



Photovoltaics in Switzerland - the cycle of research, technology, industry and markets





Content

- Introduction: PV development, context & issues
- The PV RTD Programme and activities
- International Cooperation
- Swiss PV industry activities
- PV market development
- The future of PV
- Conclusions



The role of PV

Einschätzung Energie-Triolog Schweiz und „Neue Energiepolitik“

Technik	2050 ETS Potential / TWh	2050 NEP Potential / TWh
Photovoltaik	8 - 12	10.4
Biomasse	5	3.8
Geothermie	1.5 - 3.5	4.4
Windenergie	2 - 3	4.0
'Neue' erneuerbare En. NEE: 16.5 - 23.5		
Wasserkraft (2000 34.3)	31-32 *	39-40
Total	51	62

NEE: 22.6



Why PV research & innovation

- Long track record of scientific & technological development
- Innovation and industrial implementation
- Proven and reliable products
- Rapid industrial expansion (as energy technology)
- New materials, technologies, processes, applications
- Competitive advantage through technological progress
- New challenges: grid integration and storage
- Leading PV countries with strong RTD base



The context

Unprecedented cost reduction and growth:

- PV module prices: - 80 % in only 4 years
- PV system prices: - 67 % in only 4 years
- Grid parity about to be achieved
- PV market in 2011: + 30 GW / + 75 %
- PV in Europe in 2011:
largest increase of all additional capacity
- Increasing role of PV in recent energy scenarios
- Energy policy (Fukushima, climate change, etc.)



The issues

- Fierce competition
- Overcapacity and consolidation
- Transition to sustainable markets
- Economic crisis in many countries
- Policy and regulatory framework
- Perceptions:
failure or success, challenge or opportunity

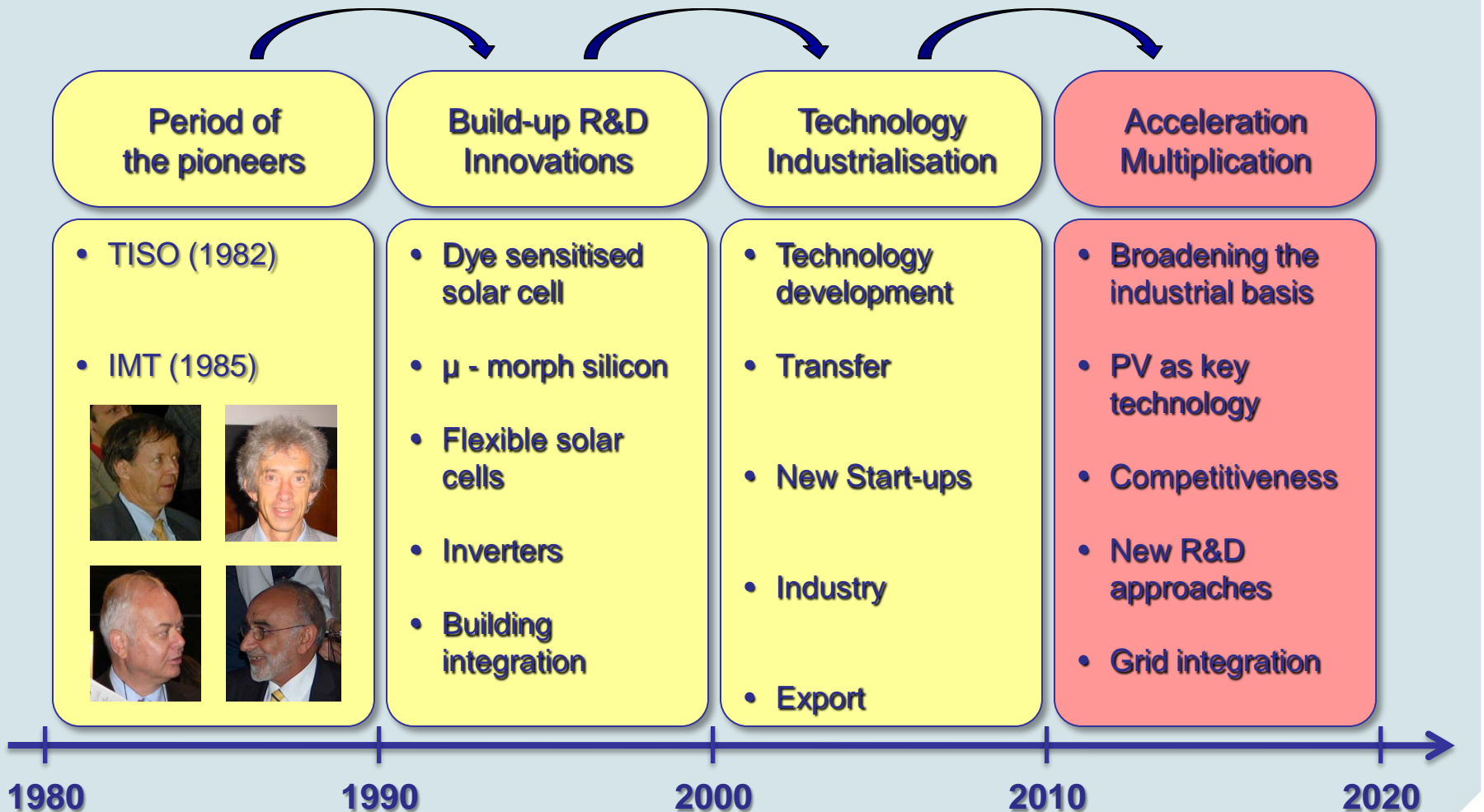


Swiss (PV) energy research

- CORE – Swiss Energy Research Commission
- CORE Energy research master plan 2008 – 2011
Confirmation of PV RTD
- PV RTD master plan 2008 – 2011
- Key partners SFOE, CTI, ETH-domain, Universities



PV in Switzerland: history & future





Goals 2008 – 2011

- Cost goal 2011:
Module 3 CHF/Wp, System 5 CHF/Wp
- Increase of efficiency of solar cells
(technology specific)
- Reduction of material and energy use
- Simplification and standardisation of system technology
- Increasing the availability and variety of industrial products

ENERGIEFORSCHUNGSPROGRAMM
PHOTOVOLTAIK
FÜR DIE JAHRE 2008 – 2011





Factsheet Swiss PV RTD 2011

- Total 70 projects
 - 28 SFOE projects
 - 10 CTI projects
 - 23 EU projects
 - 9 various projects
- 57 R+D-, 13 P+D- Projects
- Funding volume ~ 15 Mio. CHF, of which SFOE ~ 10%





Swiss PV RTD Programme

- Solar cells
- PV modules and building integration
- System technology
- Projects and studies
- International Cooperation





