Ultra-high performance panels in the utility scale projects in the European markets

24.04.2019

Andrea Viaro, Head of Technical Service Jinko Solar Europe

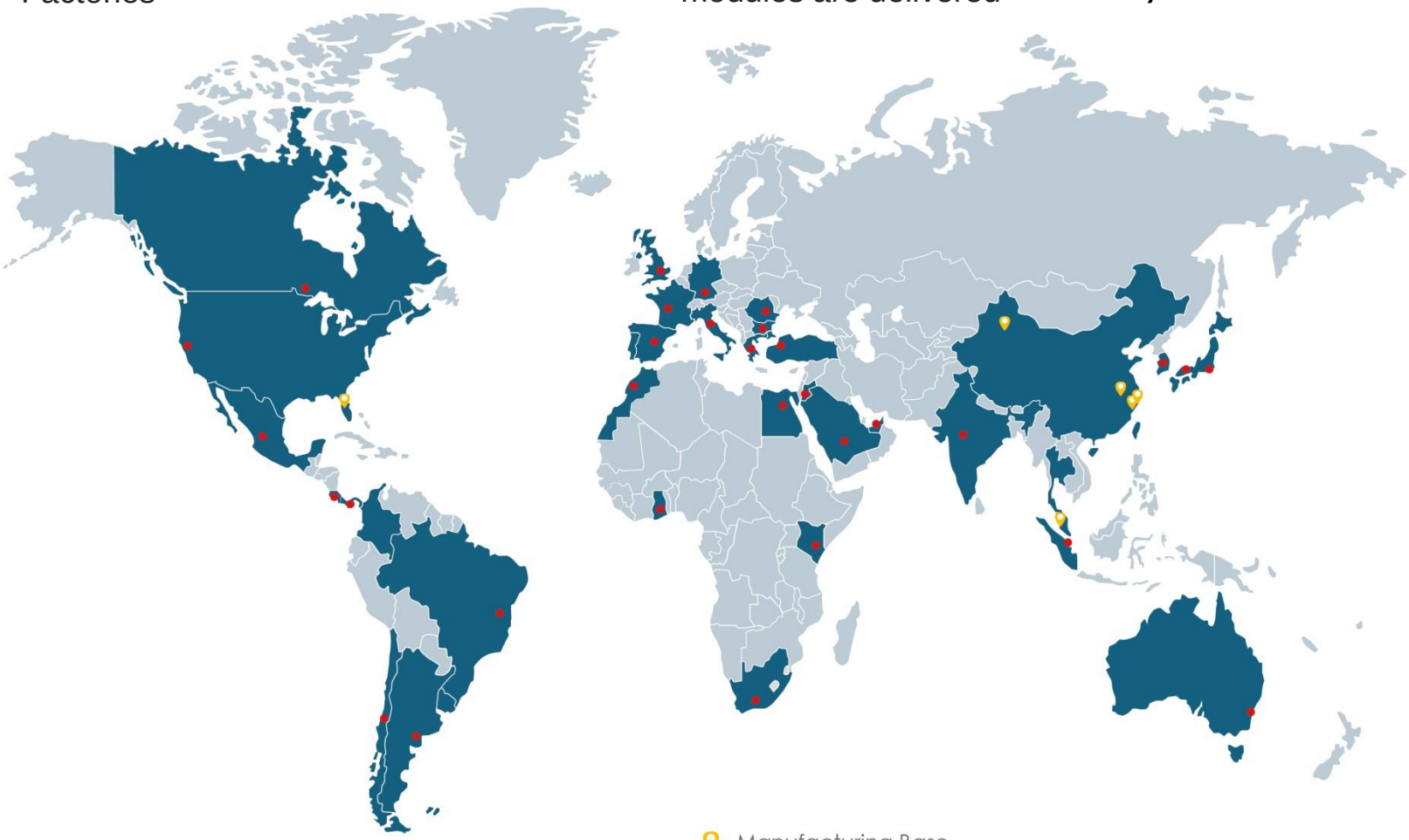
Facts and Figures

6 Global Factories

34 Sales Offices

80+ Countries where the modules are delivered

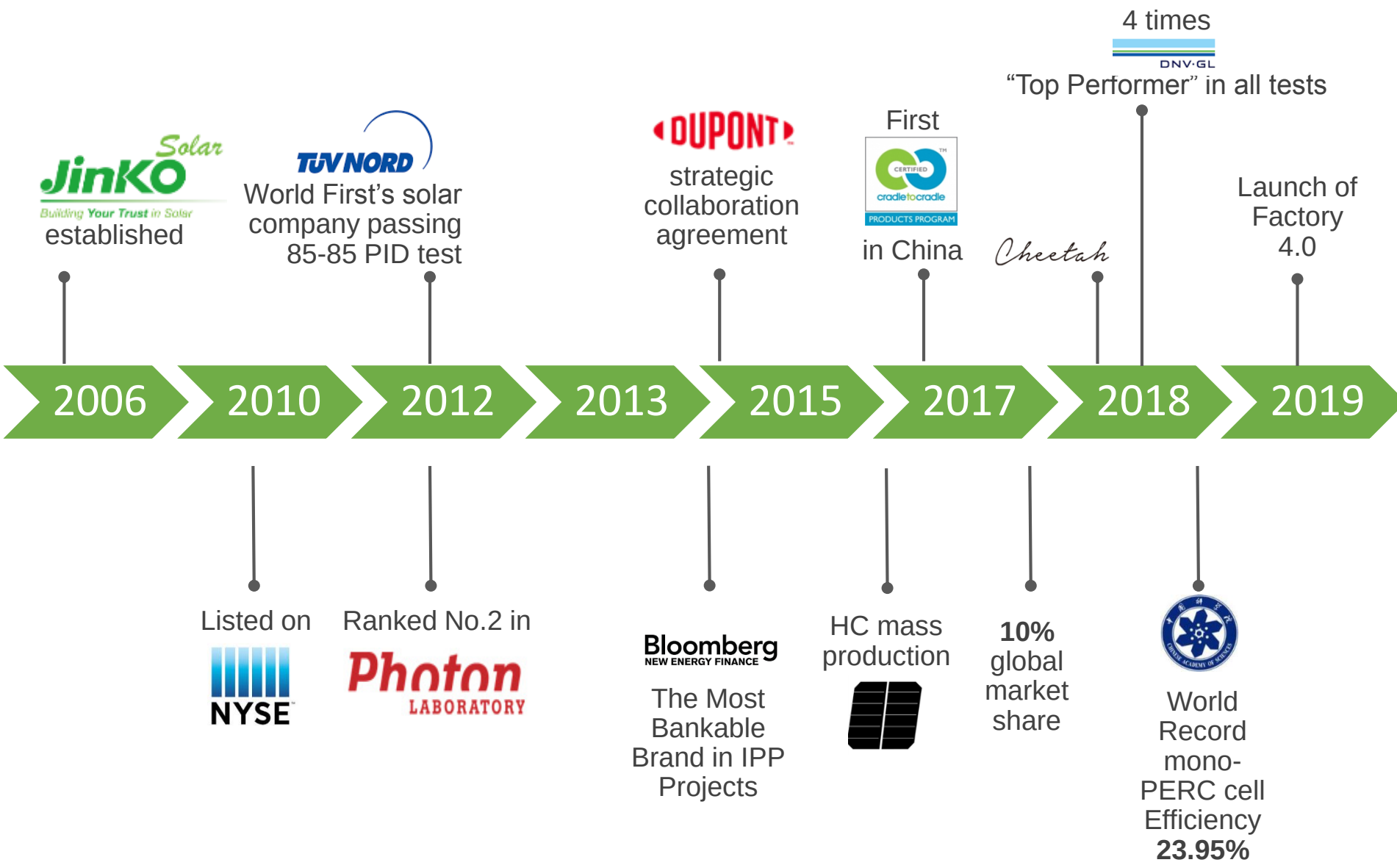
12,000 Employees



11.3 GW Capacity (‘18)

