Baku International Humanitarian Forum
Round Table VII;
Converging Technologies and Outlines of the Future Landmark Challenges of 21st Century

# Research and Development of Renewable Energies in Japan after the Fukushima Nuclear Plant Disaster

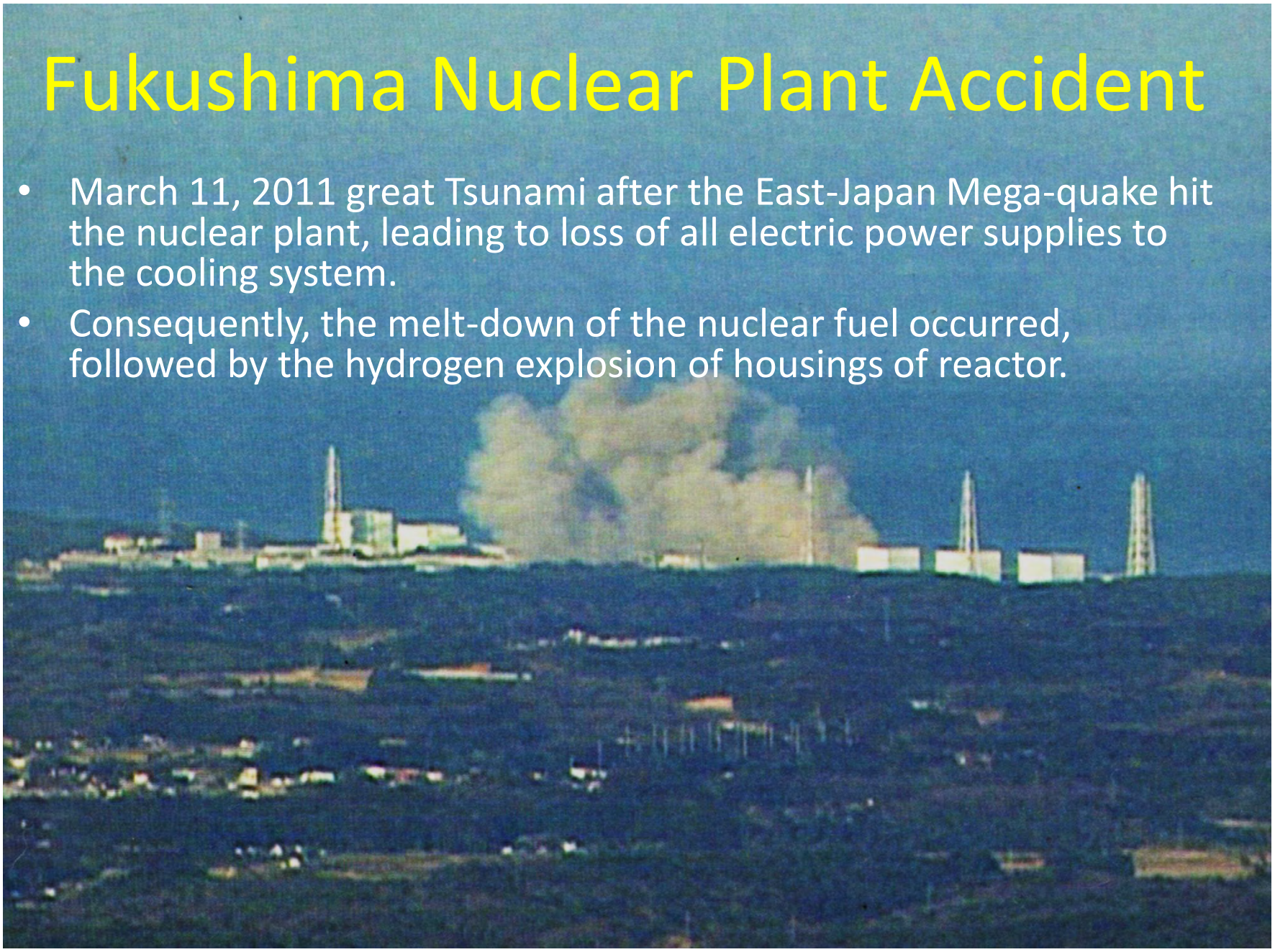

Katsuaki Sato

Prof. emeritus Tokyo Univ. Agriculture and Technology

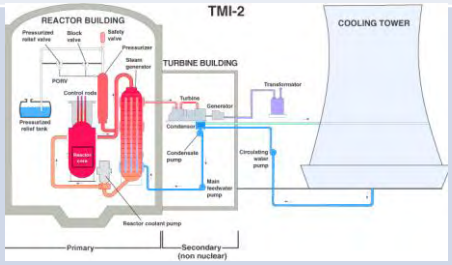
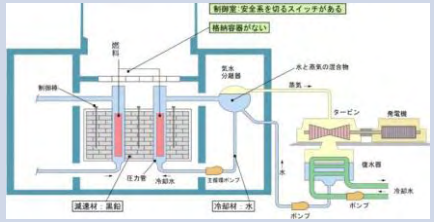
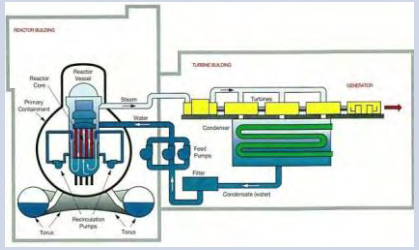
Center for Research and Development Strategy (CRDS),
Japan Science and Technology Agency (JST)

# Fukushima Nuclear Plant Accident

- March 11, 2011 great Tsunami after the East-Japan Mega-quake hit the nuclear plant, leading to loss of all electric power supplies to the cooling system.
- Consequently, the melt-down of the nuclear fuel occurred, followed by the hydrogen explosion of housings of reactor.



# Major nuke plant accidents

| | Three Mile Island | Chernobyl | Fukushima Daiichi |
|---|---|---|---|
| Year.month.day | 1979.3.28 | 1986.4.26 | 2011.3.11 |
| Reactor type | PWR | graphite-moderated | BWR |
| INES level | Level 5 | Level 7 | Level 7 |
| Core damage | 45% | ～100% | 100(1),97(2),97(3) |
| Trigger | operation error | Violation of rules | earthquake/tsunami |
| Hydrogen explosion | In the container | In the reactor | housings |
| Evacuation area | 8km | 30km | 20km |
| Radioactive exaust | Rare-gas: $9.25 \times 10^{16}$Bq<br>iodine : $5.55 \times 10^{11}$Bq | $5.2 \times 10^{18}$Bq | $7.7 \times 10^{17}$Bq |
| Schematic illustration |  |  |  |

# Possibility of forecast and prevention of the Fukushima Daiichi accident?

- Probably Yes!
