



# MERSEN'S CONTRIBUTION TO SOLAR PHOTOVOLTAIC ENERGY

CAPITAL MARKETS DAY  
NOVEMBER 29, 2018







## **PHILIPPE CHEMIN**

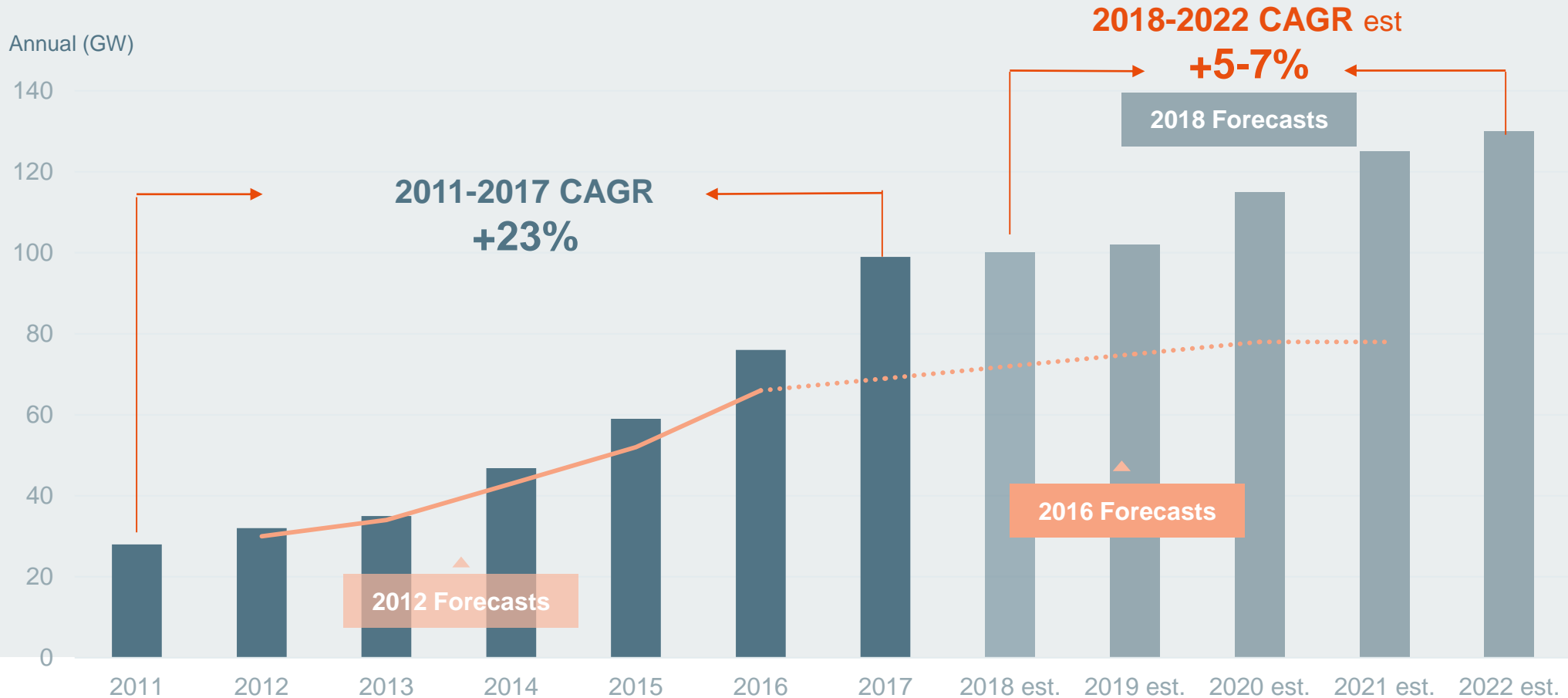
VP SALES & MARKETING, GRAPHITE SPECIALTIES  
BUSINESS UNIT

**MERSEN IN THE UPSTREAM PHASE OF THE  
SOLAR PHOTOVOLTAICS VALUE CHAIN**

# SOLAR: AN ENERGY SOURCE SEEING STRONG GROWTH

NUMBER OF PANEL INSTALLATIONS GROWING SHARPLY EACH YEAR

CONSISTENTLY OUTPACING FORECASTS



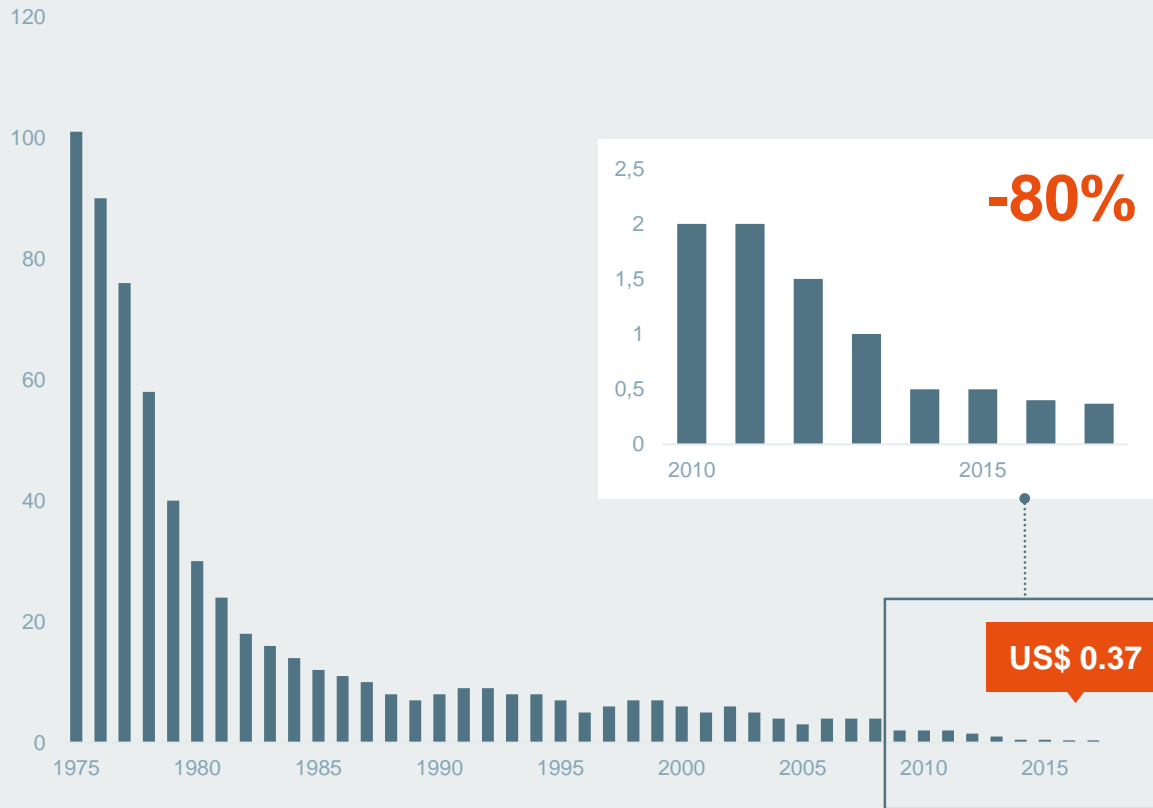
Source: IHS Markit, Exawatt, Mersen estimates

