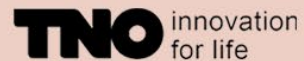


BCworkshop2024



12th workshop on

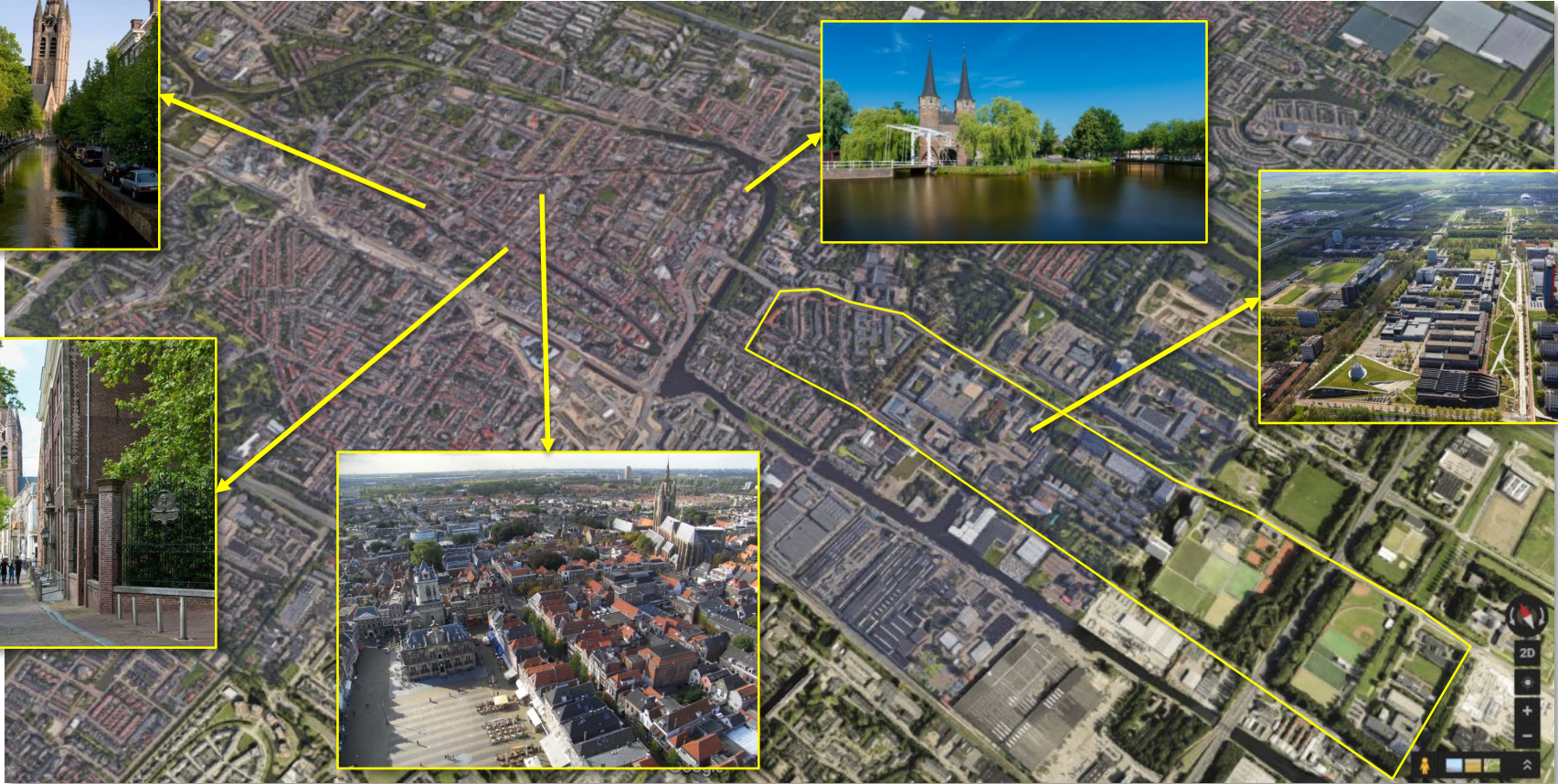
Back contact solar cell
and module technology

#BCworkshop

December 4-5, 2024
Delft, the Netherlands

Hosted by  TU Delft

Welcome in the historical city of Delft





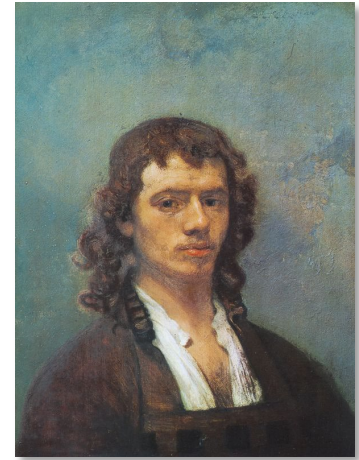
Delft and light



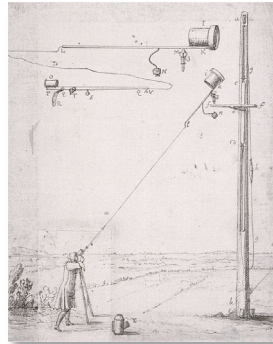
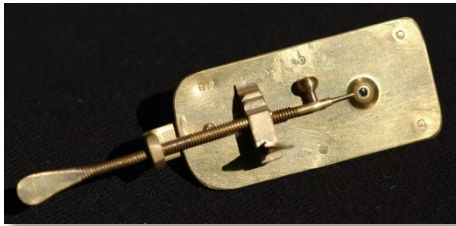
Antoni van Leeuwenhoek



