IEA TECHNOLOGY ROADMAPS: SOLAR ELECTRICITY
2014 Updates - 1st Workshop
3-4 February 2014 - IEA Headquarters
9, rue de la Fédération 75015 Paris

Focus : Thin Film Solar Cells

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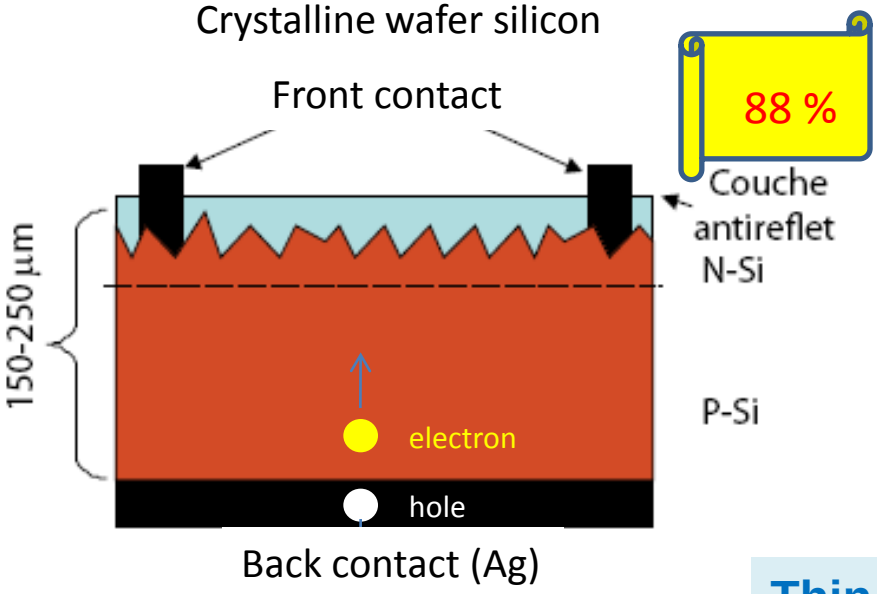
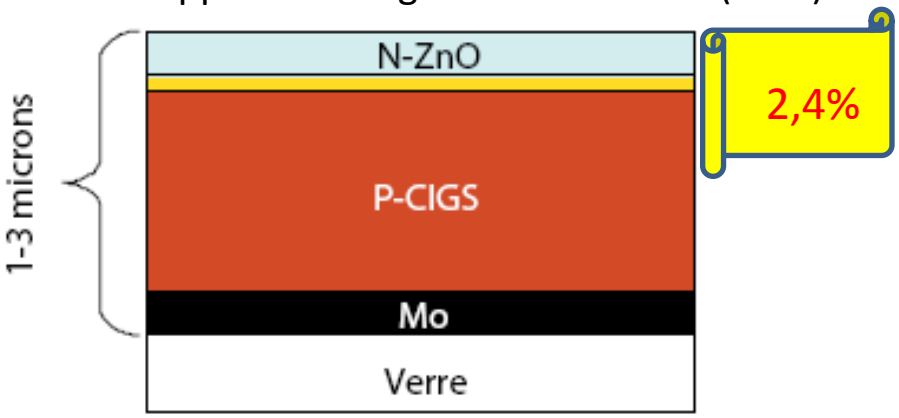
Technologies

