

World First Large Scale 1.25MW Bifacial PV Power Plant on Snowy Area in Japan

Presented by

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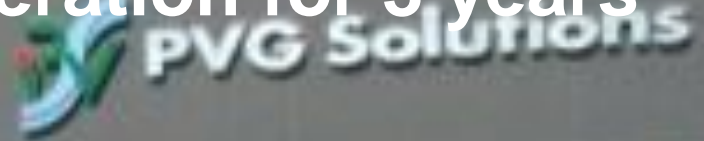


September 29th, 2016

**EarthON Cell
High Efficiency & Bifacial**

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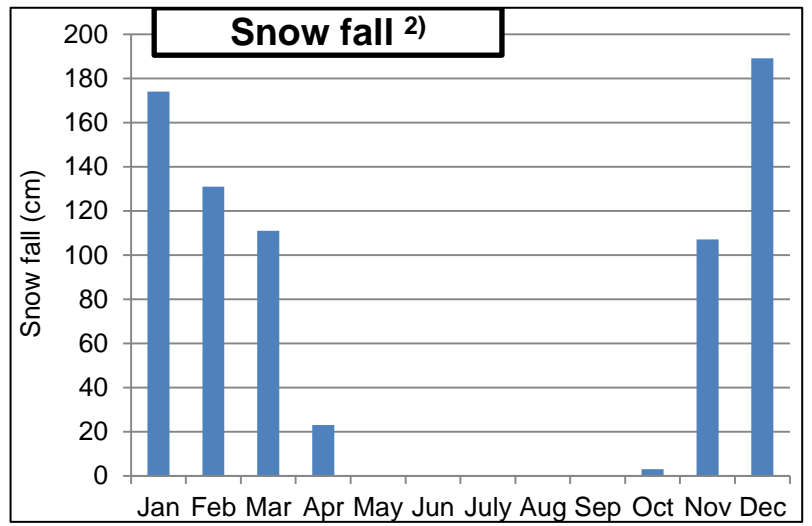
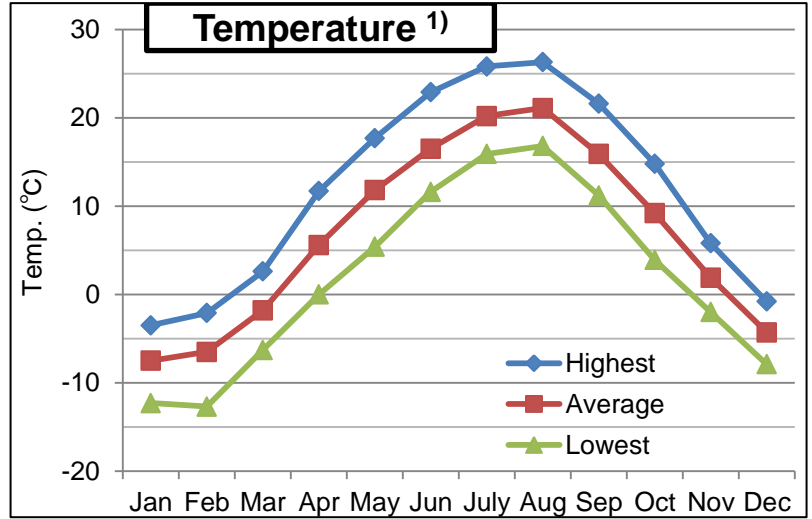
1. Outline of bifacial PV power plant
2. Motivation of owner “Why bifacial?”
3. Results of power generation for 3 years
4. Summary





