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First International orgaPVnet Conference

Linz 06-08/02/2008

Dr. Laurence Lutsen
Dr. Jef Poortmans

imec

General Outline

- IMEC a short overview

- Strategic Research Agenda of the European Photovoltaic Plateform

- OrgaPVnet a coordination Action towards Organic based Solar Cells

- Conclusions

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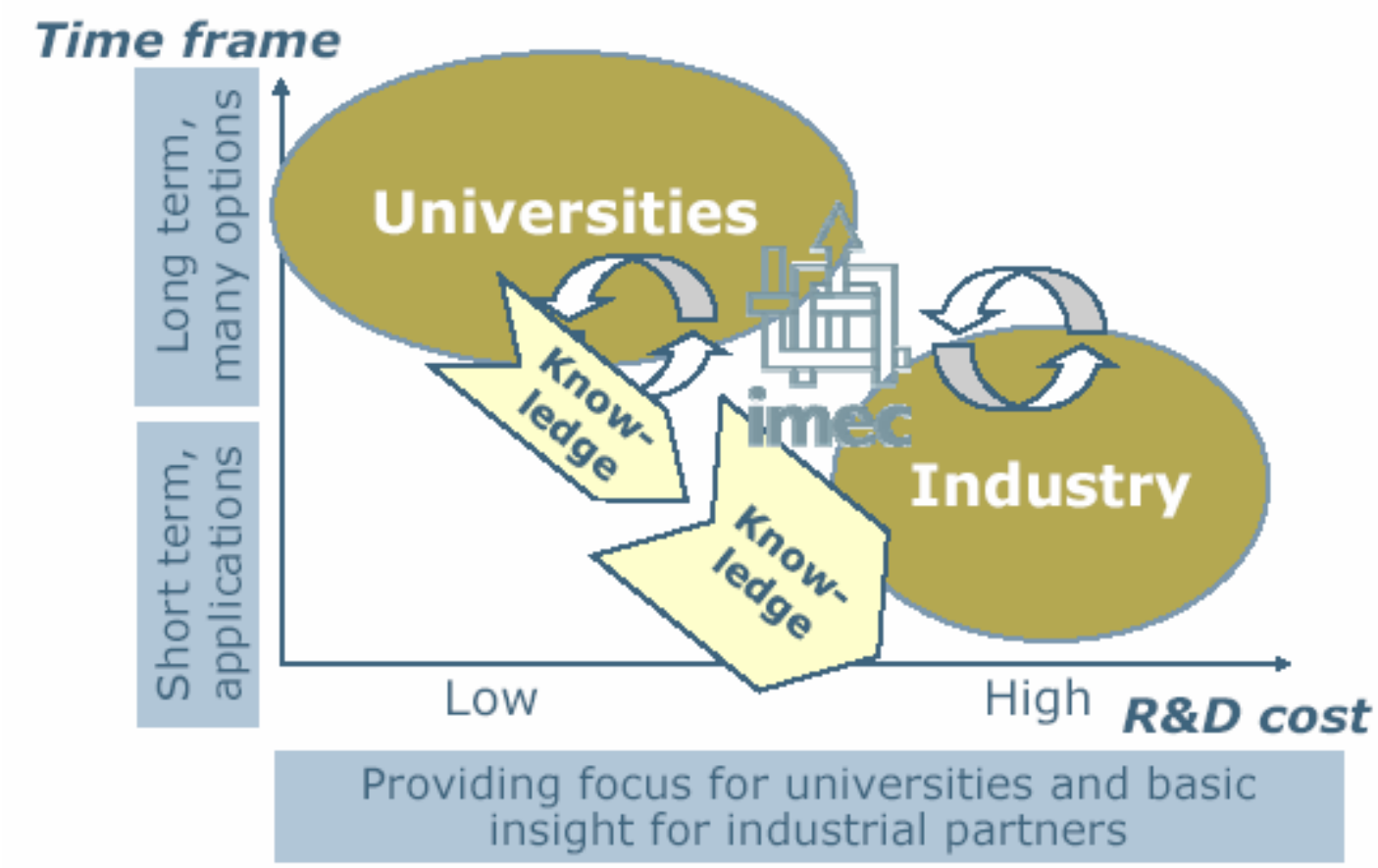
IMEC : Mission Statement

« To perform research & development, ahead of industrial needs by 3 to 10 years, in microelectronics, nanotechnology, design methods and technologies for ICT »

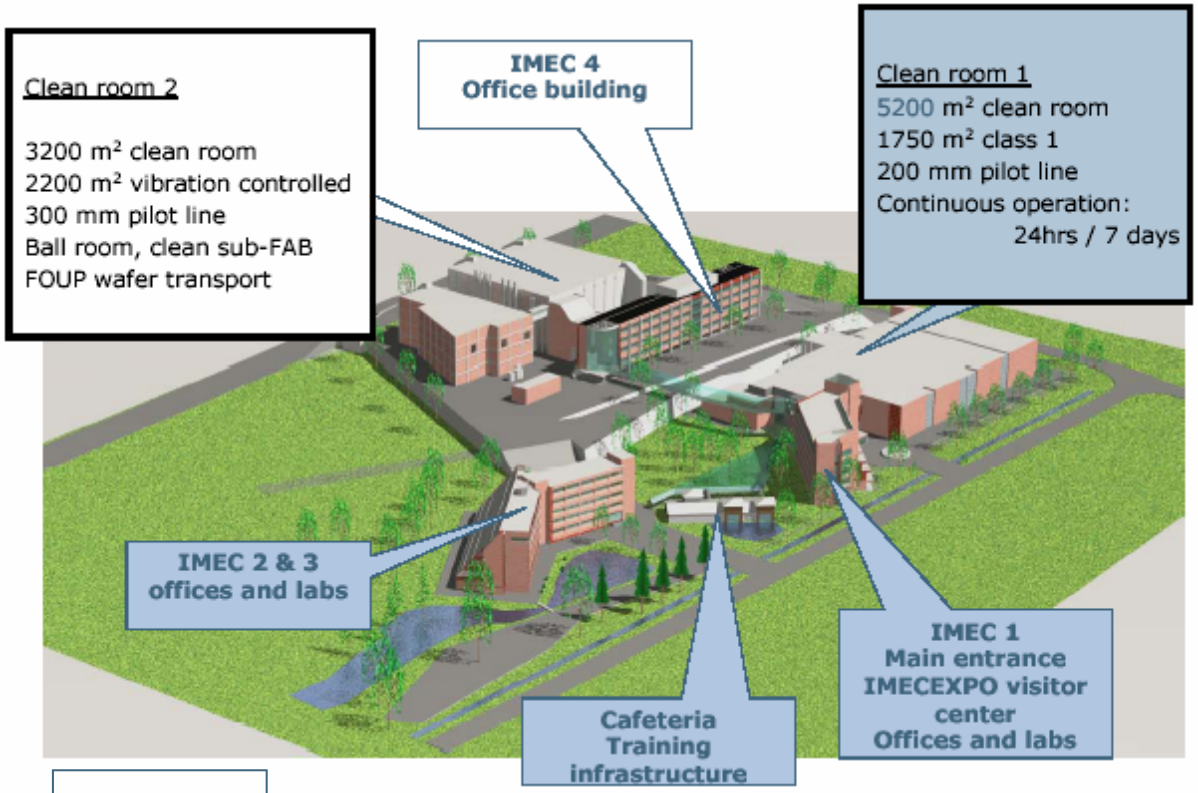
Performance criteria:

- **Being a worldwide center of excellence**
  (total contract revenue, publications, invited papers)
- **Being excellent in exploratory work**
  (number of PhDs, projects and publications with universities)
- **with impact on local industry**
  (new spin offs, collaborations, training)

IMEC : as a « Transformer »



