

PVSEC-25 & GPVC 2015

Conference Highlights & Summary

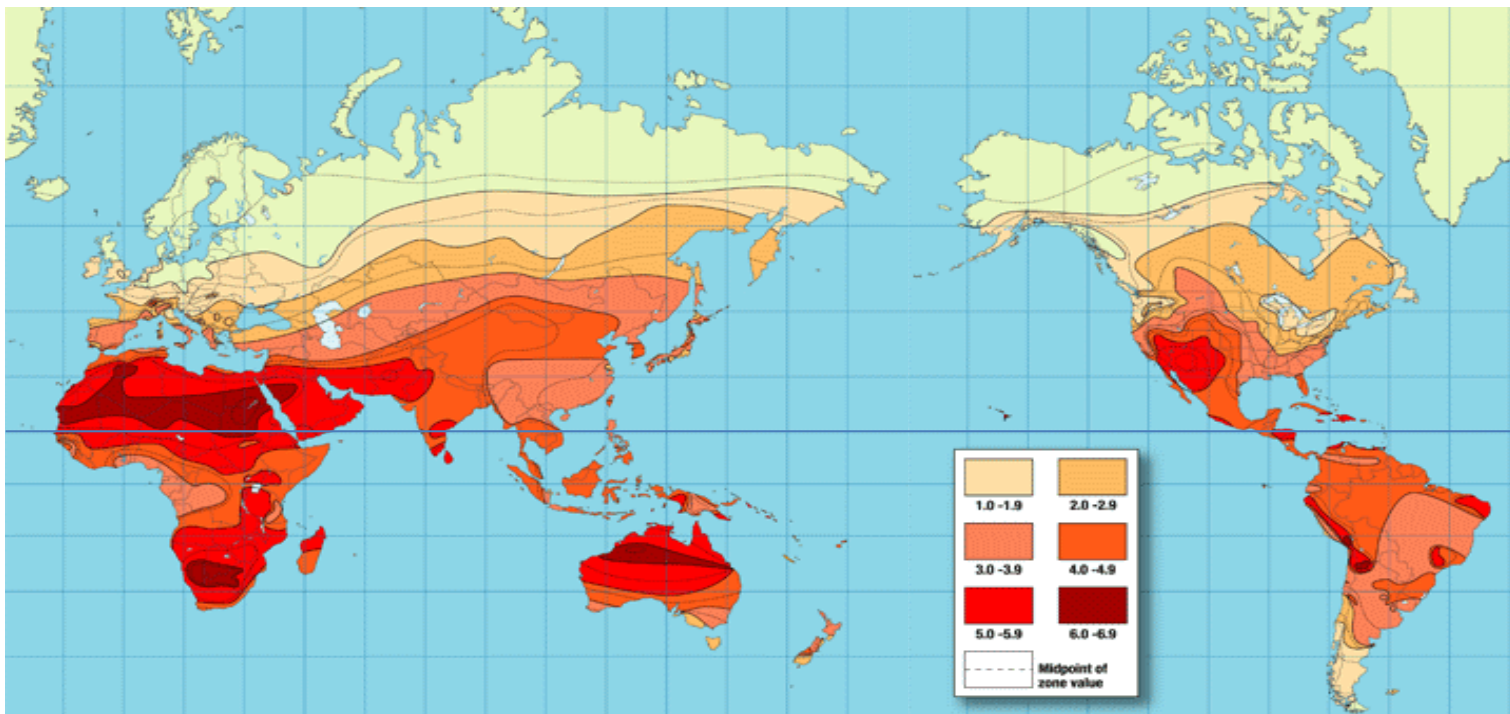
November 15-20, 2015

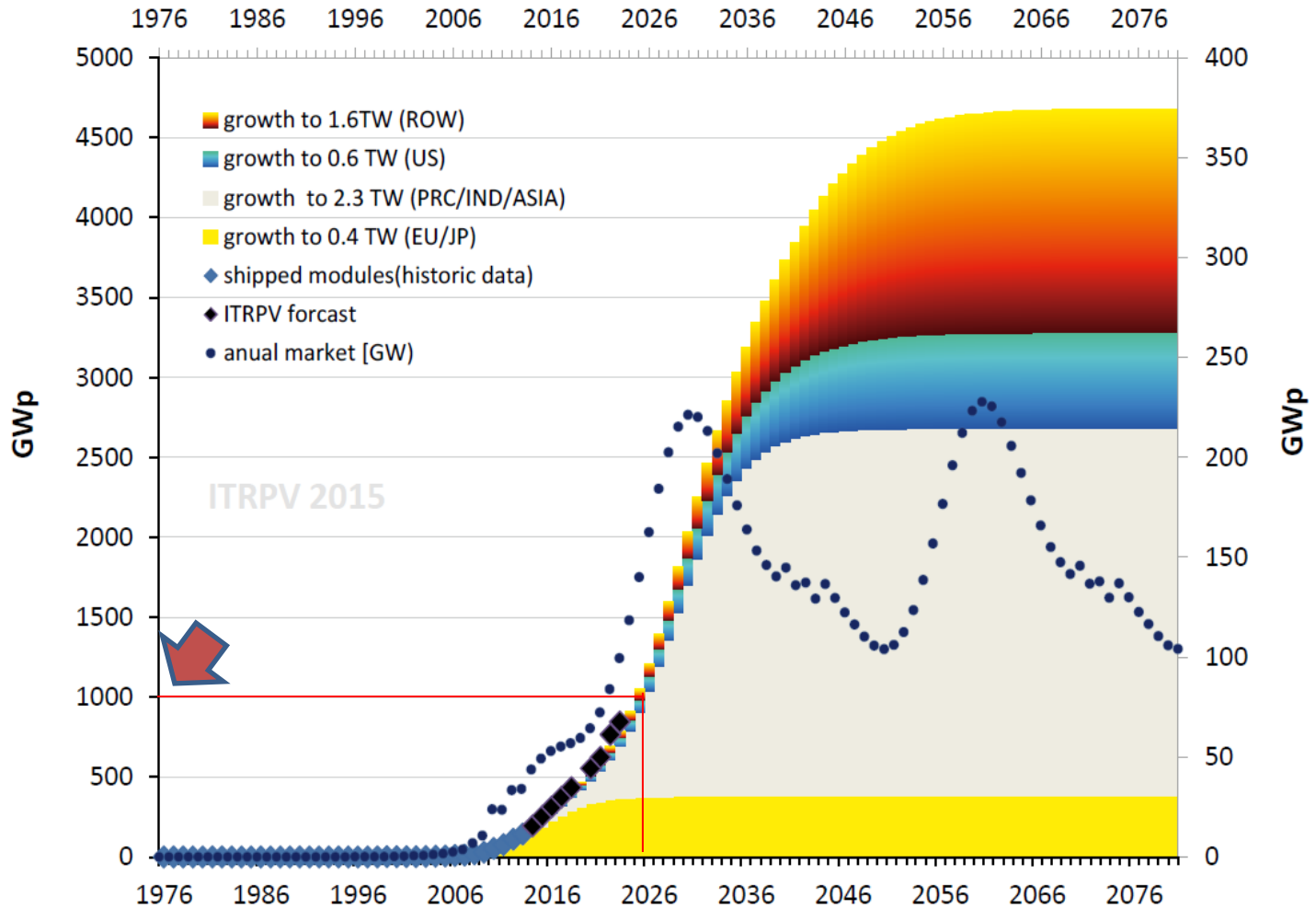
Busan Exhibition & Conference Organization

Program Chair

Sang-Jin Moon (KRICT/UST)

When the sun rises, it rises everywhere..(Cuban Proverb)







INTERNATIONAL
YEAR OF LIGHT

“ IYL-2015 ”