- Scholars of AIST warned the possibility of huge tsunami attack from ancient literatures.
- Nevertheless, TEPCO and administration ignored the report. They believed “Safety Myth” and never prepared for tsunami.
- They could have prepared to move the alternative power supplies to elevated positions to prevent the damage of tsunami.

# What was done after the Accident

- Until the accident both promotion and regulation committees are under MITI.
- After the accident the regulation committee was moved under the Environment Ministry.
- Members of the committee were drastically changed involving specialists of geophysics.
- No Nuke plant has been under operation until now after the new regulation.
- Recently re-operation of one PWR plant in Kyushu is under consideration, despite many objections.

# Scientists lost reliability of people. What should we do?

- Urgent problems on Fukushima Daiichi Plant and its environment
  - How to remove nuclear debris and close reactors.
  - How to manage and stop radioactive contaminated water flow to ocean.
  - How to manage used nuclear fuels and wastes.
  - How to clean radioactive substances from environment area.
- Without the solution of above problems people may continue to be uneasy and anxious, which cease proper communication between specialists and people.

# Other problems to be solved

- Development of technologies to close reactors
- Nuclear Securities including interbational contribution to IAEA
- Nuclear fuel cycles: How to manage plutonium
- Funding system for nuclear R&D
- Regulation committes
- Relations between stakeholdrs
- Globalization with transparency
- Safety Technology
- Risk Communications and Managements
- Education and Training etc.

