



Metallization & Interconnection  
**WORKSHOP 2021**  
10TH EDITION for Crystalline Silicon Solar Cells

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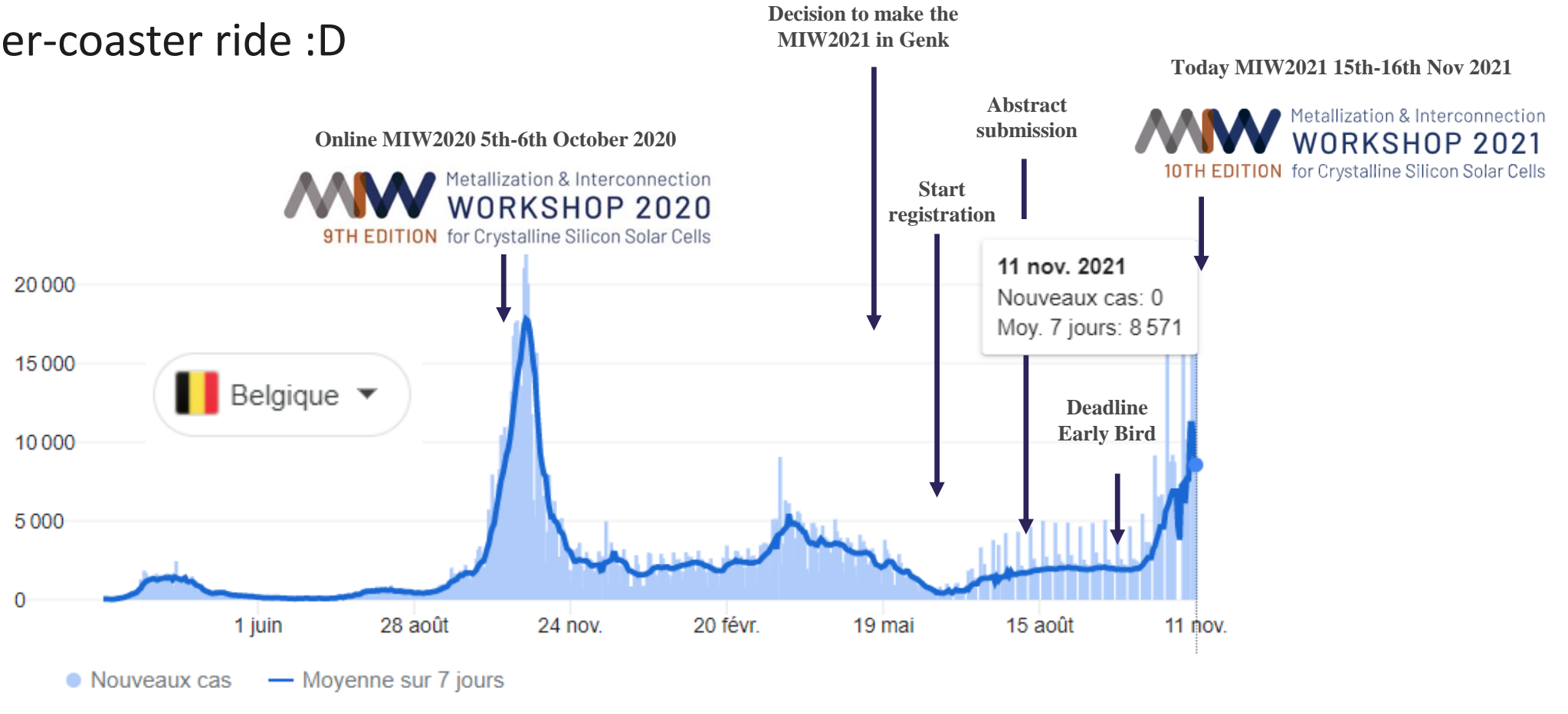


# MIW2021 organization vs Covid



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- A bit of roller-coaster ride :D



# 1<sup>st</sup> time in Genk, Belgium!



Metallization & Interconnection  
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welcome reception at M Hotel



