

# Raising the Bar in PV Connectors Technology

Frank Rosenkranz – Global PM  
Royer Zuleta – BDM Renewables

EVERY CONNECTION COUNTS



# About the Presenters



**Frank Rosenkranz**

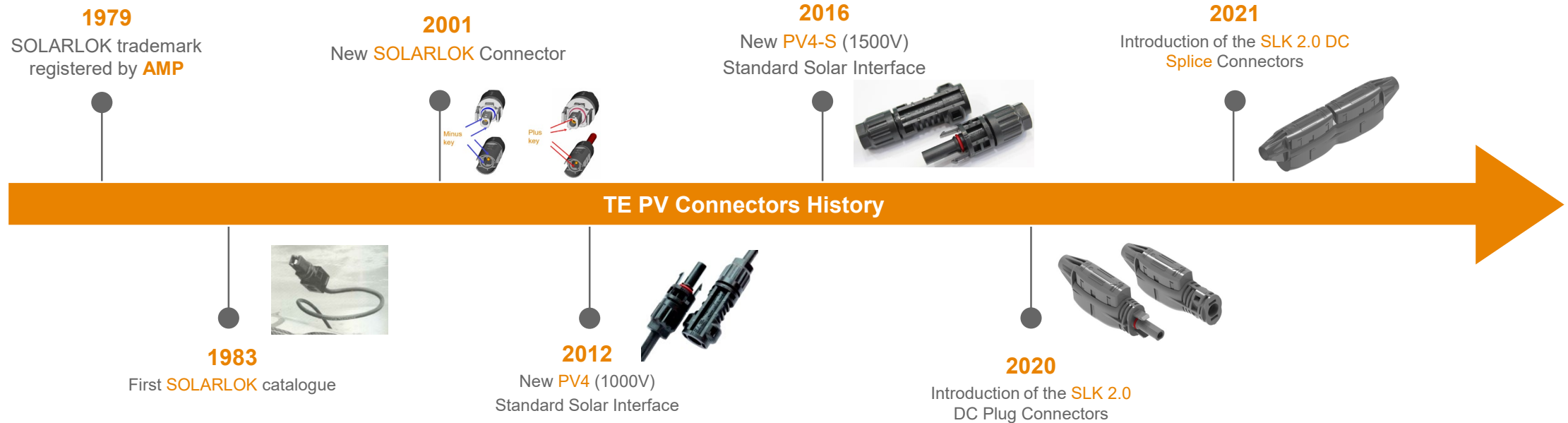
- Product manager of SOLARLOK solar connectors
- 38+ years of experience in sales & product management
- Contributor to new product innovation and development of the 1<sup>st</sup> generation of SOLARLOK connector and inventor of the new SLK 2.0



**Royer Zuleta**

- Business Development Manager for renewable energies
- 16+ years of experience in electrical products manufacturing including R&D, engineering, product management and business development.

