Topic: Why PV quality matters in Asia?

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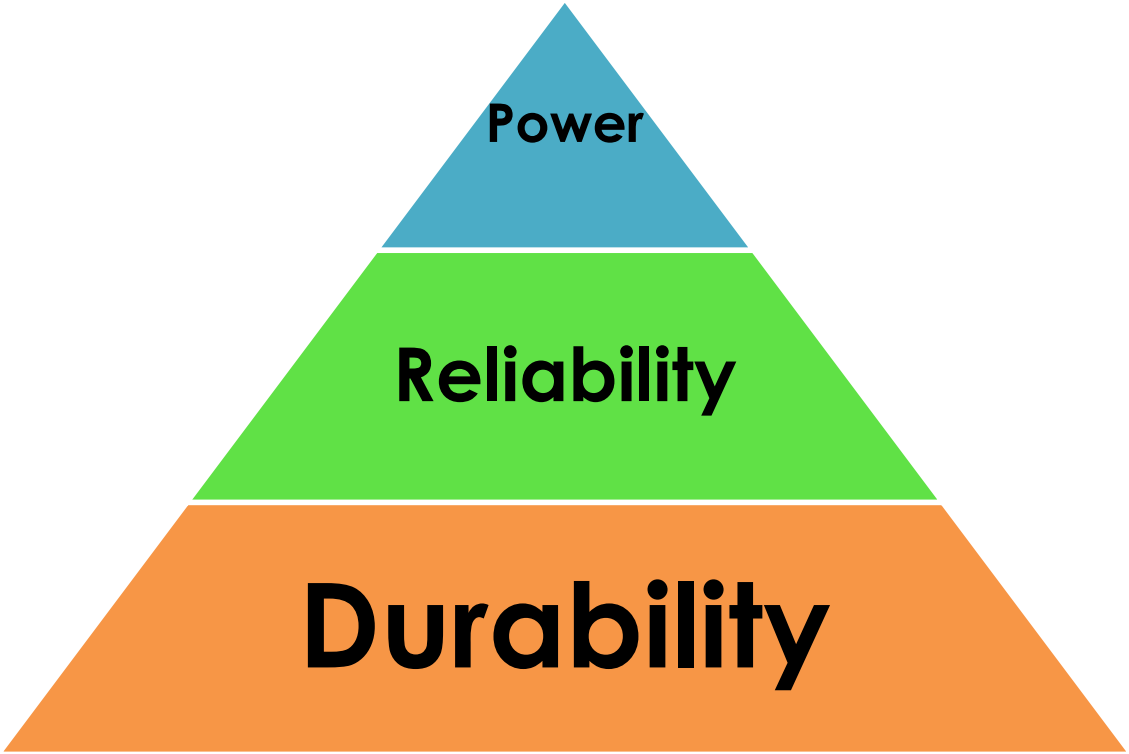
JinKO Solar
Building Your Trust in Solar

Let's think about one question

How to ensure high quality?

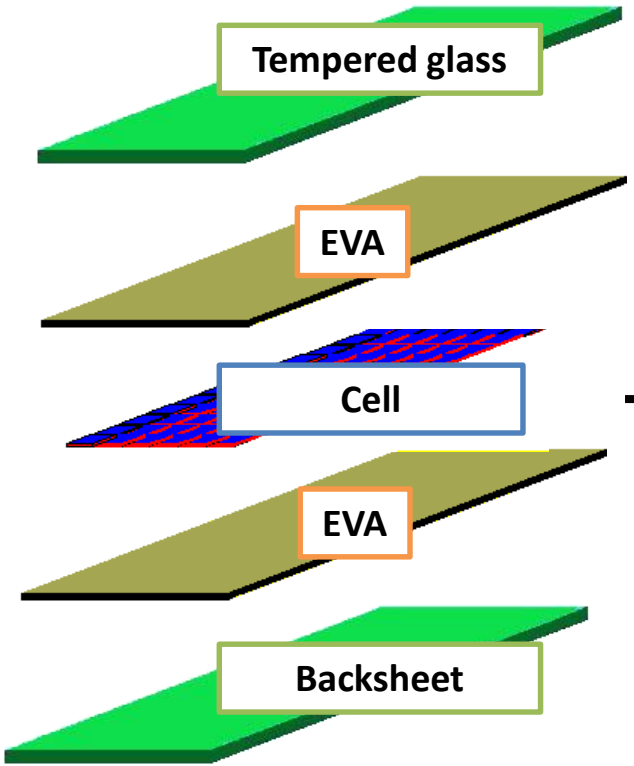
- To provide quality benchmarking measures
- Consequences of module failures
- The financial implications
- Tips to ensure high IRR