<Paris, January 19, 2015>

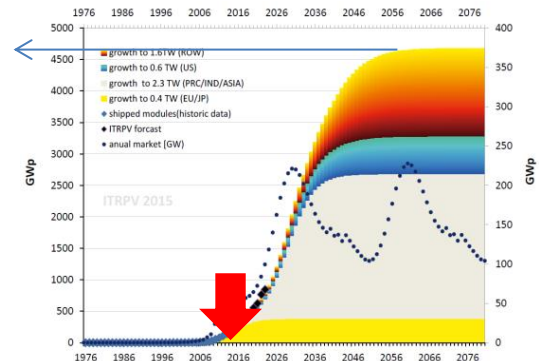


INTERNATIONAL
YEAR OF LIGHT

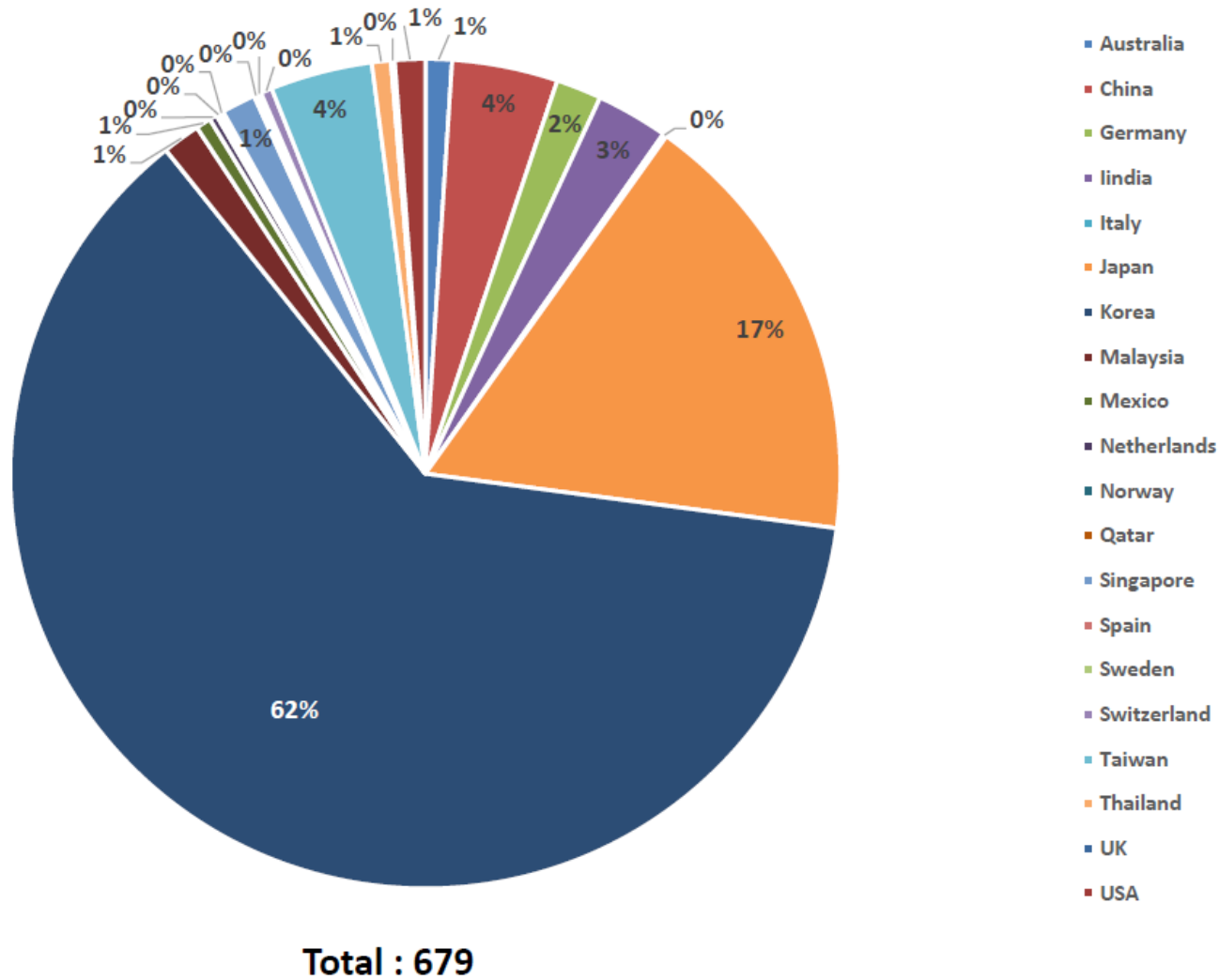
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Sunlight to TW Power

