

ADB's Rooftop Solar Project

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1. Project Summary





ASIAN DEVELOPMENT BANK HEADQUARTERS

Mandaluyong, Philippines

HAS SUCCESSFULLY ACHIEVED THE FOLLOWING LEVEL OF CERTIFICATION ESTABLISHED BY THE U.S. GREEN BUILDING COUNCIL
IN THE LEED GREEN BUILDING RATING SYSTEM™ AND VERIFIED BY THE GREEN BUILDING CERTIFICATION INSTITUTE.

LEED FOR EXISTING BUILDINGS: OPERATIONS AND MAINTENANCE

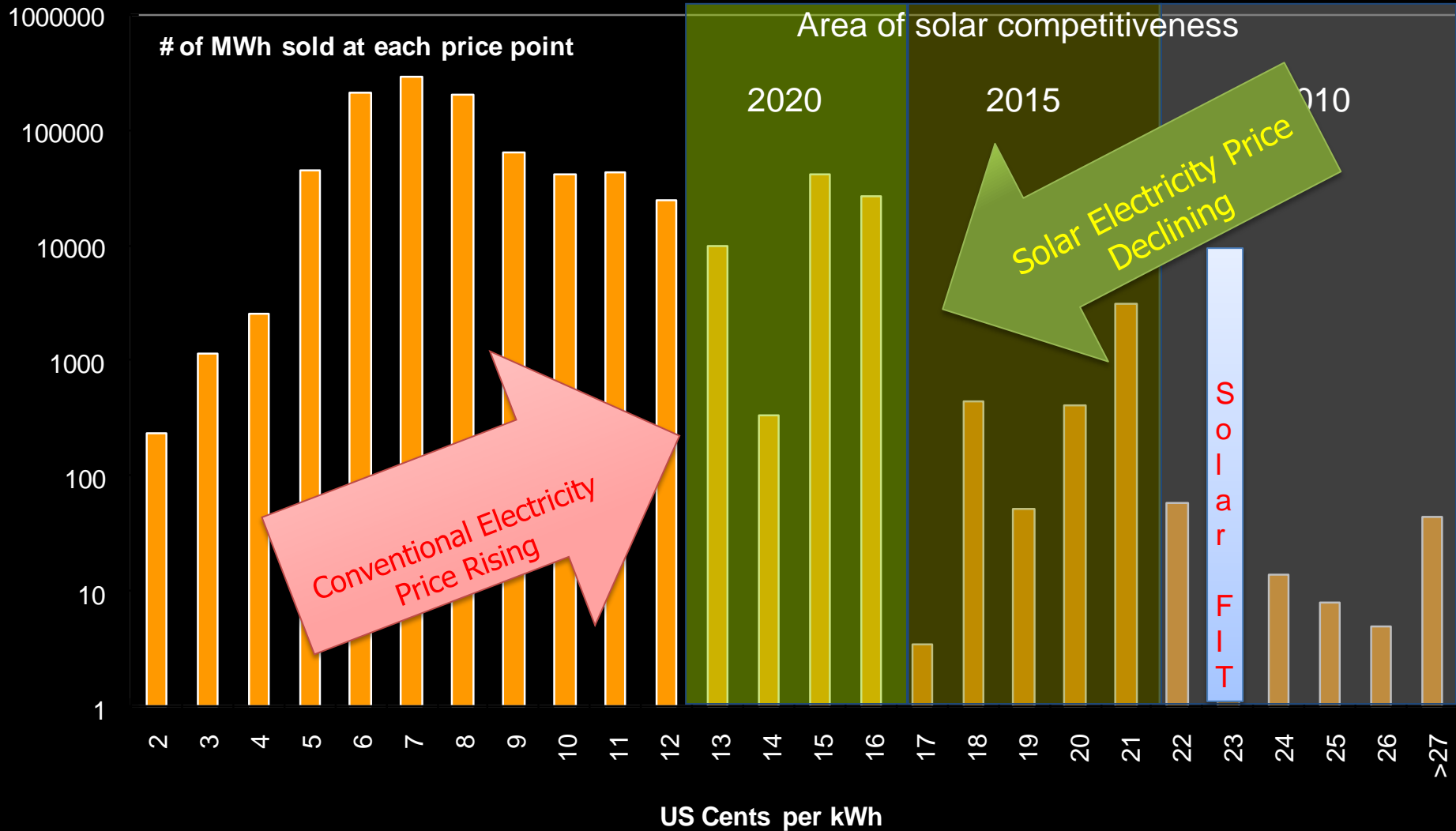
GOLD

S. RICHARD FEDRIZZI, PRESIDENT & CEO
U.S. GREEN BUILDING COUNCIL

