Technology Collaboration Programme
by IEA

International Energy Agency
Photovoltaic Power Systems Programme

Task 1 Strategic PV Analysis and Outreach

PVPS

# National Survey Report of PV Power Applications in JAPAN

2022

NEDO

# 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 25 IEA PVPS participating countries are Australia, Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, 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, the Solar Energy Industries Association, the Solar Energy Research Institute of Singapore and Enercity SA 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 2022. Information from this document will be used as input to the annual Trends in photovoltaic applications report.


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**COVER PICTURE**: "H2 KIBOU FIELD " demonstration facility connecting fuel cells (495 kW), PV modules (approx. 570 kW) and lithium-ion storage batteries (1.1 MWh) by Panasonic

**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 2022 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2022, although commissioning may have taken place at a later date.

## 1.1 Applications for Photovoltaics

In 2022, 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 were ground-mounted systems, but the floating PV (FPV) systems and agricultural PV (AproPV) 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 2022 reached 6,653 MW (DC), an increase of approximately 1.7% from 6,545 MW (DC) in 2021.

**Table 1: Annual PV power installed during calendar year 2022**

| | | Installed PV capacity in 2022 [MW] | AC or DC |
|---|---|---|---|
| **PV capacity** | Off-grid | 2.4 | DC |
| | Decentralized | 2,895 | DC |
| | Centralized | 3,756 | DC |
| | **Total** | **6,653** | **DC** |

## Table 2: PV power installed during calendar year 2022

| | | | Installed PV capacity [MW] | Installed PV capacity [MW] | AC or DC |
|---|---|---|---|---|---|
| **Grid-connected** | BAPV | (1) Residential (< 10 kW) | 2,845 | 1,137 | DC |
| | | (2) Commercial (< 50 kW, including ground-mounted) | | 1,045 | DC |
| | | (3) Industrial (50 kW - 1 MW, including ground-mounted) | | 662 | DC |
| | BIPV | (4) Residential (< 10 kW) | 50 | 30 | DC |
| | | (5) Commercial (10 - 250 kW) | | 20 | DC |
| | | (6) Industrial (> 250 kW) | | | DC |
| | Utility-scale | (7) Ground-mounted (1 MW ~) | 3,756 | 3,206 | DC |
| | | (8) Floating PV (FPV) systems | | 150 | DC |
| | | (9) Agricultural PV (AgroPV) systems | | 400 (including some small-scale systems) | DC |
| **Off-grid** | | (10) Residential | 2.4 | NA | DC |
| | | (11) Other | | | DC |
| | | (12) Hybrid systems | | NA | DC |
| **Total** | | | 6,653 | | DC |

### 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)<br>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, FPV systems, and AgroPV systems are estimates by RTS Corporation based on hearings, etc.<br>- 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 (in Japanese) |
| Other issues to be noted | DC capacity was estimated in consideration of over-panelling ratio of PV modules |

The cumulative PV installed capacify in Japan as of the end of 2022 reached 85,066 MW (DC). The cumulative PV installed capacity by application is; 180.6 MW for off-grid and 84,886 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] | Grid-connected centralized [MW] | 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 |
| 2021 | 178.2 | 78,235 | | 78,413 |
| 2022 | 180.6 | 84,886 | | 85,066 |

**Table 5: Other PV market information**

| | 2022 |
|---|---|
| Number of PV systems in operation in Japan | N.A. |
| Decommissioned PV systems during the year [MW] | ~300 MW |
| Repowered PV systems during the year [MW] | N.A. |

**Table 6: PV power and the broader national energy market**

| | 2021 | 2022 |
|---|---|---|
| Total electricity demand (electricity consumption) [1] | 873 TWh | 883 TWh |
| Estimated total PV electricity production | 78,413 GWh | 82,334GWh |

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

## 1.3 Key enablers of PV development

Table 7 shows the information on key enablers contributing to PV dissemination. 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-scale battery storage systems. However, transportation applications (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 8.55 million units of Eco Cute heat pump systems have been installed in houses as of the end of FY 2022.

As for electric vehicles (EVs), the number of units sold in 2022 and the number of units owned as of the end of March 2023 (end of FY 2022) (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 | 1,026 MWh (136,356 units) | 5,964 MWh (760,907 units) | The Japan Electrical Manufacturers' Association (JEMA) |
| Residential heat pumps | Residential heat pump water heater with natural refrigerant (Eco Cute) | 695,428 units | 9,123,643 units | The Japan Refrigeration and Air Conditioning Industry Association, Heat Pump & Thermal Storage Technology Center of Japan |
| Electric vehicles (EVs) | Passenger car (PC), Light car (LC) | 79,341 units (2022) | 226,574 units (2022) | Next Generation Vehicle Promotion Center |
| Electric buses and trucks | EVs other than passenger cars or light cars, which are categorized as "Other" in the statistics | 611 (2022) | 2,403 (2022) | Same as above |

# 2 COMPETITIVENESS OF PV ELECTRICITY

## 2.1 Module prices

Table 8 shows average 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: Average module prices (end-user prices)**

| Year | Average price (JPY/W) | Best price (JPY/W) |
|---|---|---|
| 2005 | 428 | |
| 2006 | 433 | |
| 2007 | 436 | |
| 2008 | 447 | |
| 2009 | 393 | |
| 2010 | 366 | |
| 2011 | 327 | |
| 2012 | 284 | 120 |
| 2013 | 251 | 112 |
| 2014 | 227 | 101 |
| 2015 | 196 | 89 |
| 2016 | 169 | 78 |
| 2017 | 150 | 69 |
| 2018 | 139 | 62 |
| 2019 | 133 | 56 |
| 2020 | 127 | 52 |
| 2021 | 111 | 58 |
| 2022 | 123 | 51 |

## 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 diverse 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 | 220 |
| Grid-connected commercial and industrial<br>10 kW- < 1 MW | Commercial and industrial | 152 |
| Grid-connected ≥ 1 MW | Utility-scale (mainly ground-mounted) | 122 |
| Other category (hybrid diesel-PV, hybrid with battery…) | | N.A. |

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

| Year | Residential (< 10 kW) | Commercial and industrial (10 kW - 100 kW) | Commercial and industrial (100 kW - 250 kW) | Ground-mounted (≥ 1 MW) |
|---|---|---|---|---|
| 2005 | 661 | | | |
| 2006 | 683 | | | |
| 2007 | 696 | | | |
| 2008 | 723 | | | |
| 2009 | 605 | | | |
| 2010 | 559 | | | |
| 2011 | 513 | | | |
| 2012 | 451 | 410 | 380 | 280 |
| 2013 | 405 | 380 | 330 | 260 |
| 2014 | 366 | 343 | 290 | 235 |
| 2015 | 332 | 313 | 256 | 217 |
| 2016 | 293 | 265 | 227 | 192 |
| 2017 | 272 | 236 | 202 | 170 |
| 2018 | 252 | 217 | 185 | 152 |
| 2019 | 242 | 200 | 178 | 139 |
| 2020 | 231 | 187 | 165 | 128 |
| 2021 | 229 | 188 | 164 | 127 |
| 2022 | 220 | 178 | 155 | 122 |

## 2.3 Cost breakdown of PV installations

The 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 systems, installers, EPCs and others.

**Table 11: Cost breakdown of residential PV system of 1-5 kW** **(JPY/W)**

| Cost category | Average | Best price |
|---|---|---|
| **Hardware** | | |
| Module | 145 | 123 |
| Inverter | 42 | 30 |
| Mounting structure | 21 | 21 |
| Other (electric equipment/ materials of electric equipment, etc.) | 0.2 | |
| **Subtotal hardware** | 208.2 | 174 |
| **Soft costs** | | |
| Installation | 71 | 46 |
| Other (promotion/ administration cost, etc.) | | |
| Permits | | |
| Project margin | | |
| **Subtotal soft costs** | 71 | 46 |
| **Total (excluding VAT)** | 279 | 220 |
| Average VAT | 10% | 10% |
| **Total (including VAT)** | 307 | 242 |

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

| Cost category | Average | Best price |
|---|---|---|
| **Hardware** | | |
| Module | | 51 |
| Inverter | | 21 |
| Mounting structure | | 15 |
| Other (electric equipment/ transformers, materials of electric equipment, etc.) | | |
| **Subtotal hardware** | | 87 |
| **Soft costs** | | |
| Installation | | 35 |
| Land development cost | | |
| Shared cost of grid connection | | |
| Design and development cost | | |
| Financing cost | | |
| Other (administrative expenses, etc.) | | |
| **Subtotal soft costs** | | 35 |
| **Total (excluding VAT)** | | 122 |
| Average VAT | | 10% |
| **Total (including VAT)** | | 134.2 |

## 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 financing through a variety of schemes. Corporate finance, project finance, financing via the Infrastructure Fund Market which was established by the Tokyo Stock Exchange (TSE) as well as the issuance of green bonds have been conducted. Table 13 shows the general financing schemes in Japan.

