/year in FY 2010, before the earthquake. In recent years, greenhouse gas emissions are turning to the declining trend, due to promotion of energy conservation, expansion of renewable energy introduction, restart of nuclear power plants, and so on. To achieve the mid-term target of the Paris Agreement, that is, by FY 2030, to reduce greenhouse gas emissions by 26 % from the FY 2013 level, further reduction of emissions is required. Under such circumstances, the Fifth Strategic Energy Plan was approved by the Cabinet in July 2018, which shows the direction of Japan's new energy policy toward 2030 and further toward 2050. Japan will be committed to promoting efforts to realize the energy mix for 2030 and make renewable energy a mainstream power source. In the Strategic Energy Plan, it is stated that renewable energy does not emit greenhouse gases and is a promising and important domestic energy source that can contribute to energy

security as well, although there are currently various issues in terms of cost and stable supply. From the viewpoint of stable supply, the capacity market was created as a medium- to long-term measure to secure supply capacity in response to growing concerns about a shortage of supply capacity as an increasing number of existing thermal power plants are becoming idle or retiring. The main auction was held in July 2020, targeting to start supply in FY 2024.

- PV's contribution during peak demand hours

After the Great East Japan Earthquake, electricity supply and demand status has become tight in Japan. Accordingly, METI evaluates the actual performances and makes a forecast on electricity supply and demand from the viewpoint whether electricity can surely be supplied to cover the demand in peak hours in the summer and in the winter. Following full liberalization of electricity retailing from April 1, 2016, from the winter of 2016, supply and demand of all areas including Power Producers and Suppliers (PPS) were included in the scope of verification in addition to former General Electricity Utilities. Verification is conducted by OCCTO and the actual power supply capacity records of PV systems are also evaluated.

As shown in Table 20, in the summer of 2019, electricity supply capacity in the peak hours of the day with the peak demand was expected to be 13,02 GW (excluding Okinawa Prefecture), but the actual supply capacity was 30,86 GW in total. It is estimated that the supply capacity in the summer of 2020 will be 15,10 GW (excluding Okinawa Prefecture), which is higher than the previous year's result. This estimation assumes that, since the PV power generation cannot always expect sufficient irradiation in the peak hours of electricity demand, supply capacity of PV is expected conservatively.

Table 20: Evaluation of power supply capacities of PV systems in the summer by electric companies in Japan (MW)

Former General Electricity Utilities by area		Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Total
Summer of 2020 (Actual)	Assumption	180	1 320	3 560	2 280	310	1 620	1 480	770	1 520	13 020
	Actual supply capacity records on a day and an hour of peak demand	**400**	**3 350**	**7 280**	**5 160**	**690**	**3 250**	**3 000**	**1 610**	**5 930**	**30 860**
	Actual ratio of adjustment factor (%) records on a day of peak demand	**20,0**	**59,7**	**46,8**	**55,9**	**64,3**	**53,8**	**62,8**	**60,5**	**59,5**	
	Peak demand date and hour in Japan	2 - 3 p.m., Friday, Aug 2, 2019									-
	Peak electricity demand	4 310	14 120	56 040	26 240	5 130	29 110	10 830	5 330	16 370	167 470
	PV ratio to peak demand	9,3 %	23,7 %	13,0 %	19,7 %	13,5 %	11,2 %	27,7 %	30,2 %	36,2 %	18,4 %
Summer of 2021 (Forecast)	Estimated peak demand hours	2 - 3 p.m.	2 - 3 p.m.	2 - 3 p.m.	2 - 3 p.m.	2 - 3 p.m.	2 - 3 p.m.	2 - 3 p.m.	2 - 3 p.m.	2 - 3 p.m.	-
	Estimated supply capacity	**190**	**1 800**	**4 080**	**2 810**	**400**	**1 710**	**1 750**	**880**	**1 480**	**15 100**
	Adjustment factor (%)	**9,0 %**	**25,9 %**	**25,9 %**	**28,7 %**	**35,8 %**	**27,6 %**	**29,7 %**	**32,8 %**	**13,8 %**	-

Source: Report on electricity supply-demand verification (October 2020 and May 2021)

*1: "Supply capacity" of PV power generation is the installed capacity of PV systems which contributed to the peak demand hours. With regard to PV power generation, since the PV power generation cannot always expect sufficient irradiation in the peak hours of electricity demand, in the preliminary assumptions, the stable power source replacement value of thermal power and other power sources based on the calculation of expected unserved energy (EUE) was included in the supply capacity.

*2: PV generated power used for self-consumption is evaluated as energy conservation and not included in supply capacity. Only the surplus electricity connected to electric grids is evaluated here.

*3: Detailed numbers for the adjustment factors are available on the website of the Organization for Cross-regional Coordination of Transmission Operators, JAPAN (OCCTO). The OCCTO's electricity supply plan uses a stochastic calculation method to assess the reliability of electricity supply, and the supply capability of power sources is calculated as follows: Supply capacity = Installed capacity x Adjustment factor. The adjustment factor varies by area and is published as a reference material in the OCCTO's electricity supply plan. For further information, please visit the following website (Japanese only):
https://www.occto.or.jp/kyoukei/teishutsu/files/210601_2021kyoukei_sankoushiryou.pdf

3.9.5.4 Taxes on pollution (e.g. carbon tax)

In Japan, "Tax for Climate Change Mitigation" has been imposed since October 2012, which requires the public to widely and fairly share the burden for the usage of all the fossil fuels including petrolium, natural gas and coal, in proportion to their enviromental load (CO_2 emissions). This tax is imposed on top of the conventional Petroleum and Coal Tax, in proportion to the usage amount of fossil fuels. From April 2016 (start of FY 2016) onwards,

when the phased tax rate increase was completed, the definitive tax rates have been applied and the petroleum and coal taxes, including the additional amount, are 2 800 JPY/kl for crude oil and oil products, 1 860 JPY/t for hydrocarbon gas and 1 370 JPY/t for coal.