40 GW Delivered (Dec’18)

JinkoSolar's Major Milestones



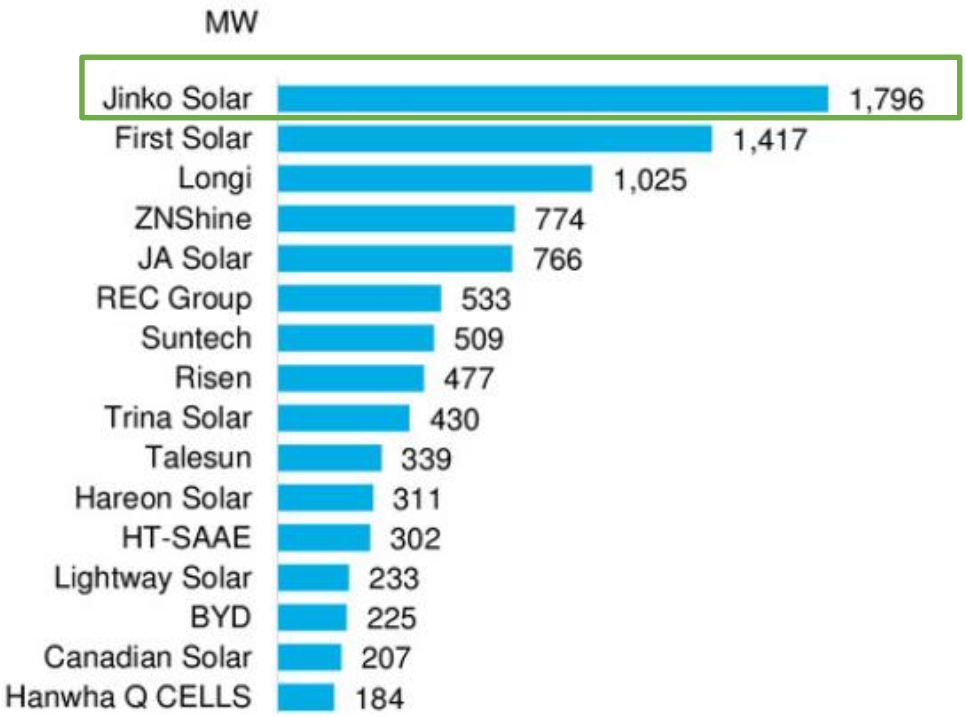
JINKO as the Most Bankable Brand in IPP Projects

Top 10 Solar Module Suppliers of 2018

#	Module Supplier	Y/Y
1	JinkoSolar	≡
2	JA Solar	↑
3	Trina Solar	↓
4	LONGi Solar	↑
5	Canadian Solar	↓
6	Hanwha Q-CELLS	↓
7	Risen Energy	↑
8	GCL-SI	↓
9	Talesun	↑
10	First Solar	↑

