

**Back to the future technology**

Thank you "Clean Energy"

# Thin Film CIS Solar Modules

Asset Performance Management (APM)  
Statement for Sustainability

**"Innovative solutions come from you & us"**

Prepared for General use

**NIPCO Electrical Engineering & Trading Sdn. Bhd.**

**11<sup>th</sup> September 2019**

File name: 20190911\_CIS Thin File PV Module\_SBD Scheme\_General\_2.0



# Consolidated Capability for Solution

## NIPCO & Solar Frontier

Energy Management	Business Management	Electrical Panel Building	Energy Electrical & Instrumentation	EnMoS Hardware Software	Solution Technology
ISO MS 50001 class	Operation Performance Improvement	Switch Board	Integrated Electrical Engineering	Energy Data Hardware /Software Solutions	Planning Engineering Procurement
Energy Treasure Hunt (Energy Audits)	Financial Solution	Metering Panel	Electrical Full-support Business	Energy Efficiency Analysis	Wiring Installation Commissioning
REEM Consulting	HR Development	Energy Management Panel	Renewable Energy solution	EnPI	Energy Management Solutions
Green Initiative Implementation	Skill Resourcing	Control Panel	Solution Maintenance	Evaluation Measurement Verification	<ul style="list-style-type: none"> <li>• Switchboards</li> <li>• Metering Panels</li> <li>• Energy Mgmt Panels</li> <li>• Control Panels</li> <li>• Capacitor Bank</li> <li>• Thin Film (CIS) PV system for kWh yield optimization</li> </ul>
Documented Information	Energy Management Consulting & Training	Capacitor Bank	Quality/Safety Solution	Data Management Analysis	
Integrated Management System Experts	Project Management Supervising	Motor Control Centre		Energy Performance Improvement Procedure	
ISO 9001		Panel building tailored to client			
ISO 14001					
ISO 27001					
OHSAS 18000					
ISO 50001					



EnMoS : Energy Monitoring System

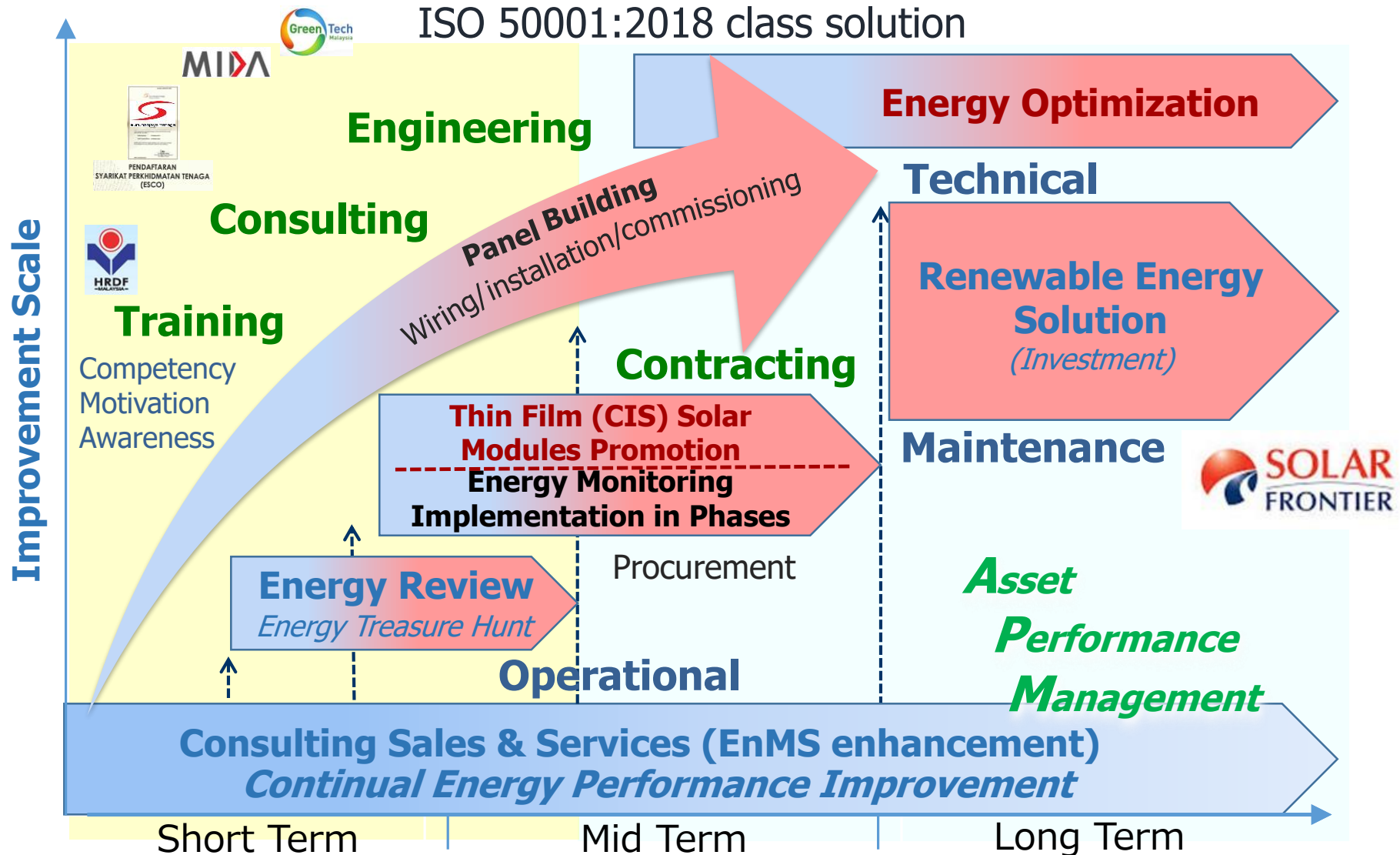
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EnPI : Energy Performance Indicator



# Sustainable Business Development Partner

ISO 50001:2018 class solution





# NIPCO is one stop solution provider firm

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**Ensures you improve efficient use of energy**

**□ Feature:**

**Ensures you improve efficient use of energy**

**□ Function:**

1. Design, build, install and wiring of various **Electrical Distribution Boards** for business owners ensuring proper energy management at their sites
2. Design install and wiring of **Energy Monitoring hardware/software** best fit to business owner's scale of economics
3. **Provide solution with CIS Thin Film Technology PV modules made in Japan**
4. Provide energy management **consulting services** for improvement requiring low-no investment
5. Provide various **training** sessions related to energy management tailored to trainees aiming to gain improvement from trainees as result of the session

**□ Feature:**

**improve net income by reducing energy bill**





# Solar Frontier Teamwork in Malaysia



**Int'l Business Mgr.**  
*Hidemi Sakaguchi*



Japan

Malaysia

**CIS Thin Film Business  
Development**  
*Nobby Yamanouchi*



**Malaysia-Japan Relations**



**PV System Business  
Director**  
*Andrew Lee*



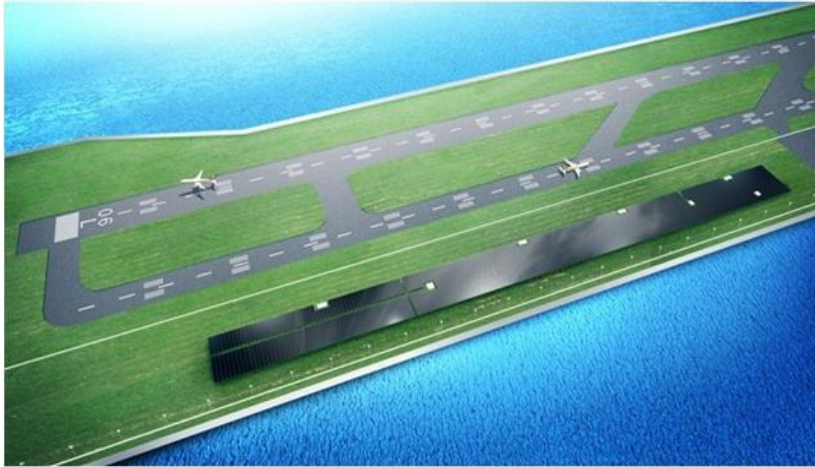
**REEM & Technical Specialist**







# CIS Thin Film Solar Module Solution Provider



Kansai International Airport  
11.6 MW



Solar Frontier's solar panels installed on the roof of a Shell Service Station in Thailand



AEON Shopping Mall, Yamato, Kanagawa  
30.6 KW

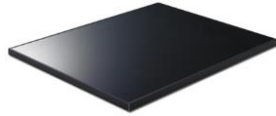


We represents CIS Thin film solar panel from Japan

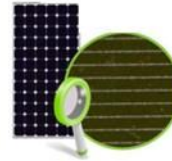


# Comparison from experience in Japan

CIS Thin Film



Monocrystalline



Polycrystalline



Module Brand	Solar Frontier	Panasonic	Kyocera	Mitsubishi	Sharp	Q-cells (Korea)
Manufacturing Ownership	Japan	China	Japan	Japan	Japan	Korea
Type of Modules	Thin film (CIGS)	HIT	Monocrystalline	Monocrystalline	Polycrystalline	Monocrystalline
Cell Mfg Process	Japan	Malaysia	Japan	China	China	Malaysia
Assembly	Japan	Malaysia	China	Japan	China	Malaysia
Amount of power generation※1	1313kWh/kh	1219kWh/Wh	1258kWh/Wh	1214kWh/Wh	1257kWh/Wh	1238kWh/Wh

※1 PV Energy site (Japan, Hokkaido, based on mean value analysis done by Nipco)

※Nipco does not intend to warrant any data in this presentation document

# Comparison of Specification

Manufacturer	Solar Frontier	Panasonic	Kyocera	Mitsubishi	Sharp	Q-cells
Modules output	185W	250W	250W	-	256W	305W
Conversion efficiency*2	15.1%	19.5%	17.6%	-	19.6%	18.3%
Limited power output Warranty	25years	25years	25years	-	25years	25years
Size/panel	977×1257×35mm (1.2m <sup>2</sup> )	1580×812×35mm (1.28m <sup>2</sup> )	1470×990×36mm (1.4553m <sup>2</sup> )	1657×858×46mm (1.42m <sup>2</sup> )	1318×990×46mm (1.30m <sup>2</sup> )	1670×1000×32mm (1.67m <sup>2</sup> )
Weight /panel	18.5kg	15kg	17.1kg	16.0kg	17kg	18.8kg

※2: Shall be measured under standard test conditions(STC)as follows;(a)Irradiance1000W/m<sup>2</sup>,(b)Cell Temperature of 25°C,and (c) Air Mass of 1.5g. ⇒ under this test condition CIS Thin film technology will be rated the least.