# About TE's SOLARLOK Product Range





# With You Every Step of the Way to Keep Your Grid Connected

## + EQUALS MORE

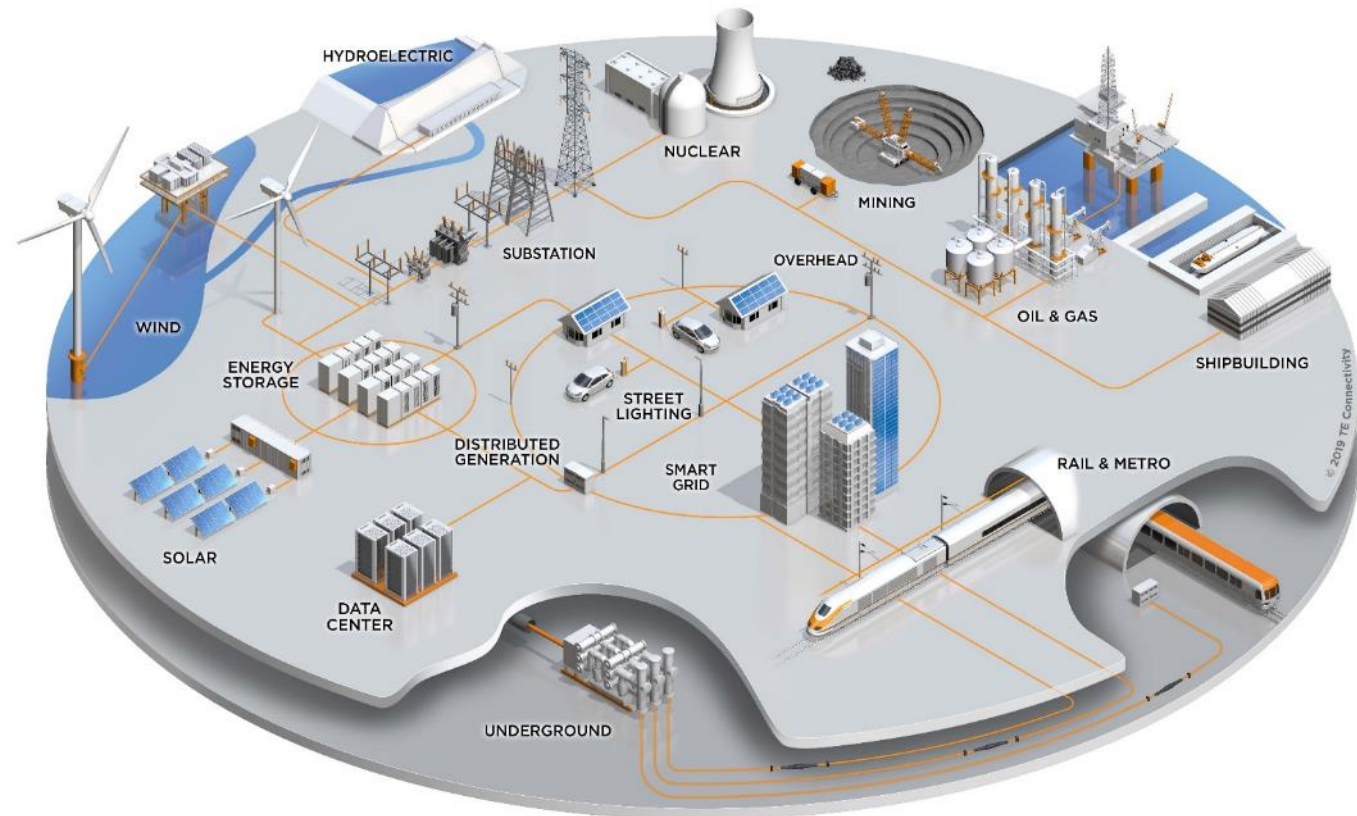
Comprehensive solutions and services from a single partner:

- Cable Accessories
- Connectors & Fittings
- Insulation & Protection
- Metering
- Installation Training

Enabling more than

# 85 GW

solar generation worldwide  
over the past ten years



# Solar Market Trends

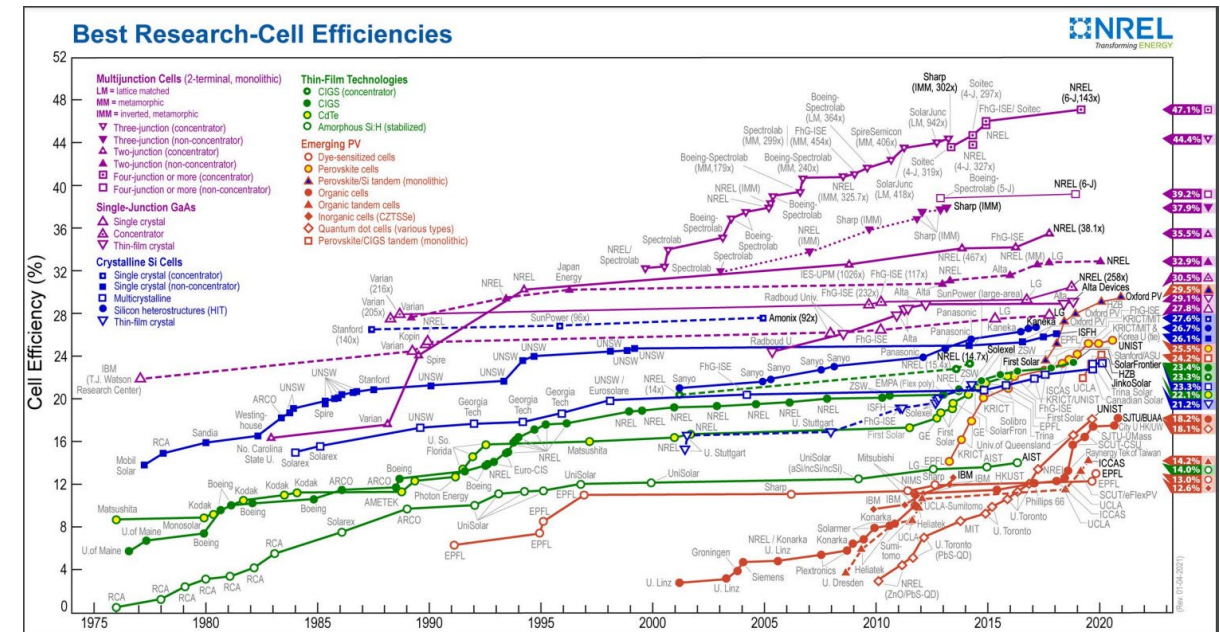
- High performance solar panels (600+ W)
- Larger central inverters (4,6+ MW)
- Larger string inverters (750+ kW)
- Larger installations (1+ GW)
- More power out