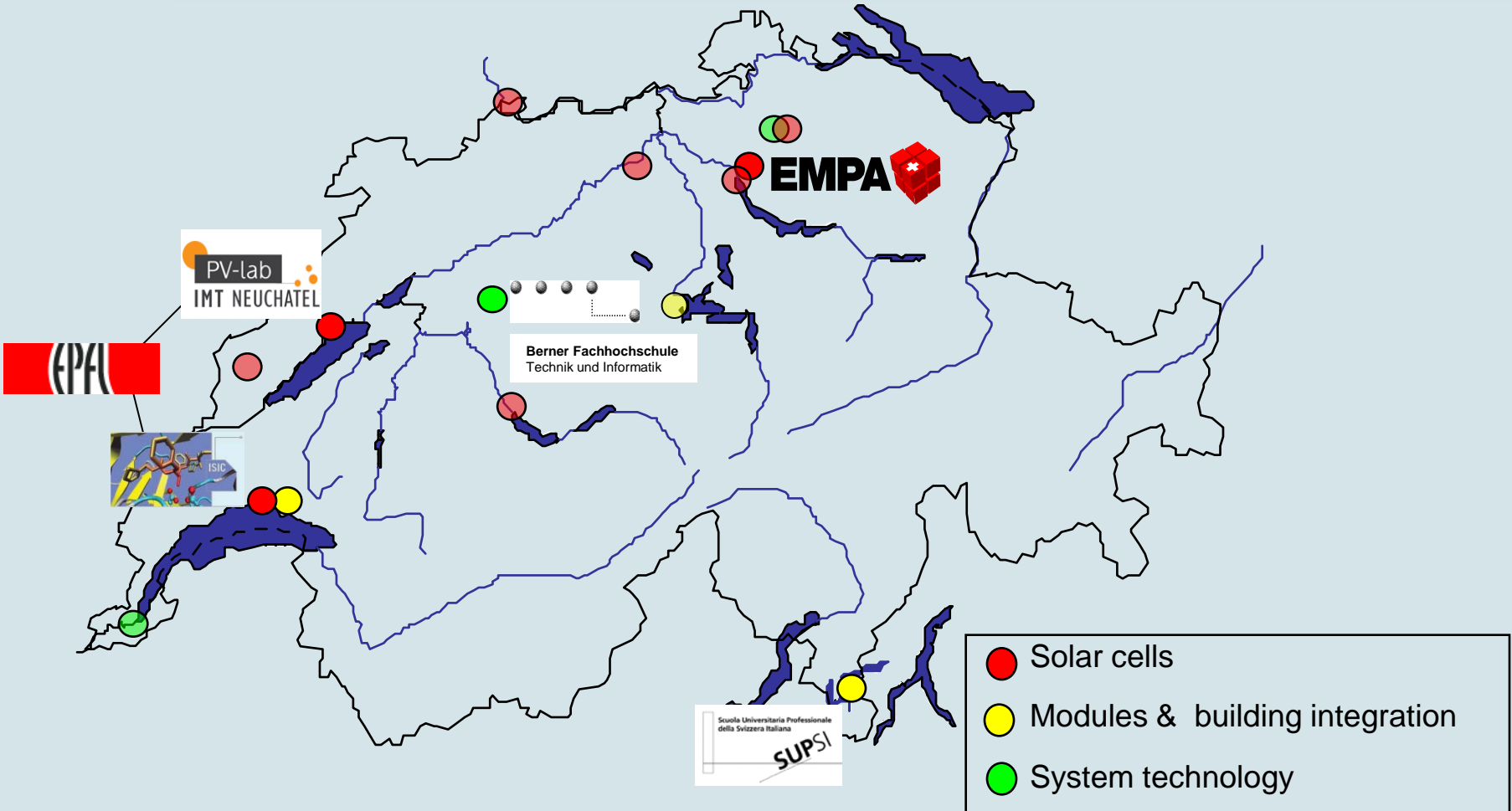
Characteristics and criteria

- Innovation potential
- System orientation
- Industry relevance
- Market potential
- Critical mass
- Continuity





Swiss PV RTD map





Programme limits and interfaces

„Upstream“

- Materials research
- Technology enablers

„Downstream“

- Building technology
- Grid integration
- Energy storage
- Measurement technology



Solar cell research in Switzerland




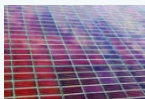

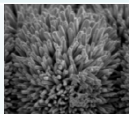


4th Wädenswil Day of Chemistry
Stefan Nowak
Wädenswil, 21 June 2012

Source: Ch. Ballif, EPFL



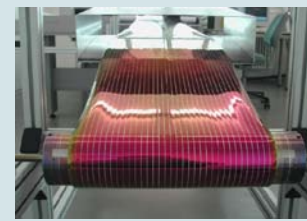
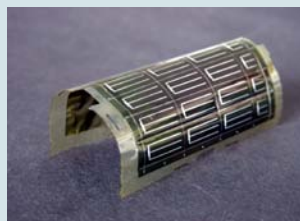
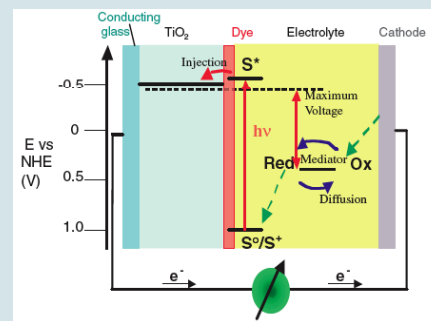
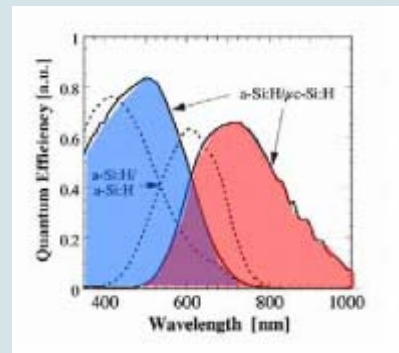
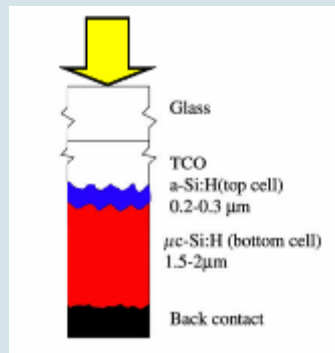
Solar cell research in Switzerland

	Technology	where	R & D	Transfer	Industry
	Crystalline silicon	EPFL (IMT) EMPA	X	X	XXX
	Thin film silicon	EPFL (IMT)	XXX	XXX	XXX
	CIGS, CdTe	EMPA	XX	X	X
	Dye sensitised cells	EPFL (LPI)	XX	X	
	Organic solar cells	EMPA, ZHAW, CSEM	XX		
	ETA solar cells	EMPA	X		



Solar cells: Swiss specialties

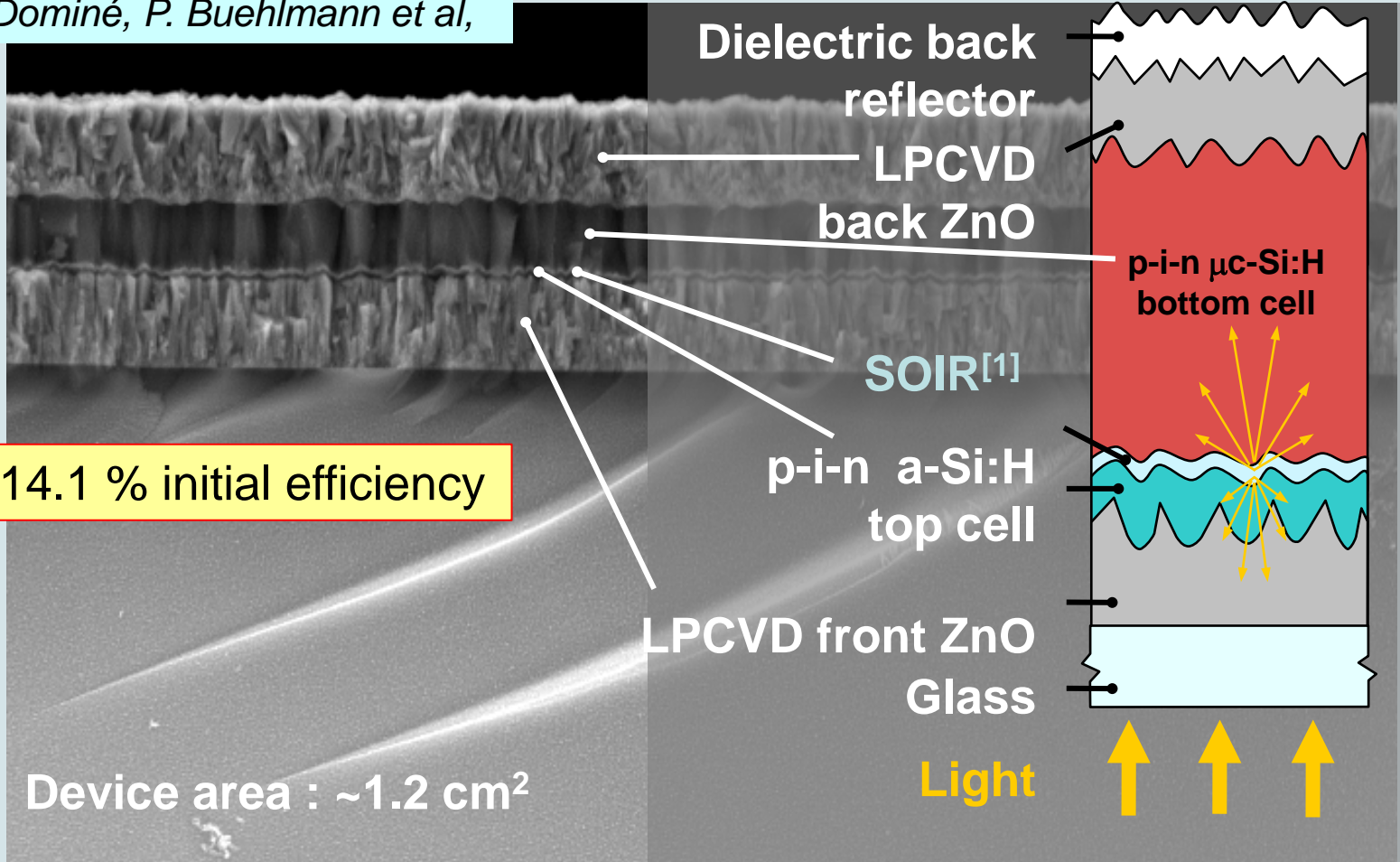
- Micromorphous silicon thin film solar cell
- Dye sensitised solar cell
- Flexible solar cells (amorphous silicon, CIGS)





