

## Future key factors of PV power generation to become a mainstream power source - Action plans of PV150@2030 -

### <Key points>

- ✓ New installation target of 150 GW by 2030 was proposed based on the forecast on PV installed capacity in Japan
- ✓ Action plans consisting of eight key factors to realize domestic installation of 150 GW by 2030 (PV150) were suggested
- ✓ Action plans include the viewpoints from industry, policy and installers

Based on the international PV trend that continues to expand rapidly and sustainably, RTS Corporation has been pointing out the importance of utilizing PV power as a mainstream energy in Japan. In February 2018, it has recommended introduction of 150 GW (cumulative) of PV systems by 2030 for the development of Japan's PV industry.

In the Fifth Strategic Energy Plan approved by the cabinet in July 2018, it is specified that Japan will "aim to make renewable energy including PV a mainstream power source" and main policies for promoting PV towards 2030 and the future direction were presented.

In this article, domestic and overseas environments surrounding PV power generation will be analyzed and ideas and action plans to realize introduction of 150 GW as described above, assuming the ideal future, will be proposed.

### Current status and trends of the global PV market

The global PV installed capacity has expanded to 98 GW (annual) and 401 GW (cumulative) in 2017. 29 countries exceeded the cumulative installed capacity of 1 GW and eight countries recorded annual installation capacity of 1 GW or more. The global PV power generation amount (theoretical value) accounted for over 2 % of the global total power generation amount.

With the decline in PV power generation cost, the price of power purchase agreement (PPA) decreased to 2 to 3 cents/kWh in the areas with good solar irradiation conditions, and internationally, the economic efficiency of a PV system has reached the level competitive with that of conventional power generation systems.

In 2017, the power generation capacity of newly built power plants

was 260 GW, 176 GW of which was of renewable energy (including 98 GW of PV systems). In the course of the energy security and environmental problems becoming the main themes of the policies in many countries, PV has come to be recognized as an important option of energy.

However, in order to enhance the effective utilization of natural energy, which is a variable power source, studies and experiments are being conducted in many places based on the necessity to transform conventional power generation and transmission systems and the requirement to change the philosophy and mechanism of energy management on both supply and demand sides.

### Current status and future trends of PV power generation in Japan

In Japan, since the start of the Sunshine Project in 1974, practical use and dissemination of PV have been advancing with the support of policies to promote technological development and market introduction of PV power generation. Japan still maintains its PV technology on the world's highest level and has disseminated grid-connected systems as early as possible. With the history of once being the world's largest PV production and introduction country, Japan has now made achievements and returned to the world's top group in terms of PV installed capacity.

The PV installed capacity in Japan rapidly boomed with the start of Feed-in Tariff (FIT) program in July 2012. The annual installed capacity exceeded 10 GW in 2015 and cumulative installed capacity largely increased to 55.5 GW (estimate as of the end of 2018) from approximately 5 GW before the start of the FIT program. It is highly likely that the country's installed capacity target of 64 GW (cumulative) for 2030 will be

achieved in the beginning of 2020.

In the Fifth Strategic Energy Plan, it is specified that Japan would aim to make renewable energy a mainstream power source that is economically independent toward realizing decarbonization, and responses are being actively made to overcome the issues the surely achieve the target.

### Forecast of PV installed capacity in Japan

Based on recent circumstances, the PV installation and demand trends until 2030 in Japan were examined and the annual installed capacity forecast by capacity range and application was calculated for the BAU scenario (when the current assumed technological development, introduction measures and energy policy advance without the force of specific acceleration factors or negative factors) and the accelerated scenario (when the PV introduction environment is significantly improved and installation is accelerated). As shown in Figure 1, the cumulative installed capacity in 2020 and 2030 are 66 GW and 121 GW, respectively under the BAU scenario, and 70 GW and 153 GW, respectively under the accelerated scenario.

