A photograph of the Sanyo Solar Ark building, a large, modern structure with a curved, metallic facade. The building is covered in solar panels. The Sanyo logo is visible in red on the upper part of the facade, and the words "SOLAR ARK" are written in large, white, stylized letters on the lower part. The sky is clear and blue. In the foreground, there is a paved area and a small, modern structure.

Research and Development of Silicon Solar Cells in SANYO

October 20, 2010

Makoto TANAKA
Solar Energy Research Center
SANYO Electric Co., Ltd.

- 1. History of Sanyo's PV business**
- 2. HIT Solar Cells**
- 3. Thin Film Silicon Solar Cells**
- 4. Future Prospect**

History of photovoltaic technology in SANYO



2nd Gen.

HITTM Solar Cells

HIT ; Heterojunction with Intrinsic Thin-layer



23.0% (100cm²)
HITTM cell (R&D)

Mass production 1997

2009



1990

2001

Stable 10.0%
(>8,000 cm²)
a-Si/a-SiGe



1980

Mass production
a-Si solar cell
AMORTON



1975

**NEDO
Sunshine
Project**

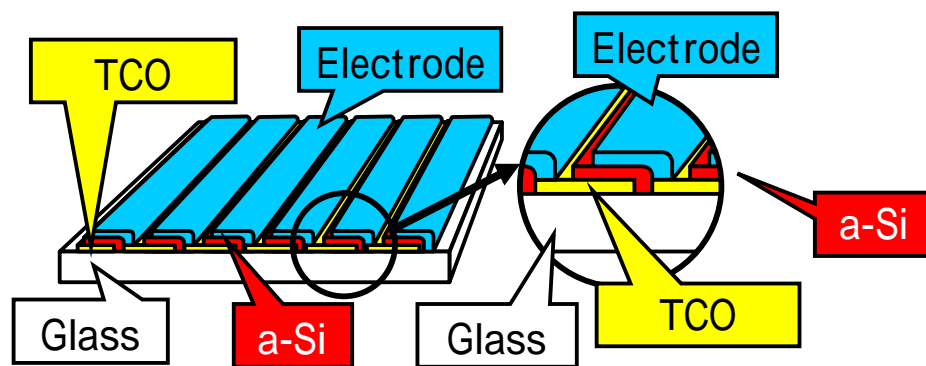
1st Gen.

a-Si Solar Cells

1st Generation in SANYO - Amorton -



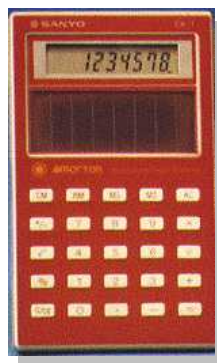
3



Original structure



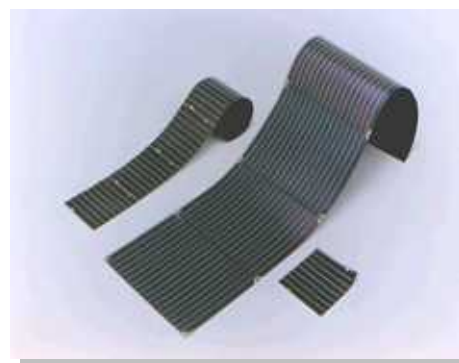
Residential use



Pocket calculator



See-through solar cell



Flexible solar cell



Solar plane

1. History of Sanyo's PV business

2. HIT Solar Cells

- a) Conversion efficiency
- b) Thin wafer HIT

3. Thin Film Silicon Solar Cells

4. Future Prospect

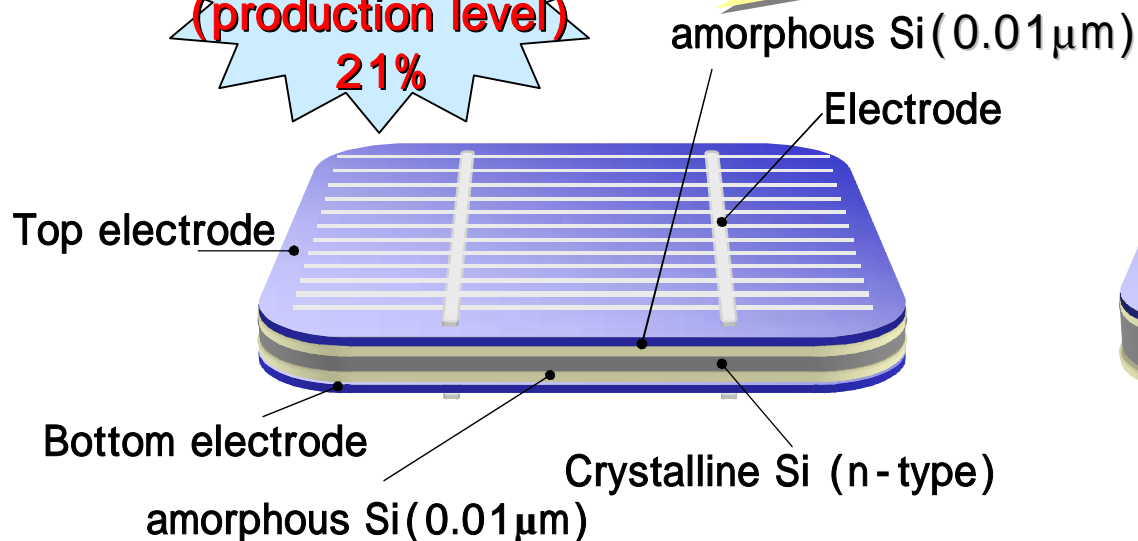
1. SANYO carries on a PV business by HIT solar cell, which is superior to solar cells of other companies.
2. All process including production of wafer, system and house building can be done in SANYO Group companies.
3. New technologies have been continuously created through research and development by members of world highest and maximum level.



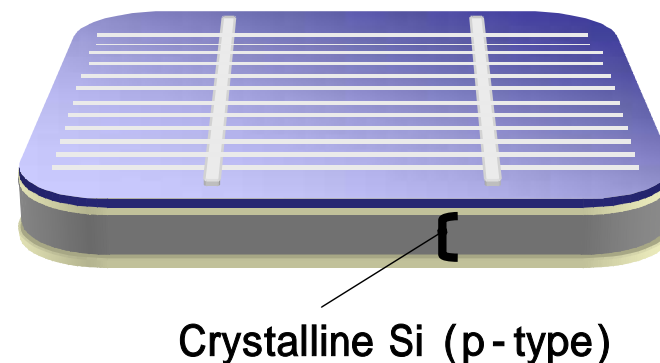
HIT solar cell is composed of thin single crystalline silicon wafer sandwiched by ultra-thin a-Si layers

* HIT: Heterojunction with Intrinsic Thin-layer

**The world highest
solar cell conversion efficiency
(production level)
21%**

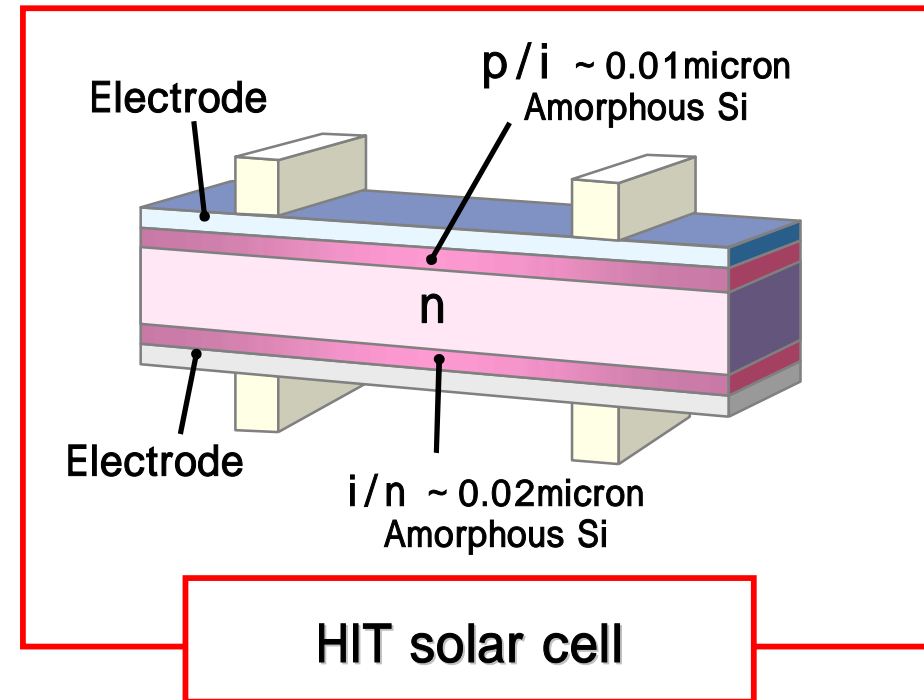
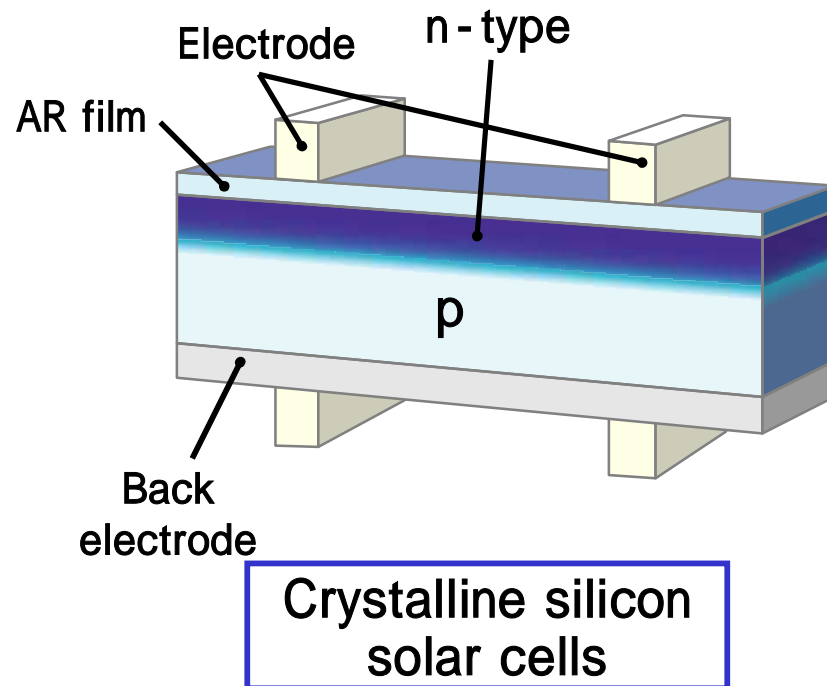