High-efficiency p-i-n micromorph solar cells

D. Dominé, P. Buehlmann et al,

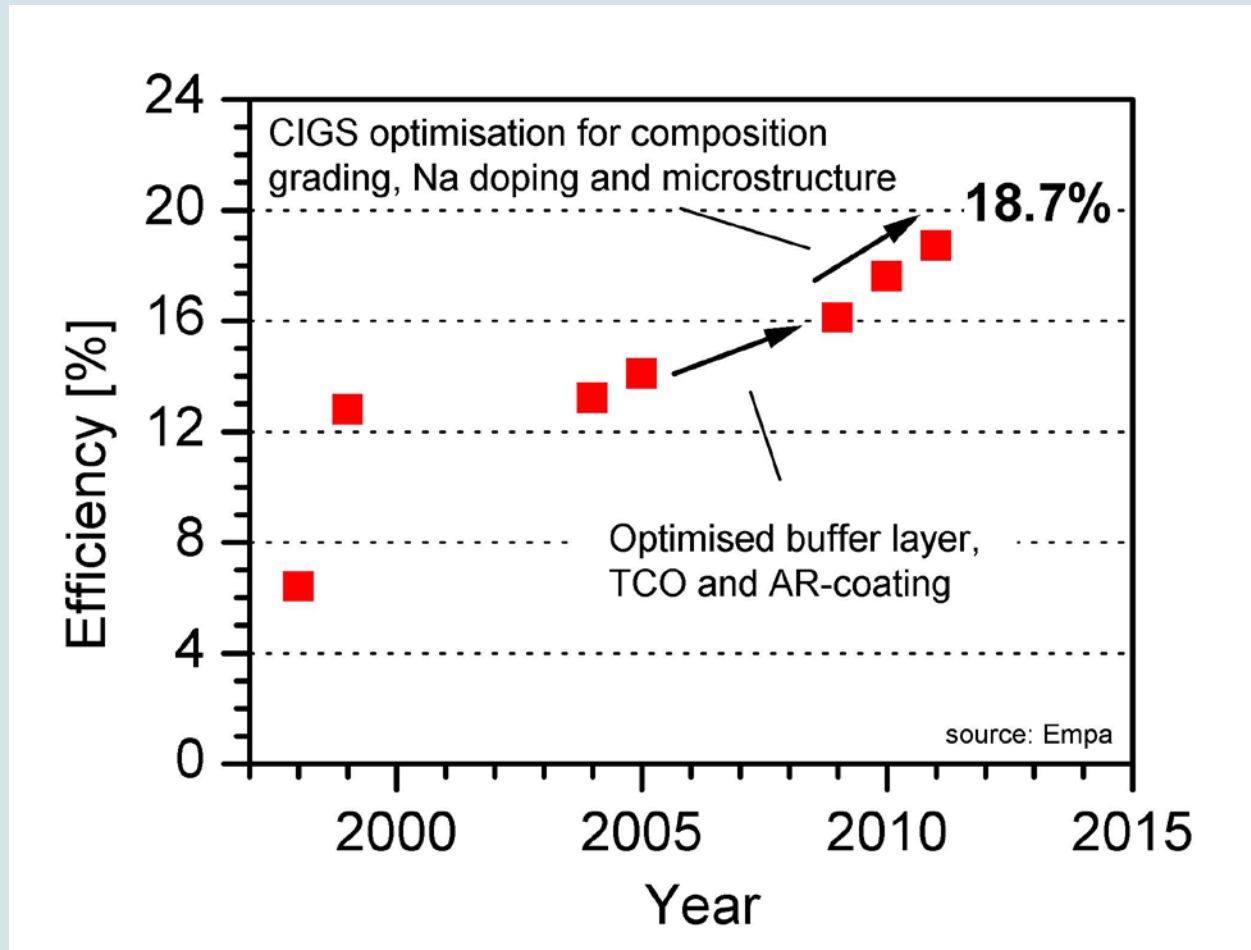


2011: 14.1 % initial efficiency

Device area : ~1.2 cm²

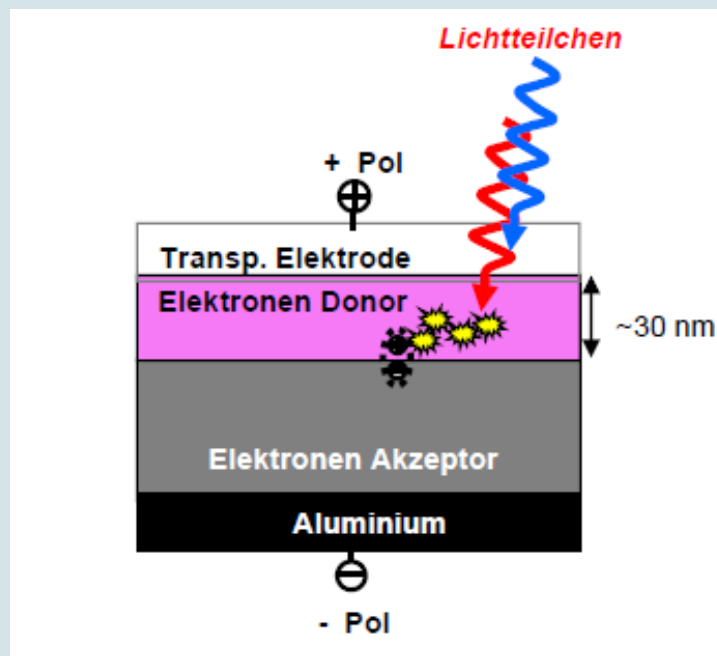
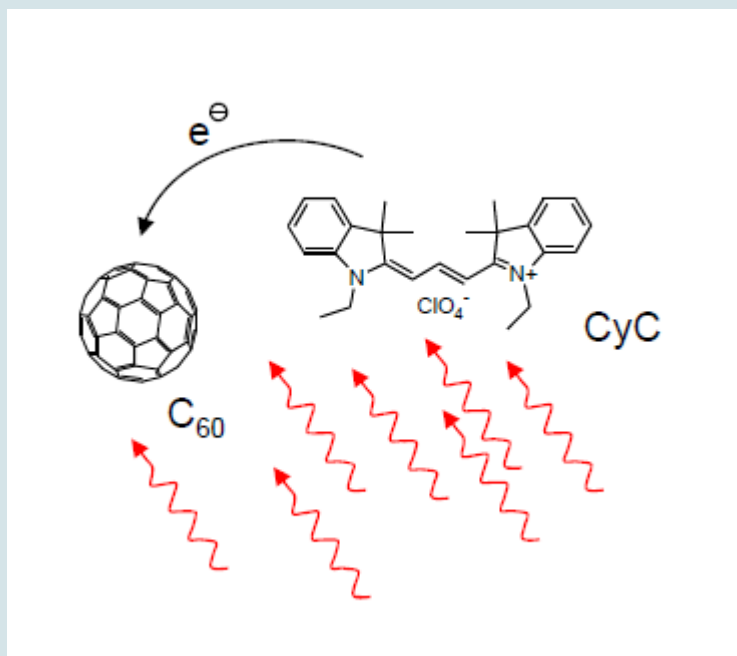


World record flexible CIGS solar cells





Organic solar cells (EMPA)





Printed organic solar cells (zhaw)