Christiaan Huygens



Johannes Vermeer



Delft University of Technology

- **Largest and oldest Dutch public technical University**
 - Established in 1842: > 180 years of history!
 - > 27000 students
 - > 4400 scientists (30% female)
 - > 3200 support/management staff
- **One of the most prominent technical universities**
 - Ranked 13th in the World (Engineering and Technology)
 - Ranked 6th in Europe (Engineering and Technology)
- **TU Delft**
 - Attracts students from many countries
 - Encourages science career among women
 - Cooperates with several (inter)national industries and SMEs
 - Has a successful incubator for spin-off companies



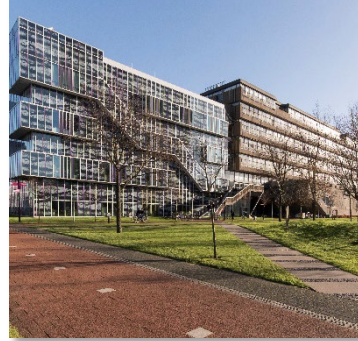
TU Delft campus



TU Delft faculties



Architecture and the Built Environment



Civil Engineering and Geosciences



Aerospace Engineering



Applied Sciences



Electrical Engineering, Mathematics and Computer Sciences



Industrial Design Engineering

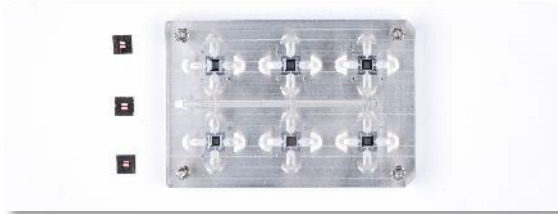


Mechanical Engineering



Technology, Policy & Management

EEMCS departments



Micro Electronics



Quantum & Computer Engineering



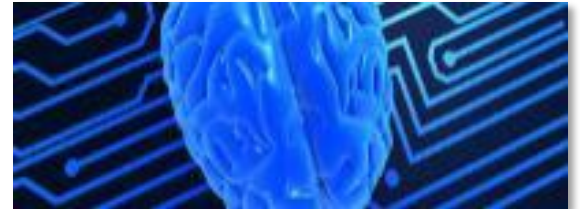
Electrical Sustainable Energy



Applied Mathematics



Software Technology



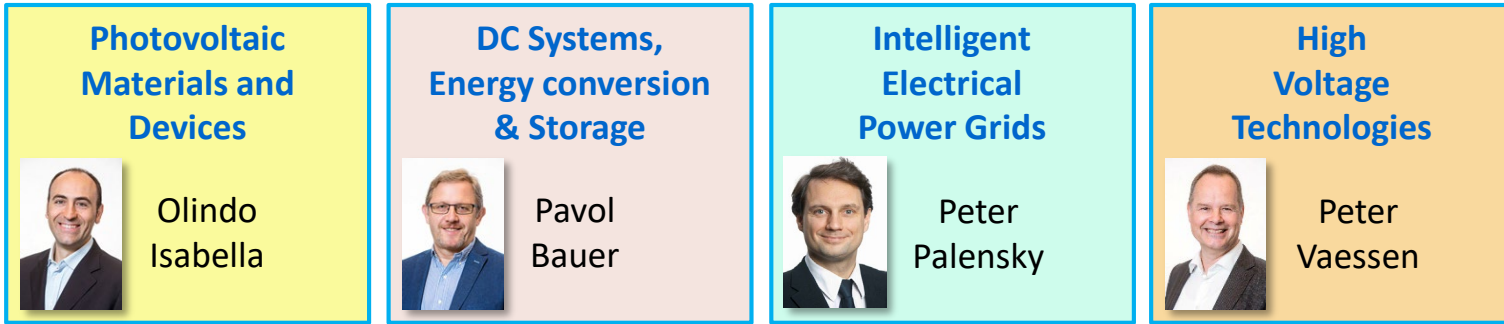
Intelligent Systems

Electrical Sustainable Energy department

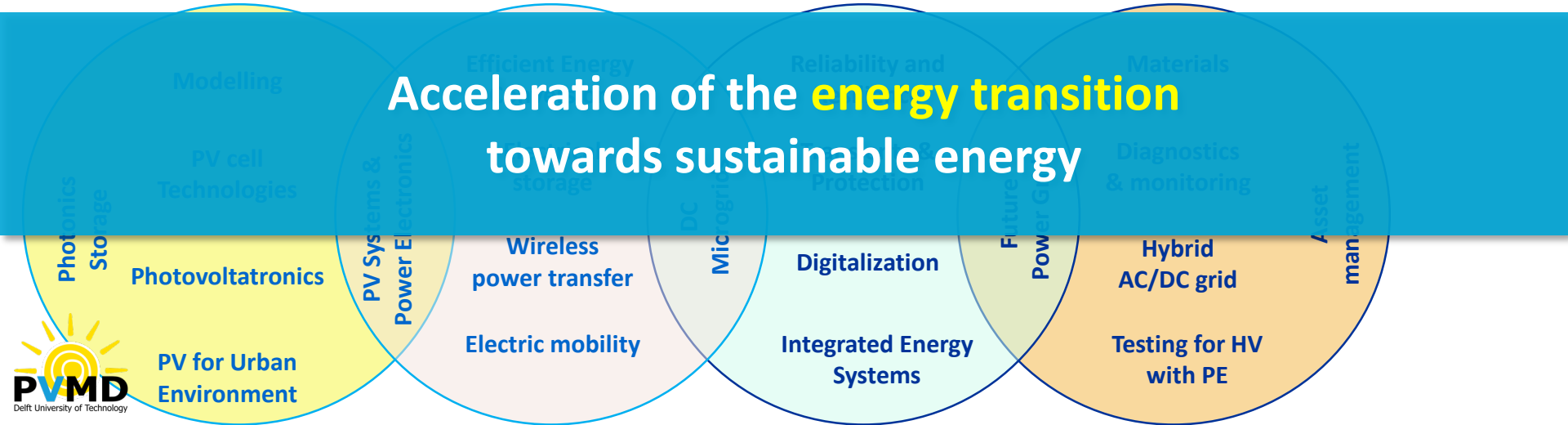
Department
Head



Peter Palensky



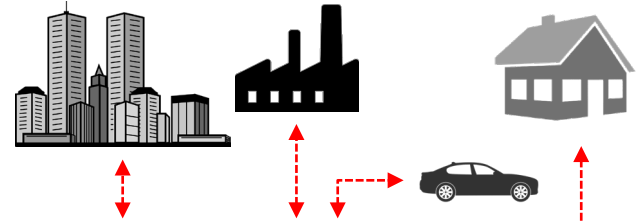
Acceleration of the **energy transition**
towards sustainable energy





Vision in Research

*Deploy **X-IPV** systems providing green electricity for the sustainable electrification of society*



Urban-Integrated
Photovoltaics (**UIPV**)

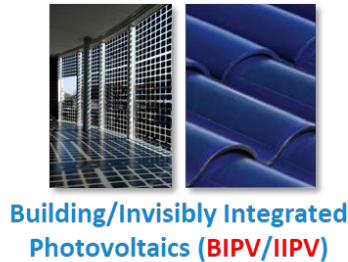


Built-Added
Photovoltaics (**BAPV**)

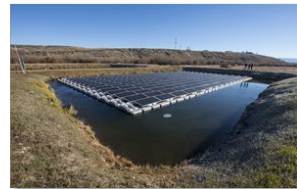


... and much more!

Product-Integrated
Photovoltaics (**PIPV**)



Building/Invisibly Integrated
Photovoltaics (**BIPV/IIPV**)



Environment-Integrated
Photovoltaics (**EIPV**)

E-mobility

E-bike charging
station by TU Delft



Solaroad
by TNO



Vehicle-Integrated
Photovoltaics (**VIPV**)





Vision in Research

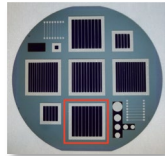
Deploy **X-IPV** systems providing green electricity for the sustainable electrification of society