# Comparison of EPC Total Cost

Type of Modules	Solar Frontier	Crystalline-Si
Panel/W ※1	\$ 0.455	\$ 0.345 ( \$ 0.30)
BOS/W ※1 (balance of system)	\$ 0.39	\$ 0.32
EPC total Cost/W ※1 (including civil works)	\$ 0.845	\$ 0.665

※1 PV Energy site (Japan, Hokkaido, based on mean value analysis done by Nipco)

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# Kumamoto Technical Center (Sony Semiconductor Manufacturing Corporation)

Kumamoto Technology Center (Kumamoto TEC)  
(Sony Semiconductor Manufacturing Corporation)

CMOS Image Sensors, Displays

Development of Motion Picture Devices &  
Manufacturing



Established	1 <sup>st</sup> October, 2001
Location	4000-1, Haramizu, Kikuyou-machi, Kikuchi-gun, Kumamoto, Kumamoto, 869-1102 Japan
Representative	Keigo Yukihide, Executive Director & Head of Kumamoto TEC
Main product Line	CMO CMOS/CCD Image Sensors for Audio Visual and Monitors, CMOS Image Sensors for Automotive purpose Micro-displays (LCD/OLED)
Area of the Location	Land area: 266,000m <sup>2</sup> Floor Area: 198,000m <sup>2</sup>

For the purpose of energy use efficiency and reduction of environmental load and burden, Kumamoto installed a solar system on the rooftop Technology Center in February 2019, of #1 Building Wing designed to generate annually 1,240 MW. This power generation by solar system is one of the largest levels

installed among Sony group operation units domestic, Japan. It was carefully designed system tailored for Japan's irradiation characteristics in selecting CIS thin film solar modules to ensure maximizing the kWh yield on the cloudy days and time zones critical of requiring solar power. The plant aims at energy efficiency drive and reducing environmental burden following Sony's group intensive drive for sustainability.

© Solar Frontier K.K.



# We promote Solar Frontier CIS Thin Film Modules

*My***HIJAU** • MARK



**Listing No. MyHP0013/19-E002**

CIS Thin Film Solar Module

SFK180-S  
SFK185-S



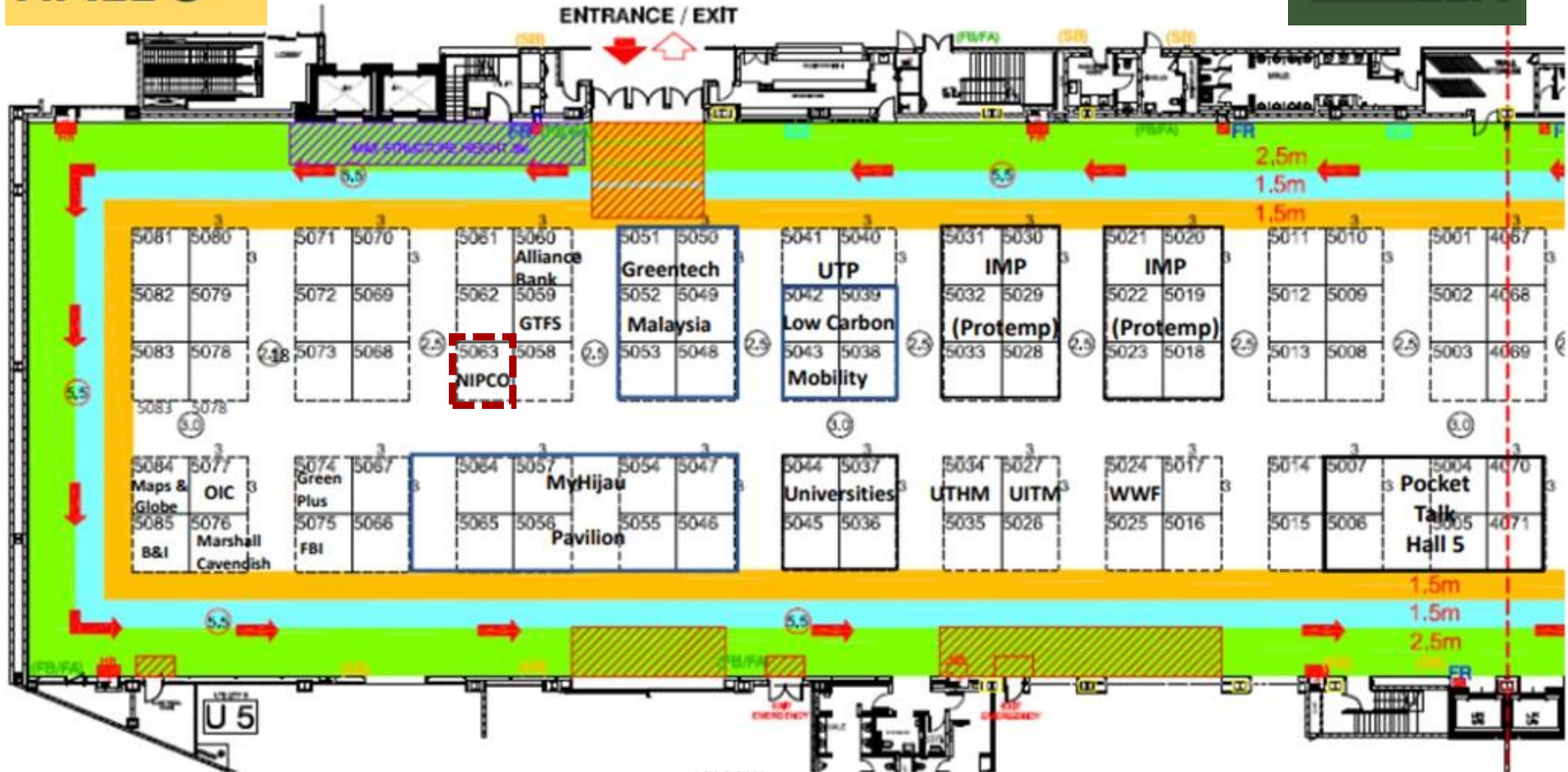
Nipco Electrical Engineering & Trading Sdn Bhd



9<sup>th</sup> – 11<sup>th</sup> October



## HALL 5



1. Energy: People & Organization
2. Seeing is “believing” & “action”
3. Energy Performance Indicator “EnPI”
4. See what you are and how to improve
5. Skill/Competence, Awareness & Motivation
6. Continual performance improvement
7. Lifecycle lean energy procurement
8. Documented information
9. Performance over conformance management system
10. Asset Performance Management
11. Thin Film (CIS) solar module promotion
12. Green Technology Incentive consulting & escort services

**ISO MS 50001 class  
Quality**

Best practice operation





# Back to the Future Technology

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Now, sustainably conscious and intelligent **investors** knows:

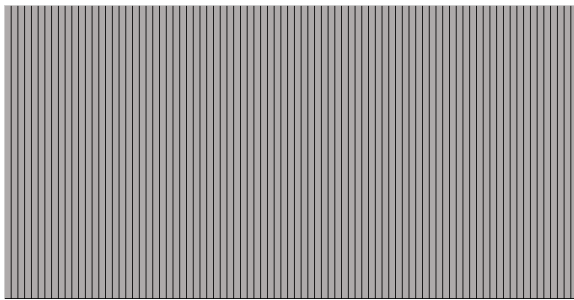
**CIS Thin Film Technology Solar Modules  
can  
Yield up to 20% more kWh  
over  
Conventional Silicon type Solar Modules  
Maximizing their asset performance...**





# Back to the Future Technology

## CIS Thin Film

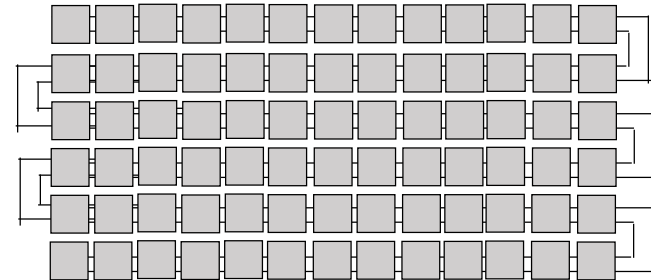


One thin film containing strips of 170 cells

## Crystalline silicon



**VS.**



Number of cells soldered in series

# Four Reasons Why CIS Generates More Energy

Performance at **High Temperatures**



CIS modules' **Light-Soaking Effect**



Tolerance to **Partial Shading**



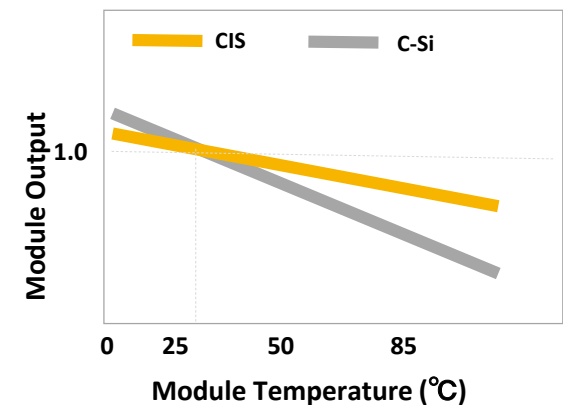
Superior quality for **Durability**



# Performance at High Temperatures



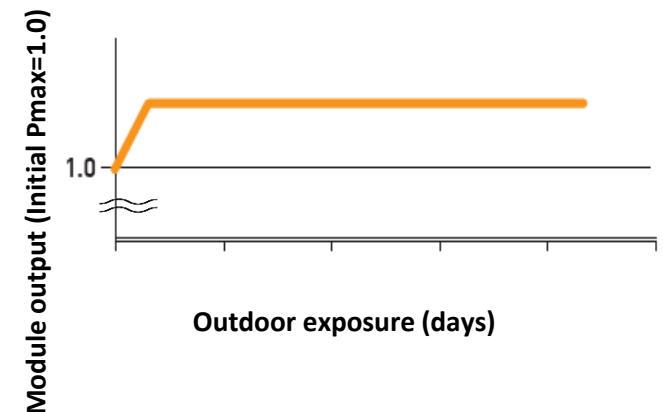
- CIS delivers high yields – even in desert heat
- This is indicated by the lower temperature coefficient of CIS compared to crystalline silicon modules