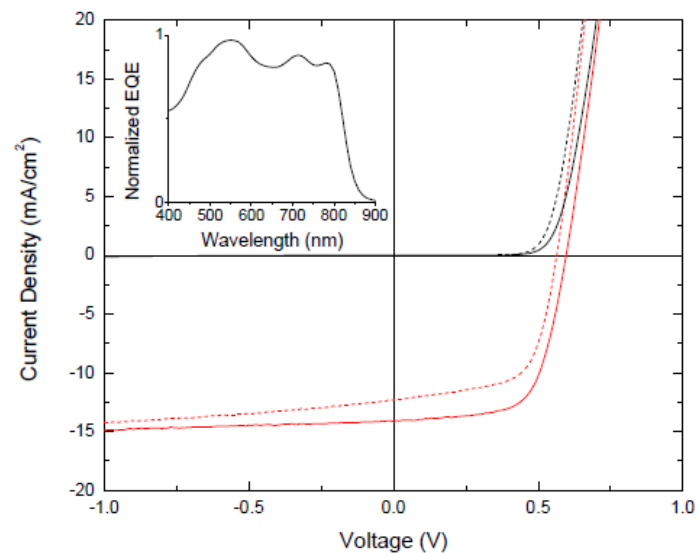
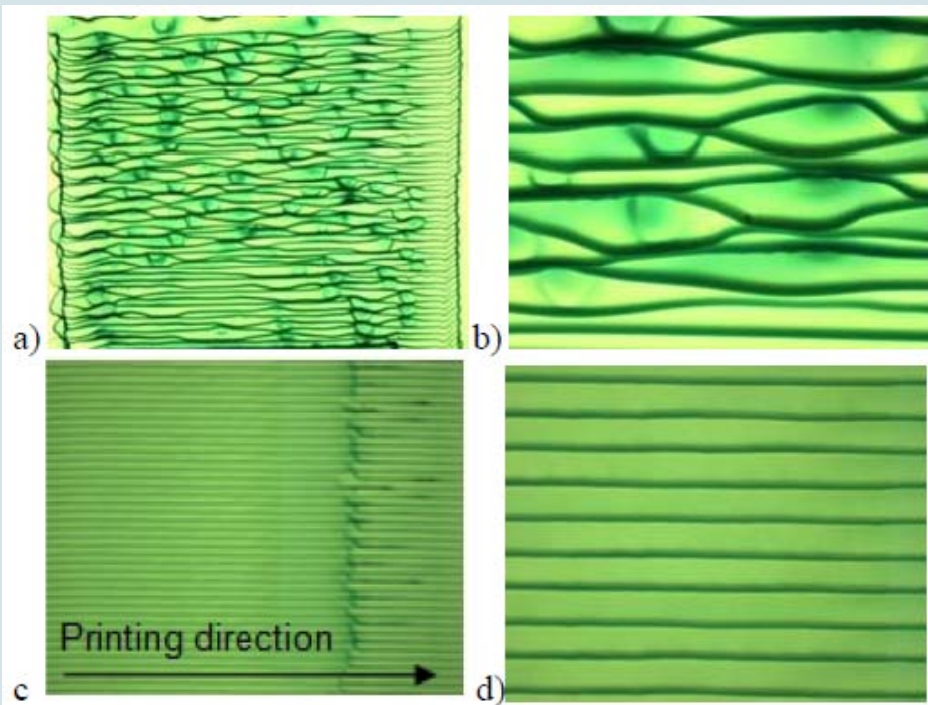
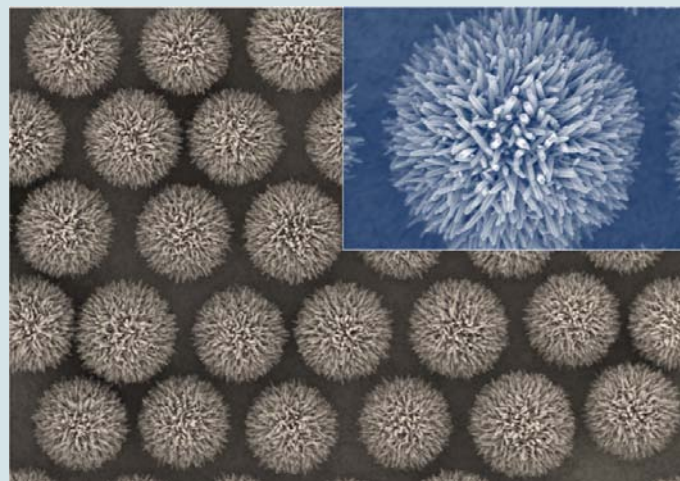
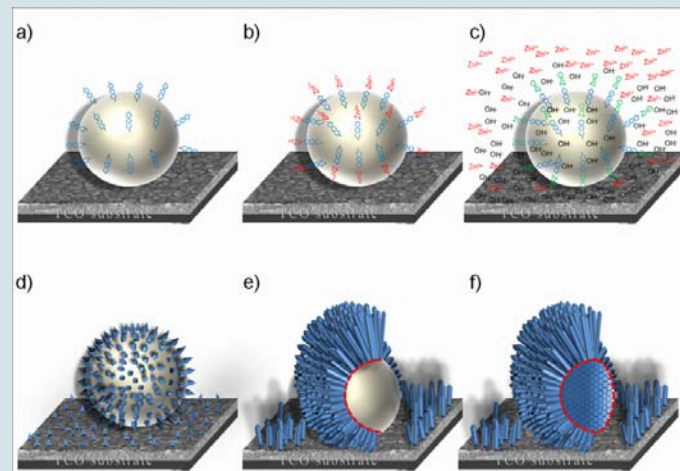
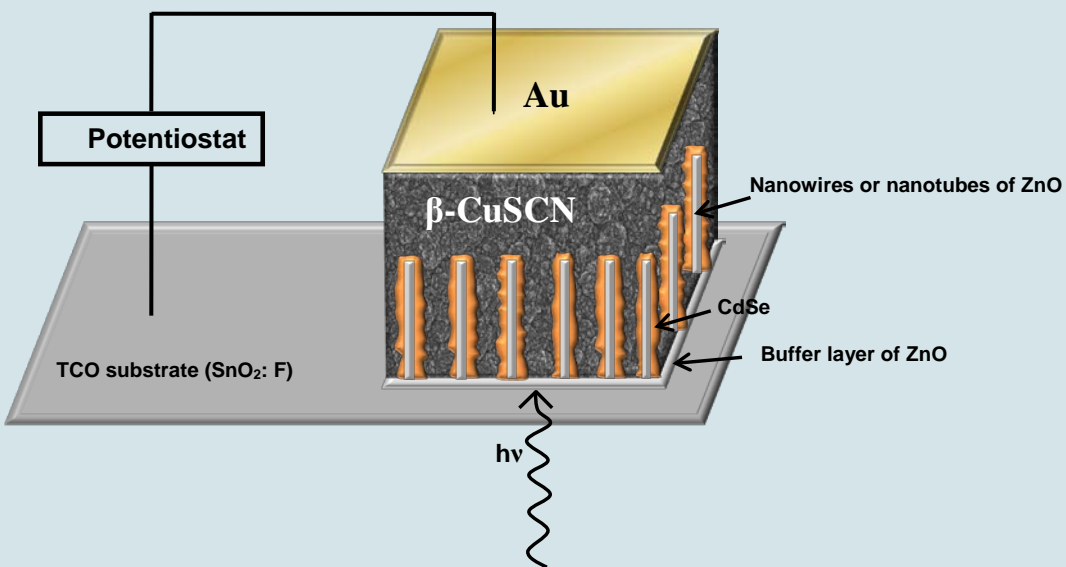


Figure 6. Current density–voltage measurements in dark (black) and under approximate AM1.5g illumination ($1000\text{W}/\text{m}^2$) (red). Solid lines: spin coated cells, dotted lines: printed cells. The inset shows the spectral response of the spin coated cell.