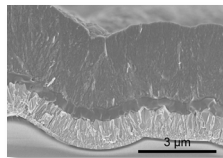
Systems



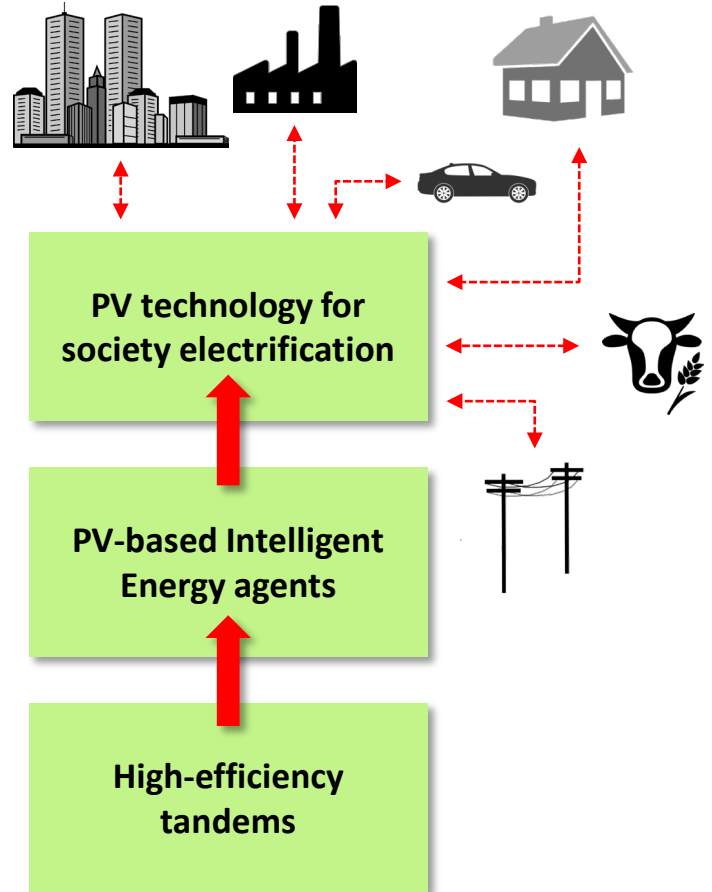
Modules



Devices



Materials

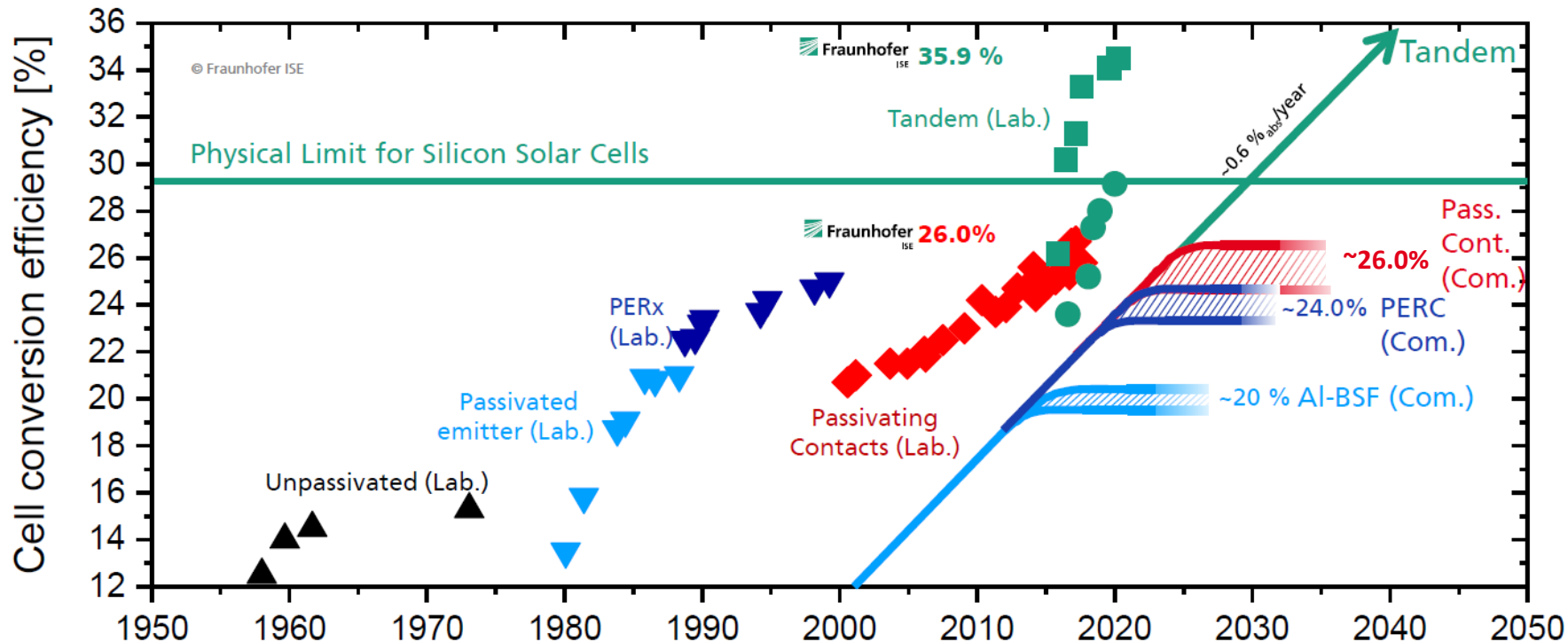


c-Si (BC) solar cells

BC Workshop 2024

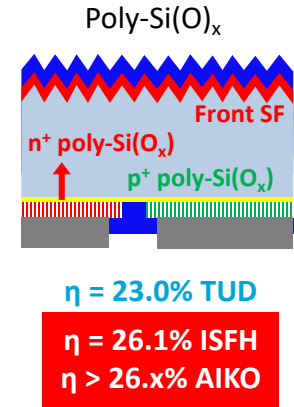
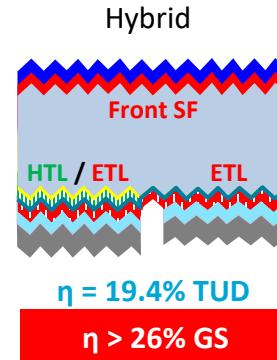
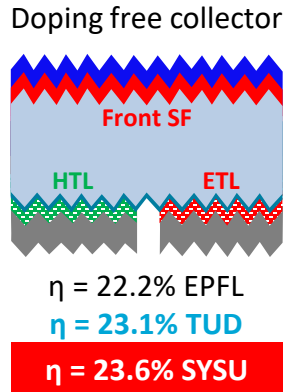
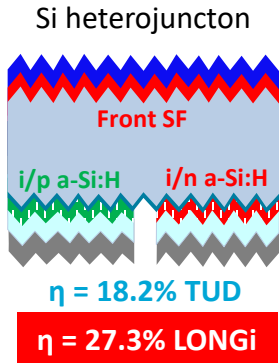


Crystalline silicon solar cells technology

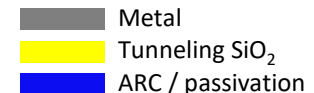