# The CIS “Light-Soaking Effect”



- CIS modules increase in power output after exposure to light
- In other words, the module has “warmed up” and is now operating at its full capacity, contributing to CIS’ higher performance ratio





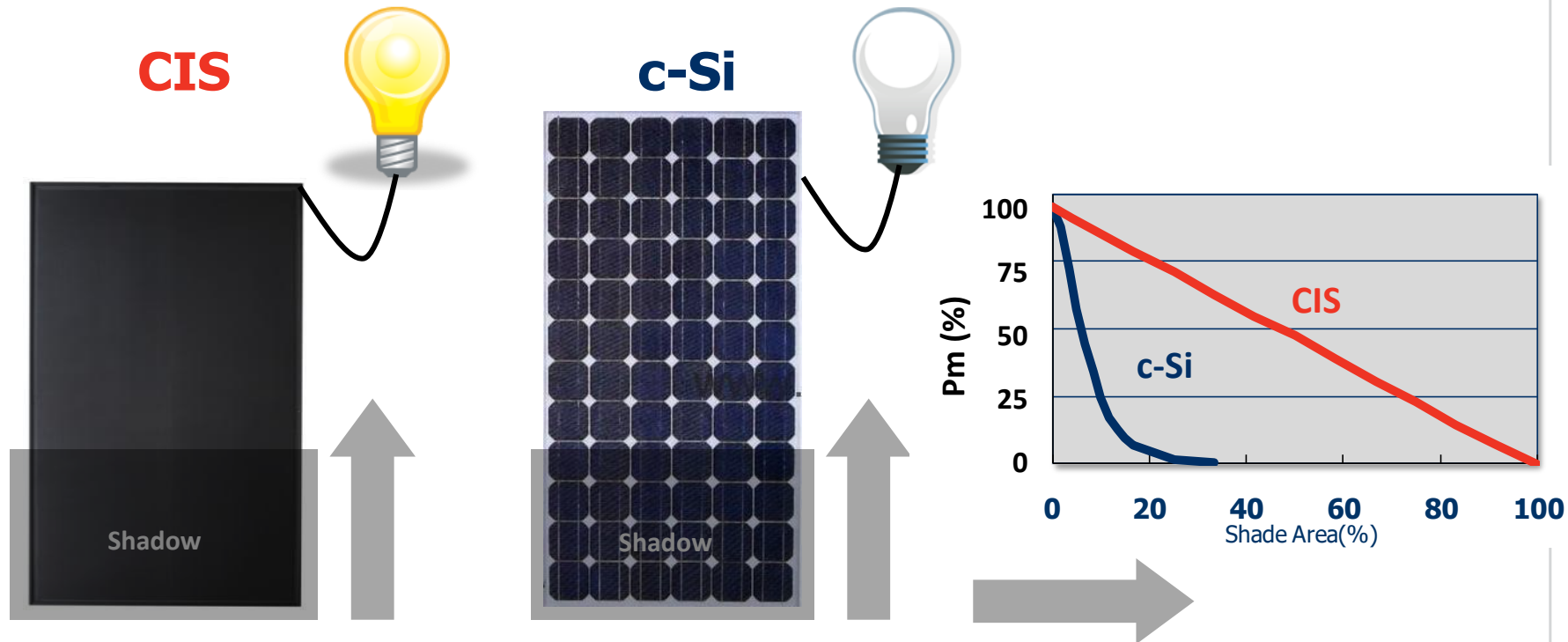
# Tolerance to Partial Shading



- **Even under partial shading from neighboring objects, CIS continues to perform**
- Shadows cast perpendicular to the shorter end of the module will only affect the covered part

# Tolerance to Partial Shading

- Under partially shaded conditions, the unique patterning of CIS modules keeps the drop of output to a minimum



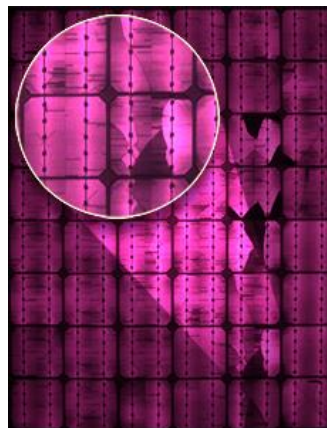
There is a partial loss of output but the overall effect is minimum

The module's output drops significantly under partial shadow



## CIS: A More Durable Technology

- Microcracks
  - More critical for p-Si than m-Si
  - Caused by weight on modules
- „Snail tracks“
  - Material defects, can be caused or boosted by microcracks
- PID
  - Potential-Induced Degradation



**NO RISK  
for Solar Frontier  
CIS modules,  
due to different  
technology!**

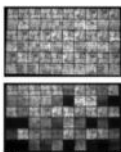
# CIS: A More Durable Technology



## PID Resistant

■ **Crystalline silicon:** susceptible due to insulation layers and thin N-layer

■ **CIS:** resistant due to no insulation layer



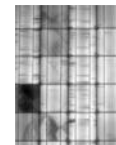
*C-Si:  
PID*



## No Microcracks

■ **Crystalline silicon :** fragile cell material affected by micro-vibrations

■ **CIS:** resistant to cracking because cell laid directly onto thick glass layer



*c-Si:  
microcracks*



Robust structure:  
glass/glass/backsheet



No hotspots



Resistance to  
salt mist corrosion



Resistance to  
ammonia corrosion

# The World's Largest CIS Manufacturer



## Kunitomi Plant

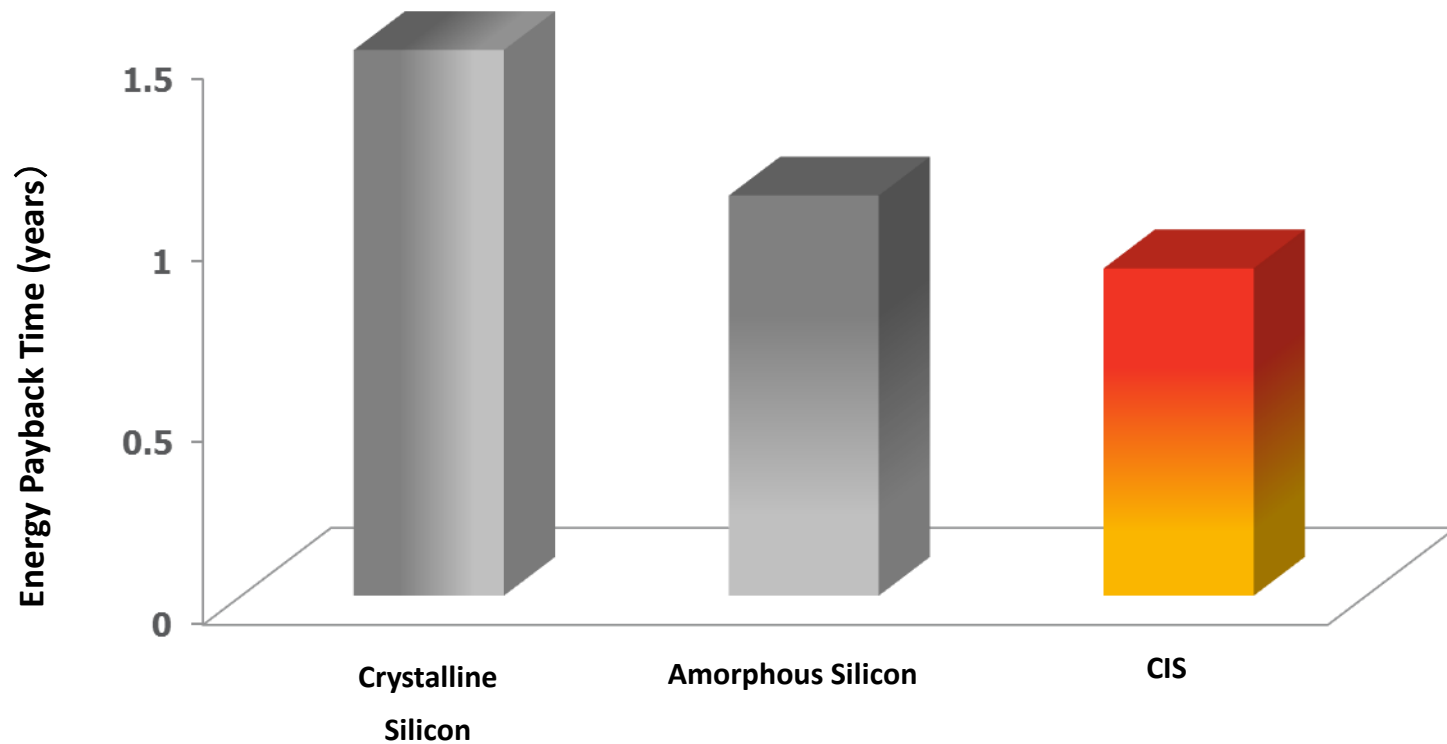
Online:	2011
Capacity:	900 MW
Land:	400,000 m <sup>2</sup>
Total floor area:	158,000 m <sup>2</sup>
Location:	Miyazaki, Japan

**Only Solar module manufacturer  
in the world committed to Cd  
free "CIS Thin Film"**

**Only "Tier 1" Solar module  
manufacturer from Japan**

## Environmentally Friendly Production

Energy Payback Time (EPT) measures how long it takes for a module to generate the same amount of energy as required to manufacture it. CIS modules require 60% less time compared to that of crystalline silicon panels.