The Solar Pyramid – build from the solid foundation



High Nameplate Power CSIRO Performance Report
Low Annual Degradation DNV GL Reliability Scorecard Report
DuPont Tedlar Backsheet Thicker wafers and frames

The Solar Pyramid – Durability



They all matter

A supreme BOM selection to avoid micro-cracks and backsheet failures:

1. Thicker solar cells (imagine if you prefers a thicker wall of you home?)
2. Strategic partner with Dupont to utilize Tedlar backsheets (imagine if you prefers denser construction materials of your wall?)

The Solar Pyramid – Durability

■ **Premium raw materials**

Jinko vs Key competitors – Raw material

Raw materials			Jinko	T-Company	C-Company	J-Company	H-Company
Cell	Avg. Cell thickness	Poly cell	≥210	200-210	200-210	200-210	200-210
		Mono cell	195-200	≈195	≈195	≈195	/
Connector	Poly	60/72-cells	Jinko connector /MC4/UTX	MC4/H4/UTX/EVO3	T4/ PV2/H4	J-Company connector /MC4	MC4/UTX
	Mono	60/72-cells					
Backsheet	Poly (Main)	60-cell	TPT/TPE/TFB/KPF	TPT/TPE/KPF/PYE	TPT/TPE/KPF	TPT/TPE/KPF/KPE	FFC/PYE
		72-cell	TPT/TPE/TFB/KPF	TPT/TPE/KPF/PYE	TPT/TPE/KPF	TPT/TPE/KPF/KPE	FFC/PYE
	Mono (Main)	60-cell	TPT/TPE/TFB/KPF	TPT/TPE/KPF/PYE	TPT/TPE/KPF	TPT/TPE/KPF/KPE	/
		72-cell	TPT/TPE/TFB/KPF	TPT/TPE/KPF/PYE	TPT/TPE/KPF	TPT/TPE/KPF/KPE	

→ Thicker cells

→ Supreme backsheet

Superior point in BOM – Thickening and selection of material makes final products more Robust and Reliable.

Risky point in BOM – Which may take risk in module's mechanical loading performance/reliability /safety.

4

A supreme BOM selection to avoid micro-cracks and backsheet failures.

The Solar Pyramid – Backsheet Durability

Severe backsheet failures were observed in Australia to cause:

1. Unprotected module
2. Current leakage

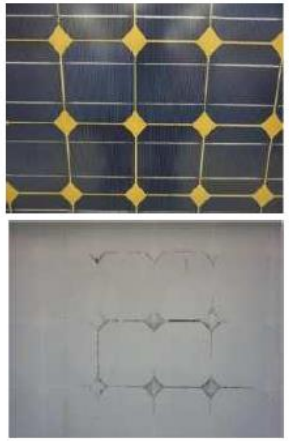
→ Tedlar backsheet can avoid these critical issues.

The Solar Pyramid – Backsheet Durability

Is Module still Module after 10 Years?

Backsheet Type: PET
- 5 years old installation in Spain
- Yellowing and Cracking
- 32% power loss over 5 years (6.4%/year)
- Some modules failed wet leakage test – Safety Risks

Backsheet Type: PVDF
- 4 years old installation in North America
- Severe cracking and delamination of PVDF film
- 57% of the installed modules impacted



Backsheet Type: PET
- 9 years old installation in West China
- Severe cracking, chalking, peeling and yellowing

Backsheet Type: Polyamide (PA)
- 5 years old installation in Italy
- Severe cracking and delamination of PA film
- Inverter tripped due to current leakage

The Solar Pyramid – DNV GL Reliability Scorecard Report

DNV·GL

PV Module Reliability Scorecard Report 2017

Report contributors
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DNV GL Reliability Scorecard Report 2017						
Test conditions	Test type	Thermal cycling	Dynamic mechanical load	Humidity-freeze	Damp heat	PID
	Standard test	200 cycles		3 cycles	1000 hours	96 hours
	DNV test	600 cycles	1000 cycles	30 cycles	2000 hours	96 hours
	Top performance criteria	2%	2%	2.50%	1%	2%
2017	Jinko	Top	Top	Top	Top	Top
	T-Company	Top	Top	Top	Top	Top
	H-Company	Lower	Lower	Top	Top	Top
	Y-Company	Lower	Top	Lower	Top	Top
	L-Company	Top	Top	Top	Top	Top
	G-Company	Lower	Top	Lower	Lower	Top
2016	Jinko	Lower	Lower	Top	Top	Top
	T-Company	Top	Top	Lower	Top	Lower
	H-Company	Lower	Top	Top	Lower	Top
	Y-Company	Lower	Top	Lower	Lower	Lower
	L-Company	*	*	*	*	*
	G-Company	*	*	*	*	*

Strict quality control to ensure long term reliability → report available upon request.
Who does not participate in this test?

