















# ELECTRONIC DEVICES ELECTRONIC COMPONENTS

### **DEVICES**

 Production solutions for the manufacture of consumer electronics as well as industrial and automotive electronics

# DISPLAY & TOUCH

 Wet chemical production solutions for the manufacture of LCD and OLED flat screens & touch sensors

### **PCB**

 Production solutions for the manufacture of Printed Circuit Boards and Chip Carriers





# **ENERGY STORAGE**

# **ELECTRO- MOBILITY**

 Production solutions for lithium-ion batteries, super-caps and capacitors for hybrid electric and electric vehicles

# STATIONARY STORAGE

 Production solutions for lithium-ion batteries and capacitors for stationary energy storage for private homes and large-scale photovoltaic plants

# CONSUMER ELECTRONICS

 Production solutions for lithium-ion batteries for consumer electronic products like tablet computers, mobile phones and notebooks

MANZ COVERS ALL EXISTING CELL GEOMETRIES DUE TO EXPERTISE IN WINDING AND STACKING





# **NEW BUSINESS**

### LIGHT-WEIGHT

 Development of processes and machines for lightweight solutions – from single systems to complete production lines

# **SPORTING GOODS**

 Additive manufacturing solutions for the production of sporting goods



# OUR TECHNOLOGIES

# **OUR TECHNOLOGIES**





# **AUTOMATION**

- Leading position in robotic and automation systems for small part handling
- Proven solutions for handling of sensitive materials such as glass, metal, plastic, ceramics
- Outstanding expertise in fab planning and integration

# METROLOGY – INSPECTION TECHNOLOGY

- Inline quality inspection
- Optical systems for vision inspection
- Physical measurement systems
- Integrated analytic instruments (XRF, ...)
- Proprietary software for easy integration and data analysis

# **OUR TECHNOLOGIES**





### LASER PROCESSING

- Longtime expertise in the field of micromachining laser processes for various applications
- Strong expertise in design of optical systems for beam shaping, splitting and guiding

# PRINTING/COATING

- Standardized printing platforms for highspeed printing of small substrates
- Unique stainless steel vacuum conveyor for high-speed substrate transfer
- Highest accuracy in the market due to vision alignment of substrates

# **OUR TECHNOLOGIES**





# WET CHEMICAL PROCESSING

- With an installed base of more than 3,000 tools Manz is market leader in Taiwan and China for wet chemical processes for display and touch panel manufacturing
  - Cleaning, developing, etching, stripping and reworking of substrates
- Highly integrated equipment production at low costs in Taiwan and China

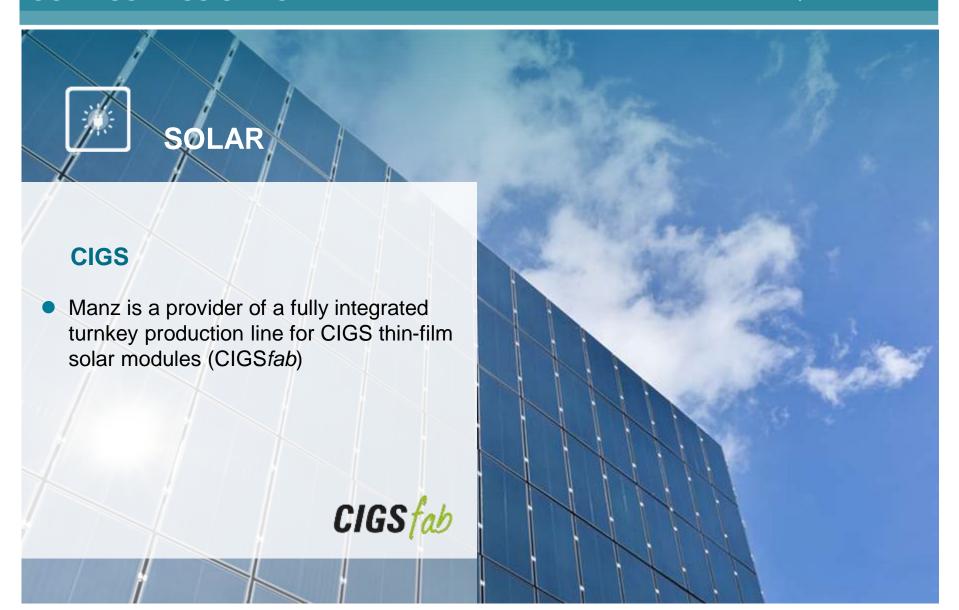
# ROLL-TO-ROLL APPLICATIONS

- Decades of experience in the development and construction of paper winding equipment and winding and stacking systems for the production of lithium-ion batteries and capacitors
- Successful development of a roll-to-roll platform, which can be integrated in existing processing solutions and widely applied to various industries