ETA solar cells by electrochemistry





Solar cells: options for the future

- Optimized approaches and structures
- Window and intermediate layers
- Multiple junctions
- New materials
- Contacts
- New technologies and processes
- Radically different approaches

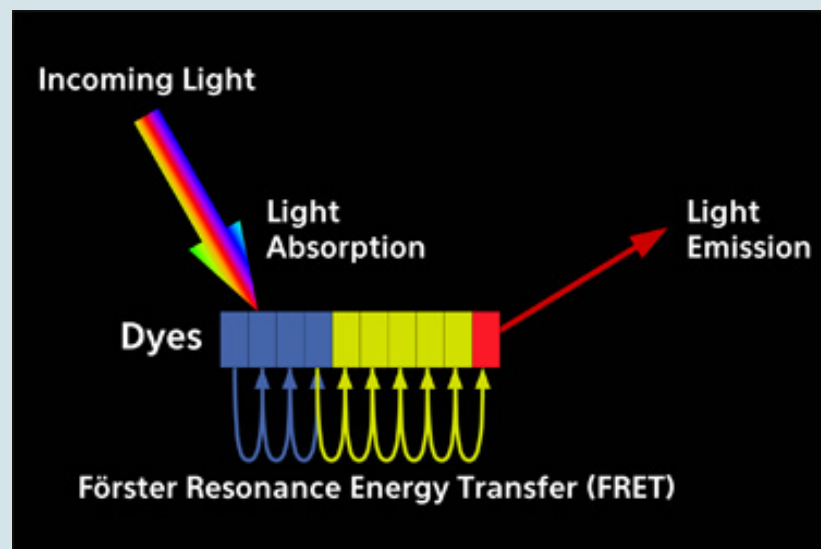
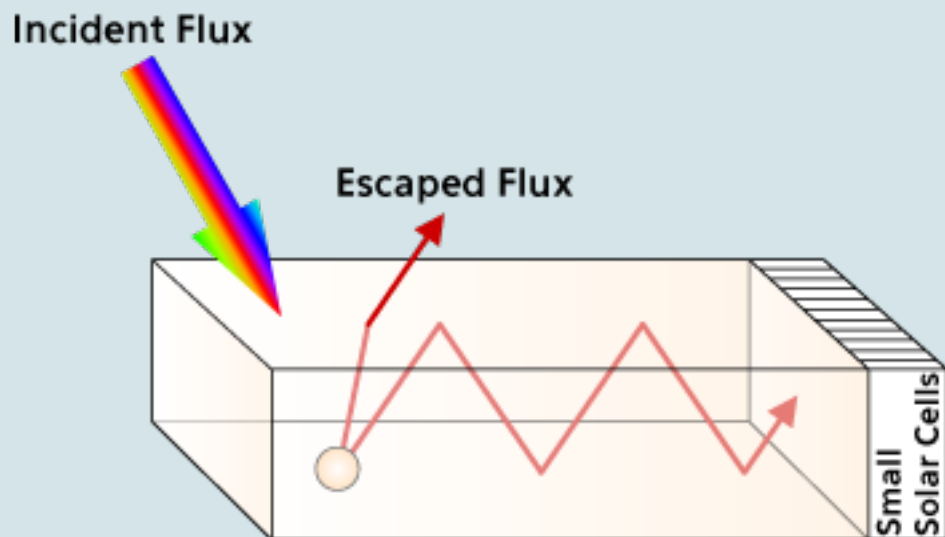


Scientific aspects

- Understanding of complex processes
- Better optical absorption
- Better spectral absorption
- Reduction of charge recombination
- Photon management
- Nanostructures (e.g. quantum dots and wells)



Example: luminescent concentrators





Quality assurance of PV modules



ISAAC – SUPSI

Module testing

- Long term
- Third parties
- Energy rating

Module certification

- IEC standards

Building integrated PV

- www.bipv.ch



Quality assurance of PV inverters



HTI Burgdorf

Inverter testing

- Long term
- Third parties
- Up 100 kW simulator

System analysis

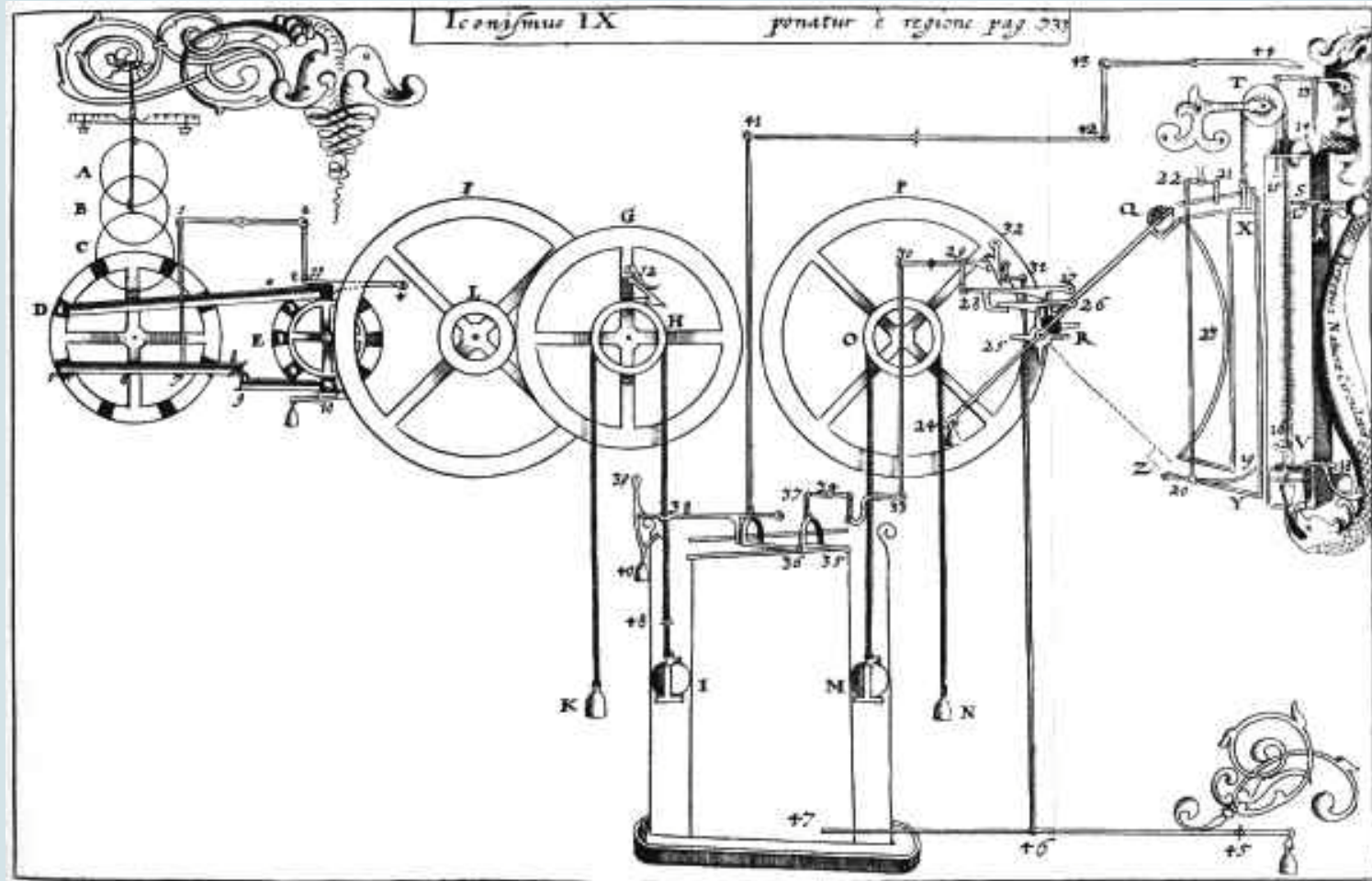
- High voltage
- Lightning
- Arc detector