The Solar Pyramid – CSIRO Performance Report

Test results	View product > Canadian CS6P-250P	View product > JA Solar JAP6-60-260/3BB	View product > Jinko JKM250P-60-A	View product > Q-Cells Q.PRO-G3 255	View product > Renesola JC260M-24/Bb	View product > Sunpower SPR-E20-327	View product > Suntech STP250-20/Wd	View product > Trina TSM-260PC05A
Price ($)	$240	$301	$215	$209	$263	$217	$233	$238
Test results								
Overall score (%)	89%	85%	91%	84%	84%	85%	89%	87%
Measured average power outdoors 12 months	236.2	239.9	238.4	234.4	239.3	301.7	236.1	242.8
Measured average power outdoors 3 months (W)	234.7	235.4	234.7	229.5	235.4	298.1	231.4	239.5
Measured power in lab when new (W)	250	252.6	254.7	250.3	251	322.2	247.8	256.5
Yield per 1000W by label 12 months (W)	944.7	922.8	953.8	919.4	920.6	922.5	944.4	934
Yield per 1000W by label 3 months (W)	938.6	905.4	938.6	900.1	905.5	911.6	925.5	921
Efficiency (%)	15.6%	15.5%	15.6%	15%	15.4%	19.8%	15.2%	15.7%
Comments								
Good points	• Very good performance across 12 months of outdoor testing.	• Very good performance across 12 months of outdoor testing.	• Excellent performance across 12 months of outdoor testing.					
Bad points	• Nothing in particular.	• Nothing in particular.	• Nothing in particular.					
Specifications								
Claimed nominal power (W)	250	260	250					
Claimed power tolerance	0 to +5W	0 to +5W	0 to +3%					
Width (mm)	980	991	990					
Length (mm)	1638	1650	1650					

- **NO.1 performance ratio in a 12-month field test.**
- **A real difference in actual operating conditions in the field.**

The Solar Pyramid – The Actual Power in the Field

	Standard Mono as an example				
	Jinko	T-company	C-company	Q-company	J-company
Nameplate power (W)	NOCT power (W)				
325				239	
330			242	243	
335	250	250	246	246	244.9
340	254	253	250	250	248.5
345	258	257	253	254	252.2
350	262	261			255.8
355	266	264			259.5
360	270	268			

Take-home message: Jinko's excellent NOCT power output ensures high actual energy yield.

NB: all data extracted from public datasheets.

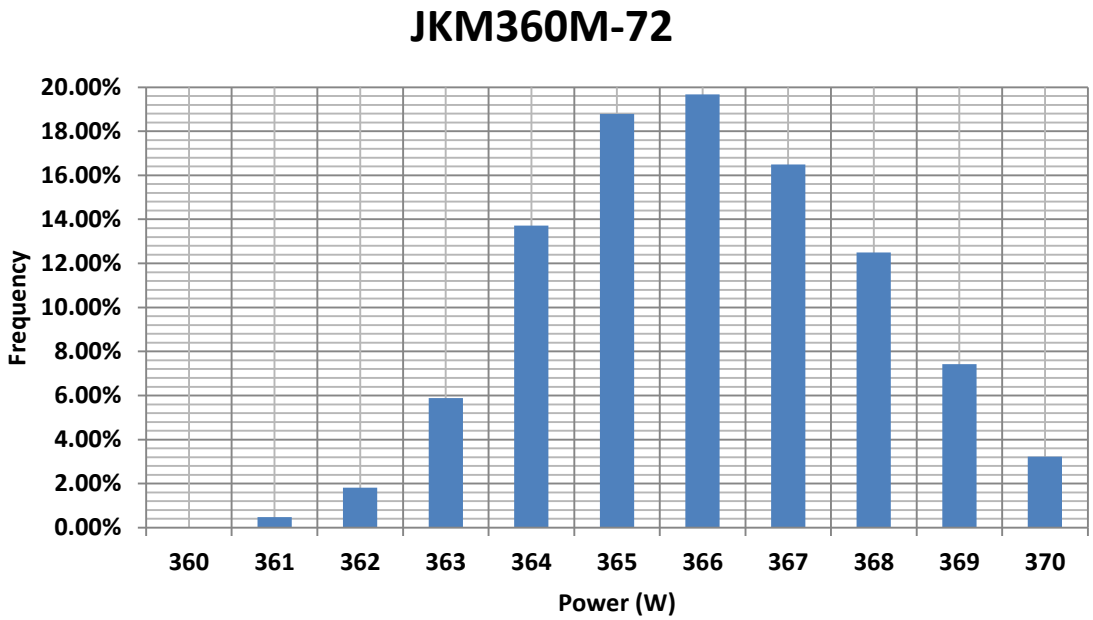
The Solar Pyramid – The Actual Power in the Field