The FY 2020 tax revenue from the petroleum and coal tax, including the Tax for Climate Change Mitigation, was 655 BJPY. Of this amount, revenue from the Tax for Climate Change Mitigation was 234 BJPY, which will be used for implemention of various measures to curb energy-based CO_2 emissions including energy-saving measures, dissemination of renewable energy, and greening and streamlining of fossil fuels. For instance, revenue from the Tax for Climate Change Mitigation is utilized as financial resources for projects to subsidize the introduction of independent and distributed energy systems, the introduction of renewable energy and storage batteries through the use of PPAs, and the purchase of electric vehicles powered 100 % by electricity generated from renewable energy source, etc., as well as for the development and demonstration of technologies such as ZEB, floating offshore wind power, and hydrogen derived from renewable energy, etc. As for the effets of CO_2 emisison reduction via the Tax for Climate Change Mitigation, price effects (effects of curbing CO_2 emissions via taxation) and effects on financial resource (tax revenue for curbing energy-based CO_2 emissions) are expected. According to the estimate by a research institute on the price effects and the effects on financial resource by the Tax for Climate Change Mitigation, it is estimated to reduce CO_2 emissions by approximatly 0,5 % to 2,2 %, or reduce emission amount by around 6 million t to 24 million t by 2020 compared to the 1990 levels. As a result, it was estimated that the price effects of - 3,2 % or 3,2 million t and the effects on financial resources of 3,55 million t were produced in FY 2019.

The subjects of taxation under the Tax for Climate Change Mitigation are limited and the usage of tax revenue is limited to measures to address global warming. Accordingly, in order to archieve the commitment of the Paris Agreement, the Ministry of the Environment (MoE) started discussion on adopting the environment tax (carbon tax) which expands the subjects of taxation as well as the usage.

MoE started studying carbon pricing in January 2017 and discussions are ongoing. MoE has been discussing carbon pricing since FY 2018 in the Subcommittee on the Use of Carbon Pricing under the Global Environment Committee of the Central Environment Council. As for the options of carbon pricing, various methods such as carbon border adjustment mechanism (CBAM) and internal carbon pricing within a company, in addition to carbon tax, cap-and-trade and credit trading, are being discussed. MOE is examining how carbon pricing can lead to growth, including system design, with the aim of increasing the share of renewable energy in the energy mix in 2030 and achieving carbon neutrality by 2050, both of which are government goals. In February 2021, METI launched a study group on economic methods for achieving carbon neutrality in the world as a whole, etc., and started discussions on the system design of carbon pricing that would contribute to Japan's growth.

3.9.5.5 National policies and programmes to promote the use of PV in foreign non-IEA countries

In order to achieve the reduction target of greenhouse gas emissions, Japan has implemented the Joint Crediting Mechanism (JCM). The JCM is a mechanism in which credits issued depending on the reduced amount of greenhouse gas emissions are utilized to achieve target of Japan’s greenhouse gas emissions reduction through support for

dissemination of high-quality low carbon technologies, etc. to developing countries. As of June 2021, Japan has signed the bilateral documents with 17 countries namely Mongolia, Bangladesh, Ethiopia, Kenya, Maldives, Vietnam, Laos, Indonesia, Costa Rica, Palau, Cambodia, Mexico, Saudi Arabia, Chile, Myanmar, Thailand and the Philippines. In these countries, from FY 2013 to FY 2020, more than 600 funding projects and demonstration projects (MoE/ METI) were adopted. As of June 2021, 110 PV-related projects with a total capacity of approximately 1,9 GW have been promoted by Japanese companies. With these projects, support has been provided to projects to introduce PV systems and various feasibility studies have been conducted including the following: introduction of high-efficiency PV systems and appropriate O&M; application of PV systems as a substitute for grid elecricity by diesel power generation or fossil fuel power generation, as well as a substitute for self-generation, and installation of floating PV systems.

In addition to JCM, international demonstration projects through NEDO started in FY 1993, and "International Demonstration Project on Japan's Energy Efficiency Technologies" is being implemented from FY 2017. Although no demonstration projects focusing solely on PV technology are currently being conducted, technology demonstration projects related to technologies that enable the introduction of renewable energy in regions where dissemination of renewable energy is slow due to the harsh natural environment and technologies that enhance the competitiveness of the model of local production and local consumption of energy are being carried out. In non-IEA countries, a demonstration study on portable battery sharing was conducted in Indonesia, and a smart community demonstration project was conducted in Slovenia in 2020.

The Japan International Cooperation Agency (JICA) conducted inter-governmental cooperation, through grant aid or loan assistance, as well as technological cooperation based on requests from developing countries. It supports developing master plans mainly for rural electrification using PV power generation through the study of development for rural electrification. In 2020, Chubu Electric was commissioned by JICA to undertake the "Capability Improvement Project for Achieving the Electricity Sector Master Plan in the Democratic Socialist Republic of Sri Lanka" jointly with Nippon Koei. This project provides technical training and transfer of technology to Sri Lanka, including the development of a power transmission and distribution network to realize an optimal energy mix and promote the introduction of renewable energy, as well as power output forecasting. In Vietnam, the Asian Development Bank (ADB) signed a contract to provide financing for Vietnam's and Southeast Asia's one of the largest 257 MW PV project by using the Leading Asia's Private Infrastructure Fund (LEAP) which JICA funded (93 MUSD in LEAP financing). JICA signed a loan contract with Sistema de Crédito Cooperativo (Sicredi), one of the Brazil’s largest credit union alliances, to provide up to 100 MUSD for "Distributed Solar Power Generation Project".

The Japan Bank for International Cooperation (JBIC), in its environmental initiatives, contributes to addressing global environmental issues through a variety of financial options to support the export of sophisticated environmental technologies from Japan and overseas development. As part of these initiatives, in January 2020, JBIC established the "Growth Investment Facility" as a financing option to support the development of high-quality infrastructure. Under this facility, JBIC provides loans for projects aimed at reducing greenhouse gas emissions, such as renewable energy, energy conservation and green mobility, and for other projects aimed at protecting the global environment. In 2020, JBIC provided project finance for Qatar's first large-scale PV project (800 MW) under the Growth Investment Facility. In Thailand, JBIC financed a Thai subsidiary of West Holdings, a

Japanese company, for its energy service company (ESCO) business under the Growth Investment Facility. The loan is intended to be used for the installation of PV systems in its ESCO business. In India, as part of its “GREEN (Global action for Reconciling Economic growth and ENvironmental preservation)” support program, the Growth Investment Facility was used to provide a loan to NTPC of India for PV projects and the projects to installenvironment-friendly equipment. Moreover, JBIC provides assistance to the projects registered in the Joint Crediting Mechanism (JCM) through co-financing with private banks.