## Leading to:

- Improved ROI
- Better LCOE
- Less time for execution
- Minimum/optimal O&M
- Harsher environments
- Energy storage required

Highest confirmed conversion efficiencies for research cells for a range of photovoltaic technologies, plotted from 1976 to the present



Source: NREL - National Renewable Energy Laboratory of the U.S. Department of Energy. 2020

# Reasons for Downtime

- **Corrective maintenance** ↑
- **PV connectors need replacing** ↑
- **DC cable needs replacing** ↑
- Micro inverters high internal temperature alarm
- Soiling, dirt or dust removal
- Damaged panels need replacing
- Wind or swell damages





# Potential Failure Points

## Performance implications of poor installations:

- Poor crimping (burnt connectors) ↓
- Poor PV connector insertion (hot spots) ↑
- Improper plug assembly (power losses) ↑
- Cross pairing (high contact resistance)
- “Overcrowded” DC combiner boxes (blown fuses)
- Improper module handling (damaged panels)
- Poor lug installation (no torque monitoring)
- DC cabling on sharp edges (DC Cable damages)



Source: Guidelines for evaluating the fire risk in PV systems, TÜV Rheinland Energy and Environment GmbH. <http://www.pv-brandsicherheit.de/46/>



# PV Connectors Technology

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EVERY CONNECTION COUNTS





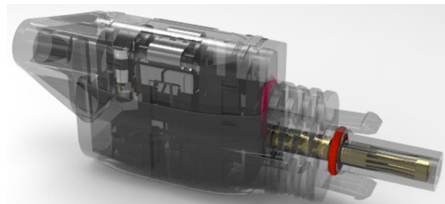
# Common PV Connector Challenges

**Missing Parts (contacts, pinch rings, hex nuts,...)**



**You have to grab new parts or worst case go find them**

**Incorrect Conductor Insertion (insert wrong gender or via interface)**



**All parts are pre-assembled and ready to install**

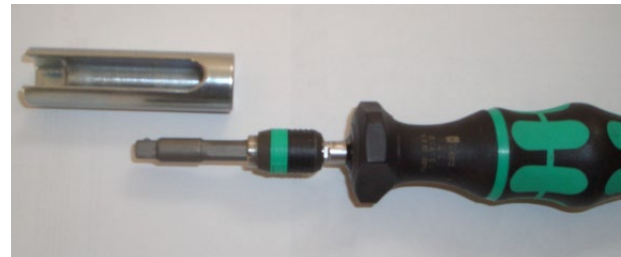
**Special Hand Tool Required (produced by the connector manufacturer)**



**Wouldn't it be easier to simply use this universal tool?**



**Improper IP (internal) protection**



**Over torqued = cable insulation issue  
Under torqued = not as tight as defined**





# Common PV Connector Challenges

1

## Improper Crimping

Using the wrong tool or a defective tool can cause electrically unstable crimps [ $P = I^2 \times R_{\text{crimp}}$ ]

