

# LCoE Assessment of Trina Vertex PV Modules in Brazil & Germany

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Shaily Milany, Solar Advisory Lead - APAC  
[Shaily.milany@ul.com](mailto:Shaily.milany@ul.com)

# Agenda

1. About UL Solutions
2. Overview of Assessment
3. LCoE Assessment
4. LCoE Results

# UL SOLUTIONS

# Key office locations - renewables



**300 + GW**  
Total renewable energy gigawatts (MW) assessed



**100,000+**

HYBRID POWER PROJECTS  
MODELED SINCE 2014



Forecast provider for  
**100+ GIGAWATTS**  
OF INSTALLED RENEWABLE ENERGY  
PROJECTS



Independent/Owners Engineer for  
**600+**  
WIND AND SOLAR PROJECTS  
SINCE 2012



**500+**  
RENEWABLE  
ENERGY EXPERTS

**35+** *years of*  
EXPERIENCE IN  
RENEWABLE ENERGY



UL has assessed

**100+**

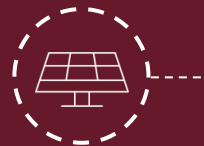
UTILITY-SCALE SOLAR  
PROJECTS SINCE 2013



HOMER Energy  
Software is used in

**190+**

Countries, with over  
**250,000** users



**1000+**

PV products  
evaluations annually

Wind, solar, storage and hybrid power solutions for the renewable energy future.



Wind



Solar



Storage



Microgrids



DER

# UL Advisory Services Life Cycle – Energy & Storage

## Feasibility



Conceptual Designs &  
Feasibility Studies

## Development



Energy and Storage  
Modeling

## Preconstruction and Financing



Independent  
Engineering

## Construction



Construction  
Monitoring

## Operations, Repowering and Refinancing



Operational  
Reviews



# OVERVIEW

## Assessment of Levelized Cost of Energy (LCoE) for 2 Scenarios

- Vertex 210RN 610Wp & 210N 700Wp
- Bifacial Monocrystalline Technology
- 2 Geographic regions in Brazil & Germany
- Trina 1P Trackers for Brazil
- Fixed-Tilt Structure for Germany
- LCoE Comparison with 3 Reference Modules





# Overview

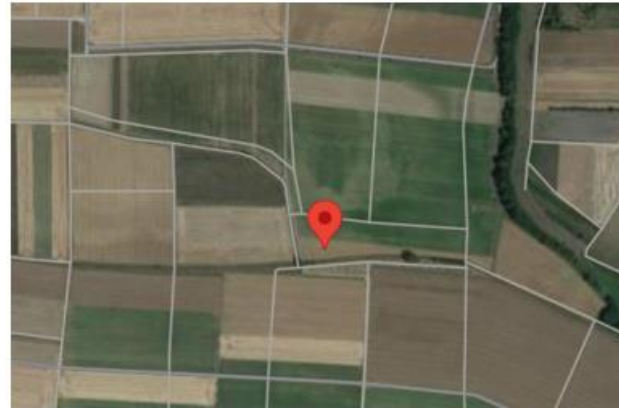
## Project Configuration

	Brazil	Germany
DC capacity- MWp	125	62.5
AC Capacity- MW	100.2	50.1
DC/AC Ratio	1.25	1.25
MMS configuration	Single axis N-S Tracker (E-W tracking angle: +60°/-60°) with 1P orientation	Fixed tilt of 20° with 2P orientation
Inverter type	Huawei string inverter	Huawei string inverter
Inverter capacity- kW	300	300
Inverter quantity	334	167