Crystalline wafer silicon

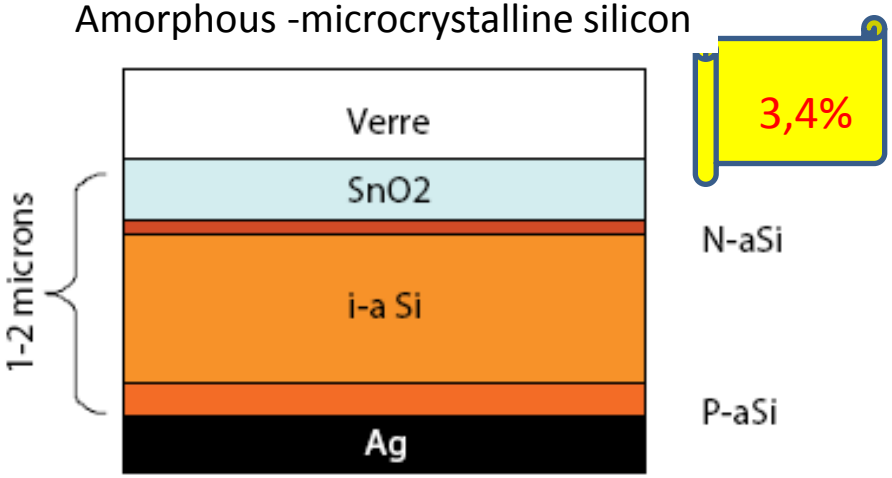


Copper indium gallium diselenide (CIGS)