PV plant analysis

www.pvtest.ch

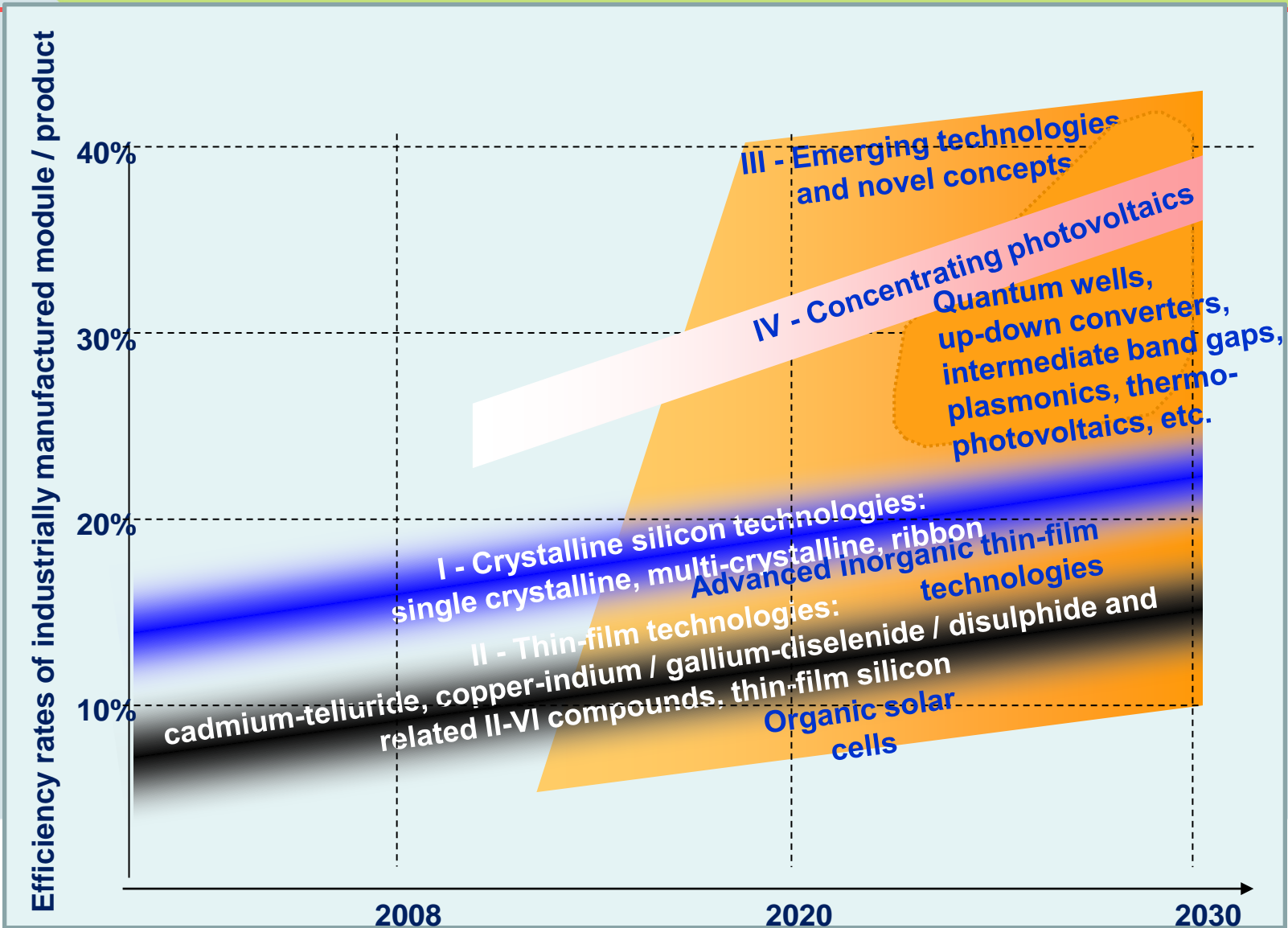


Complex system, many variables!





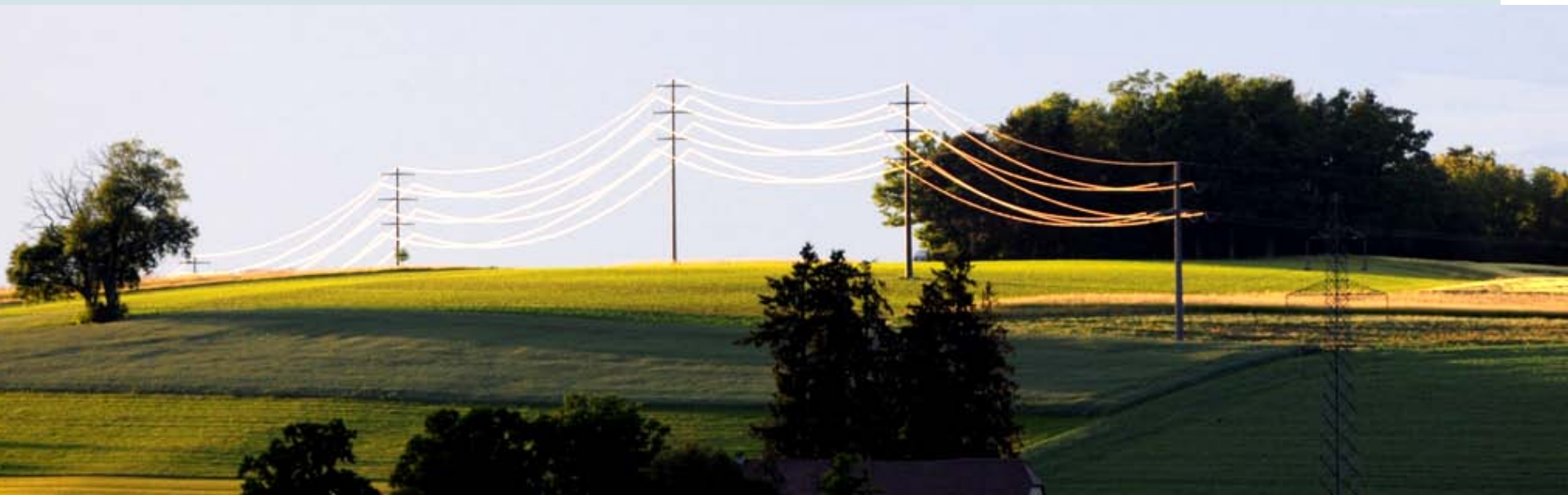
Technological development





System oriented topics

- Grid integration and storage
- Photovoltaics and smart grids
- High grid penetration of photovoltaics





International Cooperation

- EU-Projects (FP 6, FP 7)
- IEA PVPS
- EU PV Technology Platform
- Solar Europe Industry Initiative
- Solar ERA NET





The IEA PVPS Programme

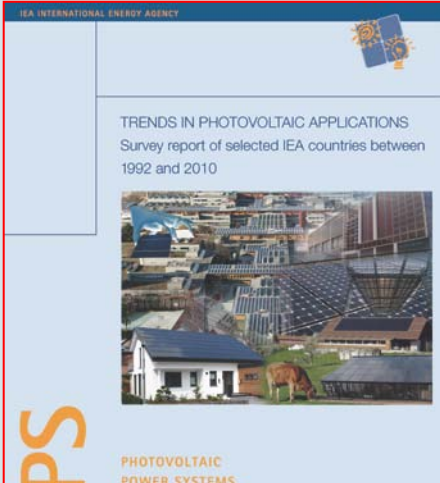


- One of more than 40 technology cooperation programmes of the IEA
- 26 members: 22 countries, EC, EPIA, SEPA, SEIA
- Good coverage of the worldwide PV sector
- Technical and non-technical issues
- Presently 7 projects ongoing
- ~ 120 experts worldwide

www.iea-pvps.org



Task 1: Information exchange



TRENDS IN PHOTOVOLTAIC APPLICATIONS
Survey report of selected IEA countries between
1992 and 2010



PHOTOVOLTAIC
POWER SYSTEMS
PROGRESS

PVPS

Vol. 36 March 2012

PV Power Update

Report

Newsletter of the International Energy Agency **Photovoltaic Power Systems Programme** IEA PVPS
www.iea-pvps.org

PVPS - Bringing Professionals Together

The wide range of PVPS workshops held over the last few months has shown the importance and value of international collaboration and exchange of experiences. IEA-PVPS has provided a solid platform for experts to discuss and share ideas and visions on an international level. Recent months have seen workshops on:

- High Penetration of PV Systems in Electricity Grids, held in China in October 2011 (see page 2)
- National PV Programmes in Asia-Pacific Regions, held at PVSEC in Japan in December 2011
- Driving Future PV Deployment – Electricity Utility PV Business Models, held at EUVSEC in Germany, September 2011
- Advantages of and Possible Issues Surrounding Grid-Connected PV Power Systems, held in Turkey, in conjunction with the Turkish PV Technology Platform
- Photovoltaic Pumping Systems in Rural Water Supply – Field Experiences, New Trends, and Applications. This seminar was part of the 6th Rural Water Supply Network Forum held in Uganda, November 2011.