HIT solar cell



Conventional c-Si solar cell

Synergy of crystalline and amorphous technologies



Features

- (1) Highest conversion efficiency
- (2) High performance even in Summer
- (3) Thin crystalline silicon

World's Highest Cell Conversion Efficiency and Excellent Temperature Tolerance

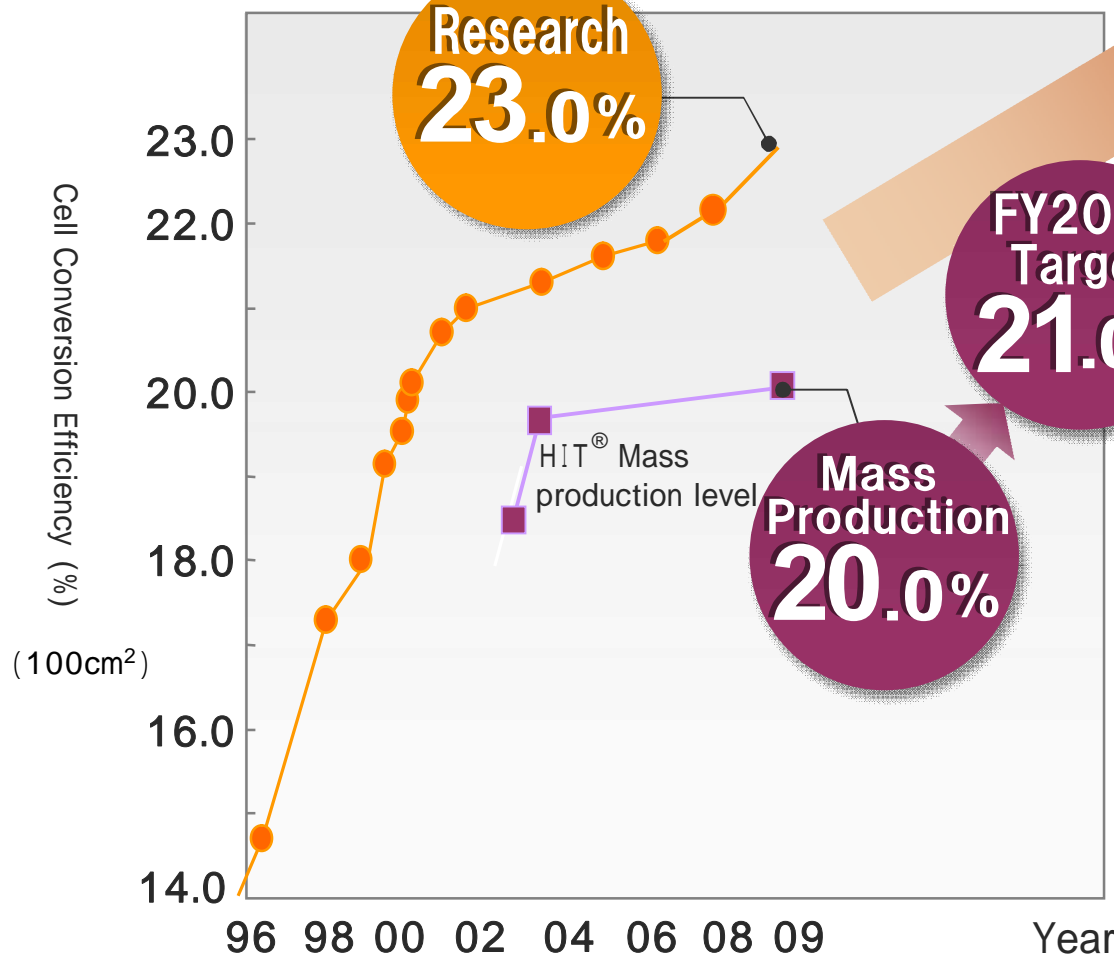
SANYO

8

World's highest conversion efficiency achieved
for practical use size

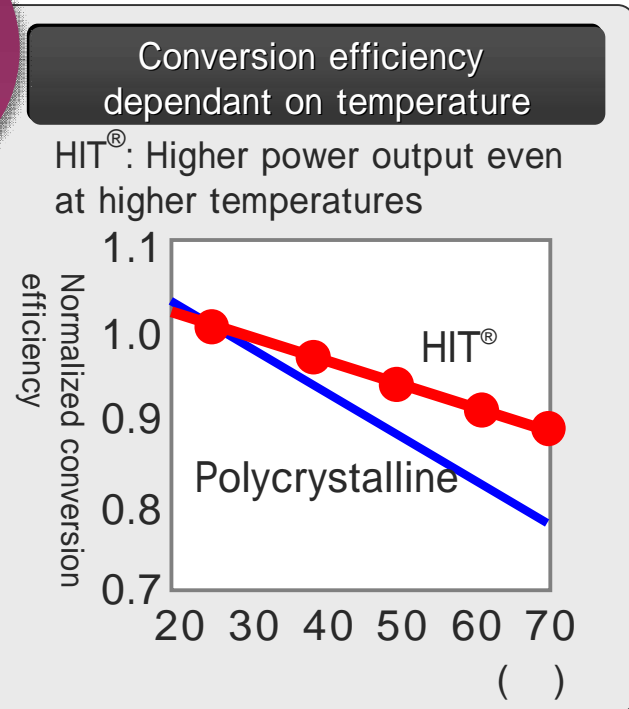
(HIT[®] R&D Level: 100 cm²)

Higher
Efficiency



FY2011
Target
21.0%

Mass
Production
20.0%



* HIT[®] is a registered trademark and an original technology of SANYO Electric Co., Ltd.

Copyright(C) SANYO Electric Co., Ltd. 2010

1. History of Sanyo's PV business

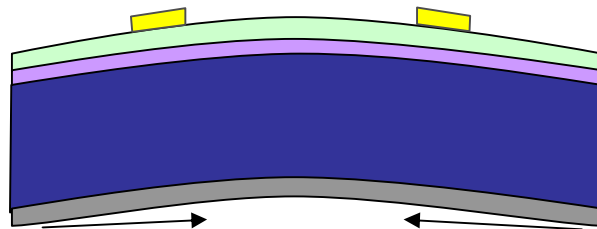
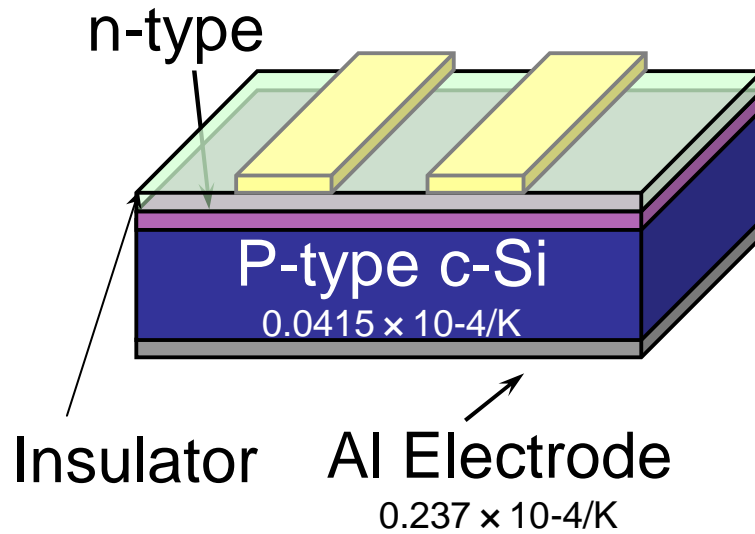
2. HIT Solar Cells