Voltage drops ↑

Live cycle ↓

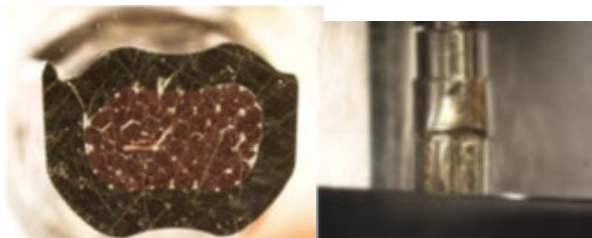
Losses ↑

Reliability ↓

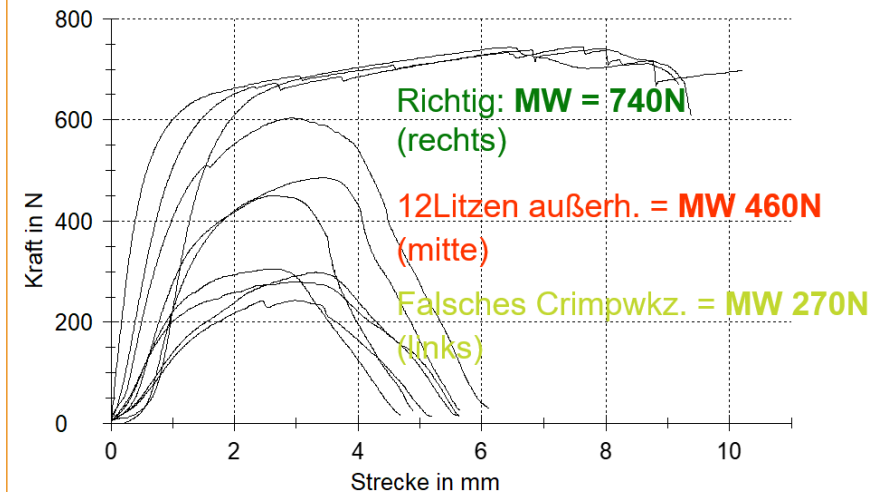
Cross-section of crimp shows:

- Weak compression of strands, airgaps visible
- Crack across the barrel
- Crimp is asymmetrical shaped

Bad part



## Crimp pull out force vs. Crimp quality



Dark green = Correct crimp  
Red = 12 strands cut  
Light green = Incorrect tool

EN 60352-2  
defines 310N min.



2

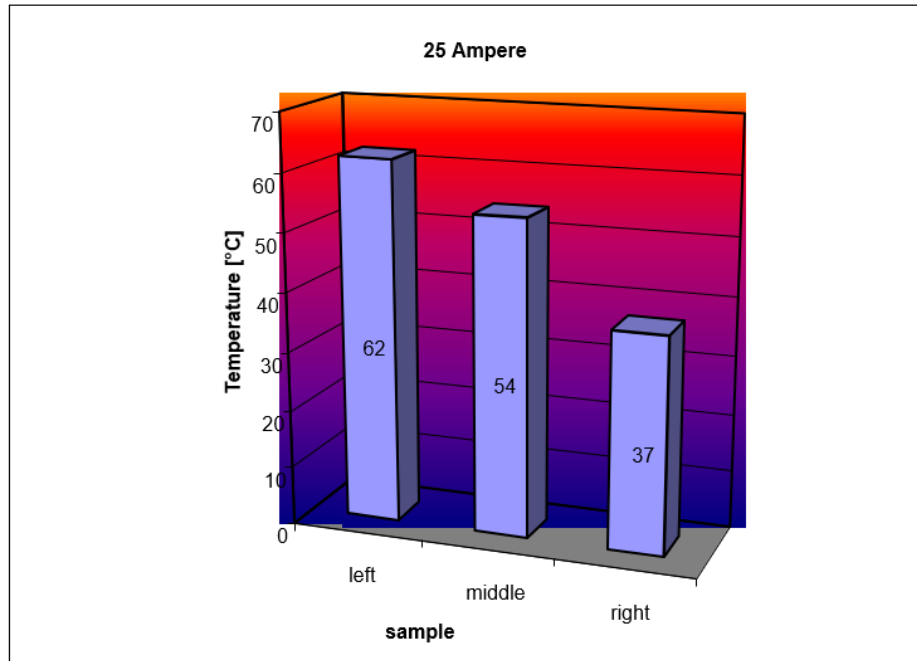
With these defects, the expected lifetime of 25+ years is very unlikely!