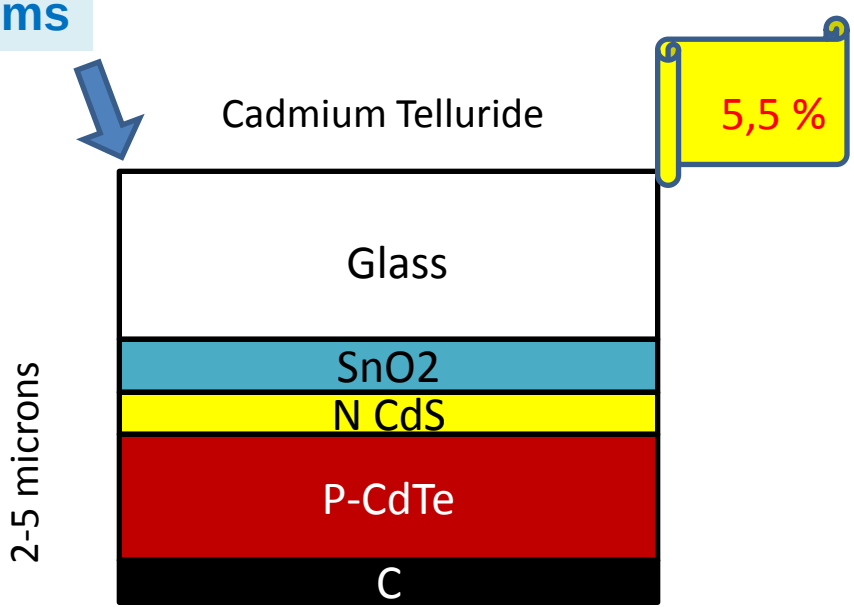


Thin Films

Amorphous -microcrystalline silicon

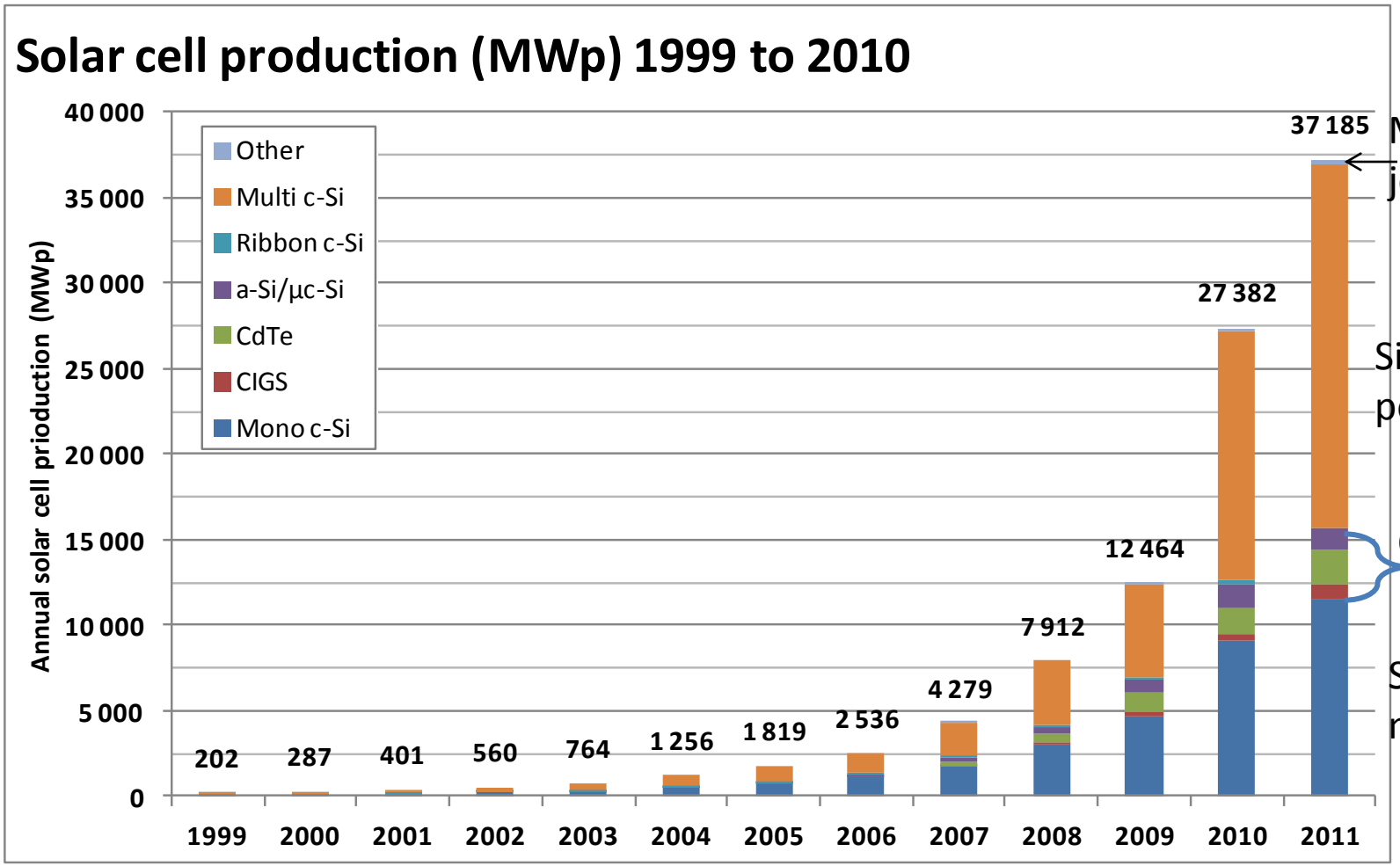


Cadmium Telluride



Year 2011

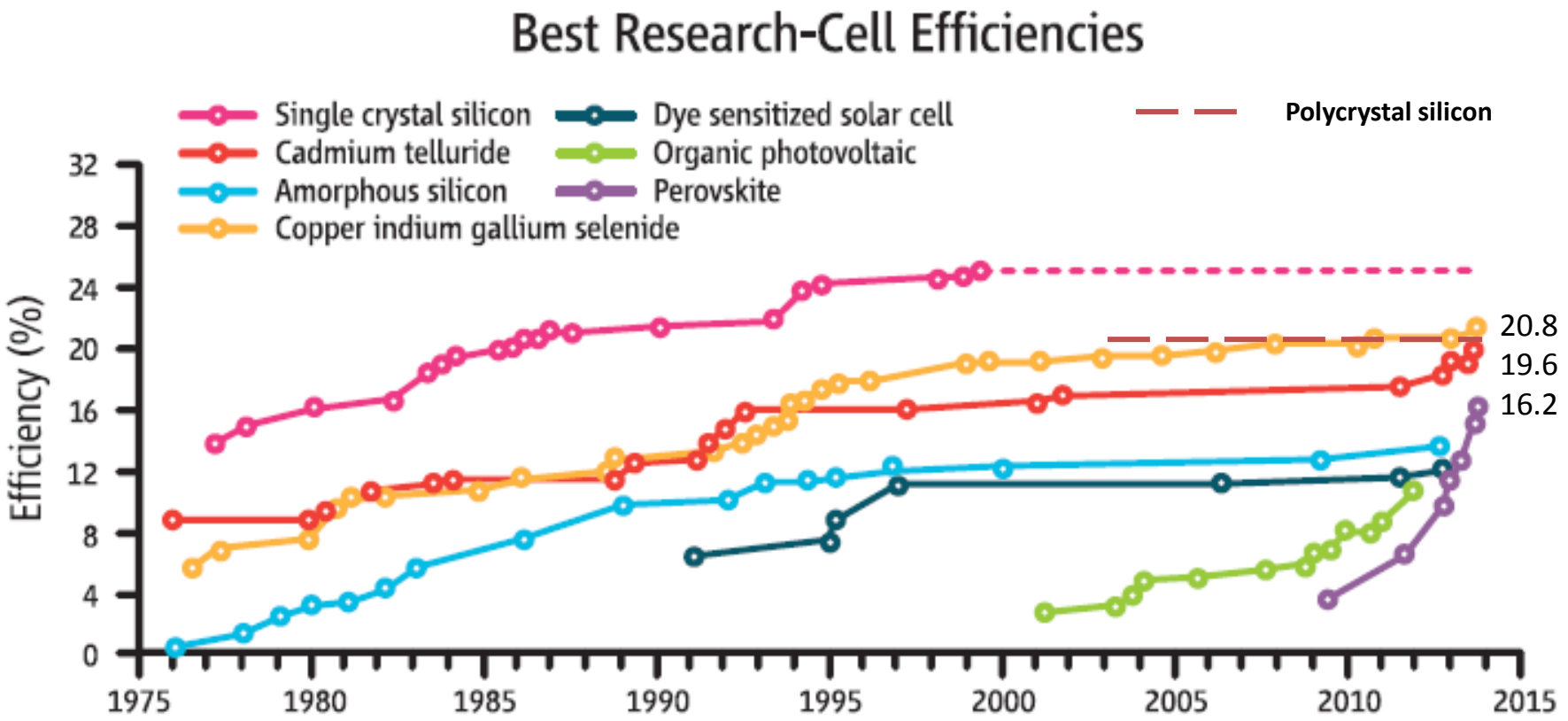
Production



Cumulated production end of 2012: 100 GW

Source : Photon International

Performances



Best Modules : 15.7 % CIGS, 14.4 % CdTe,
Production costs : 0.7 dollar/W (CdTe 2012)