3.10 Financing and cost of support measures

Under the FIT program, the largest incentive for PV dissemination, which took effect in July 2012, all the electricity consumers share the cost which electric companies paid for purchasing the electricity generated by renewable energy power generation systems, in the form of surcharge in proportion to the amount of electricity they consume. The surcharge is added to the electricity bill. In order to remove regional discrepancies in surcharge collected by electric companies, “Organization to adjust cost burden” (consigned by the Green Investment Promotion Organization (GIO)) collects the surcharge once and distribute the grant to electric companies in proportion to their records of purchasing renewable energy-based electricity. Under this scheme, however, high-volume electricity consumers such as manufacturers are entitled to reduction of surcharge under the FIT program. METI covers the expenses required to compensate the losses generated from the surcharge reduction and incurred by the Organization to adjust cost burden in the form of subsidy through the national budget. The budget amount is; 7 BJPY in FY 2012, 19,1 BJPY in FY 2013, 29,0 BJPY in FY 2014, 45,6 BJPY in FY 2015, 48,3 BJPY in FY 2016, 29,2 BJPY in FY 2017, 15,5 BJPY in FY 2018, 8,2 BJPY in FY 2019, 8,2 BJPY in FY 2020 and 8,0 BJPY in FY 2021. Following the revision of the FIT Act in 2016 and the enactment in April 2017, the surcharge reduction system was reviewed, and it was decided to set the reduction rate according to the type of business and the status of efforts to improve the electric consumption unit. Amount of purchased electricity generated by PV systems under the FIT program is around 330,98 TWh cumulatively as of the end of December 2020, exceeding 12,8391 TJPY in total.

4 INDUSTRY

4.1 Production of feedstocks, ingots and wafers (crystalline silicon industry)

Table 21: Silicon feedstock, ingot and wafer producer's production information for 2020

Manufacturers	Process & technology *	Total Production	Product destination	Price
Tokuyama	Polysilicon (for semiconductor, Siemens process)	Undisclosed (production capacity: 8 500t/year)		
Mitsubishi Materials	Polysilicon (for semiconductor, Siemens process)	N/A		

As of 2020 in Japan, the scale of production of polysilicon, silicon ingot and wafer for solar cells is not large. As for high purity polysilicon for semiconductor-grade silicon wafers, Tokuyama and Mitsubishi Materials manufacture it. Tokuyama manufactures polysilicon in full capacity at its factory in Shunan City, Yamaguchi Prefecture. Tokuyama is asking wafer companies to correct the price due to the heavy burden of capital investment in reducing the percentage of impurities in silicon wafers for cutting-edge semiconductors. Mitsubishi Materials is manufacturing polysilicon in Japan and the USA. At its US manufacturing base, profitability was improved in the first half of FY 2020 as a result of reduced manufacturing costs.

M.SETEK, a subsidiary of a Taiwanese company AU Optronics (AUO), manufactures sc-Si ingots for solar cells at its factory in Susaki City, Kochi Prefecture, and supplies to AUO, etc. Its ingot production capacity is said to be equivalent to 1,5 GW/year. M.SETEK also manufactures silicon ingots of semiconductor-grade up to 300 mm (12 inch), which are processed into wafers for sale by its affiliated company. In 2019, Ferrotec proceeded to withdraw from the PV business and shifted its focus to semiconductors. The company manufactures 150 mm (6 inch), 200 mm (8 inch) and 300 mm semiconductor-grade silicon ingots and wafers in China. Ferrotec entered the semiconductor-grade silicon wafer recycling business in China in 2020.

4.2 Production of photovoltaic cells and modules (including TF and CPV)

Production and shipment volumes of Japanese PV cell/ module manufacturers in 2020 stayed on the decreasing trend. According to PV shipment statistics by the Japan Photovoltaic Energy Association (JPEA), total PV module shipments by domestic production in Japan in 2020 (from January to December) fell below 1 GW, a 12 % decrease year on year. Domestic shipments were 5,5 GW, and the share of overseas-produced products in the domestic market was 83 %, the same as the previous year. JPEA's shipment statistics do not include the shipments by JinkoSolar (China) and Trina Solar (China).

Mitsubishi Electric terminated manufacturing and sales of its own brand PV modules and inverters in March 2020 and shifted to procure from Kyocera. In the end of July 2020, Panasonic announced to cancel partnership agreement on the PV business due to the failure of GS Solar (China) to fulfil the requirement necessitated to launch by the deadline agreed to in the contract. Panasonic terminated the joint production with Tesla (USA) and halted production of heterojunction solar cells in its factory in Buffalo, New York, US at the end of June 2020, and completed the withdrawal in September. The company also announced that it will complete the structural reform of its solar business by withdrawing from the production of crystalline silicon solar cells in Japan and overseas during FY 2021. It will continue to produce amorphous silicon solar cells for consumer use and to sell them in Japan and overseas.

Major Japanese PV manufacturers are reorganizing the production framework from around 2017 and are transferring its business model from the traditional PV module sales business to the PV solutions business. They actively worked on providing comprehensive PV solutions including PV systems for self-consumption and ZEH applications, as well as combination of PV systems with HEMS, storage batteries, hybrid inverters, etc. Besides, they are also focusing on sales of power purchase services and storage battery systems linked to PV for the owners of post-FIT PV systems with their FIT purchase period terminating sequentially from November 2019. Manufacturers are cooperating with electric companies, trading companies, etc. and are starting to offer a plan to install residential PV systems for free of charge combining with Power Purchase Agreement (PPA), which is expanding to industrial applications as well. Further, more manufacturers are entering the electricity business such as the renewable energy power generation business and the energy aggregation business, with a focus on PV power generation. These major Japanese manufacturers are also progressing technology development towards commercialization of highly efficient solar cell such as tandem type of perovskite/ c-Si and perovskite/ CIGS, as well as light weight flexible PV module, aiming for cultivation of new markets.