IMEC : Campus & Associated laboratories



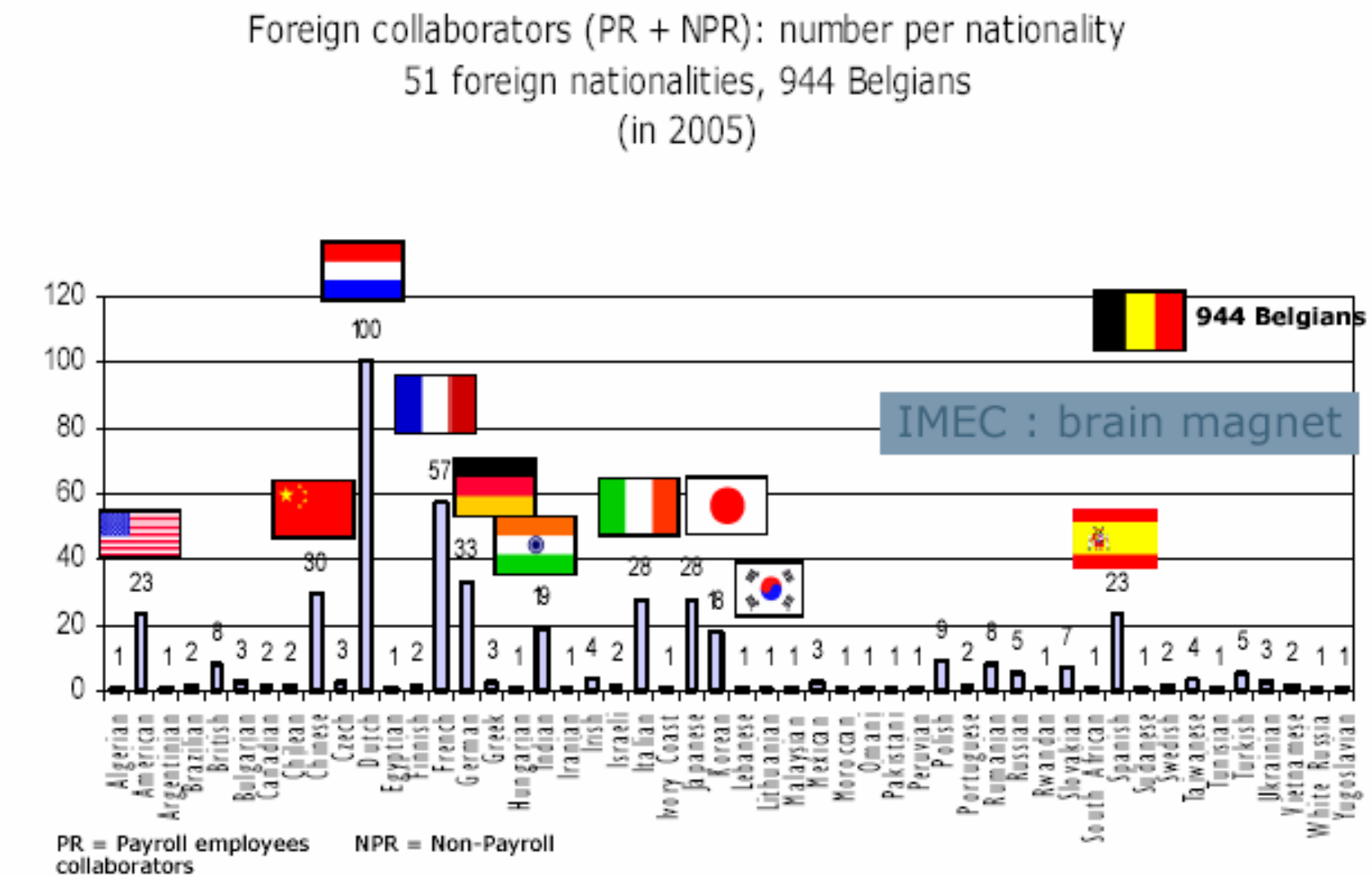
Leuven

Hasselt (IMOMEC)

Ghent University
(UGent/INTEC)

Vrije Universiteit Brussels
(VUB/ETRO)

IMEC : more than 50 nationalities



IMEC : 1984 - 2008

1984

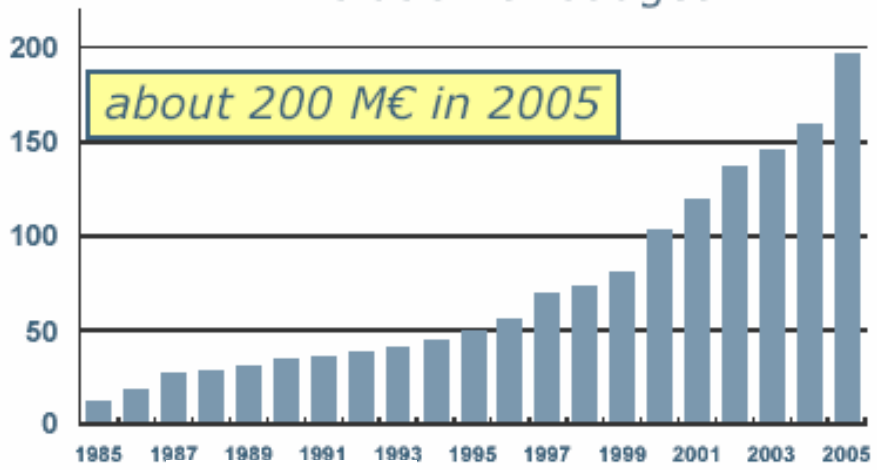
Established by state government of Flanders in Belgium

Non-profit organization

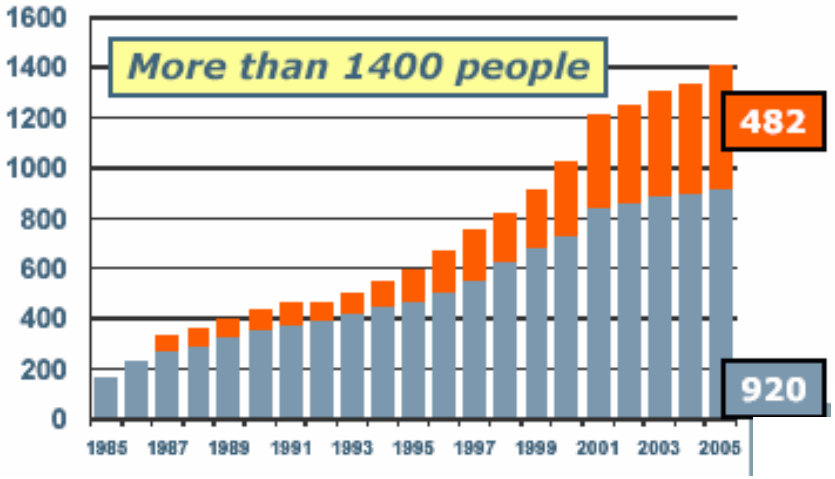
Initial investment: 62M€

Initial staff: ~70

Evolution of budget



Evolution of staff



2008

One of the largest independent R&D organizations in its field, worldwide

Annual budget : close to 200M€ (includes 35 M€ grant from government)

< 18% government/state funding

Staff: more than 1400

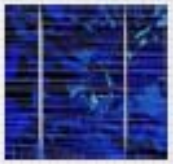
Collaboration with >550 partners

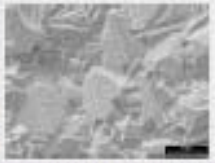
SOLAR + : IMEC Internal Roadmap

Silicon Solar Cell Program

Thin crystalline Si
(200 → 80 μm)

Higher efficiency (15→20%)
Si-ribbons
Thin-film crystalline Si (<20 μm)





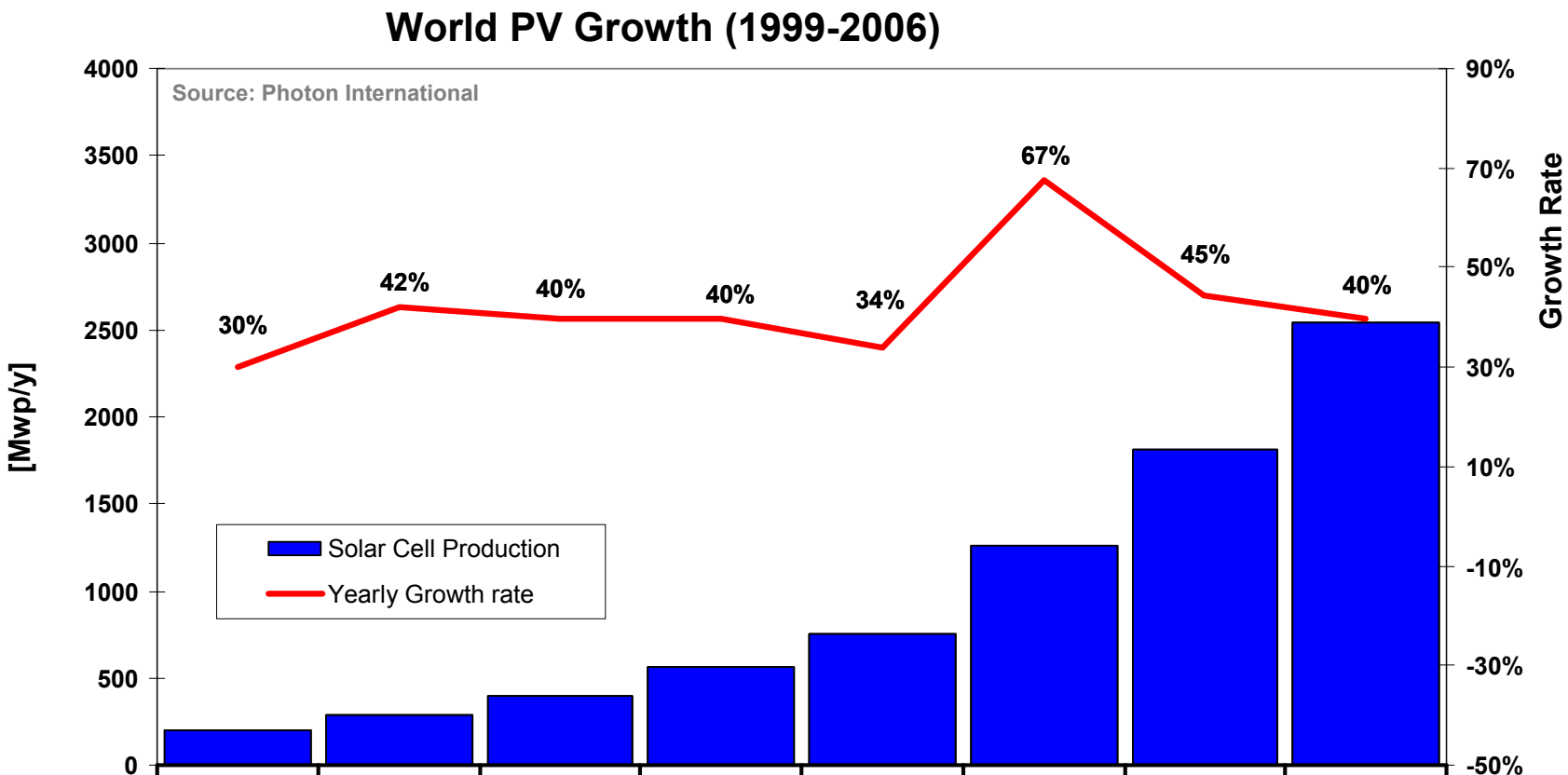
Organic Photovoltaics

Higher efficiency
Stability

Consumer applications
Ambient intelligence

Large-scale application?