*Note: EPT depends on the level of irradiation. This data was sourced from NEDO, Japan.*



# Development of Next-Generation Modules

## Thin and durable ultra-lightweight modules slated for backend of 2019

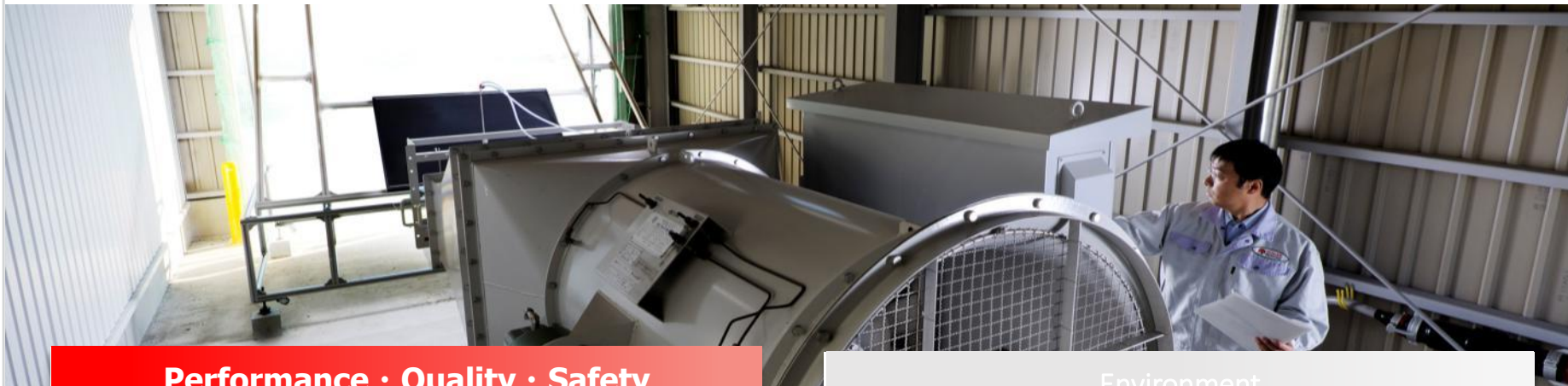


The thin new ultra-lightweight modules will achieve greater durability by having the glass typically used in the substrate replaced with an aluminum currently under development.



**Leveraging what we expect to be a success domestically, we intend to provide these modules in solution packages for the overseas market.**

# Widely Certified



## Performance · Quality · Safety



■ JET ■



■ UL ■



■ ISO9001 ■

## Environment



■ ISO14001 ■



■ L2-Tech ■

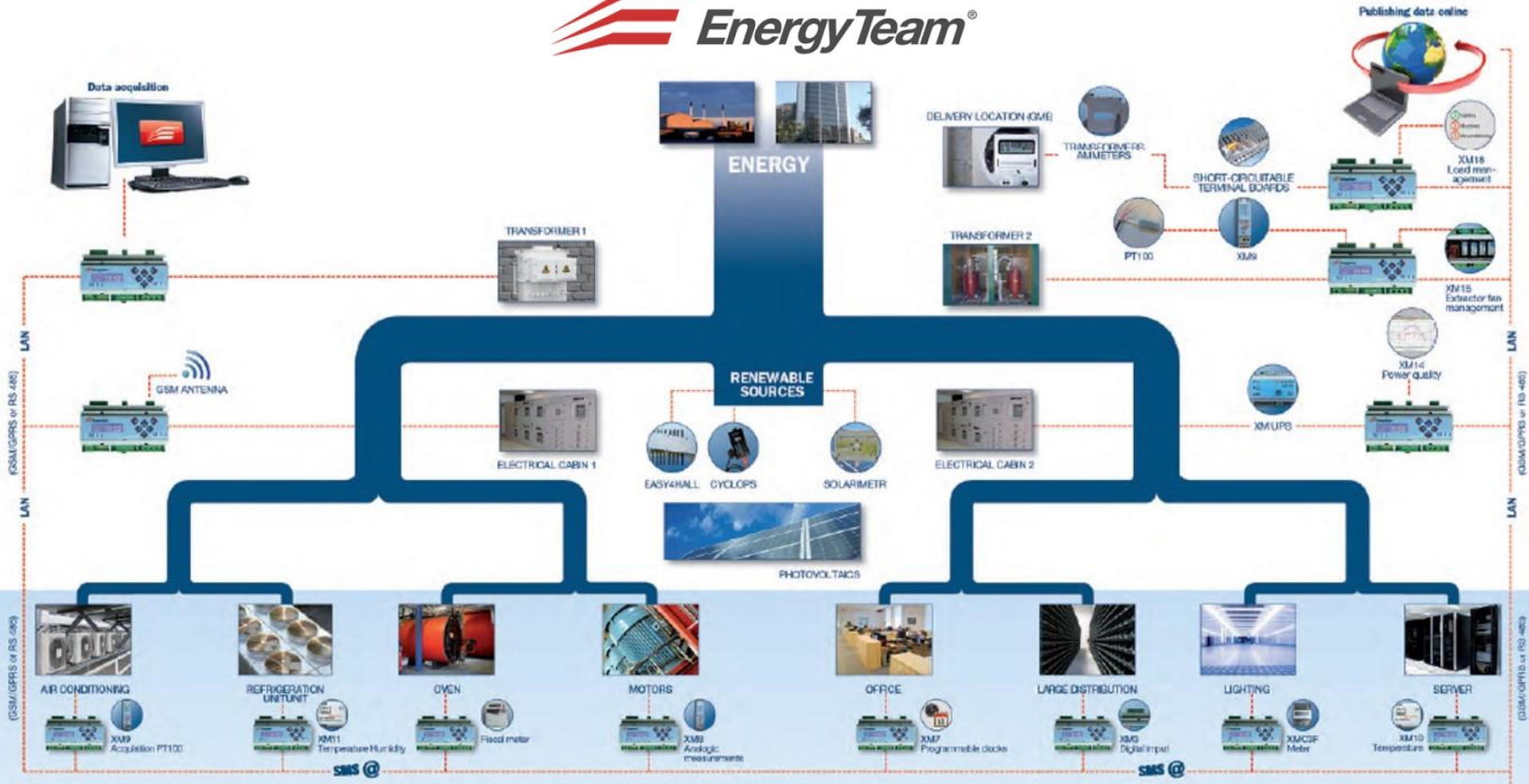


■ ISO18001 ■

※Most certificates are obtained at Kunitomi Factory



*Representing*



# Recent achievement in Energy Monitoring

## Centralized Energy Monitoring System (CEMS) Design & Implementation For the expanded new plant

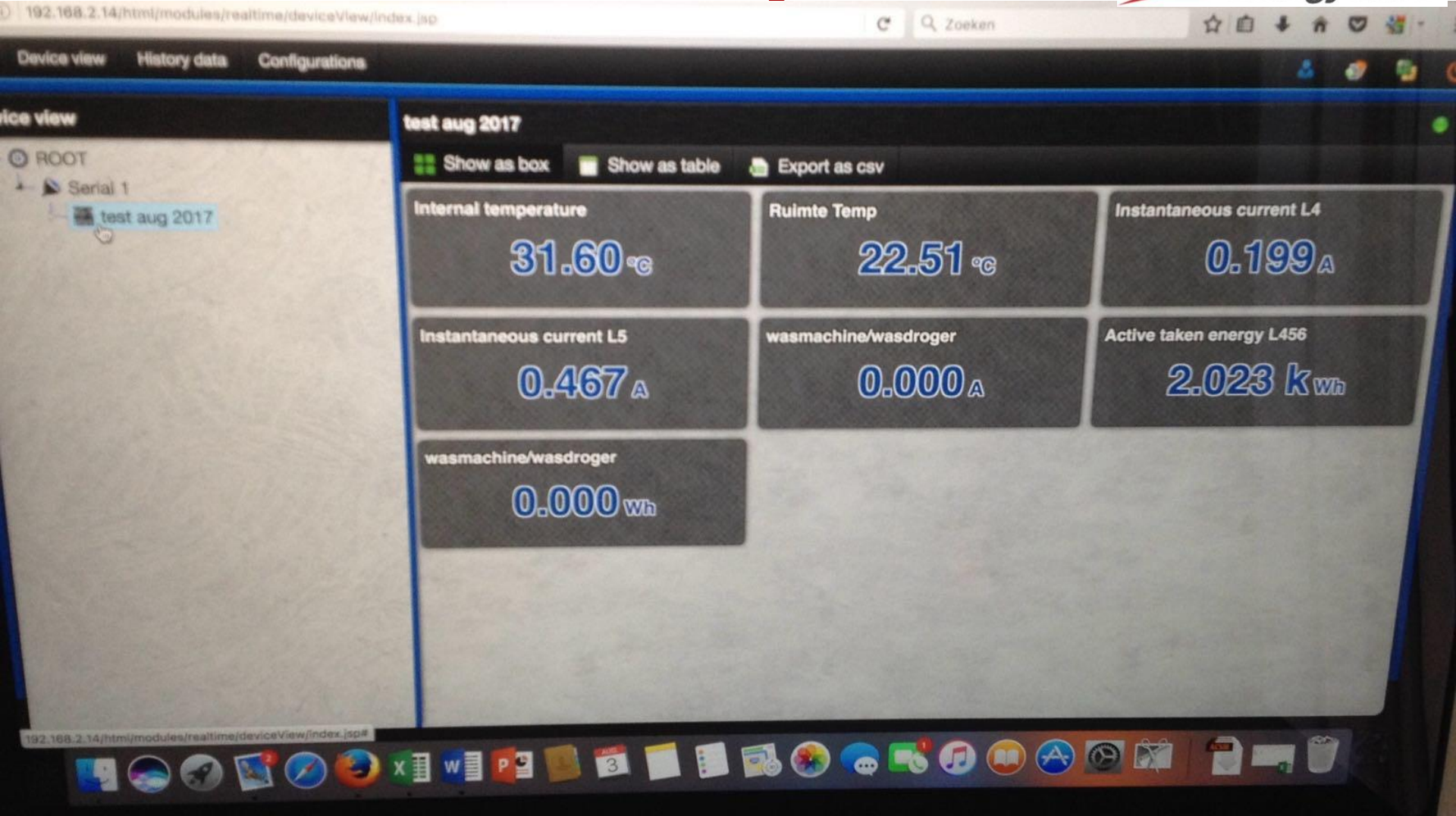


**388 measuring points**  
**Data logger & software solution**  
**Panel building, wiring, installation & commissioning**



