

# Annual outdoor performance of LG Bifacial Module

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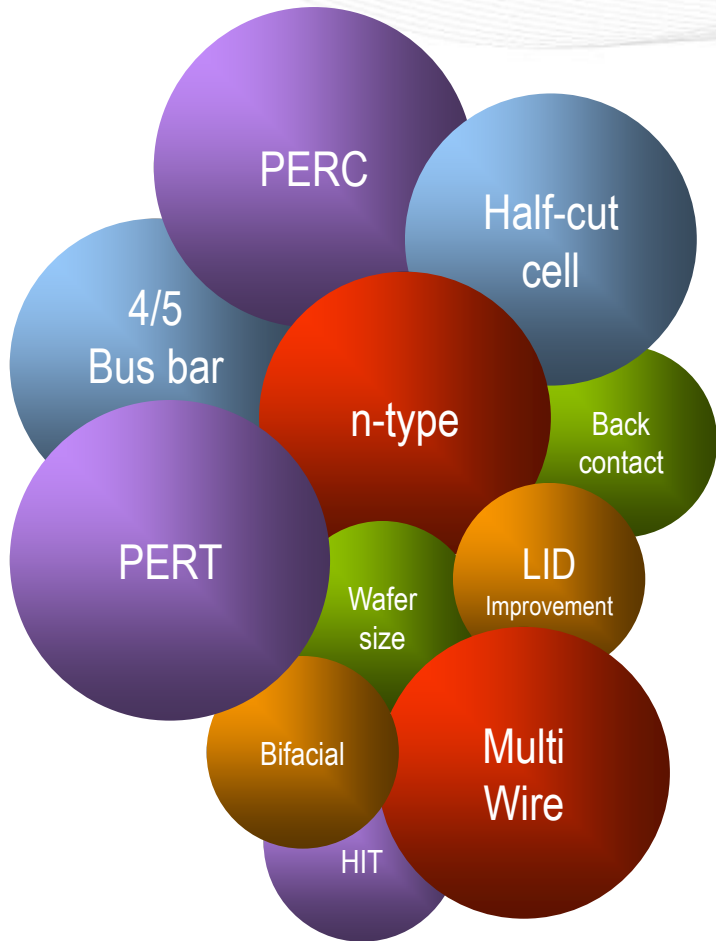


# 1. Motivation

- **To obtain performance and annual yield comparison of bifacial and monofacial PV modules in the field.**
- **To compare annual yield of N-PERT bifacial module with P-PERC bifacial modules in the field.**
- **To compare bifacial gain value from field with simulation value from PVsyst.**

## 2. LG solution for Bifacial

High Efficiency Bifacial Cell and Multi wire busbar technology make the High efficiency LG Bifacial module



## LG solution for Bifacial

- Cell tech. :  
**n-Type, PERT, Bifacial Cell**
- Module tech. :  
**Multi wire busbar (12 ea)**  
**Transparent backsheet**  
**Avoid rear shading design**

### 3. LG N-type Cell Technology

The LG NeON2 Cell is capable of generating electricity on both sides, and the front and back cell efficiencies are higher compared to P-type Bifacial Cell.

		P-type PERC :Monofacial	P-type PERC Bifacial	LG N-type Bifacial
<b>Cell structure</b>				
<b>Front Cell <math>\eta</math> (%)</b>		$\geq 21$	$\geq 20$	$\geq 23$
<b>Rear Cell <math>\eta</math> (%)</b>		0	$\geq 14$	$\geq 18.2$
<b>Distinct feature in Rear</b>	<b>Surface</b>	Polished	Polished	Textured
	<b>BSF</b>	Al-Si alloy	Al-Si alloy	Phosphor Poly-Si doping
	<b>Electrode structure</b>	Al Full coverage	Same as front (Al grid )	Same as front