Outline of bifacial PV power plant

4 Location and Climate of the site



*1,2) Data from Japan Meteorological Agency

5 Location and Climate of the site



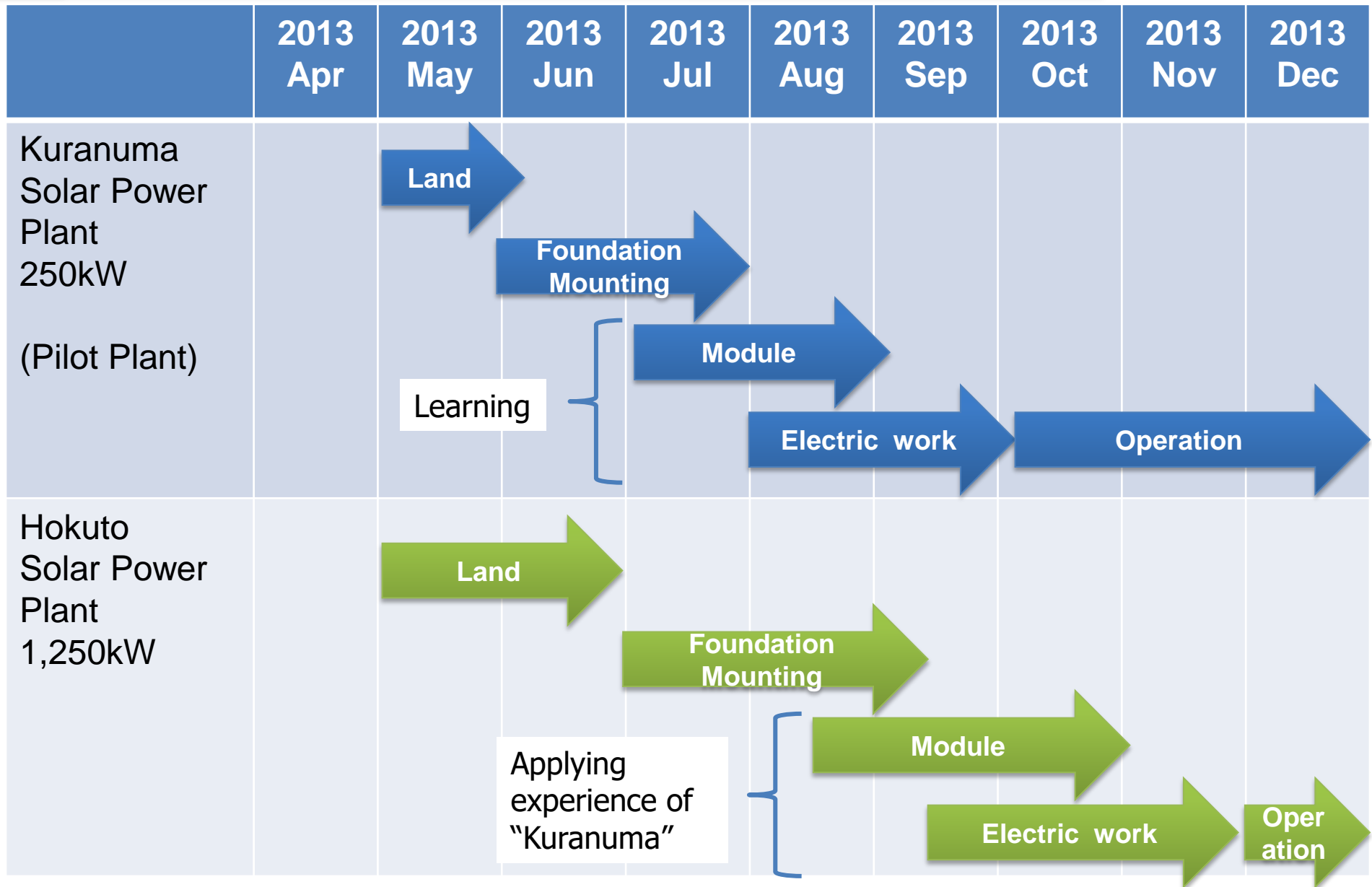
Asahikawa
latitude 43.50N.

Hokuto Solar Power Plant
1.25MW



Kuranuma Solar Power Plant
0.25MW

✓As a role of pilot plant for 1.25MW construction



Kuranuma Solar Power Plant (Pilot plant)



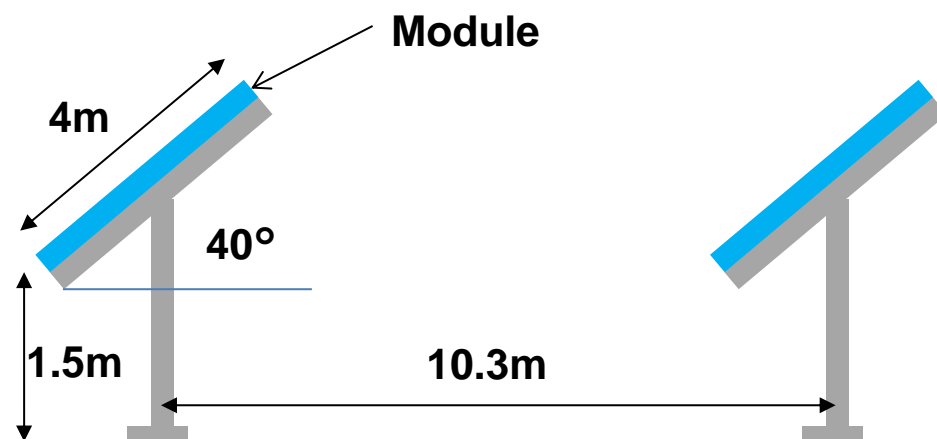
Location Asahikawa, Hokkaido

PCS Capacity **250 kW**

PV Capacity **270.26 kW (Front)**
324.3 kW (bifacial gain 20%)
 1,064 modules
 (PST254EarthON60)