# SOLAR: A COMPETITIVE COST

## DECREASE IN COST OF SOLAR CELLS

US\$ 101.00

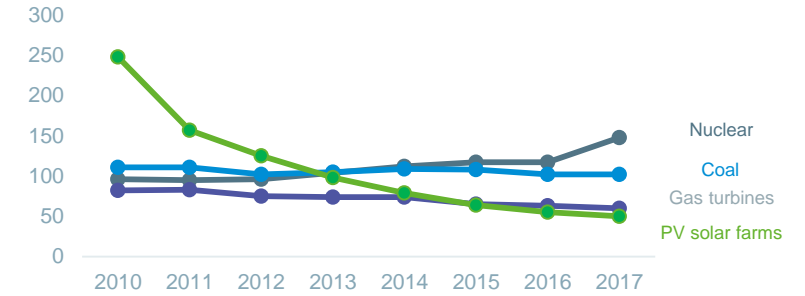
Price of solar cells in US\$ per watt



Source: Bloomberg New Energy Finance and pv.energytrend.com

## THE LOWEST\* ENERGY PRODUCTION COST

US\$/MWh



**-20%**

vs. natural gas

**3X**

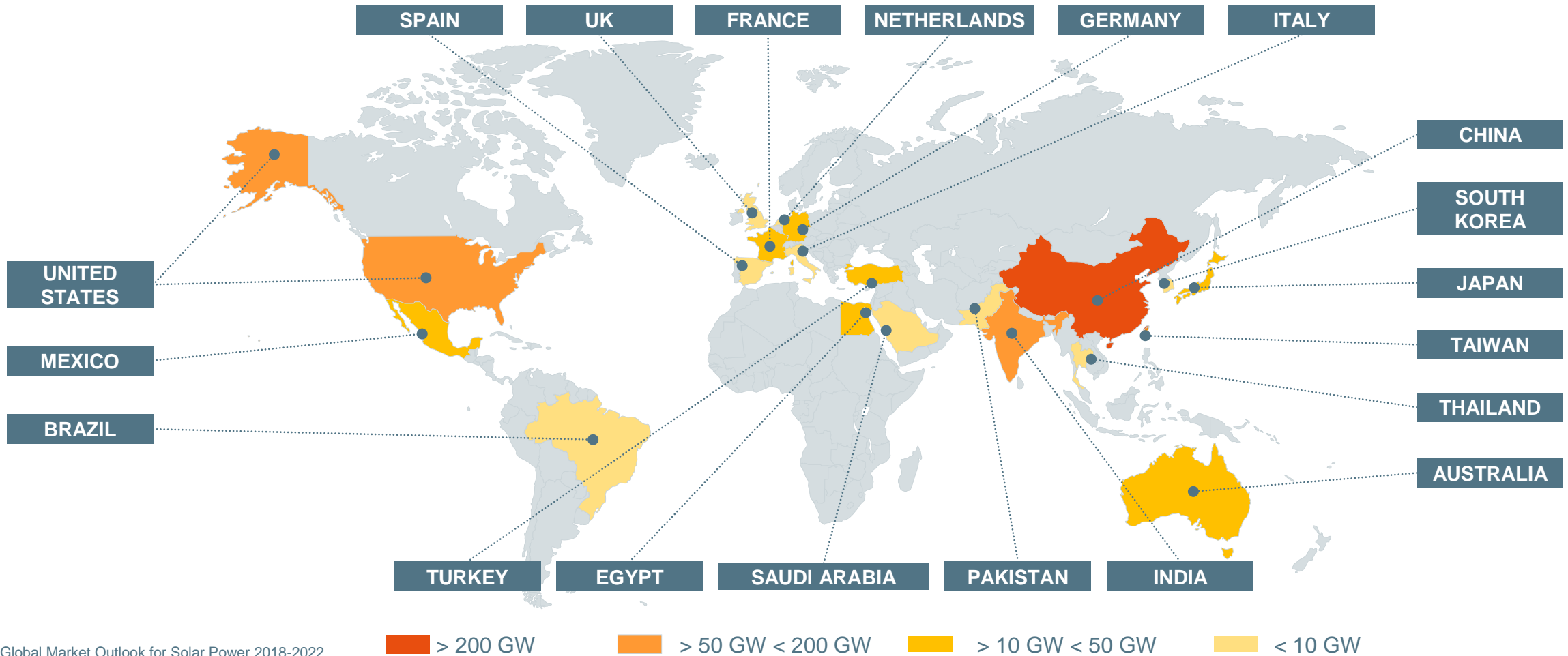
**LESS EXPENSIVE**

vs. nuclear power

\* On average - Source: Lazard's 2017 Levelized Cost of Energy Analysis

# SOLAR: A STRONG POTENTIAL THANKS TO ITS EASY INSTALLATION

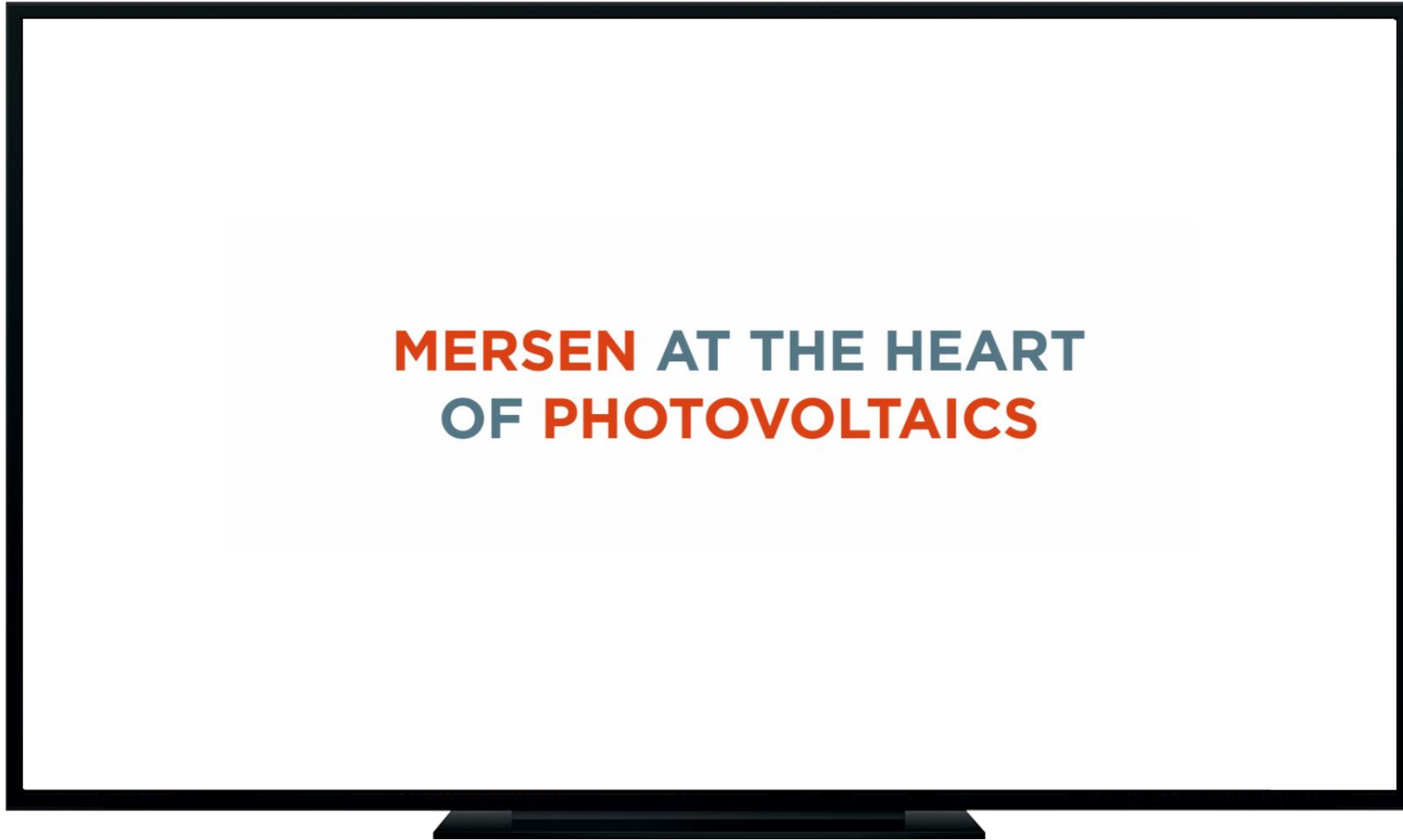
## MAIN COUNTRIES WITH UPCOMING SOLAR PANEL INSTALLATION PROGRAMS



Source: Global Market Outlook for Solar Power 2018-2022



# MERSEN AT THE HEART OF SOLAR PHOTOVOLTAICS



# MERSEN, THE WORLD'S NO. 1 SUPPLIER FOR THE POLYSILICON INDUSTRY



## A ROBUST GLOBAL NETWORK

Longstanding supplier  
for all leading global companies



Machining capacities  
in all major industrialized nations



## SOLUTIONS THAT ENHANCE OUR CUSTOMERS' PERFORMANCE

Joint development programs to help  
polysilicon makers stay competitive  
despite a significant drop in the price  
of polysilicon

Unique expertise in the design and  
manufacture of large components,  
to improve capacities and productivity  
at our customers' sites



## WIDE-RANGING EXPERTISE

Synthesis units,  
graphite parts

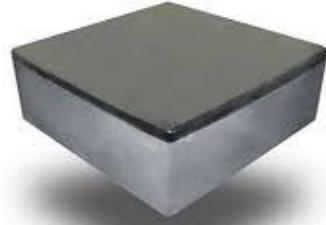
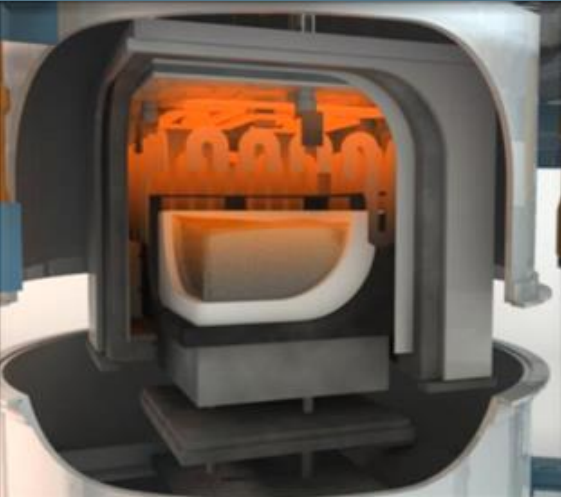
2 centers of expertise  
(Bay City, Michigan, United States –  
Gennevilliers, France) with coating  
capabilities