Rio Verde,  
Goias, Brasil



Eurbach,  
Germany



# LCOE ASSESSMENT

# Module Specifications

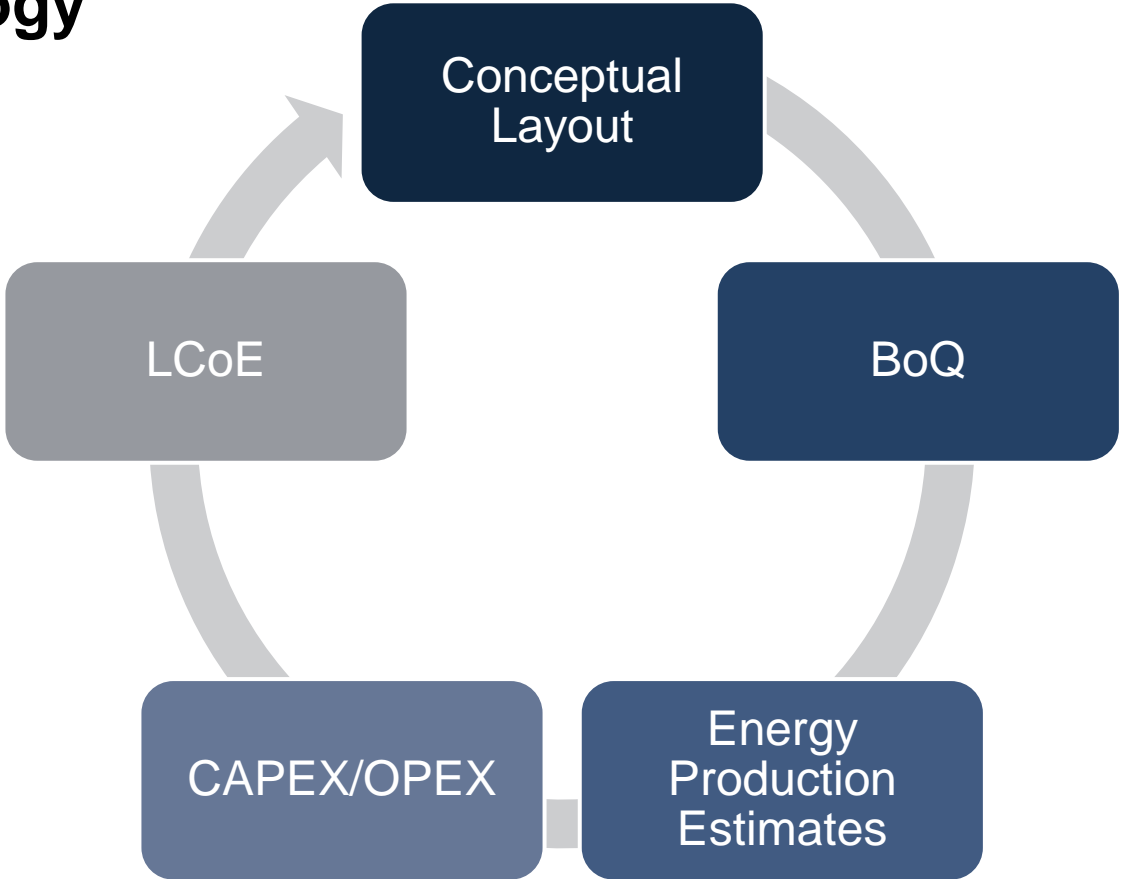
Parameter*	182N-78-625Wp	182N-72-580Wp	182RN-72-610Wp	Trina 210RN-66-610Wp	Trina 210N-66-700Wp
Module Type	Bifacial, Monocrystalline	Bifacial, Monocrystalline	Bifacial, Monocrystalline	Bifacial, Monocrystalline	Bifacial, Monocrystalline
Max Power Output (Wp)	625	580	610	610	700
Open circuit Voltage (V)	55.49	51.02	51.42	49.0	48.6
Short circuit Current (A)	14.36	14.47	14.77	15.86	18.32
Max power point Voltage (V)	46.37	42.37	43.61	40.8	40.5
Max. power point Current (A)	13.48	13.69	13.99	14.96	17.29
Number of cells	156	144	144	132	132
Module Size (W x L)	1.134m x 2.465m	1.134m x 2.278m	1.134m x 2.382m	1.134m x 2.382m	1.303m x 2.384m
Efficiency (%)	22.4	22.45	22.6	22.6	22.5

\*All electrical parameters are at STC.