PV market



	1999	2000	2001	2002	2003	2004	2005	2006
Solar Cell Production	202.0	287.0	401.0	560.0	750	1256	1815.0	2536.0
Yearly Growth rate	30%	42%	40%	40%	34%	67%	45%	40%

PV-markets are booming

- Also for 2007 a growth of 40% probably occurred bringing total production level > 3.5 GWp/year
- Strong increase of the thin-film PV-technologies with many new players entering the field
- Traditional equipment/material suppliers and chip producers are more and more turning towards PV (e.g. Applied Materials, …)
- The expectations on PV are high which should result in a continued growth rate of at least 40%/year
- There is a strong need for a Roadmap to guide R&D in Europe

General Outline

- IMEC and its activity on Organic Solar cells

- Strategic Research Agenda of the European Photovoltaic Plateform

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The PV Technology Platform

- The PV Technology Platform
  - Structure
  - The Strategic Research Agenda (SRA)
  - SRA contents summarized

The PV Technology Platform: Structure

PhotoVoltaic TECHNOLOGY PLATFORM

http://www.eupvplatform.org

- Contributes to a rapid development of a world-class **cost competitive European PV** for a sustainable electricity production
- Involves stakeholders in the **formulation of research programmes**
- Ensures strong links and coordination between **industry, research & market.**
- **Implements the strategic plan**

The PV Technology Platform: 4 working groups

- Adressing different field of activity
  - Policy and Instruments (WG1)
  - Market Deployement (WG2)
  - Science, Technology & Applications (WG3)
  - Developing Countries (WG4)

The PV Technology Platform: results

- Key result over the 2 first years

Strategic Research Agenda (SRA)

- prepared by WG3, 25 members
- started end of 2005

WG3 : 4 subgroups

-Cell & modules technology

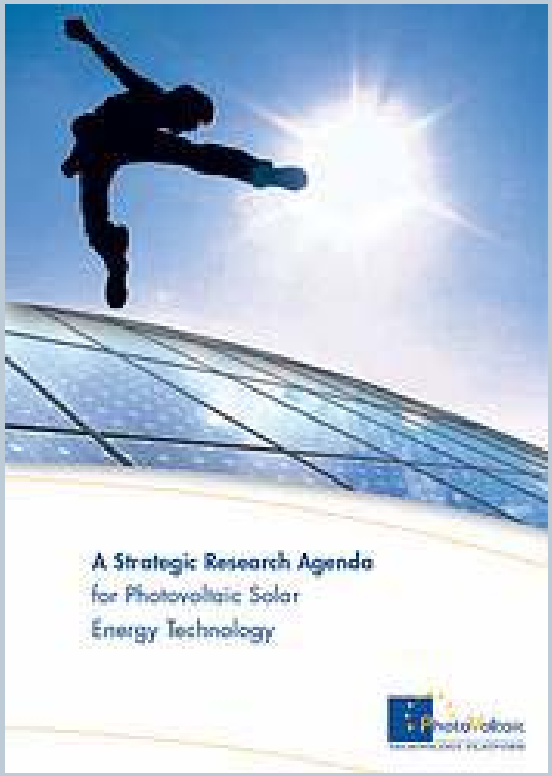
-Balance of system (BoS) components & systems

-Standards, Quality Assurance,
Safety & Environmental Aspects

-Socio-economic and enabling research

Strategic Research Agenda: what is it?

- Defines broadly supported overall dev. targets for PV technology
- Outlines research fields & topics to be adressed to reach these targets
- First complete version now available through webpage www.eupvplatform.org
- Printed version 12 June 2007
- Implementation process can now start - Formal Implementation Plan to be prepared during 2008



Outline

- The PV Technology Platform
  - Structure
  - The Strategic Research Agenda (SRA)
  - SRA contents summarized
- OrgaPVnet European Project
  - Structure
  - Contents summarized
- Conclusions

SRA Contents Summarised: Terminology

Terminology

- short term (ST): 2008 ~ 2013
- medium term (MT): 2013 ~ 2020
- long term (LT): 2020 ~ 2030+

» 2013: end of FP7

Research Priorities

- Timing – for a use in Commercial products/applications

(But NOT to an expected widespread use)

- Cost Targets – demonstration of the technology in pilot scale production/installation

(Commercial production/price/1 or 2 years later)

SRA contents summarised: starting principles

- **SHORT-TERM** Research should be **fully dedicated** to the **COMPETITIVENESS** of the **EU industry.**

- **No EXCLUSIVITY**
  - PV comes and will come in different forms
  - SRA does not exclude technologies but sets overall targets & research priorities for each formats in order to reach the defined targets

- **Need to address ALL PARTS of the value chain**
  - From materials to final product, incl. manufacturing and socio-economic aspects

SRA contents summarised: starting principles

- **Need to address ST, MT and LT research SEPARATLY**

  - Use budget firewalls between ST/MT/LT (specific budgets)
  - Specific priorities within each category

  Research spending ratios:
  - public/private R&D shares 1:1, growing to 1:2
  - private R&D typically ST/MT 3:1
  - public R&D typically ST/MT/LT 2:2:1

  ⇒ **resulting typical total R&D shares ST/MT/LT of 6:3:1 moving to 10:5:1 as private sector funding will increase**

SRA contents summarised: Choices on cost targets

- **Based an a detailed analysis of cost reduction potential:**
  - Same cost targets for all flat-plate PV module technologies:
    - ST: 0.8 - 1.0 €/Wp *(2013)*
    - MT: 0.6 - 0.75 €/Wp *(2020)*
    - LT: 0.3 - 0.4 €/Wp *(2030)*
  - Indicative cost targets for BoS (roof-top systems):
    - ST: 0.9 - 1.1 €/Wp
    - MT: 0.75 - 0.9 €/Wp
    - LT: < 0.5 €/Wp
  - Turn-key concentrator system cost targets:
    - ST: 1.2 - 1.9 €/Wp
    - MT: 0.8 - 1.2 €/Wp
    - LT: 0.5 - 0.8 €/Wp

Costs, not prices

Decisions – not predictions

SRA contents summarised: Any PV techn. dev. targets

Cost – direct relation with manufacturing/installation ➔ R&D

Price – Crucial parameter for application & market development

Constant 2007 values	1980	Today	2015	2030	Long term potential
Typical turn-key system price (2007 €/Wp, excl. VAT)	**>30**	**5** *(range 4-8)*	**2.5/2.0** *(range 2-4)*	**1**	**0.5**
Typical electricity generation costs South Europe (2006 €/kWh)	**>2**	**0.30**	**0.15/0.12** *(competitive with retail electricity)*	**0.06** *(competitive with wholesale electricity)*	**0.03**
Typical commercial *flat-plate* module efficiencies	**up to 8%**	**up to 15%**	**Up to 20%**	**up to 25%**	**up to 40%**
Typical commercial *concentrator* module efficiencies	**(~10%)**	**up to 25%**	**Up to 30%**	**up to 40%**	**up to 60%**
Typical system energy pay-back time Southern Europe (yrs)	**>10**	**2**	**1**	**0.5**	**0.25**

SRA contents summarised: Any PV techn. dev. targets

- The conversion from turn-key prices to generation costs requires several assumptions
- SRA assumes:
  - An average performance ratio of 75%
  - Operation & maintenance (1% of the system price)
  - economic value depreciation over 25 years
  - 4% discount rate

- **Overall aim** of short-term research is for the price of PV electricity to be **comparable** to the **retail price** of electricity for small consumers **in southern Europe by 2015 & in most of Europe in 2020.** (Grid parity)