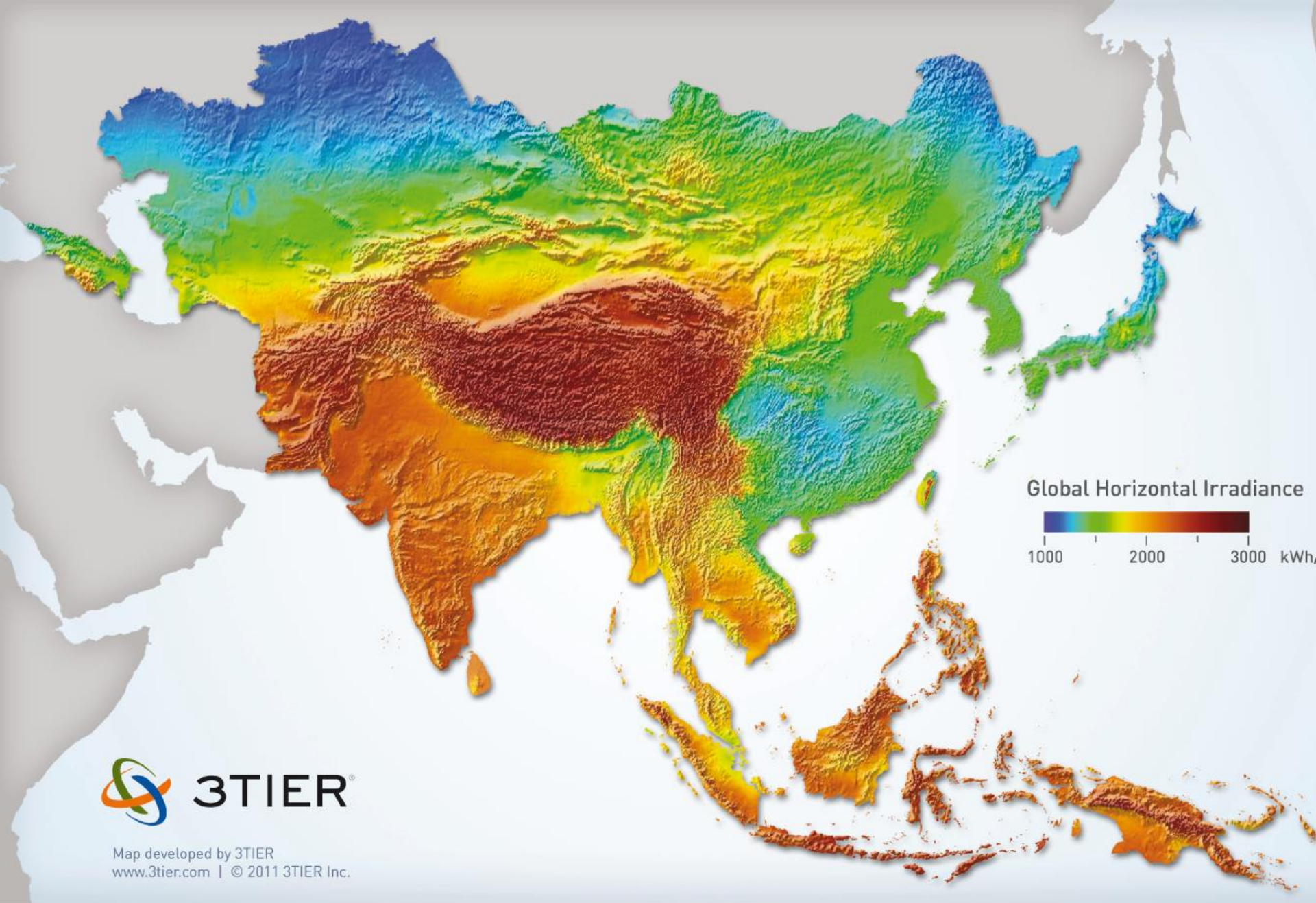
June 2011

PETER TEMPLETON, PRESIDENT
GREEN BUILDING CERTIFICATION INSTITUTE

Why Solar Energy



Source: Jigar Shah, 2011



Global Horizontal Irradiance



Map developed by 3TIER
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kWh/m²/year = kilowatt-hour per square meter per year.
Source: 3TIER Inc. 2011. www.3tier.com. (Reproduced with permission).

Approaches for Solar Project Financing

Bankable Solar Projects

Fiancing



- PPA
- System Lease
- Contractual Intermediary
- Utility Owned
- User Owned
- Others