Table 22: PV cell and module production and production capacity information for 2020

Cell/Module manufacturer	Technology [1]	Total Production (MW)		Maximum production capacity (MW/yr)	
		Cell	Module	Cell	Module
Wafer-based PV manufacturers					
1 Sharp Energy Solutions [2]	c-Si	Undisclosed	Undisclosed	Undisclosed	Undisclosed
2 Kyocera	c-Si	Undisclosed	460	Undisclosed	Undisclosed
3 Panasonic	sc-Si (HIT)	Undisclosed	Undisclosed	Undisclosed	Undisclosed
4 Kaneka	sc-Si	Undisclosed	6	Undisclosed	Undisclosed
5 Fujipream	sc-Si	0	4,0	0	6,0
6 Choshu Industry	sc-Si	Undisclosed	96	Undisclosed	140
7 INFINI [3]	sc-Si	Undisclosed	0,5	Undisclosed	1,2
8 KIS [4]	sc-Si	Undisclosed	8	Undisclosed	11 [4]
Thin film PV manufacturers					
1 Solar Frontier	CIS	250	250	900	900
2 Kaneka	a-Si	Undisclosed	Undisclosed	Undisclosed	Undisclosed
3 FWAVE	a-Si	Undisclosed	Undisclosed	Undisclosed	Undisclosed
Cells for concentration					
1 Sumitomo Electric Industries [5]	CPV	Undisclosed	Undisclosed	Undisclosed	20
Totals [6]		**467** [6]	**910** [6]	**2 369** [6]	**2 279** [6]

[1] : c-Si: crystalline silicon ,sc-Si: single crystalline silicon, a-Si: amorphous silicon
[2] : Overseas shipments of PV modules are 710 MW
[3] : All for BIPV module
[4] : Overall production capacity is planned to be 12 MW/year
[5] : Overseas shipments of concentrator PV modules are 0,03 MW
[6] : Source: RTS Corporation

Trends in the development and production status of specially designed products are shown below.

- Kaneka: Manufactures BIPV modules for residential application
- Kyocera: Sells HEYBAN®, a roof-tile integrated PV module
- INFINI: Flexible modules (PV modules that are lightweight and can be installed easily)
- KIS: Hybrid PV (for industrial use), laminated glass PV (for buildings), BIPV module production capacity is 1 MW/year
- Solar Frontier: Developing an application of building-integrated PV (BIPV) modules using CIS thin-film technology jointly with China Triumph International Engineering (CTIEC)
- Choshu Industry: Heater-integrated PV modules

4.3 Manufacturers and suppliers of other components

- PV inverters

PV inverters for residential applications shifted towards certification of multiple-unit grid-connection type inverters. Manufacturers such as Omron, Tabuchi Electric, Panasonic, Kyocera, Sharp, SMA Solar Technology (Germany) and Delta Electronics (Taiwan), Huawei Technologies (China) and SolarEdge Technologies (Israel) have acquired certificates from the Japan Electrical Safety & Environment Technology Laboratories (JET) for their products.

For 10 kW to < 50 kW inverters for low-voltage grid connection, major inverters on the market used to include a 9,9-kW inverter, a 25-kW inverter and a 33,3-kW inverter by Tabuchi Electric; a 5,5-kW inverter and a 12,375-kW inverter by Omron; and 10-kW inverter by Yaskawa Electric, GS Yuasa, Sanyo Denki, and Shindengen. Recently, overseas manufacturers such as SMA Solar Technology, Huawei Technologies and Delta Electronics are increasing their market shares.

For the systems with a capacity of 50 kW or more, which are connected to high-voltage or extra-high voltage electric grids, two or more inverters are often installed in order to increase the total capacity as well as the system reliability. Unit capacities of inverters include 25 - 50 kW, 100 kW, 250 kW, 500 kW, 660 kW, 1 000 kW, 1 250 kW, 2 500 kW, 3 200 kW and 4 400 kW. As PV power plants become larger in capacity, the unit capacities of inverters are also getting larger. Tabuchi Electric, SMA Solar Technology, Huawei Technologies, Sungrow Power Supply (China) and Delta Electronics have entered the distributed inverter market. Players in the central inverter market with the capacity range of 250 kW or more are heavy electric machinery manufacturers including Toshiba Mitsubishi-Electric Industrial Systems Corporation (TMEIC), Hitachi, Fuji Electric, Daihen, Nissin Electric and Meidensha. Overseas manufacturers such as SMA Solar Technology and Sungrow Power Supply also comprise this market. Installation of distributed inverters has advanced in MW-scale PV power plants as well as small- and medium-scale PV projects, and the competition between large-capacity central inverters and distributed inverters has intensified. In this sector of the market, DC voltage of systems has increased, and more systems now correspond to DC 1 000 V, up from the conventional DC 600 V. As for extra-high voltage grids with the output capacity of 2 MW or more, the trend is shifting to higher-voltage products corresponding to DC 1 500 V systems.

Reflecting an increasing demand in overseas markets, Japanese manufacturers have expanded their overseas businesses. TMEIC and Hitachi are strengthening production facilities and expanding overseas manufacturing sites. TMEIC established a factory in India and started full operation in 2017 for shipment to Southeast Asia, Europe and so on. Hitachi owns a factory in India.

For ≤ 20 kW inverters, a certification scheme by the Japan Electrical Safety & Environment Technology Laboratories (JET) has been introduced. JET certification is shifting to the certification of multiple-unit grid-connection type inverters. Certification of multiple-unit grid-connection type inverters is designed for inverters that employ the Standard active islanding detection scheme for single-phase utility-interactive power conditioners (inverters) of distributed power sources (A frequency feedback method with step injection of reactive power) (JEM 1498) and an FRT (Fault Ride Though) function. Following the revision of the Ministerial Ordinance in January 2015, management of the FIT program was reviewed, which is requiring inverters to respond to remote-controlled output curtailment. Moreover, individual test method for grid protection devices has been revised and measures following the addition of complementary information to JEM 1498 have been promoted. For > 10 kW inverters, approval

is given by electric companies individually. JET started a certification system for high-voltage grid connected protective equipment in February 2021, which is intended for ≤ 2MW inverters.

- Storage batteries, inverters with storage function

Storage batteries are used in net zero energy house (ZEH) in combination with PV systems, as measures to address peak cut and peak shift as well as to stabilize electric grids. In particular, lithium-ion storage batteries are used for ZEH and major manufacturers launched new products one after another with long lifetime, large capacity, and high reliability. Panasonic, GS Yuasa, Nichicon, Eliiy Power, Murata Manufacturing, etc., supply storage batteries in Japan. Looop launched its original brand storage batteries for residential use. As such, new entries have advanced. Some companies are importing storage batteries from other countries such as South Korea and delivering to many storage system manufacturers.