SRA contents summarised: Any PV techn. dev. targets

Cost – direct relation with manufacturing/installation ➔ R&D

Price – Crucial parameter for application & market development

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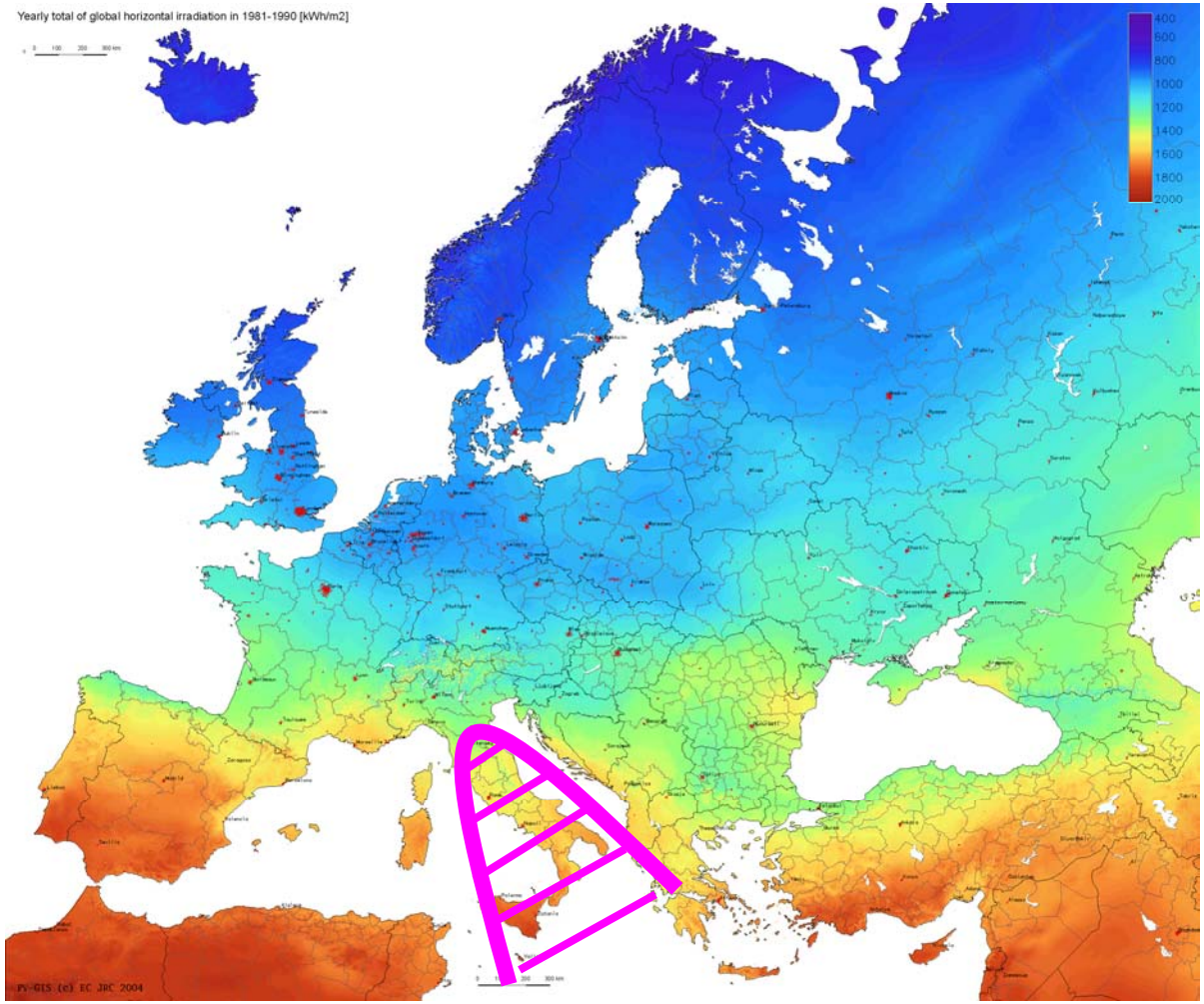
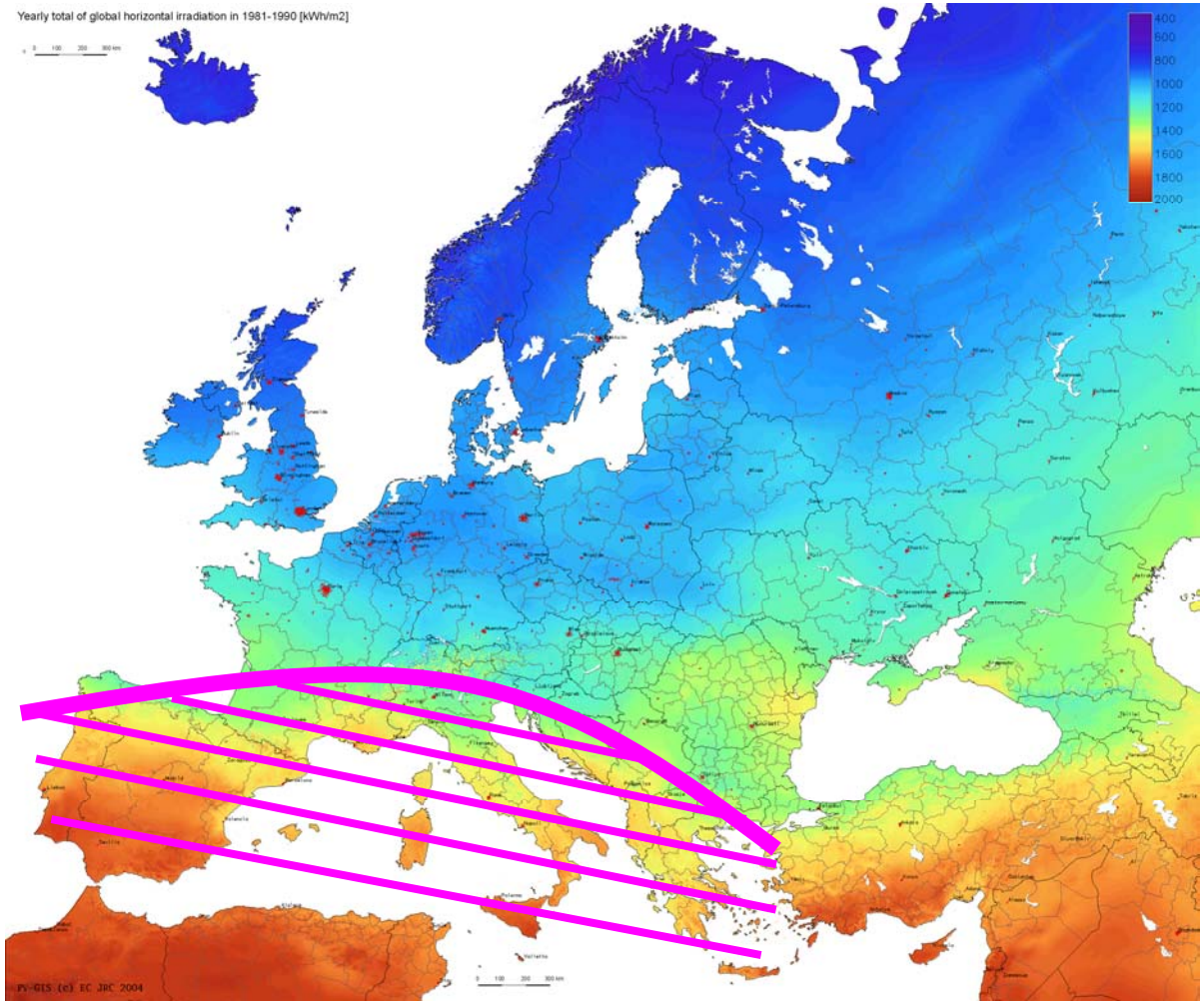
Grid parity in Europe – 2010



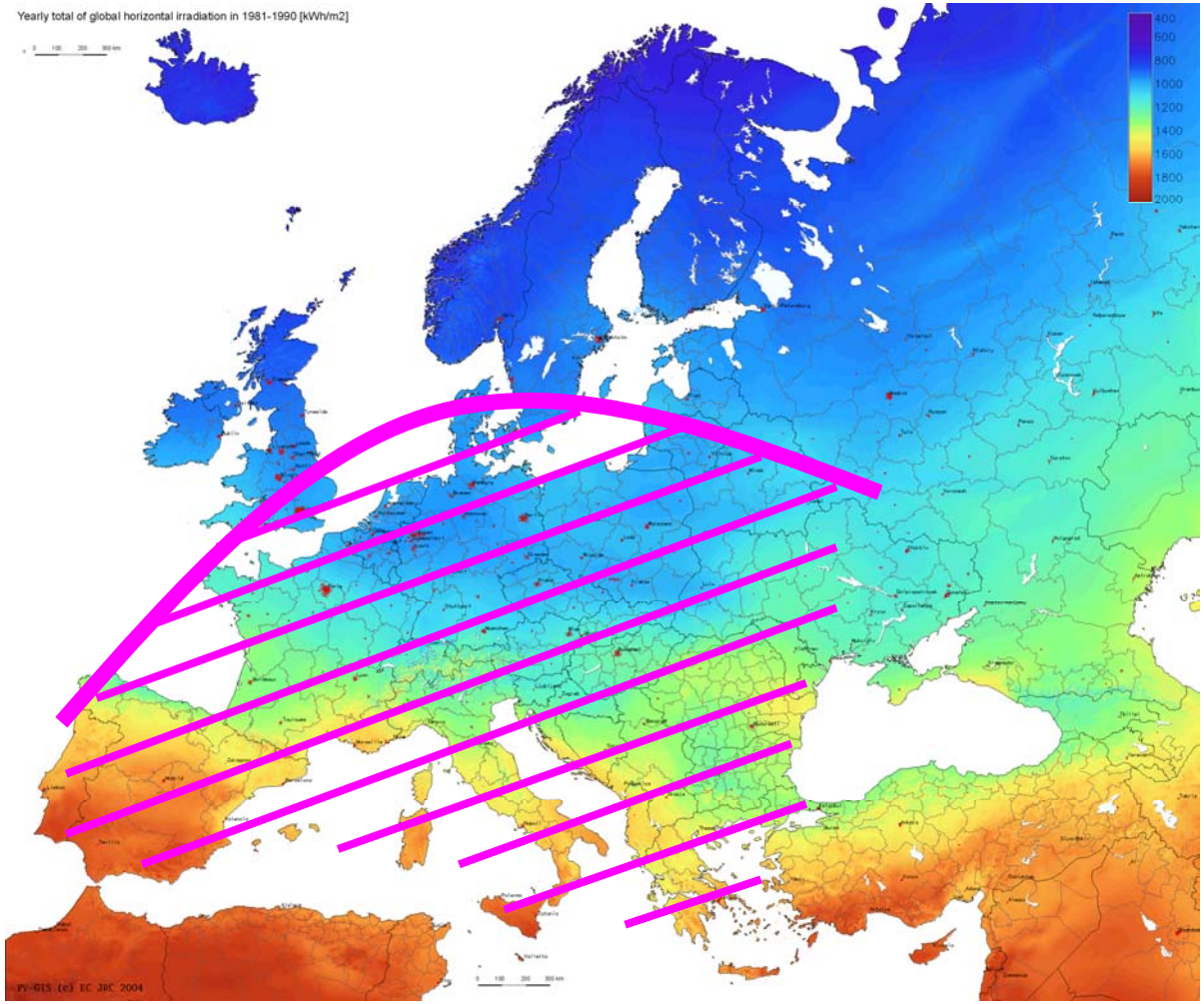
irradiation (kWh/m²·yr)	PV generation cost (€/kWh)
600	0.50
1000	0.30
1400	0.21
1800	0.17