Looking at the PV installed capacity trends by capacity range, the newly approved capacity for MW-scale PV power plant ( $\geq 1$  MW) which had been the majority in the FIT program is already declining, giving place to low voltage system of  $< 50$  kW (including residential) which will lead the market from 2020 onward.

The  $< 10$  kW system, mainly residential, is a steadily growing basic market.

The 10 to 50 kW systems is developing under various installation forms (including rooftop, etc.) and will form a major market in conjunction with the residential market.

- Annual PV installed capacity is expected to stabilize at 4 - 6 GW under BAU scenario  
Cumulative PV installed capacity is expected to reach Japan's 2030 target (64 GW) by around 2020
- Cumulative PV installed capacity is expected to exceed 150 GW by 2030, when installation is accelerated by overcoming the grid restrictions, technological development such as storage cost reduction and ease of the regulations

Unit: GW (DC)

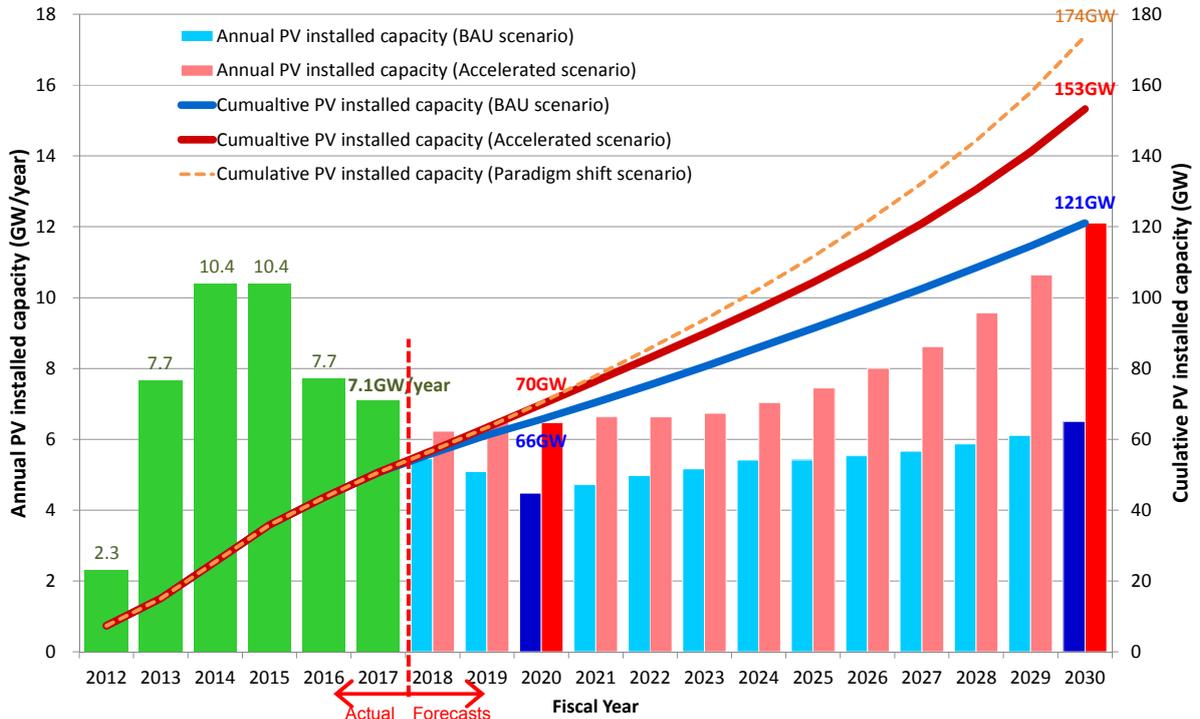


Figure 1 Forecast of PV installed capacity in Japan toward FY 2030

**Toward making PV a mainstream power source - PV150 proposal-**

In Japan, the electricity demand can be classified into four sectors, i.e. industry, business, household and transportation, and the total electricity demand is 927.8 TWh (in

2015). As shown in Figure 2, the purpose of electricity use can be broadly divided into two types, energy for manufacturing, mainly used for production activities, and energy for living, mainly used for consumption activities. Their

annual electricity demands are estimated to be approximately 540 TWh (including 110 TWh of self-power generation in the industry), and approximately 370 TWh, respectively.