ADB 571 kW-DC Rooftop Solar Project

1. Towards LEED Platinum

2. Technology Demonstration

3. Business Model, build-operate-transfer with PPA

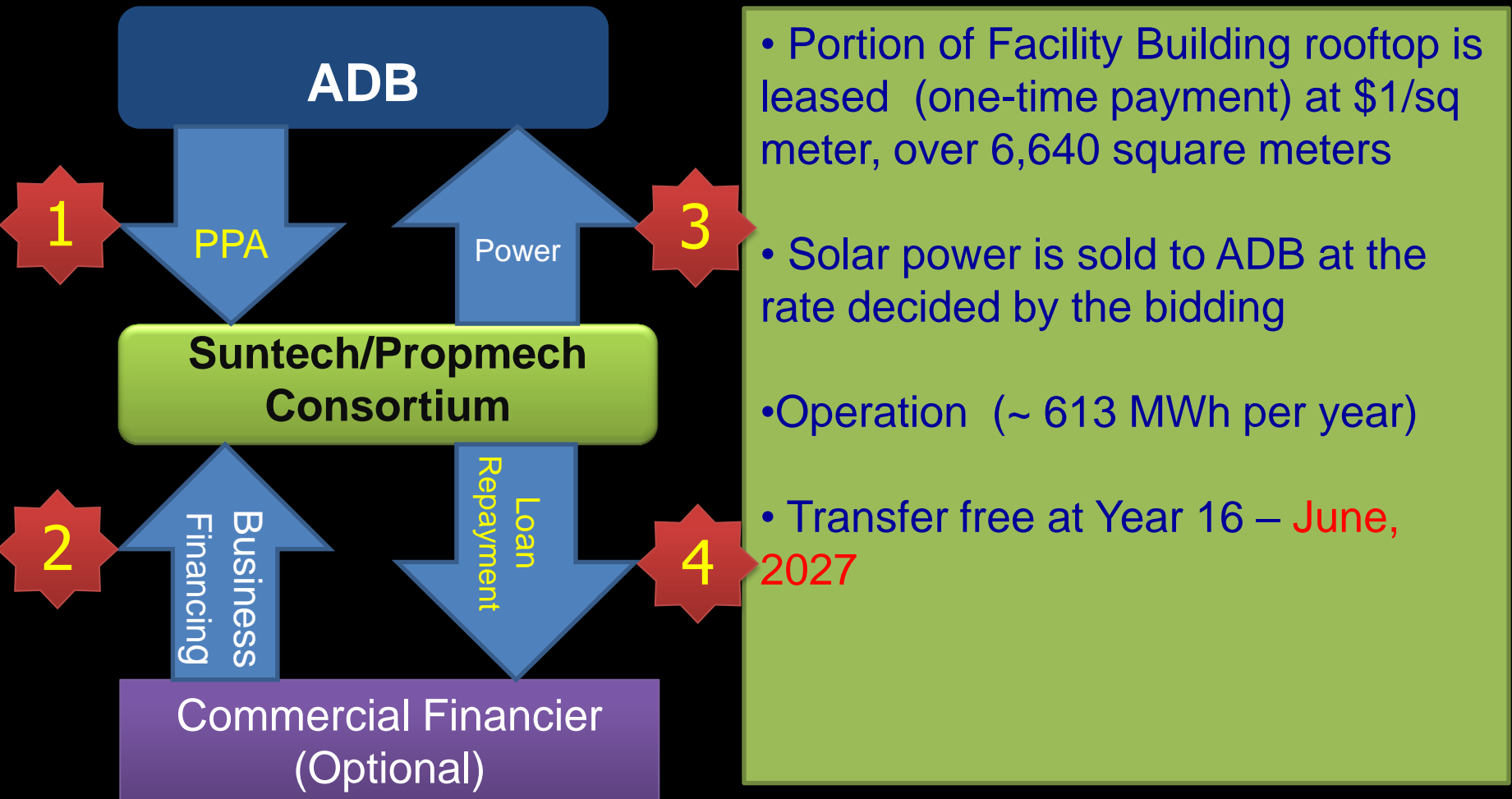
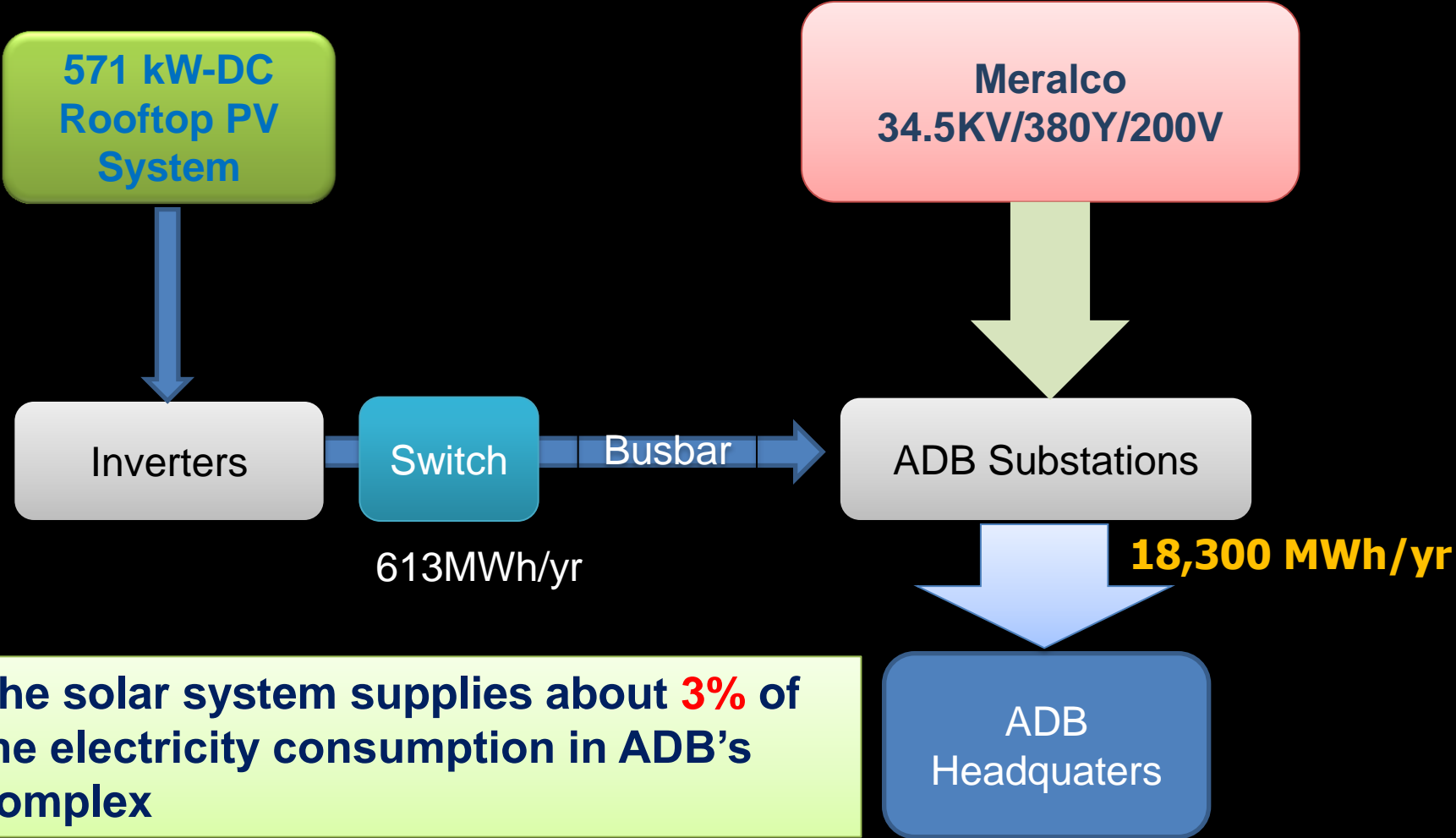