Installation South, 40°

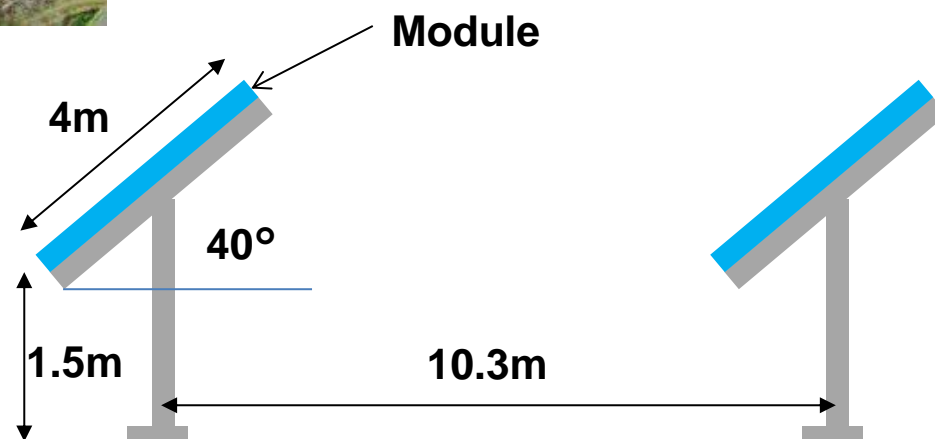
Operation Oct., 2013



Hokuto Solar Power Plant (World largest large scale bifacial plant)



Location	Asahikawa, Hokkaido
PCS Capacity	1,250 kW
PV Capacity	1,351.28 kW (Front) 1,621.54 kW (bifacial gain 20%) 5,320 panels (PST254EarthON60)
Installation	South, 40°
Operation	Dec., 2013





High power and bifacial solar module EarthON 60 Series



60-cell module exceeds 300 Wp in total.*

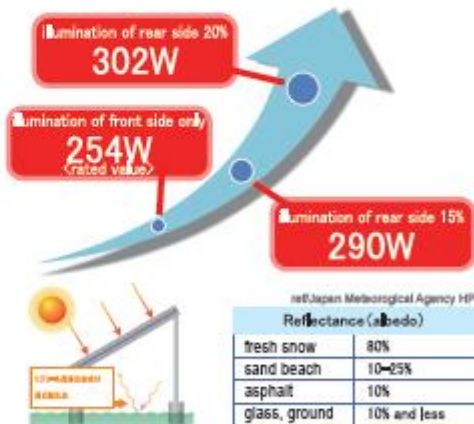
TUV certified module
ID 000036957



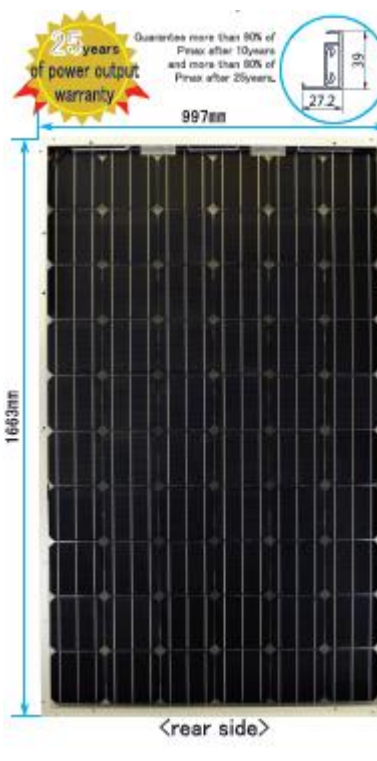
<front side>

* Based on the practical field test.
** Rear side output is not a guaranteed value.

- Using high efficiency and bifacial solar cells "EarthON", produced by PVG Solutions Inc.
- Unique technology originated in Japan.
- High efficiency and generating electricity from both front and rear sides.
- "EarthON" cell is only PV bifacial cell that has the highest bifaciality(rear output / front output).
- Utilizing reflected and diffused light from rear side, 10 to 30% output power can be increased in total.**



Bifacial PV system Field test
in Kitami Institute of Technology
at Oct. 2012
URL : www.pvgs.jp/download
Published in the test data.
Please have a look!