# CEMS Superiority (1)

Let's start small and innovative for significant result





# CEMS Superiority (2)

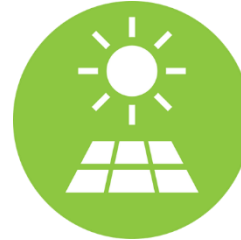


## Photovoltaics

### Irradiation and string control



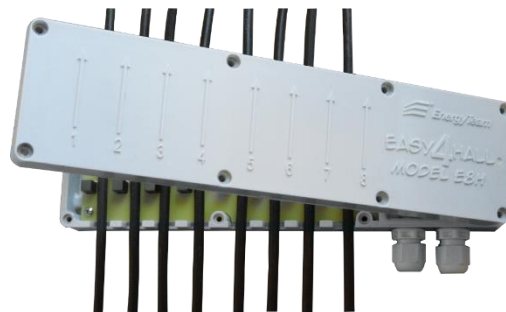
**Solar Irradiation  
and panel Temperature**



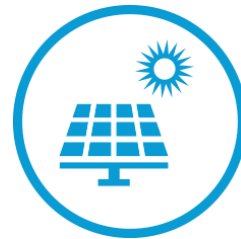
**Solar irradiation sensor  
with PT100 Temperature  
probe**



**Digital and analog outputs  
(4-20 mA) and  
RTU GSL-IT-DA Modbus.**



**Split core multichannel device for  
string current measurement in  
photovoltaic systems**



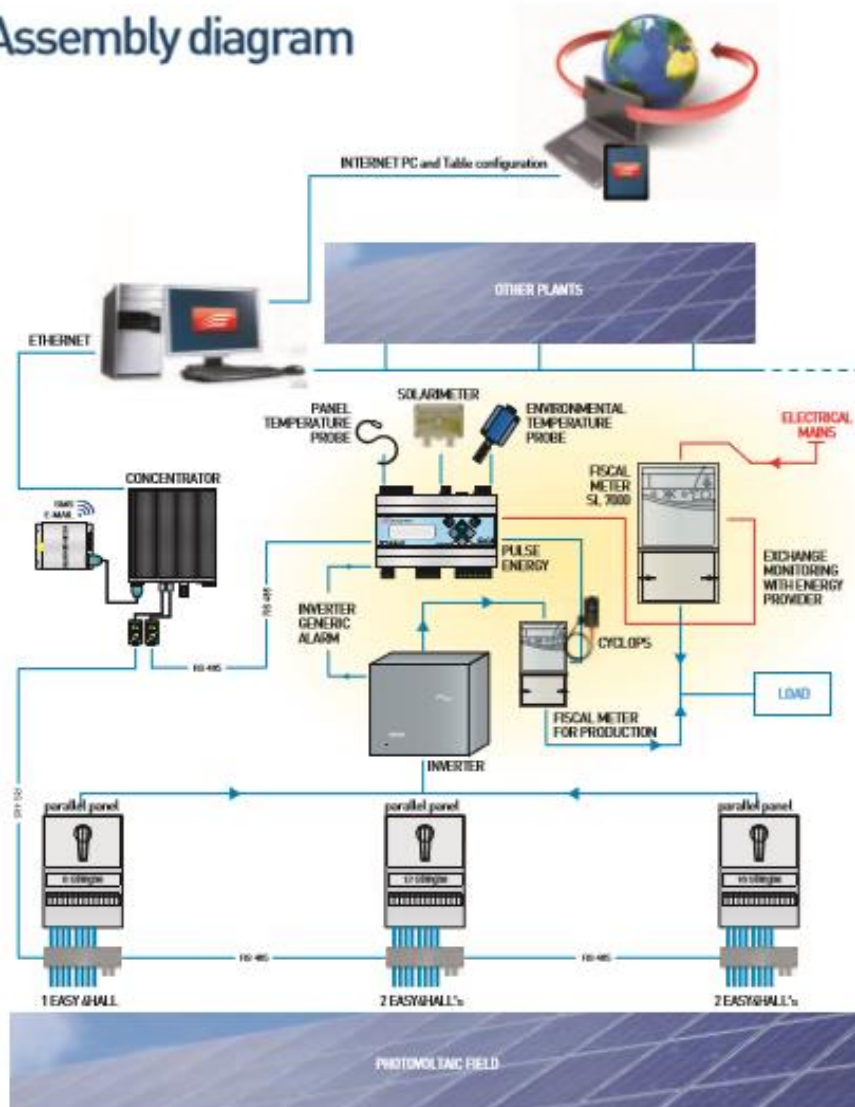
**Split core multichannel device  
for string current  
measurement in photovoltaic  
systems**



**Precise and accurate  
data readings**

# Energy Monitoring for PV (2)

## Assembly diagram





## The First CIS Thin Film Delivered in Malaysia...



**PETRONAS Research Sdn Bhd**

## The First CIS Thin Film Installed in Malaysia...



**PETRONAS Research Sdn Bhd**

Satisfied client...



**PETRONAS Research Sdn Bhd**





### EPIO by enhancing EnMS Operation

Nº	EPIO Items	% gain	Nº	EPIO Items	% gain
1	"EnMoS" operation & procedure	5.9%	2	Air leak action procedure	0.8%
1-1	Baseline and target	↑	3	Steam leak action procedure	0.2%
1-2	All workforce energy awareness		4	Waste mgmt. at product change	0.5%
1-3	Improvement procedure		5	Fine tuning cleansing efficiency	0.3%
1-4	Preventive maintenance drive		6	°C setting review in all rooms	1.3%
1-5	Communication improvement		7	Improved lubricant specifications	0.4%
1-6	Energy/production transparency		8	Aircon 1°C up with new uniform	0.8%
1-7	Quality check thru energy use		9	Air ventilation review	0.7%
1-8	Production planning enhancement		10	Top management leadership	Inc. gain
1-9	Evaluation transparency		11	EnMS training for all workforce	Inc. gain
1-10	Management review		12	Define Aircon use procedure	0.9%

### EPIO requiring NO/Low Investment

Note: "% gain" can be varied by site to site

Inc. gain: Incalculable gain





## EPIO requiring Investment

Nº	EPIO Items	% Gain	Nº	EPIO Items	% Gain
1	Boiler & steam distribution	2.5%	6	Lighting facilities	1.1%
2	Chiller/Cooling Tower	2.2%	7	Steam $\Delta P$ energy recovery	1.7%
3	Motor/Pumps renewal	2.8%	8	Steam purchasing	0.9%
4	HVAC facilities	1.3%	9	Power receiving/distribution	0.7%
5	Compressed air system	2.1%	10	Rooftop PV integrated with EnMS	2.1%