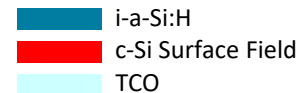
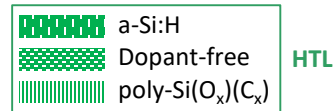
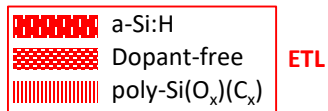


BC c-Si solar cells technology

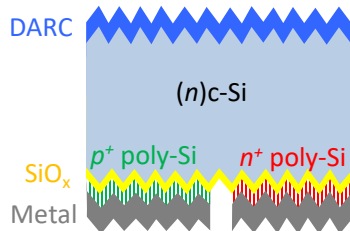
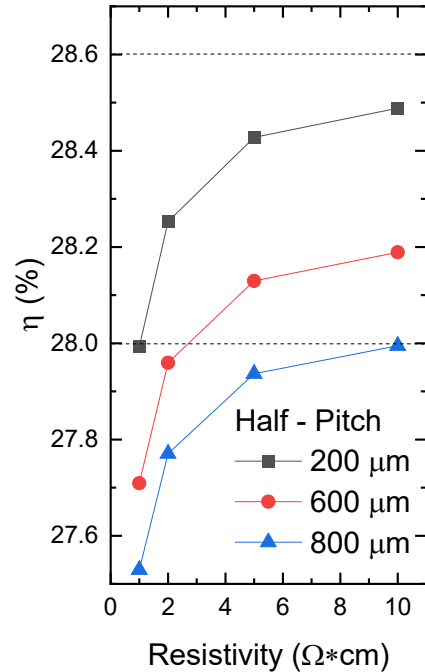
- Better optical potential
- Uniform/beautiful appearance
- TCO-free or TCO-less architectures
- Easier module manufacturing
- Low breakdown voltage
- Thinner wafers for ultimate efficiency