Residential storage systems are sold as hybrid inverters, etc. by Sharp, Nichicon, ITOCHU, Choshu Industry, Panasonic, Omron, Tabuchi Electric, Kyocera, Murata Manufacturing and so on. The inverter capacity usually ranges from 4,2 kW to 9,9 kW and the capacity of storage batteries ranges from 2,3 kWh to 16,8 kWh.

Some companies from abroad entered the Japanese market. PV manufacturers such as Hanwha Q CELLS Japan and Canadian Solar are selling residential PV systems equipped with storage batteries. JinkoSolar Japan announced its intention to enter the storage battery business in Japan.

Large-scale lithium-ion batteries with MWh level capacity, sodium-sulfur (NAS) batteries, etc., are installed for grid stabilization by electric companies and demonstration tests are conducted by Hokkaido Electric Power, Tohoku Electric Power, Chugoku Electric Power, Kyushu Electric Power, etc.

In the service area of Hokkaido Electric Power, systems with MWh-level lithium-ion batteries are operating as a backup power supply for dispatching power source under the FIT program. The storage battery manufacturers for these large-scale projects are GS Yuasa, LG Chemical, Samsung SDI and Toshiba for lithium-ion batteries, NGK Insulators for NAS batteries, and Sumitomo Electric for redox flow batteries.

- Battery charge controllers

Battery charge controllers are used for small-scale off-grid power supply systems for rural electrification, etc. The number of products for installation in Japan is very small.

- DC switch gears

Also called junction boxes, DC switch gears are manufactured by such manufacturers as Nitto Denko, Kawamura Electric and Wave Energy, who are exclusively engaged in DC switch gear manufacturing. Some products for MW-scale PV power plants have string monitors embedded, which are used for operation and maintenance (O&M) of PV power plants. Overseas manufacturers in this area include Weidmueller (Germany) and ABB (Switzerland). In addition to the products applicable to DC 1 000 V, adoption of products applicable to DC 1 500 V is increasing.

- Supporting structures

For supporting structures, hot-dip steel plate with high corrosion resistance, molten hot-dip galvanizing steel plate and single-tube pipes, aluminium and stainless steel are used. Among them, those made of hot-dip steel plate with high corrosion resistance are the most popular.

They are manufactured by such manufacturers as Neguros Denko and Okuji Kensan, who are exclusively engaged in this field. As the demand for industrial PV systems has increased rapidly, overseas manufacturers such as POWERWAY of China have entered the Japanese market, in addition to domestic manufacturers. Along with the expansion of PV installed capacity, installation locations are getting more diverse. Accordingly, development has advanced on new products which can be easily installed on slopes, products exclusive for rooftop installation, new installation methods which can reduce the installation period, automated installation systems as well as lightweight mounting structures for PV modules. Regarding brackets for supporting structures, development of lighter-weight products using aluminium is underway, in order to meet the demand for rooftop installation for industrial applications. As for the float for floating PV system (float + PV module supporting structure), in addition to reservoir solar company (Tameike Solar), West Group, etc., overseas companies such as Ciel & Terre (France) engage in the market.

5 PV IN THE ECONOMY

This chapter aims to provide information on the benefits of PV for the economy.

5.1 Labour places

Table 23: Estimated PV-related full-time labour places in 2020

Market category	Number of full-time labour places	
	2020	2019
Research and development (not including companies)	400	600
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	74 400	74 000
Distributors of PV products		
System and installation companies		
Electricity utility businesses and government		
Other		
Total	**74 800**	**74 600**

5.2 Business value

Table 24: Rough estimation of the value of the PV business in 2020 (VAT is excluded)

Sub-market	Capacity installed in 2020 (MW)	Average price (JPY/W)	Value (MJPY)	Totals (MJPY)
Off-grid	0,805			
Grid-connected roof-top < 10 kW (for residential)	731	286	209 066	
Grid-connected for commercial	1 945	204	396 780	
Grid-connected for industrial	1 142	204	232 968	
Grid-connected ≥ 1 MW	4 611	196	951 972	
Total	8 676			1 790 786
Export of PV products				3 073
Change in stocks held				
Import of PV products				203 900
Value of PV business in 2020				**1 589 959**

Import value described in Table 24 is an estimated value of import of PV modules. Although some overseas manufacturers are exporting their inverters to Japan, the total amount of their shipment volume is not included since it is unknown.

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

Following full liberalization of electricity retailing from April 2016, new players entered the electricity retailing business one after another. The number of registered electric retailers was 667 (as of December 2020) and these Power Producers and Suppliers (PPS) and ten former General Electricity Utilities that used to conduct regional monopolistic business are competing in the electricity market. Although the share of PPS increased to approximately 20 % (as of December 2020), the situation of the electricity market in which former General Electricity Utilities are dominant remains unchanged and the same situation is observed in the power generation sector. The trading quantity on the Japan Electric Power Exchange (JEPX) accounts for around 40 % of the total demand (as of December 2020). The power transmission division and the power distribution division of the former General Electricity Utilities were legally separated by April 2020, and electric companies demerged the general power transmission and distribution business. Tokyo Electric Power (TEPCO) has shifted to a holding company structure ahead of other companies, whereas Okinawa Electric was approved of not demerging the power transmission and distribution division, considering the circumstances of the region. New markets were created as a part of the electricity system reform. In the non-fossil fuel energy value trade market that trades non-fossil fuel value of renewable energy, etc. apart from the value of electricity, the non-fossil fuel values of FIT electricity and non-FIT electricity are traded. In addition, auctions were held in the capacity market that trades the value of kW as a supply capacity, and the supply/demand adjustment market that trades the value of ΔkW as a dispatching ability was launched in April 2021.

6.2 Interest from electricity utility businesses

- Introduction of PV power generation by electric companies

Federation of Electric Power Companies (FEPC) of which ten General Electricity Utilities are members announced in October 2008 that they would construct large-scale PV power plants with a total capacity of 140 MW. Construction has been almost completed. PV power plants developed by electric companies themselves are not eligible for the power purchase under the FIT program. Since it has been clearly stated in the Fifth Strategic Energy Plan that efforts will be made to make renewable energy a mainstream power source, electric companies are advancing activities to promote renewable energy. Partnerships between electric companies and renewable energy-related companies are also progressing. Also, introduction of PV power generation with the third-party ownership (TPO), which enables installation of PV systems at no initial cost, has also been progressing, targeting electricity users.