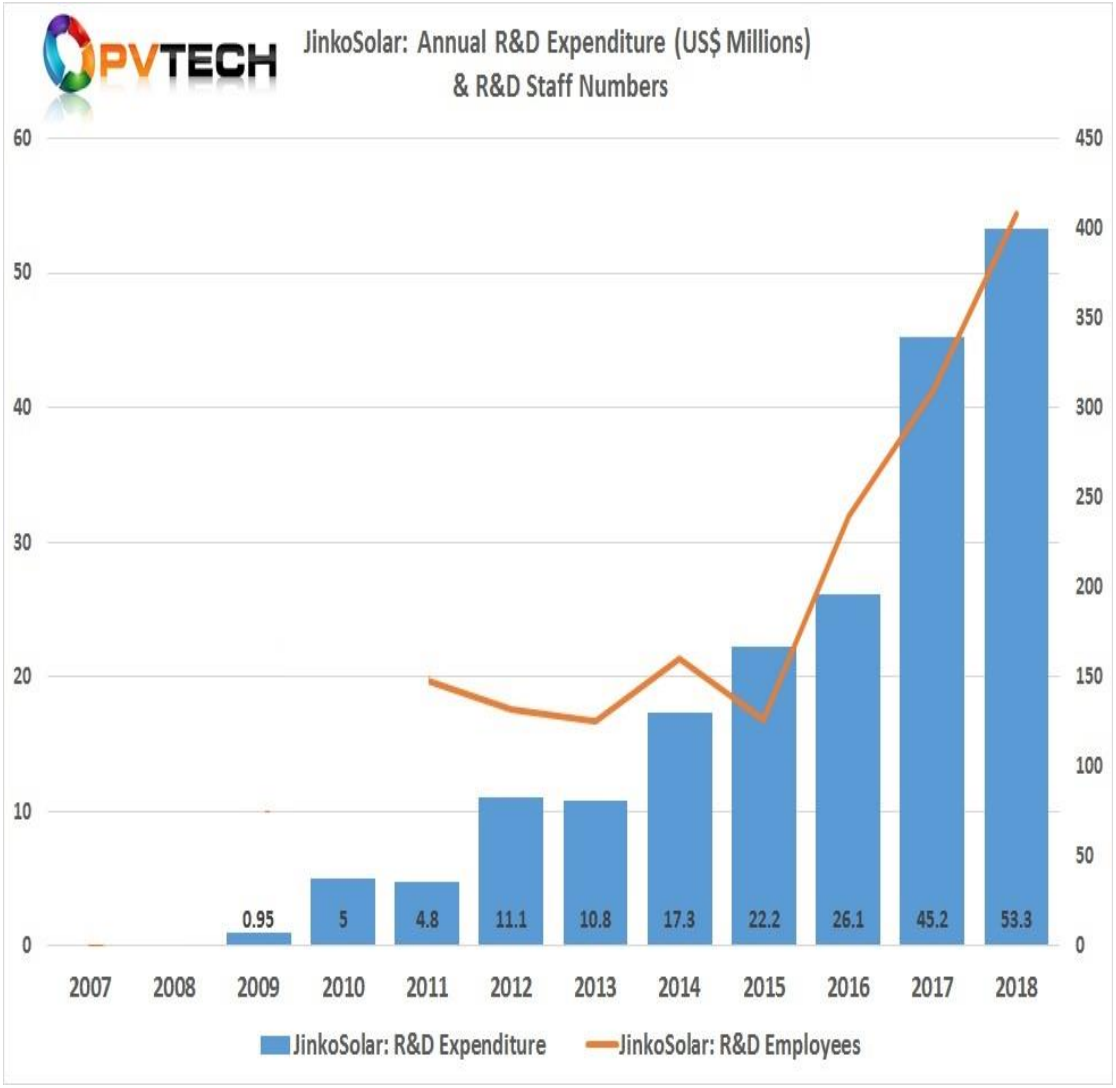
PVTECH

Figure 3: Top 20 PV module brands used in term-loan financed projects after July 1, 2016



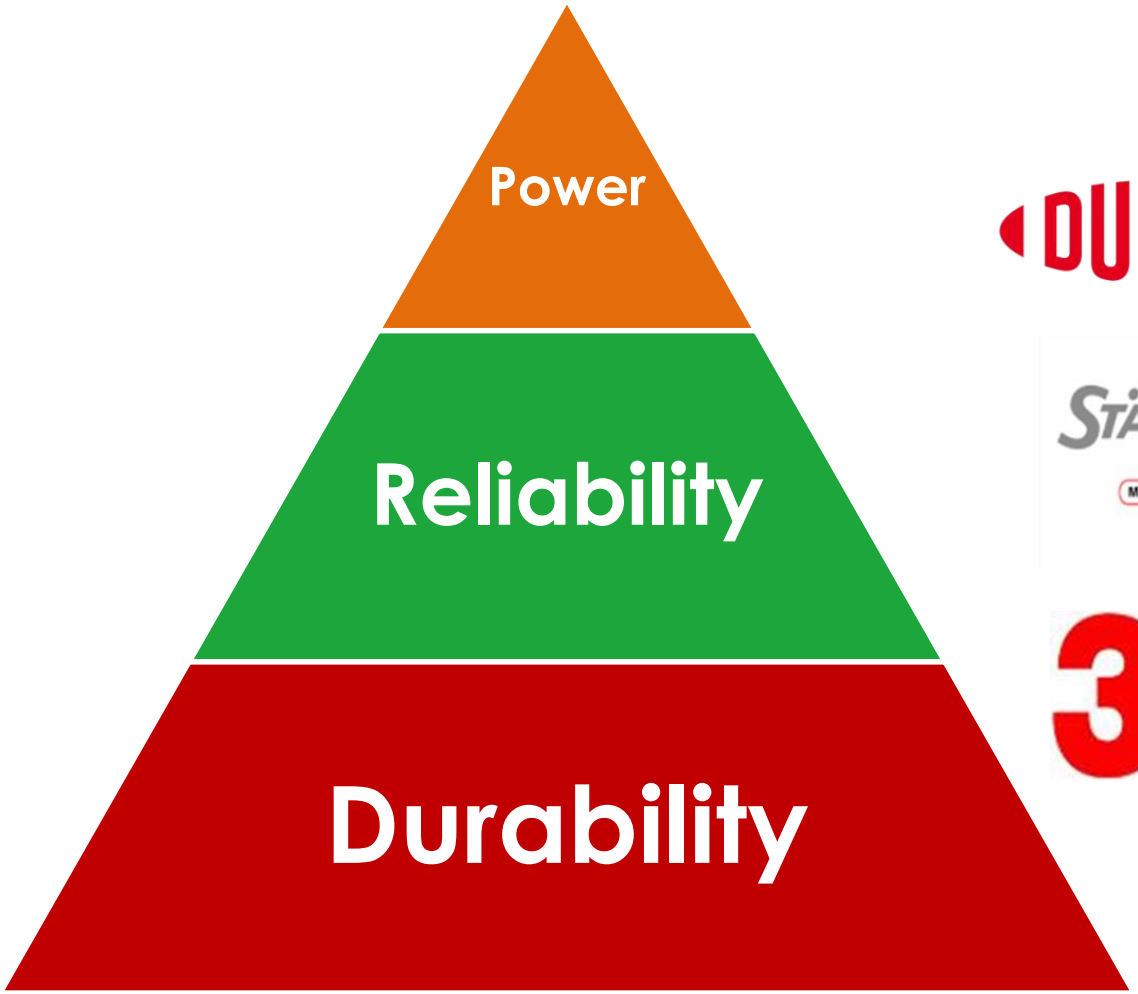
Source: Bloomberg NEF

R&D Leadership & First Class Components



- **>53 $M** in 2018 R&D expenditures
- **>400** full-time technical staff
- Dedicated **wafer, cell and module** R&D facilities
- Cooperation with global Research Institutes
- Filed **464 patents**