# Common PV Connector Challenges

## Incorrect Cable Stripping and Crimping

Use of standard PV connectors requires correct stripping of the insulation. If done improperly it influences the connection quality and lifetime.

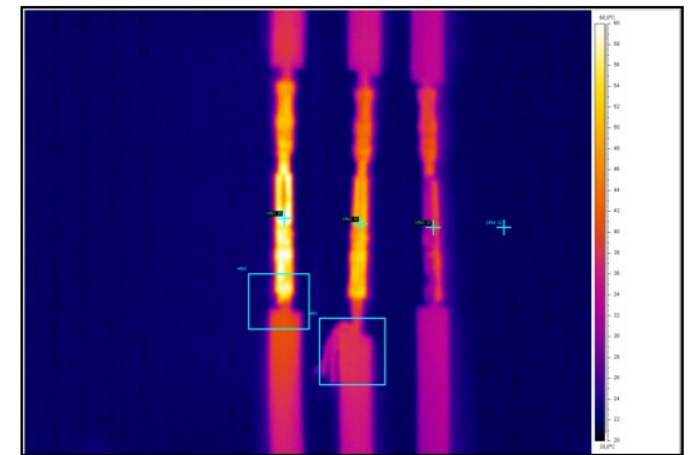
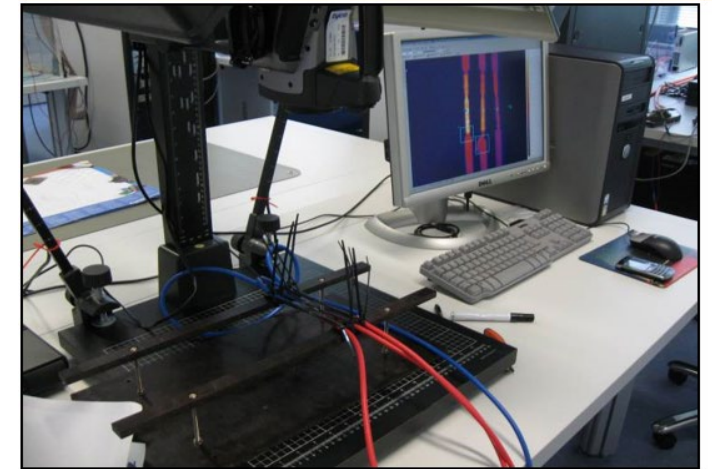
Thermography [°C] vs crimp quality @22°C



$\Delta T = 40^{\circ}\text{C} \quad 32^{\circ}\text{C} \quad 15^{\circ}\text{C}$

Left side: Incorrect tool  
Center: 12 strands cut  
Right side: Correct crimp

3

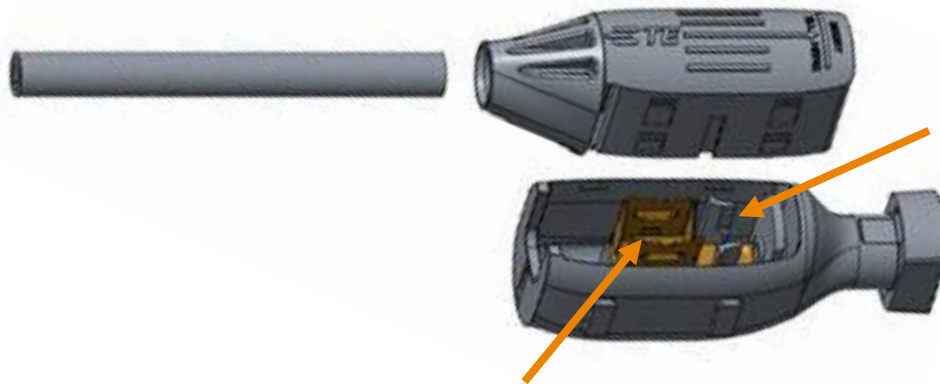


TE cable 4mm<sup>2</sup> /AWG 12 (56 strands)