Hybrid workshop at Thor Central auditorium



Workshop diner at Barenzaal (C-mine)





# Campus EnergyVille



Campus  
EnergyVille



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# EnergyVille is



Metallization & Interconnection  
**WORKSHOP 2021**  
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- A bundling of all energy research in Flanders, Belgium



KU LEUVEN

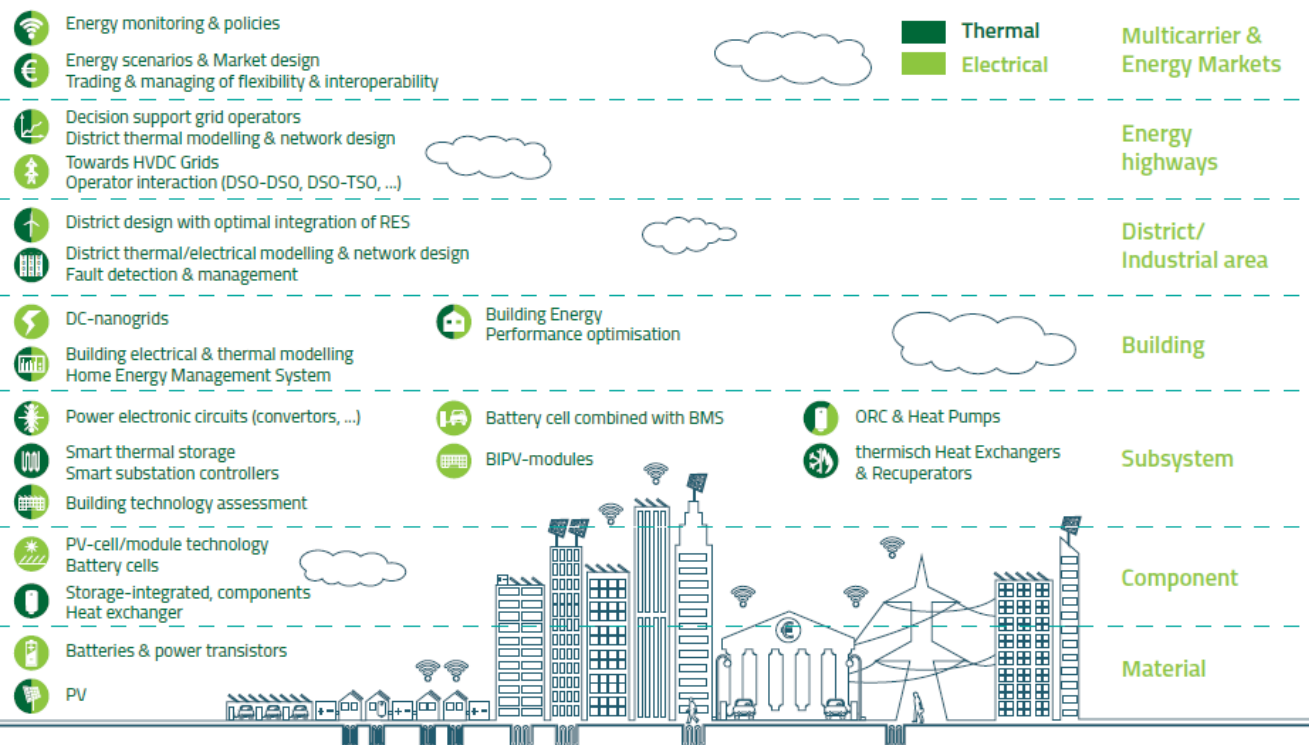
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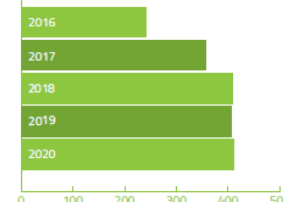