# OUR BUSINESS UNIT SOLAR





### **SEGMENT SOLAR**

# **HISTORY OF CIGS DEVELOPMENT**

Fully automated c-

Si prodcution lines

**IPO** 



groundbreaking Start basic research on CIGS research on 17.8% European CIGSfab thin film PV solar cells record cell 1975 1975 - 2005 2004 combining the best of all professions 19.6 record cell from ramp pilot support > 30 yrs of CIGS base 20.3 world 20.8 world Formation production of technology Inline CIGS record cell record cell research at ipe & ZSW of ZSW CIGS modules scale-up deopsition 2010 2013 1988 1995 2009 since 2000 > 20 years of CIGS technology development at ZSW & Würth Solar ramp of first > 5 years of CIGS mass Establishment CIGS mass re-structuring 15MW → 30MW production at Würth Solar of Würth Solar production to Innoline 2008 1999 2006 2011 > 15 yrs equipment WÜRTH supplier for PV & thin film 2000 production pilot production equipment supplier Manz Intech wet exclusive rights Manz takes for thin film PV for Würth CIGS over Würth chemical Established by market equipment technology Innoline Dieter Manz since 2005 2008 2010 2012 1987 manz 2000 2010 2012 2015 2006 2017

Manz Coating supplier

for vacuum machines

Start of strategic

collaboration with

Shanghai Electric Group & Shenhua Group

16%: CIGS

module

world record

14.6% best ever

module

produced thin film

# STRATEGIC BUSINESS UNIT SOLAR BREAKTHROUGH IN CIGS-TECHNOLOGY





- Breakthrough in successful commercialization of our superior CIGS thin-film solar technology
  - → Signing of strategic cooperation agreement with Shanghai Electric and Shenhua
  - → Bulk orders for two turnkey CIGS production lines with total capacity of 350 MW
    - → CIGS R&D line with 44 MW capacity
    - → CIGS production line with 306 MW capacity
- Total order volume is EUR 263.4m
- Proof of superiority and high potential of our CIGS thin-film technology
  - Confidence in the solar market and in our excellent engineering know-how and technology finally pays off

# STRATEGIC BUSINESS UNIT SOLAR CONTRACTUAL PARTNERS





- Biggest manufacturer of fossil power plants in China
  - → Revenues amounted to more than EUR 13bn in 2015
- Business focus on
  - → Energy efficiency & clean energy production
  - → Industrial equipment manufacturing
- Strategic focus on "Green Energy"



- Largest and most modern coal enterprise in China;
   world's largest operator of coal mines;
  - → Revenues per year approx. EUR 40bn
- One of the largest energy producers in China
- High pressure to change business model to renewables in order to contribute to solving Chinas problems caused by air pollution



Chinese state-owned companies with the goal to reach the climate targets set by the Chinese government. High potential for follow-up orders.



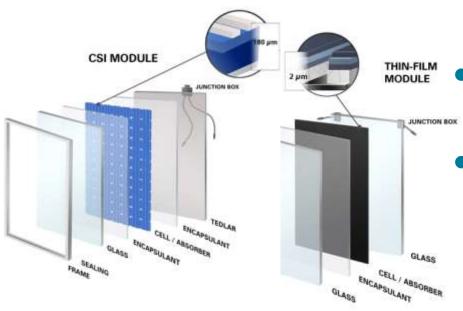
Unique chance for Manz to initiate technological change in solar industry together with strong partners.