- a) Conversion efficiency
- b) Thin wafer HIT**

3. Thin Film Silicon Solar Cells

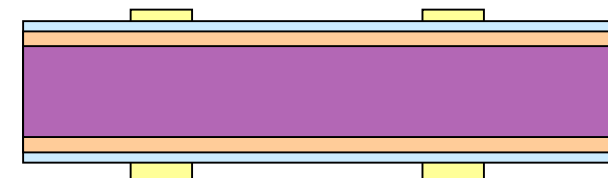
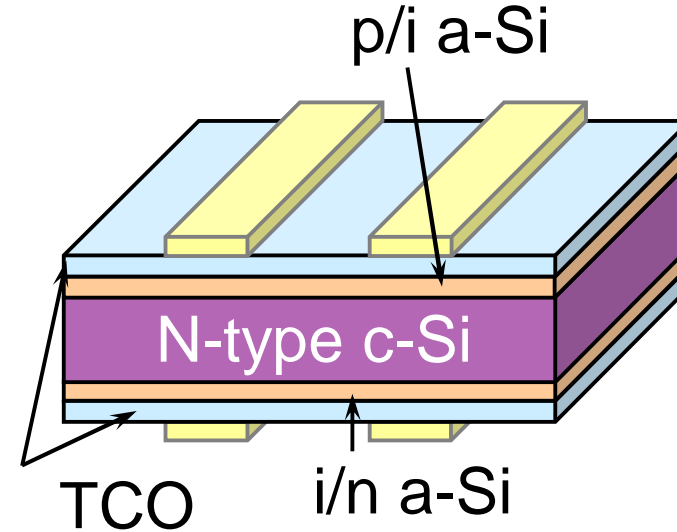
4. Future Prospect

Conventional c-Si Cell



Bending


HIT Solar Cell



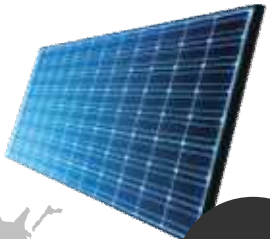
No Bending

Manufacturing Base

Expand Production in view of Mega Japan - Europe - U.S. Market




Shimane SANYO Electric Co., Ltd.
Cell Production



Japan



Shiga Plant
Module Production



Nishikinohama Factory
Cell / Module Production



Hungary Factory (Dorog City, Hungary)
Module Production


Europe



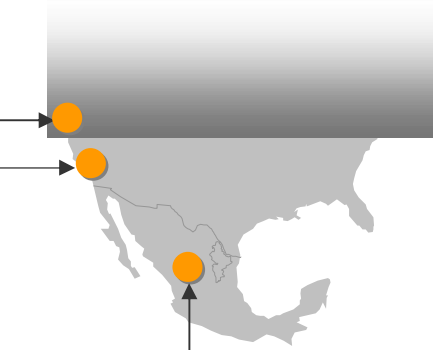
USA



SANYO Solar of Oregon (Salem, Oregon, USA)
Ingot / Wafer Production



SANYO Solar (USA) (Carson, CA)
Ingot / Wafer Production




Monterrey Factory (Mexico)
Module Production

History of photovoltaic technology in SANYO



2nd Gen.

HITTM Solar Cells

HIT ; Heterojunction with Intrinsic Thin-layer



23.0% (100cm²)
HITTM cell (R&D)