15 NOVEMBER 2013 VOL 342 **SCIENCE** www.sciencemag.org

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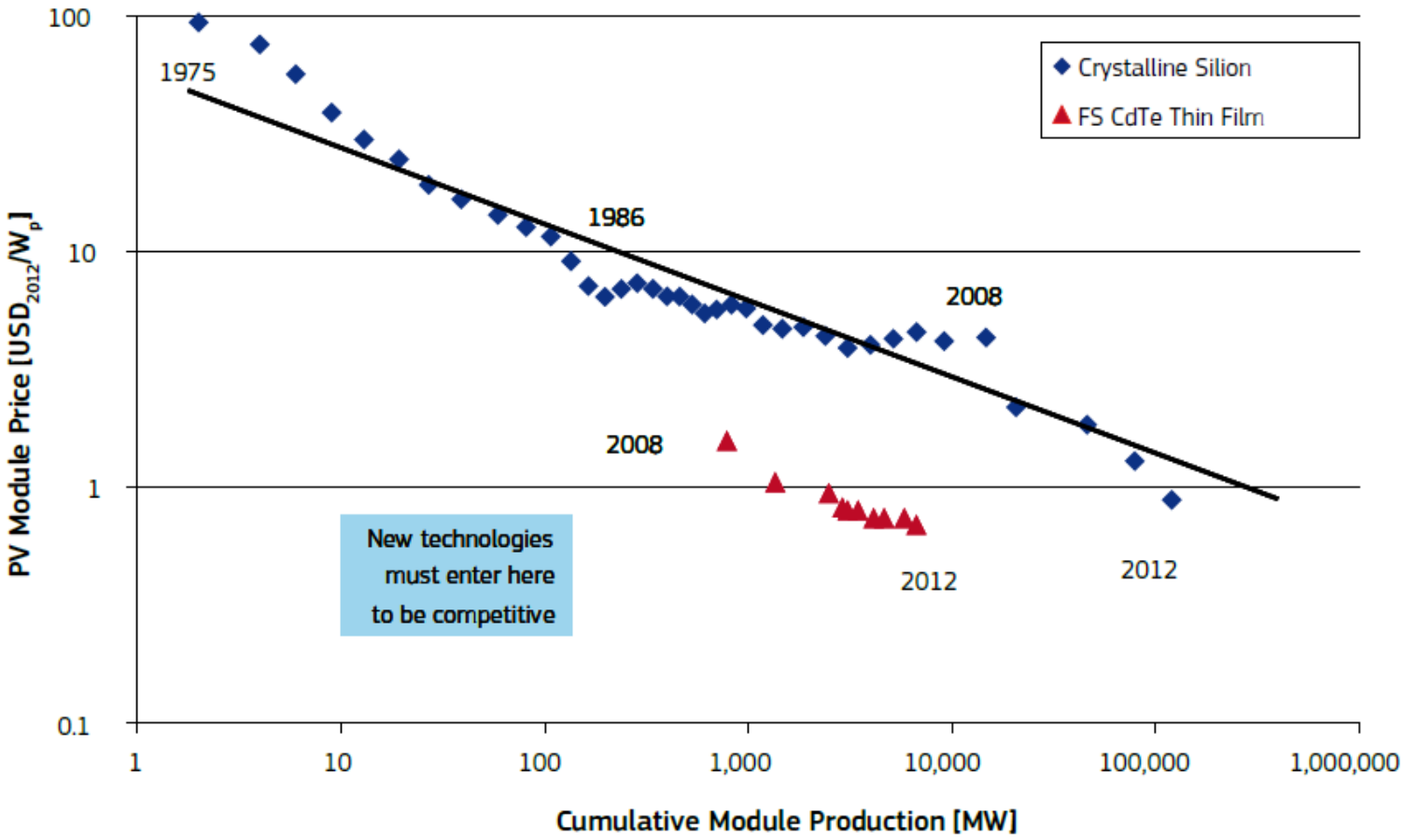
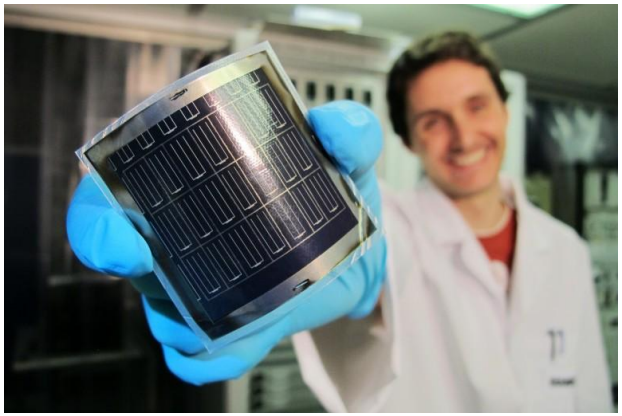
COSTS : Price-Experience curve for solar modules
(Data source Bloomberg New Energy Finance and PV News)



PV Status Report 2013 – A. Jaeger Waldau

Prospects

19th of January 2013 :
New World Record CIGS 20.4%
On flexible substrates at EMPA



Consolidation of
thin film industrial technologies
New advances :
- Efficiencies (→25% single junction)
- Flexible
- Costs

Rare Materials saving :
- In, Te, Ge new architectures (ultrathin)

New Technologies :
- -Kesterites*, Organic, Perovskite**
- -Tandem & multijunctions
- (thin films, thin film + Si, with III-V)
- -Concentration

Presseinformation 18/2013

Stuttgart, 23. Oktober 2013 **CIGS**

ZSW stellt Weltrekord-Solarzelle her

Dünnschicht-Photovoltaik überholt mit 20,8 Prozent Wirkungsgrad multikristalline Siliziumtechnologie

Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)