**Table 13: PV financing information in 2022**

| | |
|---|---|
| Residential (solar loan/ sales on credit) | Long-term prime rate + approx. 1.5% (low-interest rate financing is available by combining with home mortgage).<br>Preferential interest rate is available depending on financial institute. |
| Green reform loan | Preferential interest rates for energy-saving renovations that meet certain criteria.<br>Insulation renovations and installations of energy-saving equipment (PV systems, solar thermal utilization, high-efficiency water heaters, etc.) are eligible. |
| Small to medium size (corporate loan/ sales on credit/ lease) | Long-term prime rate + approx. 1.5-2.0%<br>Guarantor or collateral is required in many cases. Loan without collateral is available in some cases using sales on credit, though the interest rate is high. In case of the scheme of lease, the leasing companies own the facilities, etc. |
| Large-scale PV (project finance) | - Financing is provided to the sponsor on a non-recourse or limited recourse basis, collateralized by all assets and interests in the PV project.<br>- Example: 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. |
| 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 AgroPV | Loan which is provided by Norinchukin Bank aiming to increase income of Japan Agricultural Cooperatives (JA) and revitalize regional economy |
| Green loans | Financing used by businesses, local governments, and other entities to raise funds needed for green projects in Japan and abroad |
| Sustainability linked loans (SLL) | Loans that set action targets (Sustainability Performance Targets (SPTs)) consistent with the borrower's ESG strategy to encourage the borrower to improve its sustainability performance, and provide incentives or disincentives to the borrower based on its progress in achieving the SPTs |
| Green deposits (environmental deposits) | - Loans must be used only for projects that reduce $CO_2$ emissions, such as PV power generation.<br>- Companies that deposit money contribute indirectly to environmental measures by simply transferring their existing deposits to the Green deposits. |

## 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. Basically, typical business models for investment are loans and lease programs. Other business models include the following:

Regarding the third-party ownership (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 owners or removal of facilities are low compared with the lease of the roofs of private facilities, the tenders are actively responded. Also, as the FIT purchase price declined and the electric bills increased due to the soaring prices of fossil fuels, the service for self-consumption becomes more popular, in which electricity generated by PV systems installed on the rooftops of these facilities is supplied directly to them. Major electric companies, gas companies and Power Producer and Supplier (PPS) are promoting a service to install PV systems for self-consumption at no upfront cost (on-site PPA). Long-term agreements called off-site PPAs, with the PV systems installed outside the premises of consumers and the generated electricity is supplied, are progressing as well.

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 2022 as well, which offers immediate depreciation of corporate tax or tax reduction, reduction of fixed property tax on 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), on-site PPA | “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. |
| Off-site PPA | Long-term agreements called off-site PPAs, with the PV systems installed outside the premises of consumers and the generated electricity is supplied, are progressing. |
| 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 AgroPV systems |
| Utilization of taxation system | Taxation system which supports investment by small- and medium-sized enterprises (SMEs), mainly dealing with small- and medium-scale self-consumption type PV systems |

## 2.6 Merchant PV / PPA / CPPA

The Feed-in Premium (FIP) program was introduced in April 2022, and efforts are being made to integrate large-scale PV power plants into the market. For PV power generation facilities that do not receive FIT/FIP support, the government subsidizes them to support the introduction of PV systems through the PPA model. The introduction of PV systems that do not use support programs or subsidies is yet to come. The number of companies participating in the international initiative "RE100" is increasing, and the introduction of PV systems through PPAs is progressing to meet the needs of consumers who want to use renewable energy. Efforts are active on on-site PPAs that install rooftop PV systems and solar carports, etc. on the premises of consumers, as well as off-site PPAs that install PV systems outside the premises of customers. While PV power producers and PPS have taken the lead in working on PPAs, major power companies are also strengthening PPAs that utilize PV power generation. On-site PPA initiatives are taking the lead, but there are also off-site PPA initiatives in which consumers who want to procure a stable and large amount of renewable energy collaborate with power producers and electricity retailers. Due to the relatively short development time, several off-site PPAs with a total capacity of more than 10 MW by bundling multiple small-scale PV power plants have been announced. Off-site PPA utilizing self-wheeling, and combination of on-site PPA and off-site PPA have also been proposed. Virtual PPAs are also underway in which power producers and consumers directly trade environmental value. The government announced an estimate that the PV installed capacity without the support of FIT/FIP programs in FY 2022 (April 2022 to March 2023) was 0.5 GW.

As of 2022 in Japan, there were no cases of direct power trading of PV electricity on the power market without depending on incentives or subsidies.

## 2.7 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: 295.24 JPY/10 A (1 kVA)<br>Charge for the volume of usage: < 120 kWh/month 19.91JPY/kWh, 120 - 300 kWh/month 26.51 JPY/kWh, > 300 kWh/month 30.60 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)<br>*1: “Surcharge to promote renewable energy power generation (3.36 JPY/kWh (May 2021 - April 2022), 3.45 JPY/kWh (May 2022 - April 2023))” are added on top of the above-mentioned charge, depending on the electricity usage.<br>*2: Fuel regulatory costs are 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 2022: 5.13 JPY/kWh).<br>*3: There are various price plans depending on time zones.<br>*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.<br>(Source: TEPCO Energy Partner’s website) |

| | |
|---|---|
| Retail electricity prices for a commercial company (High voltage: ≤ 6.6 kV) (TEPCO Energy Partner) | Base rate: 1,814.37 JPY x (185 - power factor)/ 100 per kW<br>Charge for the volume of usage: 17.57 JPY/kWh (summer), 16.41 JPY/kWh (other seasons) (TEPCO Energy Partner, commercial use)<br>*1: Contract electricity volume is fixed according to annual maximum electricity demand.<br>*2: Surcharge to promote renewable energy power generation are added in the same way as the one for households. Fuel regulatory costs are added or reduced (fuel regulatory cost as of December 2022: 11.51 JPY/kWh).<br>*3: There are various price plans depending on time zones and seasons.<br>(Source: TEPCO Energy Partner's website) |
| Retail electricity prices for an industrial company (High voltage: ≤ 6.6 kV) (TEPCO Energy Partner) | Base rate: 1,913.37 JPY x (185 - power factor)/ 100 per kW<br>Charge for the volume of usage: 16.19 JPY/kWh (summer), 15.18 JPY/kWh (other seasons) (TEPCO Energy Partner, high voltage electricity (≥ 500 kW))<br>Base rate: 1,390.87 JPY/kW x (185 - power factor)/ 100 per kW<br>Charge for the volume of usage: 17.40 JPY/kWh (summer), 16.27 JPY/kWh (other seasons) (TEPCO Energy Partner, high voltage electricity A (< 500 kW))<br>*1: Contract electricity volume is fixed according to annual maximum electricity demand.<br>*2: Surcharge to promote renewable energy power generation are added in the same way as the one for households. Fuel regulatory costs are added or reduced (fuel regulatory cost as of December 2022: 11.51 JPY/kWh).<br>*3: There are various price plans depending on time zones and seasons.<br>(Source: TEPCO Energy Partner's website) |
| Population | 124.861 million (Statistics Bureau, Ministry of Internal Affairs and Communications (MIC), as of December 1, 2022) |
| Country size | 377,973 km$^2$ (Statistics Bureau, MIC) (as of October 1, 2022) |
| Average PV yield | 1,000 - 1,100 kWh/kW/yr. |
| Name and market share of major EPCOs (based on electricity demand of December 2022) | 1 TEPCO Energy Partner 21.0%<br>2 Kansai Electric 13.4%<br>3 Chubu Electric Power Miraiz 12.1%<br>4 Tohoku Electric 8.6%<br>5 Kyushu Electric 8.4%<br>6 Chugoku Electric 5.6%<br>7 Hokuriku Electric 3.4%<br>8 Hokkaido Electric 3.3%<br>9 Shikoku Electric 2.9%<br>10 ENNET 1.9%<br>(Source: Survey of Electric Power Statistics, METI) |
| Name and market share of electric utilities (based on electricity demand of December 2022) | 1 Former General Electricity Utilities (10 EPCOs from Hokkaido to Okinawa) 81.9%<br>2 Power Producers and Suppliers (PPS) 18.1%<br>(Source: Survey of Electric Power Statistics, METI) |

# 3 POLICY FRAMEWORK

## Table 16: Summary of PV support measures

| | Residential | | Commercial + Industrial | | Centralized | |
|---|---|---|---|---|---|---|
| **Measures in 2022** | **On-going** | **New** | **On-going** | **New** | **On-going** | **New** |
| Feed-in tariffs | Yes (purchase of surplus electricity) | - Purchase prices for FY 2023 and 2024 were determined | Yes | - Cut in purchase price<br>- Tender scheme (≥ 250 kW) | Yes | - Cut in purchase price<br>- Tender scheme (≥ 250 kW) |
| Feed-in premium (above market price) | No | Electric companies and PPS set the post-FIT power purchase menu | No | From FY 2024, subjects of FIP program will expand to include ≥ 250 kW projects | No | From FY 2023, subjects of FIP program expanded to include ≥ 500 kW projects |
| Capital subsidies | No | No | There are subsidies for non-FIT applicants | | There are subsidies for non-FIT applicants | |
| 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<br>- Intended for companies and individuals who file an income tax return on the blue form<br>- Two options: immediate depreciation (100%) or 10% tax credit<br>- Fixed Property Tax is reduced by 50% for three years as a special measure | | | | | |
| Self-consumption | No | | There are subsidies intended for PV for self-consumption purpose (non-FIT) | | No | No |
| Net-metering | No | No | No | No | No | No |
| Net-billing | Yes | Yes | Yes (in case of self-consumption) | Yes (in case of self-consumption) | Yes (in case of self-consumption) | Yes (in case of self-consumption) |
| Collective self-consumption | No | No | | | | |
| Commercial bank activities e.g., green mortgages promoting PV | There are loan programs such as mortgage and home improvement loans, etc. | | Many financial institutions offer financing options for PV systems with a capacity of 10 kW or more taking advantage of FIT. There are moves to issue green bonds and establish funds for PV power generation, and approaches for non-FIT have progressed. | | | |
| 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<br>- Economic output curtailment (online proxy curtailment) has been introduced while bringing PV power generation, etc. online in order to improve the efficiency of output curtailment | | | |
| Sustainable building requirements | - The "Act for the Improvement of the Energy Efficiency Performance of Buildings (Building Energy Efficiency Act)" was revised on June 17, 2022, which obliges all the newly built residential and non-residential buildings to conform to the energy conservation standards by FY 2025<br>- 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 |
| Merchant PV facilitating measures | No | No | No | No | No | No |
| Other | | | | | | |

## 3.1 National targets for PV

The Sixth Strategic Energy Plan was approved by the Cabinet on October 22, 2021. Under the new Strategic Energy Plan, the roadmap for energy policy was outlined to achieve carbon neutrality by 2050 and a greenhouse gas reduction target of 46% compared to FY 2013 levels by FY 2030. Based on the fundamental premise of ensuring safety, initiatives will be promoted to ensure stable supply and reduce energy costs (S+3E) while addressing climate change. The maximum introduction of renewable energy will be promoted while thoroughly making renewable energy the main power source, working on the principle of giving top priority to renewable energy, curbing the burden on the public and maintaining harmony with the local communities. The outlook for energy supply and demand in FY 2030 was also revised, setting new targets for energy conservation. The ratio of renewable energy in the energy mix was raised from the conventional 22 to 24% to 36 to 38%. Of this ratio, the share of PV power generation is 14 to 16%, with an estimated installation volume of 103.5 to 117.6 $GW_{AC}$ (equivalent to 123 to 139 $GW_{DC}$).

