Introduction, Overview of PV Market and Technology

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Business Streams

**Industry**

**Products**

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**Academy & Life Care**

**ICT & Business Solutions**

- **Employees**: 19,600
- **Sales in Bil. Euros**: 1.88
- **Growth**: 9%
- **Laboratories**: 200
- **Headquarters**: Cologne
- **Founded in Germany**: 1872
- **Locations/Countries**: 500
- **EBIT in Mil. Euros**: 101.4
- **Margin**: 5.4%
- **May 17**

**Business Field: Solar Energy**
Solar Technology
World number 1 in PV plant assessment and component testing

More than 30 years experience in PV

Inspected PV portfolio > 20 GW

Power plant inspections since 1990

PV Product testing since 1982

6 photovoltaic test centres worldwide

500 locations worldwide
1979  
Joint project between the Indonesian and German government to build and test different solar systems

1985  
Development of the solar laboratory in Cologne

1991  
Partner in the 1000 PV-roofs program

1994  
First start-up of the new solar simulator in Cologne

1996  
First type-approval certification of a crystalline PV module

2004  
First PV conference in Cologne

2007  
Opening of the PV laboratory in India

2007  
First type-approval certification of a crystalline PV module

2008  
Joint venture between Arizona State University and TÜV Rheinland

2009  
Opening of the first PV laboratory in Taiwan

2010  
Opening of the sixth PV laboratory in India

2014  
200 PV experts worldwide, 60 in Cologne
The current state of PV expansion

Global cumulative installed solar PV capacity by country, 2015

The End of 2016:

- China: 77 GW
- Japan: 41 GW
- Germany: 41 GW
- USA: 32 GW
- Italy: 19 GW
- UK: 11 GW
- India: 10 GW
- France: 7 GW
- Australia: 7 GW
- Korea: 5 GW
- Spain: 5 GW
- Belgium: 3 GW

Source: VDMA

Source: IRENA, 2016
Where is the photovoltaic market growth?

Growth 2015 > 2016

N America:
USA 11,3 GW

Asia:
China 34,2 GW
Japan 8,3 GW
India 4,4 GW
Korea 1,4 GW
Thailand 0,7 GW
Philippinen 0,6 GW

Europe:
UK 2,1 GW
Germany 1,2 GW
Netherland 0,4 GW
Italy 0,4 GW

Source: VDMA
In which emerging countries is the solar PV market growing?

Growth 2015 > 2016

S America:
- Chile: 755 MW

Oceania:
- Australia: 595 MW

Africa:
- S Africa: 505 MW
- Algeria: 171 MW
- Morocco: 162 MW

Middle East:
- Jordan: 262 MW

Eurasia:
- Turkey: 577 MW

Source: VDMA
The key to success: highly efficient Wafer-, cell- and module technology

End-Market installed PV Basis global

78 GW
New installed PV-Base in 2016

The total installed PV capacities with 308 GW in 2016

➤ Until 2022 the estimated installed PV-basis will increase to around 800 –1000 GW

Source: VDMA
The annual growth of the PV market

The current production capacity

About 90 GW end of 2016

Untill 2022 necessary production extension

5 – 15 GW per year

Source: VDMA
What are the planned investments for PV manufacturing and in which part of the value chain?

2017: Planned installations in: China, Malaysia, Korea, India,…
Biggest percentage in Cell

Source: PVTech
Cumulative PV installations 2015 vs. Demand 2016-2020

Shift also to the new market

New installations 2016-2020

Source: VDMA
Cell efficiency records / thin-film efficiency records (laboratory results) [1]

References: [1]: NREL
Cell Production: technologies / efficiency trends

**Trend: market share of cell concepts 2016:**
PERX ≈15% (in line w/ IHS Markit)

**Trend: stabilized cell efficiencies:**
⇒ p-type PERX outperforms

**PERX is gaining market share (20% 2017)**
- Back Surface Field share is shrinking
- Back contact + HJ: slow increase in share
- Si tandem: under development

⇒ stabilized >21% p-type mono PERX is in production

*Source: VDMA | International Technology Roadmap PV, ITRPV 2017*
Front side grid finger width reduction continues
- Ag reduction

- 4BB are mainstream – 3 BB will disappear

- Selective emitters + Bifacial cells require good alignment
- Bifacial cells will increase market share

Source: VDMA | International Technology Roadmap PV, ITRPV 2017
Trend: system voltage

1500V are the future

Trend: tracker systems in power plant applications

1-axis trackers will gain market share

Source: VDMA | International Technology Roadmap PV, ITRPV 2017
Balance of system (BOS) for power plants

Trend: BOS in Europe and US

Trend: BOS in Asia

Significant cost reduction still foreseen

Costs in Asia are assumed to be significantly lower

Source: VDMA | International Technology Roadmap PV, ITRPV 2017
Evolution of the PV bid prices utility-scale

Bid pricing: 2,49 $cent/kWh (UEA) - 6,9 €cent/kWh (DE)

Factor 2,5 in solar radiation

Source: VDMA
More for less money: The renewable energy in 2016 was cheaper than ever before

UN-Environment, Bloomberg New Energy Finance and the Frankfurt School-UNEP Collaborating Centre:

Investment 34% lower (Comparison of 2015 and 2016)

But the capacity has increased by 50% (50GW > 75GW)

The new investment in solar totaled $113.7 billion, is enough for adding new 75 GW capacities.

Source: VDMA
Module price:

JP / KR the highest

D / CN same price

Asean / TW the cheapest

Source: pvinsights
PV learning Curve

Shipments / avg. price at years end:

2016: 75 GWp / 0.37 US$/Wp

o/a shipment: ≈ 308 GWp
o/a installation: ≈ 300 GWp

300 GWp landmark was passed!

LR 21.5% (1976…2016)

Dramatic price drop due to market situation

➢ Comparable to 2011/2012, but faster

Source: VDMA | ITRPV 2017
Comparison of price degression PV - Wind

A fast PV learning curve


Source: VDMA

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Thank you for attention!