1) BSF: Back Surface Field

## 4. LG NeON2 Bifacial module

### [Technical Data]

Number of cells (ea.)		72
Power(W) (Front side STC)		385 ~ 390
Efficiency (%)		18.3 ~ 18.6
Warranty	Product	25 years
	Performance (apply BiFi10)	<b>1<sup>st</sup> year : 104.8%</b> <b>after 25 year: 91.9%</b> <b>(-0.50%/year)</b>
Temp. coefficient		-0.36%/°C
Mechanical Load		Front : 5,400Pa Rear : 4,300Pa

LG NeON<sup>®</sup>2 BiFacial



### [Key features]



- Double sided generation
- More energy up to 30%



- BOS saving with additional generation



- Able to generate power with snow cover

## 5. LG NeON2 Bifacial Differentiation

LG NeON2 Bifacial module has excellent power generation performance and bifacial gain, so it has More Energy Generation than P-type Bifacial.

**More Energy Yield Up to 30%!!**

The higher efficient bifacial module than P-type bifacial module

**Better Performance  
on a Sunny day**

**More Generation  
on a Cloudy day**

**Bifacial Cell**

**Near Zero LID\***

**Reliability  
LCOE**

The Lower temperature coefficient since the higher cell efficiency than P-type bifacial cell

+

LG NeON 2 Bifacial cell and module technology is more advanced in lower energy reduction in weak sunlight than P-type PERC technology

+

LG NeON2 Bifacial module has bifacial cell that improves power generation by front and rear power generation.

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The n-type cells used in LG NeON 2 Bifacial have almost no boron, which may cause the initial efficiency drop, leading to less LID

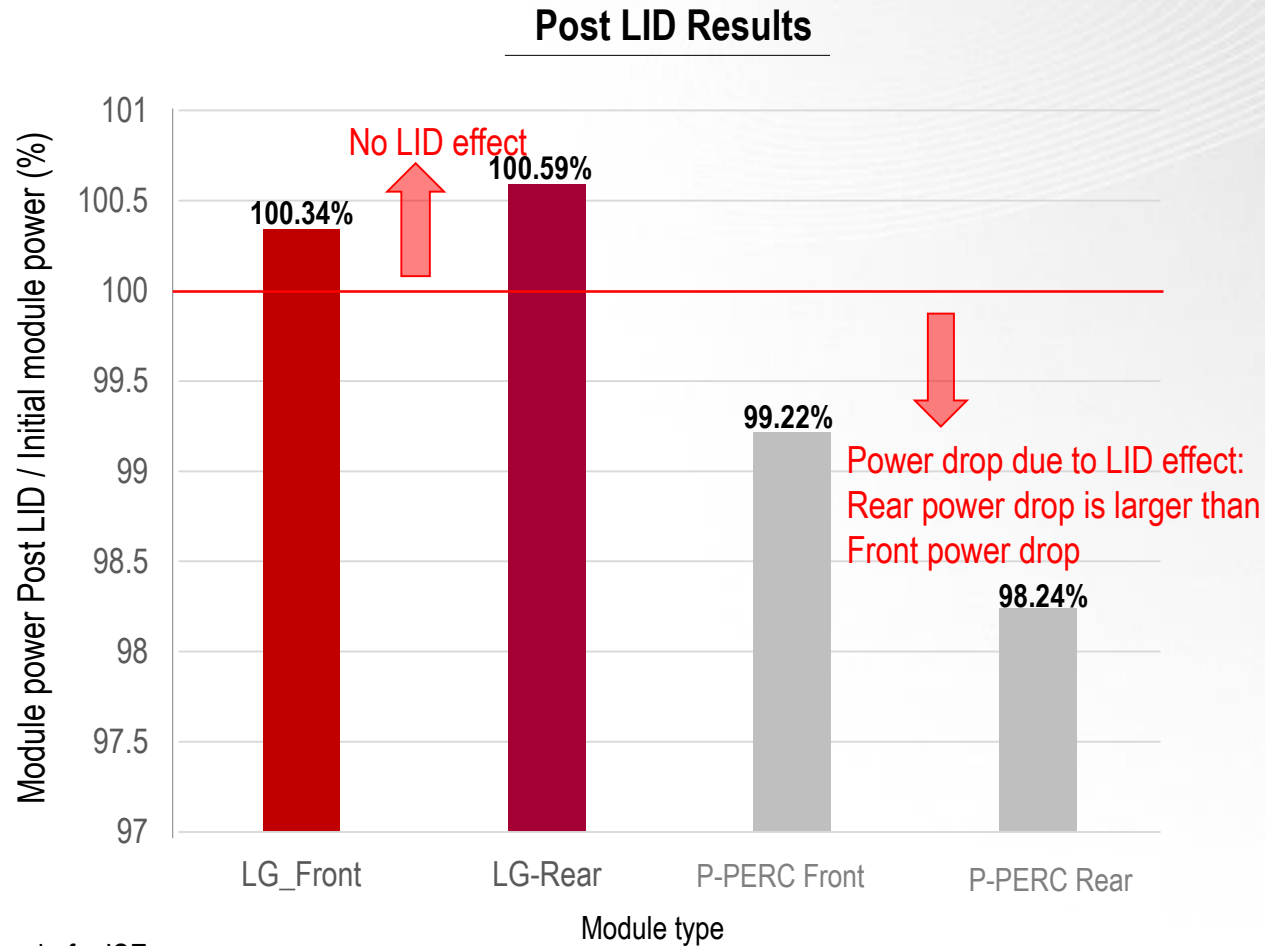
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LG NeON2 Bifacial module has 25 year product warranty and Low LCOE.