Design of customized grades

# INGOT MANUFACTURING: 2 MAJOR EXISTING TECHNOLOGIES



## DSS MULTICRYSTALLINE



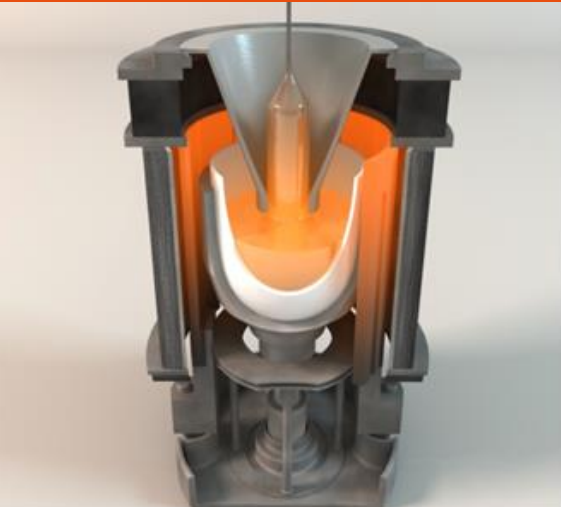
Larger block

Silicon consumption: **4-5 g/watt**

Cell efficiency: **18%-19%**

Historically lower production cost

## CZ MONOCRYSTALLINE

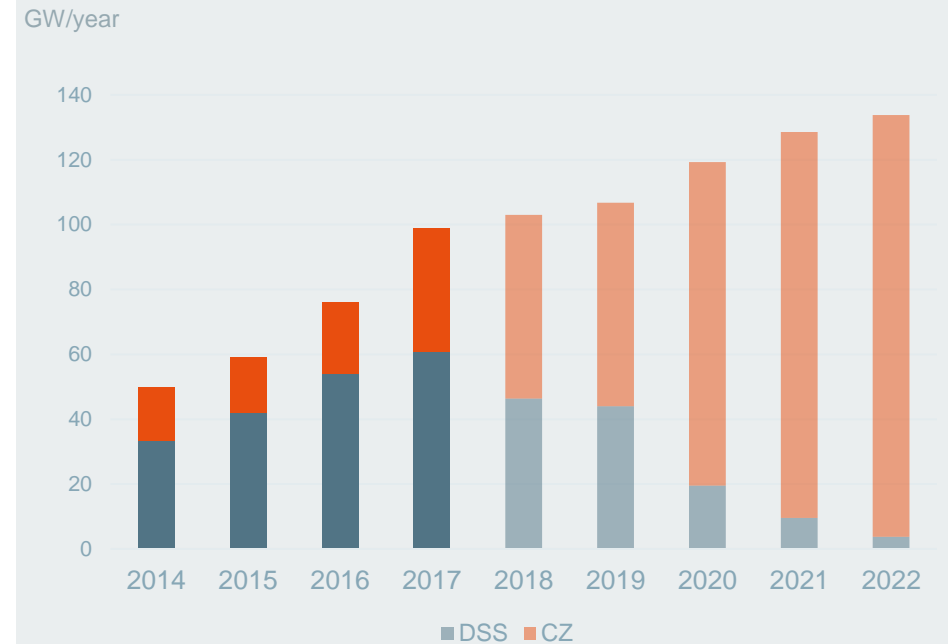


Uses less energy: **-20%**

Less loss of silicon: **(3.2 g/watt)**

Cell efficiency: **22%-23%**

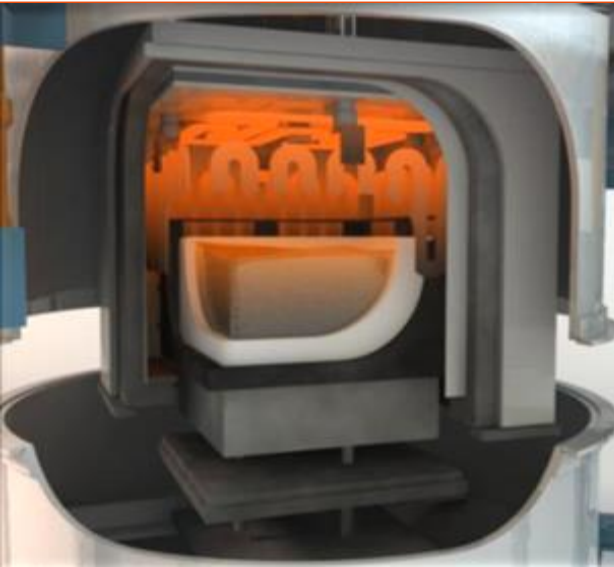
## DSS and CZ production



Sources: Exawatt - Sept. 2018; PV-Tech - Sept. 2018



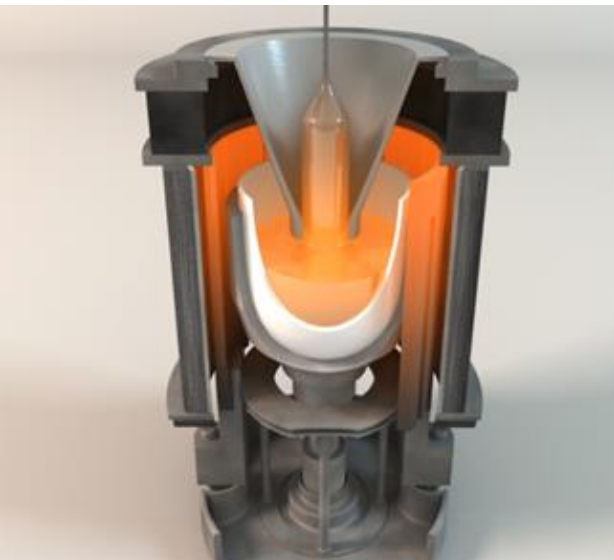
# MERSEN HAS THE ADVANTAGE THANKS TO THE EMERGENCE OF CZ TECHNOLOGY VS. DSS...



**DSS  
MULTICRYSTALLINE**

Required graphite/GW:  
**30 tons**

Less sophisticated graphite  
More competitive market



**CZ  
MONOCRYSTALLINE**

Required graphite/GW:  
**120 tons**

Large parts → customized grades, extremely  
fine-grained graphite, high-level of expertise required