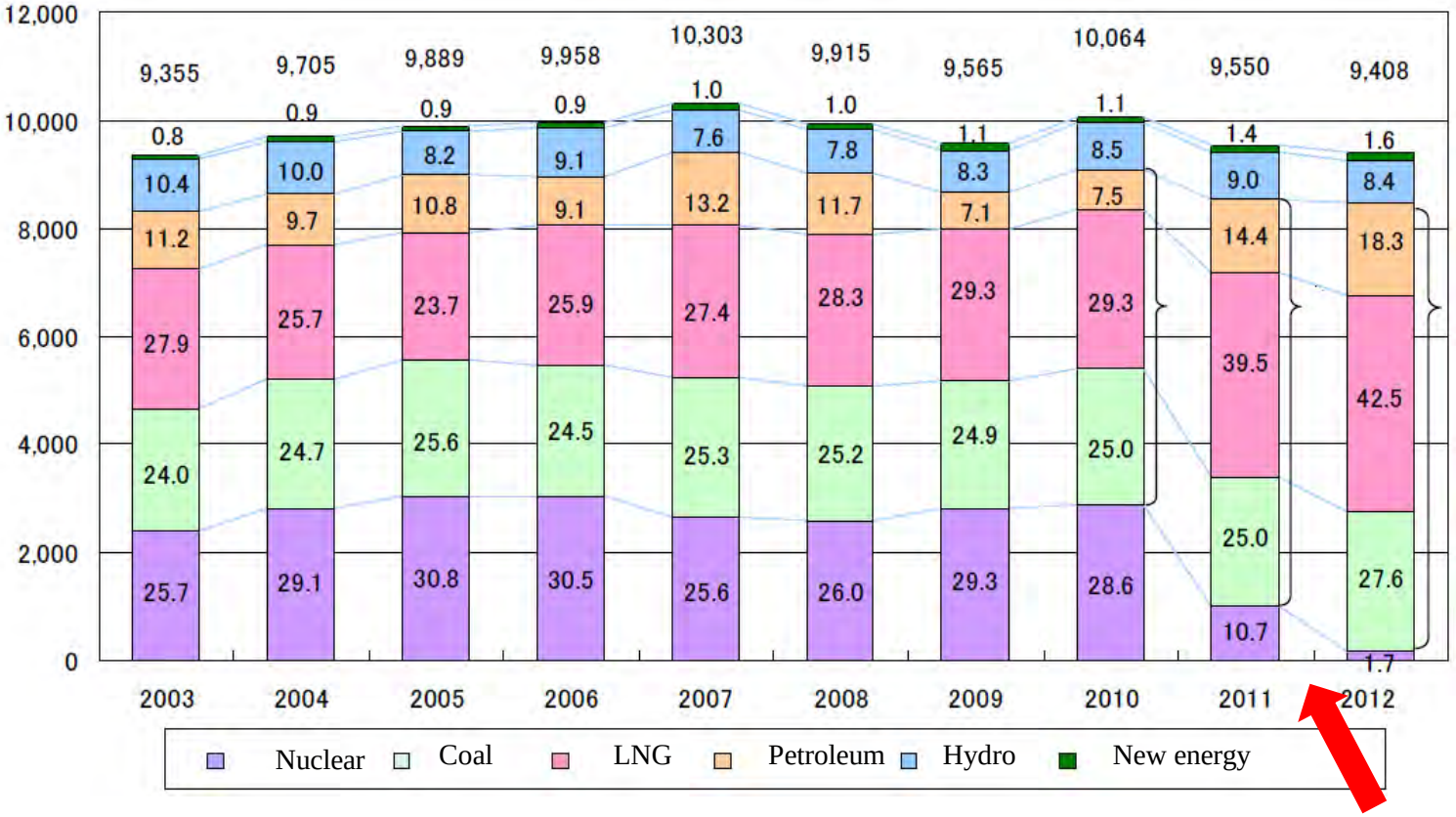
# Energy problem after Fukushima

- Planned blackout of TEPCO area just after Fukushima accident
- Reoperation of unused petroleum an coal plants
- People become conscious of saving energies
- Big trade deficit threatens Japanese economy
- People's expectation for Renewable Energies becomes very strong

# Electric power generation in Japan.

## (100 million kWh)

Renewable energy, accounted for 10.0% of Japanese power generation in FY2012; including 8.4% of hydraulic power.