**Table 17: Energy mix in Japan in FY 2030**

| | Fourth and Fifth Strategic Energy Plan | Sixth Strategic Energy Plan |
|---|---|---|
| Renewable energy | 22-24% | 36-38% |
| Nuclear power | 22-20% | 20-22% |
| LNG | 27% | 20% |
| Coal | 26% | 19% |
| Oil, etc. | 3% | 2% |
| Total electricity generation | Approx. 1,065 TWh | Approx. 934 TWh |

## 3.2 Direct support policies for PV installations

### 3.2.1 Description of support measures

- Subsidy for accelerating introduction of PV power generation with the initiative of consumers

This project provides subsidies for the introduction model (off-site PPA) of new PV systems by consumers, applicable only to the PV systems which do not use the FIT/FIP programs nor self-wheeling.

- Subsidy for transition to local decarbonization and promotion of renewable energy

This project provides subsidies as a scheme to continuously and comprehensively support local governments, etc. that are actively engaged in decarbonization projects over multiple fiscal years.

- Project to promote making renewable energy a main power source/ strengthening of resilience in local communities through the utilization of PPA

This project subsidizes the introduction of renewable energy facilities and storage batteries with such measures as the on-site PPA. The facilities under this project are not eligible for the FIT program.

- Project to promote installation of independent and distributed energy facilities to evacuation centers, etc. which realize resilience and decarbonization of local communities in parallel

This project subsidizes a part of the cost of the introduction of renewable energy facilities, etc. to public facilities designated as evacuation facilities in the event of a disaster under the Regional Disaster Prevention Plan.

- 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 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 as well.

- Project to promote $CO_2$ saving in collective housing

This project subsidizes to support energy conservation, $CO_2$ reduction and thermal insulation of collective housing, as well as the installation of storage batteries.

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

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

- 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 practical use and commercialization of renewable-energy related technologies in Fukushima Prefecture.

- Demonstration project to establish the next-generation technologies utilizing distributed energy resources such as storage batteries, etc.

This project promotes technical demonstration of aggregation technologies, etc. that utilize renewable energy and distributed energy resources such as storage batteries, etc.

- Subsidy for the Project to promote dissemination of renewable energy, etc. in harmony with local communities

This project subsidizes a certain amount of the necessary expenses for private businesses, etc. that intend to build a regional microgrid utilizing renewable energy, etc. or develop a plan to introduce such a microgrid.

- Project to accelerate the establishment of the next-generation networks toward large-volume introduction of renewable energy

This project conducts a field survey toward practical use of long-distance subsea DC power transmission systems

### 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 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. 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, the Feed-in-Premium (FIP) program has been introduced from April 2022 for ≥ 1 MW PV systems to promote the integration into the electricity market. It is planned that the subjects of the FIP program will be gradually expanded in FY 2023 onward. 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 was launched in April 2022 to deal with the FIT-approved projects which have not started operation for a long time.

From July 2022, it has become mandatory to accumulate costs for disposal, etc. for the end-of-life PV systems for commercial use. Businesses certified under the FIT program are subject to this scheme, and those who fail to reserve funds may be subject to guidance and improvement orders from the government, and approval cancellation. Approved business operators of 10 kW or larger PV projects are obliged to accumulate the "Demolition Reserve Fund" to the Organization for Cross-regional Coordination of Transmission Operators, JAPAN (OCCTO), which is an external organization designated by the government, to cover the costs required for dismantling, removal, and disposal the power generation facilities. In September 2021, the Agency for Natural Resources and Energy (ANRE) under METI published the "Guidelines for the decommissioning cost reserve system."

### 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. MoE has also expanded subsidies for self-consumption-type PV systems and on-site PPAs on buildings.

The New Energy and Industrial Technology Development Organization (NEDO) is promoting development of technologies for wall-mounted PV systems under the "Development of Technologies to Promote Photovoltaic Power Generation as a Main Power Source", a program being implemented since FY 2020. Development of see-through solar cells and perovskite BIPV modules for aperture area of building walls is underway, guidelines are formulated, and demonstrations of systems are conducted.

Also, METI started a three-year project for "International Standardization of Building-Integrated Photovoltaic (BIPV) Systems" in FY 2021. As a project consignee, Photovoltaic Generation Technology Research Association (PVTEC) undertakes international standardization of design standards for indoor window-mounted solar cells, design safety standards for snow-melting type PV modules, weather resistance evaluation methods for BIPV module design, and power generation estimation methods for vertically installed PV modules, etc.

### 3.2.4 Merchant PV development measures

As mentioned above, as of 2022 in Japan, there were no cases of direct power trading of PV electricity on the power market without depending on incentives or subsidies. There are no governmental support measures. However, there were cases of virtual PPA (VPPA).

## 3.3 Self-consumption measures

**Table 18: Summary of self-consumption regulations for small private PV systems in 2022**

| | | | |
|---|---|---|---|
| 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. |
| | 4 | Self-wheeling | If certain requirements are met, power interchange with a third party is permitted. |
| Excess PV electricity | 5 | 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. |
| | 6 | 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. |
| | 7 | Geographical compensation (virtual self-consumption or metering) | There is no compensation. |
| Other characteristics | 8 | Regulatory scheme duration | Surplus power purchase period under FIT program: 10 years for < 10 kW and 20 years for ≥ 10 kW systems. |

| | | | |
|---|---|---|---|
| | 9 | 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. |
| | 10 | 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. |
| | 11 | Regulations on enablers of self-consumption (storage, DSM…) | For residential PV systems whose FIT purchase period terminated, responses to the mode to promote self-consumption (Green Mode) are being promoted. |
| | 12 | 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. |
| | 13 | Electricity system limitations | There is no major barrier at present |
| | 14 | Additional features | Support measures for the introduction of supply/ demand integrated systems, such as those for self-consumption, etc., were strengthened and the independence from the FIT program is progressing. |

### 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 Other 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 sharing of electricity from PV systems by multiple consumers. However, METI established the Smart Community Alliance, a public-private partnership organization with NEDO as its secretariat, and 16 companies are participating as operating companies. In addition, the ministry held the Latest Trends Workshop 2022 on "Smart City x Energy-Related Businesses" to promote cooperation with other countries.

## 3.5 Tenders, auctions & similar schemes

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 launched in FY 2017. The scope of PV projects subject to the tender scheme was expanded to include ≥ 500 kW projects from FY 2019 and ≥ 250 kW projects from FY 2020. In FY 2021, the number of tenders was increased to four times per fiscal year, and in FY 2022, the tender for the FIP program was launched, which applies to ≥ 1 MW projects. The ceiling prices were announced in advance: 10.00 JPY/kWh for the 12th tender, 9.88 JPY/kWh for the 13th tender, 9.75 JPY/kWh for the 14th tender, and 9.63 JPY/kWh for the 15th tender. The total tender capacity for the 12th tender was set at 225 MW (FIT 50 MW + FIP 175 MW). For the subsequent tenders, the tender capacities are revised based on the results of the previous tender. Setting 225 MW as the minimum capacity, and if the amount of tenders received exceeds the capacity, the tender capacity will be increased for the next tender. The results of the 12th through 14th tenders are shown in the table below. The results of the 15th tender were announced in March 2023.

**Table 19a: Results of the 12th tender for FIT capacity in FY 2022**

| Item | Description |
|---|---|
| Subject of the tender scheme | ≥ 250 MW PV systems |
| Tender capacity | FIP (≥ 1 MW): 175 MW<br>FIT (250 kW - < 1 MW): 50 MW |
| Ceiling price | 10.00 JPY/kWh (preliminarily announced) |
| Winning bids | FIP: 5 projects, 128.9 MW<br>FIT: 39 projects, 24.7 MW |
| Lowest winning price | FIP: 9.85 JPY/kWh<br>FIT: 9.80 JPY/kWh |
| Highest winning price | FIP: 9.90 JPY/kWh<br>FIT: 10.00 JPY/kWh |

### Table 19b: Results of the 13th tender for FIT capacity in FY 2022

| Item | Description |
|---|---|
| Subject of the tender scheme | ≥ 250 kW PV systems |
| Tender capacity | FIP (≥ 1 MW): 175 MW<br>FIT (250 kW - < 1 MW): 50 MW |
| Ceiling price | 9.88 JPY/kWh (preliminarily announced) |
| Winning bids | FIP: 10 projects, 14,3 MW<br>FIT: 18 projects, 11.8 MW |
| Lowest winning price | FIP: 9.70 JPY/kWh<br>FIT: 9.50 JPY/kWh |
| Highest winning price | FIP: 9.87 JPY/kWh<br>FIT: 9.88 JPY/kWh |

### Table 19c: Results of the 14th tender for FIT capacity in FY 2022

| Item | Description |
|---|---|
| Subject of the tender scheme | ≥ 250 kW PV systems |
| Tender capacity | FIP (≥ 1 MW): 175 MW<br>FIT (250 kW - < 1 MW): 50 MW |
| Ceiling price | 9.75 JPY/kWh (preliminarily announced) |
| Winning bids | FIP: 11 projects, 137.2 MW<br>FIT: 17 projects, 11.3 MW |
| Lowest winning price | FIP: 9.65 JPY/kWh<br>FIT: 9.50 JPY/kWh |
| Highest winning price | FIP: 9.75 JPY/kWh<br>FIT: 9.88 JPY/kWh |

## 3.6 Other utility-scale measures including, floating and agricultural PV

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 gradually increased, and the cumulative installed capacity is estimated to have reached more than 400 MW. In addition to the installations supported by the FIT program, the introduction via corporate PPAs is also increasing. There are no actual cases of installations in coastal and offshore areas, although there are cases of feasibility studies and small-scale demonstration tests. The "Guideline for the design and construction of floating PV (FPV) systems", which has been formulated under the commission project of NEDO, was revised in April 2023 (The complete version of this guideline is planned to be issued in 2024, following the results of research and development and demonstration tests). The guideline is expected to lead to an increase in the installation of FPV systems with higher safety standards than before.