- Plans and reorganization that promotes renewable energy

Electric companies are presenting their renewable energy development targets while progressing reorganization towards promotion of renewable energy. Hokkaido Electric announced “Hokuden Group Management Vision 2030”, with a plan to increase its renewable energy capacity by over 300 MW in Hokkaido Prefecture and other regions. Tohoku Electric announced a plan to increase renewable energy capacity by 2 GW. Chubu Electric will newly develop renewable energy with a capacity of more than 2 GW by 2030. To accelerate new development of renewable energy, Chubu Electric made a reorganization in April 2020 and

divided the Business Development Group under the Planning Office of Renewable Energy Company into two groups, “Wind and PV Development Group” and “Biomass and Geothermal Development Group”. Hokuriku Electric aims to increase its power generation amount of renewable energy by 2 TWh/year in FY 2030 compared to that of FY 2018. Kansai Electric Power (KEPCO) aims for new development of more than 2 GW in Japan and abroad to achieve 6 GW of renewable energy in the 2030s. In addition, the company was reorganized in July 2019, and established “Renewable Energy Business Division”. Under its new group management vision called “Energia Change 2030”, Chugoku Electric set a target to introduce 300 to 700 MW of renewable energy by FY 2030. Toward expanding introduction of renewable energy, Shikoku Electric established “Development Promotion Office” within Renewable Energy Department, effective on November 1, 2020. TEPCO Energy Partner established “Renewable Energy Marketing and Sales Department” in September 2019 to consolidate its renewable energy related business. TEPCO demerged its renewable energy power generation business as a new company named “TEPCO Renewable Power”, which took effect on April 1, 2020. TEPCO Renewable Power succeeded approximately 10 GW of renewable energy power sources (hydro, wind, and PV) in 168 locations from TEPCO and aims to develop around 6 to 7 GW of renewable energy projects in the first half of the 2030s both in Japan and abroad.

- Purchase of surplus electricity from the post-FIT residential PV systems

The scheme to purchase surplus electricity generated by residential PV systems started from November 2009 and was passed on to the Feed-in Tariff (FIT) program in and after 2012. There are residential PV systems with their purchase period terminating from November 2019 onwards since the purchase period is 10 years, and the power sales price and conditions for these systems were presented. The surplus power purchase price after the termination of the purchase period is different among electric companies. For example, TEPCO Energy Partner set the price at 8,5 JPY/kWh; Chubu Electric at 8 JPY/kWh; KEPCO at 8 JPY/kWh. Power Producer and Supplier (PPS) are also offering the purchase menu of surplus electricity by the service area of electric companies and are purchasing surplus PV power.

- Output curtailment of PV systems

Following the expansion of PV introduction, in October 2018, the first output curtailment of renewable energy on the mainland Japan was conducted on the Kyushu mainland. Initially, output curtailment was conducted on weekends, when demand for electricity is relatively low, but with the expansion of PV installations, etc., output curtailment is now carried out on weekdays as well. In 2020, total 74 times of output curtailment were conducted (five times in January, 11 times in February, 16 times in March, 22 times in April, 16 times in May, twice in June, once each in September and October). The appropriateness of output curtailment was verified, and the verification results were published by the Organization for Cross-regional Coordination of Transmission Operators, JAPAN (OCCTO).

- Enhancement of inter-regional grid connection lines

There are two frequencies for the electric grids in Japan: 50 Hz for the eastern part of Japan and 60 Hz for the western part of Japan. The frequency conversion station connecting Tokyo area and Chubu area has the capacity of only 1,2 GW. It has also been pointed out that inter-regional grid connection lines to transport electricity from the areas with abundant land and renewable energy resources to the areas of demand for electricity are fragile. To solve these

issues, inter-regional grid connection lines need to be enhanced. In connection with the Electricity System Reform, discussions were made on the capacity of grid connection lines which need to be enhanced and a guideline for cost sharing was established. As for the frequency conversion station, the capacity was enhanced by 900 MW in FY 2020, and another 900 MW enhancement is scheduled by FY 2027, which will make the total capacity of 3,0 GW. Construction to increase the capacity of Hokkaido-Honshu HVDC Link, the grid connection lines between Hokkaido and Honshu (main island of Japan), from 600 MW to 900 MW is progressing, which started operation in March 2019. As for the Hokkaido-Honshu HVDC Link, another 300 MW enhancement is planned. According to the results of the verification by OCCTO, the total cost burden is estimated to be 48 BJPY. Improvement plan of the grid connection lines between Tohoku and Tokyo was also announced. The construction started from April 2017 to add 4,55 GW, which is scheduled to be completed in November 2027. Under the Acts for Establishing Resilient and Sustainable Electricity Supply Systems which was enacted in June 2020, a master plan was formulated and a policy to promote the establishment of the push-type grids was presented. As for the cost to enhance inter-regional interconnection lines, among the benefits of price reduction and CO_2 reduction, the cost for the effects derived from renewable energy is covered by the renewable energy surcharge, and the cost for other effects is covered by two entities on both ends of the link and nine companies, based on the national adjustment scheme. As for the cost for the benefits of stable supply, etc., individual general power transmission and distribution operators bear the cost as they conventionally do, which will be collected from the regional wheeling charge.

- Responses to accept grid connection

Along with the growth of PV installed capacity, some electric companies announced that they would suspend responses to new applications for grid connection in 2014. After that, they announced “30-day, etc. output curtailment capacity”, which sets the limit of output curtailment to 30 days/year or 360 hours/year. This is subject to be revised as needed depending on the calculation results of possible grid connection capacity for each fiscal year. In case the “30-day, etc. output curtailment capacity” is exceeded, output curtailment will have “no limit without compensation”. As of December 2020, six electric companies, namely Hokkaido Electric Power, Tohoku Electric Power, Hokuriku Electric Power, Chugoku Electric Power, Shikoku Electric Power and Kyushu Electric Power have taken this measure. TEPCO, Chubu Electric Power and KEPCO also reported the calculations results of the possible grid connection capacity, which showed that the difference between these three companies and the other seven companies has decreased. Accordingly, the rule of “no limit without compensation” is applied to all the areas, effective from April 2021. In parallel with these restrictions, a variety of information including open capacity of electric grids is released by electric companies. OCCTO announced its long-term policy on the cross-regional coordination of electric grids and set out an initiative of utilizing the existing grids to the maximum. To overcome grid restrictions, rationalization of expected power flow has been started on the “Japanese version connect & manage” which thoroughly utilizes the existing grids, followed by advanced application of N-1 (N minus one) electric control. As such, efforts have been made to realize the “Japanese version connect & manage” at an early date. Non-firm connection started to be deployed nationwide in January 2021. As for the local grids, TEPCO and NEDO plan to start a trial non-firm connection from April 2021.