Relationships with the leading players





# ...AND THANKS TO ITS STRONG PRESENCE IN ASIA

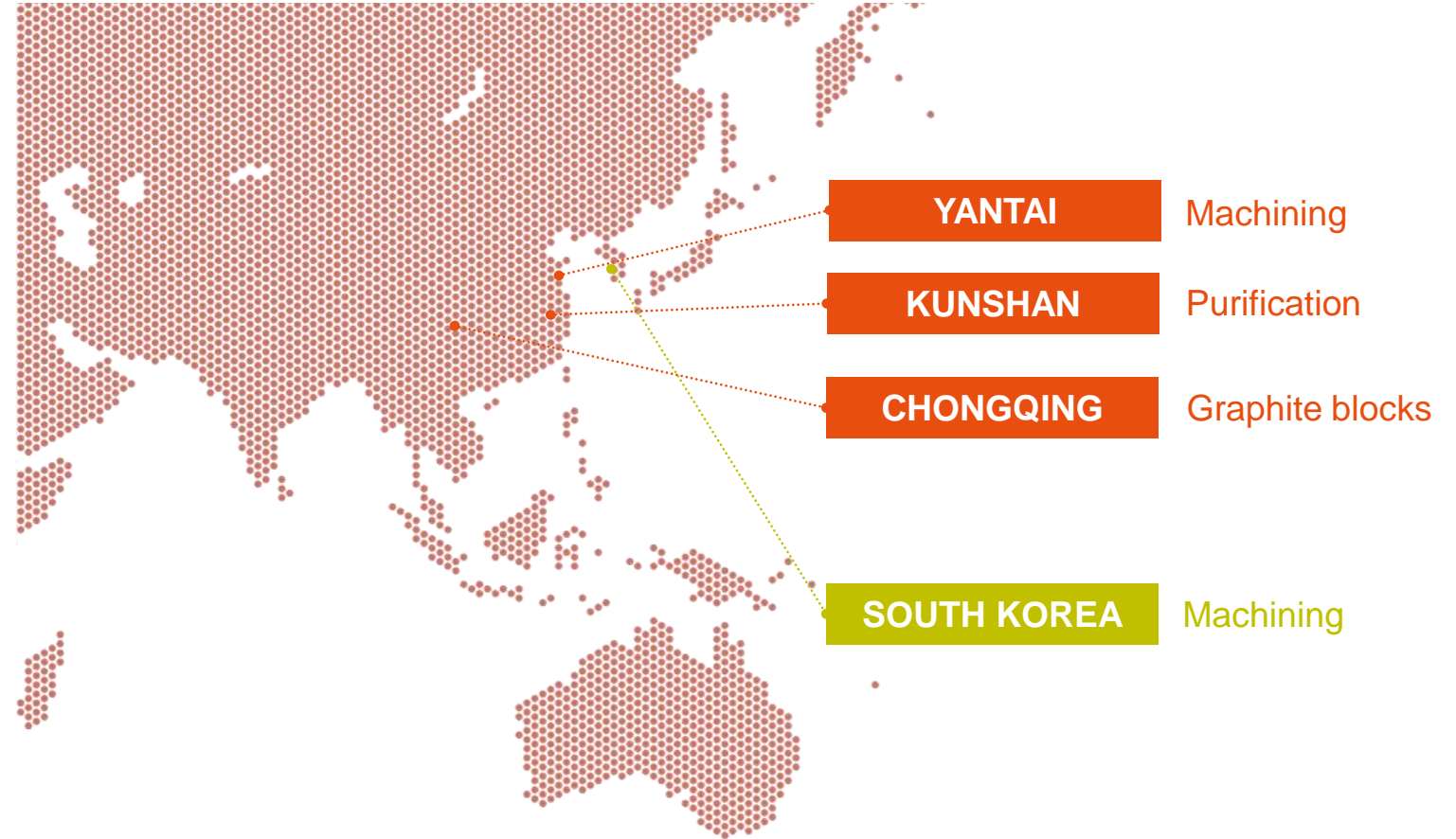
**MERSEN'S FOOTPRINT IN ASIA**

**TO SERVE THIS MARKET**

# 85%

of cell producers are  
**CHINESE** companies

Others: primarily Japan, Taiwan and  
South Korea

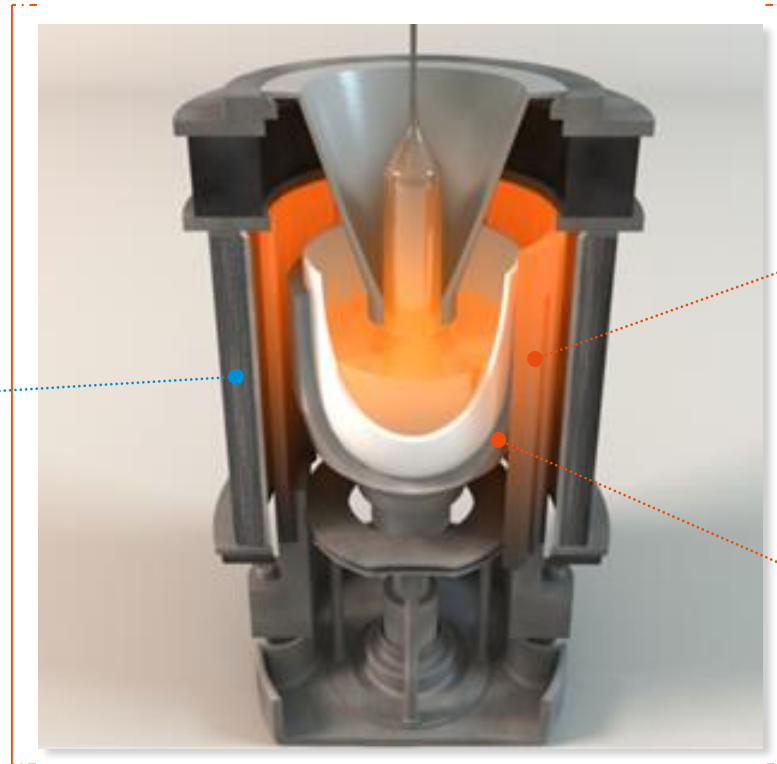


# A NEW, MORE COMPREHENSIVE RANGE OF CZ INGOT PRODUCTION SOLUTIONS TO COME THANKS TO THE MERSEN GALAXY JV



**ENHANCED OFFER**

Flexible felt insulation solutions



Furnace internal parts in graphite (150 total), including:

Graphite resistance

**COMPLEMENTARY OFFER**

Crucible support in C/C composite



# MERSEN GALAXY JV: FOR A COMPREHENSIVE CZ OFFER

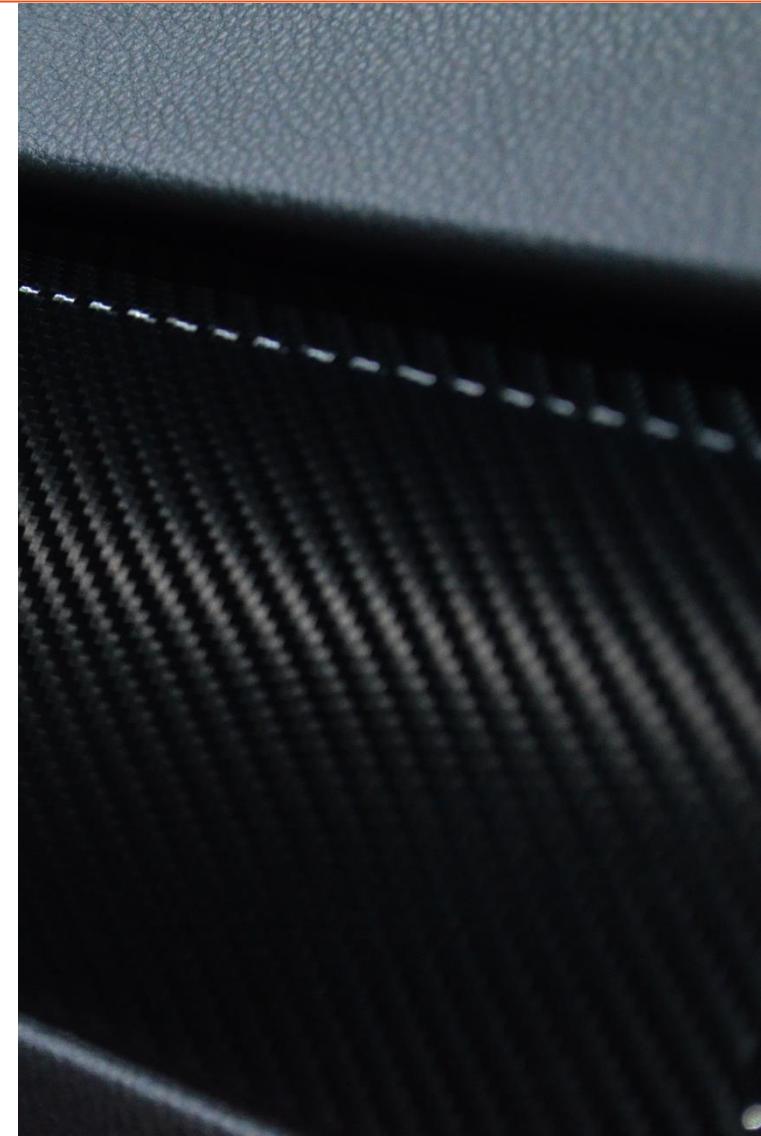
## JV (60% OWNED BY MERSEN)

- COVERS THE MANUFACTURING AND SALE OF **CARBON/CARBON** COMPOSITES AND FLEXIBLE FELT **INSULATION** SOLUTIONS FOR THE **CZ PV** MARKET IN CHINA
- MERSEN'S **LONG-STANDING** PARTNER IN ISOSTATIC GRAPHITE (YANTAI JV)

MERSEN'S CONTRIBUTION: **CNY60M (2018)**

## FIVE-YEAR SALES TARGET

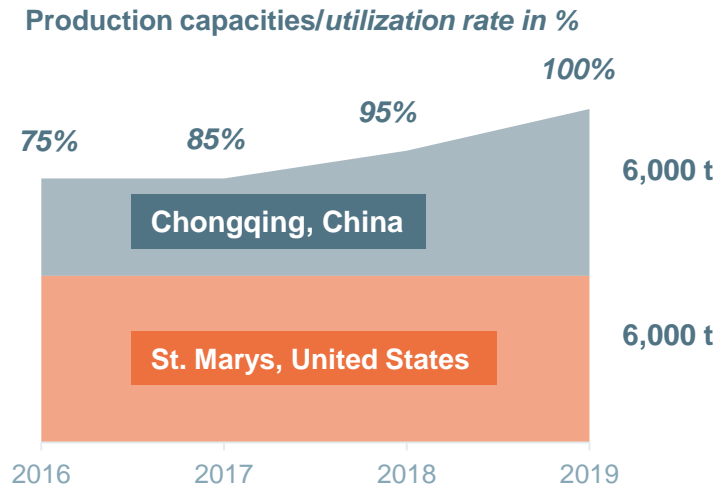
- C/C COMPOSITE: **€5M-€10M.**
- FLEXIBLE FELT INSULATION SOLUTIONS: **€5M-€10M**





# PRODUCTION CAPACITIES MEETING MARKET DEMAND

## ■ ADJUSTING GRAPHITE PRODUCTION CAPACITIES IN LINE WITH CURRENT DEMAND



- 2018: Resuming of furnace production in Chongqing  
**2018 Average: 10,500 t**
- Nominal capacities available for 2019: **12,000 t**  
**+15%** vs 2018 to meet market demand

## ■ A MORE MATURE AND STABLE MARKET THAT REDUCES THE IMPACT OF “BUBBLES”

- A replacement market that is now **spread over time**: consumable parts are sold over the useful life of products
- An immature market in 2011: each new furnace was sold with approximately three years' worth of consumables