PST254EarthON60 total output from both sides (Estimated value)*

illumination of rear side	0%	10%	15%	20%
Total Pmax[W]	254	278	290	302
Vpm [V]	32.1	32.1	32.1	32.1
Ipm [A]	7.92	8.67	9.05	9.42
Voc [V]	38.6	38.6	38.6	38.6
Isc [A]	8.44	9.24	9.64	10.0
Efficiency[%]	15.3	16.8	17.5	18.2

Mechanical specifications

dimension	1,663x997x39mm
weight	22kg
front side	4mm tempered safety glass
rear side	Transparent back sheet
cells	n-type mono-crystalline bifacial solar cell "EarthON"
frame	Anodized aluminum profile
cable	4mm ² solar cable, L=0.4m, with MC4 connectors
Mechanical load	5,400 Pa

Motivation of owner “Why bifacial?”



This picture is provided by Hokkaido PVGS Limited.
(This work is supported by Hokkaido-government and Kitami-city.)

I had two motivations.

1. Message from Prof. Kashiwagi of Tokyo Institute of Technology

I joined “Smart Community Forum” at Sapporo in 2012 by chance.

Prof. Kashiwagi said on his lecture,

Japanese Feed In Tariff system (FIT) will start.
Big company will make money using FIT.
It is local companies that should join hands
and enter into IPP business.

If you don't do it, you are STUPID !



2. Philosophy of our company

“We try what no other, at the first. ”

There were many problems to be solved.

- ✓ **How to overcome **snowfall** in winter season?
(We have heavy snowfall in Asahikawa city)**
- ✓ **Which **module****
- ✓ **Which **mounting structure**?**
- ✓ **Which **power conditioner**?**
- ✓ **etc.**



These picture are provided by Hokkaido PVGS Limited.

While I was looking for PV module for our power plant, I had found **bifacial PV system** under demonstration test at **Kitami Institute of Technology** in 2012.



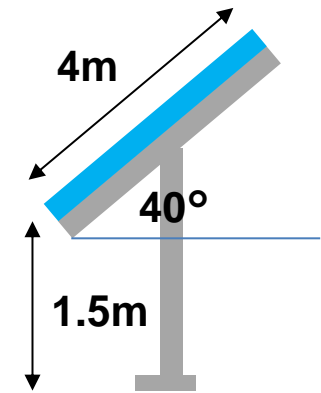
This is it!
for overcoming snowfall

This development program was ...

- Performed by
- Kitami Institute of Technology
 - Hokkaido PVGS Limited
 - Itogumi construction Co., Ltd.
 - KITABA grand planning Co., Ltd.
- Supported by
- Hokkaido Government
 - City of Kitami

How to overcome heavy snowfall?

Item	Solutions
Mounting system	<ul style="list-style-type: none">✓ Ground height 1.8m✓ Tilted angle 40 degree
Module	<ul style="list-style-type: none">✓ High efficiency bifacial module
Booster	<ul style="list-style-type: none">✓ Application of reflection light form snow and white sheet✓ Low ambient temperature



“Snow is not a enemy, but a friend for bifacial module.”



Results of power generation for 3 years

This picture is provided by Hokkaido PVGS Limited.
(This work is supported by Hokkaido-government and Sapporo-city.)

【日射量計算用情報 Information for calculation of irradiation】

項目	単位	入力			
地点 Point	-	旭川 Asahikawa			
緯度 Latitude	度	43.77			
経度 Longitude	度	142.37			
標高 Altitude	m	111.9			
日射量計算方法 Cotinuous array or not	-	連続アレイ Continuous array			
アレイ間隔 Array interval factor	%	256	256	256	
段数 Steps of array	段	4			
アレイ方位角 azimuth	度	0			
アレイ傾斜角 Tilt angle	度	40	40	40	
アレイ最適傾斜角 optimum tilte angle	度	24	24	24	

【基本情報 Basic information】

項目	単位	入力			
両面利得 Bifacial gain	%	20.0	10.0	0.0	
PVアレイ定格値(両面利得考慮) PV array STC Pmax (including bifacial gain)	kW	810.8	743.2	675.6	
PVアレイ設置方式 PV array structure	-	裏面開放形(架台設置形) Open in rear side (Mounted on tilted structure)			
太陽電池種類 PC cell	-	単結晶系 Single			
PVモジュールの経年 Age of PV module	年	0			
パワーコンディショナ(PCS)定格容量 PCS power	kW	625	625	625	
風速データ Windspeed data	-	あり With wind speed data			
PVシステム総数 Number of system	システム	2	2	2	
発電所出力容量 PV Array power	kW	1,621.5	1,486.4	1,351.3	