6.3 Interest from municipalities and local governments

In addition to the national support programs, support programs for PV and storage batteries implemented by local governments and municipalities play an important role for the dissemination. While the subsidy program for installation of residential PV systems by the national government was terminated, many local governments and municipalities have implemented programs to support installation of residential PV systems. It is often the case that the amount of subsidy for PV ranges from 10 000 JPY/kW to 50 000 JPY/kW, and that for storage batteries is around 20 000 JPY/kW. To award the subsidy, some of them set several requirements including installation of HEMS in parallel to the installation of PV systems and storage batteries. Moreover, some local governments and municipalities started to provide services of low-interest credit type loan in cooperation with financial institutions and subsidy programs for conventional homes which introduce a set of PV system and storage batteries.

Furthermore, Tokyo Metropolitan Government (TMG) selected companies providing a service to install residential PV systems at no initial cost, to which TMG will provide a subsidy of 100 000 JPY/kW. The companies receiving this subsidy will return the whole amount to homeowners through such measures as reduction of the monthly service fee and a cashback.

Some local governments and private companies are working together to invite applicants to purchase PV systems and electricity and select developers and suppliers of facilities through tenders to deliver facilities and electricity to the residents at reasonable prices. Kanagawa Prefecture, in cooperation with iChoosr, started business to jointly purchase PV systems. They will promote the dissemination of PV power generation by inviting purchasers and ordering the facilities in bulk to keep the installation cost lower. Tokyo Metropolitan Government (TMG), in cooperation with iChoosr, is conducting a project to provide electricity generated from renewable energy sources to households in Tokyo at a reasonable price.

As for industrial PV systems, loan programs and preferential tax treatments are implemented in addition to support for the facilities. In some cases, there are requirements for the subsidy as follows: generated electricity must be used for self-consumption, storage batteries must be installed at the same time when the PV system is installed, and the facilities must service as evacuation facilities and disaster prevention bases.

In Tokyo, TMG conducts the “TMG Project to enhance renewable energy for local production and local consumption”, which provides a subsidy to support a half to two-thirds of the installation cost of PV systems (5 kW and above) and storage batteries.

Following the expansion of PV introduction, many cases of troubles with residents occurred one after another, which urges several municipalities to revise their guidelines on the installation of PV systems and expanding the scope of PV projects subject to environmental impact assessment (EIA). Tono City of Iwate Prefecture decided a policy of effectively not accepting new development of large-scale PV power plants and stipulated the issues including the following: 1) PV projects covering the area of over 1 ha will not be permitted; 2) the entire city is designated as a restricted area; 3) obligation to hold a briefing session for residents in the preliminary consultation phase. PV projects covering the area of 0,3 ha or more were switched from the current notification system to the permission system. Since April 2020, Hyogo Prefecture has mandated EIA for the plans of PV systems with the project site covering the area of 5 ha or more.

In June 2020, the Ministry of the Environment (MoE) released a guide for municipalities to procure renewable energy, titled “What public organizations can do in the era of climate change - Challenging 100 % renewable energy”.

In 2020, the "Declaration of net zero CO_2 emission by 2050" has advanced. 40 prefectures, 242 cities, seven special districts, 98 towns and 20 villages, which has 110,51 million residents (as of June 11, 2021), made a declaration.

The Japanese government held the first meeting of the "The Council for National and Local Decarbonization" in December 2020 and started working on the formulation of the "Roadmap for regional decarbonization" toward 2050. The roadmap covers PV systems for self-consumption including rooftop PV systems, with an aim to achieve the ratio of PV system installation at buildings and on land owned by the national government and local governments/ municipalities at 50 % by 2030 and 100 % by 2040.

Table 25 shows the examples of support measures and projects by local governments and municipalities.

Table 25: Examples of support measures and projects by local governments and municipalities

Measures and projects	Examples of local governments and municipalities
- Regional Power Producer and Supplier (PPS) project for the purpose of utilizing renewable energy	Rikuzentakata City, Koriyama City, Utsunomiya City, Fukaya City, Chichibu City, Kakegawa City, Minami Awaji City, Ube City, Susaki City (Kochi Prefecture (Pref.)), Miyama City, Karatsu City, Nagasaki City
- Project to purchase surplus PV electricity from post-FIT residential PV systems	Tokyo Metropolitan Government (TMG), Ikoma City
- Model project to promote group purchase of renewable energy electricity	TMG
- Project to support joint purchase of PV systems and storage batteries	Saitama Pref., Kanagawa Pref., Nagano Pref. Osaka Pref.
- Project to support residents' associations and condominium associations which introduce renewable energy power generation facilities	Kyoto City
- PV power generation projects at the facilities and on land owned by municipalities (including leasing of roofs of facilities and land)	Chiba City, Kanagawa Pref., Fujinomiya City, Hamamatsu City, Osaka Pref., Akashi City
- Establishment of regional microgrids	Odawara City, Ueno Village (Gunma Pref.)
- Sale of environmental values of the region	Yamagata Pref.
- Use of electricity generated by regional power companies as a gift in return for the hometown tax	Ichikikushikino City (Kagoshima Pref.), Oguni Town (Kumamoto Pref.), Naraha Town (Fukushima Pref.)