### STRATEGIC BUSINESS UNIT SOLAR

# **COMPARISON OF SOLAR TECHNOLOGIES**



# Module Design: Crystalline Silicon vs. Thin-Film



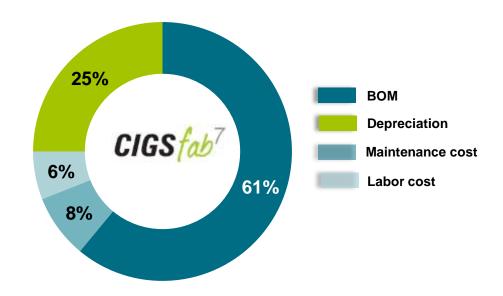
- CIGS-layer up to 100 times thinner
- Lower consumption of expensive semiconductor material
- Lower number of used materials
  - → Less production steps

- Costs per watt of CIGS are already today significantly lower
  - Further reduction by scaling of production capacities possible
- Costs of energy generated with CIGS are lower
  - → CIGS module generates 10 to 15% more power during the year
- Efficiency of Manz "champion module" is 16% and at the level of multi-crystalline cells
  - → Enormous potential demonstrated by 22.6% efficiency world record on laboratory cell format of ZSW
  - → Transfer to mass production processes of Manz CIGSfab by R&D JV
- Energy amortization time for CIGS considerably shorter
  - → Mono-Si (16.8% efficiency): 2 years
  - → CIGS (14.6% efficiency): 9 months

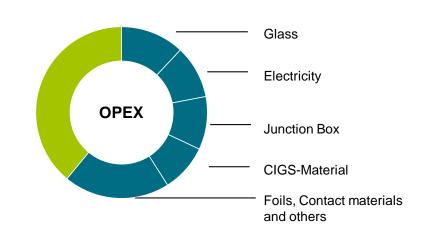
# **STRATEGIC BUSINESS UNIT SOLAR**306 MW CIGSFAB: STRUCTURE OF PRODUCTION COST







- Current guaranteed average efficiency of 14.6% on CIGSfab
- OPEX vary between 0.35 \$/Wp 0.40 \$/Wp
  - OPEX substantially affected by material costs such as glass and electricity cost
- LCOE between 0.04 0.08 \$/kWh almost on the level of fossil fuels

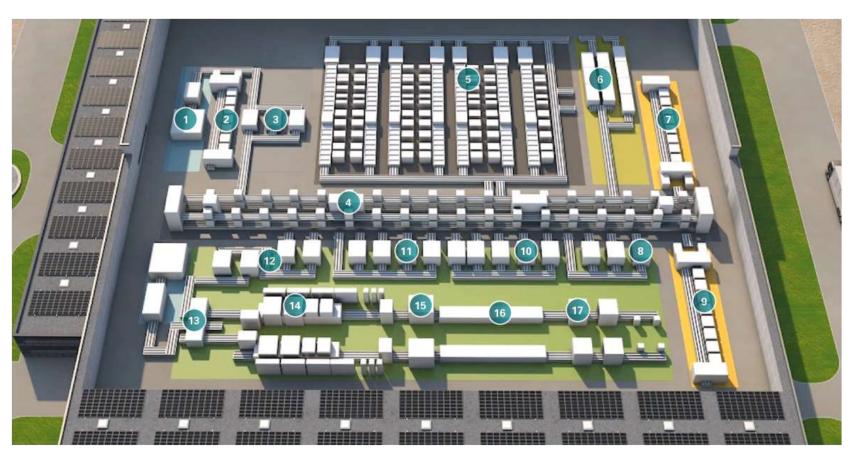


### STRATEGIC BUSINESS UNIT SOLAR

# 306 MW CIGSFAB: LAYOUT







01. Cleaning

02. Mo Coating 05. CIG

03. Automation 06.

04. P1 Laser Scribing

05. CIGS Coating

06. ICBD-CdS

07. iZnO Coating

08. P2 Laser Scribing

09. ZnO Al Coating

10. P3 Laser Scribing

11. Laser Edge Ablation

12. Laser Drilling + Contacting

13. Module Marriage

14. Lamination

15. Junction Box Assembly

16. Light Soak

17. Sun Simulator

### **AFTER-SALES SERVICE**





### **CUSTOMER SUPPORT**

- More than 300 qualified service engineers worldwide for machine installation, ramp-up and maintenance at customer site (> 200 in Asia)
- Customers can chose the service package that best fits their needs
  - → Intensive training of employees of our customers in our in-house training centers in Germany, Taiwan and China as well as on the system
  - → Local spare part management including local warehouses in each branch office
  - → Maintenance contracts with specified intervals and individually customized maintenance components
  - → Full Service: Complete maintenance of machine including spare parts supply
  - → Build Operate Transfer (BOT) model