Standort Stuttgart:
Industriestr. 6, 70565 Stuttgart

*Ex : Cu_2ZnSnS_4
** $CH_3NH_3PbI_3$

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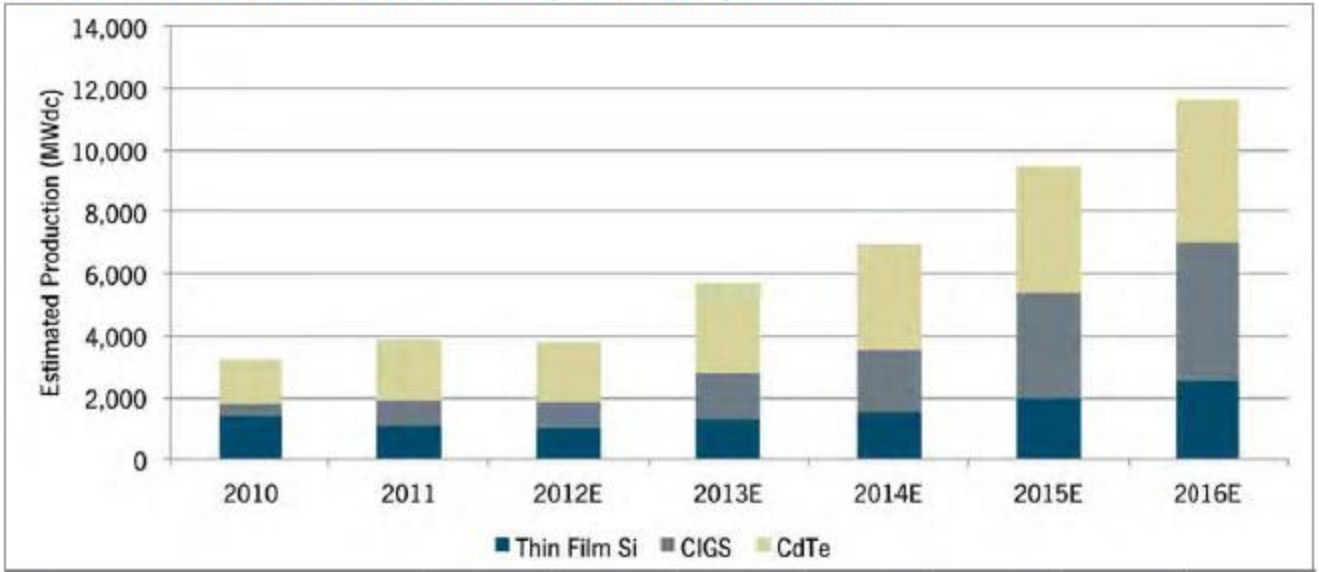
FIGURE 4-2: HISTORICAL MODULE AND RECORD CELL EFFICIENCIES THROUGH 2011

Technology	2004	2009	2012	Record Cell
Super Monocrystalline Silicon	16.0%	19.3%	20.1%	25.0%
Monocrystalline Silicon	12.8%	15.0%	16.0%	25.0%
Multicrystalline Silicon	12.5%	14.0%	14.5%	20.4%
CdTe	7.6%	11.0%	12.6%	17.3% **(19.6%)**
CIGS	10.0%	12.0%	13.3%	20.3% **(20.8%)**
µc-Si/a-Si	n/a	8.5%	10.2%	12.5%
a-Si (3-j)	6.7%	8.3%	9.7%	12.5%
a-Si (1-j)	6.5%	6.7%	7.5%	10.0%
Organic	n/a	3.5%	4.2%	10.1%