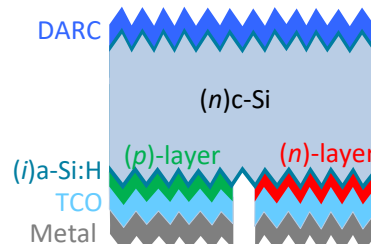
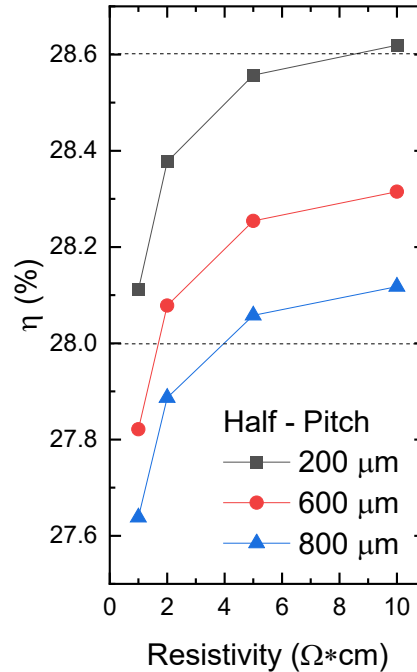
Manufacturing temperature



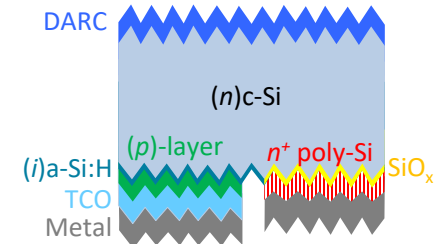
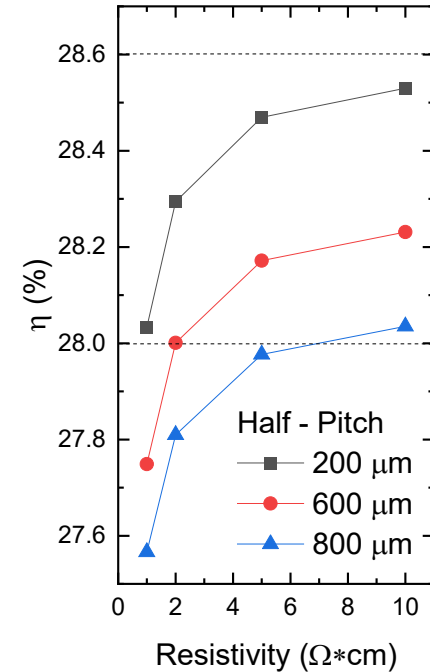
Effect of wafer resistivity



