REvision 2016
Realizing the Opportunities

Towards Further Growth of PV

March 9, 2016

Japan Photovoltaic Energy Association

1. Installation of PV systems in Japan

2. Benefits of PV generation in Japan

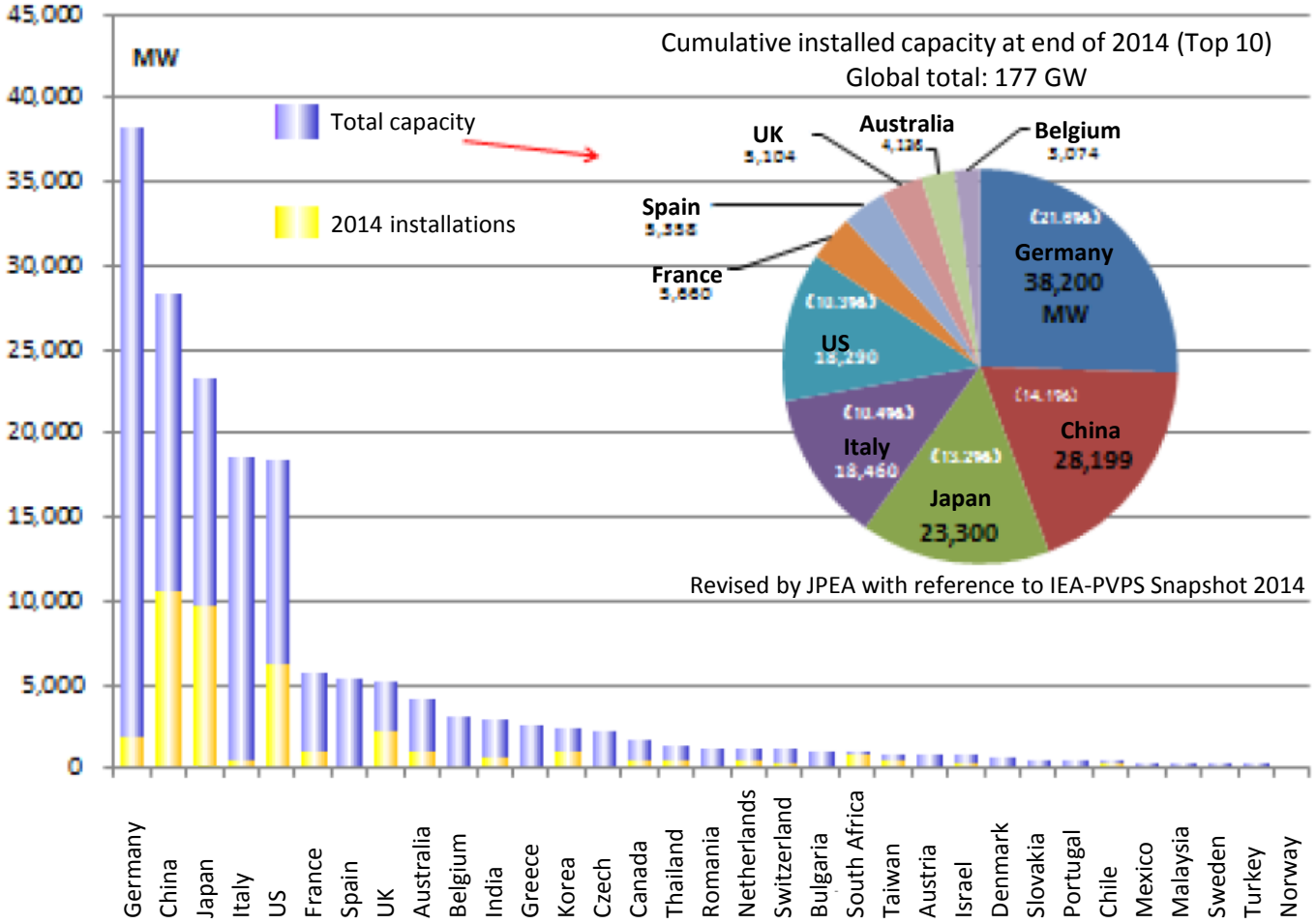
3. Toward sustainable expansion

(1) Lessons learned from Germany, etc.