Diagram of ADB Rooftop Solar System



Before



After



Photo Credit: OAS, ADB

Highlights

- **No upfront cost to ADB**

The business model uses a PPA between the Suntech/Propmech Consortium (Project Implementer) and ADB (End User), whereby the project implementers bear the investment cost and O&M costs and user purchase the electricity at bid price.

- **ADB's credit worthiness helps the consortium secure non-recourse loan financing**

PPA will help the project implementers to secure financing from local commercial financiers. With a 15-year PPA from ADB, this project becomes a bankable project

- **Challenges to replication**

Challenges could arise in countries that have regulated and partially deregulated electricity markets. This model needs permission for third party-owned systems to sell power to end users

**2. Performance Review
on
ADB's Solar PV System**

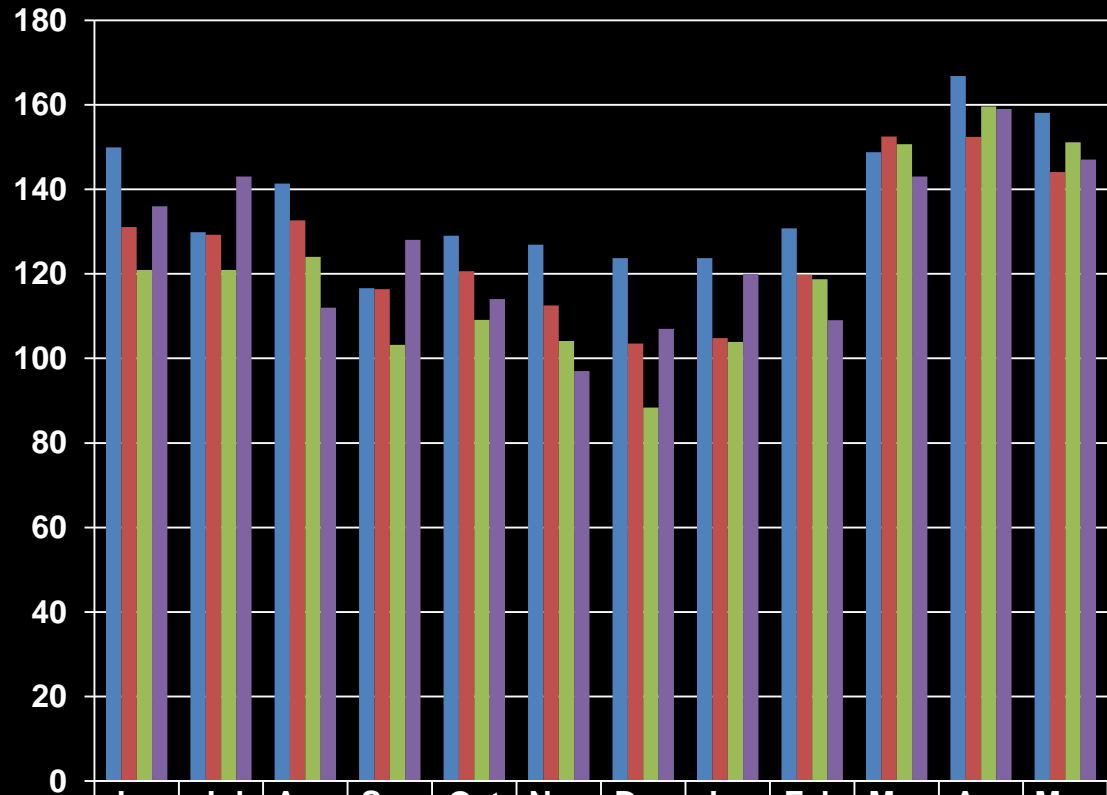
Key Performance Indicators

- Net AC Electricity Production
- AC Electricity Generation Effectiveness (ACEGE)
- Performance Ratio
- Derate Factor