Next Generation
HIT Solar Cells

Mass production 1997

2009



1990

2001

Stable 10.0%
(>8,000 cm²)
a-Si/a-SiGe



1980

Mass production
a-Si solar cell
AMORTON

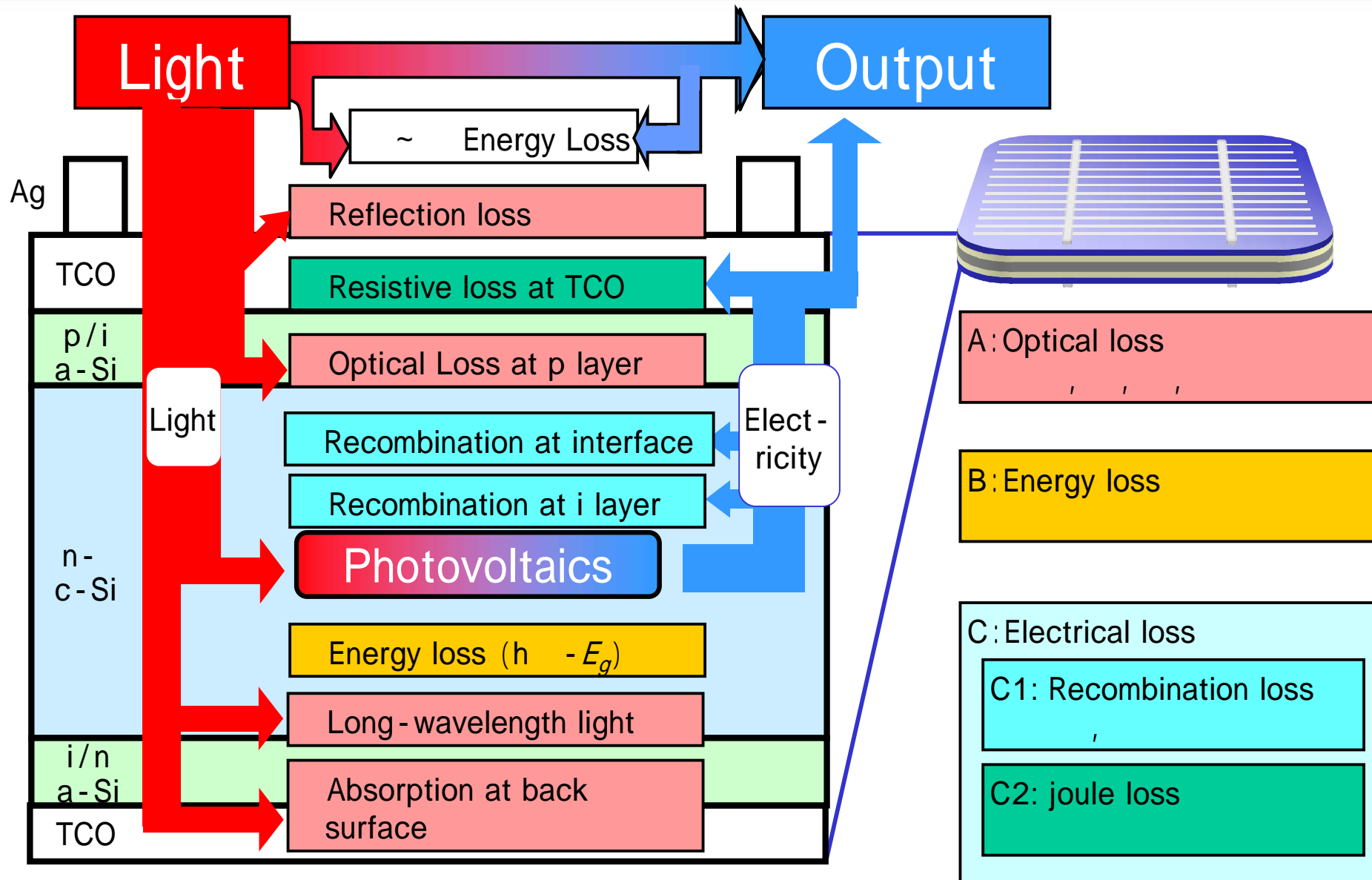


1975

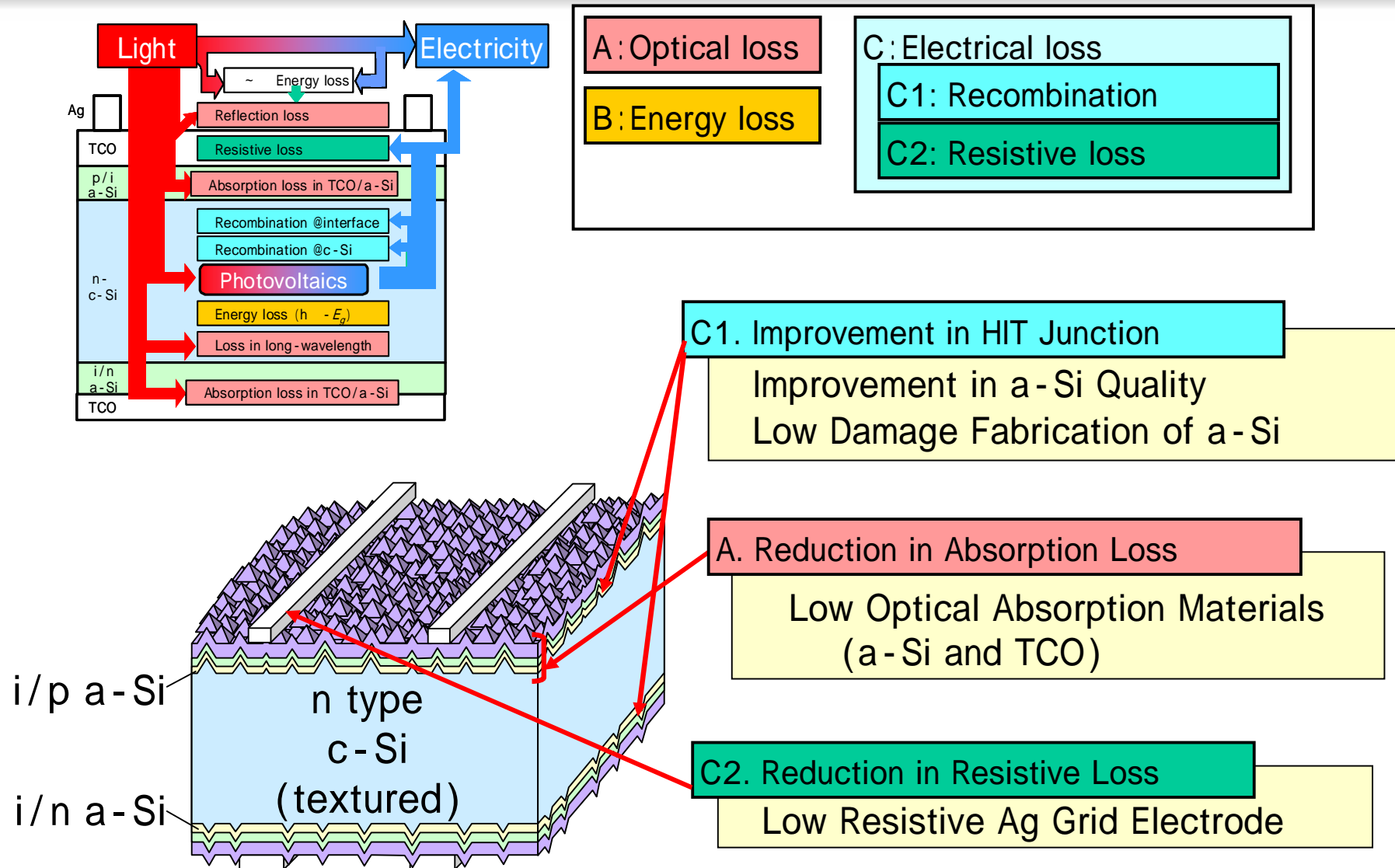
NEDO
Sunshine
Project

1st Gen.