## LAURENT MARCENAC

VP GLOBAL SALES, ELECTRICAL POWER SEGMENT

**MERSEN IN THE DOWNSTREAM PHASE OF  
THE SOLAR PHOTOVOLTAICS VALUE  
CHAIN**





# MERSEN: THE CAPABILITY TO BE ACTIVE IN SEVERAL MARKETS

AVERAGE SOLAR FARM SALES  
**€1m-€2m/gw**

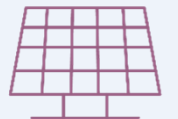
ENERGY STORAGE



INVERTERS

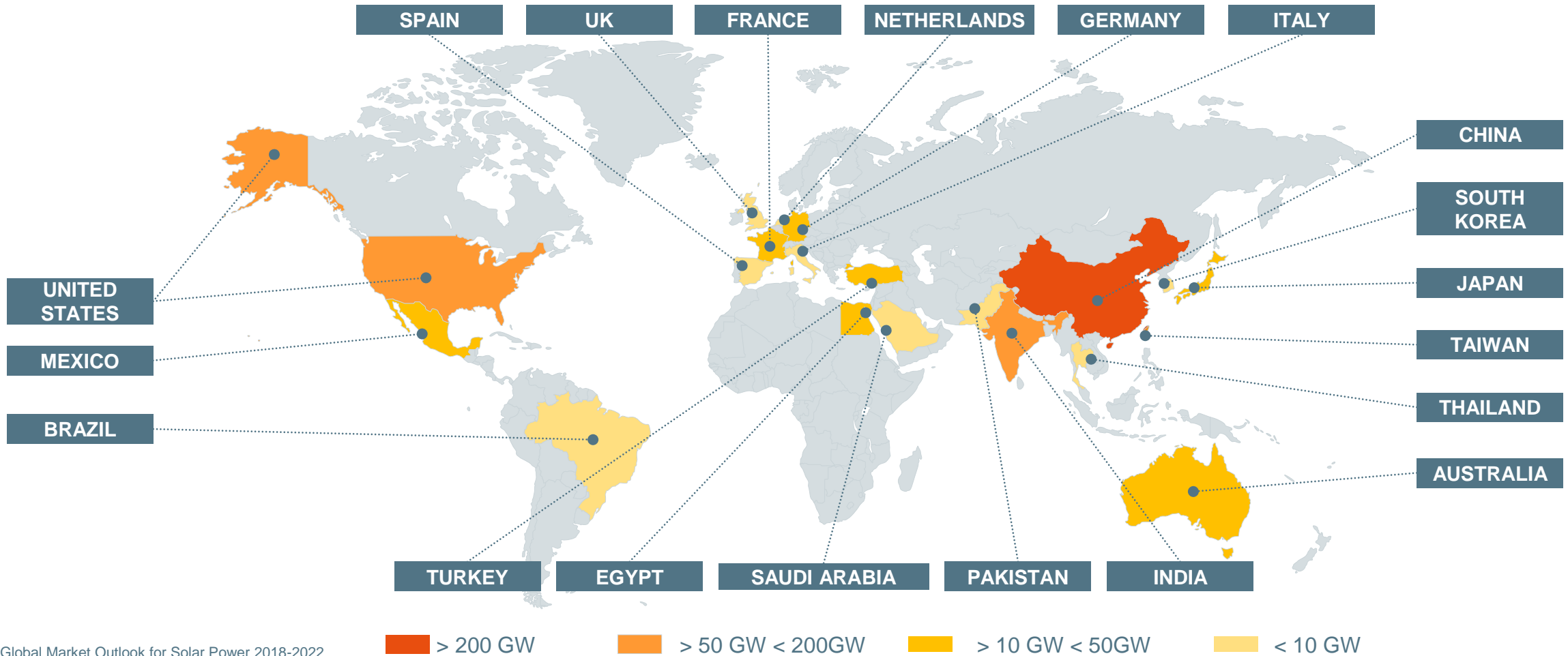


SOLAR PANEL PROTECTION



# SOLAR: A STRONG POTENTIAL THANKS TO ITS EASY INSTALLATION

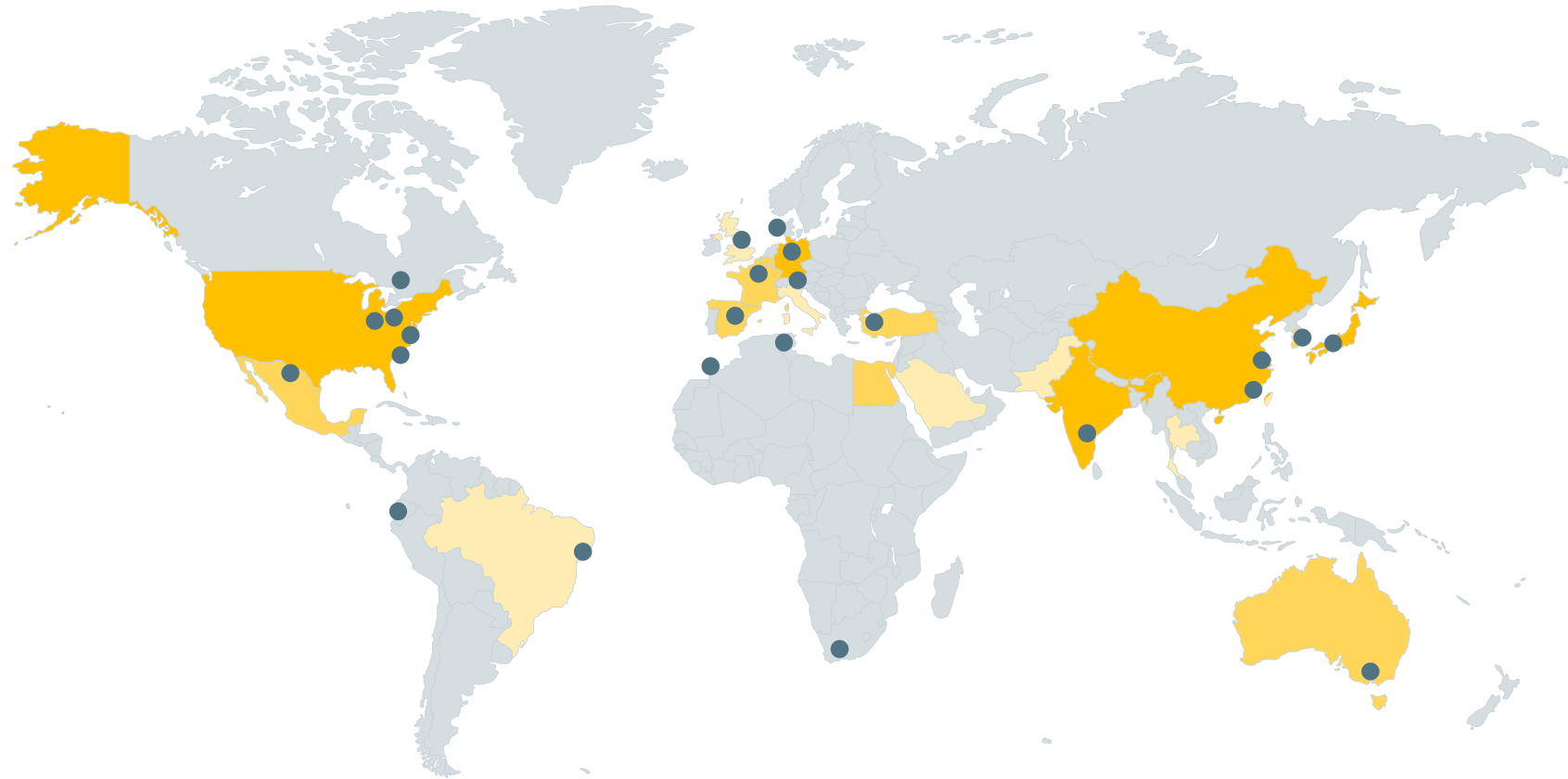
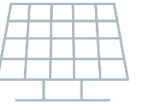
## MAIN COUNTRIES WITH UPCOMING SOLAR PANEL INSTALLATION PROGRAMS