NATIONALITIES 2020

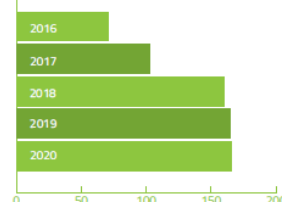
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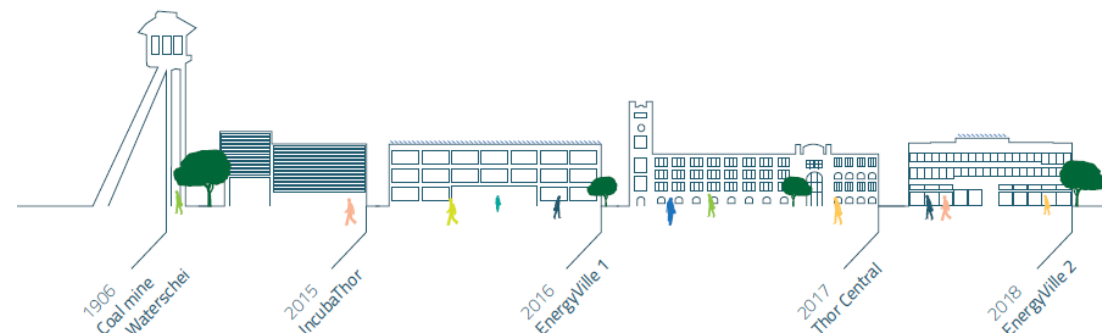
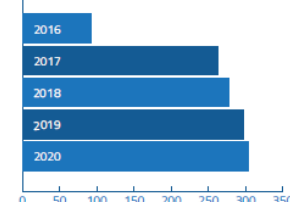
COLLEAGUES



PHDS & POSTDOCS



PUBLICATIONS





# Visit of imec PV facilities in EV1/EV2



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Outdoor testing facilities in EV1 (open-rack) and EV2 (BIPV setup)



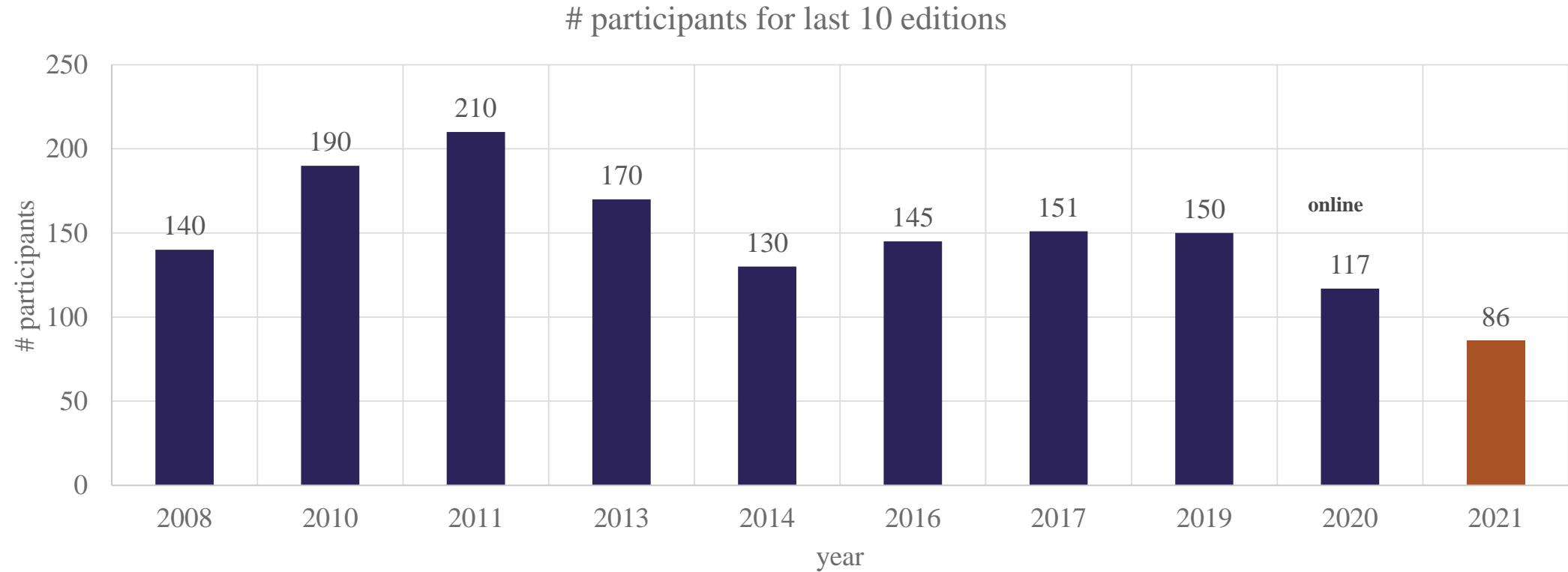
1500m<sup>2</sup> lab facilities for PV modules, battery and TF-PV in EV2