# SLK 2.0 DC Plug and Splice Connectors Solving your Challenges

**SLK 2.0 – IDC System 1500V approved per IEC 62852 & UL 6703**



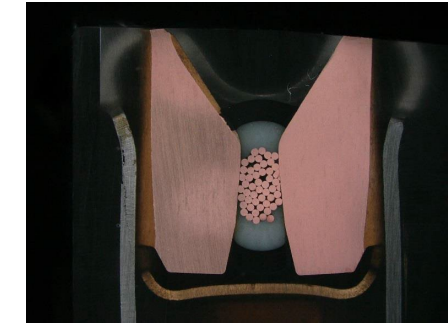
The whole connector inside is filled for IP protection  
IP X8 (1m/24 hrs.)



## Insulation Displacement Connection (IDC)

with special designed points of contact to cut insulation & touch strands for a wide range of cable diameters (2,5mm<sup>2</sup> & 4mm<sup>2</sup> & 6mm<sup>2</sup> // AWG 14-10).

All 3 ranges covered in ONE connector.



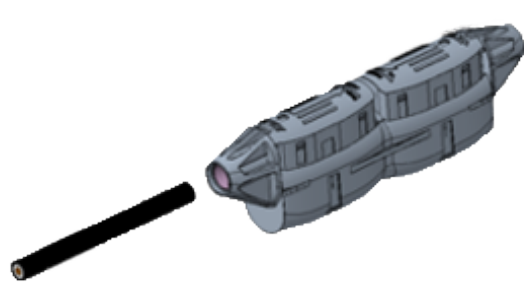
IDC is a proven, trusted and widely used technology that has passed critical parameter tests:

- Cross-section
- No impact on resistance after temperature cycle
- T-rise

**It is more than 30 years in the field used in various industries including: Automotive, Industrial, Lighting, Medical, Rail...**

# SLK 2.0 DC Plug and Splice Connectors Installation Steps

## SLK 2.0 SPLICE



**Step 1:** Insert First Cable



**Step 2:** Push First Button



**Step 3:** Insert Second Cable



**Step 4:** Push Second Button

▶ [Watch SLK 2.0 Splice Installation Video](#)

## SLK 2.0 CONNECTOR



**Step 1:** Insert Cable



**Step 2:** Push Button



**Step 3:** Fully Close

▶ [Watch SLK 2.0 Connector Installation Video](#)

### Necessary Tool



TE's SOLARLOK  
hand tool

or



Standard channel  
lock plier

**80% installation time reduction  
compared to traditional PV connectors**



# Traditional Solar Crimp Connectors VS SLK 2.0 Installation Steps

## SLK 2.0

1 Tool required



TE's SOLARLOK  
hand tool

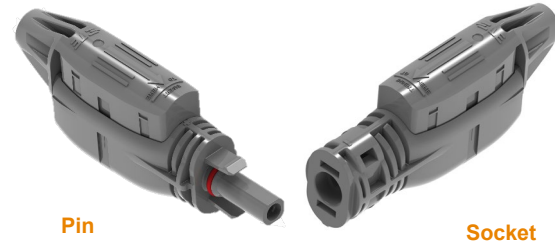
or



Standard channel  
lock plier



Termination time  
up to. 30 seconds  
per set !



Pin

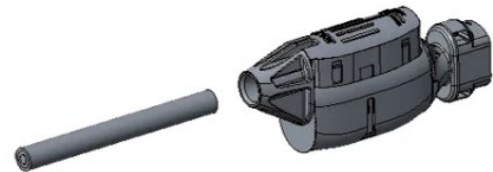
Socket

## SOLARLOK 2.0

1,500V PV Connector

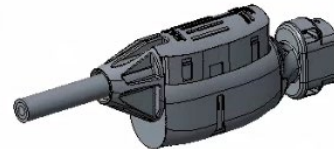
### STEP 1

Insert un-prepared cable



### STEP 2

Push button down



### Step 1

Prepare cable with wire strippers to specific dimensions

### Step 2

Insert correct contact into crimp tool

### Step 3

Insert prepared wire into contact

### Step 4

Make correct crimp and remove from tool

### Step 5

Push crimped contact/cable into correct connector

### Step 6

Check the correct position in housing  
(slight pull back)

### Step 7

Screw nut into final seated position

### Step 8

Torque to defined Nm (check specification)



## PV4-S

(traditional con.)