The Quality Pyramid – Built from Solid Foundation



Third-Party Testing: Accelerated Aging – DNV GL

4 times "DNV-GL Top Performer" in all tests

All Module Series tested: Eagle Poly, Mono Standard and PERC

HC and Cheetah Series testing ongoing

TOP PERFORMER

in 2018 Test Protocol

Damp Heat 1000

Thermal Cycling 600

Humidity Freeze 30

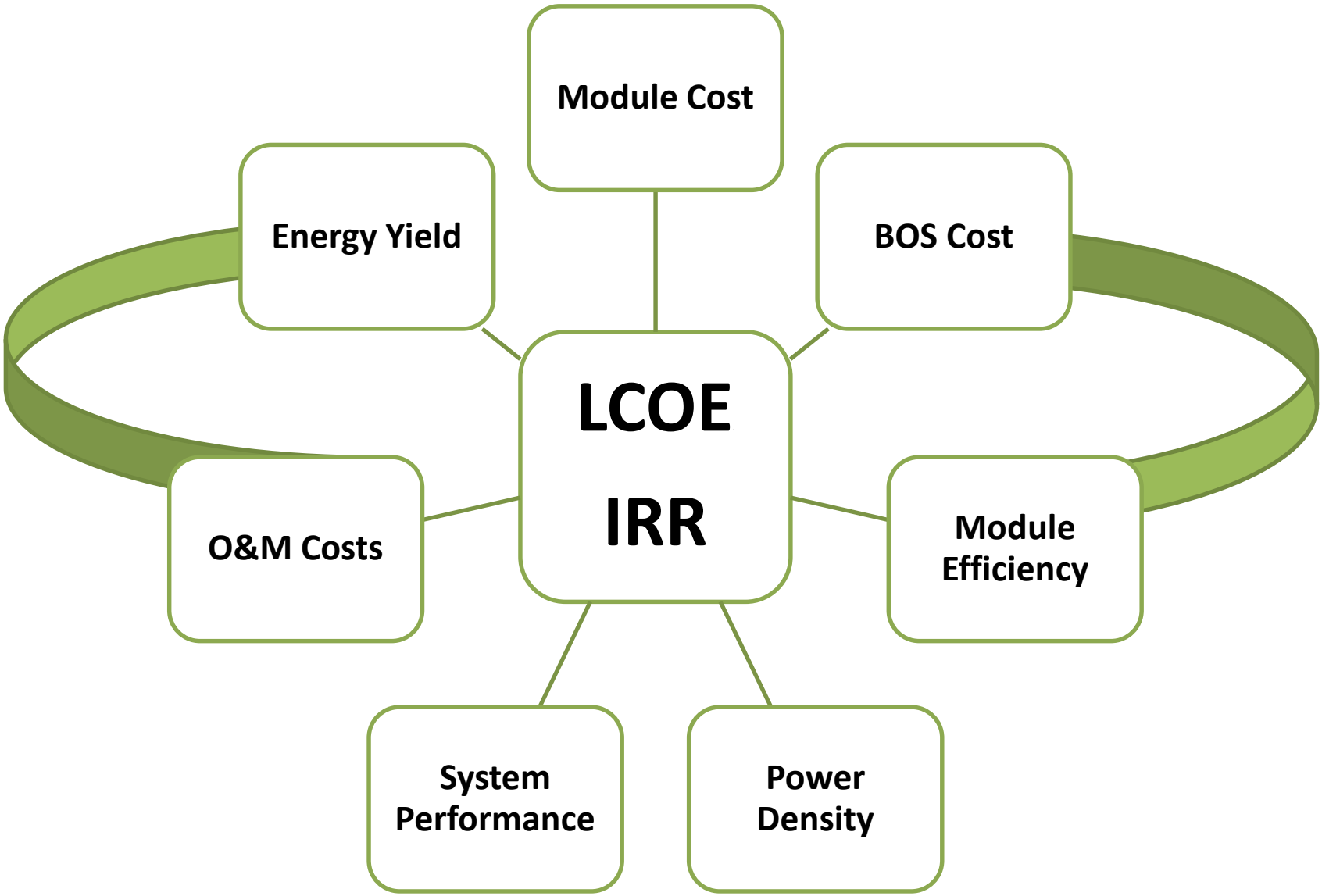
UV Light 90

Dynamic Mechanical Load 1000

PID Resistance 192

	TOP PERFORMER 2018 PV MODULE RELIABILITY SCORECARD	TOP PERFORMER 2017 PV MODULE RELIABILITY SCORECARD	TOP PERFORMER 2016 PV MODULE RELIABILITY SCORECARD	TOP PERFORMER 2014 PV MODULE RELIABILITY SCORECARD
Jinko Solar	√	√	√	√
Trina Solar	√	√	√	√
Yingli Solar	√	√	√	√
Astronergy Solar	√	√		√
Hanwha Q CELLS Co., Ltd	√	√	√	
JA Solar Holdings	√		√	√
REC Solar	√	√	√	
BYD Co, Ltd	√	√		
Flex Ltd	√	√		
GCL System Integration Technology Co., Ltd.	√	√		
LONGi Solar Technology Co, Ltd	√	√		

Levelized Cost Of Electricity



Ultra High Performance Module: Cheetah Series

Cheetah

Mono PERC Module Efficiency

Industry leading Large Cell technology (158.75mmx158.75mm)

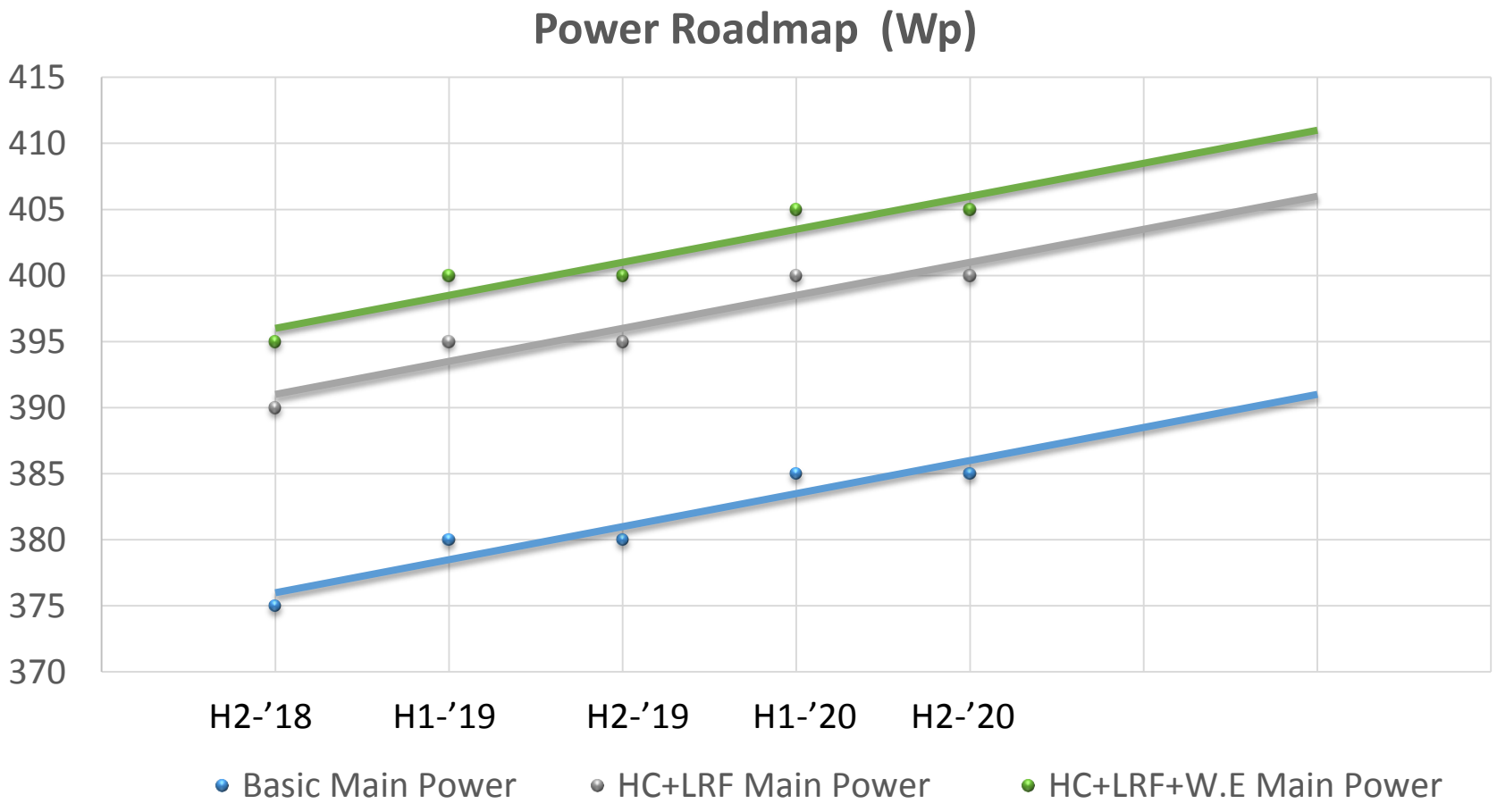
Avg. 8Wp power up compared to 156.75mm Mono PERC