\*LID : Light induced Degradation

## 6. Bifacial LID comparison

The LG NeON2 Bifacial module has no reduction in output by LID, but P-type Bifacial module's the reduction of front / rear output by the LID is high, especially the rear output reduction is high



Tested by Fraunhofer ISE

## 7. Summary of LG Bifacial module Field test

Bifacial Gain of LG Bifacial module was obtained under various installation conditions in the field.

Bifacial gain values from real field data are larger than simulation values from Pvsyst.

Bifacial Gain value ranges from +7% to +28% depending on various installation conditions.

### Bifacial Test bed

NO.	Site	Location	Albedo (%)	Period	Bifacial Gain		Mounting system
					Real Result	Simulated by PVsyst	
1	Fraunhofer ISE	Freiburg, Germany	80	' 17.Jan.23~ ' 18.Feb.9	+26.5%	+21.5%	Fixed
2	Fraunhofer ISE	Freiburg, Germany	25	' 17.Jan.23~ ' 18.Feb.9	+11.4%	+7.8%	Fixed
3	DNV-GL	Davis, California, USA	20	' 17.Jul.12~ ' 17.Aug.11	+11.2%	+5.1%	Fixed
4	DNV-GL	Davis, California, USA	70	' 17.Jul.12~ ' 17.Aug.11	+27.9%	+26.5%	Fixed



# 8. Summary of annual field test results

The LG Bifacial module has high power generation performance of +11.4% ~+26.5% compared to LG Monofacial module and high power generation performance of +5% ~ + 10% compared to P-PERC Bifacial module due to high front / rear output power for 1 year period.

Low Albedo(Concrete), Tilt angle 35°



	P-type Bifacial (P-PERC)	N-type Bifacial (LG)	N-type Monofacial (LG)
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Front output (W)	270	300	315
Rear output (W)	157	210	None
Accumulated Energy (kWh)	324.8	399.8	371.5
Specific Yield (kWh/kWp)	1243.0	1299.0	1166.0
Bifacial Gain (%)	+6.6	+11.4	-

$\Delta = +4.8\%$

High Albedo(Bright white roofing membrane), Tilt angel 35°



	P-type Bifacial (P-PERC)	N-type Bifacial (LG)	N-type Monofacial (LG)
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Front output (W)	270	300	315
Rear output (W)	157	210	None
Accumulated Energy (kWh)	357.1	458.9	375.2
Specific Yield (kWh/kWp)	1375.0	1492.2	1191.0
Bifacial Gain (%)	+16.5	+26.5	-