SOURCE: NREL, COMPANY DATA SHEETS, GTM RESEARCH

Value in 2013

FIGURE 9-7: THIN FILM PRODUCTION BY TECHNOLOGY, HIGH FORECAST, 2010 – 2016E



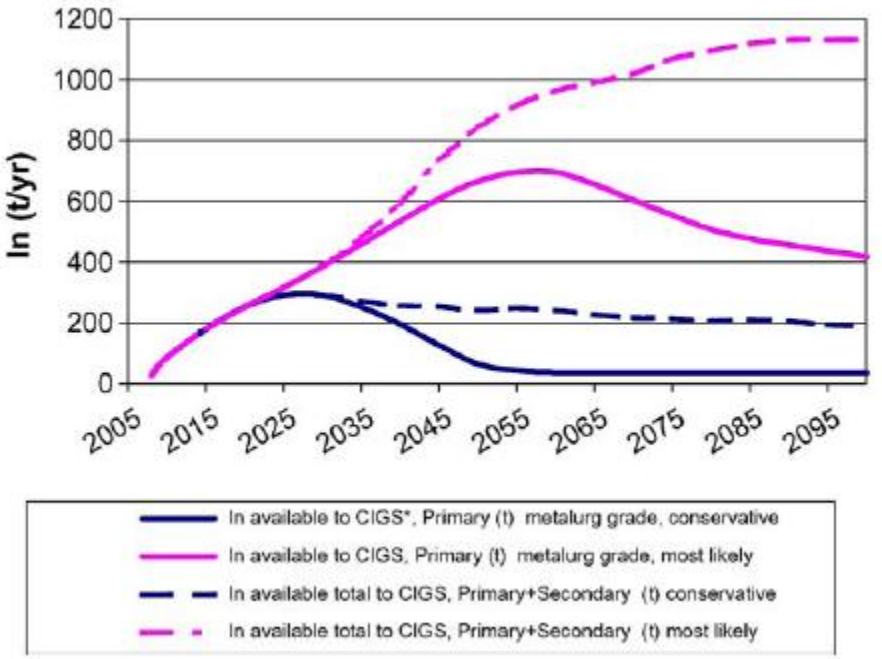
High Scenaro	2010	2011	2012E	2013E	2014E	2015E	2016E
Thin Film Si	1,395	1,101	1,027	1,245	1,557	1,982	2,568
CIGS	400	779	819	1,523	1,993	3,423	4,425
CdTe	1,456	1,991	1,927	2,895	3,416	4,083	4,610
Total	**3,251**	**3,871**	**3,773**	**5,663**	**6,966**	**9,488**	**11,603**