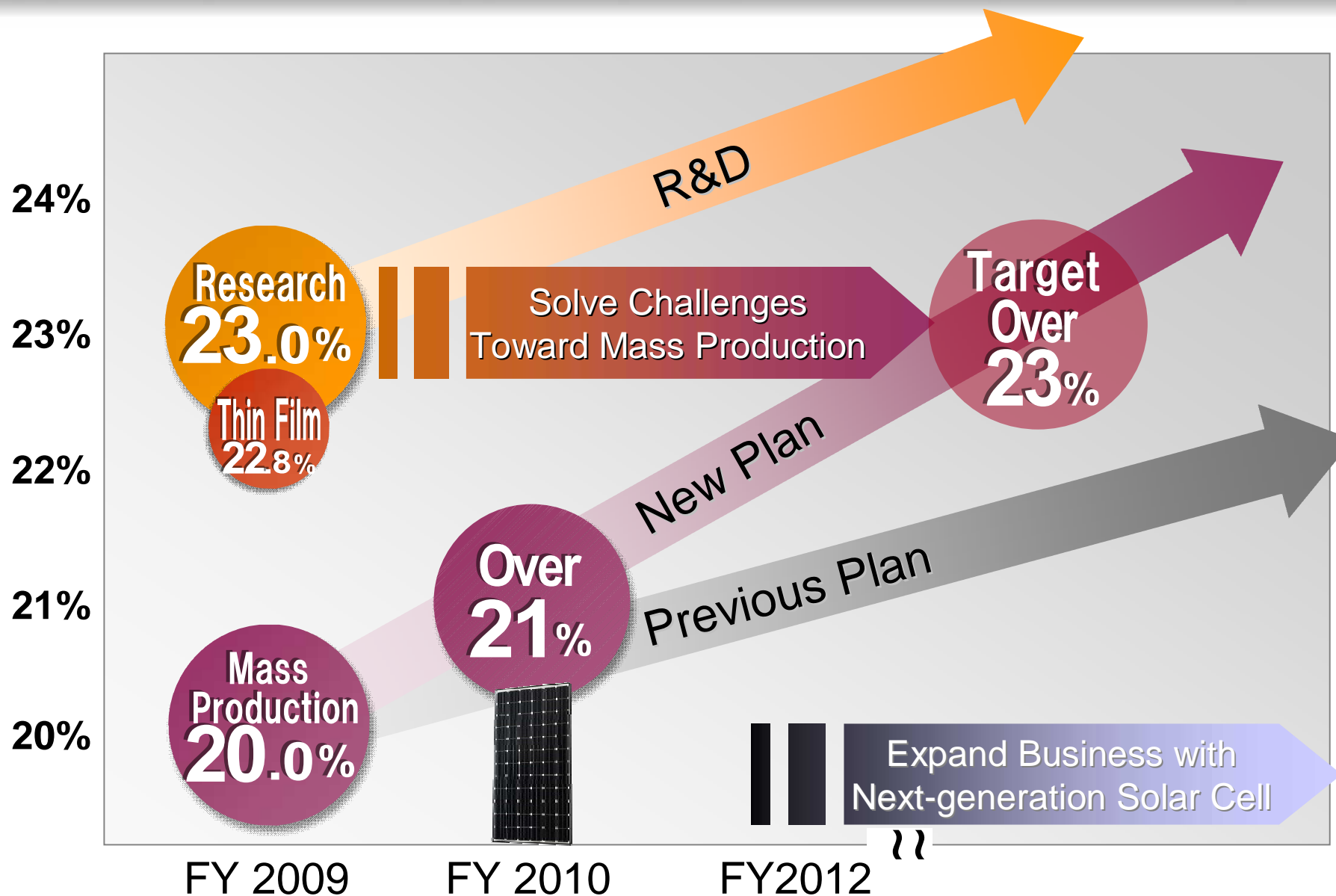
a-Si Solar Cells



Key Technologies for High Efficiency



Striving for Even Higher Efficiency

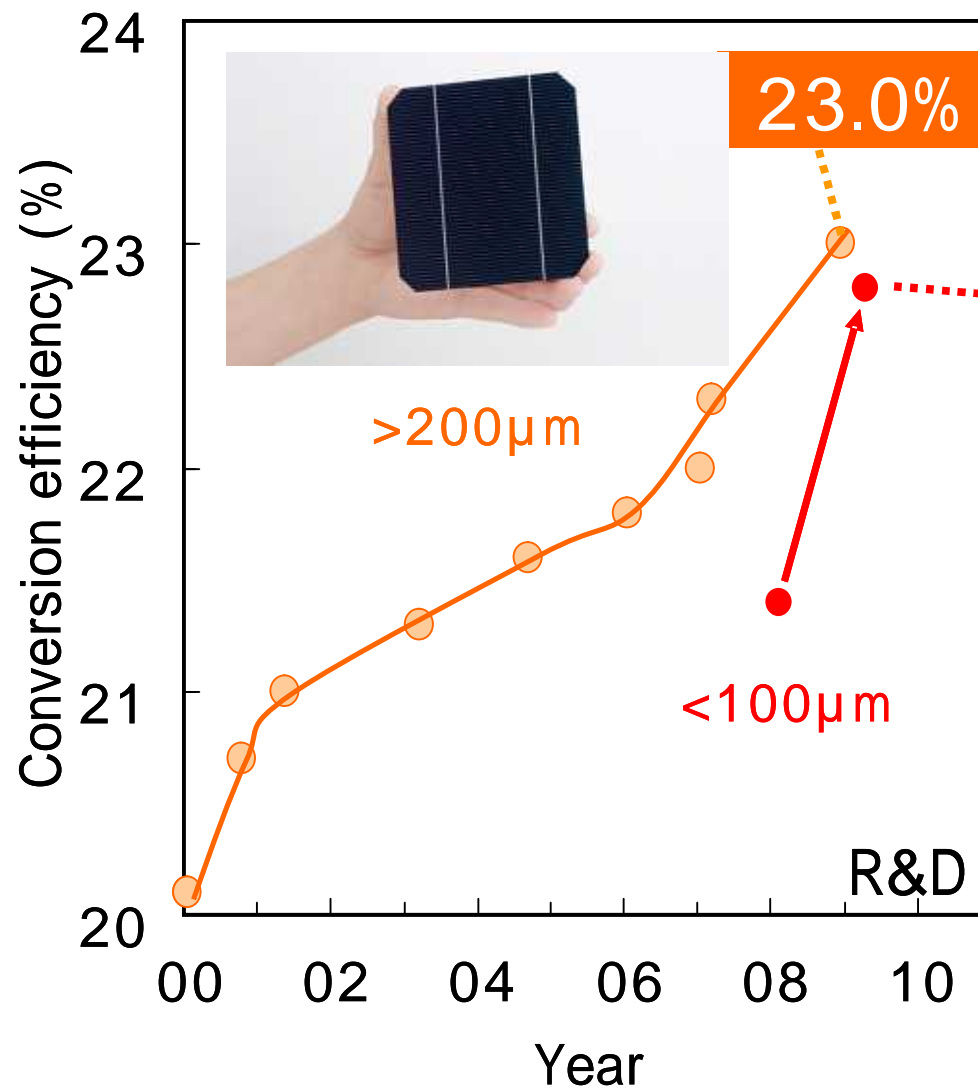


Projected progress in cell conversion efficiency

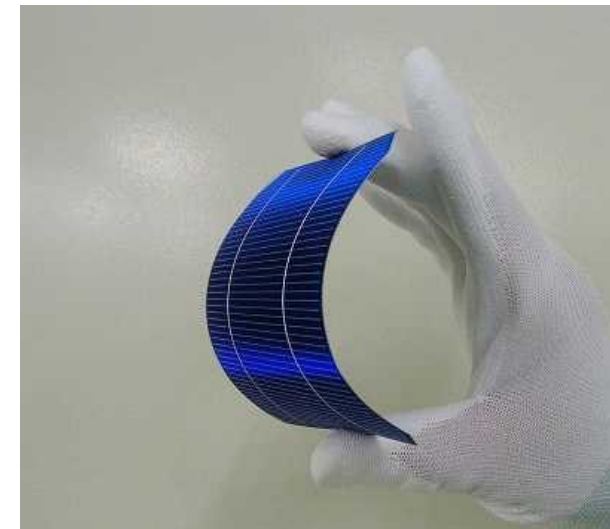
Development Concept

- Design that reduces the efficiency loss to nearly the theoretical limits
- **Conversion Efficiency: Over 23%**
- Period: Commercialization starting in FY 2014
(Accelerate schedule as soon as possible)
- Structure: HIT[®] structure
- Technology: Applying the performance of thin substrate technology
- Thickness: Thinner than current HIT[®]
- **Cost: Lower costs**
- Location: Currently under investigation with Panasonic's Amagasaki plant as the primary candidate

Progress of Conversion Efficiency in HIT Solar Cell



22.8% (d=98 μ m)