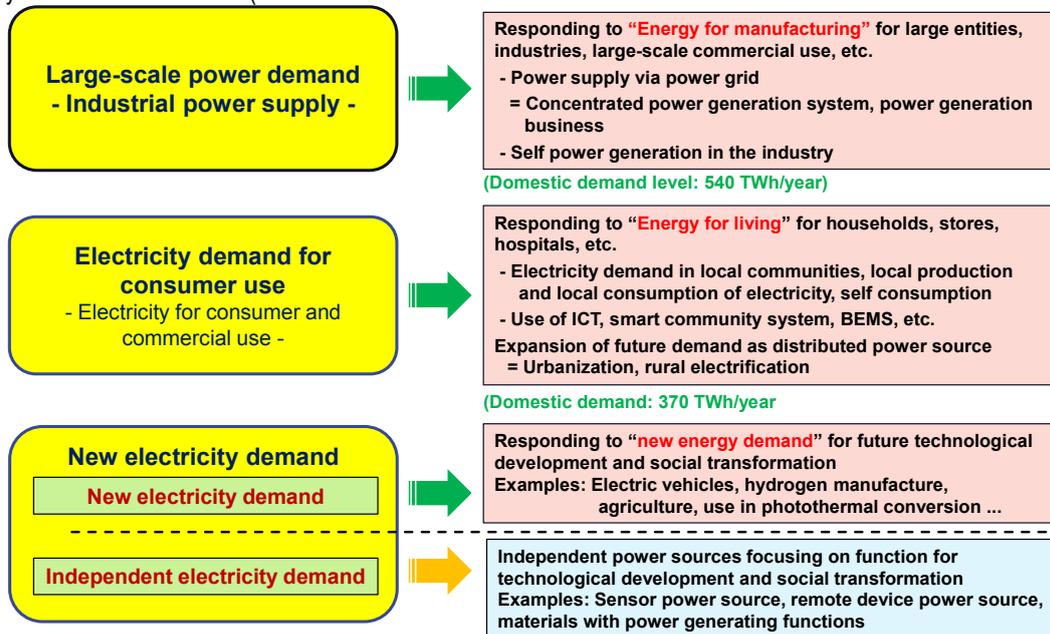


Figure 2 Characteristics of electricity demand and responses by PV power generation

The coverage ratio of PV in each sector by 2030 can be assumed as follows:

In the energy for manufacturing (demand sector for large-scale electricity supply), PV is mainly used for supplying power to large-volume consumers. Optimization of operation of existing systems such as MW-scale PV power plants and self-generation in the industrial sector will become active. Introduction and use of 60 GW of PV systems will become possible by 2030 and PV is assumed to cover approximately 10 % of the electricity demand in this sector.

In the energy for living (demand sector for consumer use distributed electricity), introduction of surplus power purchase is already in progress for residential systems. Realization of local production and local consumption of electricity and self-consumption systems will become a strong flow in the future. Considering the possible installation sites such as houses and various facilities in local communities, it is assumed that 80 GW PV installation is possible, which can cover approximately 20 % of the electricity demand.

Electricity demand for new applications is not at the stage of forming a concrete market as electricity demand, but PV demand for EV charging and demand as the power source for production of hydrogen, which is regarded as the next generation energy source, are assumed for the time being.

In addition, PV systems on farmland and use of PV as new types of off-grid power sources are assumed. Use of approximately 10

GW PV power is assumed in 2030.