## 3 Reference Modules with Comparable:

- Technology
- Efficiency Range
- Power Range 580-700Wp

# Methodology



# A. Configuration, Layout and BoQ

## Project Design - Brazil

Configuration Parameters	182N-78-625Wp	182N-72-580Wp	182RN-72-610Wp	Trina 210RN-66-610Wp	Trina 210N-66-700Wp
Tracker Range of Motion	55° Range of Motion, Backtracking				
Azimuth from True North	Azimuth of 0° from True North				
Collector width / Pitch (m)	2.465 / 7.0	2.278 / 6.5	2.382 / 6.8	2.382 / 6.8	2.384 / 6.8
Ground Cover Ratio (%)	35%				

## Project Design - Germany

Configuration Parameters	182N-78-625Wp	182N-72-580Wp	182RN-72-610Wp	Trina 210RN-66-610Wp	Trina 210N-66-700Wp
Fixed Tilt Angle	Fixed-Tilt 20° - Bifacial - 2 modules in Portrait				
Azimuth from True North	Azimuth of 0° from True North				
Collector width / Pitch (m)	4.950 / 11.0	4.576 / 10.2	4.784 / 10.6	4.784 / 10.6	4.788 / 10.6
Ground Cover Ratio (%)	45%				

# B. Energy Assessment

## Energy Production Estimates - Brazil

Performance Metric	182N-78-625Wp	182N-72-580Wp	182RN-72-610Wp	Trina 210RN-66-610Wp	Trina 210N-66-700Wp
	First Year Metrics				
Global Horizontal Irradiation (kWh/m <sup>2</sup> /yr)	1,944	1,944	1,944	1,944	1,944
Plane-of-Array Irradiation (kWh/m <sup>2</sup> /yr)	2,621	2,629	2,626	2,625	2,625
Gross Energy (GWh/yr)	327.62	328.67	328.21	328.14	328.11
Net Energy (GWh/yr)	269.43	271.78	270.32	272.80	272.11
Performance Ratio (%)	87.7%	88.5%	88.0%	88.8%	88.6%
AC Capacity Factor (%)	30.7%	31.0%	30.8%	31.1%	31.0%
Energy Yield Ratio (kWh/kW <sub>DC</sub> )	2,156	2,174	2,163	2,182	2,177

### Energy Results:

- Higher Net Energy
- Higher PR %
- Equal or Higher AC CF%
- Higher Energy Yield Ratio

# B. Energy Assessment

## Energy Production Estimates - Germany

Performance Metric	182N-78-625Wp	182N-72-580Wp	182RN-72-610Wp	Trina 210RN-66-610Wp	Trina 210N-66-700Wp
	First Year Metrics				
Global Horizontal Irradiation (kWh/m <sup>2</sup> /yr)	1,143	1,143	1,143	1,143	1,143
Plane-of-Array Irradiation (kWh/m <sup>2</sup> /yr)	1,366	1,368	1,366	1,366	1,366
Gross Energy (GWh/yr)	85.34	85.47	85.41	85.41	85.39
Net Energy (GWh/yr)	72.15	73.06	72.44	73.37	73.10
Performance Ratio (%)	89.0%	90.1%	89.3%	90.4%	90.1%
AC Capacity Factor (%)	16.4%	16.6%	16.5%	16.7%	16.7%
Energy Yield Ratio (kWh/kW <sub>DC</sub> )	1,154	1,169	1,159	1,174	1,170

### Energy Results:

- Higher Net Energy
- Higher PR %
- Higher AC CF%
- Higher Energy Yield Ratio

# C. CAPEX (kUSD)

Project Location	182N-78-625Wp	182N-72-580Wp	182RN-72-610Wp	Trina 210RN-66-610Wp	Trina 210N-66-700Wp
Brazil	76,687	76,619	76,315	76,102	75,453
Germany	44,937	45,020	44,719	44,510	44,092