The two key factors:

1. **+3% Power tolerance (Jinko 360W can be up to 371.8W, others can only go up to 355W)**
2. **Temperature Coefficient (Jinko does not lose as much power at high T as others does).**

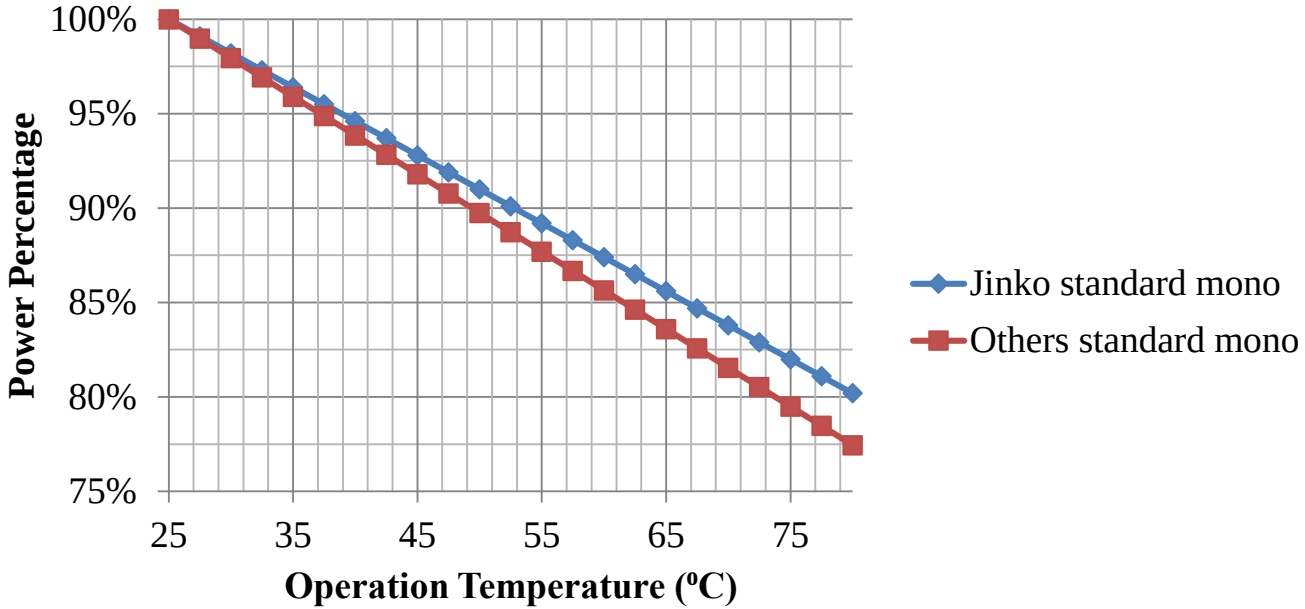
Take-home message: our better temperature coefficient and 3% power tolerance ensures higher actual output in the actual operation.

The Solar Pyramid – The Actual Power in the Field



The +3% power tolerance brings you more power from the same nameplate power.