IBC - poly-Si

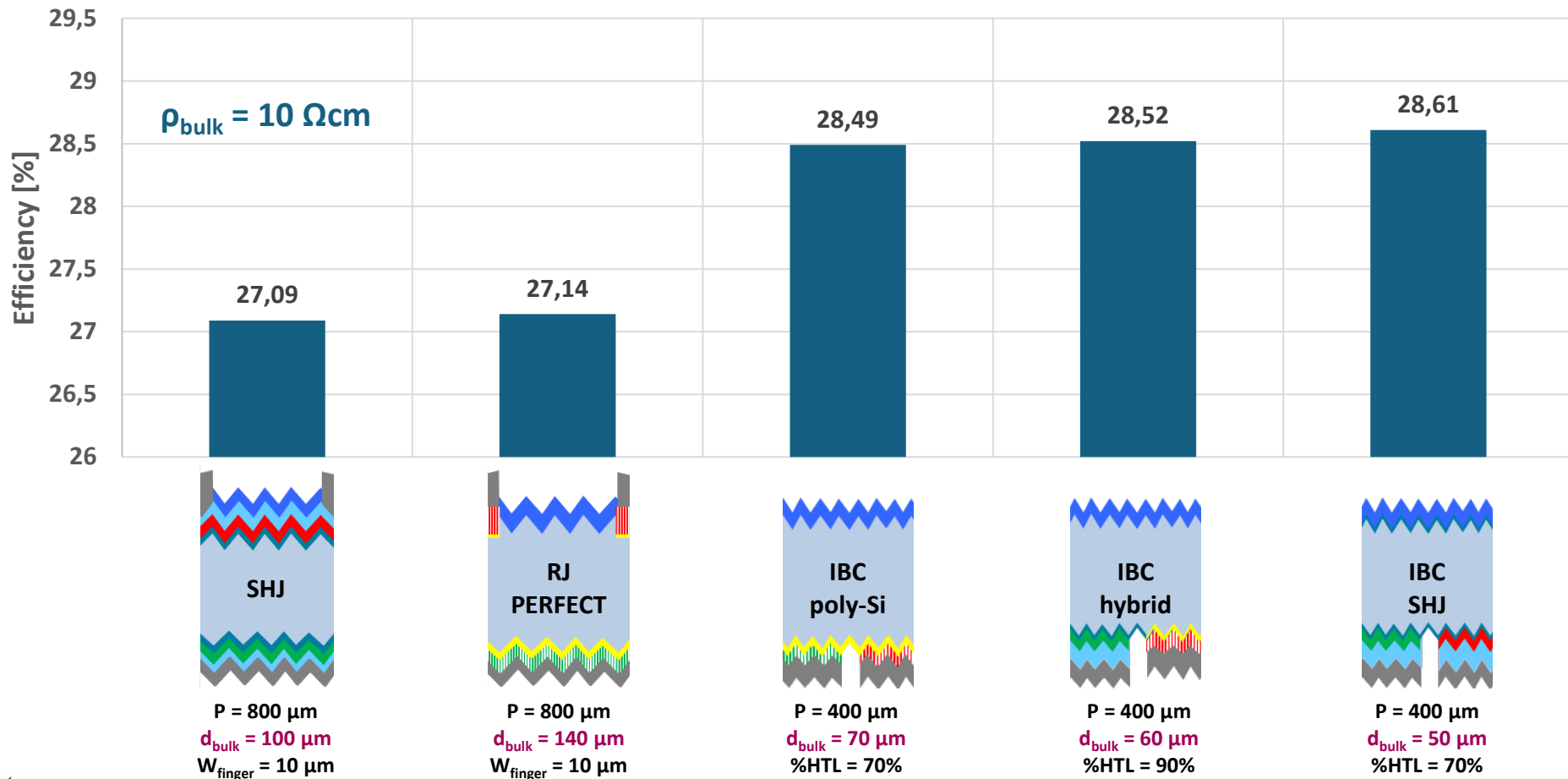


IBC - SHJ



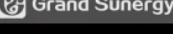
IBC - Hybrid

Ultimate efficiency from FBC to IBC architectures



TaiyangNews Top Modules

Highest Efficient Commercial Solar Modules 11-2024

Rank	Company	Series	Model	Wafer Type	Cell Size	Cells No.	Cell Tech	Module Technology	Power (W)	Efficiency (%)
1	 AIKO	Comet 2U	AIKO-G655-MCH72Mw	n-type	182	144	ABC	Half-cell, Back Contact	655	24.2
2	 Maxeon	Maxeon 7	SPR-MAX7-445-PT	n-type	125	112	IBC	Back Contact, Full-cell	445	24.1
3	 LONGi	Hi-MO X6	LR5-72HTH-590-600M	p-type	182	144	HPBC	Half-cell, Back Contact	600	23.2
4	 HUASUN	Himalaya	HS-210-B132DS720W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	720	23.18
5	 TV SOLAR	-	TWMHF-66HD690-715W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	715	23.0
5	 JA SOLAR	DeepBlue 4.0 Pro	JAM72D40 590/MB	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	595	23.0
7	 ASTROENERGY	Astro N5	CHSM78N(DG)/F-BH625-640W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	640	22.9
8	 Grand Sunergy	-	GSM-MH3/132-BHDG710	n-type	210	132	HJT	Bifacial, Half-cell, MBB	710	22.86
9	 DMEGC	Infinity RT	DM615G12RT-B66HSW	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	615	22.8
9	 TV SOLAR	-	TWMND-72HS570-590W	n-type	182	144	TOPCon	Half-cell, MBB	590	22.8
9	 SPIC	ANDROMEDA 3.0	SPICN6(LDF)-60/BIH410W	n-type	166	120	TBC	Bifacial, Back Contact, Half-cell, MBB	410	22.8
12	 Jinko Solar	Tiger Neo	JKM585N-72HL4-BDV	n-type	-	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
12	 SolarSpace	Lumina II	SS8-72HD-585N	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
14	 REC Group	Alpha®Pure-RX	REC470AA Pure-RX	n-type	210	88	HJT	Bifacial, half-cell, MBB	470	22.6
15	 中聚股份 JOLYWOOD	Niwa Pro	JW-HD108N415-440W	n-type	182	108	TOPCon	Bifacial, Half-cell, MBB	440	22.53
16	 risen	Hyper-ion	RSM132-8-700BHDG	n-type	210	132	HJT	Bifacial, Half-cell, MBB	700	22.5
16	 Trinasolar	Vertex N	TSM-NEG21C.20	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	700	22.5
16	 DASOLAR	-	DAS-DH156NA-610-630W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	630	22.5
16	 Canadian Solar	TOPHiKu6	CS6W-570-580T	n-type	182	144	TOPCon	Half-cell, MBB	580	22.5

Venue

BC Workshop 2024



FIELDLAB VOOR DUURZAME INNOVATIE

Samen werken aan een duurzame toekomst

- **Launched** in 2016
- **Situated** in the middle of TU Delft campus
- **Established** as a living lab to promote sustainable innovations in urban environments.
- **Key focus areas:**
 - Sustainable energy systems
 - Circular water systems and waste management
 - Smart mobility solutions and sustainable construction

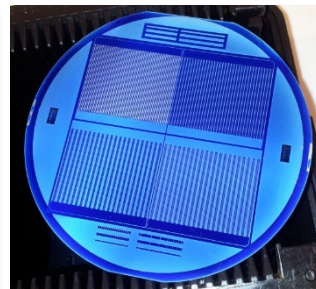
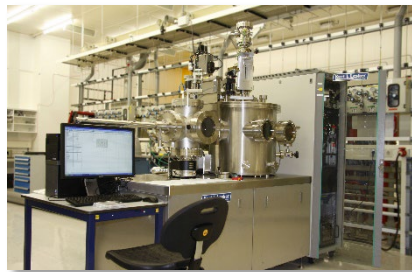
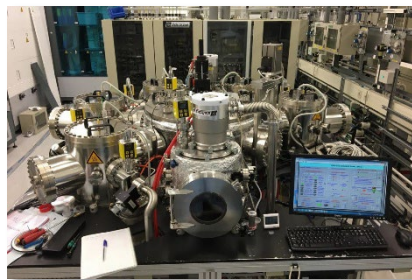
Technical tour