Net AC Electricity Production

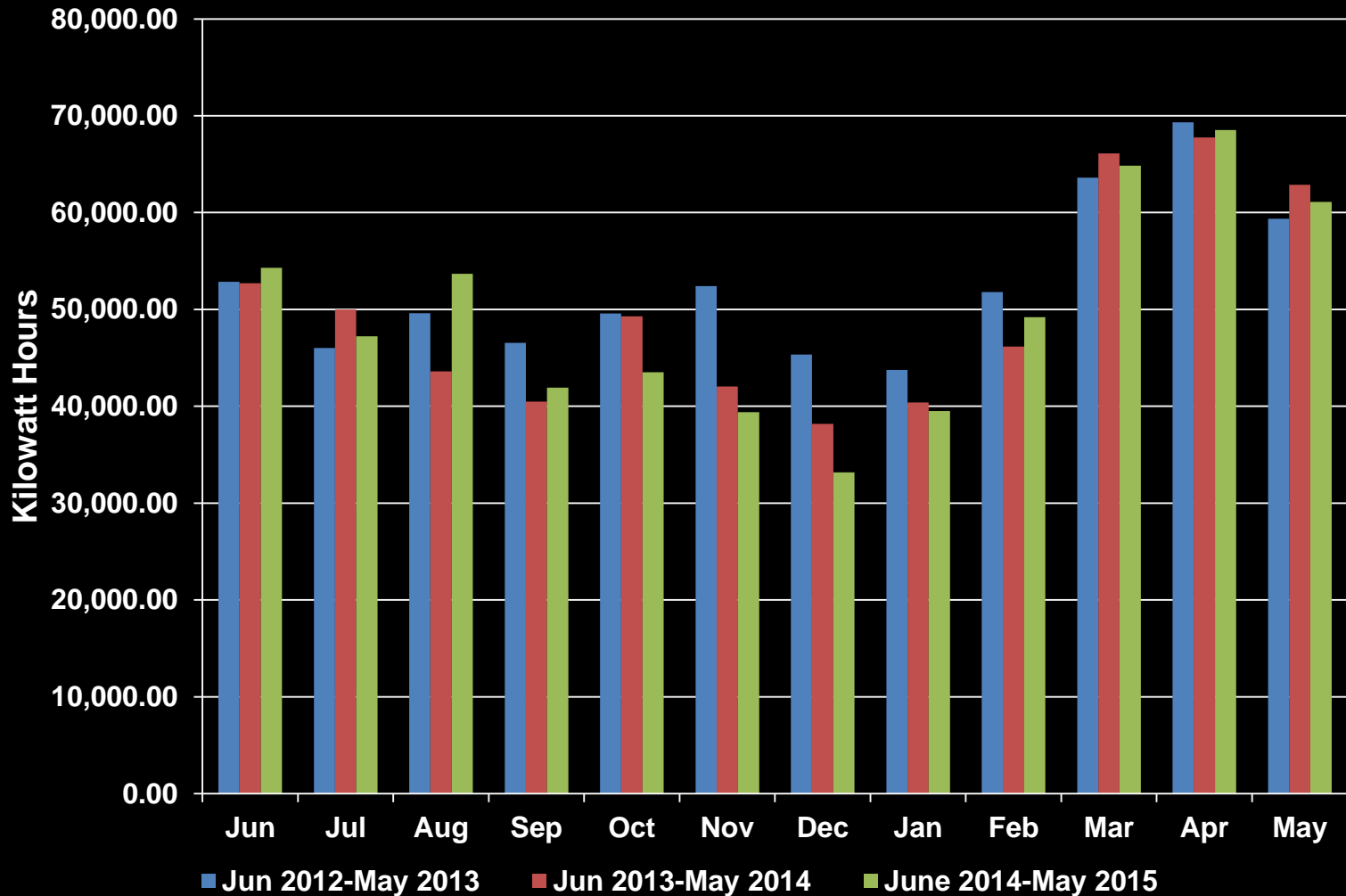
- Indicates the overall performance of the system
- Is the net electricity produced by the PV system as measured by a net meter
- measured daily, monthly, and annually, it is the basis for periodic billing
- depends mainly on irradiance, and energy conversion efficiency of the solar arrays, inverters, and associated components.