(2) Toward sustainable expansion

1. Installation of PV systems in Japan (1)

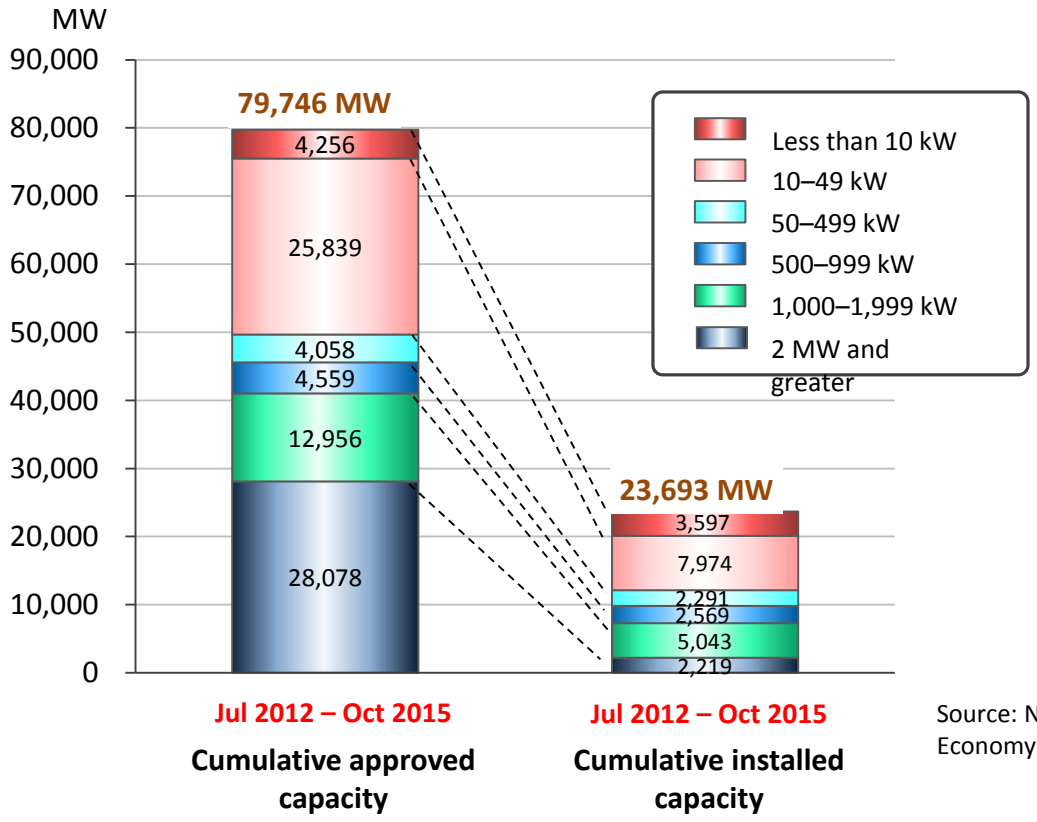
Cumulative installed capacity at end of 2014 and annual installed capacity in 2014: Top 10 countries



Source: Report IEA-PVPS TI-26 2015 4 (Snapshot of PV Global Market 2014)

1. Installation of PV systems in Japan (2)

- Number of approved systems as at Oct 31, 2015 had decreased from end of FY2014 (Mar 31, 2015), in part due to effects of withdrawn and cancelled approvals. Cumulative capacity since start of feed-in tariff scheme amounted to approx. 79,746 MW. It has also been estimated that about 40% of approved capacity for systems of 10 kW or greater are not installed.
- Possibility has also come to light that PV systems are not being installed due to constraints of local grid congestion and to the unlimited curtailment without compensation by the designated power companies.

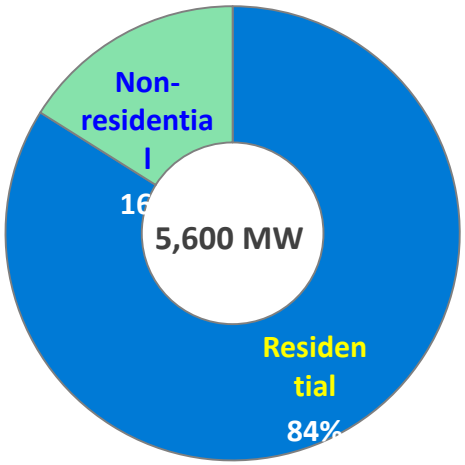


Source: News release from Ministry of Economy, Trade and Industry (METI)

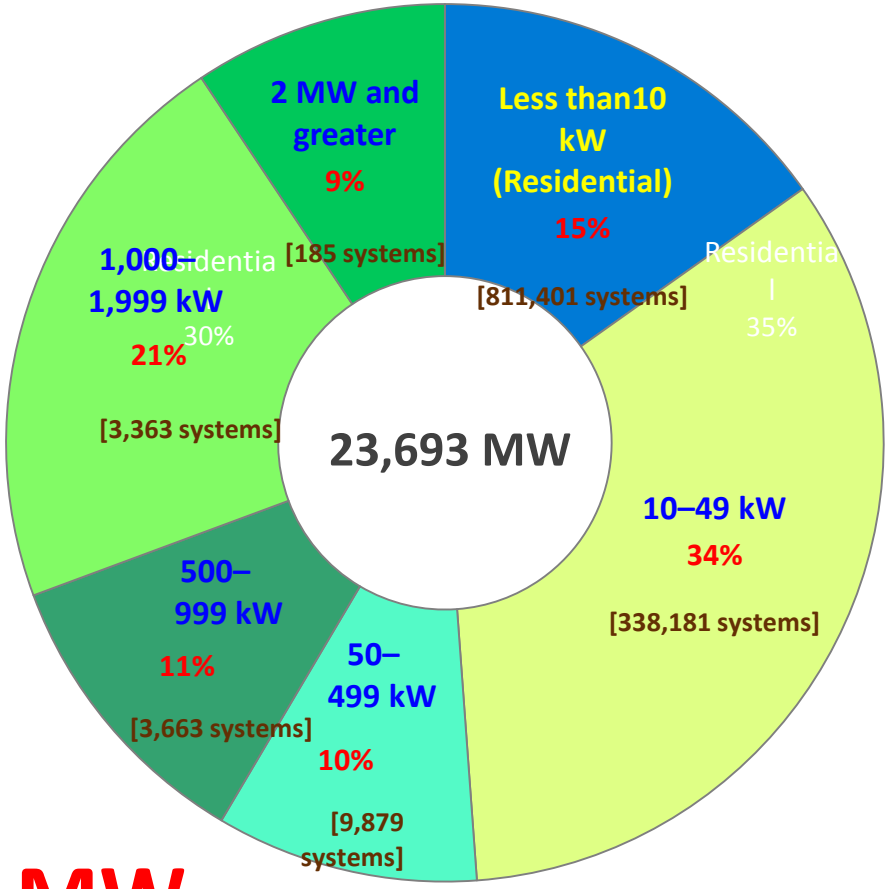
Cumulative approved capacity and cumulative installed capacity since the start of the feed-in tariff scheme