BC Workshop 2024

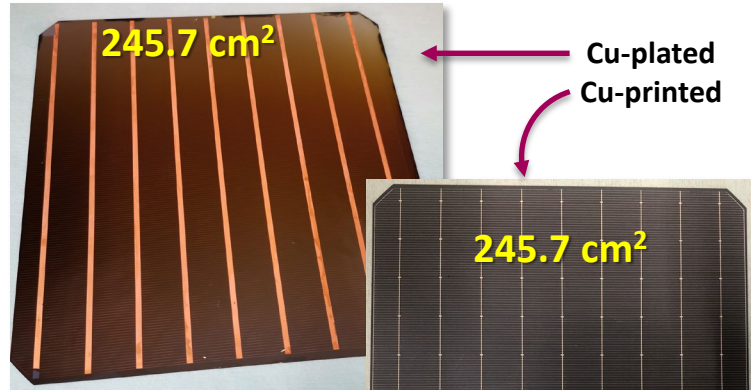
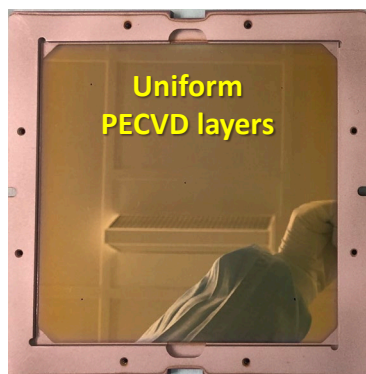
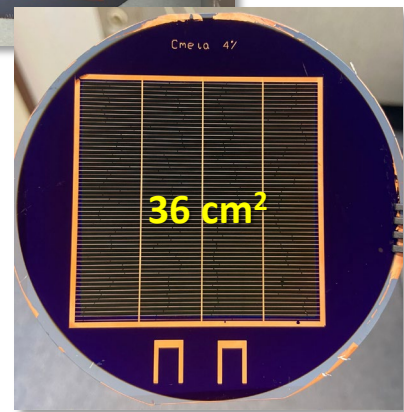
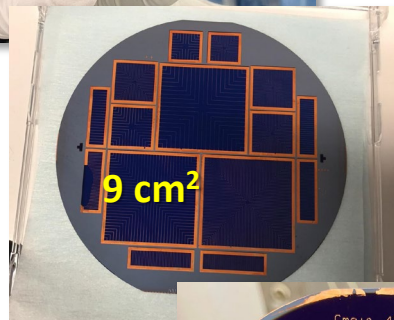
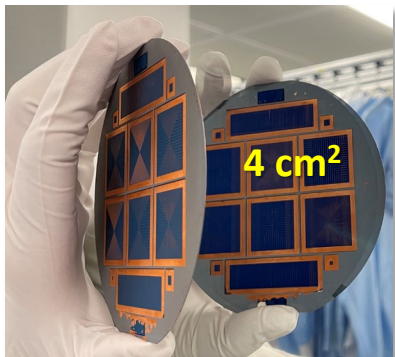




Technical tour: TU Delft PV Technology Centre



Upscaling steps

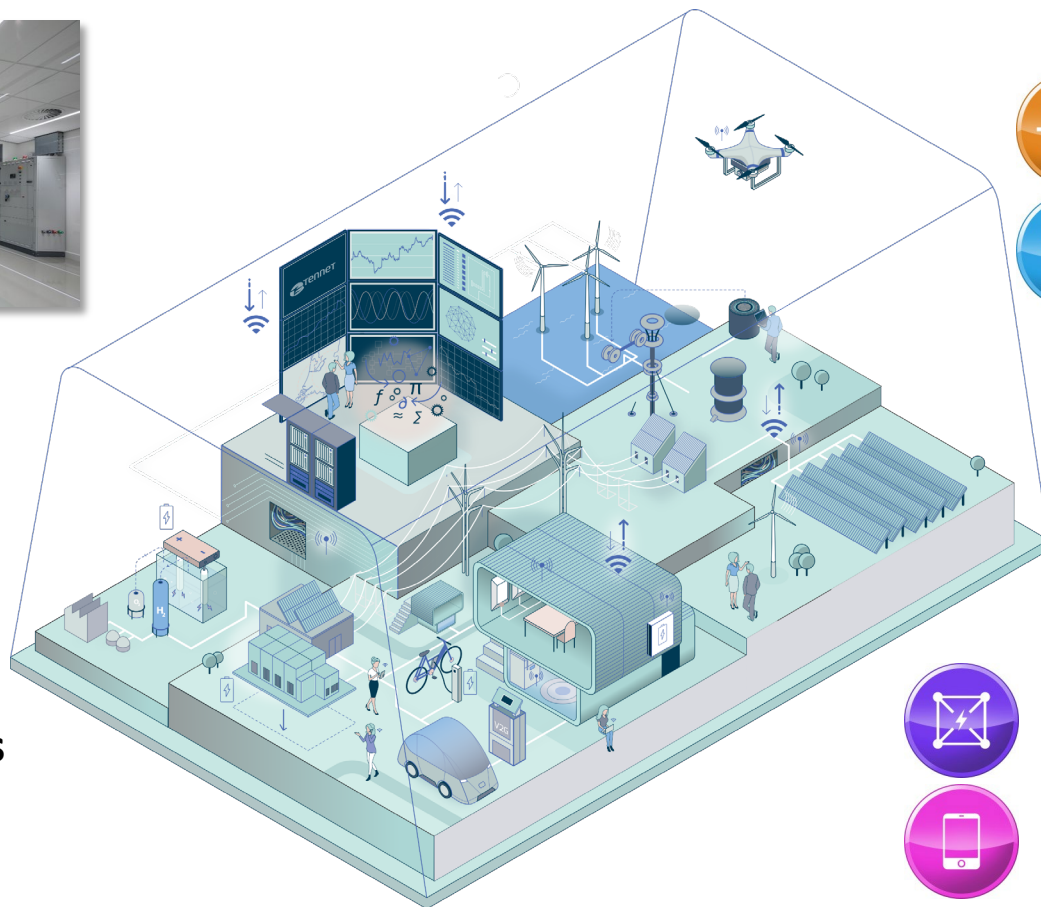
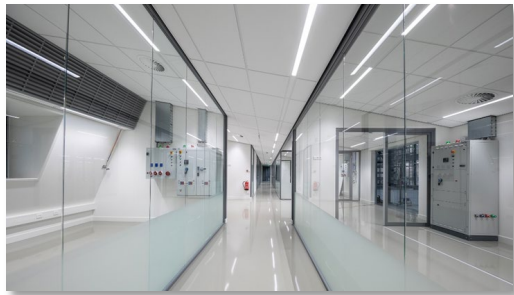