## CAPEX Considerations

Module (Wp)

PV Modules

Inverters

Mounting structure

String Cable (DC wiring)

String Cable - Inverters to CT (AC wiring)

AC BoP Equipment

Civil Works

Labor

Design & Engineering

Development Cost (Land, interconnection, etc)

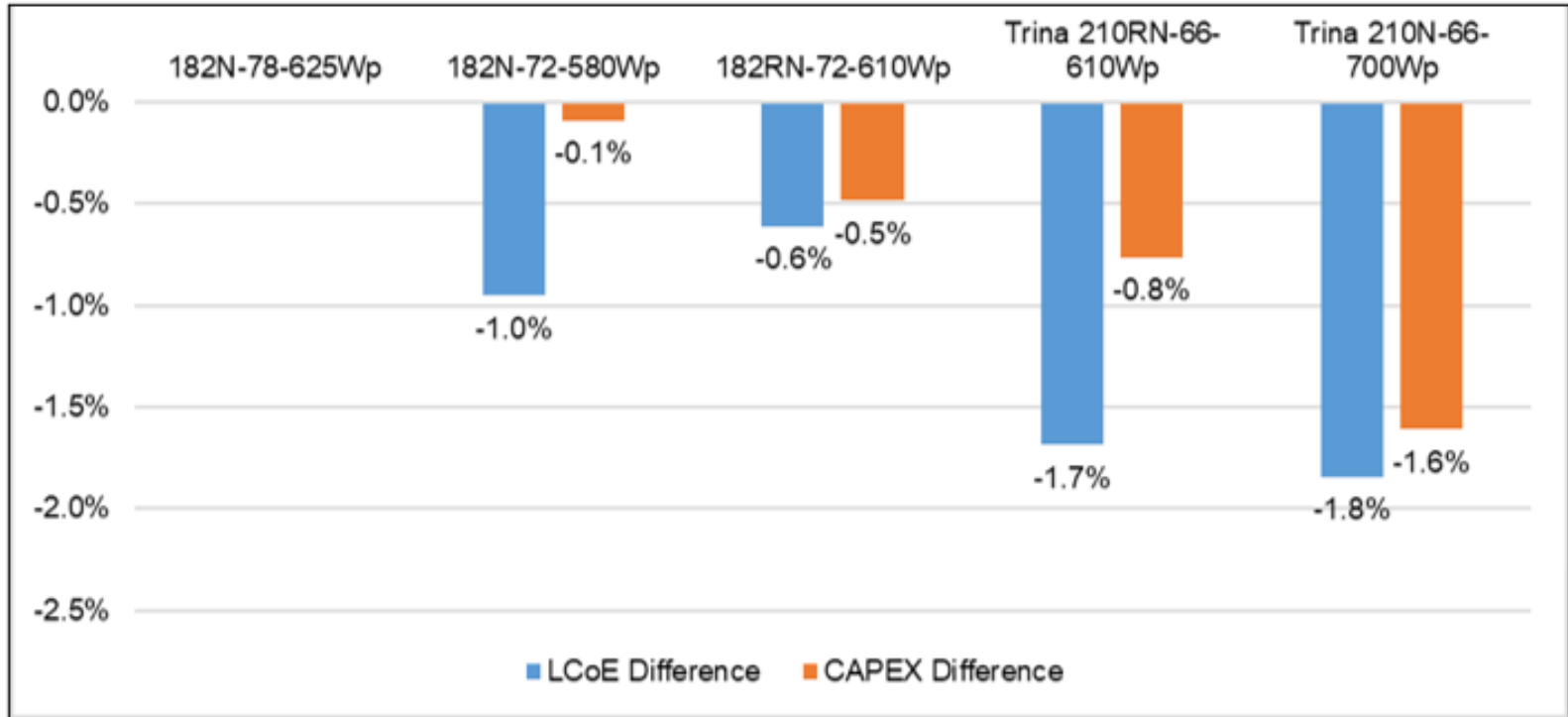
**Lower CAPEX for both Brazil and Germany**