1. History of Sanyo's PV business

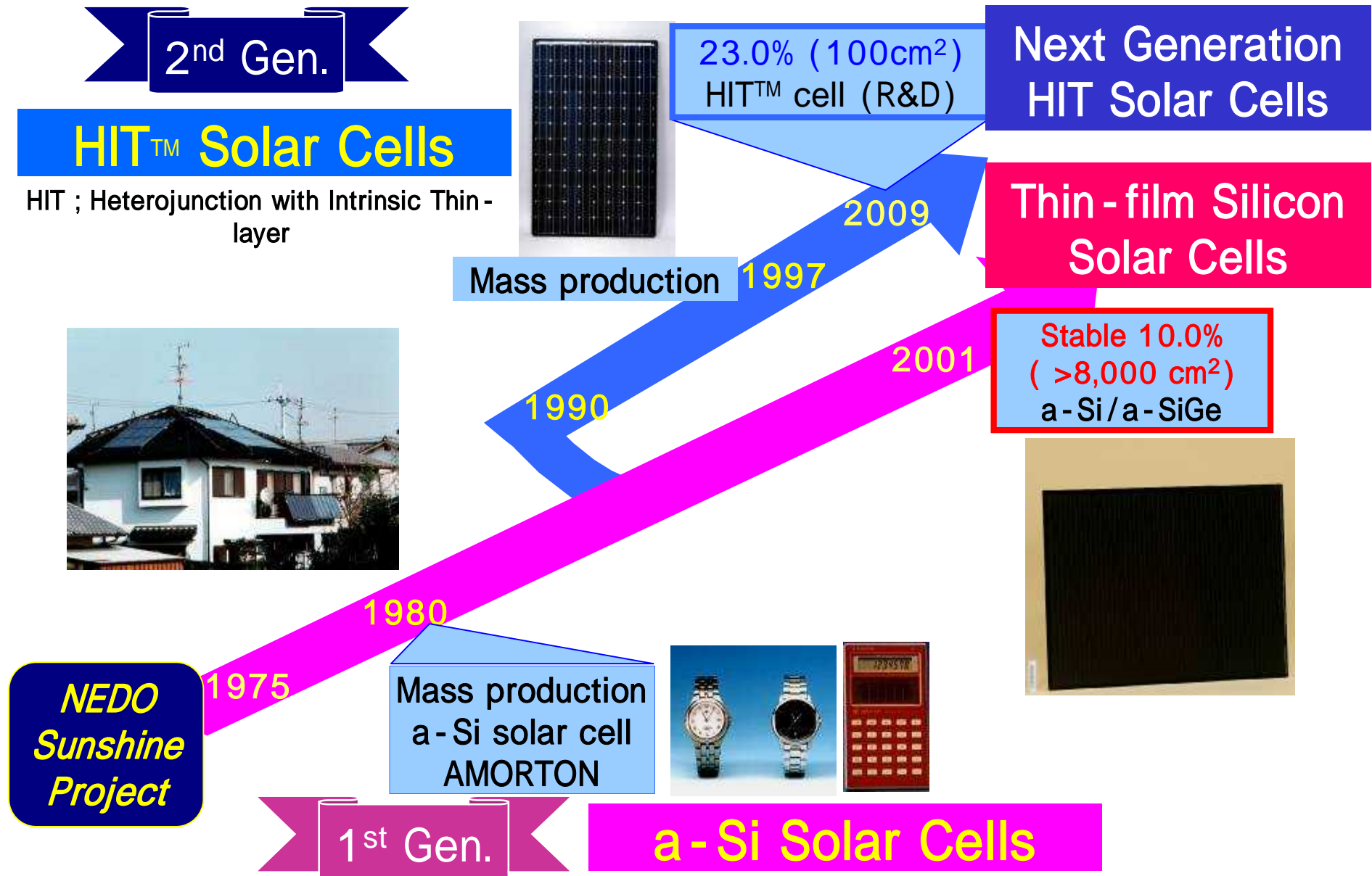
2. HIT Solar Cells

3. Thin Film Silicon Solar Cells

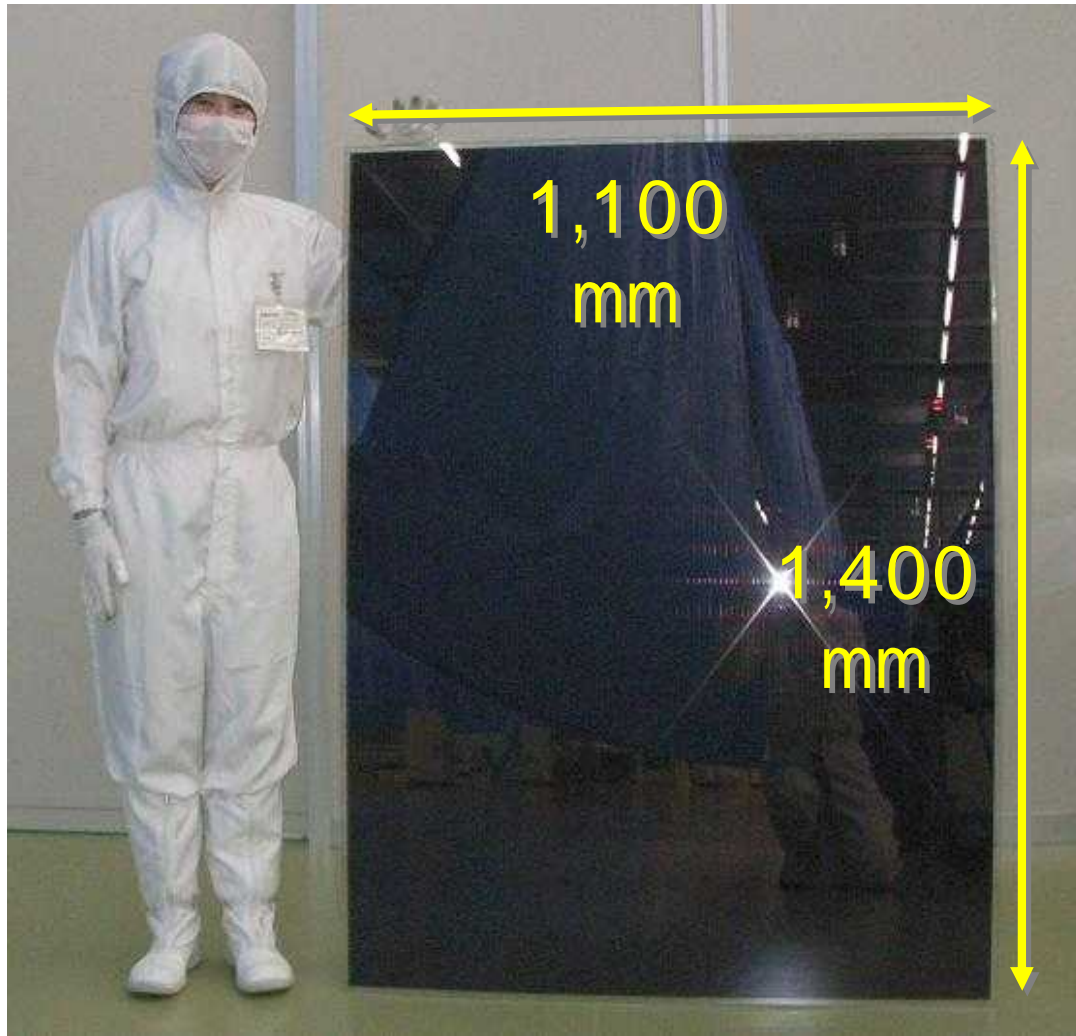
a) New Research Center

b) New p-CVD

4. Future Prospect



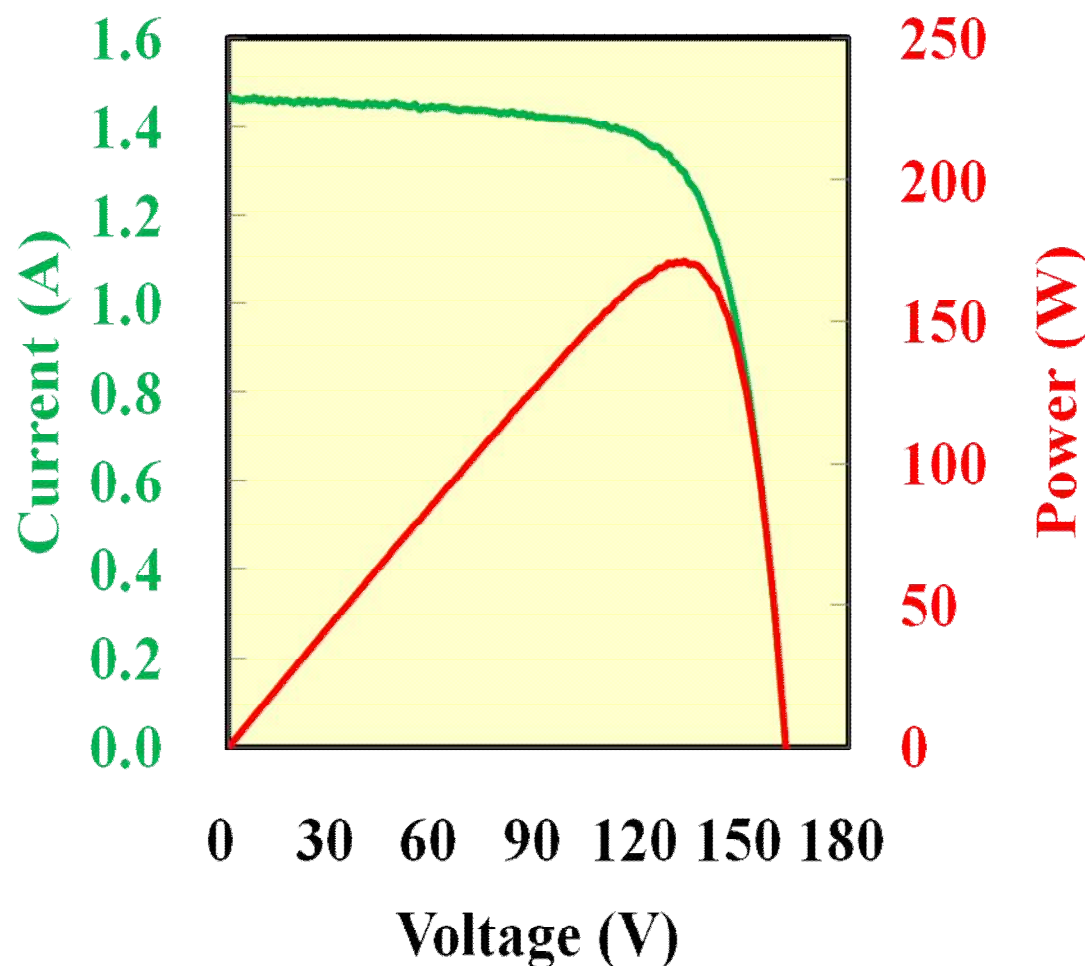
G 5.5 Glass Substrate for Mass Production



Tandem Panel



Tandem module
(InterSolar 2008, Munich)



Output performance

Substrate size : Gen5.5
 Initial Eff. : 11.1%
 (Stabilized Eff.): 10.0%
 Voc : 161.7V
 Isc : 1.46A
 F.F. : 72.4%
 Pmax : 171W
 Depo. Rate of μ c-Si:H i-layer : 2.4nm/s

I-V characteristics of an a-Si:H/ μ c-Si:H solar panel (1,100mm \times 1,400mm)