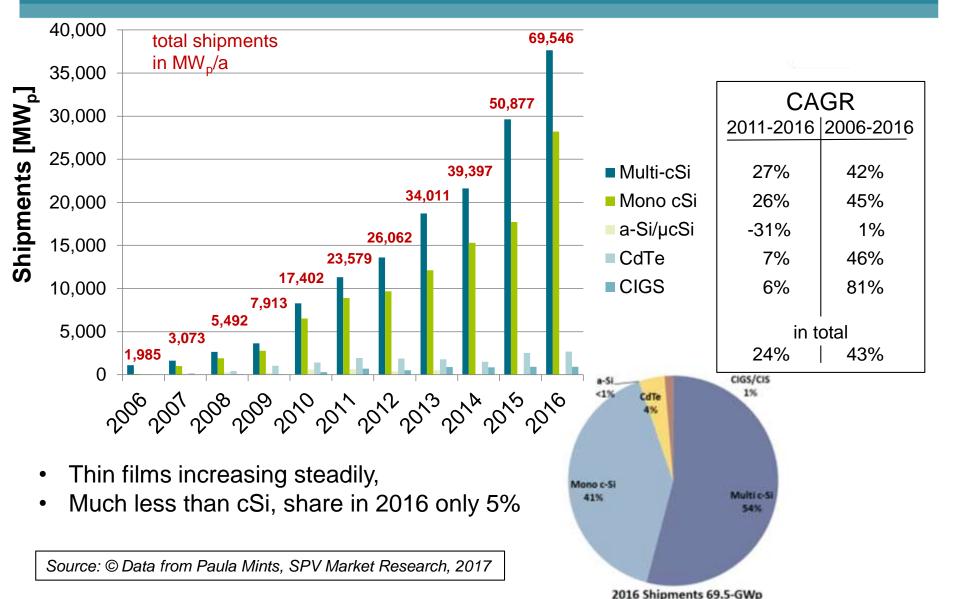


# OUR LOCATIONS

- Successful expansion of global production network
- Extension of local R&D activities at European and Asian sites

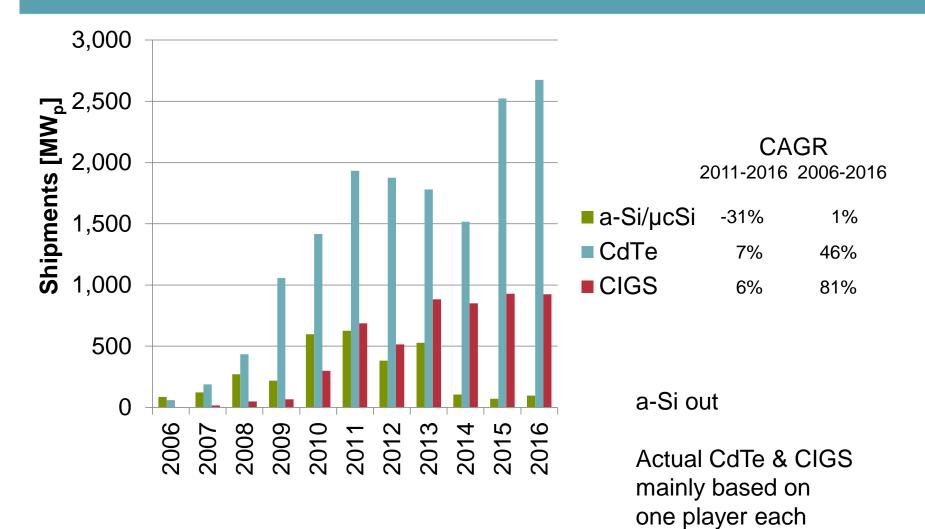
# SHIPMENTS PV MODULES WORLDWIDE OVER LAST DECADE ALL MATERIALS, CUMULATED AGGREGATED GROWTH





# SHIPMENTS PV MODULES WORLDWIDE OVER LAST DECADE DETAILS ON THIN FILM MODULES





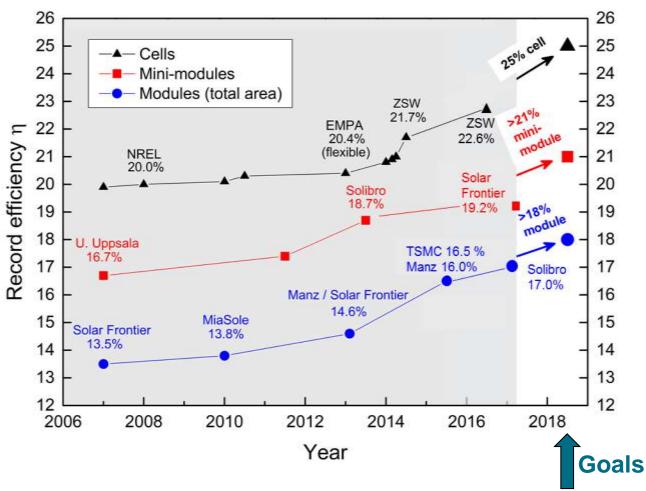
Source: © Data from Paula Mints, SPV Market Research, 2017