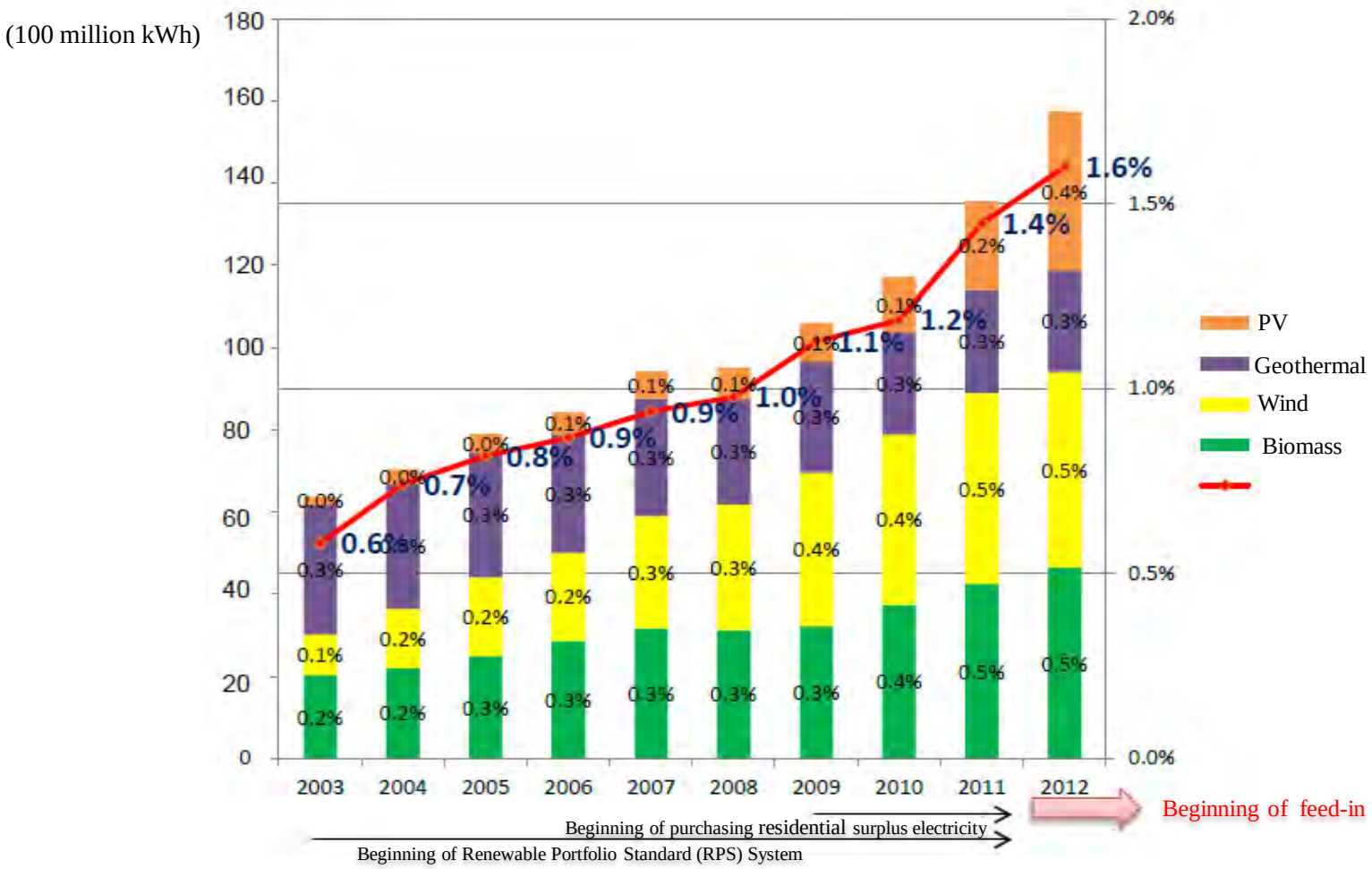

Fukushima Nuke Disaster

From the slides prepared by Atsuhiko Kiba (NEDO) September 2, 2013

Source: METI

# Long-term change in total supply from power-generating facilities of new energy except hydraulic power

- Since the introduction of the feed-in tariff scheme in 2012, the introduction of PV increased most.




Source: METI

# Situation of renewable energy introduction in 2013 FY

| Category | Before FIT introduction | After FIT introduction | |
|---|---|---|---|
| | Cumulative total(-2012.6) | 2012.7-2013.3 | 2013.4-2014.2 |
| Solar (Residential) | 4.7GW | 0.969GW | 1.221GW |
| Solar (Non-residential) | 0.9GW | 0.704GW | 5.052GW |
| Wind Power | 2.6GW | 0.063GW | 0.015GW |
| Small Hydropower | 9.6GW | 0.002GW | 0.004GW |
| Biomass | 2.3GW | 0.03GW | 0.09GW |
| Geothermal | 0.5GW | 0.01GW | 0 |
| Total | 20.6GW | 1.769GW | 6.381GW |
| | | 8.15GW | |