1. Installation of PV systems in Japan (3)

Prior to July 2012
Cumulative installed capacity before FIT



Jul 2012 – Oct 2015
Cumulative installed capacity after FIT



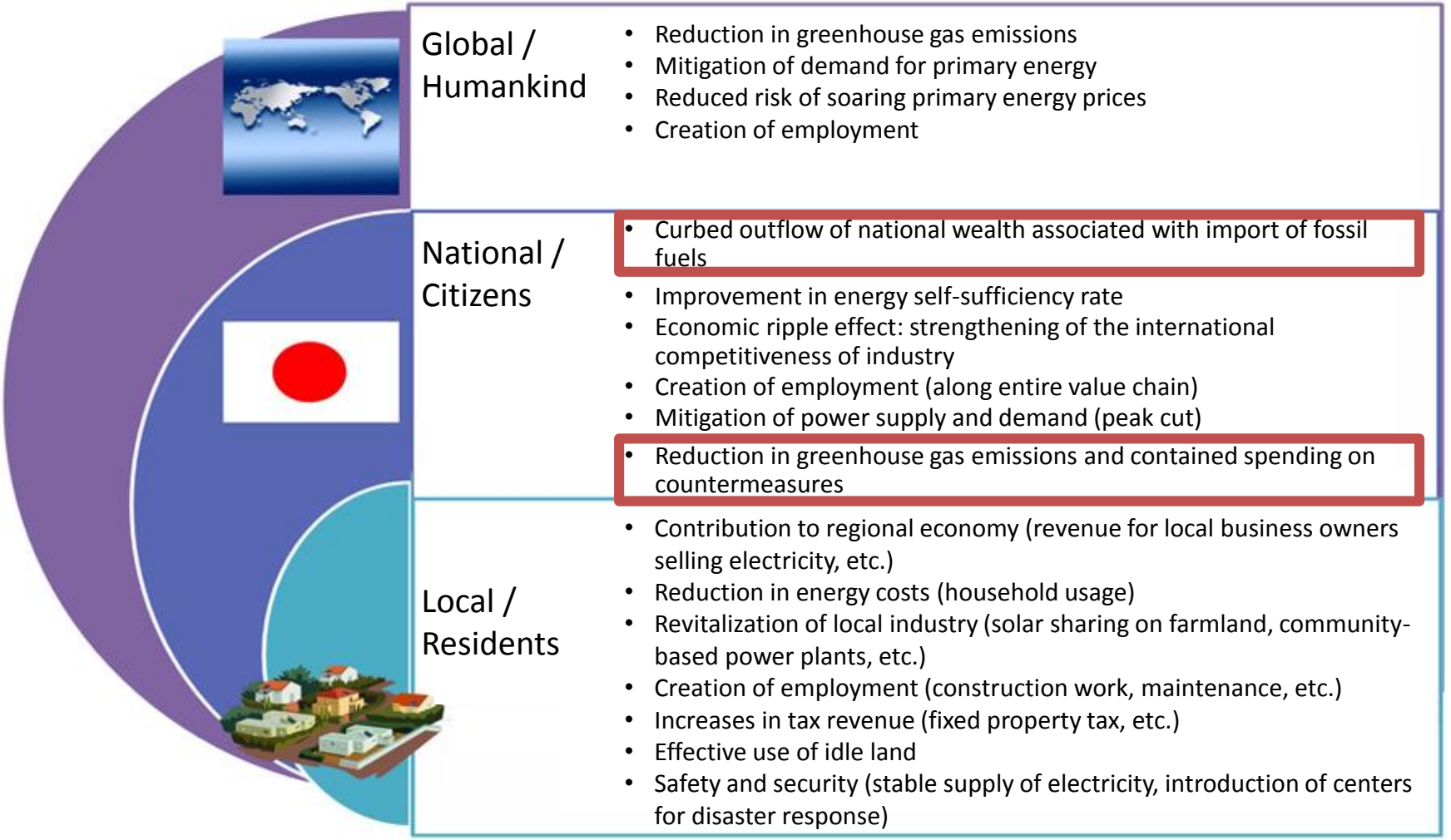
Total: 29,293 MW

Figures in square brackets [ ] indicate number of systems

2. Benefits of PV generation in Japan

Benefits of large-scale installation of PV generation systems

- **Renewable energy (photovoltaic power generation) creates a wide range of benefits, from local communities to the global community**
- **In particular, contributes to public safety and security through stabilizing an essential utility as a self-sufficient form of energy**
- **Contribution to economic revitalization is also significant, and most of this is returned to the domestic economy**