【所内負荷設定情報 Information of load in power plant】

項目	単位	入力	
PCS冷却方式 Cooling method of PCS	-	強制冷却 Forced air cooling	
→強制冷却の場合: 通年エネルギー消費効率(APF) Annual Performance Factor	-	4.0	
所内負荷消費電力 Power consumption by load in power plant	kW	5.00	

【配線条件設定情報 Information of wiring in power plant】

項目	単位	入力
直流配線の電圧降下率設計値 DC power loss in DC wiring	%	3.0
交流電圧(低圧) AC Voltage (Low voltage system)	V	210
低圧交流配線の電圧降下率設計値 AC power loss in low voltage wiring	%	2.0
高圧変圧器の有無 With or without transformers for high voltage	-	あり With transformer for high voltage
→高圧変圧器容量 Capacity of transformer for high voltage	kW	1,500
→負荷損 Load loss	kW	14,000
→高圧変圧器での集電単位 Number of system at transformer for high voltage	システム	2
→交流電圧(高圧) AC voltage (High voltage)	V	6,600
→高圧交流配線の電圧降下率設計値 AC power loss in high voltage wiring	%	2.0

【アレイ間隔計算】

アレイ傾斜角 Tilt angle	アレイ底辺長 Length of array base	アレイ間隙間 Length of array to array space	
40	3,066	7,185	
アレイ傾斜角	アレイ間距離 Array pitch	アレイ斜辺長 Length of arraoblique side	アレイ間隔 Array interval factor
40	10,251	4,003	256

※アレイ間隔 Array interval factor = アレイ間距離 Array pitch / アレイ斜辺長 Length of arraoblique sidex100

【発電所出力容量計算】

両面利得 Bifacial gain	段×列 Step by row	表面出力 Front power	出力合計 Total power (including bifacial gain)
20%	5,320	1,351.3	1,621.5
10%	5,320	1,351.3	1,486.4
0%	5,320	1,351.3	1,351.3