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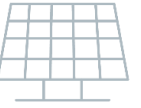


# ELECTRICAL PROTECTION OF SOLAR PANELS: A LOCAL MARKET THAT IS WELL SUITED TO MERSEN'S GLOBAL OPERATIONS



Key Mersen EP segment operations

# MERSEN'S STRENGTHS IN SOLAR PANEL PROTECTION



## A COMPREHENSIVE RANGE

Recognized expertise in **high voltage** (1500V DC)

HelioProtection® range for **Overcurrent** protection

Strengthening of **Surge protection** range, by the acquisition of the remaining stake in Cirprotec in 2018



## GLOBAL OPERATIONS

Allow Mersen to **efficiently serve** the panel builder market

Ensure **competitiveness and adaptability**



## UNIQUE TESTING CAPACITIES

**3 test sites:** St Bonnet (France), Terrassa (Spain), Newburyport (United States)

Recognized expertise in **high voltage direct current transmission**

Enable Mersen to meet market **demand for innovation** and quickly adapt its range accordingly

# POWER CONVERSION: A SEGMENTED MARKET



**HIGH VOLTAGE**

A market associated with **solar farms**

Significant **technical constraints**



**MEDIUM VOLTAGE**

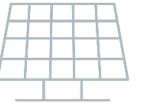
A market associated with **rooftop solar panels**

**Less powerful converters**  
increasingly associated with  
energy storage systems

**CAGR 2018-2022\***  
**4-6%**

\* Sources: Yole, Mersen and other

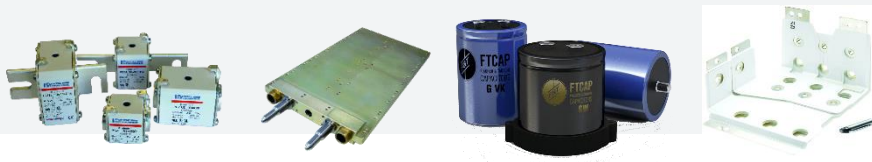
# MERSEN'S STRENGTHS IN POWER CONVERSION



## A UNIQUE INTEGRATED OFFER

Busbars/High-speed fuses for semiconductor protection/Cooling devices/Capacitors

Optimized **co-design** of capacitors and busbars



## LONG-STANDING RELATIONSHIPS WITH MAJOR WESTERN OEMs

A sales structure dedicated to **key accounts**, including:

GE, Siemens,  
Schneider, ABB  
TMEIC

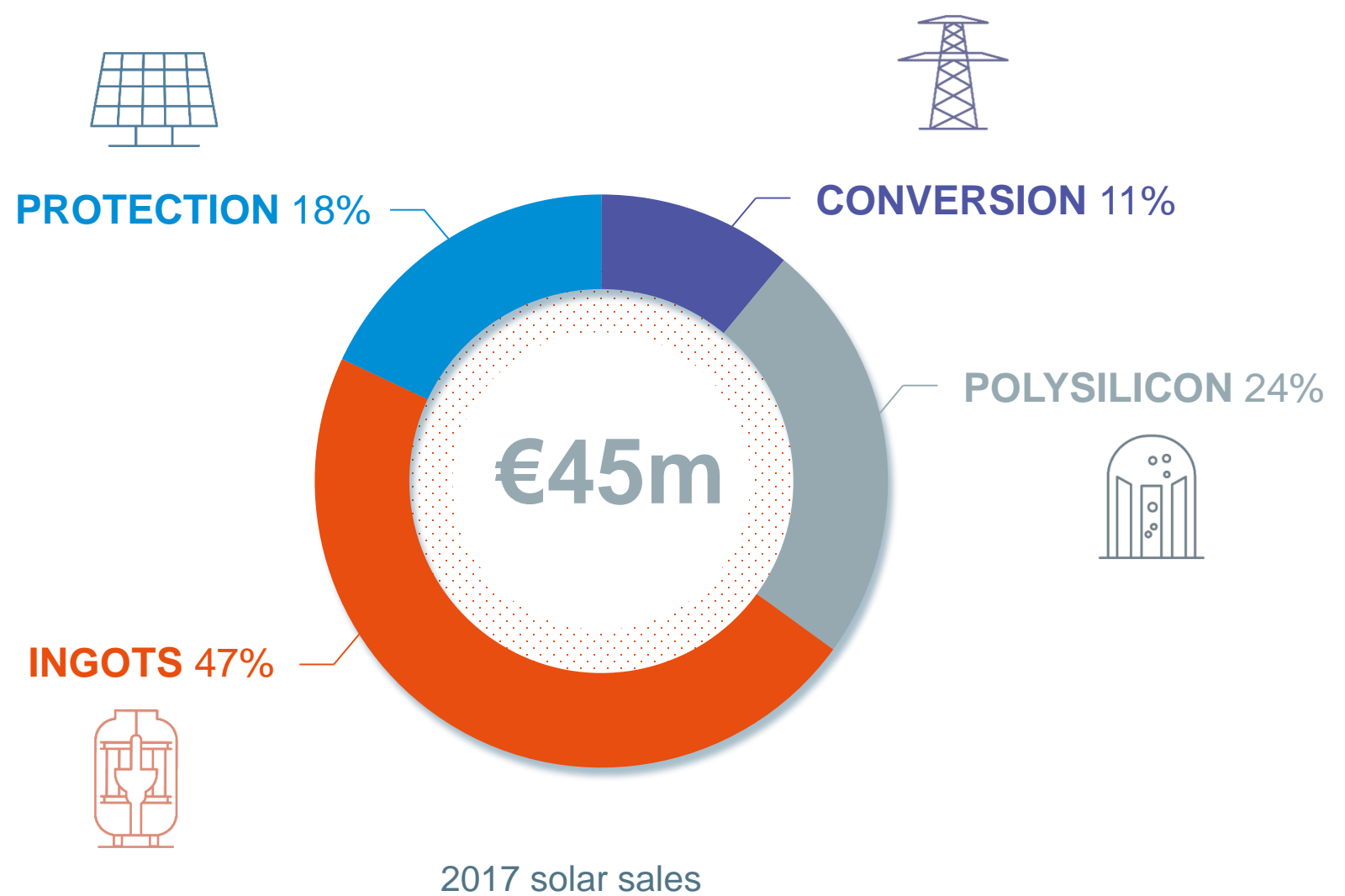


## A SOLID GLOBAL OPERATIONS BASE

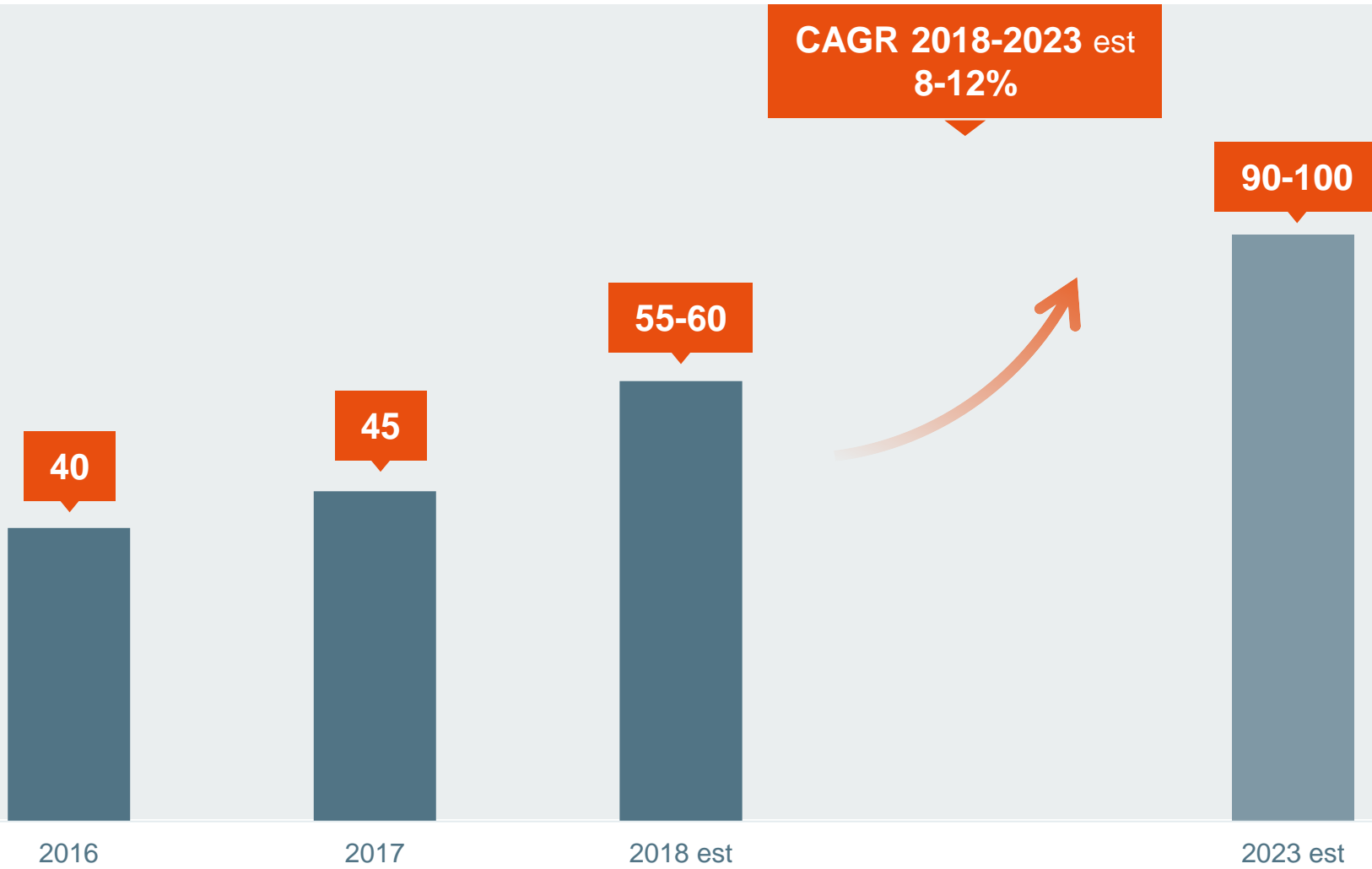
Allows Mersen to keep up with the design and production centers **relocation** of our customers towards Asia, especially India



# BREAKDOWN OF MERSEN SOLAR SALES



# MERSEN SOLAR SALES OUTLOOK



# SOLAR MARKET STRATEGY



Increase the pace of growth by **developing the Mersen Galaxy JV**