# Number of participant

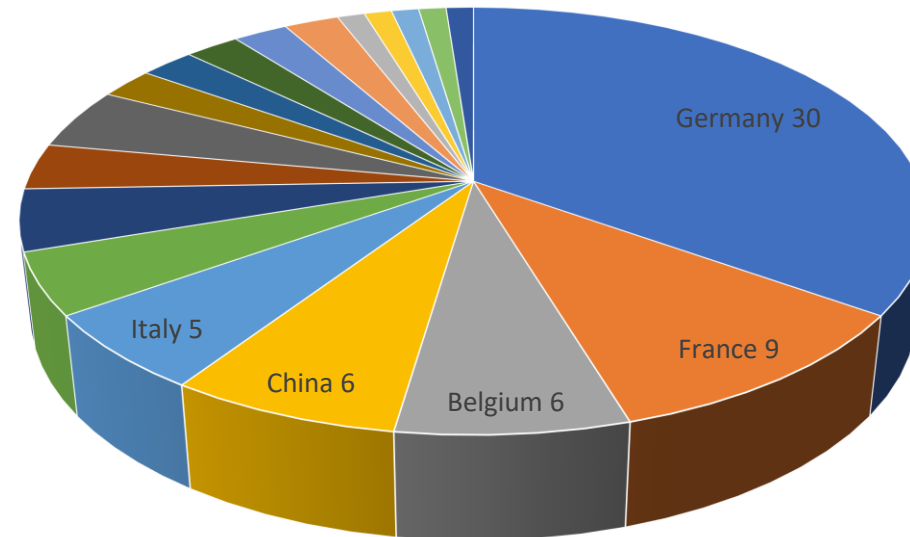


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# Number of participant

- 81 participants registered
- 19 nations

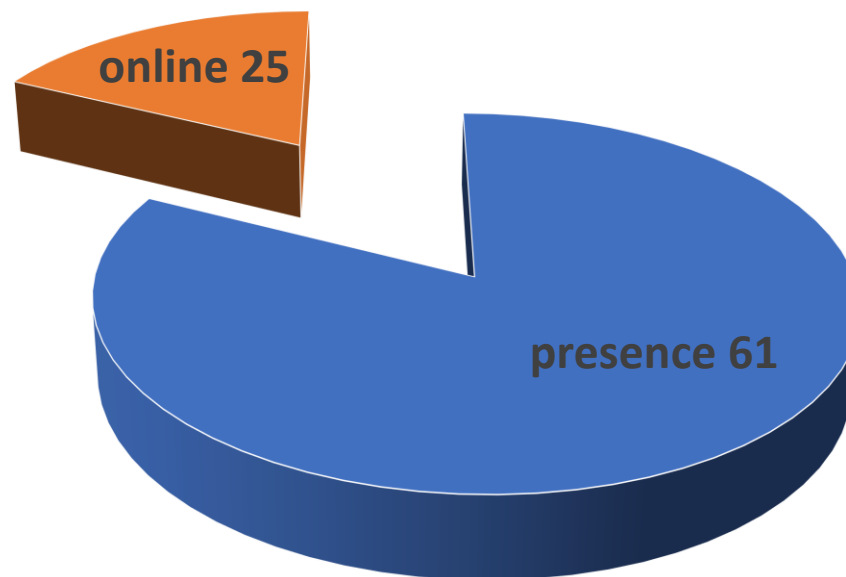


■ Germany 30	■ France 9	■ Belgium 6	■ China 6	■ Italy 5	■ Japan 4	■ Switzerland 4
■ Netherlands 3	■ Spain 4	■ Australia 2	■ Israel 2	■ Lithuania 2	■ Russia 2	■ Turkey 2
■ Austria 1	■ GB 1	■ India 1	■ Portugal 1	■ Sweden 1		