4.7 TW



Papers Submitted (Regional)



Papers Submitted (Regional)

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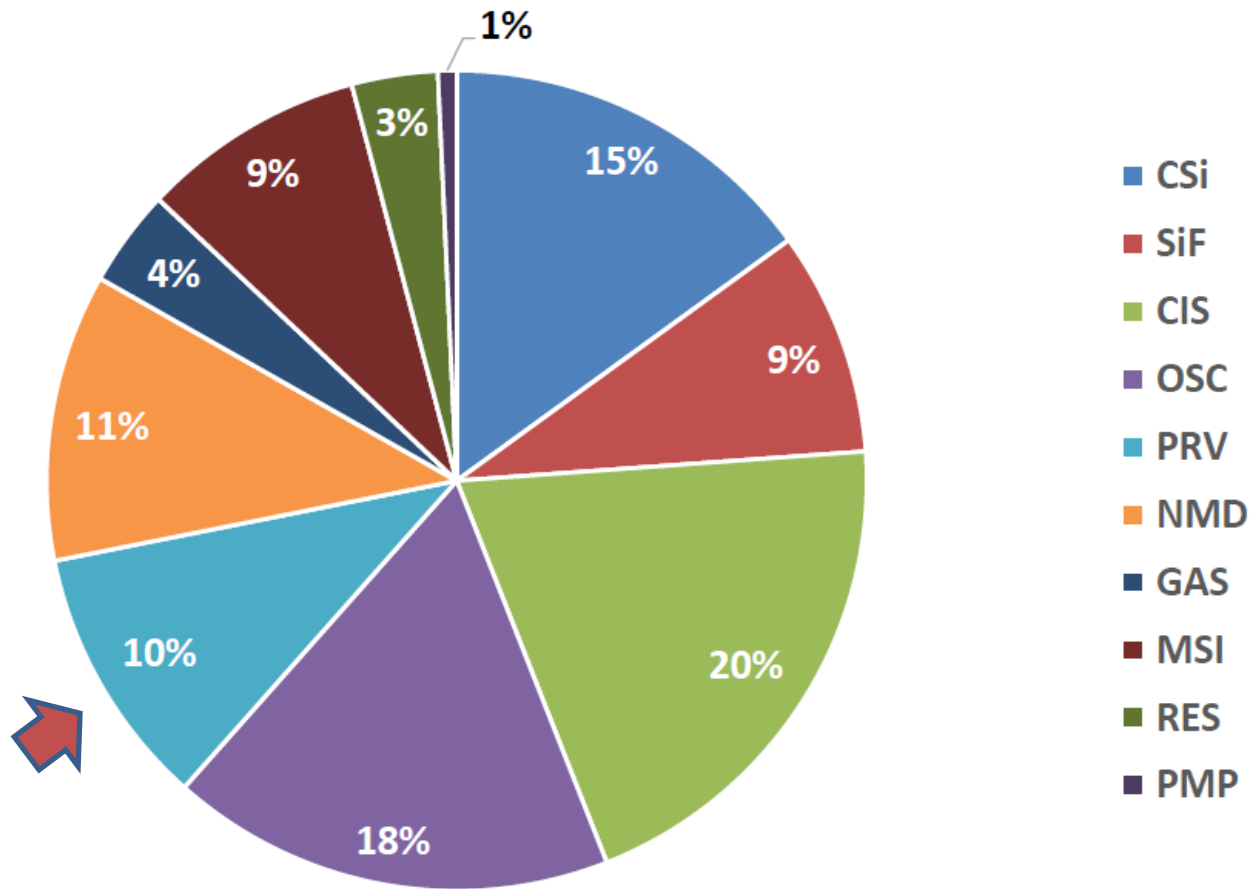
No.	Country	Plenary	Invited	Oral	Poster	Sum
1	Australia			6	1	7
2	China	1	5	13	9	28
3	Germany	2	4	2	4	12
4	India			9	10	19
5	Italy	1				1
6	Japan	4	10	49	54	117
7	Korea	1	22	70	329	422
8	Malaysia			5	5	10
9	Mexico				4	4
10	Netherlands		1	1		2
11	Norway			1		1
12	Qatar			1		1
13	Singapore		1	5	3	9
14	Spain		1			1
15	Sweden			1		1
16	Switzerland		3			3
17	Taiwan	1		8	18	27
18	Thailand			3	2	5
19	UK			1		1
20	USA	1	4	3		8
Total		11	51	178	439	679