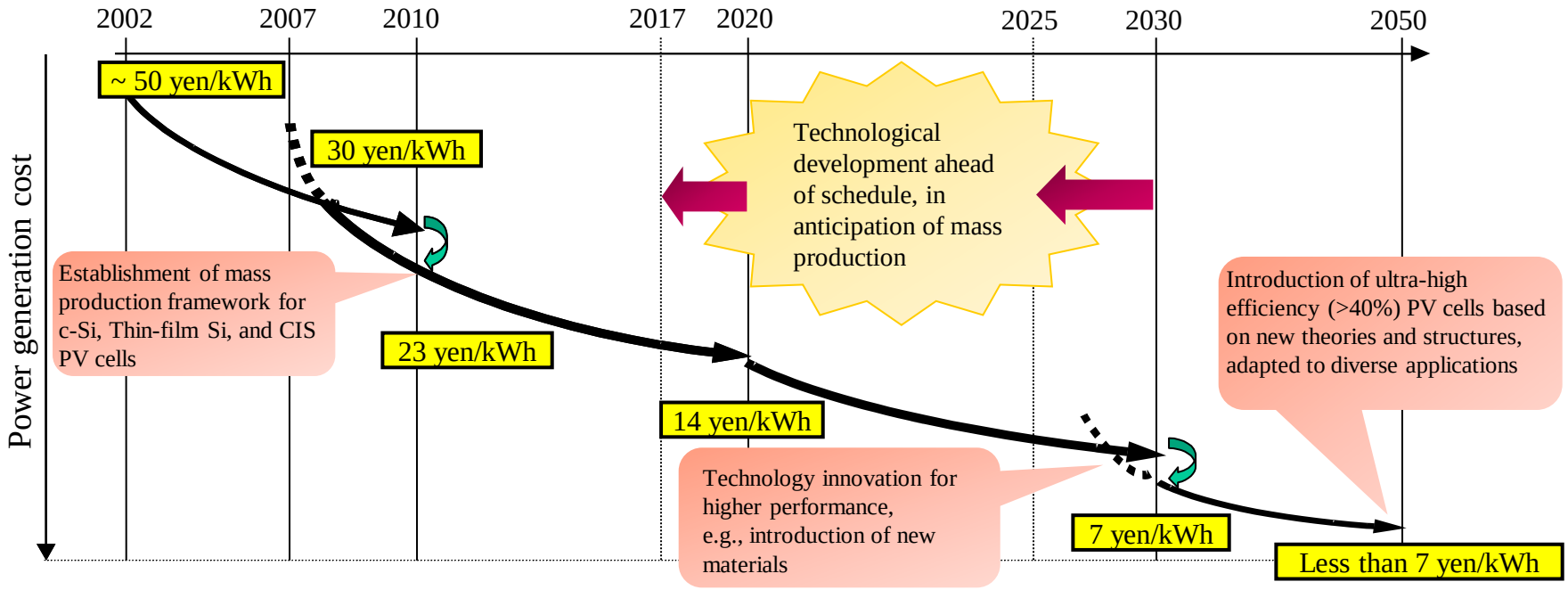
After Whitepaper(2014FY) from Agency of Natural Resources and Energy under MITI

# R&D Portfolio of NEDO for new energies

NEDO's Budget (FY2013)  Total: 121.0 billion Yen (1,210 million US$)
R&D Budget for New Energy: 28.1 billion Yen (281 million US$)

| Category | Classification | Budget 2013 FY |
|---|---|---|
| Renewable Energy | Solar Photovoltaic | 9.3 billion yen (93 million US$) |
| | Biomass | 3.6 billion yen (36 million US$) |
| | Wind power | 5.0 billion yen (50 million US$) |
| | Ocean | 2.5 billion yen (25 million US$) |
| | Geothermal | 0.5 billion yen (5 million US$) |
| Hydrogen Tech. | Hydrogen &Fuel Cell | 7.2 billion yen (72 million US$) |
| Total | | 28.1 billion yen (281 million US$) |

# PV R&D Roadmap in Japan (PV2030+)




| Target (completion of development) | 2010 or later | 2020 (2017) | 2030 (2025) | 2050 |
|---|---|---|---|---|
| Power generation cost | Equivalent to household electric rates (23 yen/kWh) | Equivalent to commercial electric rates (14 yen/kWh) | Equivalent to power generation costs (7 yen/kWh) | Used as general power source (less than 7 yen/kWh) |