The Solar Pyramid – The Actual Power in the Field

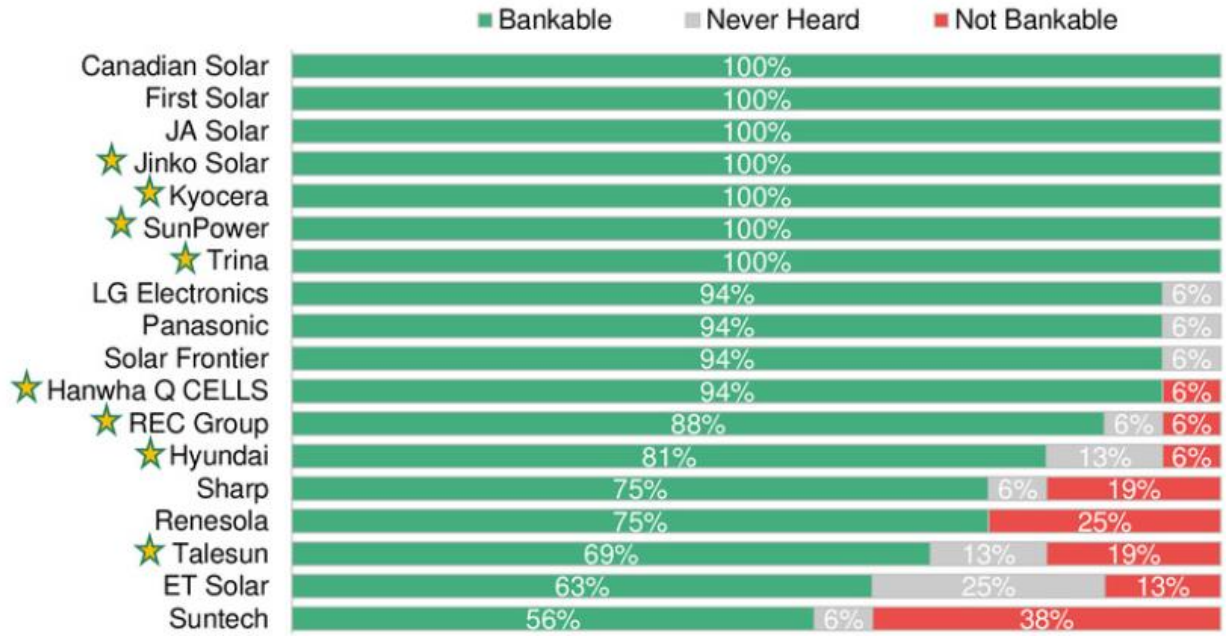


At a module temperature of 75 degree C (or ambient temperature of 50 degree C),

Jinko module produces 2.5% more power than other brands.

The financial significance of quality

Figure 1: BNEF's PV bankability survey (top 15)



Source: Bloomberg New Energy Finance Note: Stars indicate the 'top performers' within DNV GL's 2017 PV Module Reliability Scorecard Report. DNV GL did not test all of the manufacturers listed above, so a missing star is not indicative of poor quality.

The financial significance of quality

PROJECT		Basic	JINKO	Other Tier 1	Other Tier 1	Other Tier 1
Module Unavailability (%)			0	0	2	5
Positive Power tolerance(%)			+3%	+5W	+5W	+5W
Project capacity (MWp)		100	POLY	POLY	POLY	POLY
Module Power(W)			330	335	335	335
Module price (USD cents/Wp)			32	31	31	31
Power Warranty(year)			25	25	25	25
Temperature Coefficiency of Power(%)			0.4	0.4	0.4	0.4
First year degradation (%)			2.5	2.5	2.5	2.5
Annual degradation (%)			0.7	0.7	0.7	0.7
Positive Power tolerance(%)			3	1.5	1.5	1.5
Bifacial Factor(%)						
Ground reflection						
ANALYSIS RESULTS						
LCOE (USc/kWh)			5.66	5.77	5.90	6.11
IRR			15.65%	15.00%	14.16%	12.95%
Capital Invest			$ 45,552,508	$ 45,389,742	$ 45,389,742	$ 45,389,742
Land cost			$ -	$ -	$ -	$ -
EPC cost(/Wp)			$ 0.7592	$ 0.7565	$ 0.7565	$ 0.7565
Module cost			$ 19,199,981	$ 18,599,535	$ 18,599,535	$ 18,599,535
Inverter cost			$ 5,874,089	$ 5,981,738	$ 5,981,738	$ 5,981,738
Mounting Construction cost			$ 5,890,730	$ 5,802,615	$ 5,802,615	$ 5,802,615
BOS cost (/Wp)			$ 0.4392	$ 0.4465	$ 0.4465	$ 0.4465
Lifetime energy production (MWh)			2040116	1996124	1956202	1896318
O&M Cost ($)			$ -	$ -	$ 393,705	$ 984,262

Let's evaluate the financial value of performance, reliability and durability → 100MW PV project simulation.