By summarizing these assumptions, as shown in Figure 3, it is expected that approximately 150 GW of PV systems will become available in Japan by 2030, supplying approximately 150 TWh/year, which accounts for 15 % of the total domestic electricity demand.

In the process of realizing PV150 by application, the basis formed by the smooth growth of two sectors, i.e. household consumer and consumer use small-scale commercial will be topped with the steady growth of large-scale industrial sector and large-scale commercial sector and further followed by the start-up of demands in the new sector. Power generation capacity by application in 2030 will be 80 GW for the two commercial sectors, 60 GW for the two large-scale sectors and approximately 10 GW for the new sector.

With the efforts to install 150 GW of PV systems, a stable market of approximately 10 GW/year will be formed to motivate investment in the PV industry and to contribute to sound development of the industry, leading to improving international competitiveness.

PV will sufficiently play a role as a mainstream power source and mainstream energy by supplying 150 TWh/year, accounting for approximately 15 % of the total domestic electricity demand. As a result, it is expected to promote transformation of the structure of energy supply and demand, which will make Japan lead the world in establishing a decarbonized society, and enable full-fledged overseas expansion of the energy

infrastructure industry

### **Eight action plans for achieving PV150**

Eight action plans for achieving PV 150 were proposed.

As shown in Figure 4, they are essentially based on the integration of industrial side, policy side and introduction side and consists of the following approaches: 1) economic rationality, 2) proactive actions by the PV industry, 3) new business models, 4) technological development, 5) deployment of measures, 6) national target and incentives, 7) power business environment and 8) approaches from the installation/ utilization and application side.

The stakeholders of these actions are the supply industry that provides PV cells/ modules, systems and services, the technology development sectors that innovates the technical level of PV cells/ modules, systems and software, and the national government that provides utilization environment consistent to the national strategy, O&M section for electric grids, the demand industry providing platforms for efficient use of PV power from the viewpoint of consumers and the local community that secures local production and local consumption of electricity and environmental conservation while supporting PV installation by residents and enterprises.

The speed toward realization of PV 150 is expected to further increase when these stakeholders coordinate their vectors and make an all-out effort.