Note: "% gain" can be varied by site to site

Inc. gain: Incalculable gain



**CIS Thin Film  
(180W)**



**RM 187,600**

**HIT  
(240W)**



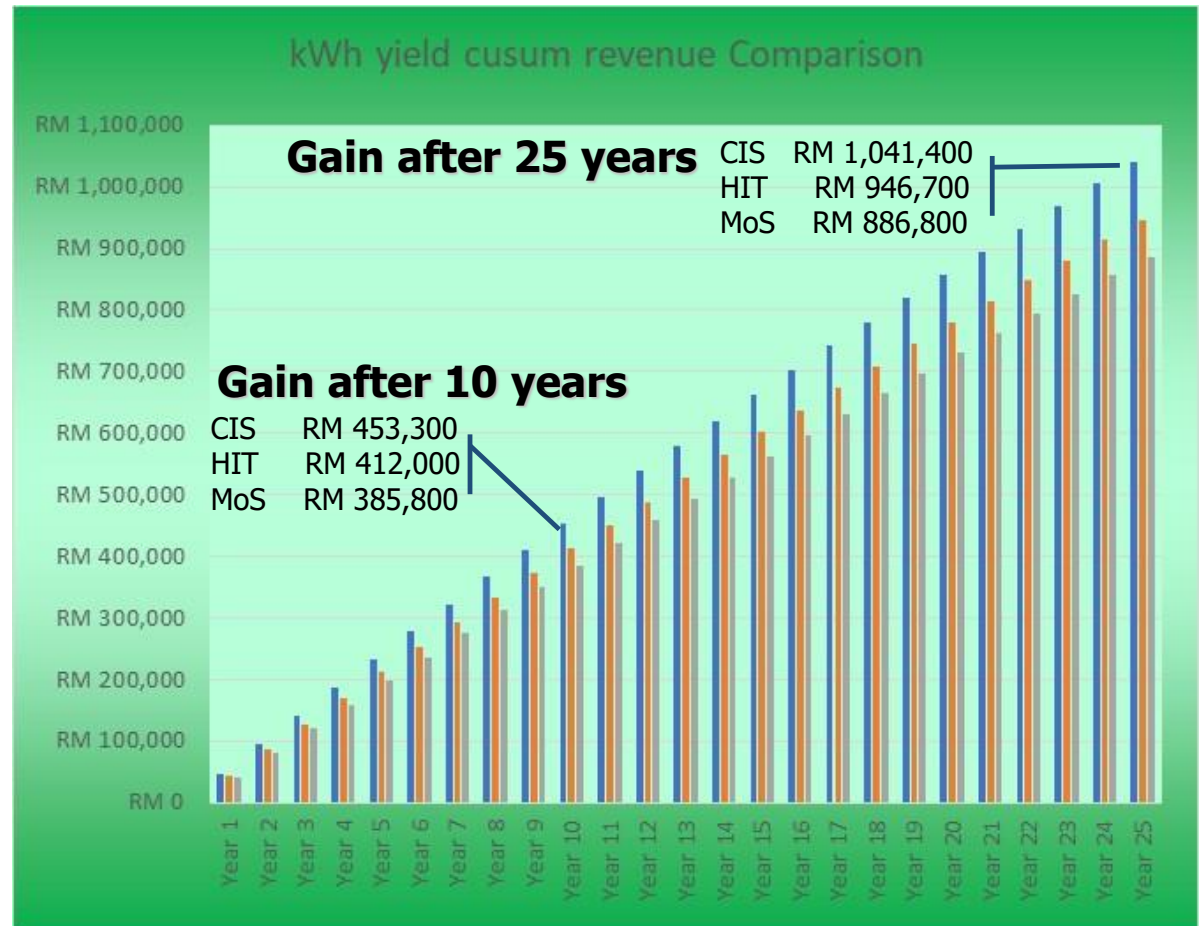
**RM 254,600**

**Monocrystalline  
silicon (220W)**



**RM 111,300**

## 75 kW in Japan



Ave temp. 16 °C, NOCT 47 °C



**CIS Thin Film  
(180W)**



**RM 187,600**

**HIT  
(240W)**



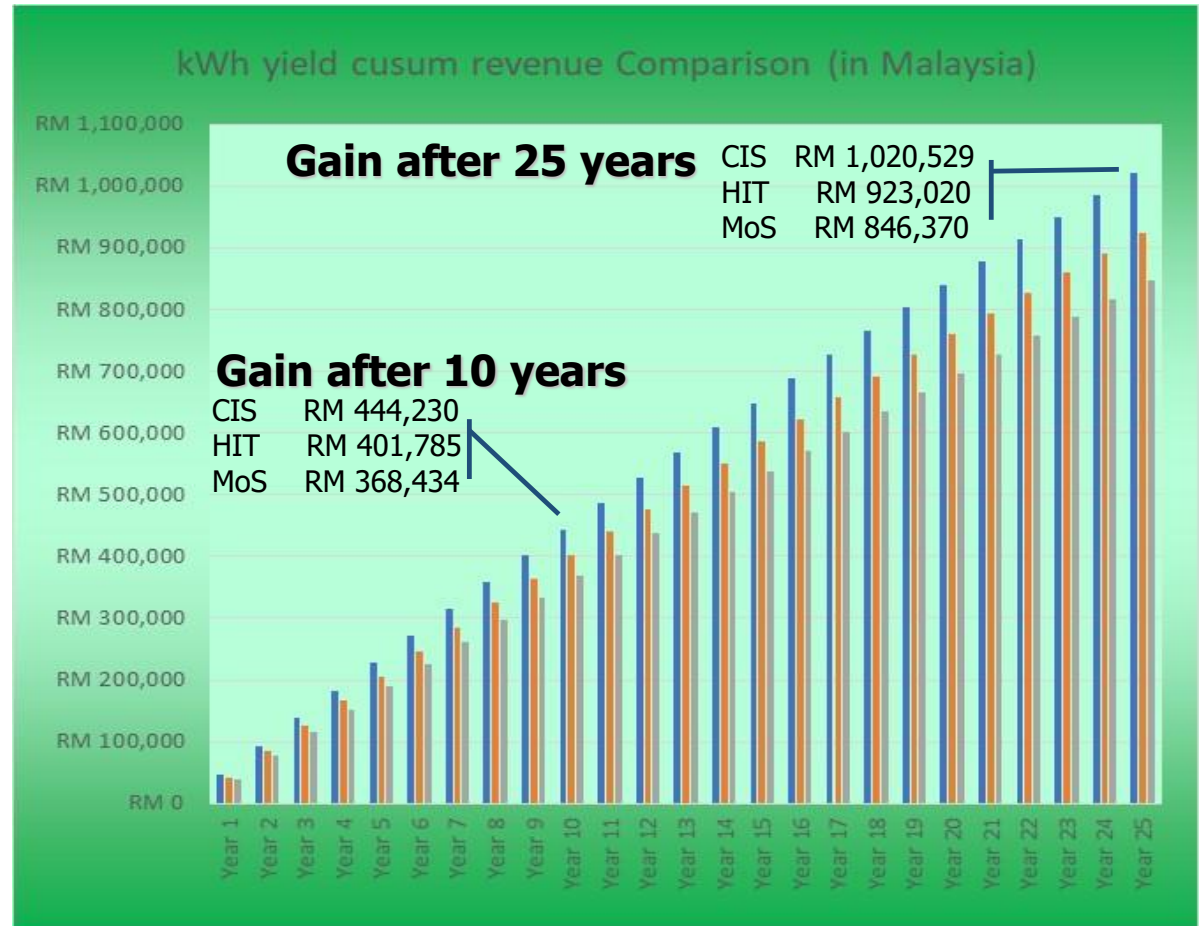
**RM 254,600**

**Monocrystalline  
silicon (220W)**



**RM 111,300**

## 75 kW in Malaysia



Ave temp. 27.5 °C, NOCT ? °C

**CIS Thin Film  
(185W)**



**¥500,000,000**

**HIT  
(240W)**



**¥760,000,000**

**Monocrystalline  
silicon (220W-370W)**



**¥370,000,000**

## 3189.6 kW in Japan

kWh yield cumsum revenue Comparison



Ave temp. 16 °C, NOCT 47 °C

	Year 1	Year 2	Year 3	Year 4	Year 5
Difference to CIS	¥10,367,246	¥20,627,614	¥30,781,103	¥40,827,713	¥50,767,444
Cumulative	¥10,367,246	¥30,994,861	¥61,775,964	¥102,603,677	¥153,371,121

**CIS Thin Film  
(180W)**



**RM 12,800,000**

**HIT  
(240W)**



**RM 19,500,000**

**Monocrystalline  
silicon (220W-370W)**



**RM 9,500,000**

## 3189.6 kW in Malaysia

kWh yield cusum revenue Comparison (in Malaysia)



Ave temp. 27.5 °C, NOCT ? °C

	Year 1	Year 2	Year 3	Year 4	Year 5
Difference to CIS	RM 258,083	RM 513,505	RM 766,267	RM 1,016,967	RM 1,269,808
Cumulative	RM 258,083	RM 771,588	RM 1,537,854	RM 2,554,821	RM 3,818,030

**3189.6 kW in Malaysia**

**CIS Thin Film  
(180W)**



**RM 12,800,000**

**Monocrystalline  
silicon (220W-370W)**



**RM 9,500,000**

Cumulative RM gain by using CIS Thin Film



	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Difference to CIS	RM 258,083	RM 513,505	RM 766,267	RM 1,016,367	RM 1,263,808	RM 1,508,587	RM 1,750,706	RM 1,990,165	RM 2,226,962	RM 2,461,099
Cumulative	RM 258,083	RM 771,588	RM 1,537,854	RM 2,554,221	RM 3,818,030	RM 5,326,617	RM 7,077,323	RM 9,067,488	RM 11,294,450	RM 13,755,550



**Our mission is:  
Protecting Investor's Assets**

**“Asset” means:**

**kWh yield**

**Protecting “asset” means:**

**Ensure the asset items are performing  
to the best of ability**

**Highest kWh yield**

**Asset Performance Management**

Site oriented

## Our mission

### **Asset Performance Management (APM)**

**Having positive discussion on “optimum performance” with the site operation members for existing operating facilities, and**