Global / Humankind

- Reduction in greenhouse gas emissions
- Mitigation of demand for primary energy
- Reduced risk of soaring primary energy prices
- Creation of employment

National / Citizens

- Curbed outflow of national wealth associated with import of fossil fuels
- Improvement in energy self-sufficiency rate
- Economic ripple effect: strengthening of the international competitiveness of industry
- Creation of employment (along entire value chain)
- Mitigation of power supply and demand (peak cut)
- Reduction in greenhouse gas emissions and contained spending on countermeasures

Local / Residents

- Contribution to regional economy (revenue for local business owners selling electricity, etc.)
- Reduction in energy costs (household usage)
- Revitalization of local industry (solar sharing on farmland, community-based power plants, etc.)
- Creation of employment (construction work, maintenance, etc.)
- Increases in tax revenue (fixed property tax, etc.)
- Effective use of idle land
- Safety and security (stable supply of electricity, introduction of centers for disaster response)

True benefits of photovoltaic power generation (1)

1. Immediate effects and benefits

   - FY2014 economic effect: Creates a market worth 3.3 trillion yen, and employment for 380,000 people (including indirect employment).
   - Contributes to mitigating daytime power supply-demand during summer, and also helps to reduce the amount that pumped-storage hydroelectric power plants have to operate.
   - Reduces power transmission losses attributable to in-house consumption of decentralized power sources (low voltage 8%, high voltage 4.3%).

2. Benefit of reduced power costs (across Japan) from a long-term perspective

   - Although systems installed under FIT work to push up power costs in the short term, they help to reduce power costs in the long term (from 2030). In particular, with respect to new systems approved in FY2016 and later, it is expected that the downward effect on power costs will significantly outweigh the upward effect.
   - Systems installed independently under free competition (presumably in 2030 and later) will be able to help reduce power costs from when they are initially installed.

True benefits of photovoltaic power generation (2)

3. Improvement in energy self-sufficiency rate (case of long-term stable growth; 100 GW in 2030)
   - 2030: 10% (relative to estimate for total amount of domestically generated power of 1,065 billion kWh)
   - 2050: 19% (relative to estimate for total amount of domestically generated power of 1,065 billion kWh)

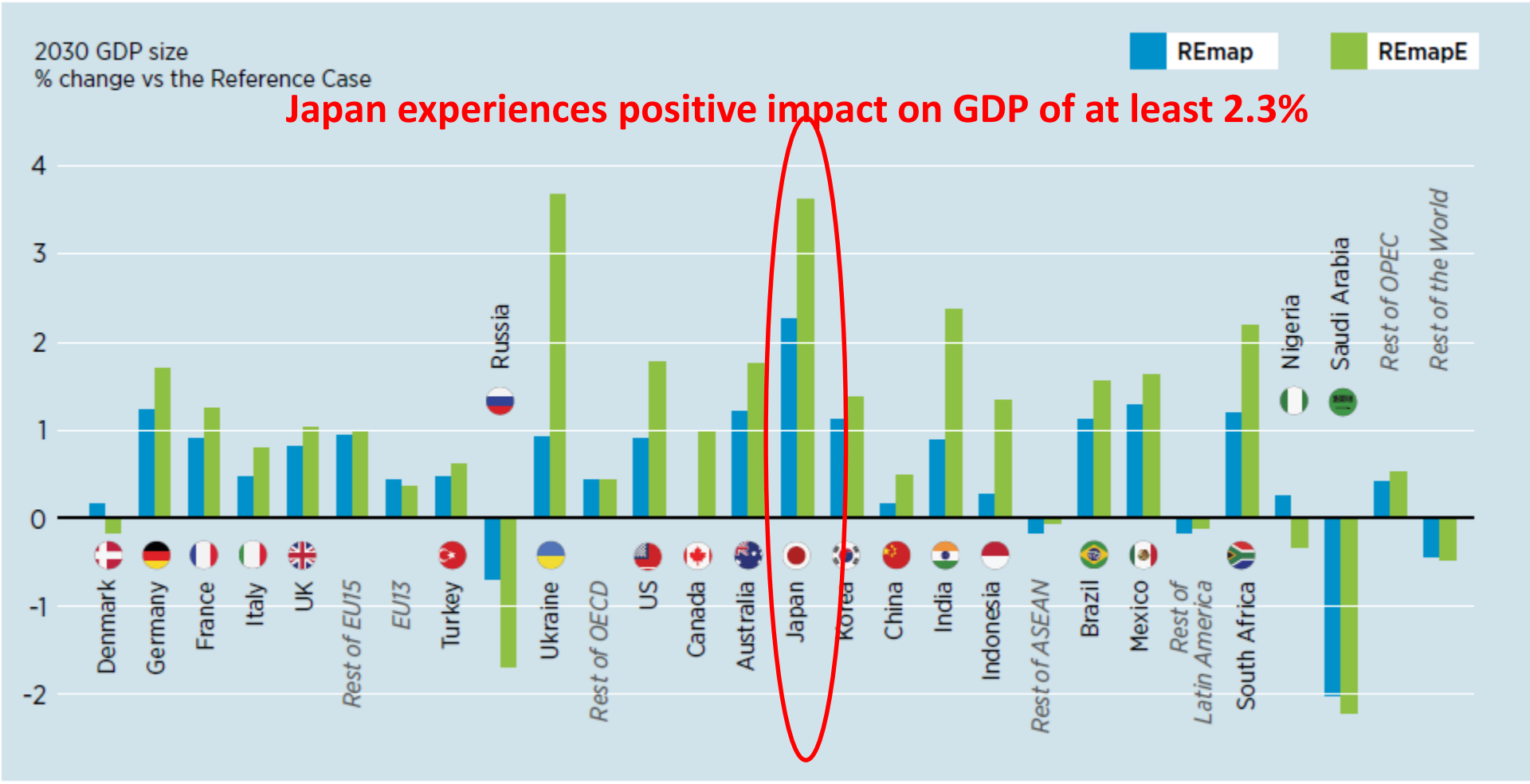
4. Curbed outflow of national wealth associated with import of fossil fuels (case of long-term stable growth)
   - 2030: about 1.075 trillion yen (fuel prices, etc. are assumptions by the Long-term Energy Supply and Demand Subcommittee)
   - 2050: about 2.088 trillion yen (fuel prices, etc. are assumptions by the Long-term Energy Supply and Demand Subcommittee)