1. History of Sanyo's PV business

2. HIT Solar Cells

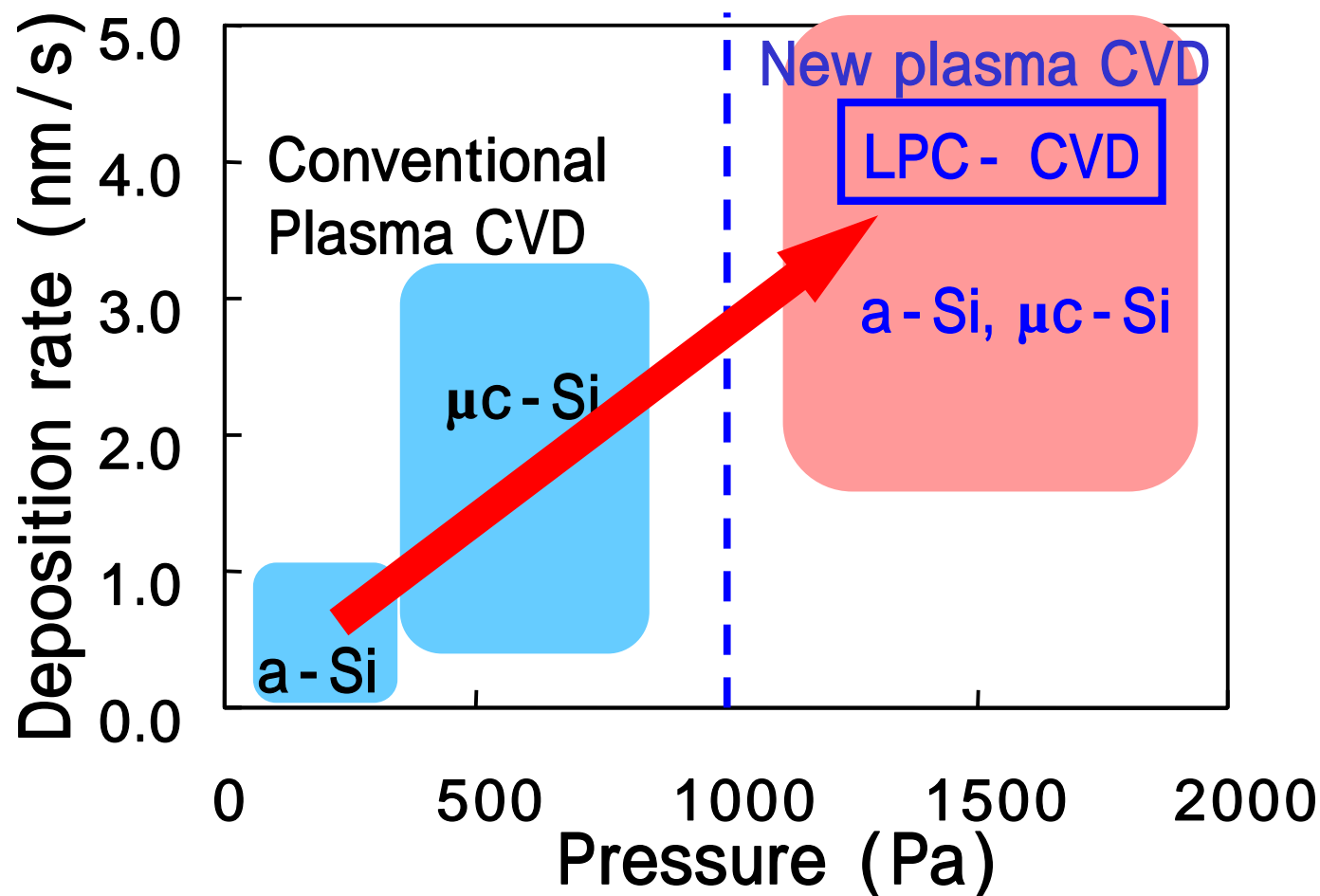
3. Thin Film Silicon Solar Cells

a) New Research Center

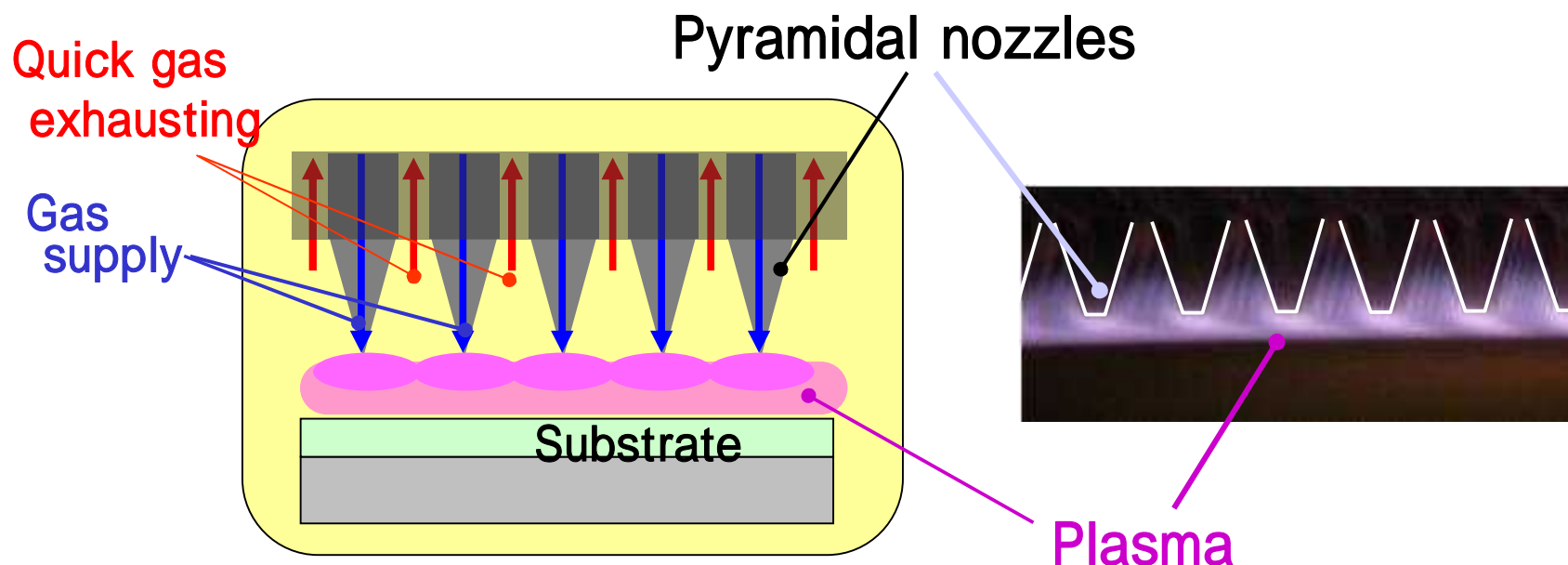
b) New p - CVD

4. Future Prospect

High Pressure Plasma is Necessary for High Rate Deposition



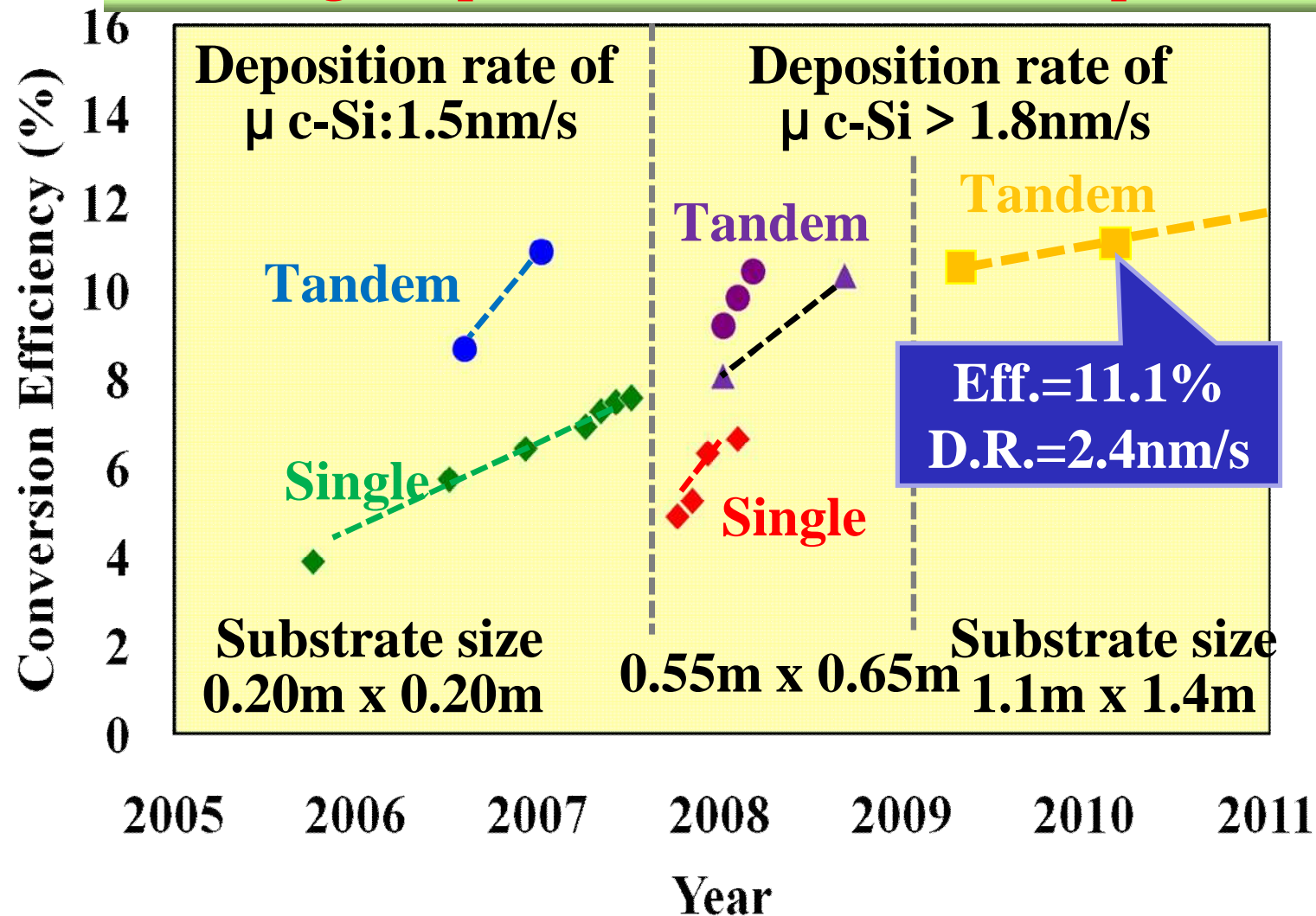
LPC : Localized Plasma Confinement



1. Pyramidal nozzles : Origin of holding plasma
➡ Stable and uniform plasma > 1,000 Pa
2. Localized supply and exhaust on shower plate :
➡ Uniform gas residence time

High rate and uniform deposition on large substrates

Balance among High Efficiency, Large Panel Size and High Deposition Rate is the most important

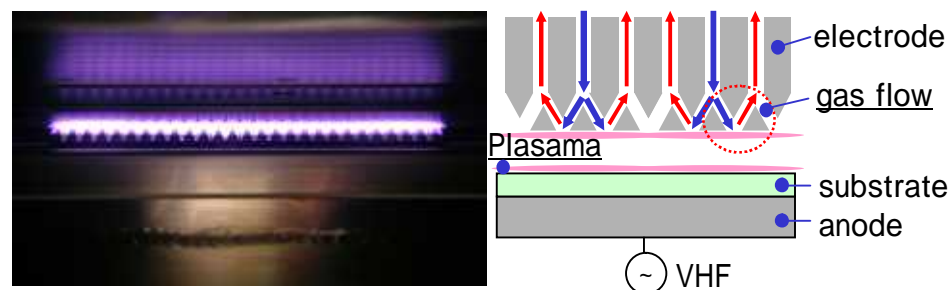
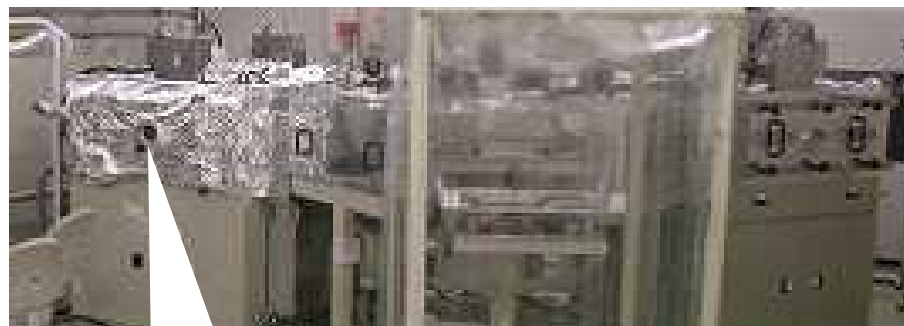