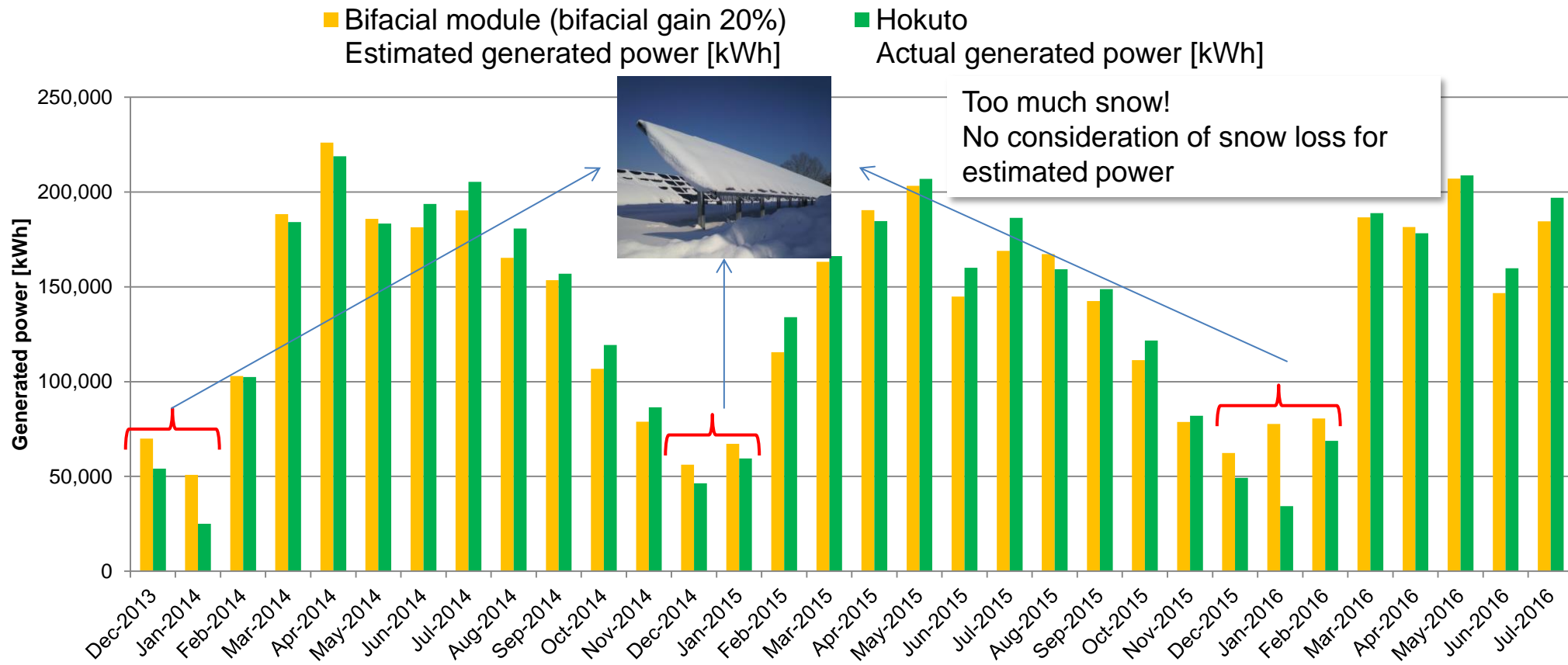
※EarthON Pmax 254 W

=1,351.3kW x 1.2

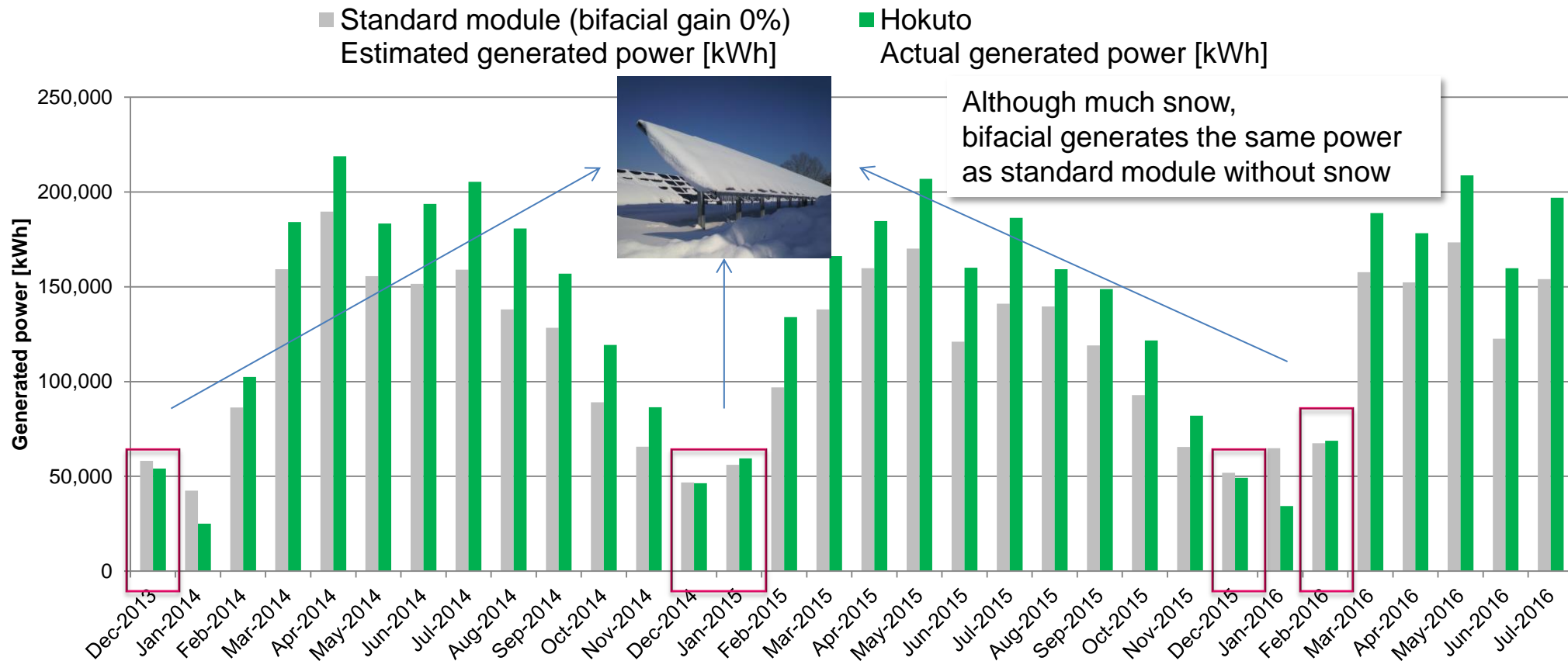
=front power

STEP-PV Simulator ver1.0 provided by NEDO

- ✓ Actual measured solar irradiance at site is used for calculation.
- ✓ Snow loss is not considered in winter season