Grid parity in Europe – 2015



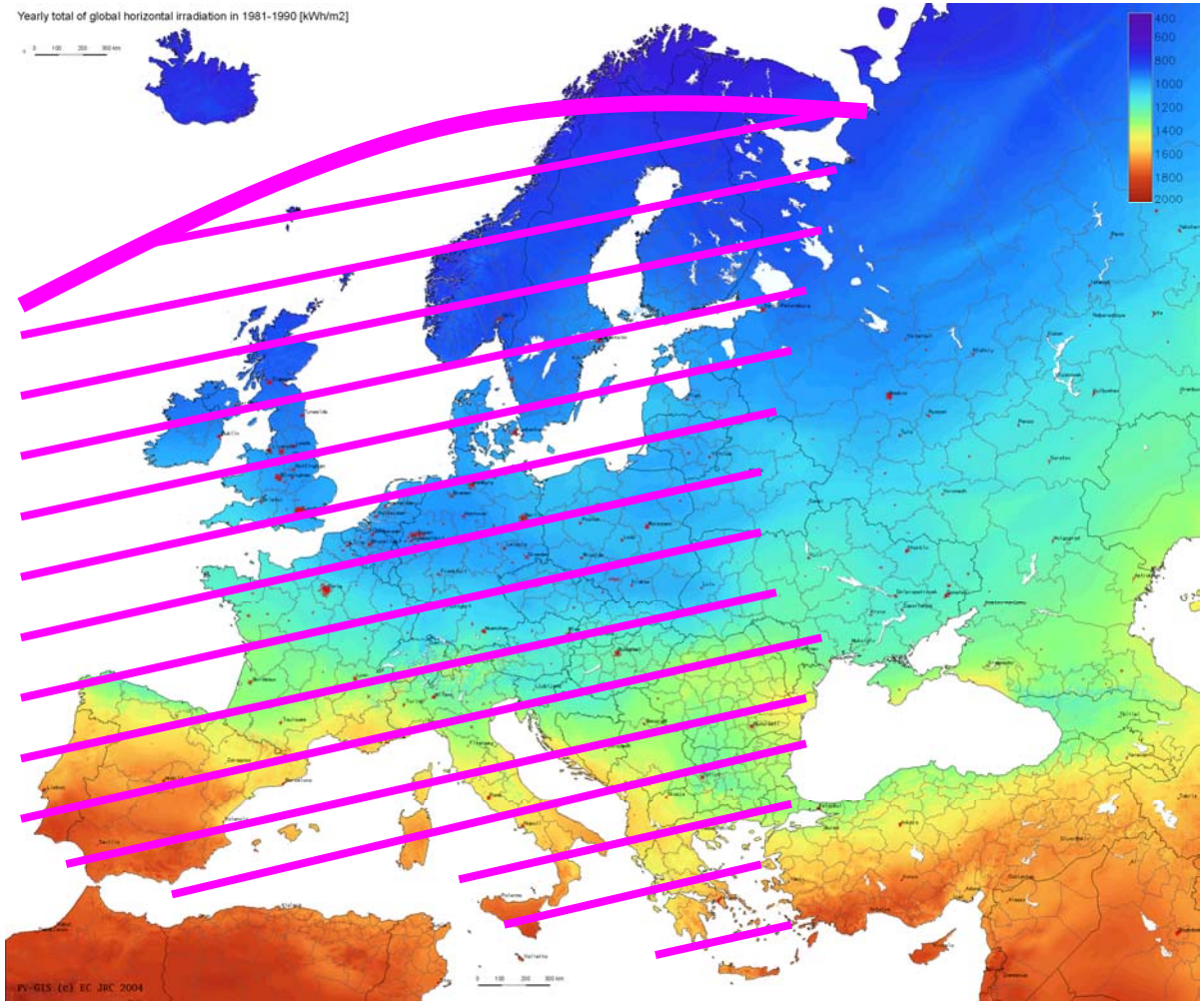
irradiation (kWh/m²·yr)	PV generation cost (€/kWh)
600	0.42
1000	0.25
1400	0.18
1800	0.14

Grid parity in Europe – 2020



irradiation (kWh/m²·yr)	PV generation cost (€/kWh)
600	0.33
1000	0.20
1400	0.14
1800	0.11

Grid parity in Europe – 2030

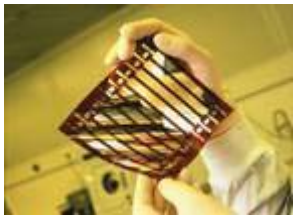


irradiation (kWh/m²·yr)	PV generation cost (€/kWh)
600	0.17
1000	0.10
1400	0.07
1800	0.06

SRA contents summarised: R&D topics addressed

- Cell & module technologies
  - wafer-based crystalline silicon
  - existing thin-film technologies
  - emerging & novel technologies



- Concentrator systems

- Balance-of-System (BoS) components
- Standards, quality assurance, safety and environmental aspects
- Socio-economic aspects of PV

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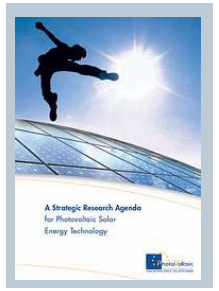

www.eupvplatform.org

- Concentrator technologies
- Balance-of-System (BoS) components and systems
- Standards, QA, safety and environmental aspects
- Socio-economic and enabling research

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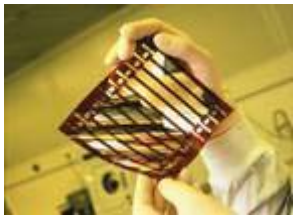

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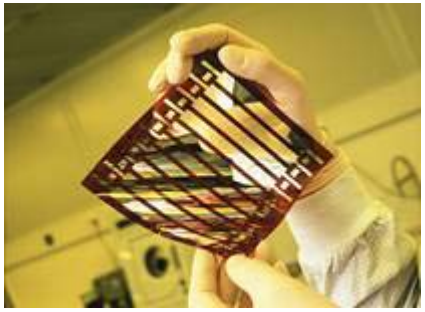
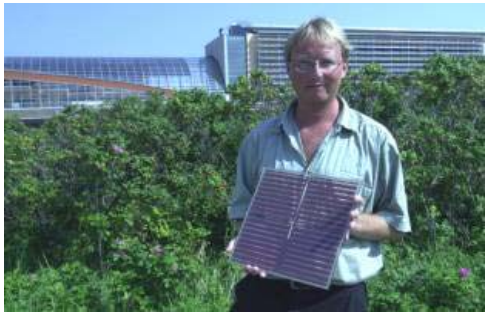
SRA contents summarised: Emerging & Novel tech.



polymer PV



dye PV

thermo PV

- Content
  - Advanced inorganic solar cell technologies
  - Organic based solar cell technologies
  - Thermophotovoltaics
- Improvement of efficiency and stability to the level needed for first commercial applications
- Product concepts and first generation manufacturing technologies

Emerging Technologies: Material aspects
(non-exhaustive)

Class	Technology	Materials synthesis	Materials analysis
Advanced inorganic solar cell technologies	Spheral CIS (on glass beads)	Efficient coating methods	Local analysis
	Polycrystalline Si solar cells	Low-cost seed layer procedures Reducing intra-grain defect densities Passivation of defects	Local intra-grain analysis (morphological and opto-electrical)
Organic solar cell technologies	Dye sensitized solar cells	Dye development for longer wavelengths QD's as sensitizer Solid state electrolytes Methods for control and reduction of interface recombination	Local morphological and opto-electrical analysis
	Full-organic bilayer and bulk donor-acceptor heterojunction structures	Low-bandgap organic materials QD's and metallic nanoparticles Improved intrinsic stability Improved stability of nanomorphology Low-cost deposition methods (printing, organic vapor phase deposition) Low-cost TCO's with controllable workfunction Low-permeability barriers (H_2O, O_2)	Local morphological and opto-electrical analysis Exciton dissociation Interface recombination Metal-organic semiconductor interfaces and their stability
Thermophotovoltaics	TPV Cells & Modules (Ge, GaSb, …)	Growth of low-E_g antimonide materials (InGaAsSb, …) Window layers Ge with adapted specs Ge on Si with buried IR-reflector	Measurement systems to make comparable measurements under well-defined high IR-fluxes
	Selective emitters	Low-cost methods ceramic and selective rear-earth emitters containing Er_2O_3, Yb_2O_3, … Photonic structures withstanding high temperatures	Standards to compare emission performance of selective emitters

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Organic solar cell technologies	**Dye sensitized solar cells**	**- Dye development for longer wavelengths** **- QD's as sensitizer** **- Solid state electrolytes** **- Methods for control and reduction of interface recombination**	**Local morphological and opto-electrical analysis**
	Full-organic bilayer and bulk donor-acceptor heterojunctio n structures	**- Low-bandgap organic materials** **- QD's and metallic nanoparticles** **- Improved intrinsic stability** **- Improved stability of nanomorphology** **- Low-cost deposition methods (printing, organic vapor phase deposition)** **- Low-cost TCO's with controllable workfunction** **- Low-permeability barriers (H_2O, O_2)**	**Local morphological and opto-electrical analysis** **Exciton dissociation** **Interface recombination** **Metal-organic semiconductor interfaces and their stability**
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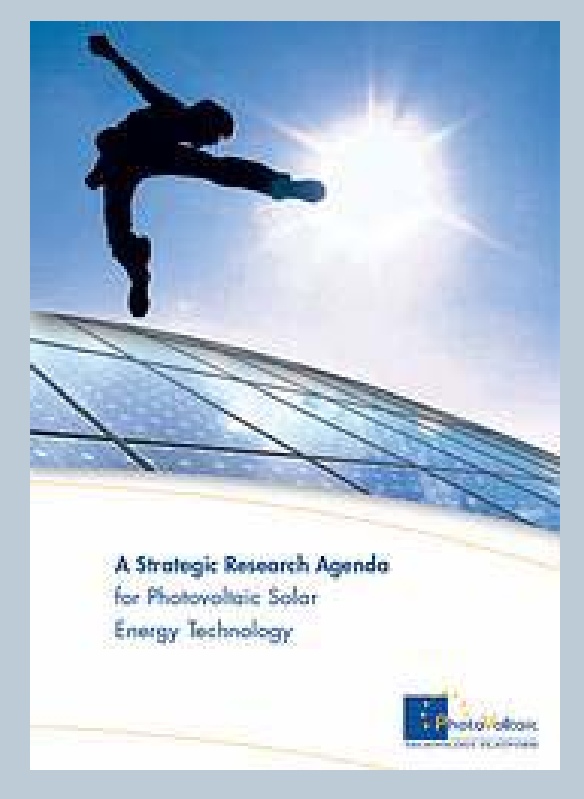
More informations