November 15~20, 2015,
BEXCO, Busan, Korea



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Papers Submitted (Areal)



Total : 679

~850 persons participated

Papers Submitted (Areal)

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Topic	Plenary	Invited	Oral	Posters	Sum
CSi	3	7	31	61	102
SiF	1	4	17	38	60
CIS	1	7	29	100	137
OSC	1	6	20	92	119
PRV	1	8	15	46	70
NMD		5	24	48	77
GAS	1	2	13	10	26
MSI	1	4	15	40	60
RES	1	6	13	3	23
PMP	1	2	1	1	5
Total	11	51	178	439	679

Events

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Tutorials & Welcome reception



Opening & Award ceremony



Exhibition



Korean tea event

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Banquet

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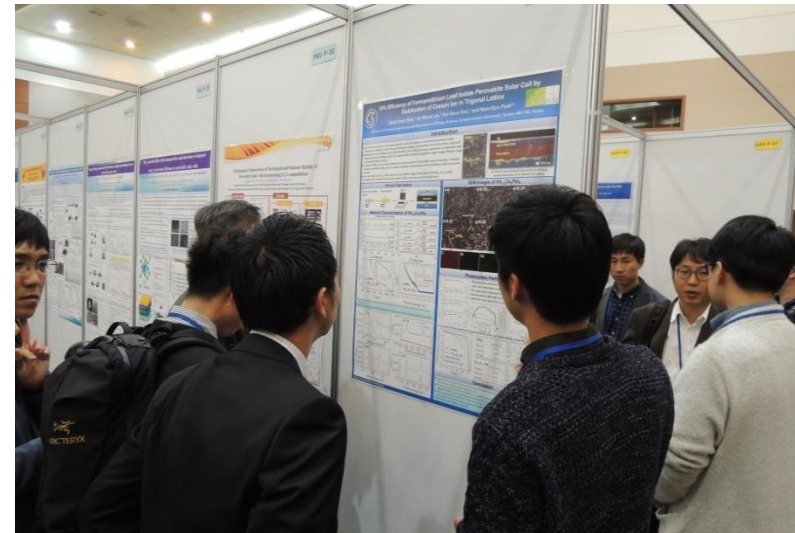
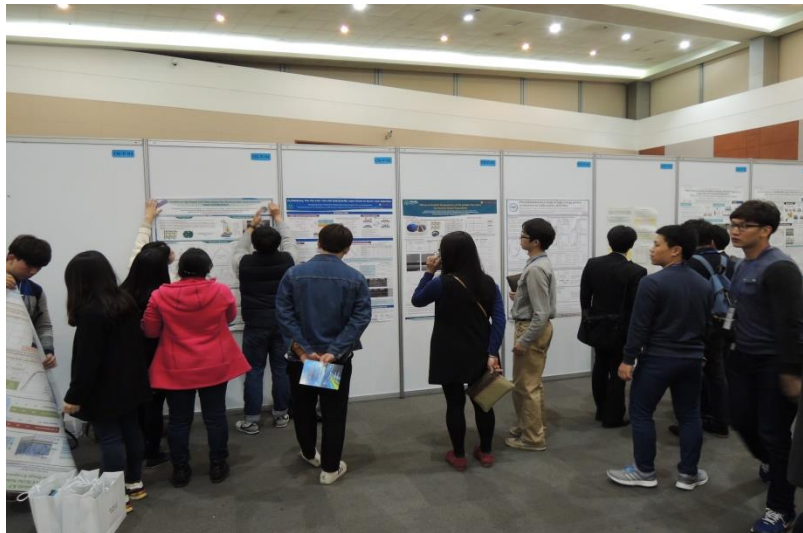
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Presentation

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PVSEC Awards

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Koeng Su Lim
KAIST



Sang Il Seok
KRICT, Korea



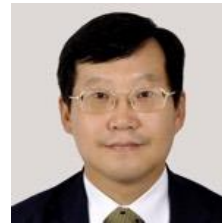
Nam Gyu Park
Sungkyunkwan Univ.