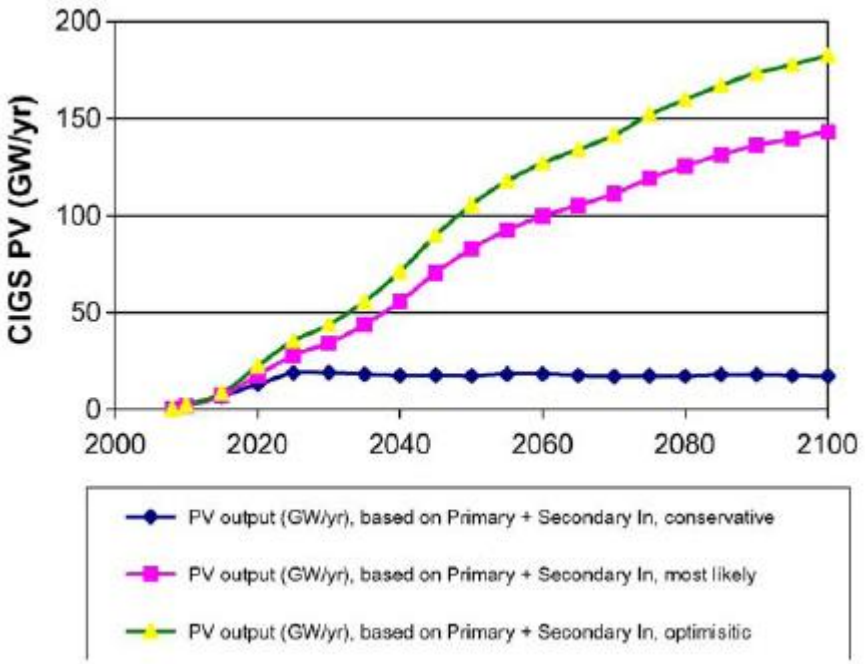
SOURCE: GTM RESEARCH

Renewable and Sustainable Energy Reviews 13 (2009) 2746–2750

Sustainability of photovoltaics: The case for thin-film solar cells

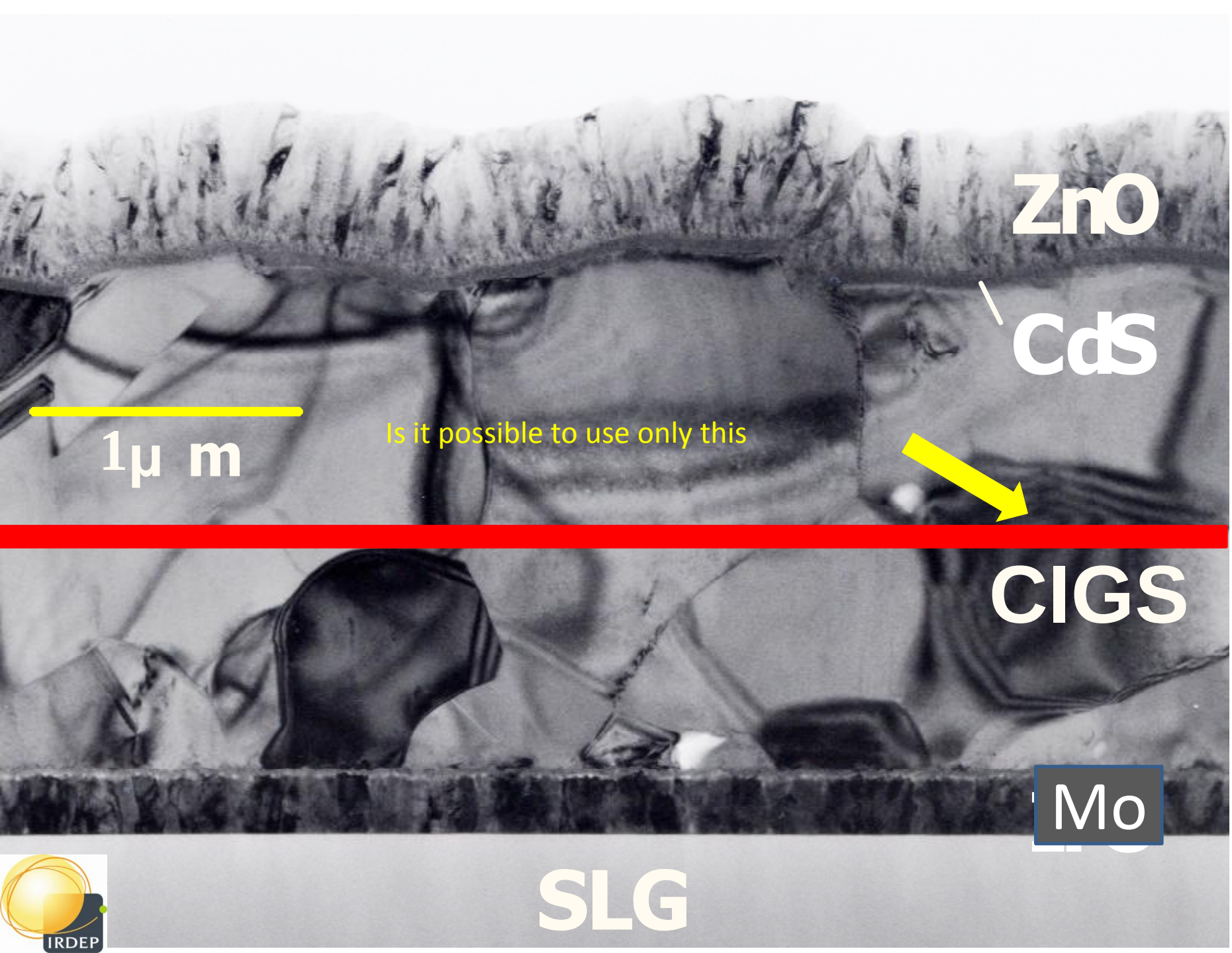
Vasilis Fthenakis *





PV type	Restricted metal	Baseline-2008		Expected-2020	
		Metal requirement (tonnes/GW)	Refinery production (tonnes)	Metal requirement (tonnes/GW)	Refinery production (tonnes)
CdTe*	Te	176	480	30–80	1412
CIGS†	In	83	545	11–20	797
a-SiGe#	Ge	73	95	36–48	153

(1t/GW with advanced architectures)


ZnO
CdS
1µ m
Is it possible to use only this
CIGS
Mo
SLG