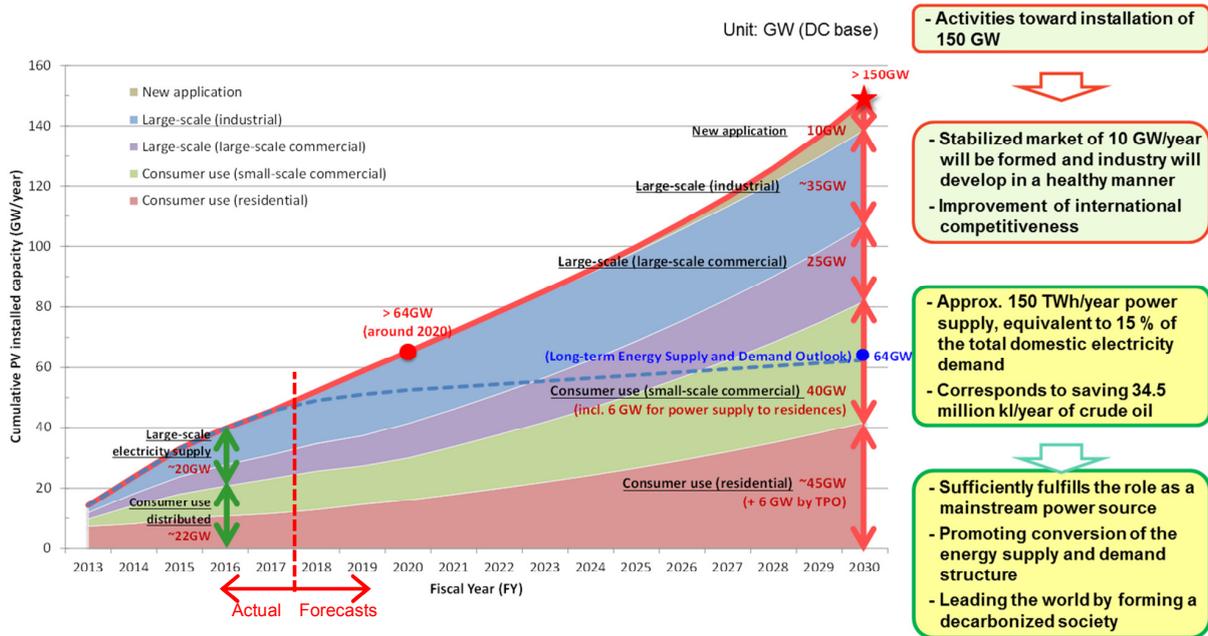


Figure 3 Forecast of PV installed capacity under PV150 and its impacts

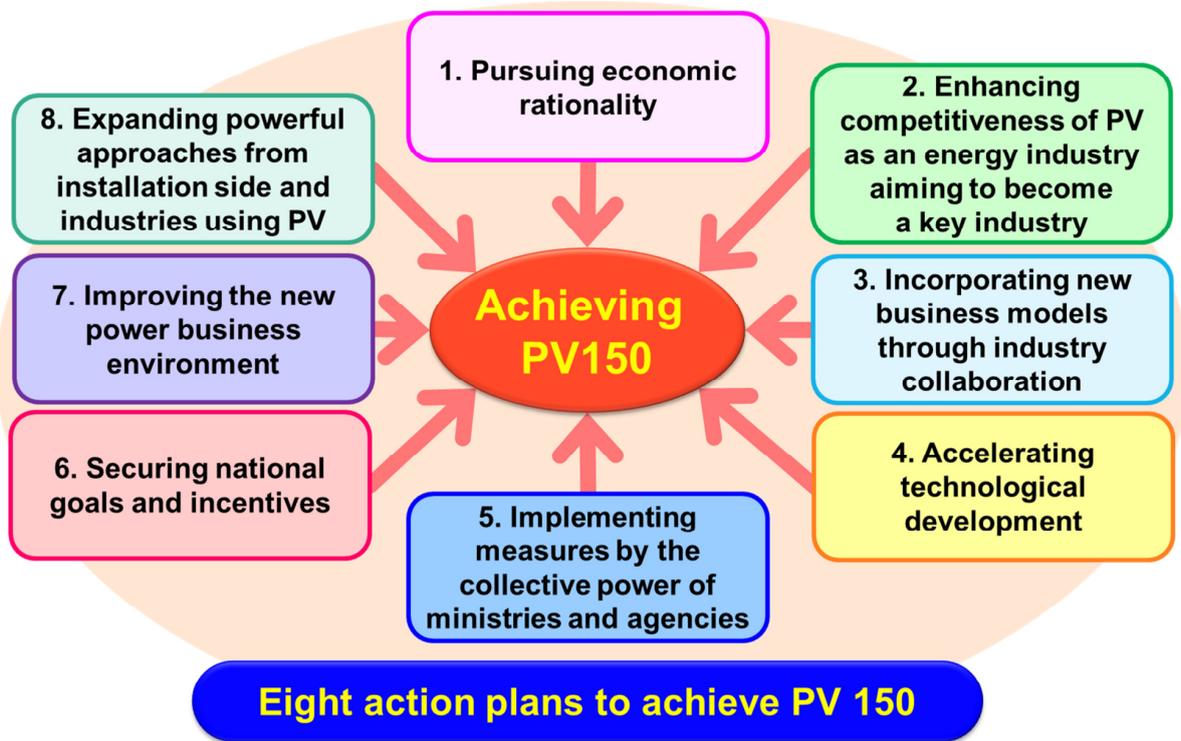


Figure 4 Eight key action plans to achieve PV150

A mechanism to promote PV as a mainstream power source will be established by the integrated effort of related sectors such as the national government, municipalities, industry and customers, which will further increase the presence of PV towards becoming a mainstream power source

In addition, realization of 150 GW PV installation by 2030 will become

a passing point toward further growth.