- Trackers/Racking Structure
- String Cables
- Civil Works
- Project Development (Land)

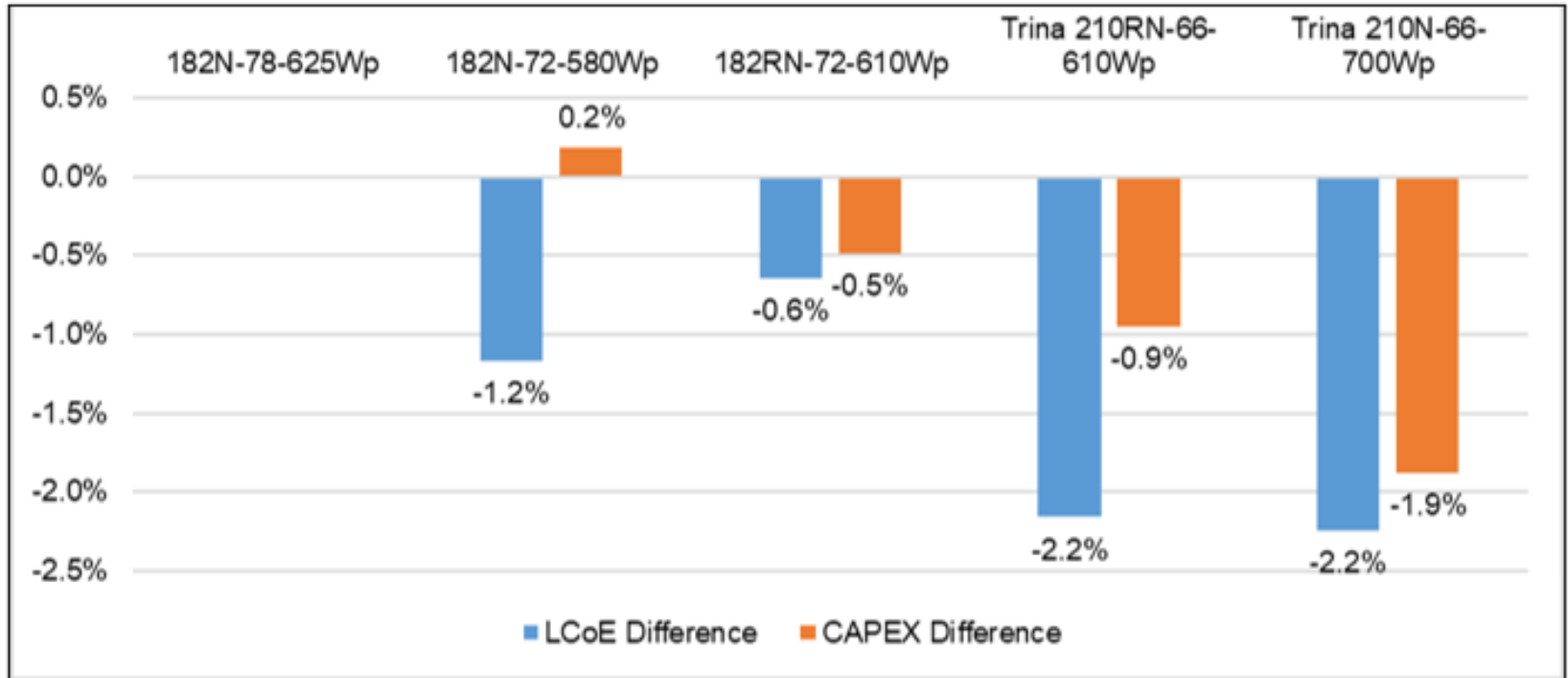


# LCOE RESULTS

# Results (USD/kWh) - Brazil



# Results (USD/kWh) - Germany





Thank you

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