There is no policy to directly promote the introduction of PV systems on farmland (AgroPV systems). Through support measures for leading model demonstrations, provision of

information such as regular updates of handbooks by the Ministry of Agriculture, Forestry and Fisheries (MAFF) and deployment of best practices, the introduction of AgroPV systems gradually increased and the cumulative total is assumed to have reached 4,000 to 5,000 projects, or over 1 GW. Installations of non-FIT PV systems as well as those in the Decarbonization Leading Areas are also increasing. Also, the "Guideline for the design and construction of AgroPV systems ", which has been formulated under the commission project of NEDO, was revised in April 2023 (The complete version of this guideline is planned to be issued in 2024, following the results of research and development and demonstration tests). The guideline is expected to lead to an increase in the installation of AgroPV systems with higher safety standards than before.

## 3.7 Social Policies: Support programs for low-income families, schools and public facilities, etc.

Although no support program is available specifically for low-income families, the Ministry of the Environment (MoE) provides generous subsidies to support the introduction of renewable energy to schools and public facilities, including the "Project to promote making renewable energy a mainstream power source/ strengthening of resilience in local communities through reduction of renewable energy price, etc. such as utilization of PPA", the "Project to establish symbiotic and recycling-based community with innovation for decarbonization" and the "Project to promote installation of independent and distributed energy facilities to evacuation centers, etc. which realize resilience and decarbonization of local communities in parallel". In particular, the "Project to promote installation of independent and distributed energy facilities to evacuation centers, etc. which realize resilience and decarbonization of local communities in parallel" subsidizes part of the installation costs for projects to introduce renewable energy such as PV power generation and storage batteries, etc. to public and private facilities that serve as evacuation centers and disaster prevention bases in the event of disasters based on local disaster-prevention plans, etc. METI supports the establishment of regional micro-grids as part of its "Project to promote dissemination of renewable energy, etc. in harmony with local communities". The Ministry of Education, Culture, Sports, Science and Technology (MEXT) supports the introduction of PV power generation in schools as part of its "Public school facility development project".

From FY 2022 onward, support projects for communities, schools and public facilities are scheduled to be launched through the "Project to grant for transition to local decarbonization and promotion of renewable energy", the "Project to establish decarbonization leading areas" based on a long-term perspective through 2030 and the "Project to accelerate priority measures".

## 3.8 Retroactive 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) has decreased from 40 JPY/kWh for FY 2012 to 10 JPY/kWh for FY 2022. 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 manage 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. In April 2022, the approval cancellation system was launched and the deadline of approval cancellation was set, 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 for the start of grid connection construction by March 31, 2023, and if the submission is not confirmed, the approval will be cancelled at that point. The Ministry of Economy, Trade and Industry (METI) announced that the number of uncommissioned projects whose approval will expire at the end of March 2023 is expected to be about 50,000 projects or 4 GW.

## 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 conducted dissemination measures for renewable energy such as PV and installation of storage batteries in remote islands to reduce fossil fuel usage.

MoE invited public participation in the "Demonstration project for the introduction of renewable energy, etc. on the islands of Iwo Jima and Minamitorishima", located at the easternmost tip of Japan, as the project for FY 2022, and launched a demonstration project to supply the necessary electricity from renewable energy sources. MoE allocated 350 MJPY for related expenses in its budget request for FY 2022. This project was commissioned by Okinawa Electric Power and its subsidiary SeED Okinawa, which started the demonstration project from April 2023. With the aim of starting to supply electricity by the end of FY 2023, the project will install PV systems and storage batteries on Iwo Jima and Minamitorishima islands, and the generated electricity will be supplied to housings for the dispatched members of the Japan Meteorological Agency and Self-Defence Forces on the islands, and also used to charge EVs. Furthermore, MoE started a project to formulate a plan for a project to introduce facilities to increase the ratio of renewable energy to the total electricity supply on remote islands by strengthening dispatching ability through management and control of renewable energy facilities and demand-side facilities on a group basis under the "Project for introduction and construction of operation control facilities to make renewable energy the main power source on remote islands". In the FY 2022 project, the MoE selected the projects which are conducted by ecolomy on Takarajima Island, Toshima Village, Kagoshima Prefecture, and by Tohoku EPCO Solar e Charge on Sado Island in Sado City, Niigata Prefecture. The Toshima Village project will introduce a certain amount of renewable energy facilities while reducing the impact

on the grid through a group control of PV power, wind power and storage batteries, etc., thereby contributing to the decarbonization of the islands.

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" initiative. 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 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. In FY 2022, a project to store electricity generated by PV modules in storage batteries and deliver the batteries in Yushima, Amakusa City, Kumamoto Prefecture, as well as other projects were implemented.

### 3.9.2 Support for electricity storage and demand response measures

The Ministry of Economy, Trade and Industry (METI) launched the “Project to support the introduction of grid-scale storage batteries to accelerate the introduction of renewable energy” in the FY 2021 supplementary budget, with Sustainable open Innovation Initiative (SII) acting as the contact point. With a budget of 13 BJPY, the project supported the introduction of storage batteries directly connected to the electricity network, which resulted in the introduction of storage batteries with a total capacity of more than 1 MW. At the same time, the Electricity Business Act and other relevant laws and regulations were amended. Under the project, 13 projects were selected in FY 2022, including the introduction of storage batteries in Hokkaido Prefecture by ENEOS, and approximately 150 MW/500 MWh of storage batteries were installed.

Regarding demand response, METI announced a public invitation for the “Demonstration project to establish the next-generation technologies utilizing distributed energy resources such as storage batteries, etc.,” conducted by the Sustainable open Innovation Initiative (SII) as a contact point. The "Renewable energy aggregation demonstration project" was added along with the demonstration projects on the consumer side in FY 2022 as well, covering the following: 1) demonstration to avoid imbalance in renewable energy generation; 2) verification to increase profits from market trading; and 3) demonstration of renewable energy generation forecasting. Five consortia participated in these demonstration studies: Toshiba Energy Systems and Solutions, ENERES, SB Energy, Chubu Electric Power Miraiz and JPN ENERGY Integrated System.

The “Demonstration project for further use of distributed energy resources (DER Aggregation)” consists of Project A for infrastructure development project, Project B for DER aggregation project and Project C for introduction of DER and others. Project A was conducted by Waseda University and Project B by ENERES, Kansai Electric Power (KEPCO), Exergy Power Systems, and Tokyo Electric Power Company Holdings as consortium leaders.

Under the DER aggregation project, the equipment and construction costs, including storage batteries, are eligible for subsidies, and in FY 2022, subsidies were also provided for residential and industrial energy storage systems (storage batteries + inverters). The target price for industrial energy storage systems was set at 190,000 JPY/kW, and subsidies of 63,000 JPY/kW (capped at one third of the price) were provided for those below the target price. For residential storage batteries, a target price of 155,000 JPY/kWh was set, and subsidies of

37,000 JPY/kWh to 52,000 JPY/kWh were provided for storage batteries purchased at or below the target price. In the area of industrial energy storage, etc., MoE provided subsidies for the introduction of self-consumption type PV systems, storage batteries, etc. that contribute to the promotion of decarbonization and disaster prevention as part of the "Project to promote making renewable energy a main power source/ strengthening of resilience in local communities through reduction of renewable energy price, etc. such as utilization of PPA".

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 establishment of net zero energy houses (ZEHs) at detached houses” is implemented by SII as a contact point for this program. In case of introducing a storage system to the eligible ZEH, 20,000 JPY/kWh is granted for an energy storage system that costs 155,000 JPY/kWh or less.

### 3.9.3 Support for encouraging social acceptance of PV systems

In October 2022, METI launched the "the Working Group for making renewable energy a long-term main power source and facilitating harmony with local communities" and began studying the development of the necessary legal system. Measures against businesses that violate relevant laws and regulations and measures to strengthen communication with the local communities where projects are located were examined, and penalties for FIT and FIP-approved projects that violate relevant laws and regulations were presented. FIT and FIP approvals for power plants with an output capacity of 50 kW or more also include a policy to require holding briefing sessions for local residents. Meanwhile, METI has decided to disseminate and promote renewable energy projects in harmony with local communities by awarding the "Community Coexistence Mark" to excellent businesses that are working to introduce renewable energy in harmony with the local communities and selected six business operators to be honoured with the "Award for Renewable Energy Projects in Harmony with Local Communities".

### 3.9.4 Other support measures

#### 3.9.4.1 *Policies related to output curtailment*

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 was implemented in mainland Kyushu. Kyushu Electric Power conducted a PV output curtailment simulation and reported that the output curtailment rate was projected to be 3.0% in FY 2022 and 4.8% in FY 2023. Output curtailment forecasts for FY 2023 were also presented for the Hokkaido, Tohoku, Hokuriku, Chugoku, Shikoku, and Okinawa areas. METI summarized the basic direction of a comprehensive package to reduce

renewable energy output curtailment including the following: 1) improvement of efficiency in output curtailment; 2) supply measures; 3) demand measures, and 4) grid measures. Consideration is also underway regarding the application of non-firm connection, which was applied to the bulk power system from January 2021. As for the local grid, Tokyo Electric Power (TEPCO) and NEDO are conducting a pilot project, with the aim of starting to accept applications in April 2023. Regarding the method to control congestion in the grid where non-firm connection is applied, re-dispatching method by general power transmission and distribution operators will be adopted at first. Online proxy curtailment, which is expected to reduce the amount of output curtailment, was studied and introduced in the Kyushu area in December 2022. Online proxy curtailment is also being introduced in other areas.