Sang-bong Lee
LG Electronics



Dong Kwan KIM
Hanwha Q CELLS



Eun-Chel Cho
Hyundai Heavy Ind.



Hae-Seok Lee
Korea University



Jae Ho Yun
KIER



Young Hyun Cho
Shinsung Solar



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Plenary Talks

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Dr. Ji-Weon Jeong
Hanwha Q Cells, Korea



Dr. Stefan Glunz
Fraunhofer ISE,
Germany



Prof. Makoto
Konagai Tokyo
City University



Dr. Katsumi Kushiya
Solar Frontier, Japan



Prof. Yongfang Li
Chinese Academy of
Science, China



Prof. M. Yamaguchi
Toyota Tech. Inst.
Japan



Dr. Sang Il Seok
Korea Research Inst.
Chem. Tech., Korea



Prof. Chung-Wen Lan
National Taiwan
University, Taipei



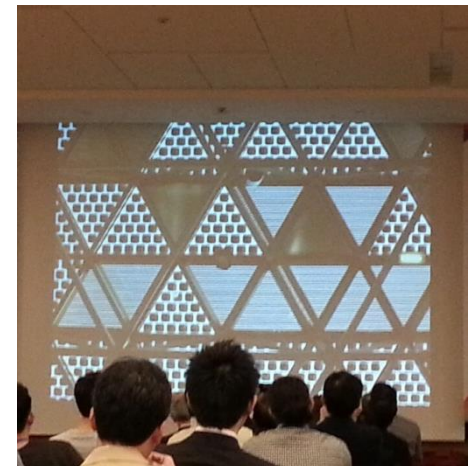
Dr. Alessandra
Scognamiglio
ENEA, Italy



Dr. George Kelly
IEC TC82, USA



Dr. Mikio Taguchi
Panasonic Corp.
Japan



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Area : Wafer-based Crystalline Silicon Cells and Materials (CSi)

Hanwha Q CELLS has mass production line **over 3.5GW**, and produce **multi-crystalline Si** solar cells.

: 2015-280W module 2019-320W module targeting

R&D efficiency **20.7%** is reported in **Q.ANTUM cell**.

[Keynote, Hanwha Q CELLS]

25.1% of **TOPcon cell** is reported with excellent fill factor(83.2%) and Voc(718mV). Different layers including MoOx are suggested as carrier selective layer for next step. [Plenary 5, [Fraunhofer ISE](#)]

Tandem structures with Perovskite solar cell and Silicon solar cell are researched.

21.2% of efficiency and 671mV open-circuit voltage of **n-type back junction PERT** solar cell with plated Ni/Ag contacts, Al₂O₃ rear passivation and screen-printed local Al BSF on industrial 156nm n-type Cz single crystalline silicon wafers is reported. [CSi-I-02, Hyundai Heavy Industries]

Various TCO and Si based intrinsic and doped layers, metal technologies are adapted to reduced the parasitic losses in heterojunction solar cells. **Panasonic** showed **25.6%** HBC with good thermal stability and **Kaneka** reported **25.1%** efficiency Cu metallized heterojunction crystalline Si solar cell.

LG electronics has been released a 300W high power solar module using n-type solar cells. **320W high power module** is introduced in the market.

Ingot growing technologies were presented that **Oxygen concentration** and **pulling speed** act as key factors in minority carrier lifetime of **n-type ingot**.