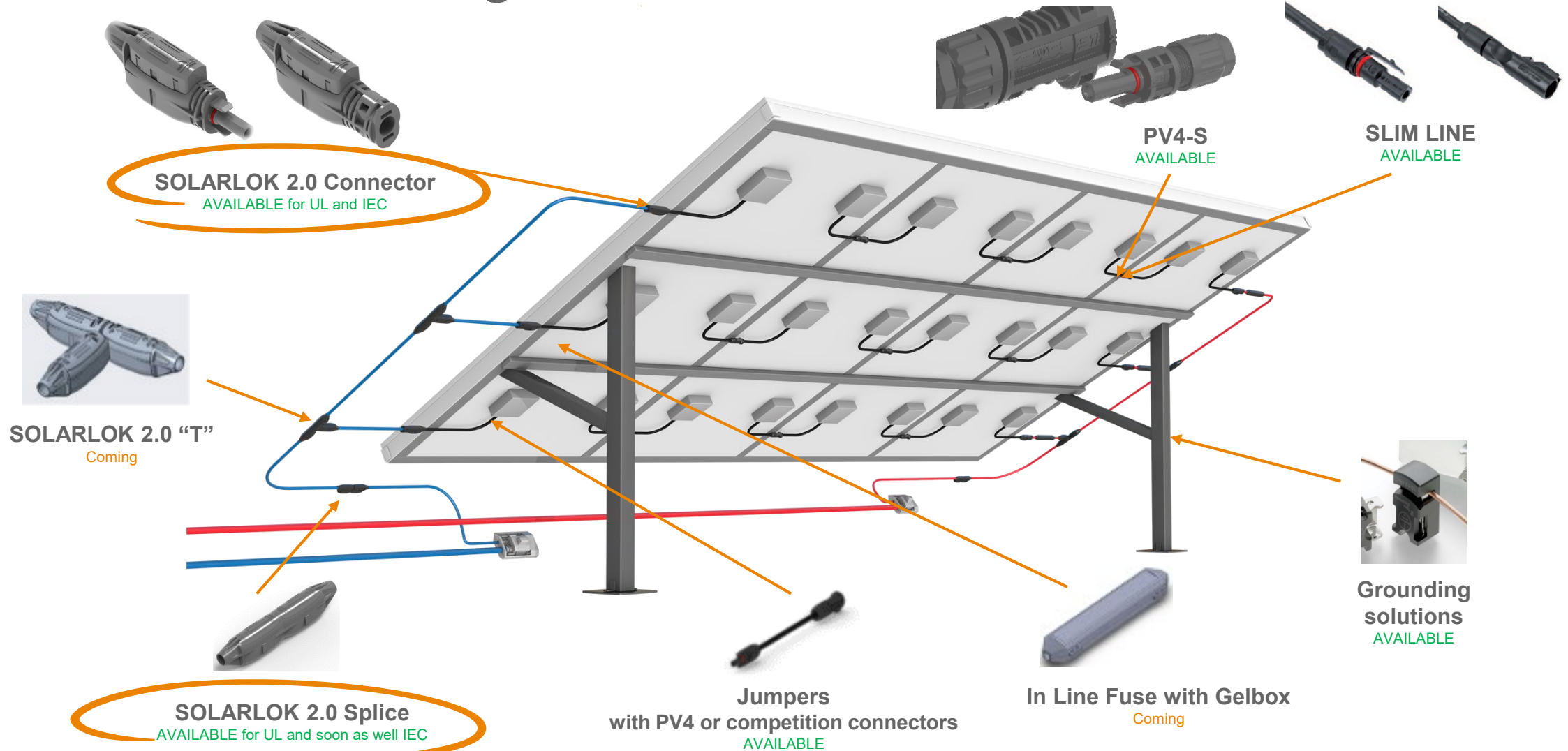
3 Tools required



Termination time  
up to. 4 minutes  
per set !

# SOLARLOK

## Solar Connectors Range





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# EVERY CONNECTION COUNTS

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**TECHTalk**  
Product Series