**Plan and Do improvement or best practice sustainability**

**EMV, the positive result in performance**

## **Asset Performance Management**

**efficient use**



**Highest productivity** (kWh Yield Optimization)

**&**

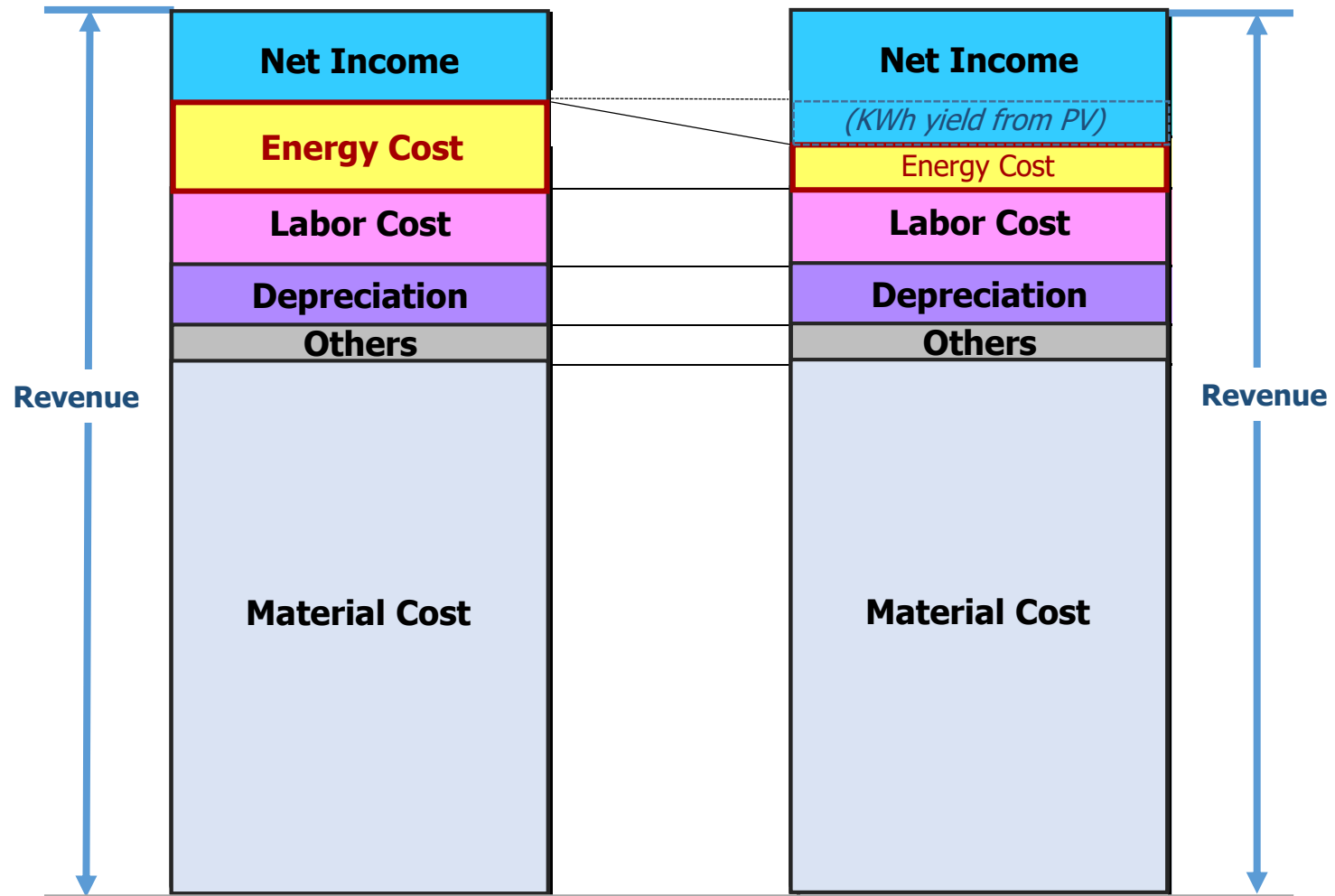
**Highest quality product**



**Sustainable business development**

**Energy is a business matter**

## Business Impact with Energy Management

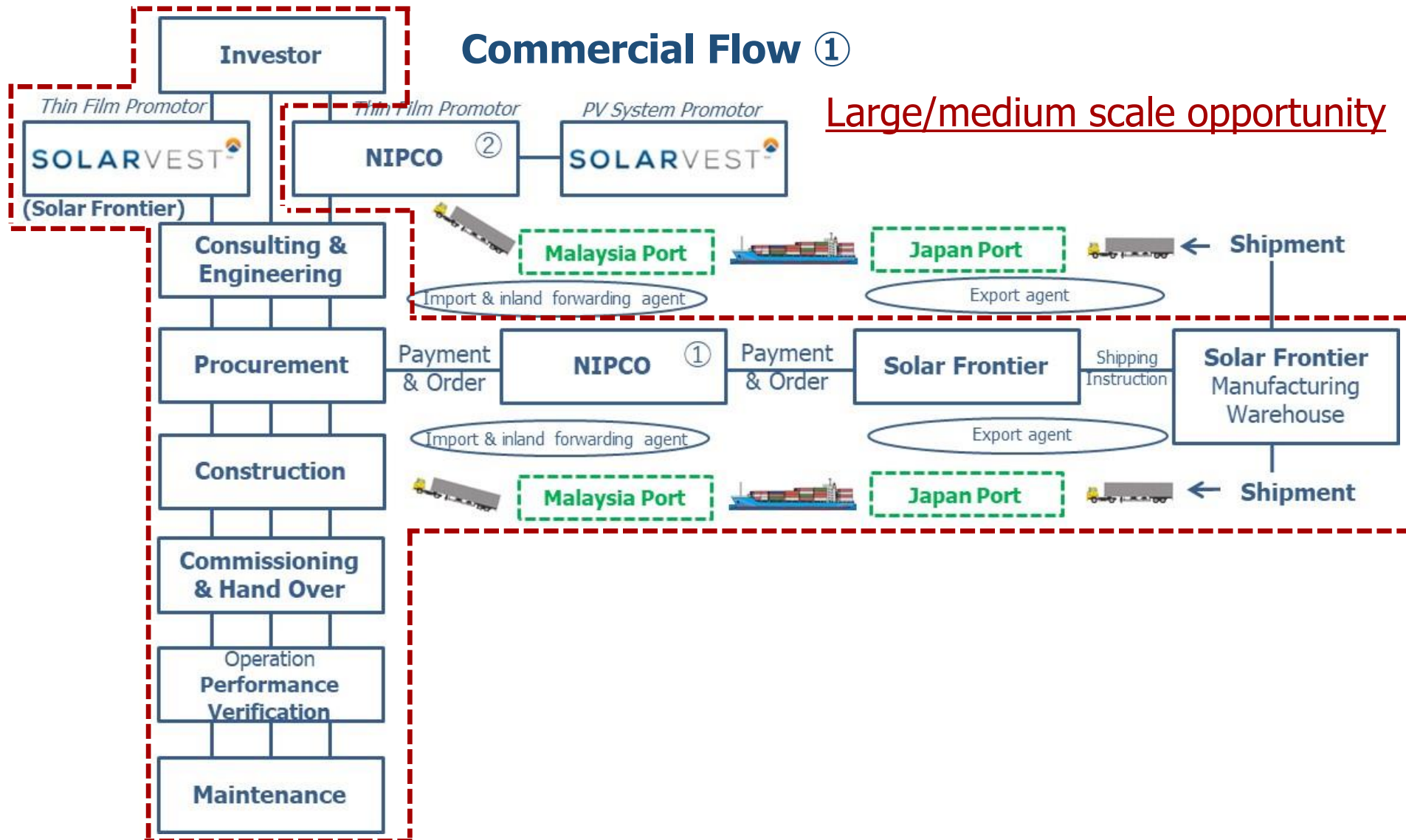




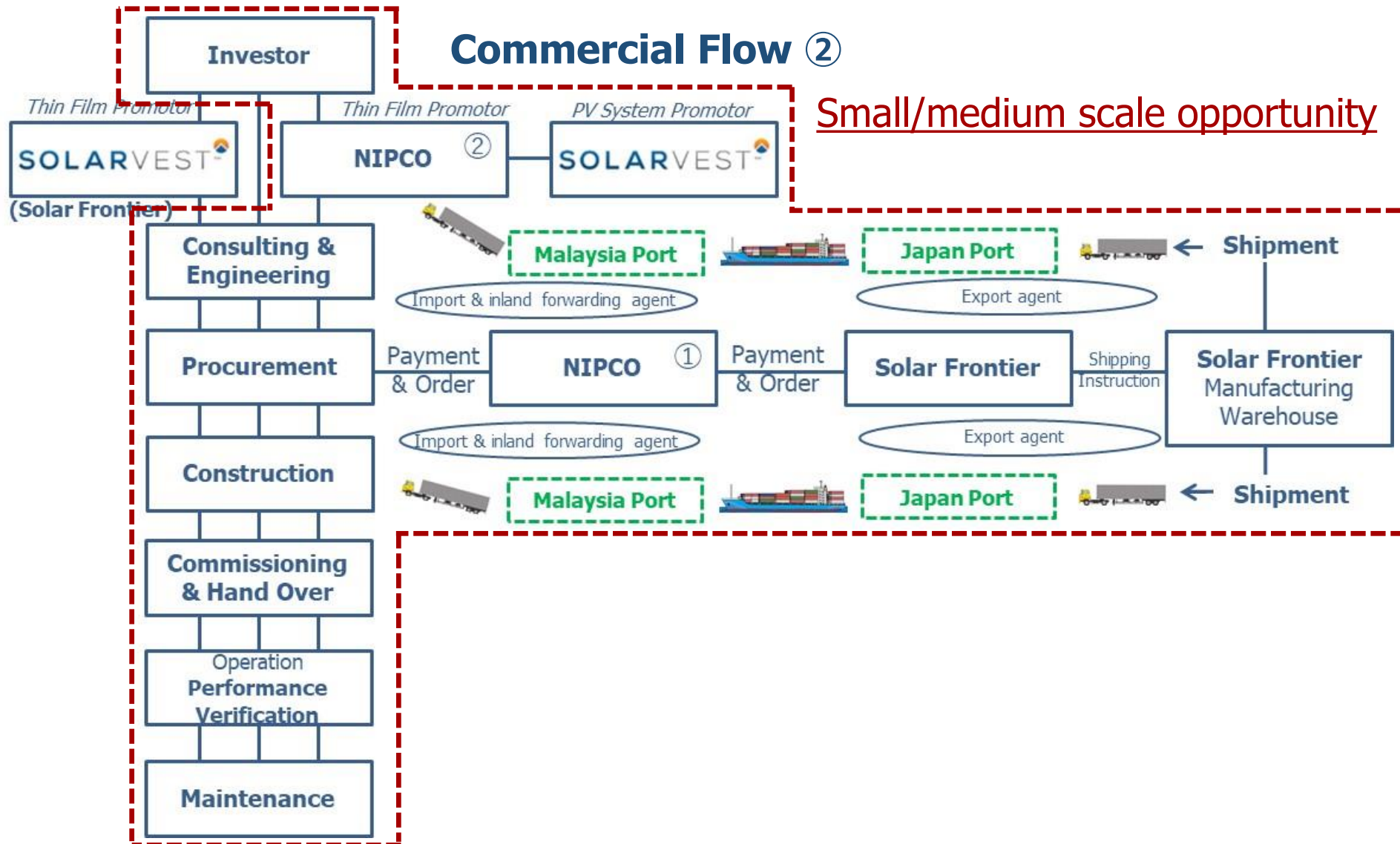
# CIS Thin Film Solar Module Promotion (1)