Examine opportunities to **expand graphite production capacity** in the medium term



**Bring the production** of the electrical protection and capacitors offers to Asia



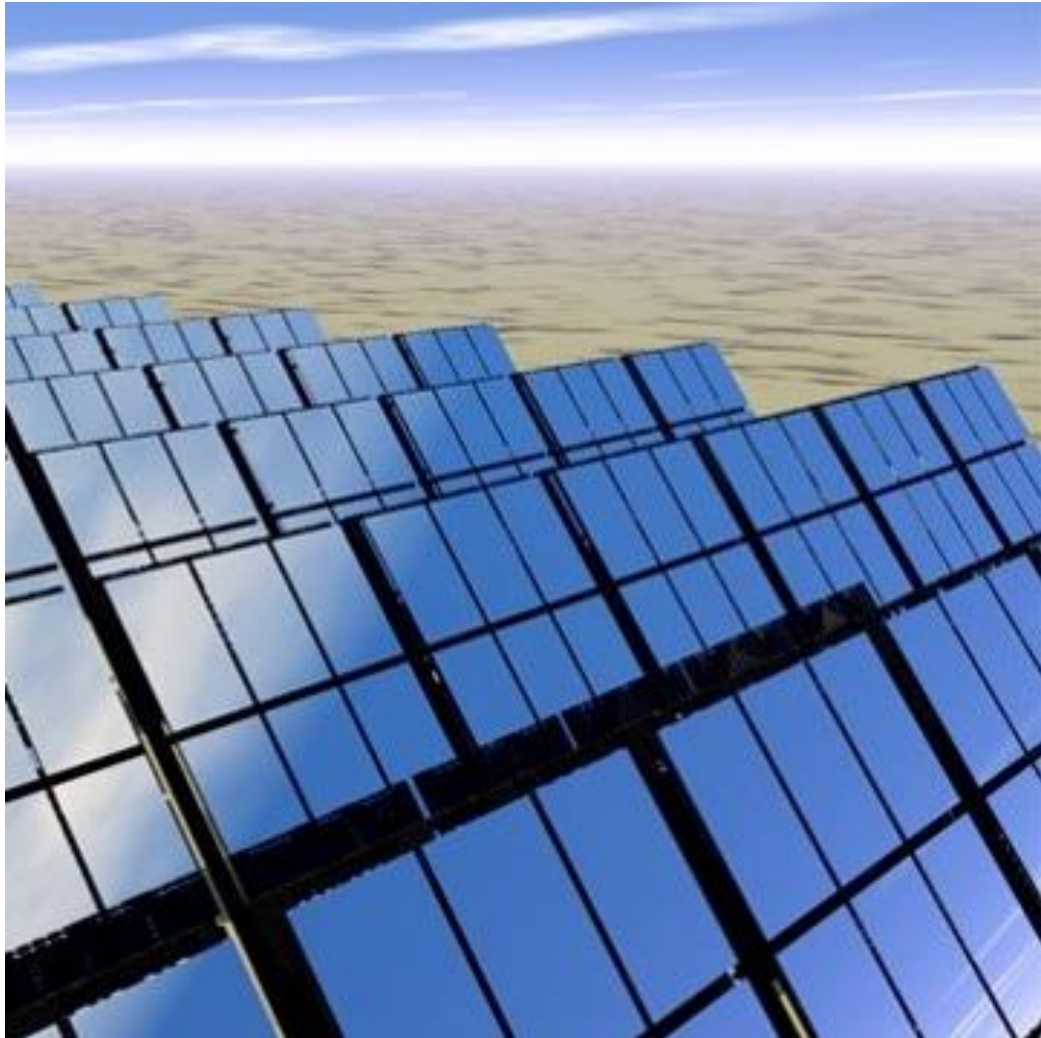
Cultivate relations with **China's major market players in energy conversion** (Huawei, Sungrow, ...)



# ENERGY STORAGE, A BOOSTER FOR SOLAR!







**QUESTIONS ?**