# Number of participant

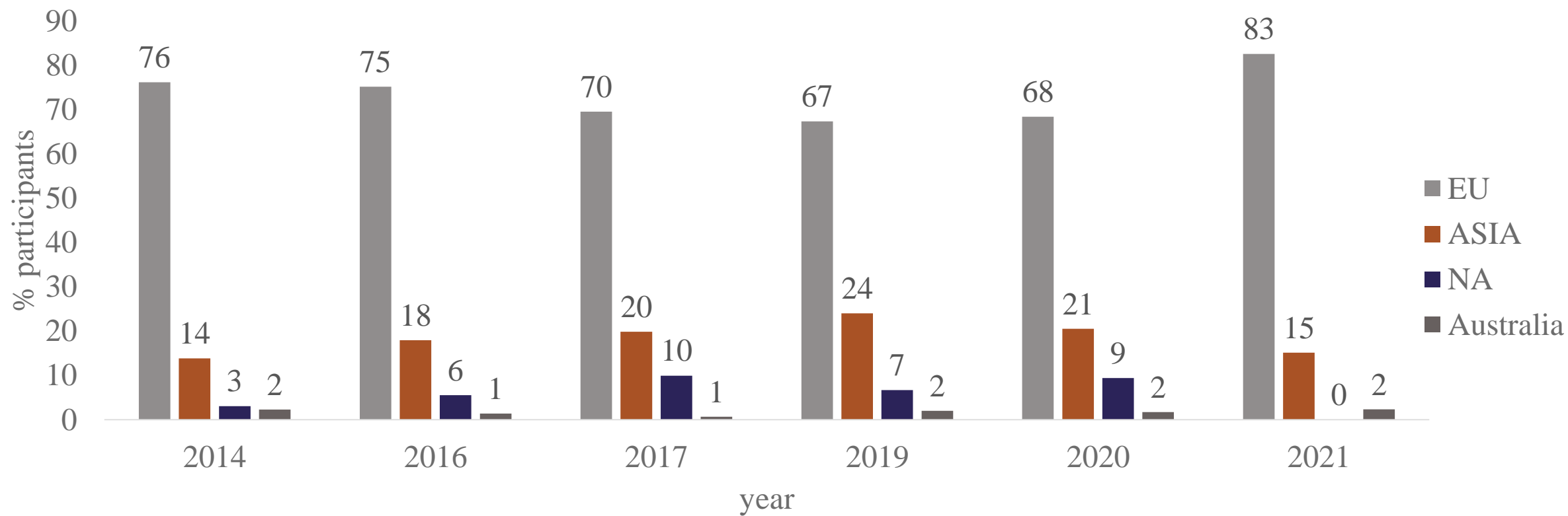
- 81 participants registered
- ~ 30% online