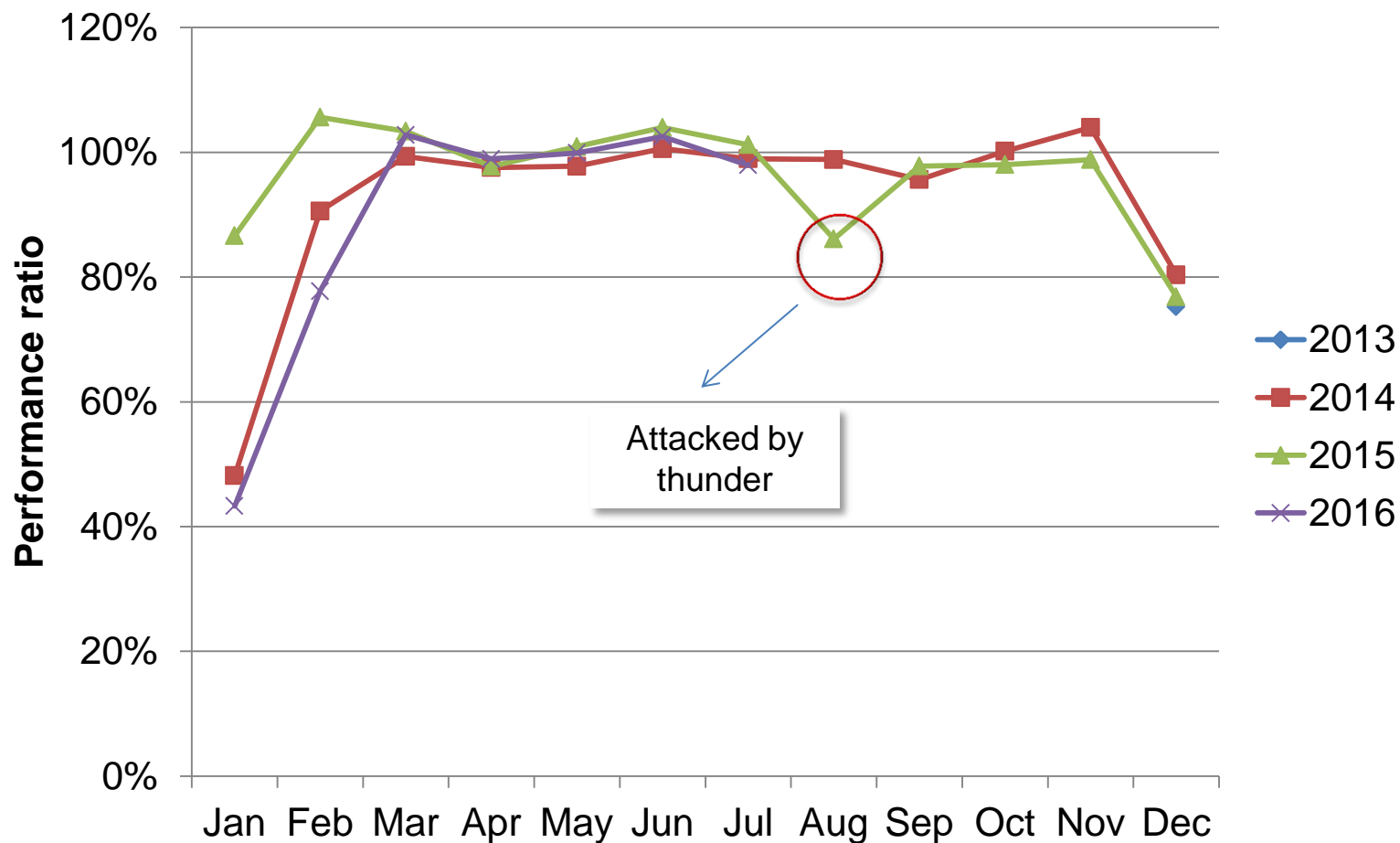


From Dec-13 to Jul-16 32 months	Generated power (Accumulated) [kWh]	Generated power (yearly per kW(front)) [kWh/kW/year]
Hokuto solar power plant	4,450,668	1,235
Estimated by STEP-PV (bifacial gain 20%)	4,435,943	1,231