$\Delta = +10\%$

# 9. Annual performance under High Albedo

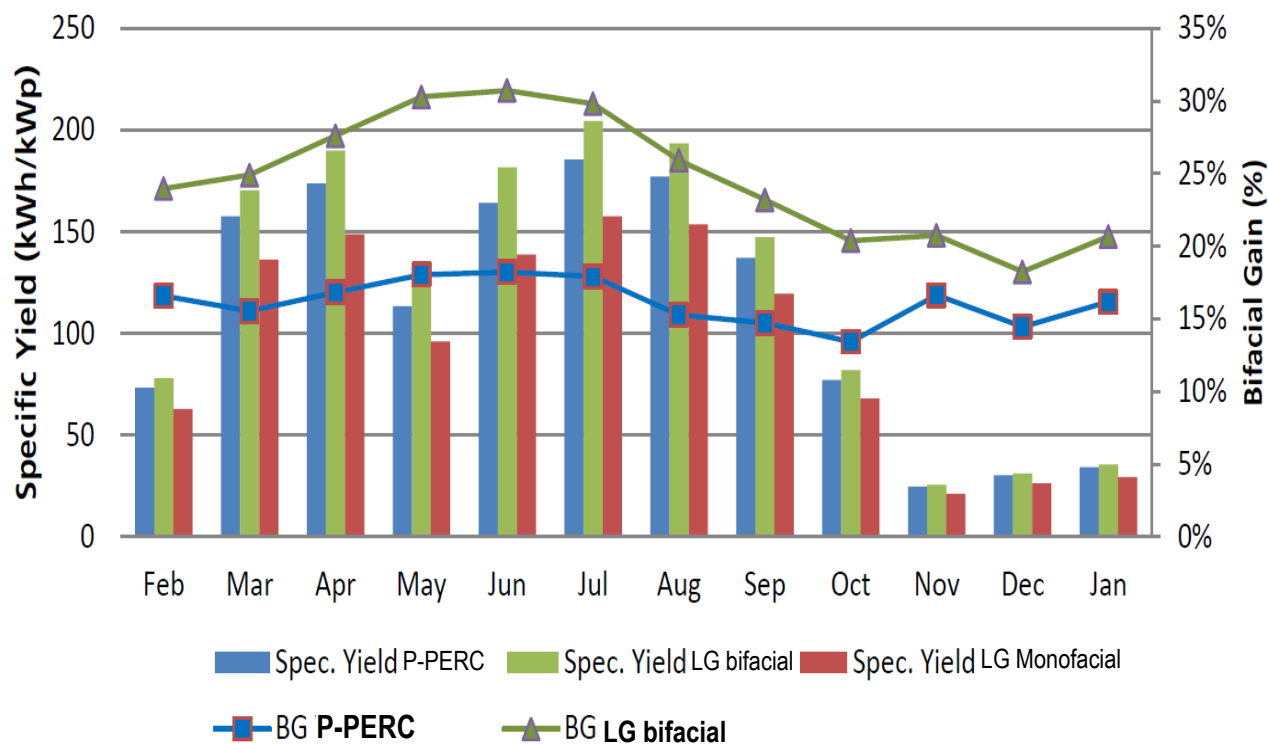
Bifacial Gain value of LG Bifacial module is getting larger for the high irradiance weather season under high Albedo condition. Bifacial Gain gap value between LG Bifacial module and P-PERC Bifacial is larger in the high irradiance weather season than in the low irradiance weather season.



### Install condition

- Site: Freiburg, Germany
- Tilt : 35deg
- Facing : South
- Ground: Bright white roofing membrane ( High Albedo, 80%)
- Period: '17.Jan.23~'18.Feb.9