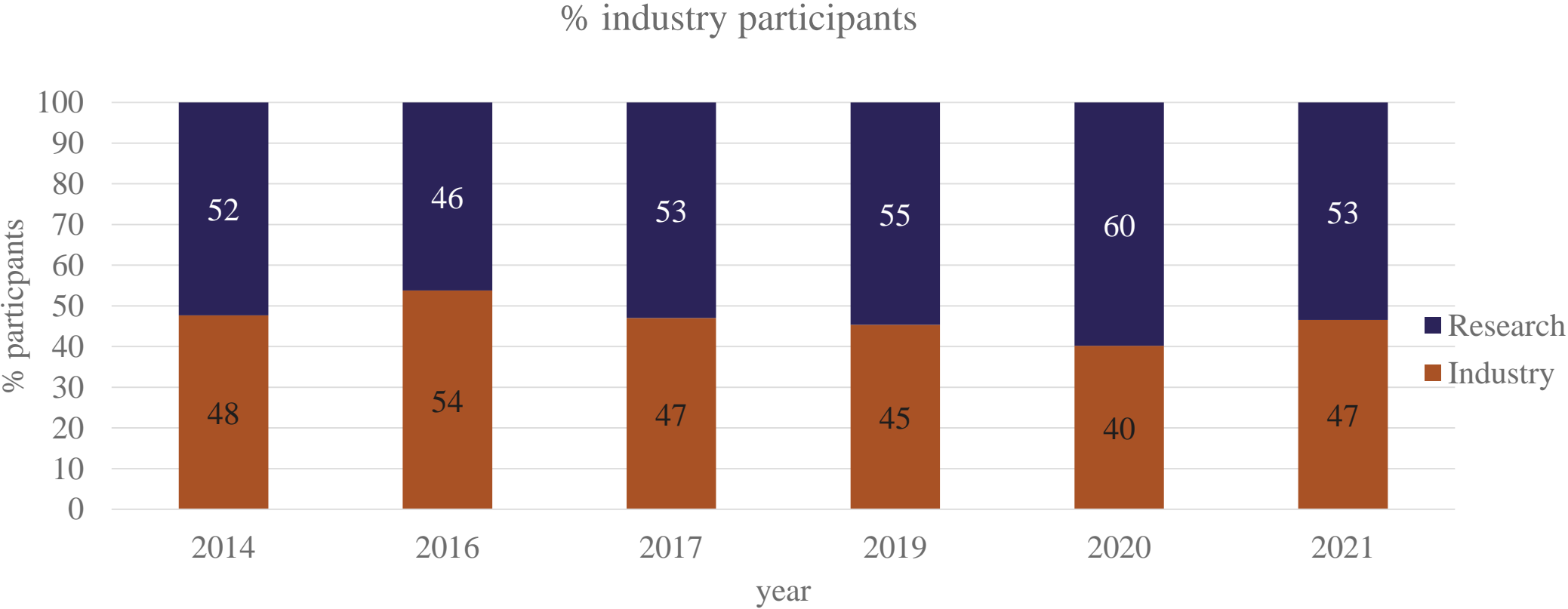
# Share by region



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# Industry participation





# Program Monday 15<sup>th</sup> morning



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Monday, November 15, 2021			
09:00 - 09:15		Welcome (Mayor of Genk)	
09:15 - 09:30		Opening (MIW2021 organizers)	
09:30 - 10:45		Session I: Understanding of screenprinted contacts	
		session chair 1: Thomas Buck (ISC Konstanz) session chair 2: Maximilian Pospischil (HighLite Technologies)	
	Eve Krassowski	CE Cell Engineering GmbH	Investigation of impact of cell properties on LECO effectiveness using off-spec PERC cells of different manufacturers on MK4 platform
	Mengmeng Deng	EPFL	Understanding and insight of paste formulation and curing behavior with sub-100-nanometer Ag-Cu core-shell nanoparticles
	Pradeep Padhamnath	SERIS	Modeling of contact resistivity of fire-through Ag-Al contacts to boron doped poly-Si
10:45 - 11:15		Coffee break	
11:15 - 12:45		Session II: Shingling interconnection	
		session chair 1: Samuel Harrisson (CEA INES) session chair 2: Marco Galliazzo (AMAT)	
	Marc Estruga	Henkel	Acrylate-, Epoxy- and Silicone-based electrically conductive adhesives as interconnection material in shingled module technology
	Daniel von Kutzleben	F-ISE	Progress in shingle interconnection based on electrically conductive adhesives at Fraunhofer ISE
	María Ignacia Devoto	ISC	Contact resistivity of ECA-based joints: How to extrapolate it?
	Margit Lang	PCCL	FEM simulation of deformations and stresses in strings of shingled solar cells under mechanical and thermal loading
12:45 - 14:00		Lunch break	