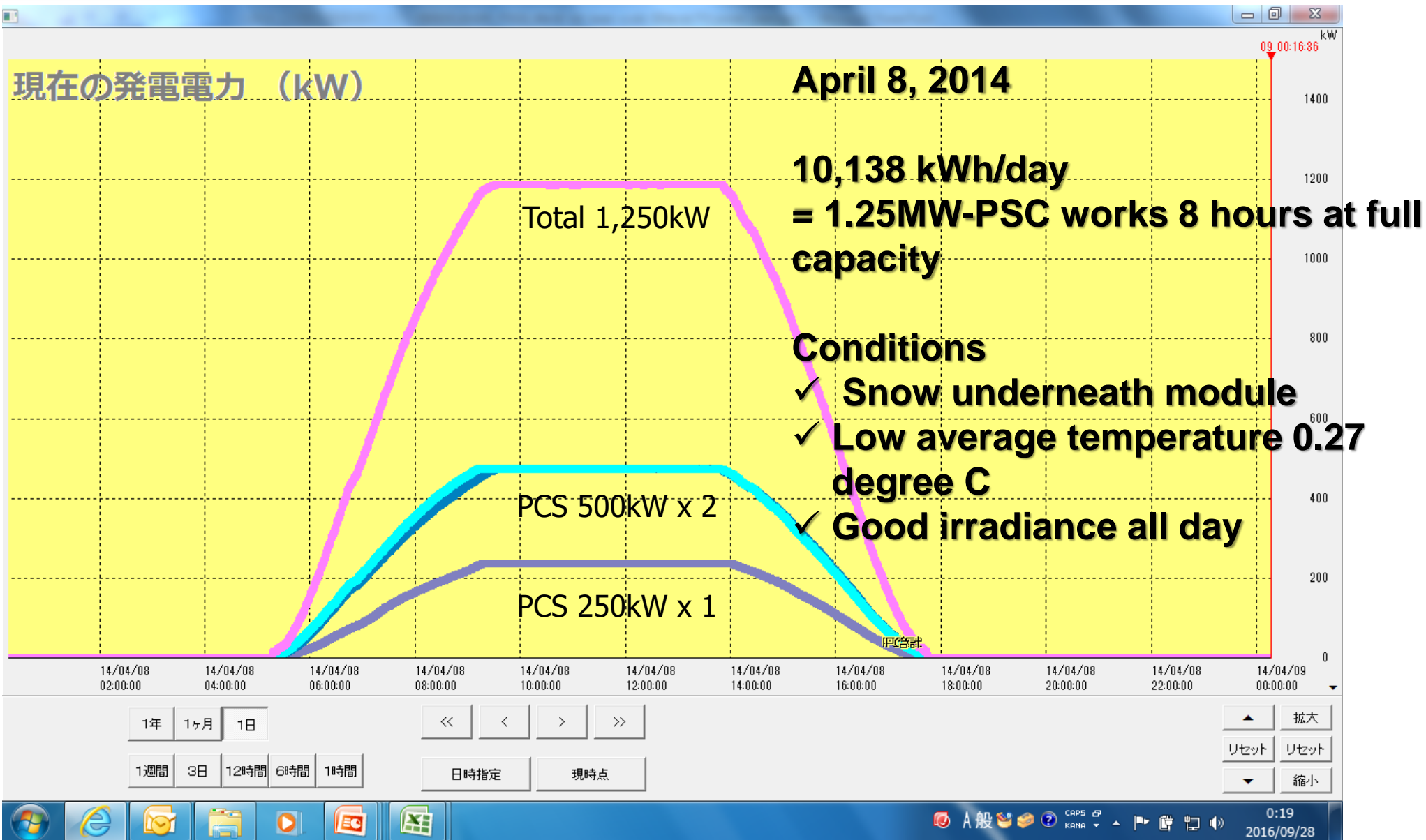


From Dec-13 to Jul-16 32 months	Generated power (Accumulated) [kWh]	Generated power (yearly per kW(front)) [kWh/kW/year]	Bifacial gain [%] = 1 - (Hokuto / BFgain0%)
Hokuto solar power plant	4,450,668	1,235	19.8%
Estimated by STEP-PV (bifacial gain 0%)	3,714,303	1,031	-

Change of monthly system performance ratio



There is no obvious degradation of system.



- ✓ **From the results 1.25MW Bifacial PV Power Plant for 3 years,**
 - ✓ **Over 1,200kW/kW/year obtained although latitude 43.5 N and heavy snowfall in winter.**
 - ✓ **Calculated power almost meets actual results in accumulation for 32 months (but, no consideration of snow loss for estimation of power).**
 - ✓ **In winter, bifacial generates almost the same power as that of calculated for standard module without snow.**
 - ✓ **There is no obvious degradation of system by the evaluation of system performance ratio.**

- ✓ **We will continue to evaluate this power plant for long period as “World First Large Scale 1.25MW Bifacial PV Power Plant”.**

Photo- Voltaic Global Solutions



PVGS make **Earth “ON”**

Thank you for your kind attention.

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Under relocation of office



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