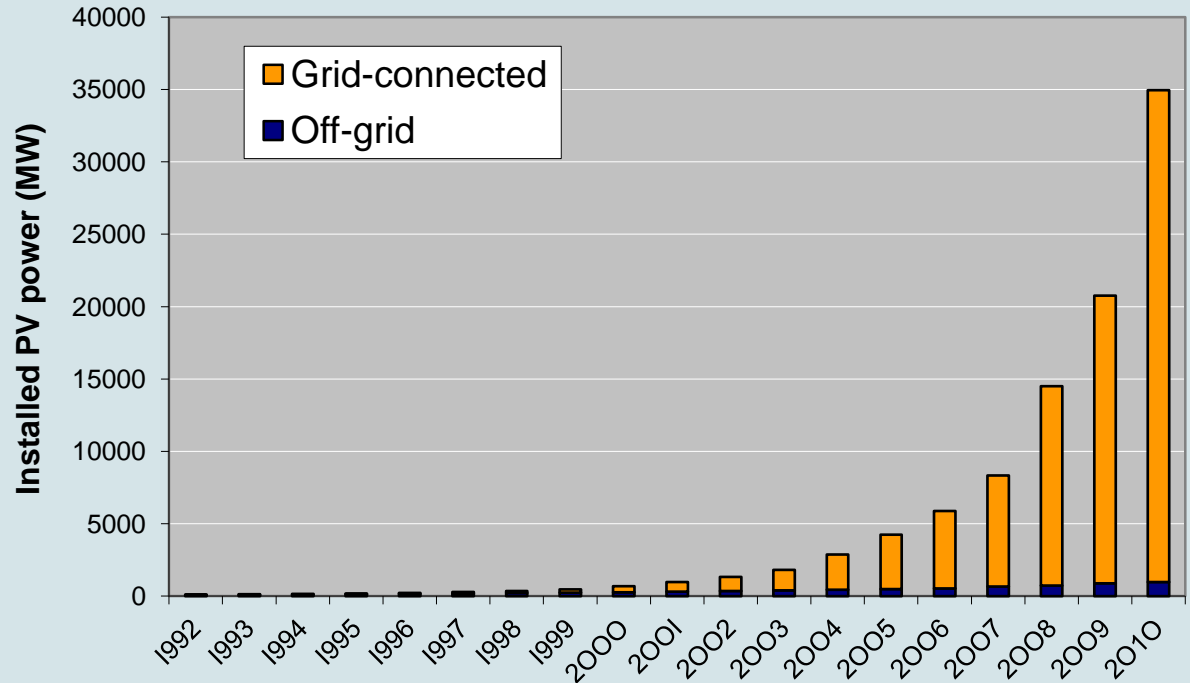
Information on the workshops, including copies of the presentations, are available on the PVPS website. In the coming months, PVPS will hold workshops at some of the major international PV conferences. There are also workshops held in conjunction with Task meetings. These allow local professionals to come along and share their experiences of PV with Task members from around the world. Look out for workshops in Sweden and Germany over the next few months.

In this issue:

- PV in the Chinese Electricity Grid - Pg 2
- Reliability of PV Modules - Pg 3
- Changes to the UK Feed-in Tariff - Pg 4
- Solar Energy Perspectives - Pg 4
- PV Training in the Netherlands - Pg 4
- PV Hybrid Systems and Mini-Grids - Pg 5
- PV Mini Grid in Yushu, Western China - Pg 5
- Feed-in-Tariff Launched in Malaysia - Pg 6
- PV Installations Rise Sharply in Denmark Pg 6
- New Life Cycle Assessment Guidelines - Pg 7
- Events and Contacts - Pg 8

Participants at the workshop on High Penetration of PV Systems in Electricity Grids held in Beijing, China, October 2011.

PVPS




Contact: Pius Hüsser, Novaenergie




Task 9: Energy services



IEA INTERNATIONAL ENERGY



RENEWABLE ENERGY SERVICES FOR DEVELOPING COUNTRIES
In support of the Millennium Development Goals:
Recommended Practice & Key Lessons



PVPS

PHOTOVOLTAIC
POWER SYSTEMS
PROGRAMME

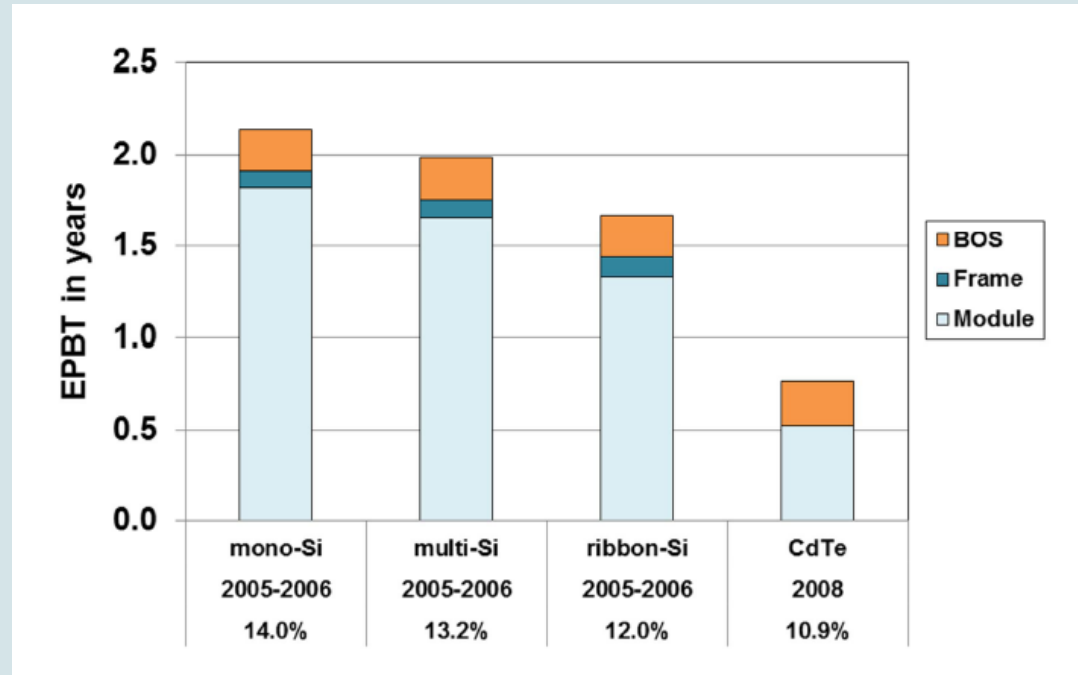
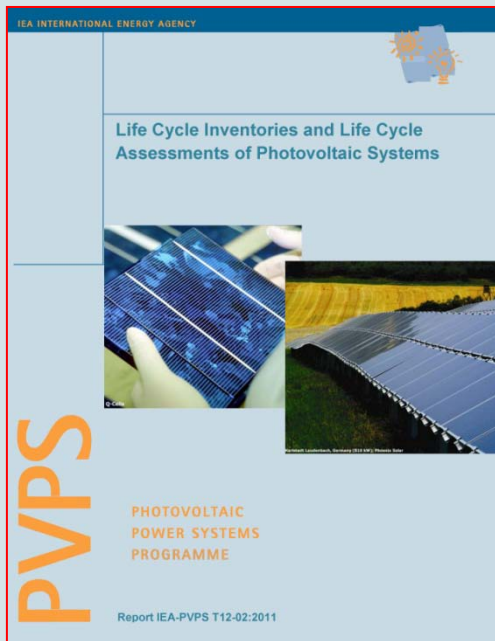
Report IEA-PVPS T9 - 09:2008



Contact: Alex Arter, Entec



Task 12: Environmental aspects



EPBT @ 1700 kWh/m² yr

Contact: Rolf Frischknecht, ESU-Services



Task 13: Performance, Quality, Reliability

IEA PVPS Task 13 Performance Database

Home

Karte Satellit

Small Marker Infos Nutzungsbedingungen

©TNC | Log Out | Home | Find | Record List | Find All | Summary Report |

IEA PVPS Task 13 Performance Database 518 / 541 | 541

MGTC Pack A1 T2 T13 All

Plant Project Inverter Array Operation

Monthly results One year Chart

2009 - 2009

Performance Ratio 2009

Month	Final yield (h/d)	Performance ratio (PR)
Jan	3.5	0.75
Feb	3.5	0.75
Mar	3.5	0.75
Apr	3.5	0.75
May	3.5	0.75
Jun	3.5	0.75
Jul	3.5	0.75
Aug	3.5	0.75
Sep	3.5	0.75
Oct	3.5	0.75
Nov	3.5	0.75
Dec	3.5	0.75