5. Reduction in greenhouse gas emissions (case of long-term stable growth)
   - 2030: about 73 million t-CO_2 (reduced emissions during power generation)
   - 2050: about 133 million t-CO_2 (reduced emissions during power generation)

6. Contribution to regional economy

7. Other benefits (difficult to quantify)
   - Control of price rises attributable to mitigation of the supply-demand of fossil fuels, and reduced risk at time of soaring prices
   - Function of operating independently during times of disaster, etc.

Impact on GDP in 2030 caused by doubling of renewable energy ratio to 36% (by IRENA)



GDP impacts (2030 GDP size, % change vs the Reference Case)

"Renewable energy benefits: Measuring the economics" by IRENA, 2016

3. Toward sustainable expansion

(1) Lessons learned from Germany, etc.

(2) Toward sustainable expansion

3. Toward sustainable expansion

(1) Lessons learned from Germany, etc.

(2) Toward sustainable expansion

(1) Purpose of study on system operation in Germany

To study the actual conditions of power systems in Germany, where the large-scale installation of RE systems is possible, as well as the actual impact of revising the FIT scheme; and to discover clues to the following issues faced by the photovoltaic power generation industry in Japan.

(1) How can the large-scale installation of RE be achieved at the same time as minimizing curtailment?

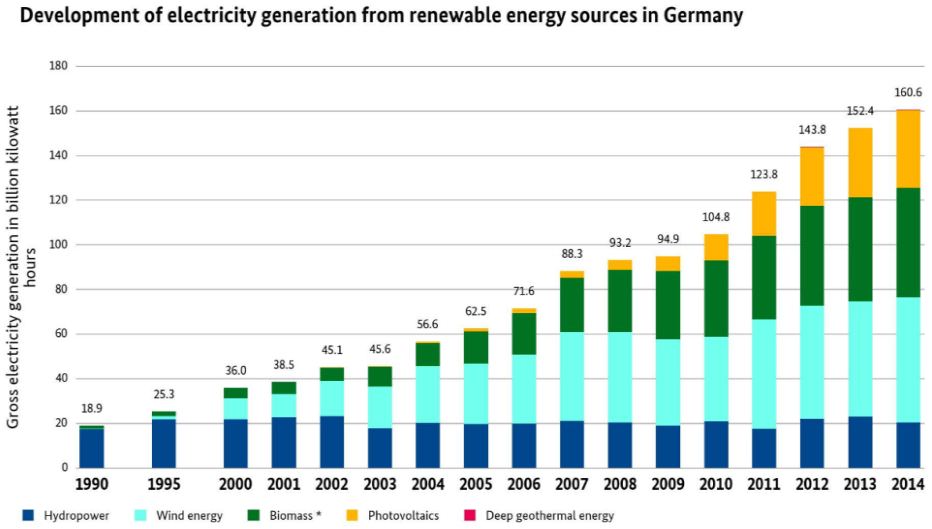
(2) What revisions/improvements should be made to the FIT scheme in order to promote photovoltaic power generation?