#### 3.9.4.2 *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. Then 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.

At the G7 environment, climate and energy ministers meetings held in Berlin, Germany, in May 2022, the ministers agreed to halt new public financing for international fossil fuel projects that have not taken measures to reduce GHG emissions by the end of 2022. However, the Communiqué stated that "concrete and timely efforts shall be made toward the goal of eventually phasing out coal-fired power generation," but a specific timing for the phase-out was not specified.

### 3.9.4.3 *The introduction of any favourable environmental regulations*

Regulatory Reform by the "Task Force for comprehensive review of regulations, etc. on renewable energy"

The need for regulatory reform is becoming a major challenge to maximize the introduction of renewable energy by making renewable energy a main power source toward carbon neutrality by 2050. In order to address the necessary regulatory reforms as a national issue and to strongly promote speedy reforms beyond the framework of ministries and agencies, the "Task Force for comprehensive review of regulations, etc. on renewable energy" was established in December 2020 under the leadership of Taro Kono, Minister for Administrative Reform and Regulatory Reform. Some examples of the outcomes are shown below. The Task Force is continuing and producing results in FY 2023.

- Approaches to location restrictions, such as elimination of single income requirement on devastated farmland and conversion of devastated farmland that is difficult to reclaim into non-agricultural use

- Establishment of the "renewable energy value trading market" where consumers can trade directly

- Review of grid restrictions on transmission networks, such as non-firm connections of local grids

- Compliance with electrical safety regulations, such as expanding the scope of pre-use self-confirmation for small-scale renewable energy facilities

- Compliance with regulations under the Fire Service Act concerning stationary lithium-ion storage battery facilities

- Clarification of technical standards for PV power generation facilities

- Reform of the Chief Electrical Engineer system

- Relaxation of requirements for the promotion of power generation facilities on farmland

- Use of agricultural reservoirs for the dissemination of floating PV (FPV) systems

- Strengthening of energy conservation standards for buildings and promotion of net zero energy houses (ZEH) and net zero energy buildings (ZEB)

- Promotion of the introduction of renewable energy on roads and in urban parks, including pavement-type PV power generation

- Review of the scheme to expand the dissemination of demand response (DR)

- Abolition of the obligation to install storage batteries related to output fluctuation mitigation requirements in the Hokkaido area

In August 2022, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), METI and MoE compiled a list of measures for housing and buildings toward achieving carbon neutrality by 2050 and presented the ideal vision for housing and buildings in 2050 and 2030 as well as the way forward for energy conservation measures and other initiatives.

**Table 20: Ideal vision for housing and buildings in 2050 and 2030**

| | |
|---|---|
| 2050 | The energy conservation performance of the ZEH/ZEB standard level is secured on average in the stocks, and the introduction of renewable energy such as PV systems becomes common in houses and buildings where the introduction is reasonable. |
| 2030 | Energy conservation performance at the level of ZEH/ZEB standards shall be ensured for newly constructed houses and buildings, and 60% of newly constructed detached houses shall be equipped with PV systems. |

### 3.9.4.4 *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 2021, it slightly decreased to approximately 73%. While the share of fossil fuels decreased, the share of nuclear power and renewable energy increased to 6.9% and 20.3%, respectively.

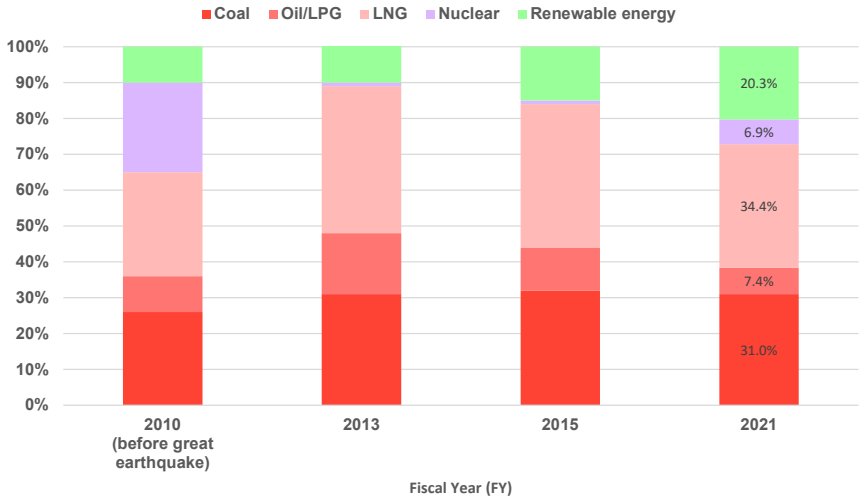



**Figure 1 Generation mix of the electric companies**

Source: Report on electricity supply-demand verification (October 2017) and White Paper on Energy 2023

Based on the Fifth Strategic Energy Plan approved by the Cabinet in July 2018, studies were conducted to address the fade-out of inefficient coal-fired thermal power plants. A policy was presented that inefficient coal-fired power plants should be steadily faded out by 2030, and that in addition to taking both regulatory and directive measures, the efforts of business operators should be confirmed and secured through the fade-out plan. In the Sixth Strategic Energy Plan approved by the Cabinet in October 2021, renewable energy is described as a promising, diverse, and important domestic energy source that can contribute to energy security because it is a decarbonized energy source that does not emit greenhouse gases and can be produced domestically. It was noted that the policy includes thoroughly making renewable energy a main power source through a principle of placing the highest priority on renewable energy. As for thermal power generation, while it is necessary for the time being as a supply capacity/dispatching ability to cover the volatility of renewable energy, it is fundamental to reduce the ratio of thermal power generation in the energy mix to a level as low as possible by FY 2030. Based on the premise of securing stable supply, while working on environmental measures toward decarbonization of thermal power generation, issues such as strengthening the competitiveness and improving the economic efficiency of thermal power generation will be addressed. From the perspective of ensuring stable supply, in light of growing concerns about supply capacity shortages due to the ongoing closure and decommissioning of existing thermal power plants, it is planned to proceed with studies on measures to prevent the withdrawal of power sources and strengthen efforts to secure fuel, while securing the necessary installed capacity on a mid- to long-term basis by means of the capacity market. In addition, the "Decarbonized Power Supply Auction," a bidding scheme for new investments in decarbonized power sources, is scheduled to start in FY 2023.

- 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 21, in the summer of 2022, electricity supply capacity in the peak hours of the day with the peak demand was expected to be 19.35 GW (excluding Okinawa Prefecture), but the actual supply capacity was 41.59 GW in total. It is estimated that the supply capacity in the summer of 2023 will be 20.22 GW (excluding Okinawa Prefecture). 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 estimated conservatively.

**Table 21: 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 2022 (Actual) | Assumption | **230** | **2,210** | **5,250** | **3,710** | **530** | **2,600** | **2,000** | **1,140** | **1,670** | **19,350** |
| | **Actual supply capacity records on a day and an hour of peak demand** | **640** | **3,760** | **11,270** | **7,070** | **880** | **4,370** | **4,100** | **2,060** | **7,450** | **41,590** |
| | **Actual ratio of adjustment factor (%) records on a day of peak demand** | **30.2** | **49.9** | **81.9** | **67.1** | **72.0** | **71.9** | **68.9** | **66.7** | **66.4** | |
| | Peak demand date and hour in Japan | 1-2 p.m., Tuesday, Aug 2, 2022 | | | | | | | | | - |
| | Peak electricity demand | 3,620 | 13,520 | 59,300 | 25,320 | 5,080 | 26,900 | 10,460 | 5,010 | 15,690 | 164,880 |
| | PV ratio to peak demand | 17.7% | 27.8% | 19.0% | 27.9% | 17.3% | 16.2% | 39.2% | 41.1% | 47.5% | 25.2% |
| Summer of 2023 (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** | **230** | **2,350** | **5,650** | **3,800** | **510** | **2,560** | **2,140** | **1,160** | **1,800** | **20,220** |
| | **Adjustment factor (%)** | **6.6%** | **24.9%** | **25.3%** | **30.4%** | **33.3%** | **28.5%** | **28.9%** | **34.0%** | **13.0%** | **-** |

Source: Report on electricity supply-demand verification (October 2022 and May 2023)

*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/2023_choseikeisu_ichiran.xlsx)

### 3.9.4.5 *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).

The FY 2021 tax revenue from the petroleum and coal tax, including the Tax for Climate Change Mitigation, was 606 BJPY. Of this amount, revenue from the Tax for Climate Change Mitigation is expected to amount to about 260 BJPY. This tax revenue 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.

MoE started studying carbon pricing in January 2017 and discussions are ongoing. 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 published an interim report on the use of carbon pricing in August 2021, but it is not intended to indicate a specific direction or conclusion. 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. In August 2021, METI compiled the results of discussions into a draft interim report. As part of the framework to bring about behavioral transformation in a medium to long term, it was proposed to establish a "Carbon neutral top league (tentative name)" in which businesses set emission reduction targets and the government verifies their performance, and a "Carbon credit market" in which businesses trade high quality credits from Japan and abroad. The timing of the introduction of carbon pricing has not yet been decided, but since the "Act Concerning the Promotion of a Smooth Transition to a Decarbonized Economic Growth Structure" (commonly known as the GX Promotion Act), which came into effect in June 2023, mentioned the collection of surcharge on fossil fuels in the future, it is assumed that carbon pricing such as carbon taxes will be introduced in earnest in the future.