Solar Radiation (kWh/m²/month)



	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
■ Jun 2012-May 2013	150	130	141	117	129	127	124	124	131	149	167	158
■ Jun 2013-May 2014	131	129	133	116	121	113	104	105	120	153	152	144
■ June 2014-May 2015	121	121	124	103	109	104	88	104	119	151	160	151
■ Meteorologic data used in design (June 2007-May 2008)	136	143	112	128	114	97	107	120	109	143	159	147

Net AC Electricity Production-ADB Solar PV system

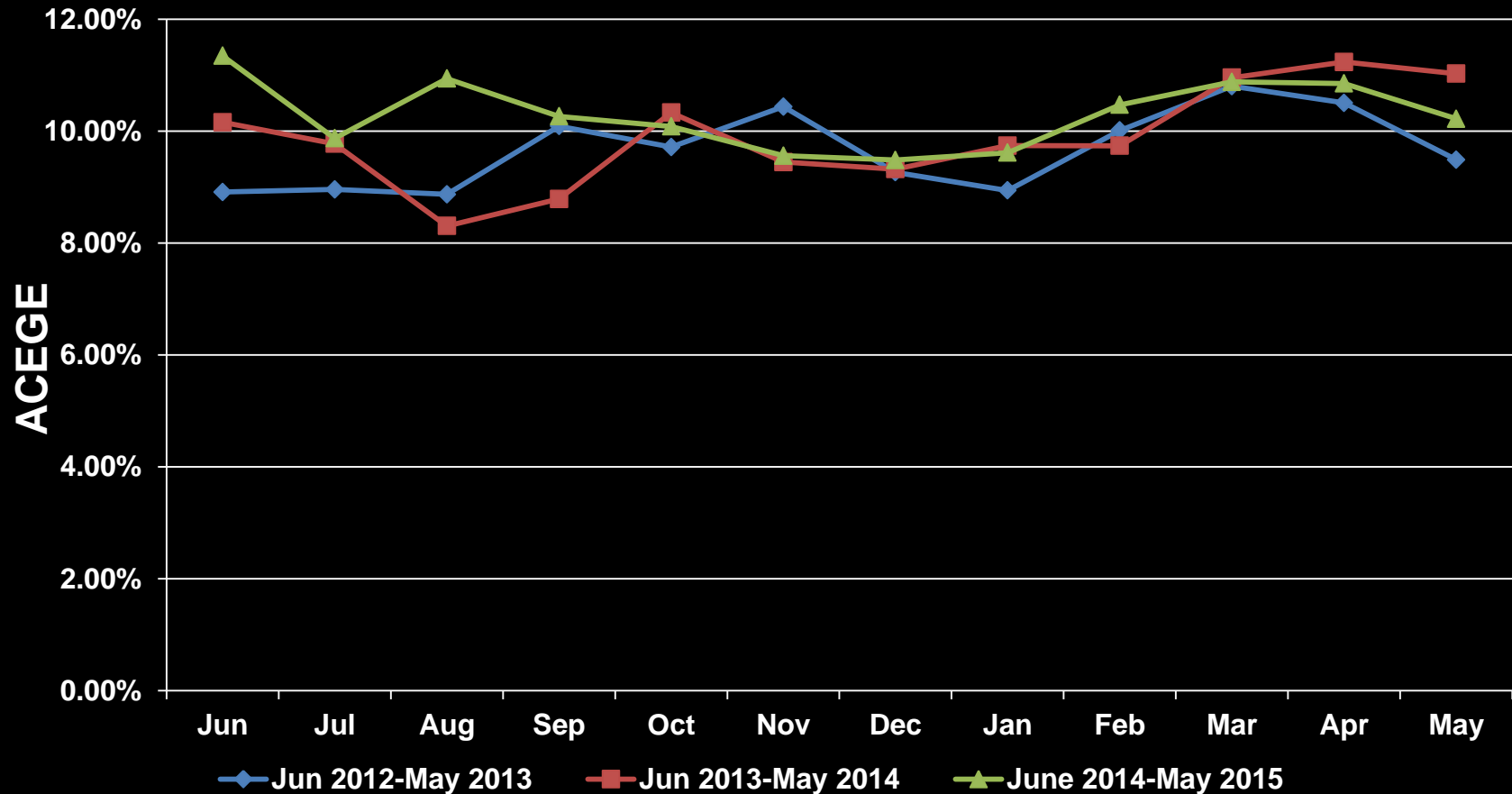


The net AC electricity production of ADB solar PV system meets the minimum required under the power purchase agreement

AC Electricity Generation Effectiveness (ACEGE)

ACEGE is defined as the ratio of the net PV system production to the total incident solar radiation or the total sun energy that falls into the solar panel. It is a measure of the effectiveness of the PV system in converting incident solar resources into AC electricity. A 7% AC generation effectiveness means that only 7% of solar energy falling into the panel is converted into AC electricity.

ADB Rooftop Solar PV System ACEGE



ACEGE values for the ADB's Solar PV System did not have significant variations in the 3-year operations.