Lower BOS costs

Avg. 7Wp power up compared to Cheetah full-cell

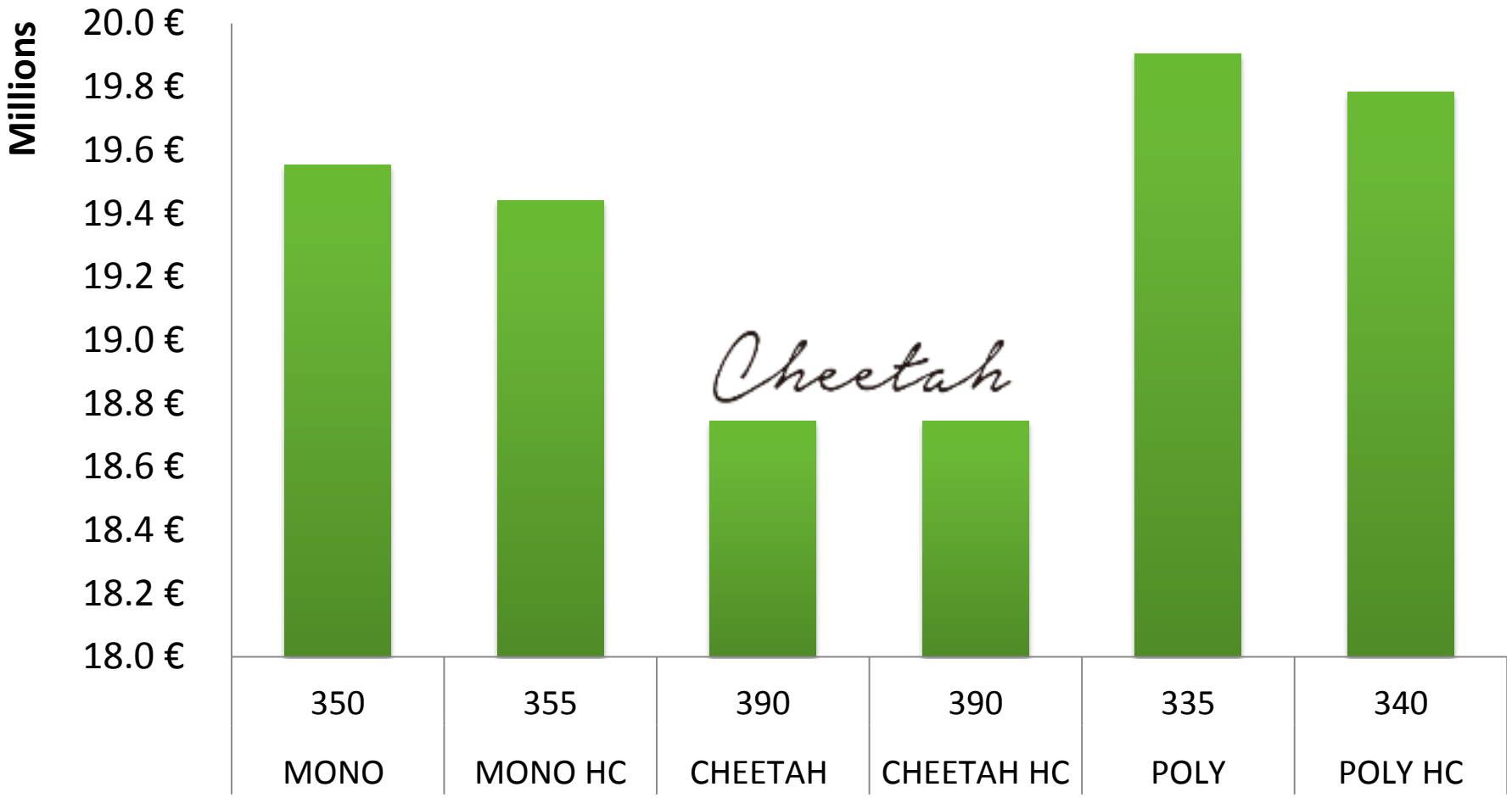
Lower thermal losses

Cheetah PERC Mono 72-cell



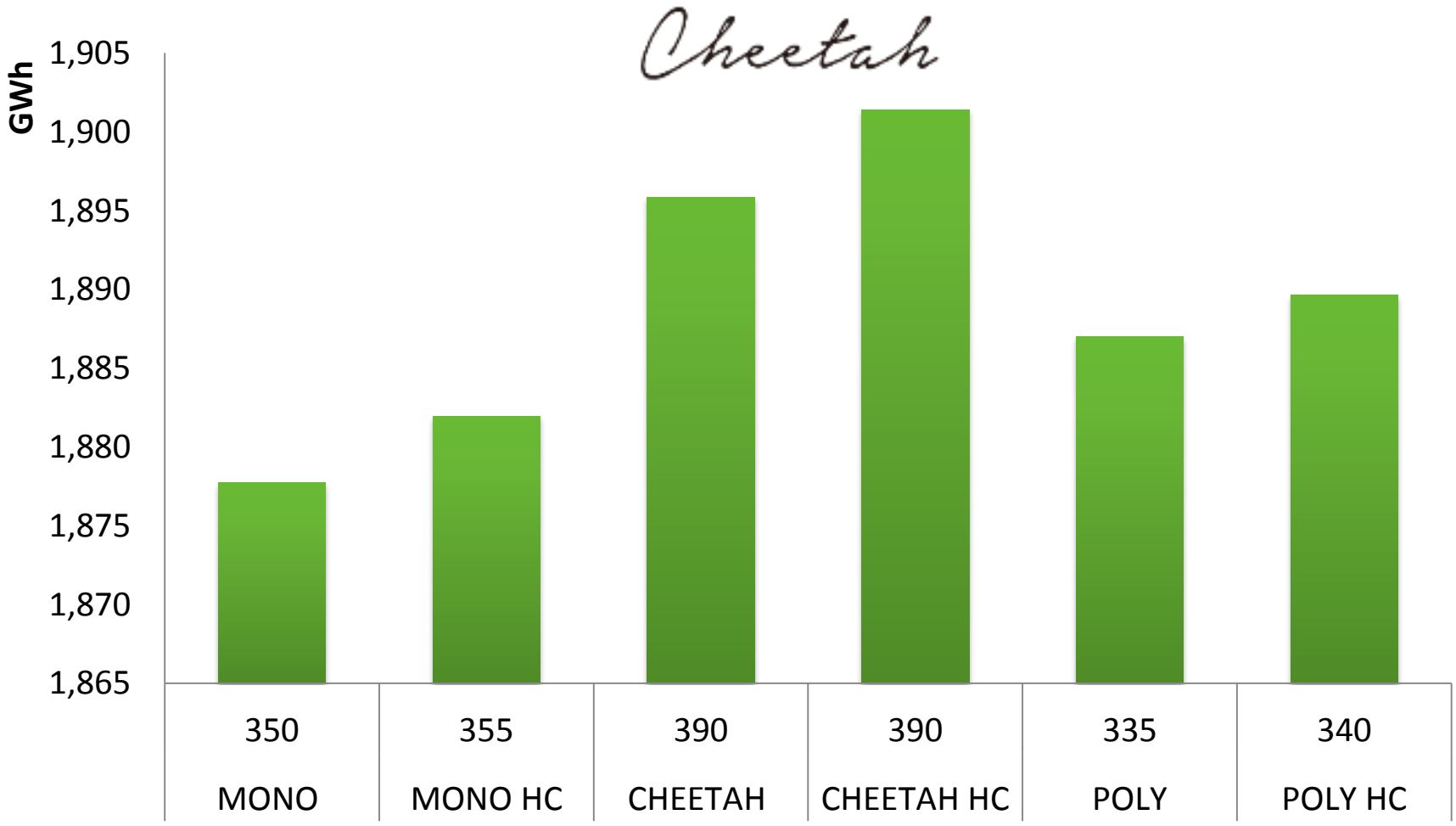
Notes: Basic means with Standard Materials; W.E means White EVA

Comparison: BOS Costs



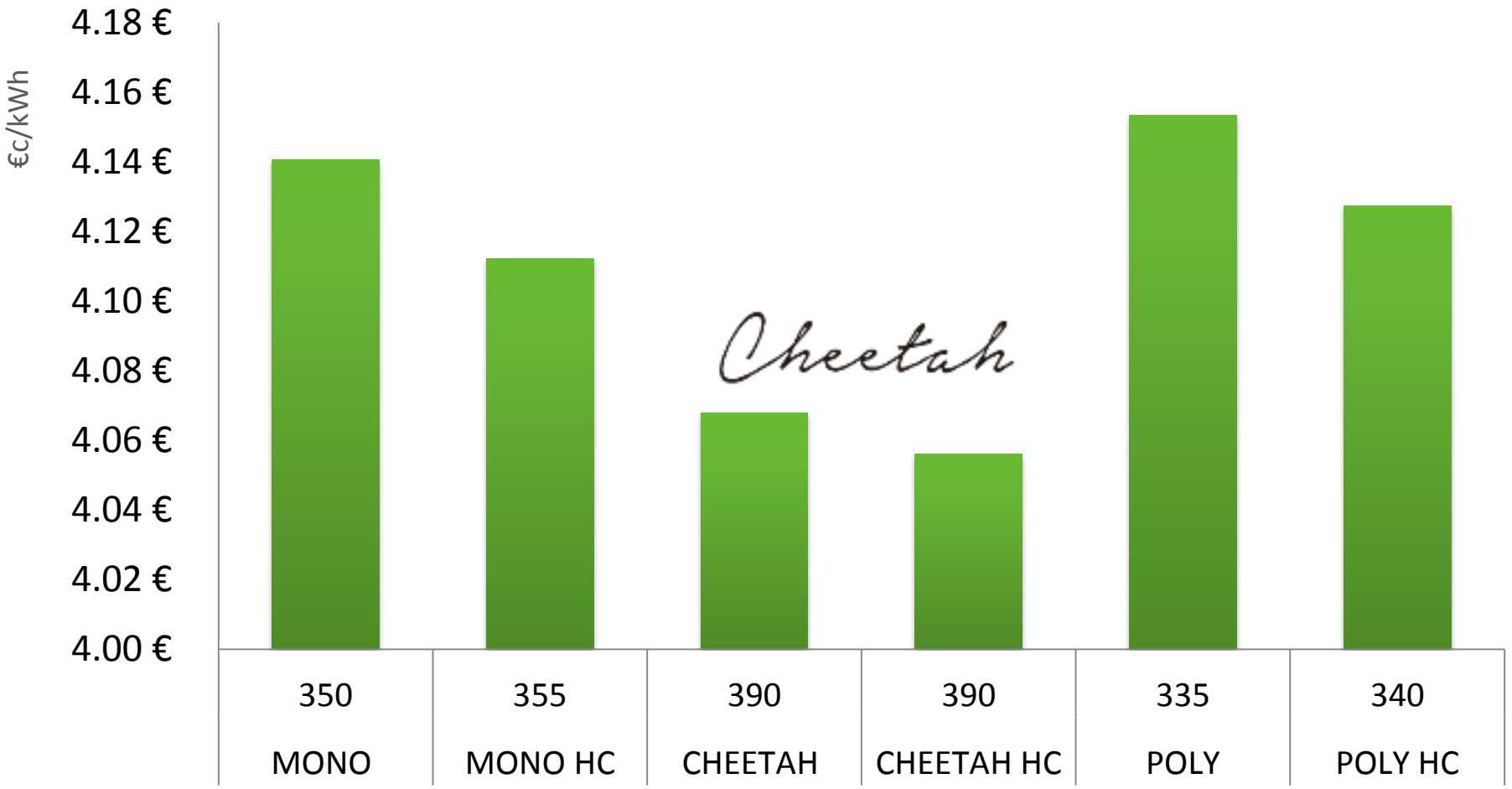
Example: Spain, Sevilla - 42.5 MW Project - ground-mounted fixed racks - 1500V System

Comparison: Lifetime Energy Yield (GWh)



Example: Spain, Sevilla - 42.5 MW Project - ground-mounted fixed racks - 1500V System

Comparison: Levelized Cost of Electricity (€c/kWh)



Example: Spain, Sevilla - 42.5 MW Project - ground-mounted fixed racks - 1500V System

The “Quality Recipe” for Secure Investment

- Think in terms of EUR/kWh, LCOE, IRR rather than EUR/Wp: **reliability & durability are key**
- Increased module peak power up to **400Wp** maximizes the economic returns and enables lower BOS and labor costs.
- Extended testing such as **PQP (DNV.GL Product Qualification Programme)** better simulate the real-aging conditions in the field **beyond IEC certifications**
- Competitive advantage of **field-proven materials and panel construction**, especially in harsh climatic and temperature-sensitive environments
- **Technical Bankability**, **Financial Stability**, proven field track record, are key for secure IRR