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

To achieve the reduction target of GHG emissions, Japan has implemented the Joint Crediting Mechanism (JCM). The JCM is a mechanism in which credits issued depending on the reduced amount of GHG emissions are utilized to achieve target of Japan’s GHG emissions reduction through support for dissemination of high-quality low carbon technologies, etc. to developing countries. As of July 2022, the Japanese government has signed bilateral documents for JCM with 26 countries including with Mongolia, Bangladesh, Ethiopia, Kenya, Maldives, Vietnam, Laos, Indonesia, Costa Rica, Palau, Cambodia, Mexico, Saudi Arabia, Chile, Myanmar, Thailand, Philippines, Senegal, Tunisia, Azerbaijan, Moldova, Georgia, Sri Lanka, Uzbekistan, Papua New Guinea and the United Arab Emirates (UAE). In these countries, from FY 2013 to FY 2022, 228 funding projects and demonstration projects (MoE/ METI) were adopted. As of August 2022, 151 PV-related projects with a total capacity of approximately 2.2 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. In FY 2022, Kansai Electric Power Company (KEPCO) and NTT DATA INSTITUTE OF MANAGEMENT CONSULTING conducted the "Demonstration study

(Chonburi Province, Kingdom of Thailand)/ the preliminary study on control technology to maximise the introduction of PV systems in an industrial complex".

The Japan International Cooperation Agency (JICA) provides grant aid (free of charge or for a fee) and technical cooperation on an intergovernmental basis at the request of developing countries. With regard to PV power generation, JICA is mainly engaged in supporting the formulation of plans for rural electrification using PV power, focusing on the preparation of master plans through development studies mainly for rural electrification.

In FY 2022, the "Electricity grid stabilisation project for the expansion of renewable energy introduction" was implemented for Mongolia. Mongolia's bulk power transmission system (Central Energy System, hereinafter referred to as CES) lacks the grid flexibility (dispatching power from other power supplies and power storage systems such as pumped storage), which is required for the mass introduction of variable renewable energy (hereinafter referred to as VRE), such as wind and PV power. The CES stabilises the grid by having the Russia's grid, which is synchronously interconnected, absorb output fluctuations of VRE. Therefore, the maximum possible installed capacity of VRE power sources is at a level that does not exceed the capacity of the interconnection line with Russia (bilateral adjustment is underway to expand the capacity from 245 MW to a maximum of 345 MW). By resolving the above-mentioned issues related to grid operation and maintenance of the power transmission and distribution systems, the project will ensure the flexibility and reliability of the electricity grid to withstand the large-volume introduction of VRE, contribute to the realization of the country's national energy policy to achieve the 30% share of renewable energy installed capacity by 2030, and help achieve carbon neutrality.

The Japan Bank for International Cooperation (JBIC) contributes to addressing global environmental issues through its environmental sector initiatives, which include various financial options to support the export of Japan's advanced environmental technologies and their overseas deployment.

In FY 2022, the government of Japan, together with the Japan International Cooperation Agency (JICA) and the New Energy and Industrial Technology Development Organisation (NEDO), concluded a Memorandum of Understanding on business cooperation with the International Solar Alliance (hereinafter referred to as ISA), an international initiative for expanding the use of solar energy. The ISA is a multilateral cooperation platform for the rapid and significant expansion of the use of solar energy in the international community, and an initiative launched by the government of India together with the government of France during the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change(COP21) in November 2015. The initiative provides financing and capacity-building support to member countries on technology and finance, etc. for the expansion of solar energy deployment. Through these initiatives, JBIC will continue to support the energy transformation towards achieving a decarbonized society from a financial perspective.

## 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 OCCTO) 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, 8.0 BJPY in FY 2021, 8.0 BJPY in FY 2022 and 8.0 BJPY in FY 2023. 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 489.9 TWh cumulatively as of the end of December 2022, and the cumulative total amounted to 18.4906 TJPY.

## 3.11 Grid integration policies

### 3.11.1 Grid connection policies

- 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 enhancement of frequency conversion stations connecting Tokyo area and Chubu area are underway. 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 need to be enhanced. 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. OCCTO compiled a master plan for the wide-area interconnection system, and in the base scenario, the required investment amount was 2.5 to 3.4 TJPY for the construction of the new Hokkaido-Tohoku-Tokyo route, and the total required investment amount including the reinforcement of other interconnection lines was 6 to 7 TJPY (550 to 640 BJPY/year). Based on this master plan, we will proceed with the realization of the development plan. 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 was 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”,

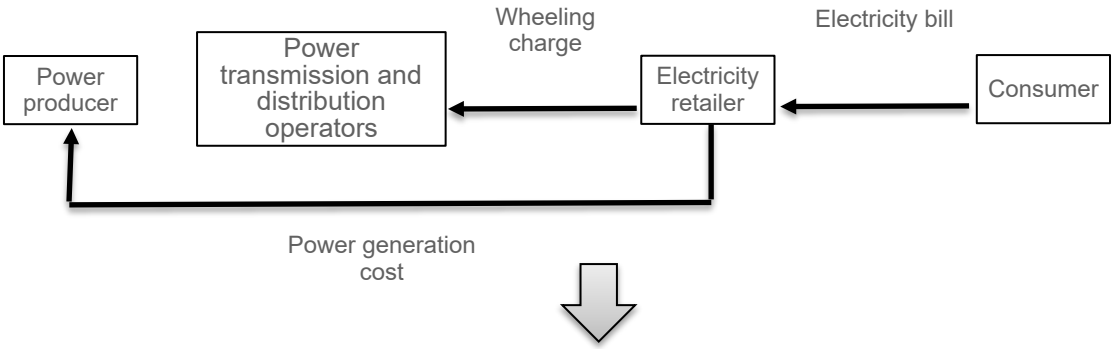
and the rule of “no limit without compensation” has applied to all the areas, effective from April 2021. To overcome grid constraints, OCCTO have been working on the “Japanese version connect & manage,” in which the existing grid is thoroughly utilized. Since January 2021, non-firm connections have been applied to the bulk power system where available capacity is insufficient. TEPCO and NEDO are conducting a trial non-firm connection to local grids, with the aim of starting to accept applications in April 2023.

### 3.11.2 Grid access policies

- Charge on the power producer side

In order to efficiently use the grid and efficiently and surely enhance the grid to expand the introduction of renewable energy, the charge on the power producer side requires the power producers, who are grid users as well as consumers, to bear part of the costs necessary for maintaining and expanding the transmission and distribution of electricity, which are all borne by electricity retailers. Regarding the subjects of the charge on the power producer side, basically all power sources connected to the grid and feed electricity to the grid are subject to be charged. On the other hand, small-scale power sources of less than 10 kW (e.g. residential PV systems) will not be subject to the charge for the time being. In order to ensure that the introduction of the charge on the power producer side does not hinder the maximum introduction of renewable energy, already approved FIT/FIPs will be subject to the charge on the power producer side after the termination of the purchase period, etc. New FIT/FIPs will be considered in the calculation of purchase prices, etc., and for non-FIT/post-FIT projects, ingenuity of business operators (bilateral contracts, etc.) will be promoted and the smooth transfer will be thoroughly pursued. Regarding the method of setting the unit price of the charge, the burden on the power producer side shall be determined so that the fixed cost of the upper-level grid (bulk electric grid and extra-high voltage grid) that is considered to benefit equally on both the power producer side and the consumer side will be borne equally by both sides. Since the ratio of kW-based charging to kWh-based charging is 1:1, the cost to be borne by the power producer side is prorated with 1:1, and the unit price of kW-based charge and that of kWh-based charge are calculated. The image of the unit price of the charge based on a simple trial calculation is that the kW-based charge is about 75 JPY/kW/month, and the kWh-based charge is about 0.25 JPY/kWh. In fact, when general power transmission and distribution operators charge power producers, they are charged in consideration of the discount system. The detailed design of the system is underway with the aim of introducing it from April 2024.

<Current wheeling charge scheme> 100% charged on electric retailers (on the consumer side)




<After the introduction of the charge on the power producer side (image)>

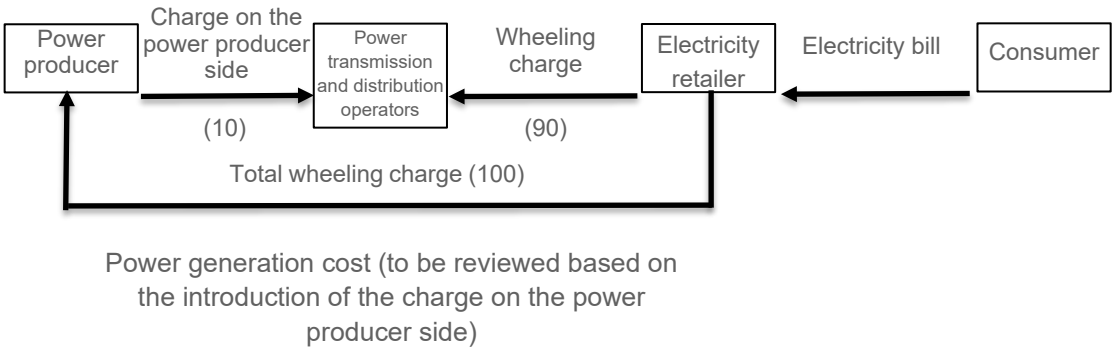



Figure Image of the introduction of the charge on the power producer side

Source: Interim report on the introduction of the charge on the power producer side (April 2023)

# 4 INDUSTRY

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

As of 2022 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 (Note: Mitsubishi Materials transferred the polysilicon business to SUMCO, and High-Purity Silicon under SUMCO started the polysilicon business from April 2023). Tokuyama manufactures polysilicon in full capacity at its factory in Shunan City, Yamaguchi Prefecture. Following the significant increases of production costs due to the rise in raw material and fuel prices in FY 2022 (April 2022 to March 2023), Tokuyama's sales volumes fell in the first half of the fiscal year. However, they increased in the second half, because the price corrections progressed and thanks to the annual contracts. Mitsubishi Materials is manufacturing polysilicon in Japan and the USA. The company transferred its polysilicon-related business to SUMCO in December 2022, due to the harsh business environment. Mitsubishi Materials established High-Purity Silicon as a successor company, and transferred its polysilicon business, its U.S. subsidiary Mitsubishi Polysilicon and silica manufacturer NIPPON AEROSIL to the new company. Tokuyama and Mitsubishi Materials do not manufacture polysilicon for solar cells, but they sometimes supply off-grade polysilicon for semiconductors for solar cells. M.SETEK, which manufactures single-crystalline silicon (sc-Si) ingots and wafers for semiconductors, is the only company in Japan that also manufactures sc-Si ingots for solar cells.