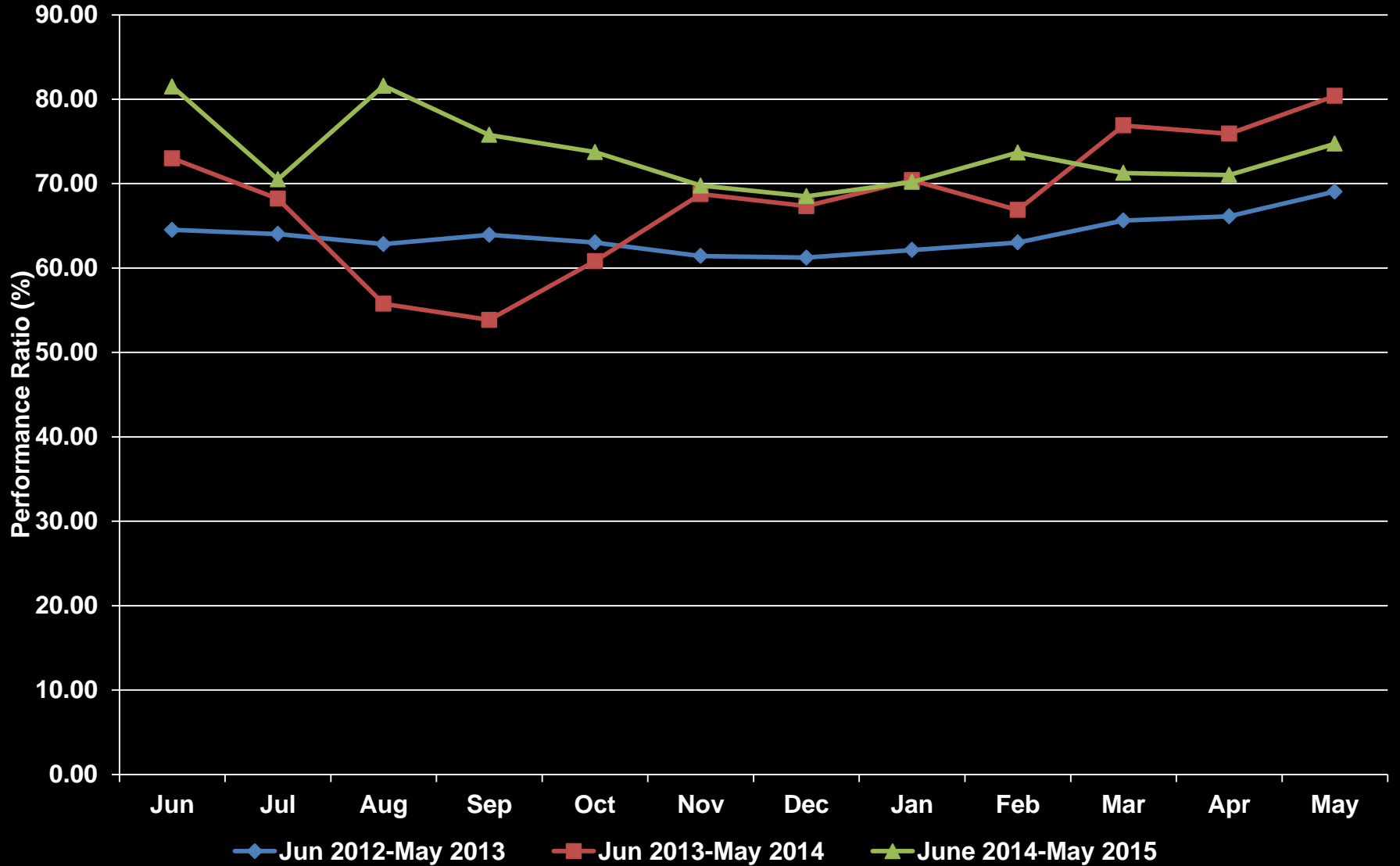
Performance Ratio (PR)

- PR indicates how well the system performs compared to an ideal system at standard test conditions (STC) that has no losses in the balance of system
- PR is also a diagnostic indicator; PR values greater than 80% are considered high, 60%-80% are considered normal, less than 60% indicates the possibility of problems that will require corrective actions

Performance Ratio-ADB's Solar PV System

- Monthly PR values ranged from 53.85% in September 2013 to 81.59% in August 2014
- PR values dipped below the critical 60% only in Aug & Sept 2013
- Average monthly PR value from June 2012 to May 2015 (3 years) was 68.54%
- **Average PR value falls within the normal limits (60%-80%)**