Thank You!

andrea.viaro@jinkosolar.com

PV TECH / JINKOSOLAR WEBINAR

Rubén Ron. Head of Solar Section

24 April 2019

GLOBAL REACH – LOCAL COMPETENCE

150+
years

100+
countries

100,000+
customers

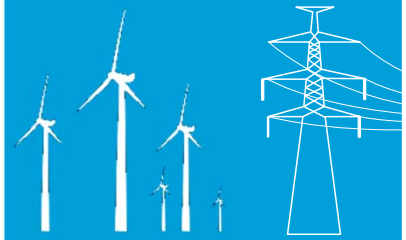
12,500
employees

OUR VISION: GLOBAL IMPACT FOR A SAFE AND SUSTAINABLE FUTURE

MARITIME

OIL & GAS

ENERGY



BUSINESS ASSURANCE

DIGITAL SOLUTIONS

TECHNOLOGY & RESEARCH

INDUSTRY CONSOLIDATION

DNV·GL

DNV

GL Group

KEMA

NOBLE DENTON

GARRAD HASSAN

ADVANTICA

BROAD AND DEEP EXPERTISE IN SOLAR PROJECTS

FEASIBILITY

- Feasibility studies
- Utility grid integration
- Environmental permitting
- Component technology reviews
- Component qualification testing
- Type and component certification of PV inverters

ENGINEERING & DEVELOPMENT

- Due diligence / Independent engineering
- Owner's engineering
- Energy assessment
- Pre-construction engineering
- Interconnection support
- Project certification

CONSTRUCTION & COMMISSIONING

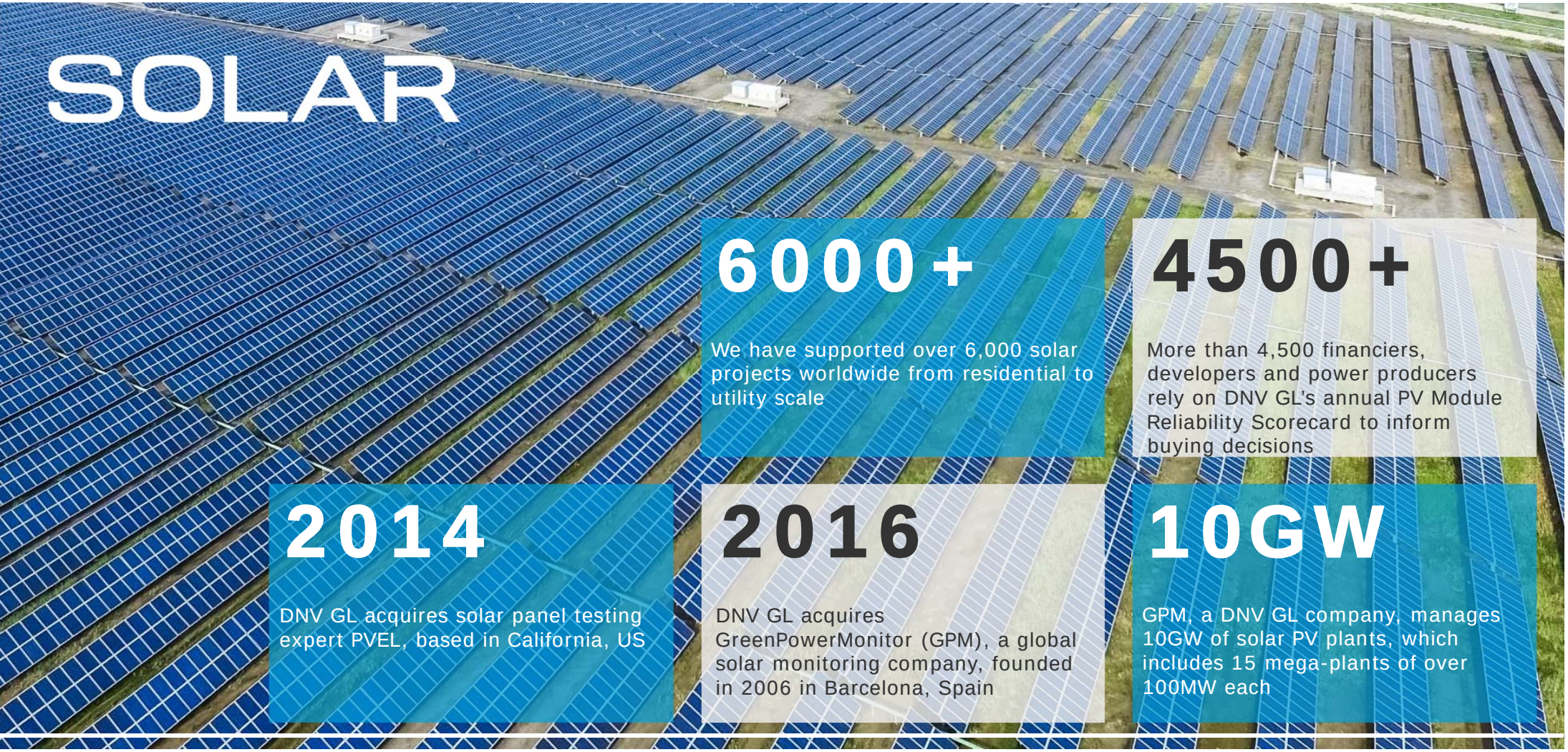
- Due diligence/ Independent engineering
- Owner's engineering
- Construction oversight
- System testing and inspection
- Project certification and grid code compliance
- Declaration of conformity
- Module batch testing
- Project certification

OPERATION

- Performance validation
- Resource and energy forecasting
- Existing asset consulting, inspections and decommissioning
- Refinancing and mergers and acquisitions advisory services
- Forensic investigations
- Monitoring, control and asset management
- Project certification

*Our testing, certification and advisory services are independent from each other

SOLAR



6000+

We have supported over 6,000 solar projects worldwide from residential to utility scale

4500+

More than 4,500 financiers, developers and power producers rely on DNV GL's annual PV Module Reliability Scorecard to inform buying decisions

2014

DNV GL acquires solar panel testing expert PVEL, based in California, US

2016

DNV GL acquires GreenPowerMonitor (GPM), a global solar monitoring company, founded in 2006 in Barcelona, Spain

10GW

GPM, a DNV GL company, manages 10GW of solar PV plants, which includes 15 mega-plants of over 100MW each

*Our testing, certification and advisory services are independent from each other