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

According to PV shipment statistics by the Japan Photovoltaic Energy Association (JPEA), domestic shipments of PV module in 2022 totalled 5,027 MW. Of this amount, 88%, or 4,445 MW, was imported. Foreign manufacturers appear to have occupied the top positions in terms of shipments, as in the previous year (JPEA's shipment statistics do not include the shipments by JinkoSolar (China) and Trina Solar (China)). In Japan, the ratio of imports has been increasing year after year since the FIT program started in 2012. Total PV module shipments by domestic production in Japan in 2022 were 583 MW. Of this total, about 300 kW was shipped overseas, and the volume of overseas shipments of overseas-produced products was 19 MW.

Major Japanese PV manufacturers are reorganizing the production framework from around 2017. Panasonic, which had manufactured the "HIT" heterojunction solar cells, terminated production of silicon wafers for solar cells, HIT solar cells and modules by March 2022, and liquidated its local subsidiary at its factory in Malaysia. The company has continued the sales under its own brand through procurement from third parties and production consignment. Solar Frontier, which had manufactured CIS thin-film solar cells, withdrew from manufacturing in June 2022, but it has continued its R&D activities. The company has switched its solar cells to crystalline silicon (c-Si) solar cells and is focusing on system sales and EPC business. INFINI, which had been engaged in consignment production of c-Si PV modules, abolished business restructuring procedures and went bankrupt in April 2022. Major companies that continue their PV-related businesses are shifting their business model from the conventional business of PV module sales to the PV solution business. They are continuing their efforts to provide total

solutions, such as PV systems for self-consumption and ZEH applications, as well as those combined with HEMS, storage batteries, hybrid inverters, etc. Further, more manufacturers are entering the electricity business such as the renewable energy power generation business, PPA business, self-wheeling and the energy aggregation business, with a focus on PV power generation. Kaneka, Toshiba, Sekisui Chemical, Aisin, and EneCoat Technologies are developing and demonstrating technologies for the commercialization of film-type perovskite solar cells with the support of the government. Sharp and Panasonic are also developing technologies for the commercialization of perovskite solar cells. Kaneka and Toshiba are conducting R&D of high-efficiency tandem solar cells such as perovskites/c-Si solar cells.

## 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, Diamond & Zebra Electric MFG, Panasonic, Kyocera, Sharp, Delta Electronics (Taiwan), Huawei Technologies (China) and SolarEdge Technologies (Israel) have acquired certifications 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 include a 25-kW inverter and a 33.3-kW inverter by Diamond & Zebra Electric MFG; a 21-kW inverter and a 42-kW inverter by Fuji Electric; and a 25-kW inverter by Yaskawa Electric, and 10-kW inverters by GS Yuasa, Sanyo Denki, etc. Recently, overseas manufacturers such as Huawei Technologies, Sungrow Power Supply (China) and SolarEdge 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, 1,000 kW, 2,500 kW and 4,400 kW. As PV power plants become larger in capacity, the unit capacities of inverters are also getting larger. Diamond & Zebra Electric MFG, Yaskawa Electric, SMA Solar Technology, Huawei Technologies, Sungrow Power Supply 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 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 as well.

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). 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 often given by electric companies individually. JET started a certification system for high-voltage grid connected protective equipment in February 2021, which is intended for ≤ 2 MW inverters, and Fuji Electric obtained the certificate.

- 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, Eliiy Power, Murata Manufacturing, etc., supply storage batteries in Japan. Many domestic manufacturers import storage batteries from South Korea and other foreign countries and incorporate them into their own systems for delivery.

Residential storage systems are sold as hybrid inverters, etc. by Sharp, Nichicon, ITOCHU, Choshu Industry, Panasonic, Omron, Diamond & Zebra Electric MFG, Kyocera, Murata Manufacturing and so on. The inverter capacity usually ranges from 1 kW to 11 kW and the capacity of storage batteries ranges from 1 kWh to 17.1 kWh.

Some companies from abroad entered the Japanese market. PV manufacturers such as Hanwha Q CELLS Japan, Canadian Solar and JinkoSolar Japan are selling residential PV systems equipped with storage batteries.

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.

From FY 2022, the introduction of large and grid-scale storage batteries has begun, and inverters have been delivered by TMEIC, Meidensha, Daihen, etc.

The storage battery manufacturers for these large-scale projects are GS Yuasa, LG Chemical, Samsung SDI, Toshiba and Tesla 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), etc. In addition to the products applicable to DC 1,000 V, adoption of products applicable to DC 1,500 V is increasing.

- Mounting structures

For mounting 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 mounting 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 mounting structure), in addition to reservoir solar company (Tameike Solar), Kyoraku, etc., overseas companies such as Ciel & Terre (France) engage in the market.

# 5 PV IN THE ECONOMY

## 5.1 Labour places

**Table 22: Estimated PV-related full-time labour places in 2022**

| Market category | Number of full-time labour places |
|---|---|
| Research and development (not including companies) | 400 |
| Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D | 68,400 |
| Distributors of PV products and installations | |
| Other | |
| **Total** | **68,800** |

## 5.2 Budget for research and development

As for R&D, D activities concerning PV, technology development for commercialization administered by METI, has been conducted by the New Energy and Industrial Technology Development Organization (NEDO) and fundamental R&D administered by Ministry of Education, Culture, Sports, Science and Technology (MEXT), has been promoted mainly by the project of the Japan Science and Technology Agency (JST) and the project to subsidize the scientific research fund.

METI's R&D budget for FY 2022 was 3.05 BJPY. NEDO made an additional public offering in FY 2021 for the Development of Technologies to Promote Photovoltaic Power Generation as a Main Power Source (FY 2020 - FY 2025) and selected five themes. These themes include development of technology to evaluate generation amount to support the next-generation O&M, as well as technology to forecast solar irradiation for a short-term forecast of generation amount. A demonstration experiment to ensure safety of PV systems on slopes, AgroPV and floating PV systems is conducted as well.

In 2021, the government established a 2 TJPY, 10-year fund called the Green Innovation Fund (GIF) as part of NEDO for development of decarbonization technology and R&D on social implementation to realize carbon neutrality by 2050. Projects across 18 areas, the key areas for which implementation plans were formulated under the Green Growth Strategy by METI, will be conducted between FY 2021 and FY 2030. As part of the GIF project, NEDO started the Next-Generation Solar Cell Development Project in 2021 as the 10-year project between FY 2021 and FY 2030 with total budget of 49.8 BJPY. Sekisui Chemical, Toshiba, EneCoat Technologies, Aisin, Kaneka and the National Institute of Advanced Industrial Science and Technology (AIST) were selected. Demonstration tests are also planned to be launched by FY 2025, aiming to achieve social implementation. In 2022, the three companies participating in the project announced plans to demonstrate installation of film-type perovskite solar cells (PSC) in 2025 as a joint project with businesses and local governments. Pilot demonstration tests are also scheduled to be conducted in FY 2023 or later, with the aim of social implementation of the solar cells. Furthermore, the Project of hydrogen production with water

electrolysis using electricity derived from renewable energy, etc. was also started under the GIF project.

## 5.3 Business value

**Table 23: Rough estimation of the value of the PV business in 2022 (VAT is excluded)**

| Sub-market | Capacity installed [MW] | Average price [JPY/W] | Value |
|---|---|---|---|
| Off-grid | 2.4 | N.A | |
| Grid-connected residential | 1,167 | 220 | 256.7 BJPY |
| Grid-connected non-residential | 1,727 | 178 | 307.4 BJPY |
| Grid-connected centralized | 3,756 | 122 | 458.2 BJPY |
| Value of PV business in 2022 | | | 1.0224 TJPY |

# 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 690 (as of December 2022) 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. Due to the impact of soaring spot market prices for electricity, PPS have suspended or withdrawn from the business one after another, and the share of PPS decreased from the previous year to 18.1% (as of December 2022). 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 46.6% of the total demand (as of December 2022). 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. 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. The auctions of the renewable energy value trading market started in November 2021, and consumers are directly purchasing FIT non-fossil fuel energy certificates. In addition, auctions are 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 started its operation. A long-term decarbonized power supply auction is scheduled to start in FY 2023 to encourage new investment in decarbonized power sources.

## 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 Sixth Strategic Energy Plan that efforts will be made to make renewable energy a main 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 with no upfront cost (on-site PPA), has been progressing, targeting electricity users, and off-site PPAs are also being proposed for large customers. The electricity rate menu that utilizes renewable energy is also expanding.

- 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 Power

announced the "Hokuden Group Management Vision 2030" with plans to increase its renewable energy capacity by more than 300 MW in Hokkaido Prefecture and other regions, and to achieve zero $CO_2$ emissions from the power generation sector in order to become carbon neutral by 2050. Effective May 1, 2022, the utility company established the Renewable Energy Development Promotion Department. Tohoku Electric announced that it will achieve its renewable energy development target of 2 GW as early as 2030 onwards, and established the Corporate PPA Office, which leads the PPA business of its group companies as a whole. Chubu Electric formulated the "Chubu Electric Power Group Management Vision 2.0" towards 2030 with the aim of developing more than 3.2 GW of renewable energy. Hokuriku Electric established the Renewable Energy Department to accelerate the development of renewable energy in order to achieve the "Hokuriku Electric Power Group 2030 Long-term Vision". Kansai Electric Power (KEPCO) formulated the "Kansai Electric Power Group Medium-term Management Plan (2021-2025)" and will invest 340 BJPY in renewable energy-related projects. Chugoku Electric set a target to introduce 300 to 700 MW of renewable energy by FY 2030 under its group management vision "Energia Change 2030" to achieve carbon neutrality by 2050. Shikoku Electric announced its challenge to achieve carbon neutrality by 2050. Shikoku Electric will work on new development of renewable energy, aiming to introduce 500 MW by FY 2030 and 2 GW by FY 2050. Okinawa Electric announced the group's medium-term management plan for FY 2025 and will invest about 6 BJPY to make renewable energy a main power source, through such efforts as increasing the installed capacity of renewable energy with PV and wind power and upgrading grid stabilization technology using storage batteries. TEPCO Renewable Power succeeded approximately 10 GW of renewable energy power sources (hydro, wind, and PV) in 168 locations from TEPCO Holdings and aims to develop around 6 to 7 GW of renewable energy projects by 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. There are also plans available that allow customers to use surplus electricity at home even if they do not have storage batteries installed.