As shown in Figure 5, in the following second step, efforts such as expansion of power storage functions and application to power supply and demand matching, practical use of system for effective use of surplus power and variable power for production of hydrogen, etc., exploiting demand for new PV

applications (transportation, agriculture, etc.) and conversion of primary energy into electric energy will be continuously enhanced. It is anticipated that PV, which will have become a mainstream power source, will function as a driving force for forming a long-term sustainable society.

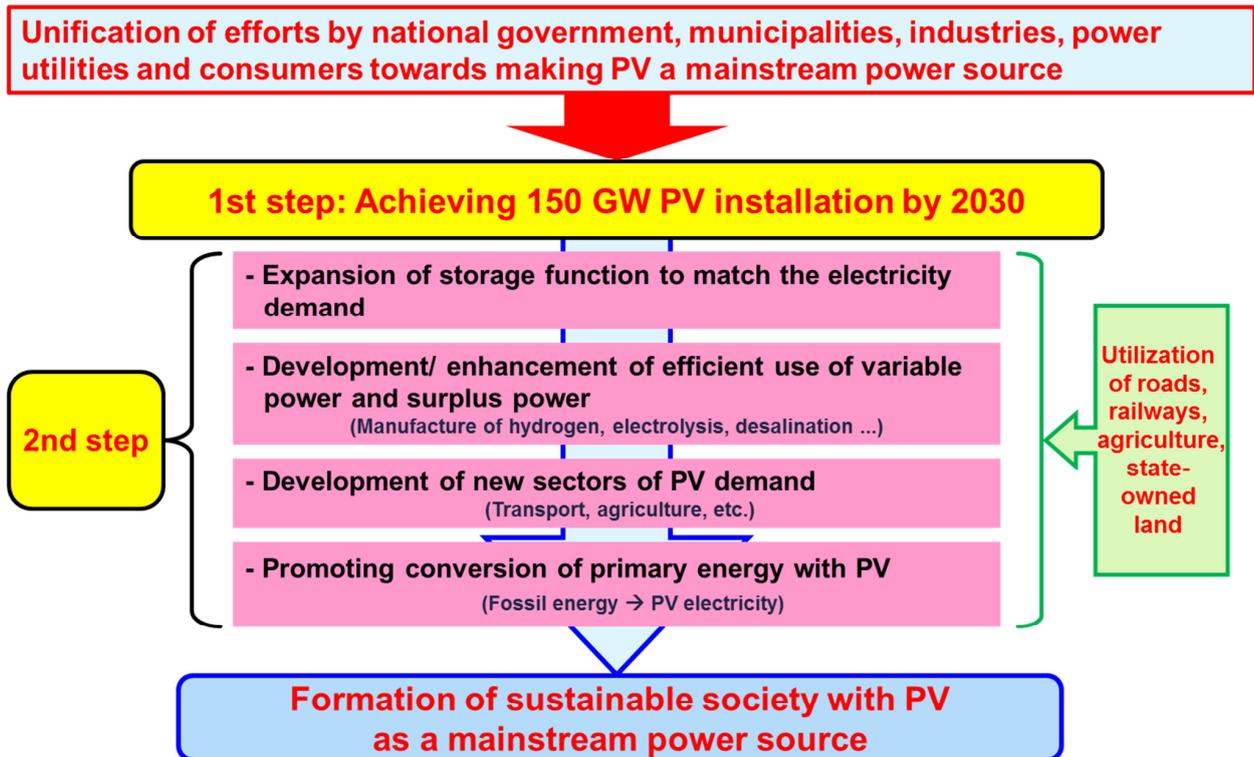


Figure 5 Development of PV power generation after 2030