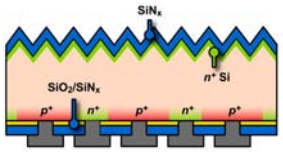
LATEST TRENDS ON PV MODULE TECHNOLOGY

Tricky Decision for Developers – Investors – Lenders – EPCs

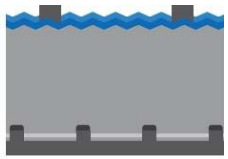
Cell / Module Technology

Half-cut cells

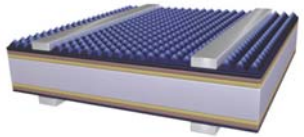
IBC



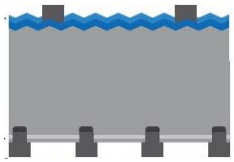
PERC



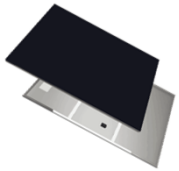
HJT



Bifacial



Thin Film



Supporting Structure

Ground Fix Structure

One Axis Solar Tracker

PV MODULE TECHNOLOGY BANKABILITY

Main Challenges – PERC / Bifacial

Manufacturing

- Additional steps
- New Materials
- Quality Assurance System

Technical

- LID / LeTID
- Long term degradation
- Weight
- Mismatching

Design

- Site Selection
- Measurements
- Supporting Structure
- Lower GCR
- Backside shading
- Overtightening bolts. Frameless

Testing

- Not fully developed
- IEC 60904-1-2
- Warranties

Modelling

- Lack of validation
- Bifaciality factor
- Albedos Variability
- Tracking System

O&M

- Limited field experience
- Higher OPEX
- Spare parts in the future

PV MODULE TECHNOLOGY BANKABILITY

Main Mitigation Measures / Initiatives

- Mixing technologies Mono/bi
- Reducing leverage of debt
- Increased warranty levels
- Manufacturer Bankability reports
- Collaboration with manufacturers
- The importance of BOM
- Maintenance Reserve Account
- Presentations to Banks

U.S. Department of Energy awards study of bifacial PV technology, which could prove a 10% increase in energy output

Research study by DNV GL will be the most comprehensive energy yield analysis for bifacial PV modules to date

PV MODULE TECHNOLOGY BANKABILITY

Solar Equipment Classification

Categories	Requirements	Level of review
Proven	▪ > 5 years/> 1 GW ▪ 2-5 years, < 1 GW – Add. information required	✓Bankability review ✓Full IE review
Qualified	▪ Met all required certifications ▪ 3rd party bankability and reliability test data	✓Fatal flow review
New Technology	▪ Not Proven nor Qualified	

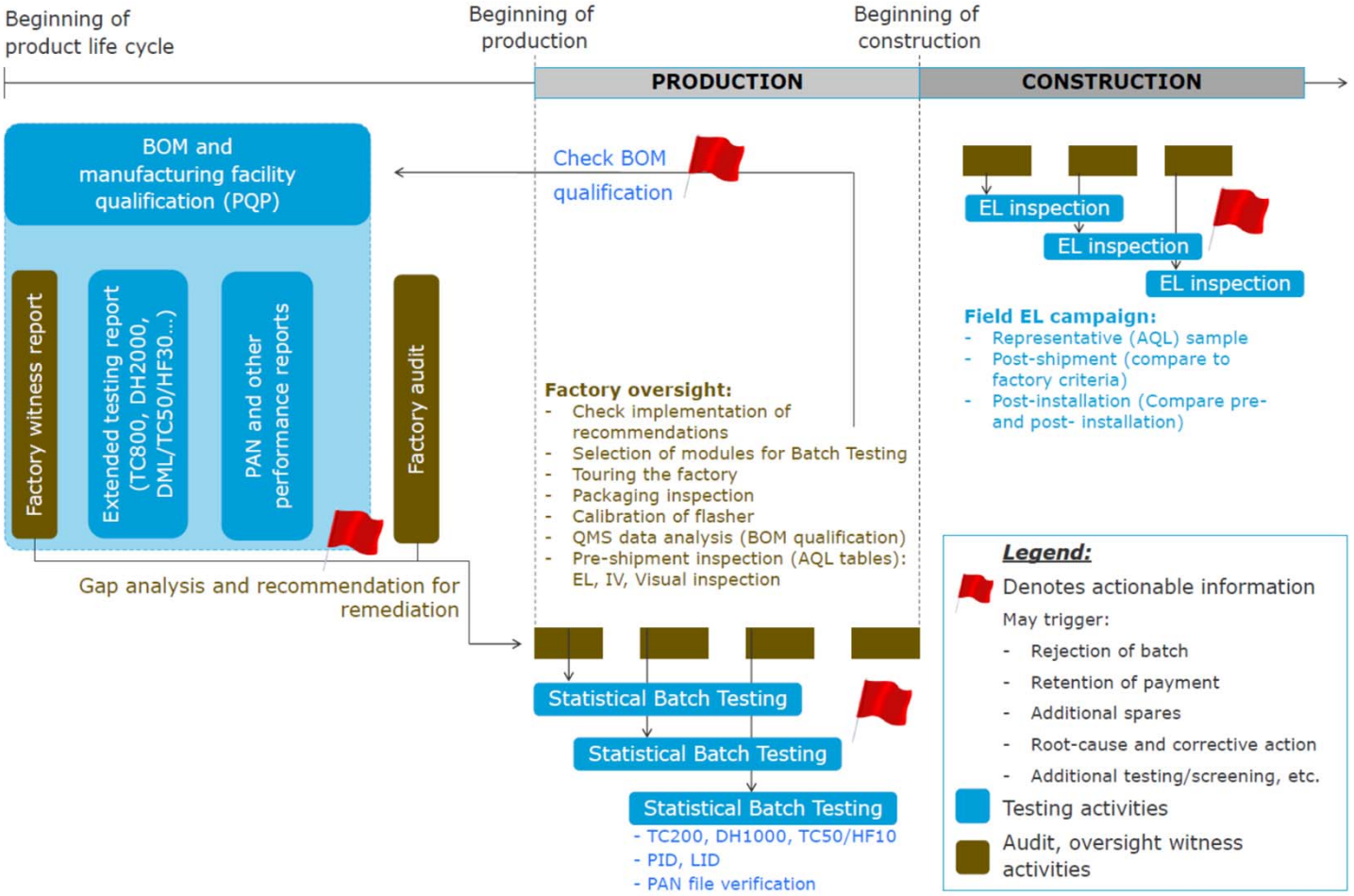
PV MODULE PROCUREMENT BEST PRACTICES

Guidelines are based on:

- Quality/reliability practices commonly observed across industries
- Technology risks which are specific to PV modules
- DNV GL's extensive experience on advisory

Not every project requires a similar level of quality

- Project size
- Buyers risk aversion
- Manufacturer guarantee level



Thank you

Rubén Ron
ruben.ron@dnvgl.com

www.dnvgl.com

SAFER, SMARTER, GREENER