Area : Thin-film based Silicon Cells and Materials (SiF)

For $\mu\text{c-Si:H}$ thin film solar cell, **11.8 %** of initial efficiency was obtained. (AIST)

For the tandem structure of a-Si:H/ $\mu\text{c-Si}$ cells, **14.8 %** of initial efficiencies were obtained using modulated surface texture. (TU Delft)

For triple junction of a-Si/ $\mu\text{c-Si}$ / $\mu\text{c-Si}$, **13.6 % of new record** was obtained. (AIST)

In a $\mu\text{c-Si}$ single cell, *n*- a-Si buffer layer was inserted to enhance the current density due to lowering the barrier for collecting carriers in n region. (Nan kai university)

For BIPV application, a-Si:H and a-SiGe:H transparent solar cells were fabricated and they show over 7 % of efficiency and 30 % of average transmittance. (ETRI)

In the fabrication of a-Si:H transparent solar cells, the ultra-thin transparent electrode has been employed to embody various colors. (ETRI)

For a-SiO_x:H solar cells, record initial efficiency of 8.4 % was obtained with absorber layer of only 100 nm. (Chung-ju university)

Area :II-VI & Chalcogenide Compound based Cells and Materials (CIS)

Solar Frontier (Plenary 8)

- : Started up their 4th plant of 150 MW/a in Miyagi, Japan in 2015
- : achieved 170 Wp at 1228 cm² module (eff. 13.8%)

Wonik IPS (CIS-I-06)

- : Efficiency of 16% (record) and 14.3% (average) for 90x160 cm² sized CIGSSe module were presented by Wonik IPS, targeting 18% module efficiency.

Ag-alloying (AgCu)(InGa)Se₂ shows improved homogeneity and adhesion of films. (CIS-I-01)

CZTS bandgap can be controlled by Ge incorporation into the films. Highest efficiency was 10.03% with Voc of 0.54V. (CIS-O-08)

The enhancement of efficiency over 10% was achieved by adding Ge (30 nm) on top of Cu₂ZnSnSe₄ that was attributed to improved Voc. (CIS-I-04)

Na(F) incorporation in co-evaporated Cu₂ZnSnSe₄ was effective for flat and large grain growth that was believed responsible for solar cell efficiency of up to 11%. (CIS-O-16)

The ways to go for realizing Cd-free CIGS solar cell with efficiency higher than 18% were suggested mainly focusing on the properties of CIGS layer and ZnSnO buffer layer. (CIS-I-05)

A pure sulfide CIGS solar cell with a record efficiency of 15.5% was presented (CIS-O-17)

CdS segregation on the absorber layer was evidenced by combined analysis of Raman, AFM and PL mapping technique. Comparison of CIGS and CZTS cases were also performed. (CIS-O-22)

Area :Organic, Dye Sensitized Solar Cells and Materials(OSC)

The development progress of molecular design strategies of conjugated polymer donor and new acceptor materials to achieve high-efficiency [Plenary 4, Chinese Academy of Science].

The development of polymer solar cells with **12 %** efficiency and **the device lifetime over 10 years** by introducing novel functional materials, such as polyelectrolytes and n- or p-doped sol-gel metal oxides. **All-printed OPV modules with a module efficiency of ~ 8%** [OSC-I-01, **GIST**].

The development of **the semi-transparent DSSC modules** and the applicability of DSSC in **BIPV** and practical uses [OSC-I-02, **Dongjin Semichem**].

Area :Perovskite Solar Cells and Materials(PRV)

Prof Seok introduced research history of perovskite solar cells and the key technology for the formation of uniform perovskite thin-film. For the formation of uniform film, initially Seok group developed non-solvent dripping process and improved the process by forming PbI₂-DMSO intermediate phase which lead the formation of larger crystalline grains [Plenary 1, UNIST].

Recent progress of Pb-free Sn based perovskite and bandgap controlled Pb/Sn based perovskite solar cells, which can improve the efficiency and stability [PRV-I-02, [Kyushu Institute of Technology](#)].

New inorganic hole transporting materials such as CuSCN and NiO and shared the progress of tandem cell of crystalline Si and perovskite solar cell [PRV-I-05, Hyogo University].

The operating mechanism of perovskite solar cells in depth [PRV-I-03, Ewha Womans University & PRV-I-04, Nanyang Technological University].