### CIGS CELL AND MODULE EFFICIENCIES



### **EVOLUTION OF LAB & PILOT & PRODUCT SIZE RECORDS**

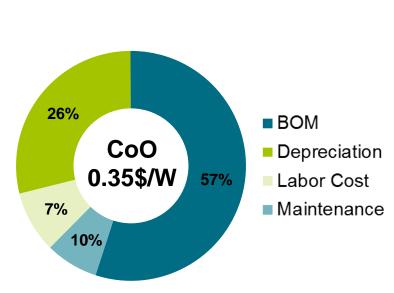
Record efficiencies from lab (cells), small pilot (mini-modules), fab (product)



Source: "CIGS alliance", white paper Nov. 2015 (data from CIGS community worldwide with update by the author

# **FACTORY LAYOUT, FUTURE CoO and shares**







BY

Further Cost improvements supported by new Joint Ventures in the areas of:

- Module Efficiency
- Productivity
- Yield

- local purchase of Material
- Equipment CAPEX

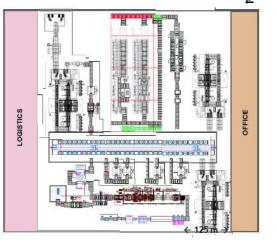
### MANZ AG, BUSINESS UNIT SOLAR, EQUIPMENT JOINT VENTURE

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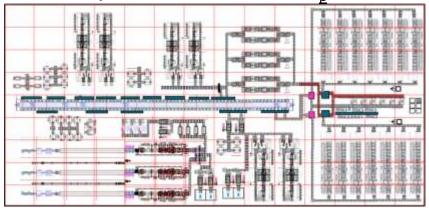
# **ACTUAL ORDERS FROM CHINA**



# Layout CIGSlab, 44 MW<sub>p</sub>/a



Layout CIGSfab, 306 MW<sub>o</sub>/a



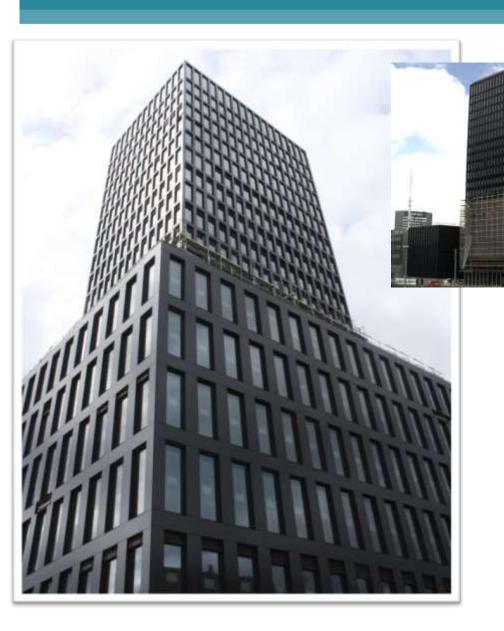
- CIGSlab with capacity of 44MW
  - Counterpart to MCT at NICE headquarter with focus on material qualification, supplier qualification, training of staff and future development
  - → CIGS*lab* will be built in existing building in Beijing
  - → FAT in 18 months
- CIGS turnkey factory (CIGS fab) with capacity of 306 MW
  - → CIGSfab will be built in new building in Chongqing
  - → FAT in 24 months

Further factories in planning

### MANZ BIPV PROJECTS

### PROJECT "GROSSPETER TOWER" BASEL





### **FACADE INTEGRATED PV**

# with Manz specialized BIPV CIGS Modules

### installed and in operation

- CIGS Module installed on all surfaces of façade excepts windows in all directions
- Tower height 78m
- Module area in total ca. 5.100 m²
- Overall 4,400 CIGS-modules
- 440 different module designs
- 80 different glass types and combinations
- 6 different cell widths
   for similar voltage in all strings



# K S

# THANK YOU **VERY MUCH FOR** YOUR ATTENTION!

### **CONTACT**

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