It is not (yet) a cell...

... but 6-in equipment is here:

- Wet benches
- PECVD, furnaces, PVD
- Photolithography
- Screen printing / Cu-plating
- Characterization (JV, EQE)

Technical tour: Electrical Sustainable Power laboratory



System grid



Microgrids

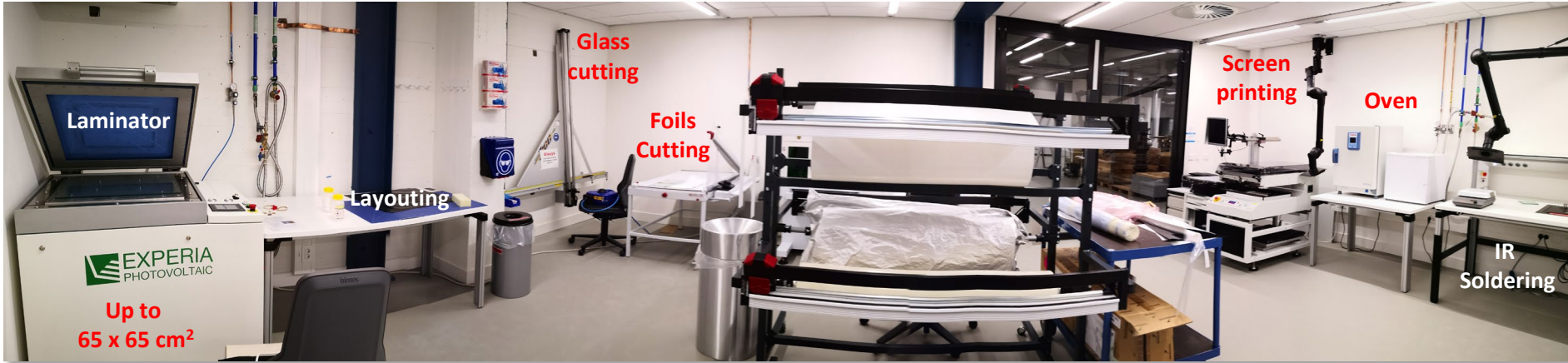


E-generation



Digitalization

Technical tour: Module manufacturing unit



Encapsulations

- Glass / Glass
- Glass / Foil
- Foil / Foil

Cell types

- Generic FBC
- (Bifacial) PERC
- IBC



Technical tour: Photovoltaic Laboratory



Technical tour: PVMD monitoring station



Agenda

BC Workshop 2024



BC Workshop 2024 - Day 1 Agenda

09:00 - 09:20	Conference opening
09:20 - 10:40	S1: Back contact cells & modules in R&D
10:40 - 11:20	Coffee break
11:20 - 12:40	S2: Back contact cells in industry
12:40 - 13:20	Lunch
13:20 - 14:00	Visiting the Green Village
14:00 - 15:20	S3: Materials and tools for BC cell technology
15:20 - 15:50	Coffee break
15:50 - 17:30	S4: Characterization / Outdoor testing / Shading resilience
17:30 - 17:40	End of the first day, reaching X Center @ TU Delft
18:00 - 21:00	Social dinner

BC Workshop 2024 - Day 2 Agenda

09:00 - 09:20	Highlights first day
09:20 - 10:40	S5: Novel interconnection technologies for BC modules
10:40 - 11:20	Coffee break
11:20 - 12:00	Round table 1: <i>Will BC technology be the next big thing?</i>
12:00 - 12:40	Round table 2: <i>Technology challenges in BC technology?</i>
12:40 - 14:00	Lunch
14:00 - 16:15	S6: Industrial BC modules and field applications
16:15 - 16:30	Closing remarks and announcement next BC workshop

Acknowledgements

BC Workshop 2024



Thanks to the Organizing Committee



Thorsten
Dullweber



Radovan
Kopecek



Olindo
Isabella



Jonas
Huyeng



Victor
Rosca



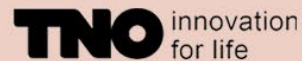
Gesche
Maass



Thanks to our sponsors for their support



BCworkshop2024



12th workshop on

Back contact solar cell
and module technology

#BCworkshop

December 4-5, 2024
Delft, the Netherlands

Hosted by  TU Delft