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orgaPVnet – FP6 European Project

- **Coordination Action towards stable and low-cost organic based solar cell technologies and their applications**
- Started on 01/11/2006 – End date 30/04/2009
- Duration 30 months
- 22 partners / Coordinator IMEC
- 15 European and Associated Countries
- 4 SMEs & 1 Industrial

orgaPVnet

Imperial College London

imec

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ceat

ECN

J. Heyrovský Institute of Physical Chemistry

swerea IVF

Consiglio Nazionale delle Ricerche

EPFL

University of Patras

Fraunhofer ISE Institut Solare Energiesysteme

Hahn-Meitner-Institut Berlin
in der Helmholtz-Gemeinschaft

Greatcell SOLAR S.A.

Merck

Vilnius University

SOLARONIX
"in sun we trust"

3E

Konarka

Bar-Ilan University

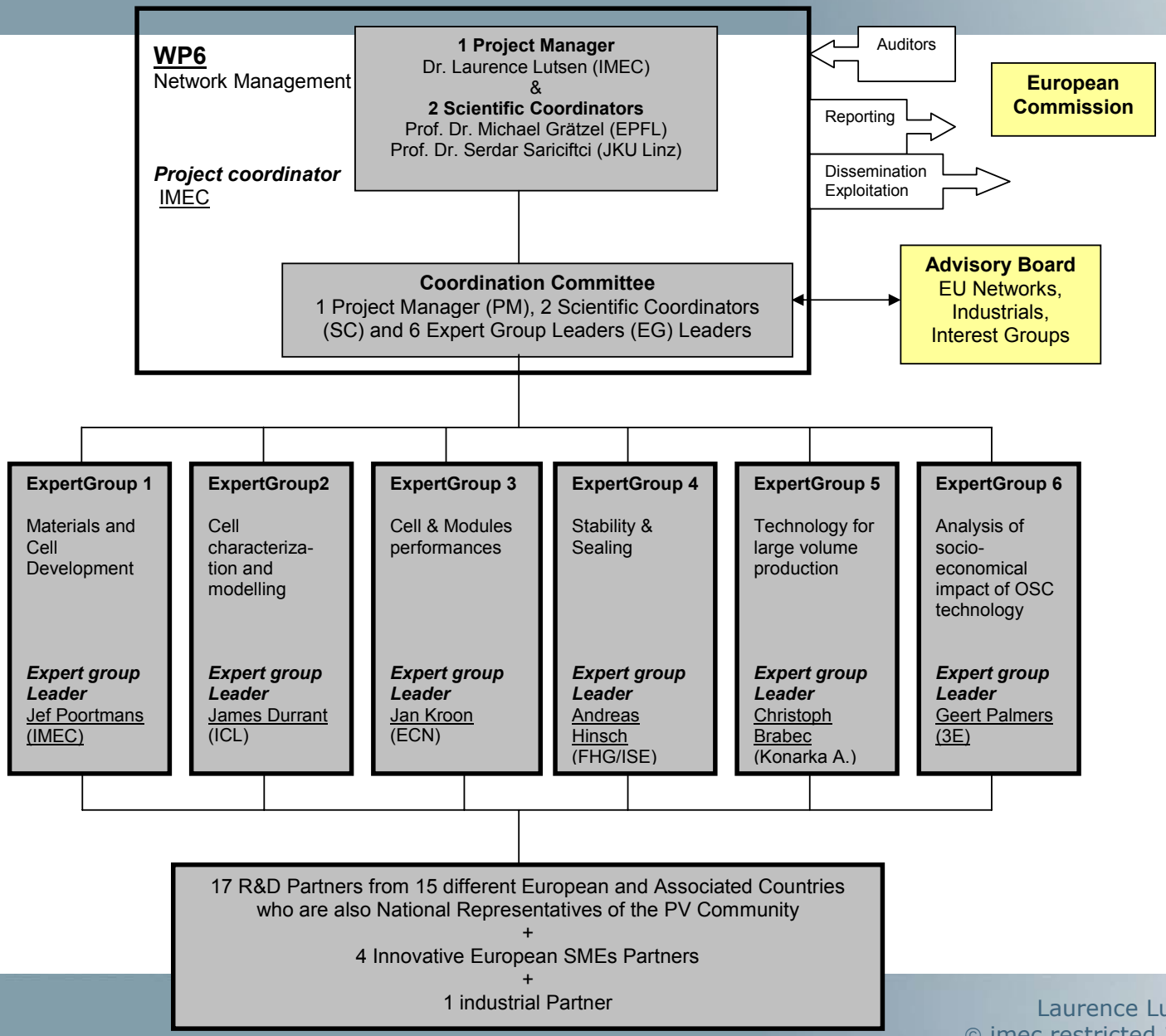
orgaPVnet

- **OrgaPVnet** is offering the opportunity for all actors in the sector to work together and discuss issues of crucial relevance, as well as to give a valuable input for the whole sector.

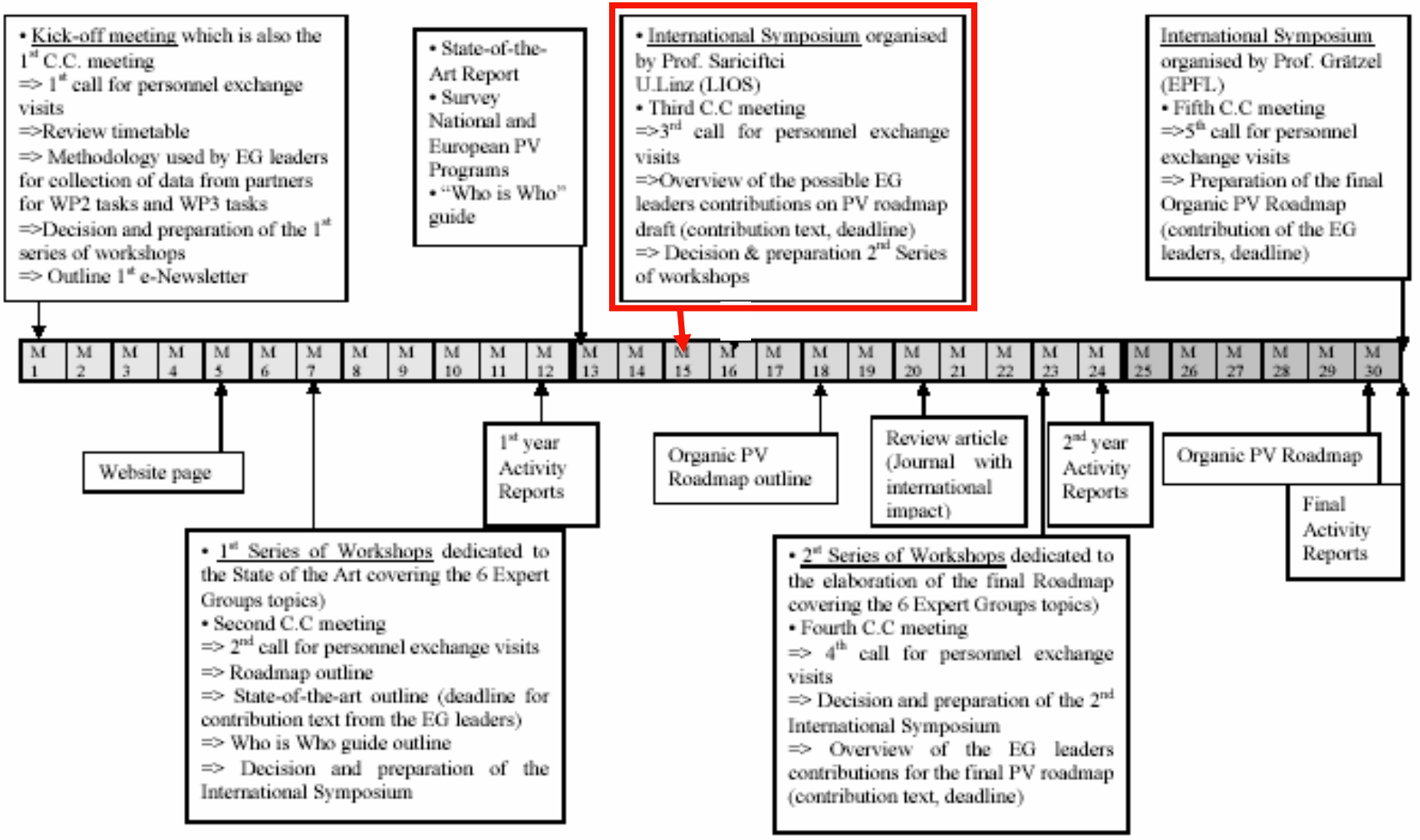
- **Main result of the project**

  An integrated vision shared by the experts from the Organic Photovolataics community in the form of a **"European Organic Photovoltaics Technology Roadmap"**

orgaPVnet: Global Project Structure



orgaPVnet: where are we?