### Monthly Specific Yield and Bifacial Gain (High Albedo)



\*BG : Bifacial Gain module

# 9. Annual performance under Low Albedo

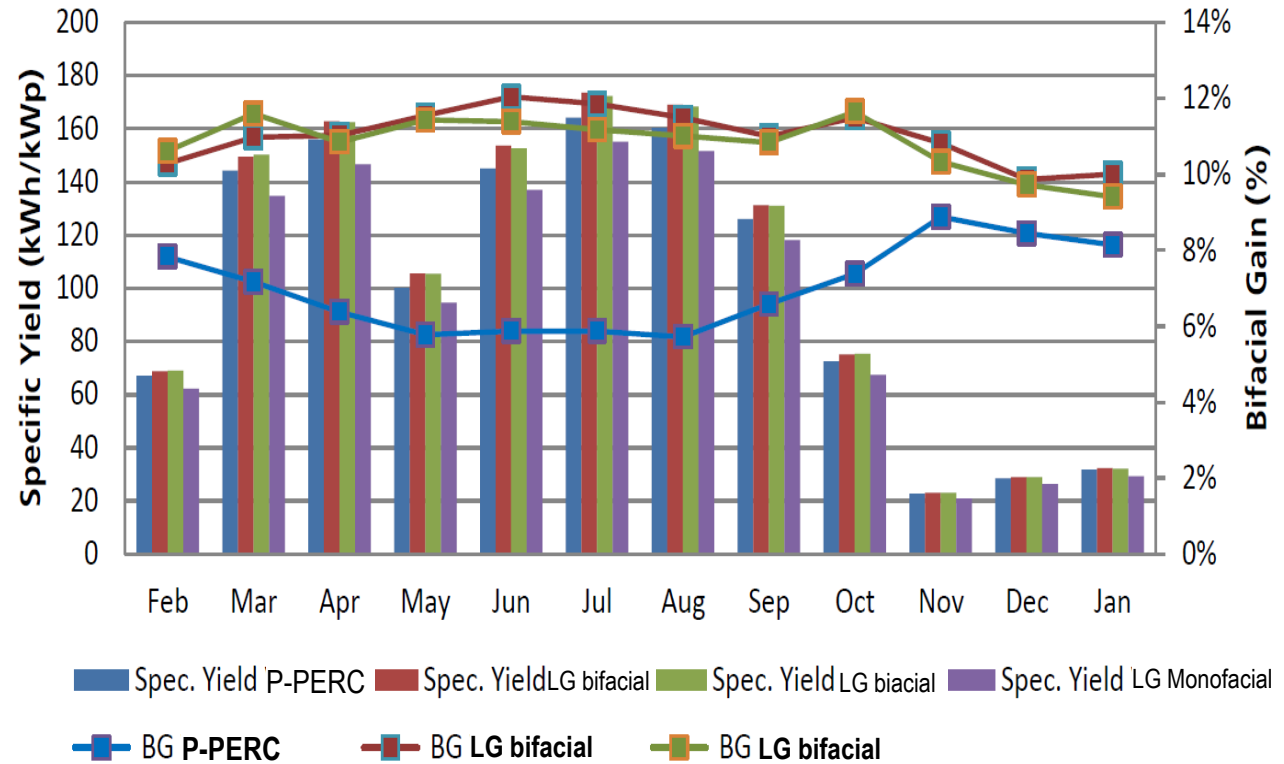
Bifacial Gain value of LG Bifacial module is almost constant for all season while Bifacial Gain value of P-PERC Bifacial module is reduced for high irradiance weather season under low Albedo condition.



### Install condition

- Site: Freiburg, Germany
- Tilt : 35deg
- Facing : South
- Ground: Concrete tiles  
(Low Albedo, 25%)
- Period: '17.Jan.23~'18.Feb.9

### Monthly Specific Yield and Bifacial Gain (Low Albedo)



\*BG : Bifacial Gain module

## 10. Conclusion

- **LG, Advnaced Technology**

LG NeON2 Bifacial provides High Efficiency with N-type PERT Cell technology, Cello for module technology and optimized module design.

- **Performance Beyond Expectation**

LG NeON2 Bifacial achieved additional harvesting against not only P-PERC Bifacial but also PV syst simulation results.

- **Proved from Real Field Data**

Bifacial gain for NeON2 Bifacial has been proved from 3<sup>rd</sup> party and in a real field