# Program Monday 15<sup>th</sup> afternoon



Metallization & Interconnection  
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14:00 - 15:30	Energyville tour 1 (max. 60 persons) or Networking		
15:30 - 17:15	Session III: Advanced printing techniques		
	session chair 1: Jan Lossen (ISC Konstanz) session chair 2: Thibaud Hatt (Fraunhofer ISE)		
	Marco Galiazzo	AMAT	Evaluation of different approaches for HJT cells metallization based on low temperature pastes
	Karim Abdel Aal	KIT	Effect of the addition of a slip agent to the bulk phase on the transfer properties of solar cell front site metallization pastes
	Antonin Faes	CSEM	Ink-jet printing of silicon heterojunction: from cell power to module reliability
	Andreas Lorenz	F-ISE	Progress with Rotary Screen Printed Fine Line Metallization for Silicon Heterojunction Solar Cells
	Maximilian Pospischil	HighLine Technology	Fully automated intermittent parallel dispensing
17:15 - 18:30	Market Place Discussions & Transfer		
From 18:30	Aperitif & Dinner		

# Market place discussion (17:15-18:30)



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- **Topic1: New interconnection technologies: a recipe for disaster in 10 years?**
- Can shingling, paving, tiling and other zero-gap technologies combine performance and reliability?
- **Moderators:**
  - Marco Galiazzo (AMAT)
  - Vincent Barth (CEA INES)
- **Topic 2: Is Cu finally ripe for the big show?**
- Cu plating and Cu pastes fight to be the solution to our Ag problem.
- **Moderators:**
  - Thibaut Hatt (ISE)
  - Antonin Faes (CSEM)
- **Topic 3: Are Electrically conductive adhesives (ECAs) the way to go to solve all problems?**
- Lead-free, low temperature, textured ribbons,... Is there something they cannot do?
- **Moderators:**
  - Armand Bettinelli (CEA-INES)
  - Giuseppe Galbiati (Henkel)
- **Topic 4: Printing at the Terawatt scale: what will it look like?**
- Will screen printing crank up its game as it has always done, or has the time come for a truly new technology?
- **Moderators:**
  - Ansgar Mette (Q-cells)
  - Sebastian Tepner (ISE)



# New book on Silicon Solar Metallization and Module technology (in press by end 2021)



Metallization & Interconnection  
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with contributions from:

## Silicon Solar Cell Metallization and Module Technology

In solar cell production, metallization is the manufacturing of metal contacts at the surfaces of solar cells in order to collect the photo-generated current for use. Being one of the most expensive steps in solar cell fabrication, it plays both an electrical and an optical role, because the contacts contribute to shading, and to the series resistance of solar cells. In addition, metal contacts may reduce the solar cells voltage due to charge carrier recombination at the metal / silicon interface. Addressing these challenges could increase solar cell conversion efficiency while cutting their production costs.

This work presents state of the art methods for the metallization of crystalline Si solar cells for industrial production as well as for research and development. Different metallization technologies are compared, and ongoing R&D activities for the most relevant silicon solar cell metallization technologies are described in detail. Chapters cover fundamentals of metallization and metallization approaches, evaporated, plated and screen-printed contacts, alternative printing technologies, metallization of specific solar cell types, module interconnection technologies, and also address module technology.

Written by a selection of world-renowned experts, the book provides researchers in academia and industry, solar cell manufacturing experts and advanced students with a thorough and systematic guide to advanced metallization of solar cells

### About the Editors

Thorsten Dullweber leads the R&D group Industrial Solar Cells at the Institute for Solar Energy Research in Hameln (ISFH), Germany.

Loic Tous is R&D Team Leader of the PV Cells and Module team at the Interuniversity Microelectronics Centre (IMEC), Belgium