(3) To ensure PV systems can continue to be operated as a long-term stable source of energy even after the FIT purchasing period:

- **What should be done technologically?**
- **What preparations are needed institutionally?**

(2) Current conditions in Germany (outline)

Overall capacity of installed systems



* incl. solid and liquid biomass, biogas, biomethane, sewage gas and landfill gas as well as the biogenic fraction of waste, from 2013 incl. sewage sludge; BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2015; all figures provisional

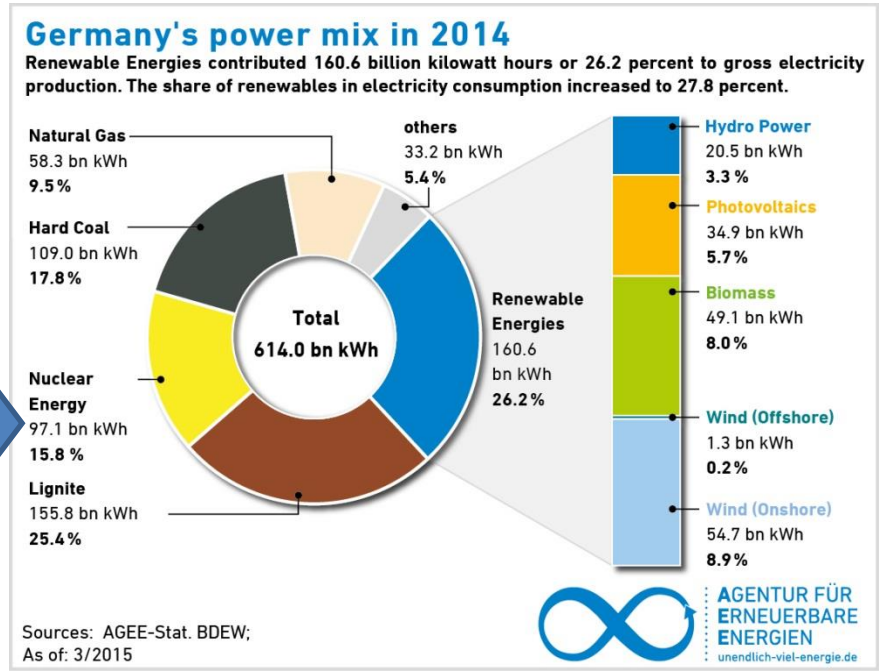
Wind	56.0 billion kWh (9.1%)
Biomass	49.1 billion kWh (8.0%)
Photovoltaic	**34.9 billion kWh (5.7%)**
Hydro	20.5 billion kWh (3.3%)
Lignite	155.8 billion kWh (25.4%)
Hard coal	109.0 billion kWh (17.8%)
Nuclear	97.1 billion kWh (15.8%)
Gas	58.3 billion kWh (9.5%)

In Germany,

- Capacity of installed RE systems is about 95 GW

(Japan's cumulative total is about **29 GW**)

- Generating capacity is 160.6 billion kWh
  - Slightly less than **28%** of domestic demand
  - Slightly more than 26% of generated power (including exports)
  - Variable RE (PV + wind) are slightly less than 15%



Source: Working Group on Renewable Energy-Statistics, BDEW (German association for renewable energies)

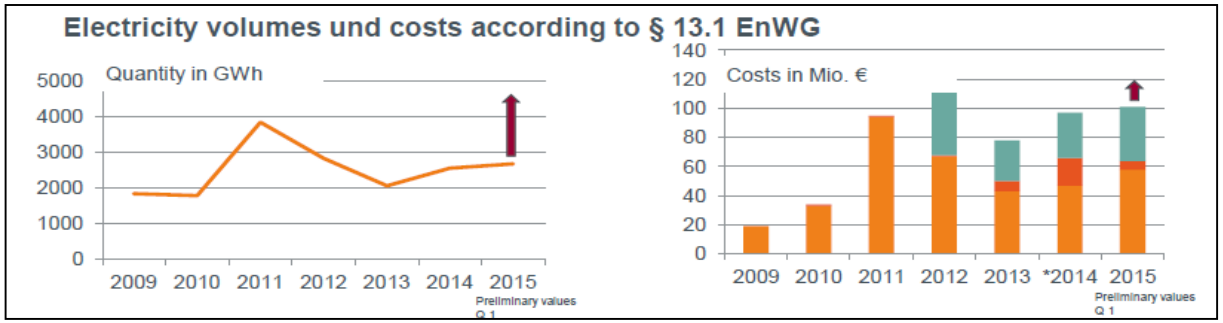
(3) System operation in Germany

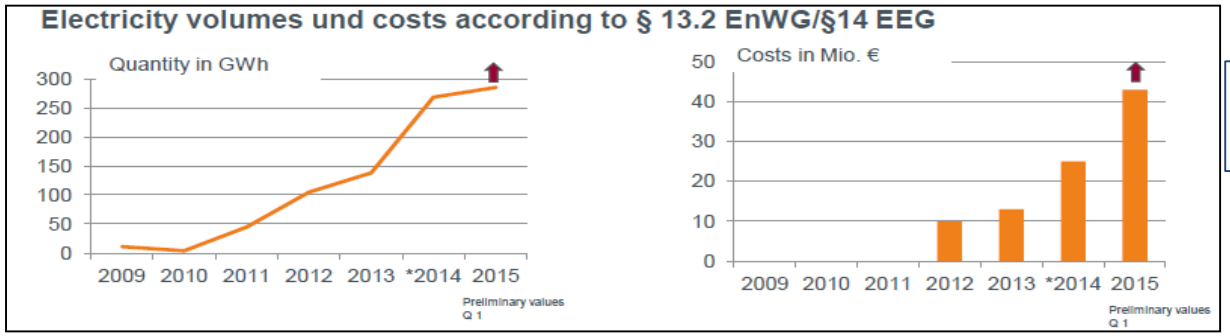
Curtailment of power generated from REs in Germany