Area : New concepts, Novel materials and devices (NMD)

- Uniform thin film BaTiO₃ nano-particle can successfully be applied in the fabrication of efficient perovskite solar cells. (CNU)
- Surface periodic nanocone arrays enhanced light trapping of for high efficiency Si solar cell applications. (EWU)
- GaP Nanocones were successfully fabricated by metal-assisted chemical etching for efficient solar energy conversion. (KAIST)
- Adoption of organic electron blocking layer in colloidal PbS quantum dot solar cells resulted in ~ 4.8 % power conversion efficiency. (SNU)
- Non-radiative energy transfer rate from the quantum dots to GaAs solar cell was achieved using quantum dots as light-converting material. (KIST)
- ALD Al₂O₃ interlayer in planar hybrid n-Si/PEDOT:PSS solar cells increased PCE upto 11.16%. (HYU)
- Embedded metal NPs in PEDOT:PSS for Hybrid n-Si/PEDOT:PSS Planar Heterojunction Solar Cells enhanced the light absorption. (DGIST)

Area : III-V Compound based Concentrator and Space PV Systems (GAS)

- There were three oral sessions and two poster sessions. Two invited talks were a new method of growing InP crystalline layer for InP solar cell and an overview of III-V on Si solar cells.
- The technical topics most highlighted were [a new trial for 5 junction cell, III-V on Si epitaxial growth techniques](#), and CPV module technology.
- Discussions after each presentation covered the importance of commercial aspects of CPV technologies including the cost issue when develop a high performance concentrator optics and the reliability test criteria when developing a high performance multi-junction solar cells.
- III-V, CPV technology and products are confronting a mission to be fulfilled as the energy supplier to provide a solution adequate even in a worse environment than the conventional PVs. More compact size of land area availability or a higher temperature for the reliability test is an example in which CPV and III-V systems should be competitive.
- III-V and CPV systems without exception should give the customers benefits technically and economically when they choose them. And in the sessions, constructive interactions among participants and speakers occurred and it revealed potential work items for the future study in this research field.



Area : PV Components, Modules and System(MSI)

FREA(Fukushima Renewable Energy Institute) launches [world's largest facility for testing and developing power conditioning systems\(PCS\)](#) for the mass introduction of DER(Distributed Energy Resources) at [April 2016](#). Its facility consists of four test beds(Grid connection, Safety, EMC, System Performance) [AIST, MSI-I-01]

Study the 350kW PV system performance and the energy monitoring yield under the IEC 61724 standard [in Thailand](#), and [FIT policy and economic analysis of each scenario](#). [Maejo Univ.MSI-O-03]

New modeling and simulation of BIPV systems are reported.

: EnergyPlus and PVsyst building energy performance programs.

[Kongju Nat'l Univ. MSI-O-10]

Effective tool for calculate the thermal efficiency of PVT model. [UNSW. MSI-O-11]

Area : PV Reliability and Standardization (RES)

Excellent comprehensive introduction and root-cause **analysis of PID degradation**.
[Fraunhofer CSP, RES-I-01]

Correlation Study between Material Degradation Behavior and PV module Performance
: Experimental tests of Material Degradation Behavior and PV module Performance and
get the mathematical correlation analysis. [Underwriters Lab. RES-O-02]

Development of S/W simulation tools to quantitatively connect the lab AST data and field
performance data. [Yeungnam Univ. RES-O-03]

On the standardization for EH&S Risk Assessment of PV, new working items proposed entitled
'EH&S Risk Assessment for the sustainability of PV module manufacturing (KTL, RES. I. 05)

Introduction of combined PV module and Heat system
: The system removes heat from PV module through air or liquid
(Kongju Nat'l Univ., RES. I. 06)

Investigation of the hysteresis I-V curve measurements at various sweep speeds and conditions
on Perovskite solar cells (AIST, RES. O. 13)



Solar power and electric vehicles will lead the energy revolution within 2030, by disrupting the fossil fuel & nuclear power industry and the petroleum industry... In the book, “Clean disruption of energy and transportation” by Prof. Tony Seba (Stanford U.)

- As the next president of KPVS, I hope that we could keep communicating and collaborating within the frame of the same working field, “Solar”.
- I wish you all best of luck and health !



<KPVS: Korea PV Society>