The financial significance of quality

In this case, Jinko module is assumed to be 3% more expensive than other Tier 1 peers, but remember:

1. Module is not the only project component.
2. The outcome is what we care about.

The Solar Pyramid – The Actual Power in the Field

Distinct energy output through 25 years due to:

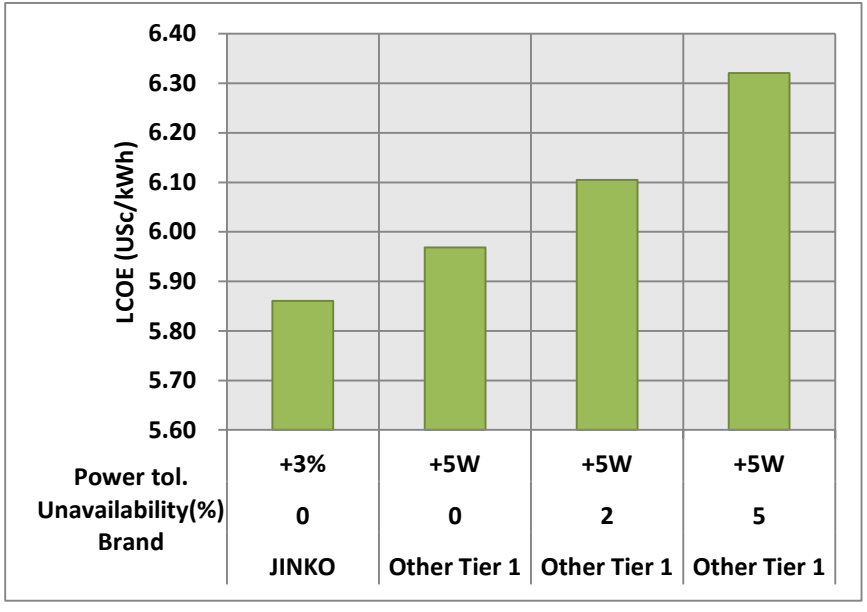
1. **Performance difference in hot climate;**
2. **Module reliability and durability → please refer to DNV GL report.**

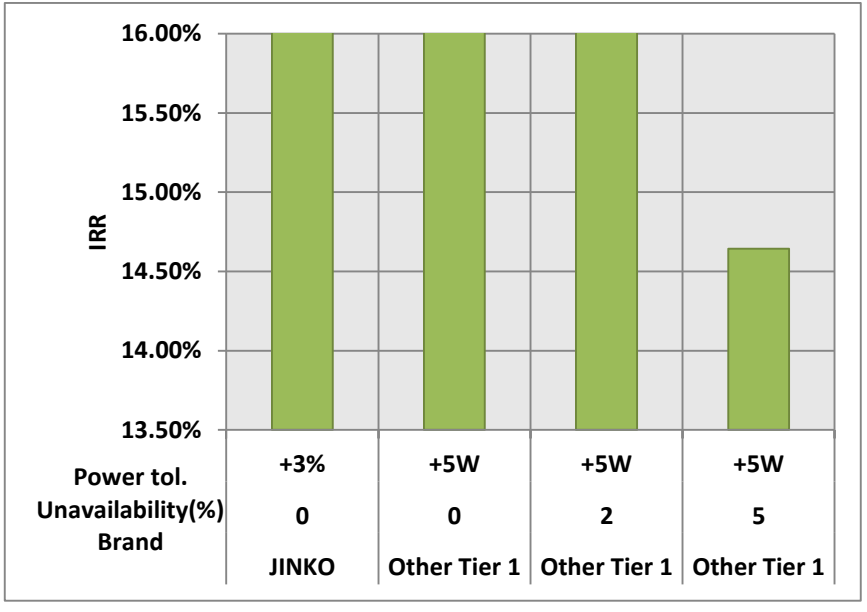
The Solar Pyramid – The Actual Power in the Field

Poor reliability and durability can result in high O&M cost, up to USD 1m.

→ This can be avoided by evaluation about quality vs price.

The Solar Pyramid – The Actual Power in the Field





Key to succeed a good PV investment:

1. **Excellent actual outdoor performance;**
2. **High reliability and durability due to superior BOM.**

→ High IRR (up to 2.5% higher in this case).

Tips to ensure high IRR

Tips to consolidate a high IRR → quantify everything rather than only $$$:

1. *Top performers at DNV GL reliability scorecard report*
2. *Superior BOM to minimize module failures*
3. *High outdoor actual performance*
4. *+3% power tolerance and excellent temp coeff*

Contact details

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Jinko develops advanced technologies to …

"A new technology aims to reduce the electricity cost and make electricity more affordable for the society, and this is what science is for."

- Prof. Stuart Wenham

The End