Source: NEDO PV R&D Roadmap (PV2030+), 2009

# Promotion of Green Innovation by JST's Strategic Basic Researches (1) CREST*

| Category | Title | Supervisor |
|---|---|---|
| Energy carriers | Creation of Innovative Core Technology for Manufacture and Use of Energy Carriers from Renewable Energy Research | K. Eguchi |
| Phase interface science | Phase Interface Science for Highly Efficient Energy Utilization Research | N. Kasagi |
| Carbon dioxide utilization | Creation of essential technologies to utilize carbon dioxide as a resource through the enhancement of plant productivity and the exploitation of plant products | A. Isogai |
| Bioenergy Production | Creation of Basic Technology for Improved Bioenergy Production through Functional Analysis and Regulation of Algae and Other Aquatic Microorganisms | T. Matsunaga |
| Solar energy | Creative research for clean energy generation using solar energy | M. Yamaguchi |
| Water system | Innovative Technology and System for Sustainable Water Use | S. Ohgaki |
| Carbon dioxide emission control | Creation of Innovative Technologies to Control Carbon Dioxide Emissions | I. Yasui |

CREST is a team-oriented research program aiming to generate breakthroughs with a significant impact on the development of science and technology and providing tangible benefits to society

# Promotion of Green Innovation by JST's Strategic Basic Researches (2) PRESTO*

| Category | Title | Supervosor |
|---|---|---|
| Energy carrier | Creation of Innovative Core Technology for Manufacture and Use of Energy Carriers from Renewable Energy | K. Eguchi |
| Phase Interface | Phase Interfaces for Highly Efficient Energy Utilization | N. Kasagi |
| Carbon dioxide utilization | Creation of essential technologies to utilize carbon dioxide as a resource through the enhancement of plant productivity and the exploitation of plant products | A. Isogai |
| Bioenergy production | Creation of Basic Technology for Improved Bioenergy Production through Functional Analysis and Regulation of Algae and Other Aquatic Microorganisms | T. Matsunaga |
| Solar Cells | Photoenergy conversion systems and materials for the next generation solar cells | S. Hayase |
| Chemical conversion | Chemical conversion of light energy | H. Inoue |

*PRESTO(Precursory Research for Embryonic Science and Technology)