Source: BNetzA documents

	2010	2011	2012	2013
Amount of curtailment	130 GWh	420 GWh	390 GWh	560 GWh
Curtailment ratio	**0.16%**	**0.41%**	**0.33%**	**0.44%**
Compensation (M€) Converted into yen at 135¥/€	10 1.35 billion	34 4.59 billion	33 4.46 billion	44 5.94 billion

State of curtailment at 50Hertz





Curtailment to thermal power, etc.
2014: about 2,000 GWh
About 100M€ (13.5 billion yen)

Curtailment of RE
2014: **about 270 GWh**
About 25M€ (3.4 billion)
0.7% of power from REs

In 2015, curtailment is trending rapidly upward

Expand to system buildup program

Source: 50Hertz documents

(4) Germany's FIT scheme policy and transition

State of Germany's FIT scheme

Apr 2000 **Enforcement of Renewable Energy Act (EEG)**

FIT scheme has continued to operate for 15 years since then.
(revised through amendments to law about once every 2 years)

Main points of 2012 amendment

1) **FIP** (Feed-in Premium) scheme introduced whereby RE power is **sold directly in the market and RE producers receive a market premium**.
2) Established a **capacity limitation on amount of PV eligible for FIT purchase**. (52 GW)
3) Purchase price is **revised monthly according to capacity of new installed systems**.

Main points of 2014 amendment

1) Feed-in tariff for new RE systems constructed in 2015 set at an **average of 12 € cents/kWh**.
2) **Application of FIP gradually required**, starting with new facilities.
3) Ground-based PV systems gradually transition to tender system.

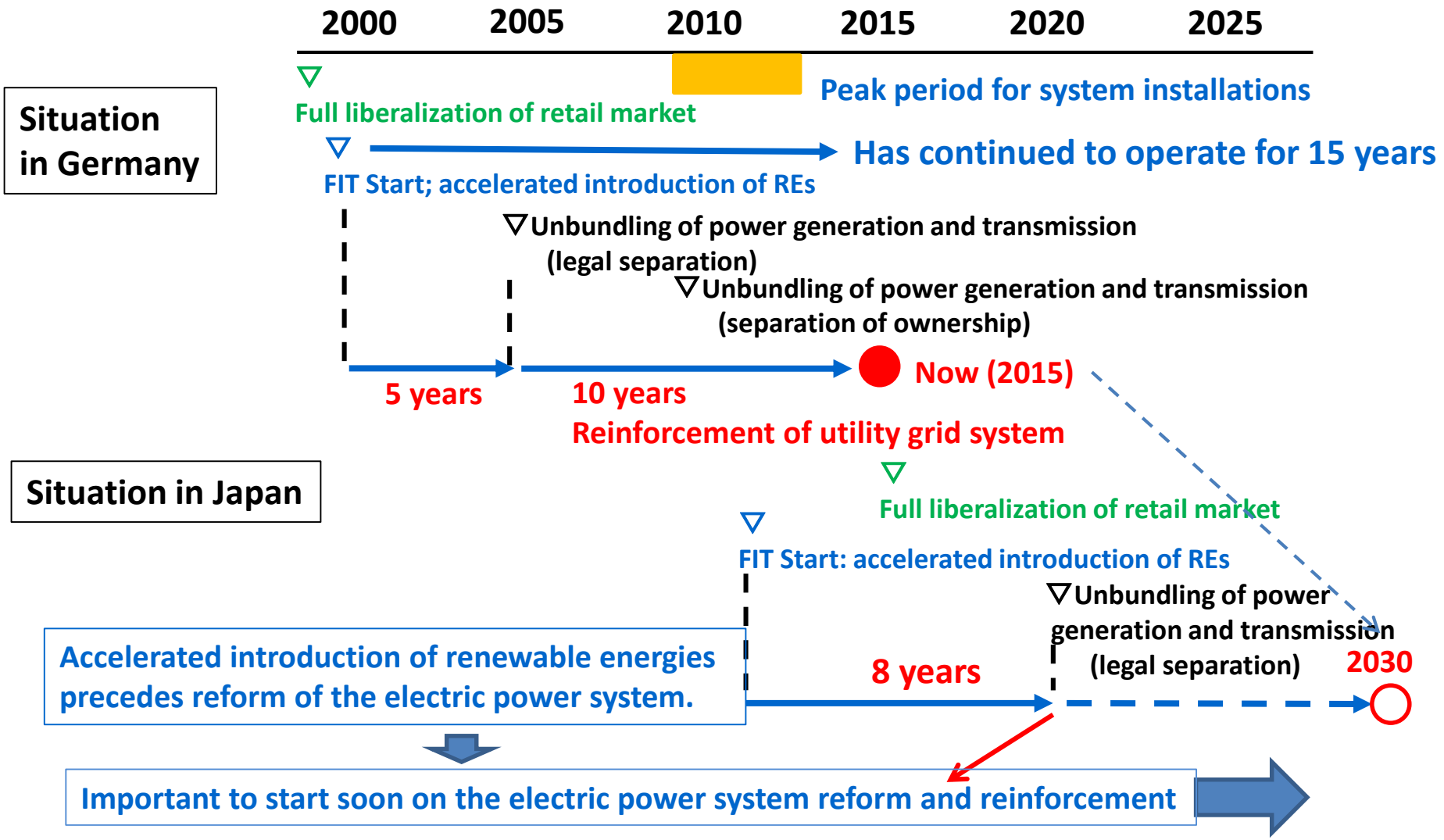
Constant basic policy

(1) Costs of strengthening and increasing utility grid system shared universally.
(2) All REs are to be connected to the power system regardless of whether eligible for FIT or not.
(3) Priority is given to REs both when bought through FIT scheme and when sold through FIP scheme.
(4) Curtailment on REs is the last resort, and curtailed REs are eligible for compensation.