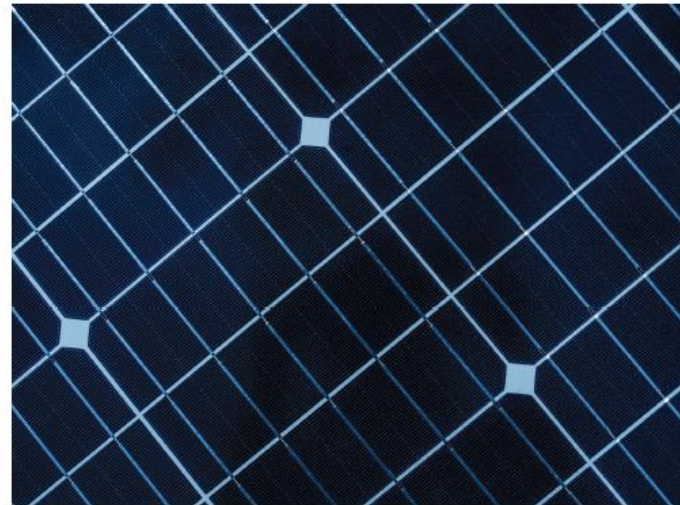
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## Silicon Solar Cell Metallization and Module Technology

Edited by  
Thorsten Dullweber and Loic Tous



Silicon Solar Cell Metallization  
and Module Technology

Edited by Dullweber and Tous

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Linda Ney (ISE)  
Pradeep Padhamnath (SERIS)  
Maximilian Pospischil (HighLine Technologies)  
Armin Richter (ISE)  
Torsten Roessler (ISE)  
Angela De Rose (ISE)  
Charles Roux (CEA-INES)  
Henning Schulte-Huxel (ISFH)  
Sebastian Tepner (ISE)  
Loic Tous (IMEC)  
Jutta Trube (VDMA)  
Anthony Valla (CEA-INES)

# Program Tuesday 16<sup>th</sup> morning



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Tuesday, November 16, 2021			
09:00 - 09:30		Wrap - Up Market Place Discussions	
09:30 - 11:00		Session IV: Cu plated contacts	
		session chair 1: Loïc Tous (imec) session chair 2: Antonin Faes (CSEM)	
	Bertrand Paviet-Salomon	CSEM	Reinforcement of screen-printed copper paste by electrodeposited copper for metallization of heterojunction solar cells
	Thibaud Hatt	F-ISE	Copper electroplating for SHJ solar cells - Adequate contact by electrolyte tuning
	Can Han	TU Delft	Controllable simultaneous bifacial Cu-plating for high efficiency crystalline silicon solar cell
	Thibaud Hatt	F-ISE	23.6 % Efficient Bifacial I-TOPCon Silicon Solar Cells with < 20 $\mu$ Wide Ni/Cu/Ag-Plated Contact Fingers
11:00 - 11:30		Coffee break	
11:30 - 12:45		Session V: Multi-BB interconnection	
		session chair 1: Guy Beaucarne (Dow) session chair 2: Andreas Schneider (ISC Konstanz)	
	Veronika Nikitina	F-ISE	High Speed Characterization of Electrically Conductive Adhesives for Industrial SHJ Solar Cell Ribbon Interconnection
	Vincent Barth	CEA-INES	Innovative industrial strategy based on Electrically Conductive Adhesive for HJT solar cells
	Li Carlos Rendler	F-ISE	Wave shaped wires for the interconnection of silicon solar cells without busbars or contact pads
12:45 - 14:15		Lunch break	

# Program Tuesday 16<sup>th</sup> afternoon



Metallization & Interconnection  
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14:15 - 15:45		<b>Session VI: Metallization of advanced cell concepts</b>	
		session chair 1: Ansgar Mette (Q-Cells) session chair 2: Thorsten Dullweber (ISFH)	
	Andreas Nägele	F-ISE	FOILMET®-CONNECT: Upgrading Adhesion by Employment of LMB
	Dominik Rudolph	ISC	Screen printable, non-fire-through copper paste applied as busbar metallization for back contact solar cells
	Juan Diaz Leon	CSEM	Sputtered polySi(n) passivating contacts compatible with direct metallization
	Martin Bivour	F-ISE	Challenges and Perspectives for the TCO and Metal Electrodes in Perovskite-Silicon Tandem Solar Cells: Performance and Scalability
15:45 - 16:00		<b>Closing and Goodbye</b>	
16:00 - 17:30		<b>Energyville tour 2 (max. 60 persons) or Networking</b>	



# Enjoy the program



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