Original technologies have been under development.

ex) Very high throughput deposition technology, Localised Plasma Confinement (LPC) CVD method

Original technologies have been developed in NEDO R&D

1. Higher throughput
(10 times higher)
“Localized Plasma”
2. Higher performance
from 10% to >14%
(same level with multi-Si)
Technology of new thin Si



Localized Plasma Confinement CVD

Accelerate in “Advanced Photovoltaics Development Center”

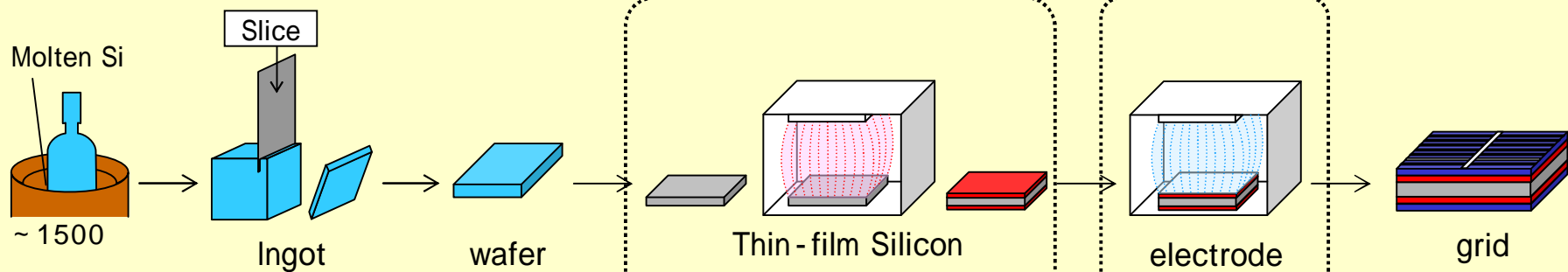
1. History of Sanyo's PV business
2. HIT Solar Cells
3. Thin Film Silicon Solar Cells
- 4. Future Prospect**

Fusion ; technologies of HIT and Thin-film Solar Cells

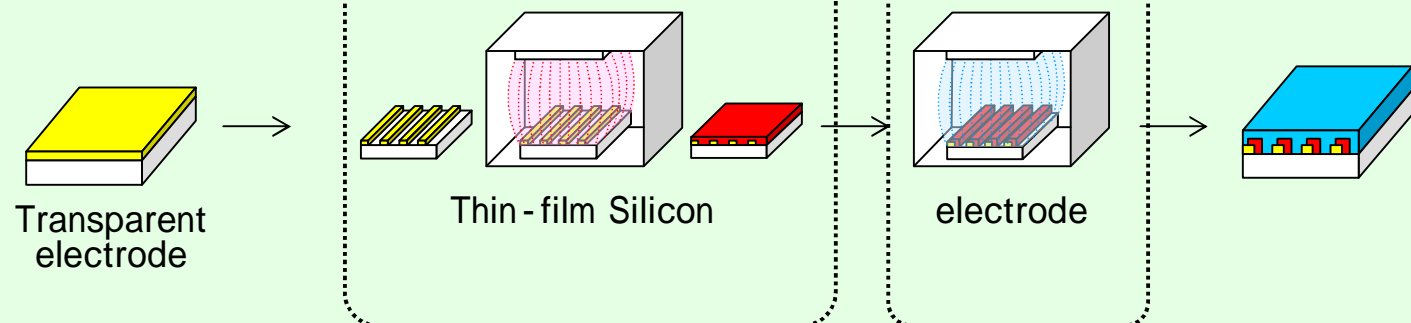


Technologies for thin-film Si solar cells are similar to those of HIT solar cells. Therefore, the highest level technologies for HIT can be easily applied to thin-film Si solar cells.

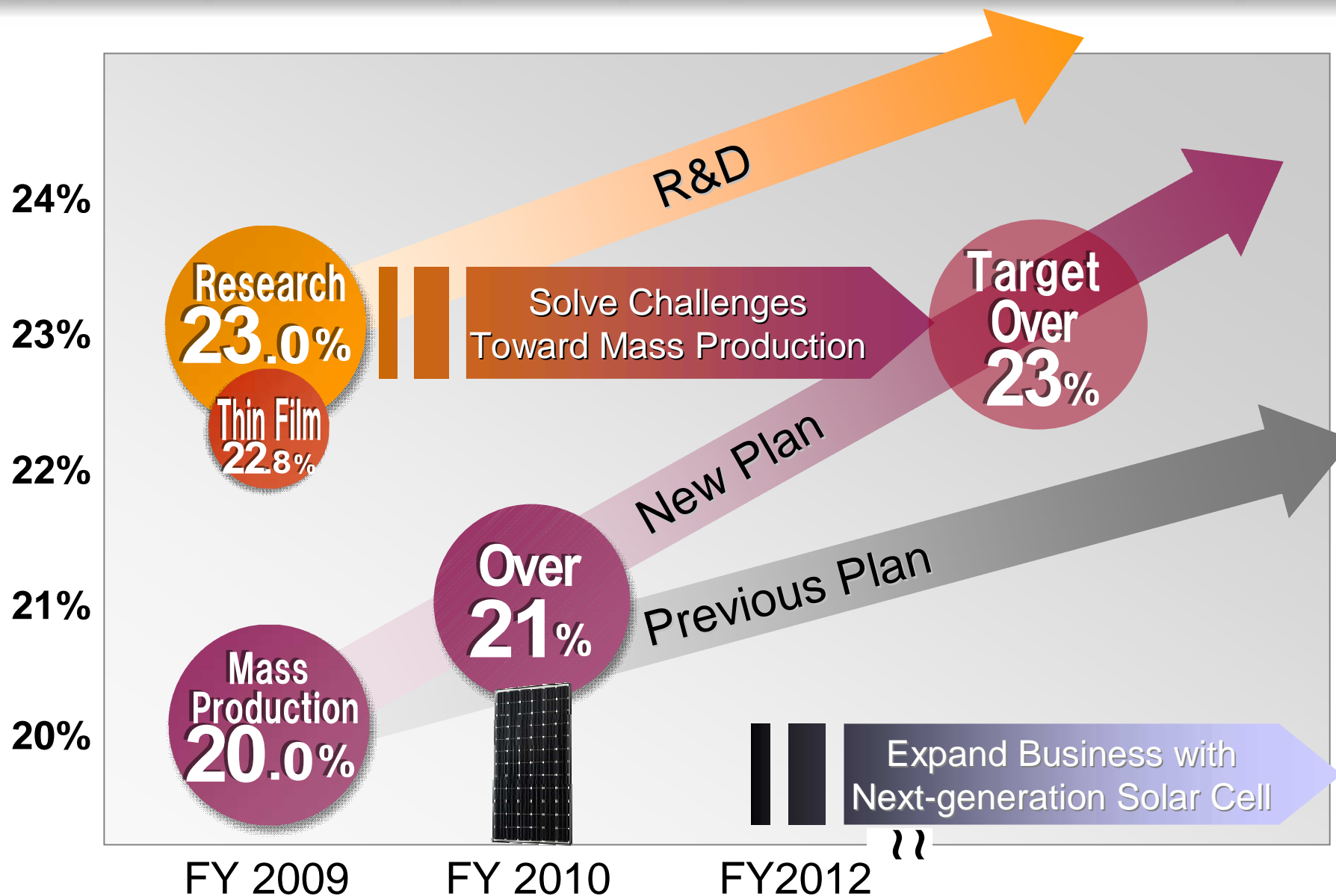
HIT solar cells



Thin-film solar cells



Striving for Even Higher Efficiency



Projected progress in cell conversion efficiency

Panasonic

- Panasonic Group expertise and techniques for design, development, production and cost reduction
- Panasonic's global network
- Human resources

SANYO

- HIT[®] solar cell device technology and production technology
- Sanyo's global network
- Human resources

Sharing use of resources, and acceleration of efforts to become one of the global top 3 by 2015