No matter what the scheme, the policy ensures no RE is wastefully discarded.

(5) Developments in reform of electricity systems

Comparison of electricity systems in Japan and Germany



3. Toward sustainable expansion

(1) Lessons learned from Germany, etc.

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(1) Proposal for active use of renewable energies

Need for active use of renewable energies

Electricity from renewable energy

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CO_2-free energy that does not burn fuel

↓

- **Don't use energy = NO**
  Nothing comes from simply not using energy.

↓

- **Actively use acceptable energy = YES**

Energy conservation is important!

~~**Wasteful consumption**~~

↓

Enjoy a comfortable and healthy life by consuming energy properly at home.

Achieve results by consuming energy properly in industrial activity.

↓

Effective use of electricity from renewable energy = Competitive edge

(2) Forward the sustainable expansion of PV

What's needed to promote the active use of variable REs such as solar?

Reform of the electricity system

- **Effective use of interregional connection lines**
  Development of usage rules for effective use (short-term measure).
- **Maintenance of interregional connection lines**
  To develop necessary plans for an ideal robust infrastructure for electric system that endure a disaster
- **Expansion of the electricity market**
  Realization of increase of trading, including interregional transactions, and adjustment between supply and demand through the market mechanism

Proposals for program design

- **Reconsideration of the order for curtailing REs**
  In order that RE is used effectively, preferred order is to curtail when absolutely necessary even after using interregional connection lines between regions.
- **Environmental improvements for effective use of electricity from RE after the FIT purchase period**
  In 2019, the FIT period for 2+ GW systems will conclude. Going forward, systems for grid connections and proper ongoing purchase need to be designed to actively utilize this non-FIT electricity.

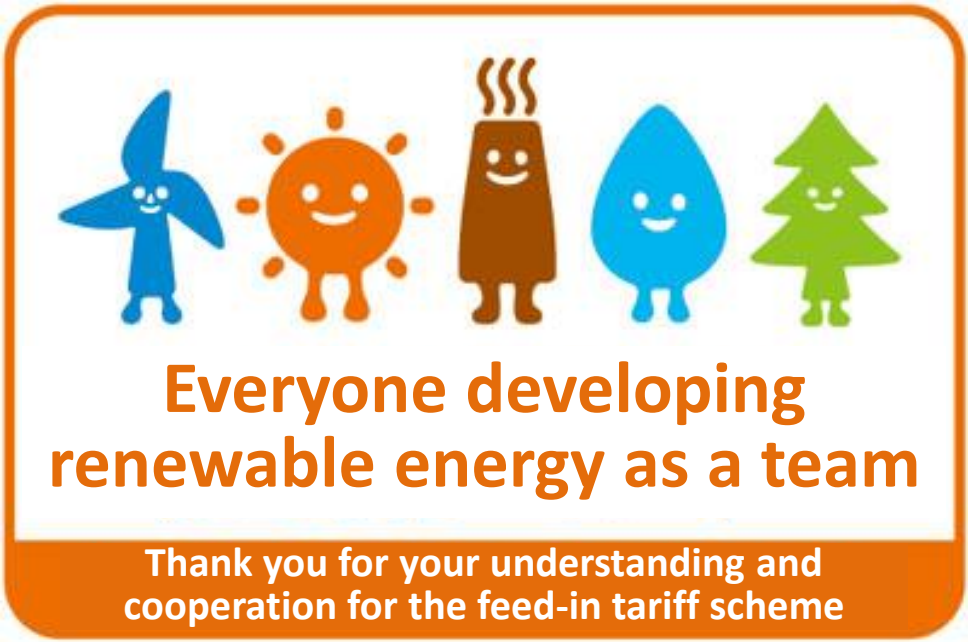
Smart operational ideas

- **Advance and appropriate use of forecasting technology**
  In Germany, forecasting generating power of the following day is being effectively used and adjust supply and demand in a way that makes best use of RE.
- Equitable use of the power grid
- Stable operation of FIT

Toward the next step in photovoltaic power generation

- **Promoting the installation of systems where generated electricity is consumed in-house**
  This is a feature of photovoltaic power generation, and is an effective means for sustainable development. Measures promoting in-house consumption are anticipated, such as for institutional development and subsidies for storage batteries.
- **Maintenance and inspection system supporting long-term operation**
  To ensure the healthy continuation of power generation even after the FIT purchase period, develop proper schemes related to O&M, such as the establishment of technologies and the training of technicians.

Thank you for your attention.



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http://www.jpea.gr.jp/