## Commercial Flow ①

Large/medium scale opportunity

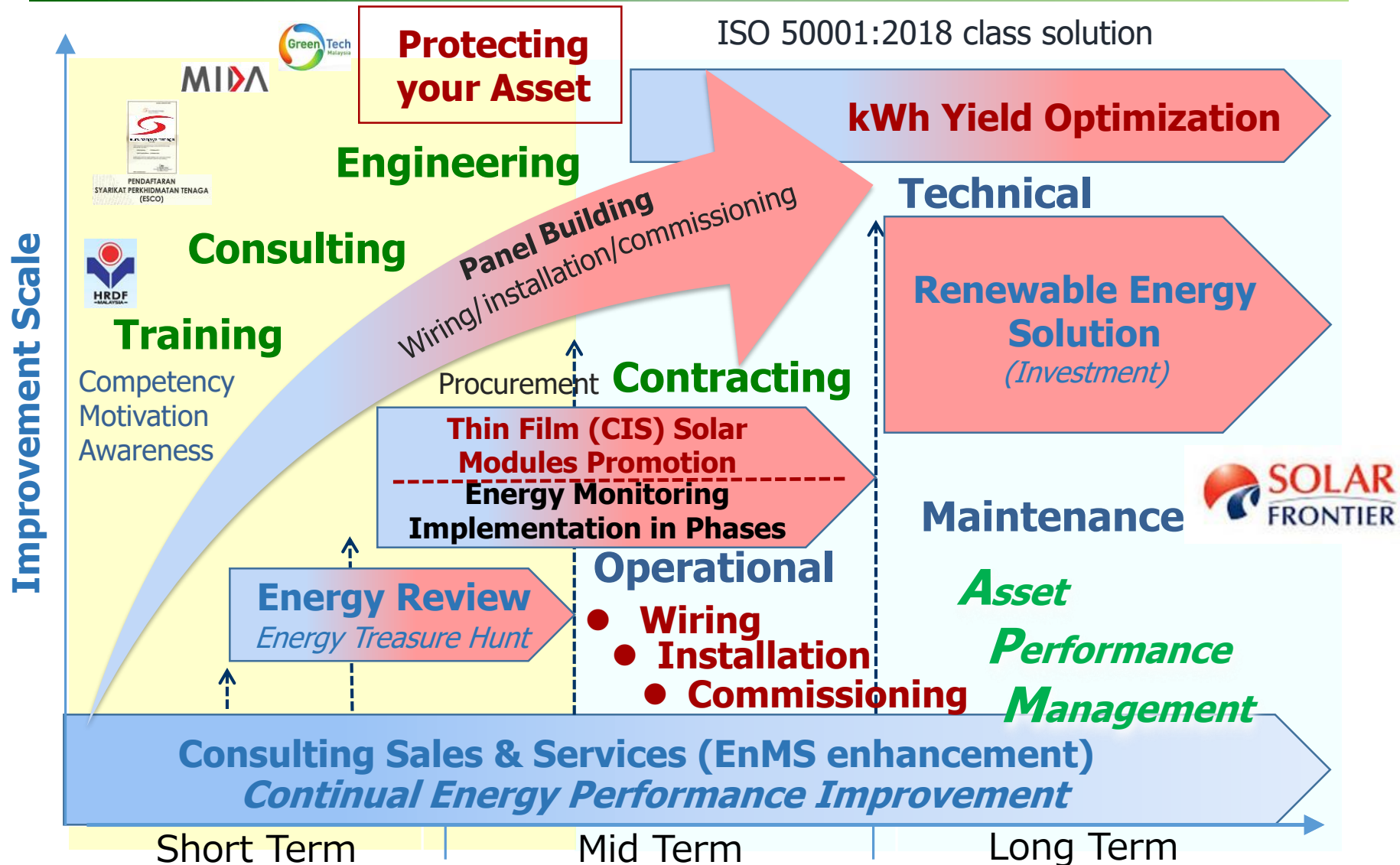


# CIS Thin Film Solar Module Promotion (2)





# Sustainable Business Development Partner



**Would like to become sustainable partner with you ...**



**Thank you so much for your continuing collaboration**

Note: Nipco does not intend to warrant any data in this presentation document



# Reference sites

# Kumamoto Technical Center (Sony Semiconductor Manufacturing Corporation)

Kumamoto Technology Center (Kumamoto TEC)  
(Sony Semiconductor Manufacturing Corporation)

CMOS Image Sensors, Displays

Development of Motion Picture Devices &  
Manufacturing

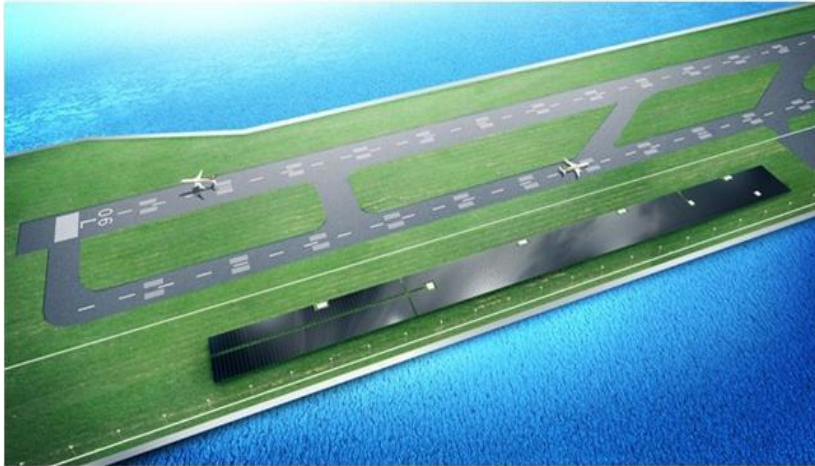


Established	1 <sup>st</sup> October, 2001
Location	4000-1, Haramizu, Kikuyou-machi, Kikuchi-gun, Kumamoto, Kumamoto, 869-1102 Japan
Representative	Keigo Yukihide, Executive Director & Head of Kumamoto TEC
Main product Line	CMO CMOS/CCD Image Sensors for Audio Visual and Monitors, CMOS Image Sensors for Automotive purpose Micro-displays (LCD/OLED)
Area of the Location	Land area: 266,000m <sup>2</sup> Floor Area: 198,000m <sup>2</sup>

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# CIS Thin Film Solar modules



Kansai International Airport  
11.6 MW



Solar Frontier's solar panels installed on the roof of a Shell Service Station in Thailand



AEON Shopping Mall, Yamato, Kanagawa  
30.6 KW



We represents CIS Thin film solar panel from Japan





# Residential Rooftop PV Systems

**Kumamoto**  
Japan

**7.4 kWp**



**Mehring**  
Germany

**8.4 kWp**



**Newcastle**  
Australia

**9.2 kWp**



**Windhoek**  
Namibia

**9.2 kWp**



**Backnang**  
Germany

**9.6 kWp**



**Hawaii**  
U.S.A.

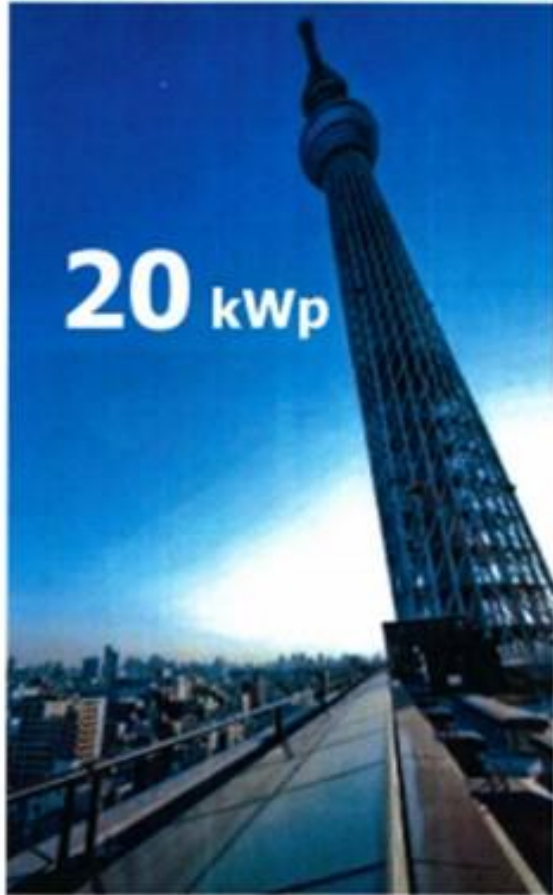
**16.7 kWp**





# Commercial Rooftop PV Systems

Tokyo Sky Tree<sup>®</sup>, Japan



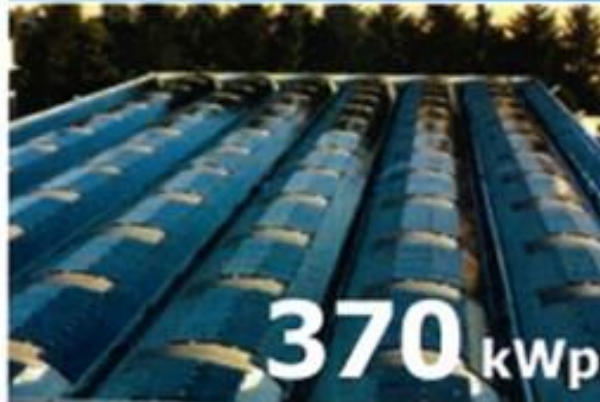
Lelystad, Netherlands



Tokyo, Japan



Burago di Molgora, Italy



Hamburg, Germany



# Ground-Mount PV Systems

Canlubang, Philippines



Farasan Island, Saudi Arabia



Phetchabun, Thailand



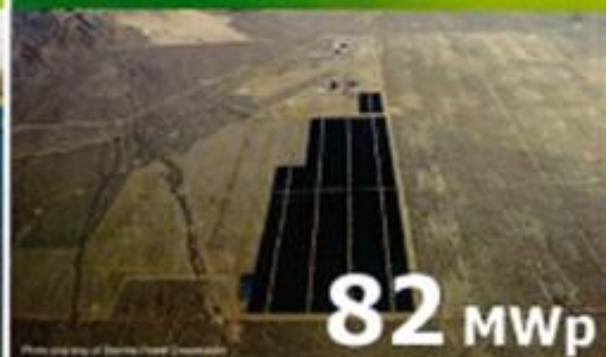
Kansai Airport, Japan



Bochow, Germany



California, U.S.A.





# Solar For Relief Efforts

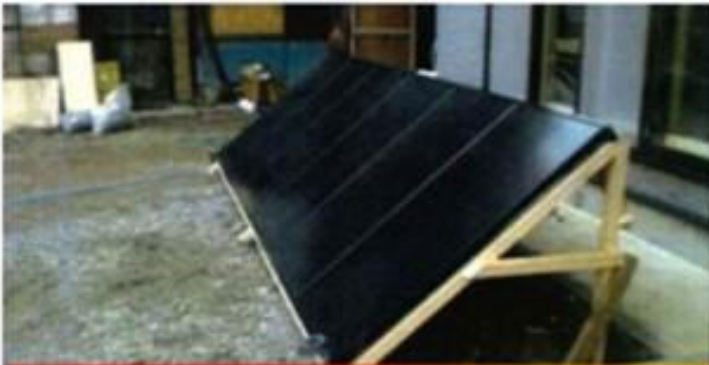
**Service Stations**



**Kindergartens and Nurseries**



**Refugee Centers**



**Street Lighting**