- 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 conducted on weekdays as well. In 2022, output curtailment was conducted in Hokkaido, Tohoku, Chugoku and Shikoku areas as well. 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).

- Introduction of a new wheeling scheme

In FY 2023, a new wheeling scheme called the "revenue cap system," is scheduled to be introduced. Based on national guidelines, general power transmission and distribution business operators prepare business plans that clarify the targets to be achieved during the five-year regulation period. They must obtain approval from the government for the outlook of income based on the estimated expenses necessary for the implementation of the business plan, and flexibly set the wheeling charge within the scope of the income outlook. Comparing the current wheeling charges with those after April 2023, they are expected to increase by 0-5% in Tokyo, Chubu, and Kansai areas, by 5-10% in Hokkaido, Tohoku, and Shikoku areas, and by 10% or more in Hokuriku, Chugoku, Kyushu, and Okinawa areas.

## 6.3 Interest from municipalities and local governments

In FY 2022, the Ministry of the Environment (MoE) launched the “Project of Subsidy for transition to local decarbonization and promotion of renewable energy”, in which it publicly invited applications for 1) Decarbonization leading areas development project and 2) Project to accelerate priority measures. Under these projects, municipalities can take the lead in structuring the project, apply to MoE for the details of the project and obtain budget for the implementation of the projects as a grant. The municipalities can utilize these grants to solicit public applications and promote the introduction of renewable energy facilities, etc. to reduce $CO_2$ emissions in their areas. By April 2023, 62 projects, 83 cities, towns and villages from 32 prefectures had been selected in the first three rounds of public calls. For the “Project to accelerate priority measures,” 29 projects, 81 cities, towns and villages and 110 municipalities have been selected as of May 2023.

In FY 2022, a number of municipalities enhanced their subsidy programs with regard to the introduction of PV systems and storage batteries, contributing significantly to the expansion of their introduction. In most cases, subsidies range from 10,000 JPY/kW to 50,000 JPY/kW for PV systems and approximately 20,000 JPY/kWh for storage batteries.

In FY 2022, the Tokyo Metropolitan Government (TMG) launched the “Project to promote the introduction of large grid-scale storage batteries”. The project supports four-fifths of the initial cost of installing grid-scale storage batteries of 1 MW or more in the TEPCO service area. For residential storage batteries, a subsidy of 70,000 JPY/kWh is provided. For PV systems, 100,000 JPY/kWh to 150,000 JPY/kWh is provided as part of the “Project to promote energy-saving renovation in existing houses”. In FY 2023, the subsidies will be provided as part of the “Subsidy for the project to promote the introduction of PV systems in households”.

TMG is implementing the “TMG project to enhance local production and local consumption of renewable energy,” for businesses. This project supports storage batteries, etc. to be installed with PV systems. For small and medium-sized enterprises (SMEs) and others, the project subsidizes up to two-thirds of the costs eligible for the subsidy (Subsidy cap: 100 MJPY). For other businesses, up to one-half of the eligible costs are covered by the subsidy (Subsidy cap: 75 MJPY).

In FY 2023, more than 600 municipalities plan to provide support for the introduction of residential storage batteries.

# 7 HIGHLIGHTS AND PROSPECTS

## 7.1 Highlights

The year 2022 urged Japan to act on the Sixth Strategic Energy Plan formulated in 2021 as well as the Plan for Global Warming Countermeasures, aiming to achieve the national goal of reducing greenhouse gas (GHG) emissions by 46% by FY 2030.

Following the enforcement of the Act for Establishing Energy Supply Resilience, the Ministry of Economy, Trade and Industry (METI) shifted its development of policy measures from those based on the Renewable Energy Act (FIT Act) in 2010 focusing on the expansion of the PV installed capacity to those simultaneously promoting integration into the electricity market and 46% reduction of GHG emissions in the 2020s, and started new schemes such as “Feed-in Premium (FIP) program,” “Approval cancellation system,” and “Decommissioning cost reserve system.” In addition, METI promoted the strengthening of environmental improvement toward sound dissemination of renewable energy by compiling business disciplines toward facilitating PV installations in harmony with local communities, responding to grid constraints and output curtailment including the application of non-firm connection as well as the review of rules for grid utilization, working on regulatory reforms concerning installation, and revising the Energy Conservation Act. The Ministry of the Environment (MoE) started to develop policy measures toward the maximum introduction of renewable energy following the enforcement of the revised Act on Promotion of Global Warming Countermeasures. MoE selected 46 locations as the Decarbonization Leading Areas and started the projects to promote the intensive introduction of renewable energy in local communities led by municipalities. MoE also strengthened PV introduction on public facilities as well as support for introducing self-consumption type PV systems by private companies. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) enacted the revised Act on the Improvement of Energy Consumption Performance of Buildings (Building Energy Efficiency Act), which mandates residential houses to conform to energy-saving standards. MLIT has also been promoting the expansion of PV installations on public infrastructure facilities, expanding the scope not just to airport facilities but also to road and railroad facilities. Among municipalities, many of them started their efforts to expand the introduction of renewable energy such as the setting of the target installed capacity of renewable energy, the setting of renewable energy introduction promotion areas, the introduction of PV systems on facilities owned by municipalities, and the establishment of subsidies for introducing renewable energy. Tokyo Metropolitan Government (TMG) enacted the ordinance to mandate the installation of PV modules on newly built houses starting from FY 2025.

The PV industry has entered the new dissemination environment, promoting a shift to business development utilizing business models based on the on-site and off-site Corporate PPA scheme. As a new move toward 2030, PV introduction projects are also emerging under which electricity consumers such as local governments and private companies cooperate with PV developers (including EPCs) supported by the former FIT program, the conventional energy industry players, and trading companies and the like. In the PV market, a shift has now begun to renewable energy-based electricity led by electric consumers through the introduction of PV systems, against the background of the rise in the electricity bills and the adoption of the PPA scheme.

Under these circumstances, Japan’s cumulative PV facility approved capacity and cumulative installed capacity as of the end of December 2022 based on the FIT program increased to 78.0

$GW_{AC}$ and 63.9 $GW_{AC}$, respectively. In 2022, the annual installed capacity reached 6.6 $GW_{DC}$ and the cumulative PV installed capacity was 85.0 $GW_{DC}$, exceeding 80 GW.

## 7.2 Prospects

The Green Transformation (GX) Implementation Council chaired by Prime Minister Fumio Kishida compiled the Basic Policy for the Realization of GX which bundles the “Sixth Strategic Energy Plan,” “Green Basic Plan,” and “Plan for Global Warming Countermeasures,” and the Japanese government made a cabinet decision on the Basic Policy in 2023 and will go into action to promote economic growth and create a decarbonized society, including the securing of energy stability. The Basic Policy has two main pillars: Efforts on GX with the securing of stable energy supply as its major premise and the realization and implementation of a growth-oriented carbon pricing initiative, etc. The former pillar consists of 1) thorough promotion of energy conservation, 2) making renewable energy a main power source, 3) utilization of nuclear power, and 4) other 11 important matters. As for making renewable energy a main power source, the government aims to steadily achieve the renewable energy ratio of 36 to 38% in 2030. Concerning the introduction development of renewable energy hereafter, as a response that should be immediately dealt with, the government intends to promote renewable energy introduction led by local communities to public facilities, houses, factories, warehouses, and airport and railroad facilities, etc. while also utilizing the revised Act on Promotion of Global Warming Countermeasures, toward the maximum introduction of PV systems on suitable locations. As for the FIT and FIP programs, the utilization of PV tender schemes for cost reduction will be promoted and the introduction of the FIP program will be expanded. Meanwhile, a model for introducing PV systems based on the long-term contracts with consumers without relying on the FIT and FIP programs will also be expanded. Toward achieving output stabilization, the promotion of power supply based on supply-demand situations will be promoted by additionally installing storage batteries and promoting the FIP program. As for the mid- to long-term measures, grid improvement based on the master plan as part of the grid improvement nationwide will be promoted to accelerate responses to grid improvement and output fluctuations toward expanding renewable energy introduction. As for interregional interconnection lines, the grid improvement will be accelerated with a scale more than eight times compared to the last 10 years approximately over the next 10 years. Toward securing dispatching ability of decarbonized power sources, it is planned to formulate the introduction outlook of stationary storage batteries toward 2030 and seek to create the market that can attract investment from private companies and that distributed power sources such as residential storage batteries can enter into. The rules which enable storage batteries to smoothly connect to the grids will be established. Toward expanding PV introduction, aiming to improve the technology self-sufficiency ratio, research and development (R&D) and demonstrations of next-generation solar cells (perovskite solar cells) will be accelerated toward early social implementation, electricity demand will be created and the mass production framework will be established. The systematic responses to the massive disposal of PV modules which is expected in the second half of the 2030s will be promoted and the appropriate business disciplines will be ensured toward expanding the introduction of renewable energy in harmony with local communities. Moreover, output increase and long-term operation of existing renewable energy facilities will be promoted.

Toward achieving the Basic Policy for the Realization of GX, the government enacted the “GX Promotion Act” and the “GX Decarbonization Power Supply Act” and will accelerate the introduction development led by related government ministries and agencies as well as municipalities by fully utilizing the GX-related policy measures.

Meanwhile, it is expected that the PV industry will move into the development phase consisting of three axes, namely “Expansion of new installations,” “Thorough operation and maintenance (O&M) of existing PV systems,” and “Stable supply of electric power generated by PV systems” toward achieving the introduction of 120 GW PV power generation by 2030.