Performance Ratio of ADB's Solar PV System



Derate Factor

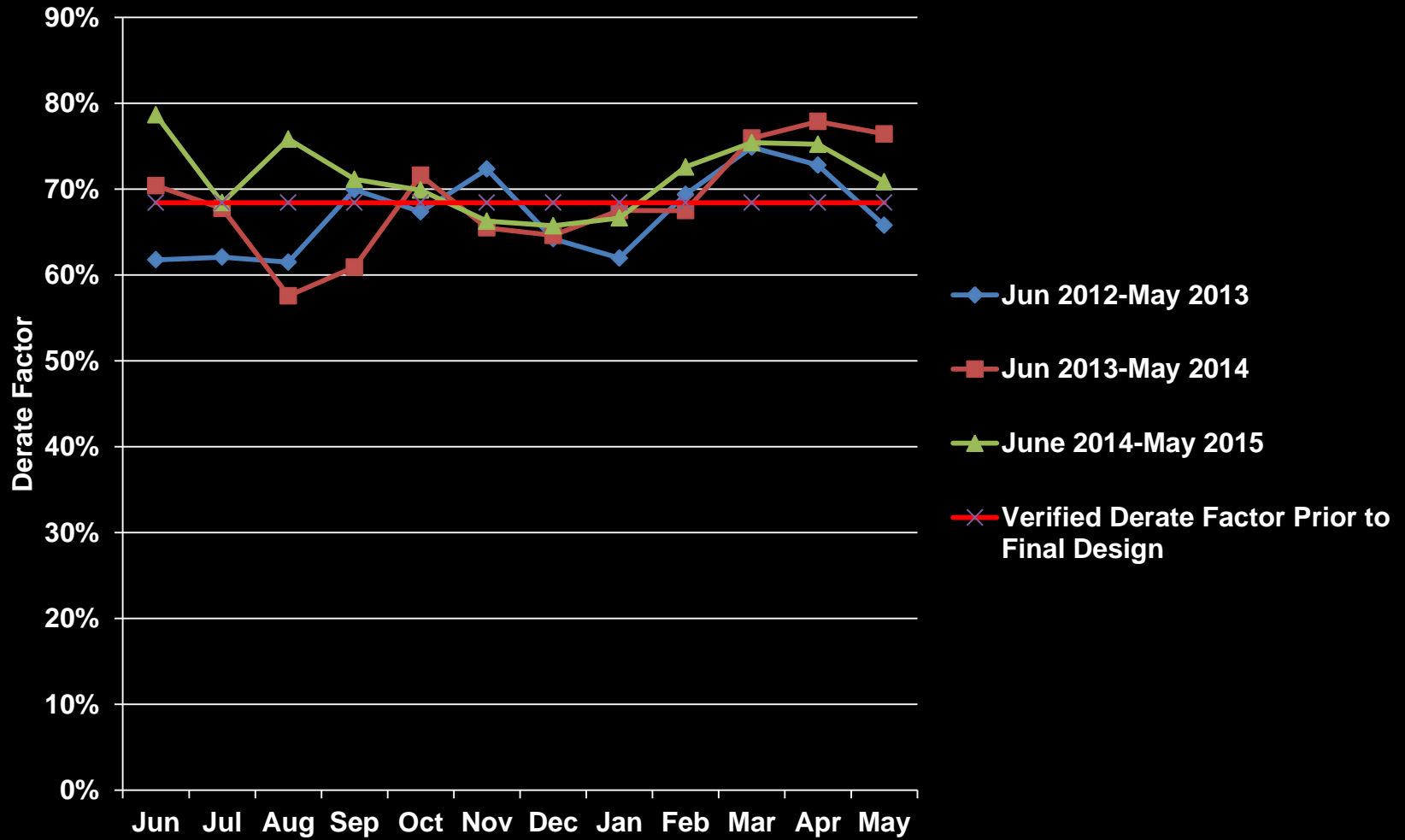
- Derate Factor represents the estimated efficiency of a component of, or environmental effect on a solar PV system.
- Derate Factor represents the percentage of remaining power or energy after all inevitable losses have been deducted.
- Optimal derate factor is 1 or 100%; a value less than 100% means reduced system power output. If power loss through a component is 2%, derate factor for that component is 98%.

Derate Factor

Inevitable losses covered by the derate factor are caused by:

- shading from any sunlight obstruction such as nearby building or trees
- dirt or materials that fell on the modules which block the sunlight
- performance mismatch among modules
- resistance of system's wiring
- sunlight reflection
- operating temperature higher than standard test temperature
- inverter losses

Derate Factor



Derate Factor of ADB's Solar PV System

- Monthly derate factors varied from 58% in Aug 2013 to 79% in June 2014
- Average derate factor over the 3-year period is 69%
- Predicted derate factor at design stage is 68.4%
- Average derate factor is just a little over the predicted derate factor at design stage

Performance Indicator at a Glance

ADB's Solar PV System

Performance Indicators	Year 1	Year 2	Year 3
Average kWh Production	630,227	599,599	596,395
Average ACGE (%)	9.66	9.9	10.3
Average Irradiance (kWh/m ² /day)	4.55	4.17	4
Average Performance Ratio (%)	63.92	68.18	73.52
Average Derate Factor (%)	66.98	68.62	71.37
Average PV Module Temperature (°C)	48.58	58.64	48.68
Average Inverter Efficiency (%)	97.10	97.00	96.94

Conclusions

- The operation of the ADB's Solar PV System during the last two years was more efficient than the first year's. The average values of efficiency measures considered – ACEGE, performance ratio, derate factor – indicated upward trend from year 1 to year 3.
- Despite improving efficiency, the output on year 3 is the lowest; this is likely because of (i) decrease in average irradiance from 4.55 kWh/m²/day in year 1 to 4 kWh/m²/day in year 3 (ii) decrease in average inverter efficiency from 97.10% in year 1 to 96.94 in year 3.
- The average PV module temperature has been almost constant that it has no significant effect on the AC output.
- **Overall, the 3-year operations of the ADB's Solar PV System has been normal, stable, and reliable**

Thank You !

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**More information:
www.adb.org/clean-energy**