h/d PR

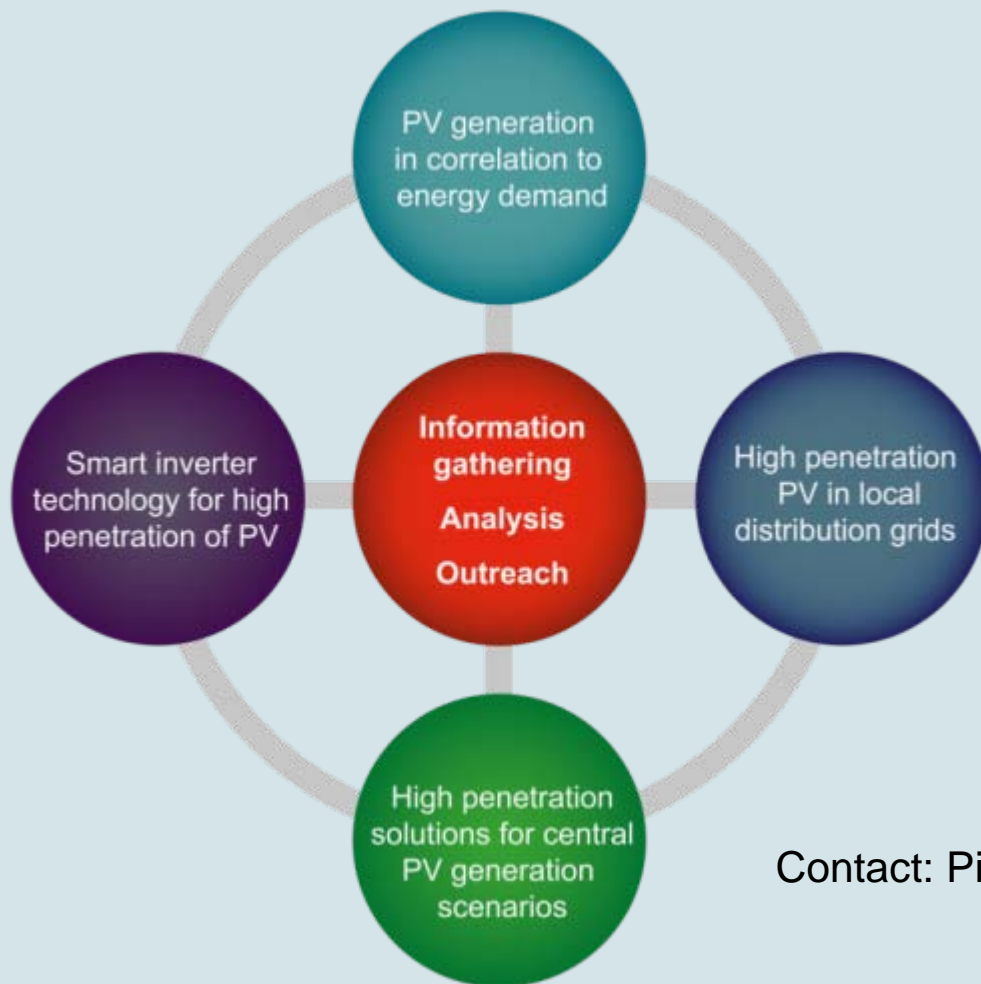
Month

©TNC | Log Out | Home | Find | Record List |

Contact: Thomas Nordmann, TNC
Thomas Friesen, ISAAC



Task 14: High PV Penetration in electricity grids



Contact: Pierre Renaud, Planair



PV RTD instruments



FNSNF
SCHWEIZERISCHER NATIONALFONDS ZUR
FÖRDERUNG DER WISSENSCHAFTLICHEN FORSCHUNG

ETH-RAT

ETH-Domain, Universities

csem centre suisse d'électronique
et de microtechnique

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE

ccem.ch

swisselectric research

SEVENTH FRAMEWORK PROGRAMME

ETH-Domain, Universities, Univ. Applied Sciences

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Berufsbildung und Technologie BBT
Förderagentur für Innovation KTİ

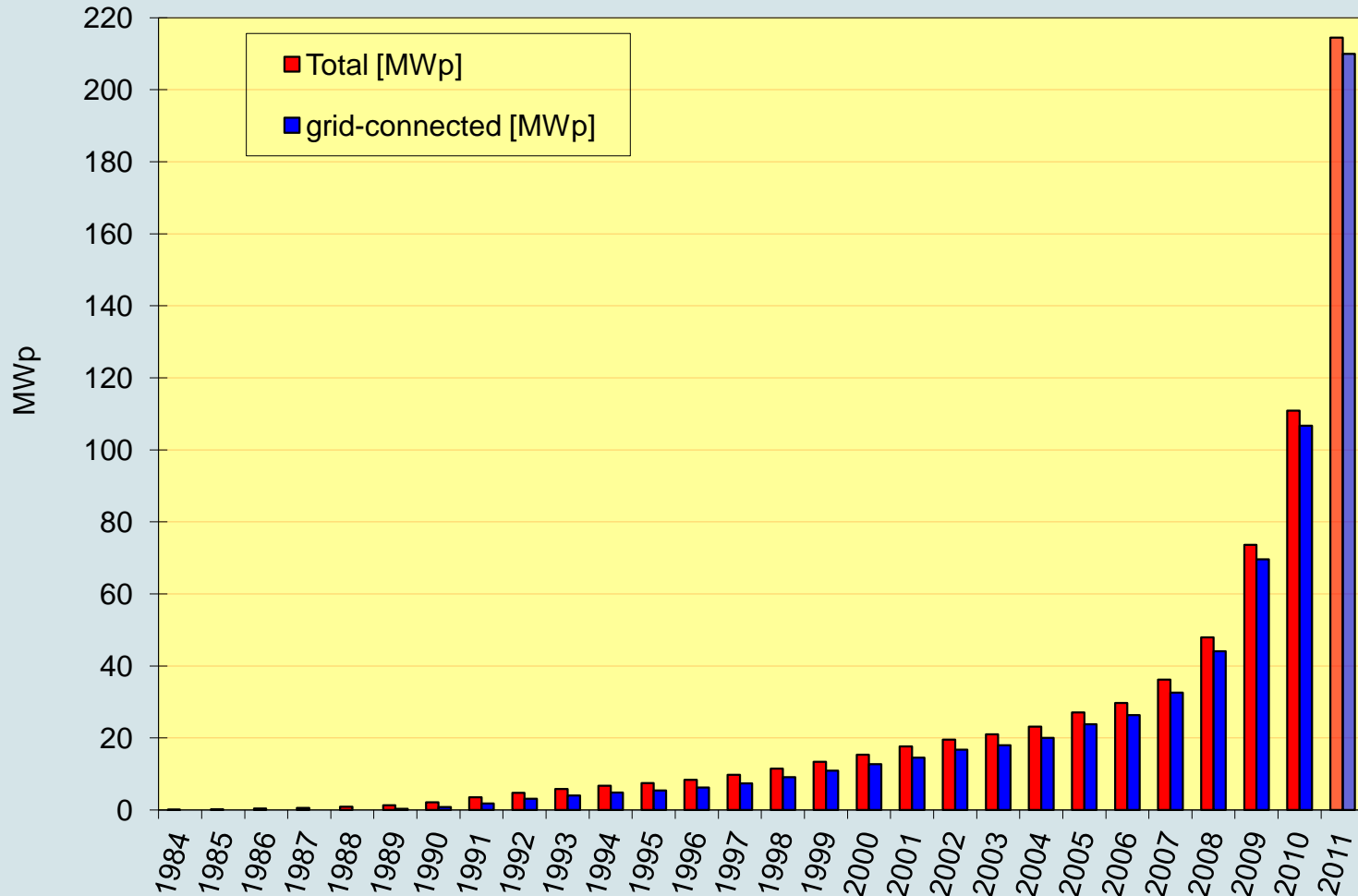


Swiss PV industry: rapid implementation along the entire photovoltaic value chain





The Swiss PV market





The future of PV RTD in Switzerland

- The relevance of photovoltaic research is confirmed (CORE energy research master plan 2013 – 2016, Action plan coordinated energy research)
- However: financial means so far unchanged (reduced)
- Additional financial means for P+D-projects (2013)
- Master plan PV 2020
- Photovoltaic research 2013 – 2016
- Photovoltaic Technology Center (2013)



Challenges

- R&D excellence
 - Continuity
 - Industrial cooperation
 - Quality of Products
 - Education of staff
 - **Acceleration**
- ➔ Technology competence
 - ➔ World class R&D
 - ➔ Innovation / implementation
 - ➔ Reliability and energy yield
 - ➔ Transfer of knowledge
 - ➔ **Growth**





Conclusions

- Swiss PV R&D, technology and industrial base excellent
- Potential and possible role of photovoltaics are widely recognized
- RTD becomes more industry and system relevant
- The next decade is decisive for PV – worldwide and in Switzerland
- Long term options should not be forgotten
- Sustainability becomes key (technologies and markets)
- Competition has become fierce
- Constant innovation is a must
- Strong PV needs a strong technological base !



Thank you for your attention !

<http://www.bfe.admin.ch>

<http://www.photovoltaiic.ch>

<http://www.eupvplatform.org>

<http://www.pv-era.net>

<http://www.iea-pvps.org>

Your contacts:

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