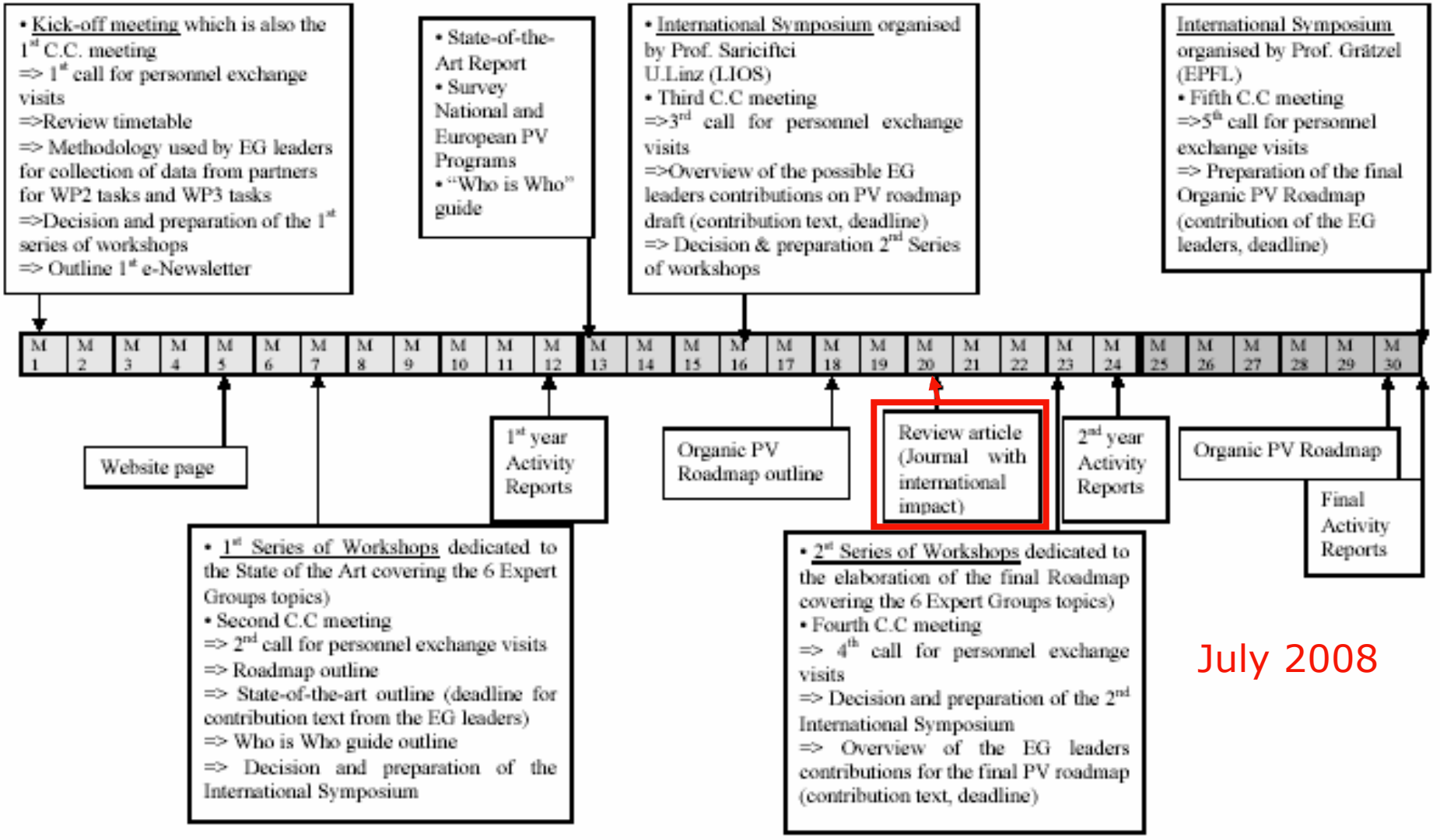
orgaPVnet: main results so far

- Webpage
- « Who is who » guide
- Survey National & European Programs
- A first workshop in Prague, May 2007
- State-of-the Art Report

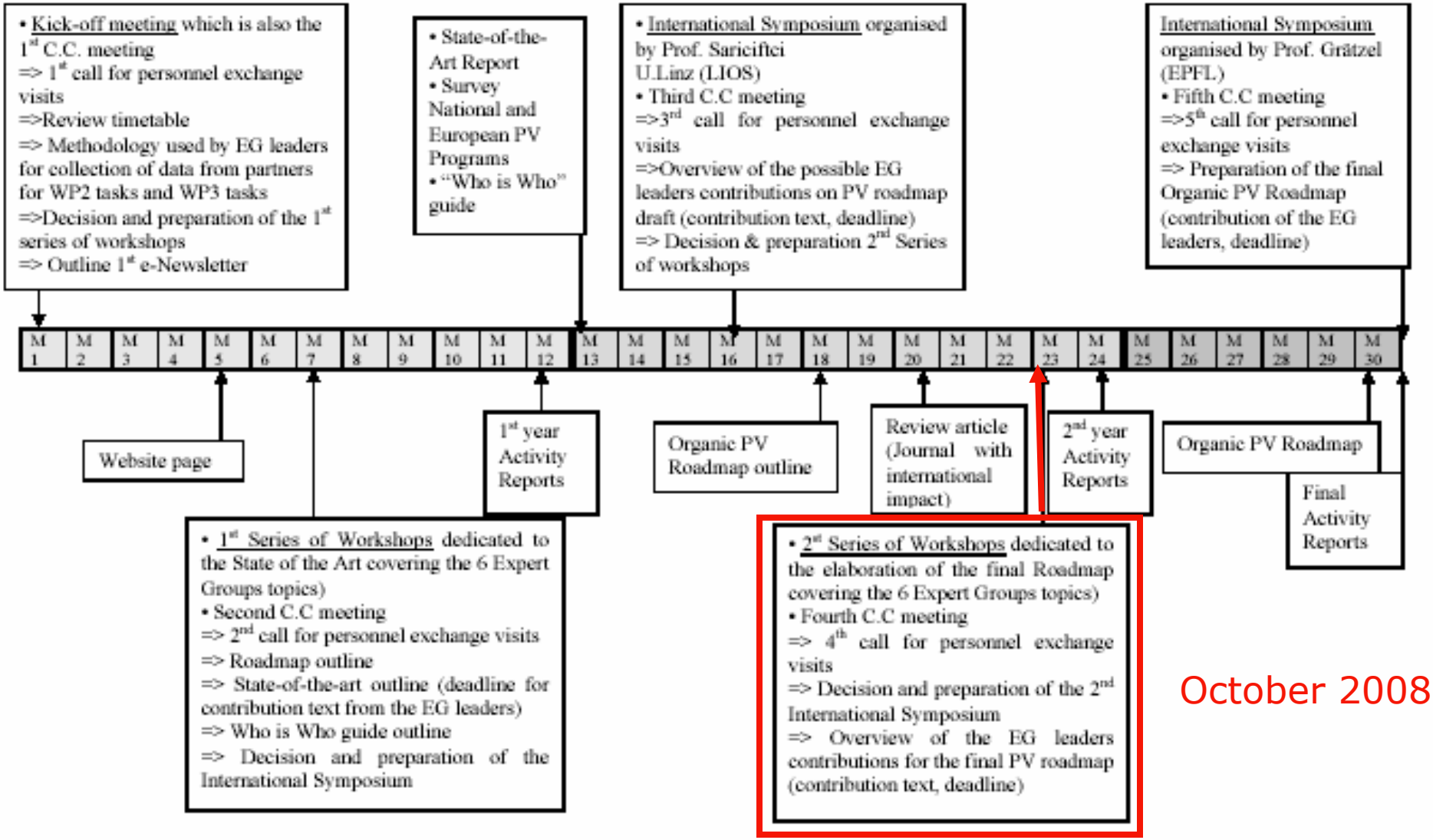
- All available soon on a project webpage:

www.orgaPVnet.eu

orgaPVnet: Still to come

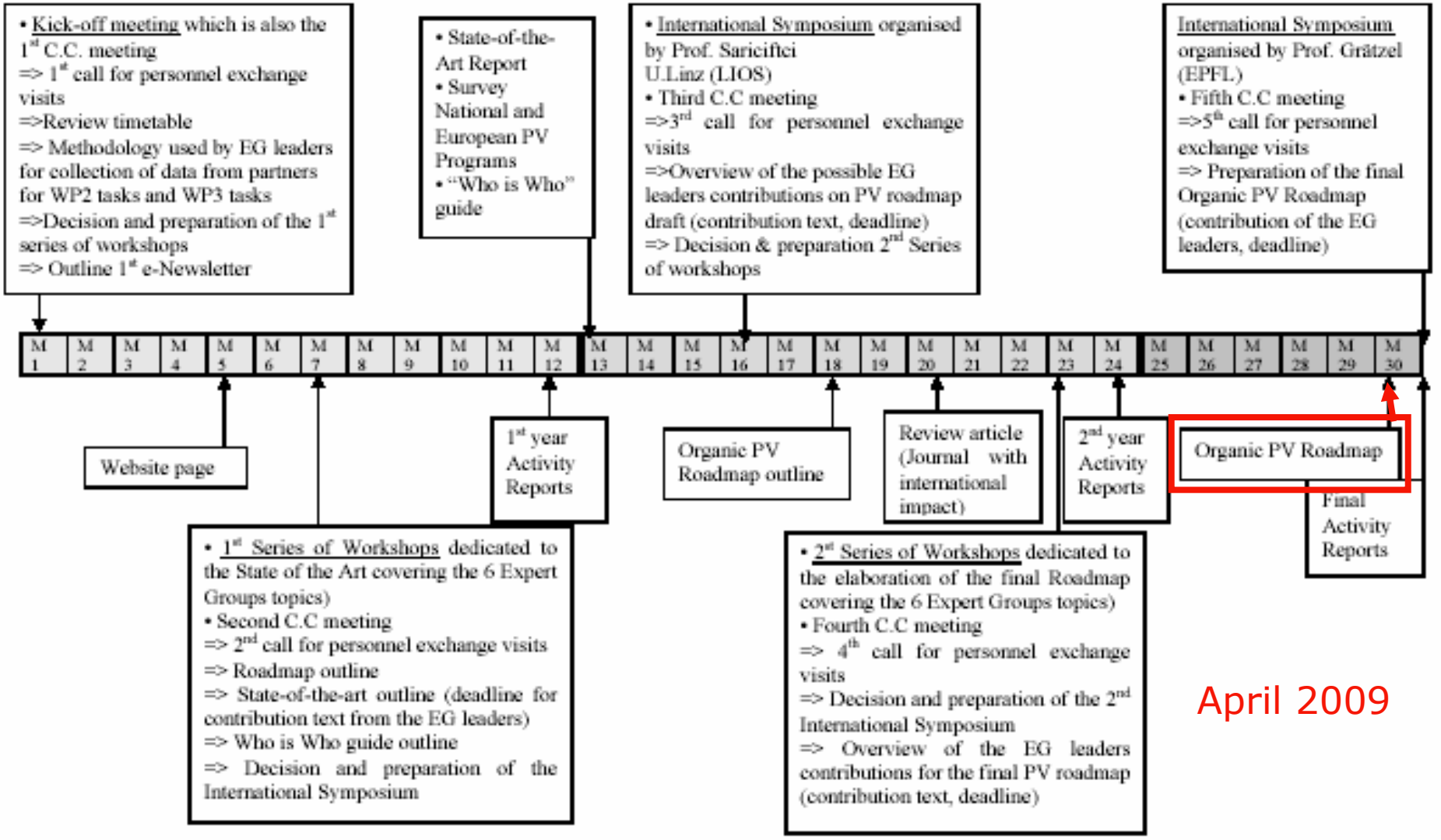


orgaPVnet: Still to come



October 2008

orgaPVnet: Still to come



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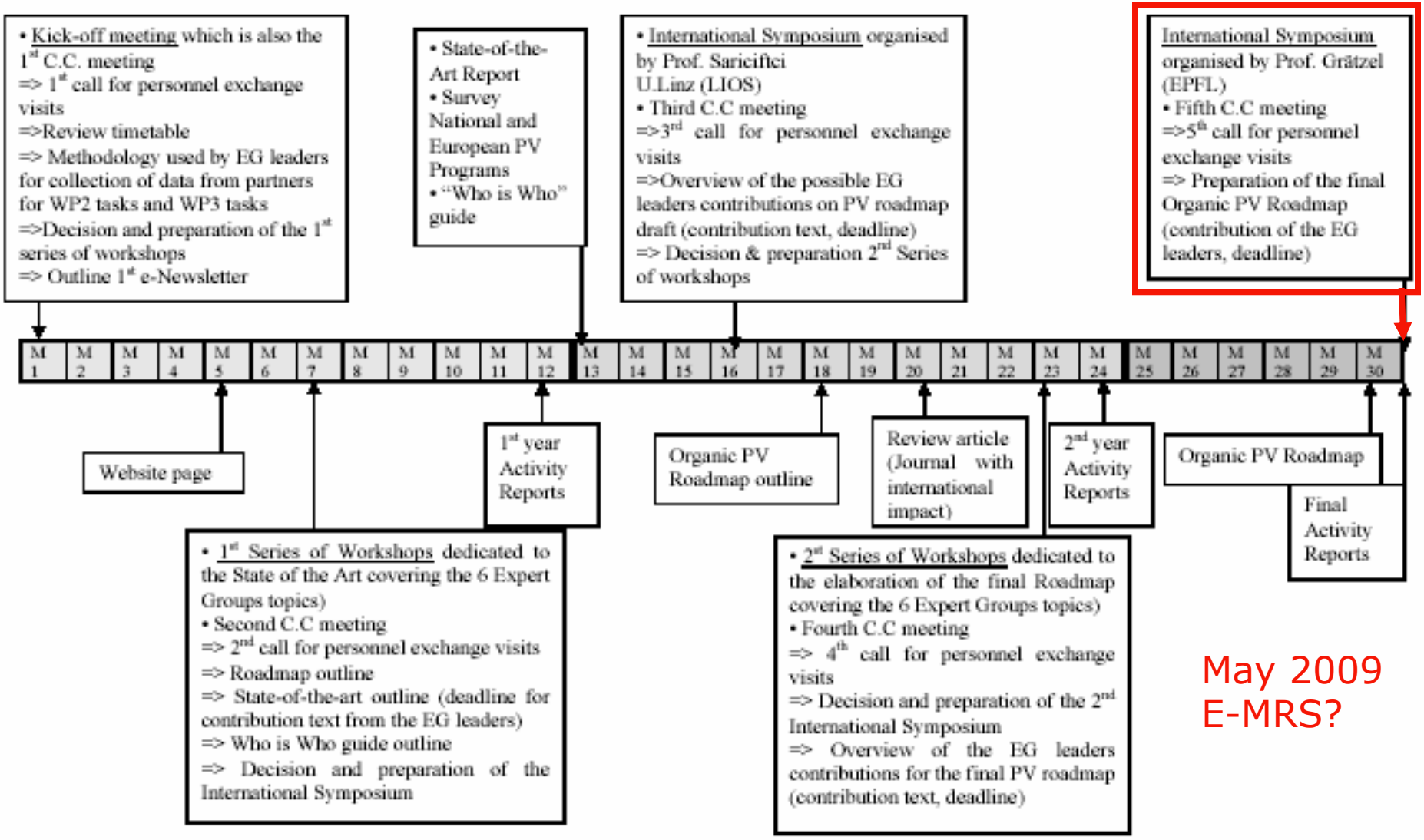
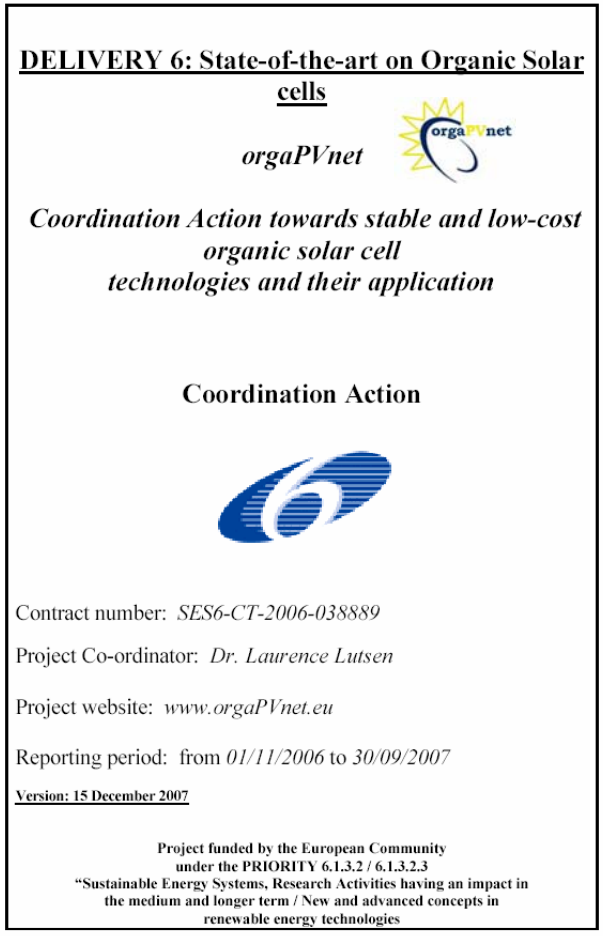


More information



DELIVERY 6: State-of-the-art on Organic Solar cells

orgaPVnet

Coordination Action towards stable and low-cost organic solar cell technologies and their application

Coordination Action

Contract number: *SES6-CT-2006-038889*

Project Co-ordinator: *Dr. Laurence Lutsen*

Project website: *www.orgaPVnet.eu*

Reporting period: from *01/11/2006* to *30/09/2007*

Version: 15 December 2007

Project funded by the European Community under the PRIORITY 6.1.3.2 / 6.1.3.2.3 "Sustainable Energy Systems, Research Activities having an impact in the medium and longer term / New and advanced concepts in renewable energy technologies

orgaPVnet

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General Outline

- IMEC a short overview

- Strategic Research Agenda of the European Photovoltaic Plateform

- OrgaPVnet a coordination Action towards Organic based Solar Cells

- Conclusions

Conclusions

- Comprehensive PV-roadmap was developed by European PV Technology Platform
- This comprehensive roadmap starts from the basic idea that for the foreseeable time there will be a mix of PV-technologies, serving the market
- For all the PV-technologies there are material challenges
- Some aspects are common between organic solar cells and other PV-technologies
- A specific roadmap for organic based solar cells will be developed & available in April 2009 by orgaPVnet and will be presented in an international conference

I would like to acknowledge
all the members of WG3 of the EU-PVTP,
the orgaPVnet consortium
&
the members of the IMEC PV-teams
MCP-Leuven and IMOMEC-Hasselt

!Thank you for your attention!

aspire invent achieve

« Genius is 1% inspiration & 99% perspiration ! »

Thomas Alva EDISON
1847-1931