7 HIGHLIGHTS AND PROSPECTS

7.1 Highlights

Year 2020 was the turning point for Japan's policies on energy, the environment and industry. Prime Minister Yoshihide Suga declared that Japan aims to achieve "net zero greenhouse gas (GHG) emissions by 2050", aiming to realize a decarbonized society. Following the declaration, Japan set the realization of a carbon-neutral society through the virtuous cycle of economy and the environment as the pillar of the national growth strategy. The Cabinet Office, all the ministries and agencies started making full-fledged efforts by employing all the policy measures. As the bill of the Acts for Establishing Resilient and Sustainable Electricity Supply Systems, which include the drastic revision of the FIT Act, were enacted, the Ministry of Economy, Trade and Industry (METI) aims to "create a renewable energy-oriented economic society" and started designing a system based on the new "Renewable Energy Promotion Act (revised Act on Special Measures Concerning Procurement of Renewable Energy Sourced Electricity by Electric Utilities, or the current FIT Act)" which is scheduled to take effect in April 2022, with the following pillars: 1) Evolution to the competitive renewable energy industry; 2) Improvement of a social infrastructure such as networks to support renewable energy and 3) Establishment of communities which exist in harmony with renewable energy. Furthermore, METI started working on the revision of the "Fifth Strategic Energy Plan," which serves as the base of Japan's energy policy, to formulate the "Sixth Strategic Energy Plan" toward acceleration of the scenario to achieve carbon neutrality by 2050 and making renewable energy a mainstream power source. In parallel, METI formulated the "Green Growth Strategy Through Achieving Carbon Neutrality in 2050". Assuming that renewable energy will account for 50 % to 60 % of all the electricity demand in 2050 through the promotion of electrification, METI selected 14 industries for the Green Growth Strategy which are expected to grow to support carbon neutrality and set an aggressive target for each industry, as the industrial policy. PV is positioned as one of the 14 industries as the next-generation PV industry.

With regard to technology development related to PV, the New Energy and Industrial Technology Development Organization (NEDO) started a new five-year plan on PV for the project of "Development of Technologies to Promote Photovoltaic Power Generation as a Main Power Source," aiming to make renewable energy a mainstream power source, designed to work on the following subjects: 1) Development of Photovoltaic Power Generation Technologies to Create New Markets; 2) Development of Technologies to Make Photovoltaic Power Generation a Long-term Stable Power Source; 3) Development of Advanced Common Basic Technologies; and 4) Survey of Trends.

Despite the significant restrictions of new sales activities due to the COVID-19 pandemic, the Japanese PV industry has started shifting the dissemination scheme and the industrial structure toward the business development not dependent on the FIT program, while taking measures to the Renewable Energy Promotion Act, which will be newly enacted, including such activities as the introduction of the PPA business model under the third-party ownership (TPO) scheme, and the shifting from the conventional energy industry to the renewable energy business.

Under such circumstances, cumulative capacity of facility approval under the FIT program and cumulative commissioned (start of operation) capacity as of the end of December 2020 increased to 74,7 GWAC and 54,9 GWAC, respectively. Accordingly, the annual and the

cumulative PV installed capacity in 2020 in Japan reached respectively 8,7 GWDC and 71,9 GWDC, exceeding 70 GW.

7.2 **Prospects**

Starting in 2021, not only METI that manages Japan's energy policy, but also all the other governmental ministries and agencies are making full-scale efforts with their policy measures to realize the national targets: "Carbon neutrality by 2050" and "46 % greenhouse gas reduction by 2030". METI is making a large step forward in 2021 toward achieving the Green Growth Strategy and creating the renewable energy-oriented economic society. METI is scheduled to formulate the Sixth Strategic Energy Plan, which is designed to accelerate making renewable energy a mainstream power source, and significantly increase the 2030 target installed capacity of renewable energy. R&D and social implementation plans under the Green Innovation Fund based on the Green Growth Strategy have newly started, and the project of the "Development of next-generation solar cells" will start. The Ministry of the Environment (MoE) revised the Law Concerning the Promotion of the Measures to Cope with Global Warming, which sets forth the "Realization of a decarbonized society by 2050". Also, MoE established a scheme to promote introduction of renewable energy by local governments, aiming to strengthen support for them on renewable energy. The Ministry of Agriculture, Forestry and Fisheries (MAFF) formulated the "Green Food System Strategy", with which MAFF aims to expand introduction of renewable energy in agricultural, forestry and fishing villages, including dissemination of PV systems on farmland. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) formulated the "MLIT Green Challenge", aiming to establish a smart and robust way of living and town development which contributes to expanding energy conservation and renewable energy in housing and buildings, as well as to promote utilization of renewable energy for the infrastructure development such as roads, railroad, and aviation. The Cabinet Office, in partnership with MoE, other ministries and agencies, formulated the "Local Decarbonization Roadmap" and promote regional revitalization through expansion of renewable energy introduction such as utilization of PV power generation as the local growth strategy. Also, ministries and agencies will accelerate reviews of regulations which disturb expansion of PV installations, within the framework of developing laws and schemes under the jurisdiction of each ministry or agency. As such, the national government, by uniting the capabilities of all the ministries and agencies, will enhance efforts to realize carbon neutrality, which is expected to accelerate the trends of making renewable energy a mainstream power source and expanding renewable energy introduction.

Meanwhile, the PV industry is responding to the changes in the business environment, which is the shift from the FIT program to the FIP program and shifting their business deployment scheme from the government support-based to the market-based deployment. The PV industry will depart from the FIT program which had been the driving force for PV dissemination and identify the new driving force by adopting new business models such as power purchase agreements (PPA), while expanding new markets such as the supply and demand integrated market based on self-consumption, the market utilizing farmland, as well as the floating PV market. Business fields of the PV industry have been expanding with deployment of new business fields such as the O&M business, the PV system trading business and the repowering business which are based on the existing PV systems, in addition to the conventional business of installing new PV systems. The new service business via the electricity business created through both the existing PV systems and the newly installed PV systems is expected to grow on a full scale. With the expansion of the business fields, a wide variety of players are expected

to form the industry. Furthermore, the demand for switching to renewable energy-based electricity by electricity consumers such as industries and local governments is rapidly increasing. Consequently, PV introduction will advance from “points” to “surfaces”, from “individual” to “group”, and from “independently” to “systematically”. The market formation will shift from the supply side to the demand side. As for the PV system itself, technology development will advance, moving forward to sophistication and multifunctionality through the integration with peripheral technologies and cutting-edge technologies including storage batteries. These technologies are expected to support the future growth of the market.

Year 2021 is the last year for the application of the current FIT Act. Japan’s PV power generation will start moving toward the independence of the PV industry and the expansion of the PV market, based on the Acts for Establishing Resilient and Sustainable Electricity Supply Systems and the revised Law Concerning the Promotion of the Measures to Cope with Global Warming. The PV power generation is expected to develop under the new business environment.