# Promotion of Green Innovation by JST's Strategic Basic Researches (3) ALCA*

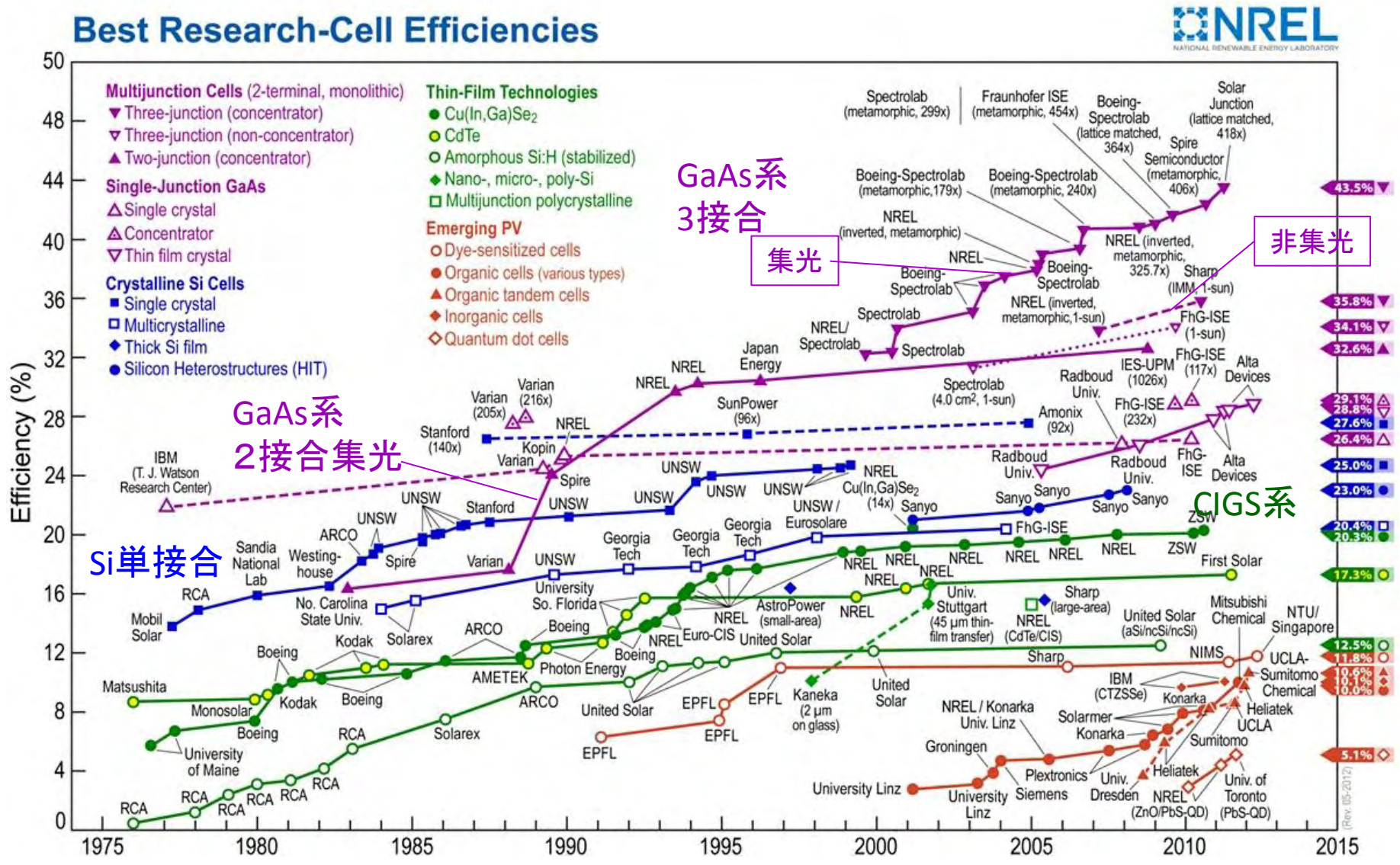
| | |
|---|---|
| Solar Cell and Solar Energy Systems | 14 projects |
| Superconducting Systems | 8 projects |
| Electric Storage Devices | 18 projects |
| Ultra Heat-Resistant Materials and High Quality Recycled Steel | 13 projects |
| Innovative Energy-Saving and Energy-Producing Chemical Processes | 13 projects |
| Innovative Energy-Saving and Energy-Producing Systems and Devices | 7 projects |
| Next-generation Rechargeable Battery | 4 projects |
| Energy Carrier | 1 project |

ALCA: Advanced Low Carbon Energy Research and Development Program

# Solar Cell and Solar Energy Systems ALCA

| Title | Researcher |
|---|---|
| Development of the high-efficiency photovoltaic rectenna | S. Nozaki |
| Development of organic inorganic hybrid high performance solar cells | T. Miyasaka |
| Electricity generation by combination of solar-pumped lasers and PV devices specially designed for monochromatic laser light. | T. Motohiro |
| Realization of all crystalline ideal structure of organic photovoltaics and efficiency maximization by utilizing co-evaporant induced crystallization method | T. Kaji |
| Novel Thin Film Solar Cell Technologies for TW PV Generation | S. Niki |
| Integration of nanostructures in crystalline silicon solar cells for advanced management of photons and carriers | N. usami |
| Printable organic solar cell based on liquid crystal science | M. Ozaki |
| Development of environment-friendly solar cell made by clathrate compound of group VI elements | T. Kume |
| Crystal Growth and Interface Control Technology of Group IV Semiconductor Thin Films for Multi-Layered Solar Cell | O. Nakatsuka |
| Advanced solar energy utilization systems based on high-temperature photonics | H. Yugami |
| Artificial Photosynthesis System | S. Fukuzumi |
| Development of non-vacuum processing for high efficiency next-generation thin-film solar cells | A. Yamada |
| Smart Innovation on Nitride Semiconductor Solar Cells with Superstructure Magic Alloys: SMART | A. Yoshikawa |
| Spinodal Nanotechnology for Super-High Efficiency Energy Conversion | H. Katayama-Yoshida |

# Recent Development of Solar Cells



# Summary

- After the Fukushima Disaster Japanese Government changes the energy policy and energy saving and creation of new energies are encouraged.
- By introduction of FIT solar cells installation is enhanced very much resulting in renewable energy portion higher than 10%.