PhotoVoltaic TECHNOLOGY PLATFORM

# The Solar Europe Industry Initiative Implementation Plan 2013-15 *Overview of R&D priorities*

Nicola Pearsall
WG3, European PV Technology Platform

# Background

- The Solar Europe Industry Initiative (SEII) was launched in 2010 to address the development of the European solar industry as part of the realisation of the 2020 renewable energy targets
- The approach of the EIIs is to have a rolling implementation plan, updated every three years, so as to be able to reflect developments in the sector and realign R&D priorities as necessary
- The SEII is currently finalising its second 3-year Implementation Plan (PV IP2) covering the period 2013-2015

# Background (2)

- SEII PV IP2 has been prepared by EPIA and the PVTP, with the input of experts from the Industry Advisory Committee and Working Group 3
- Consultations were held over the second half of 2012, including a stakeholder workshop at the European PV Solar Energy Conference in Frankfurt
- The final draft was completed in April following consultation with the SEII Secretariat at the European Commission
- It has been provisionally approved by the SEII Team, pending some minor amendments
- SEII PV IP2 will now be presented to the SET Plan Steering Committee in July for formal adoption

# Structure of the SEII PV IP 2013-15

**Chapters:**

- Overview of the environment in which the next IP will operate
- Introduction to the new list of R&D priorities, followed by the detailed lists of projects
- Governance of the SEII
- Main goals and KPIs 2013-2015
- Links with other EIIs

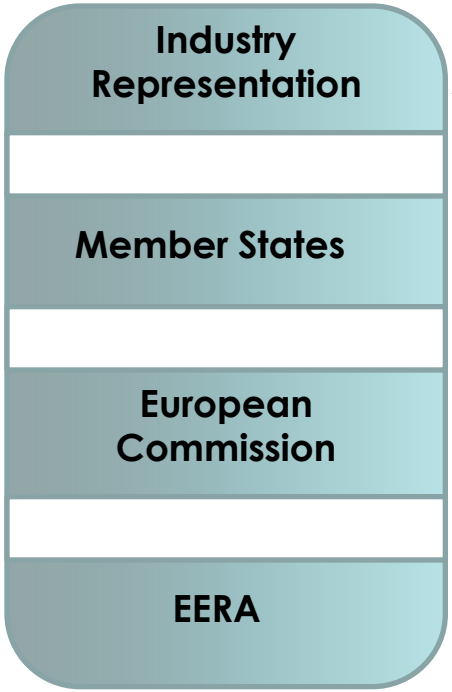
**For clarification**

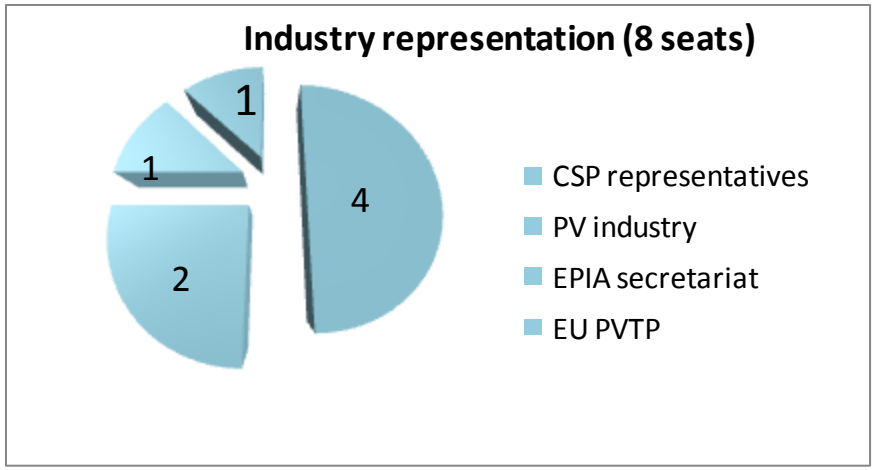
- *The SEII has two technology themes, photovoltaics and concentrated solar power (sometimes called solar thermal electricity) and each has a separate implementation plan*

# The Governance Structure

The governance section of the IP describes the structure adopted by the SEII Team in May 2011

SEII Team




Current PV Industry Representatives

| Full member | | Alternate member | |
|---|---|---|---|
| **Industry** | Fabrice Stassin, Umicore | **Industry** | Fabrizio Bonemazzi, Enel Green Power |
| **Industry** | Gerhard Strobl , Azur Space | **Industry** | Achim Woyte, 3E |
| **EU PV TP** | Wim Sinke | **EU PV TP** | Andreas Bett |
| **EPIA** | Paolo Basso | **EPIA** | Ioannis-Thomas Theologitis |

# Preparing the SEII PV IP2 – some considerations

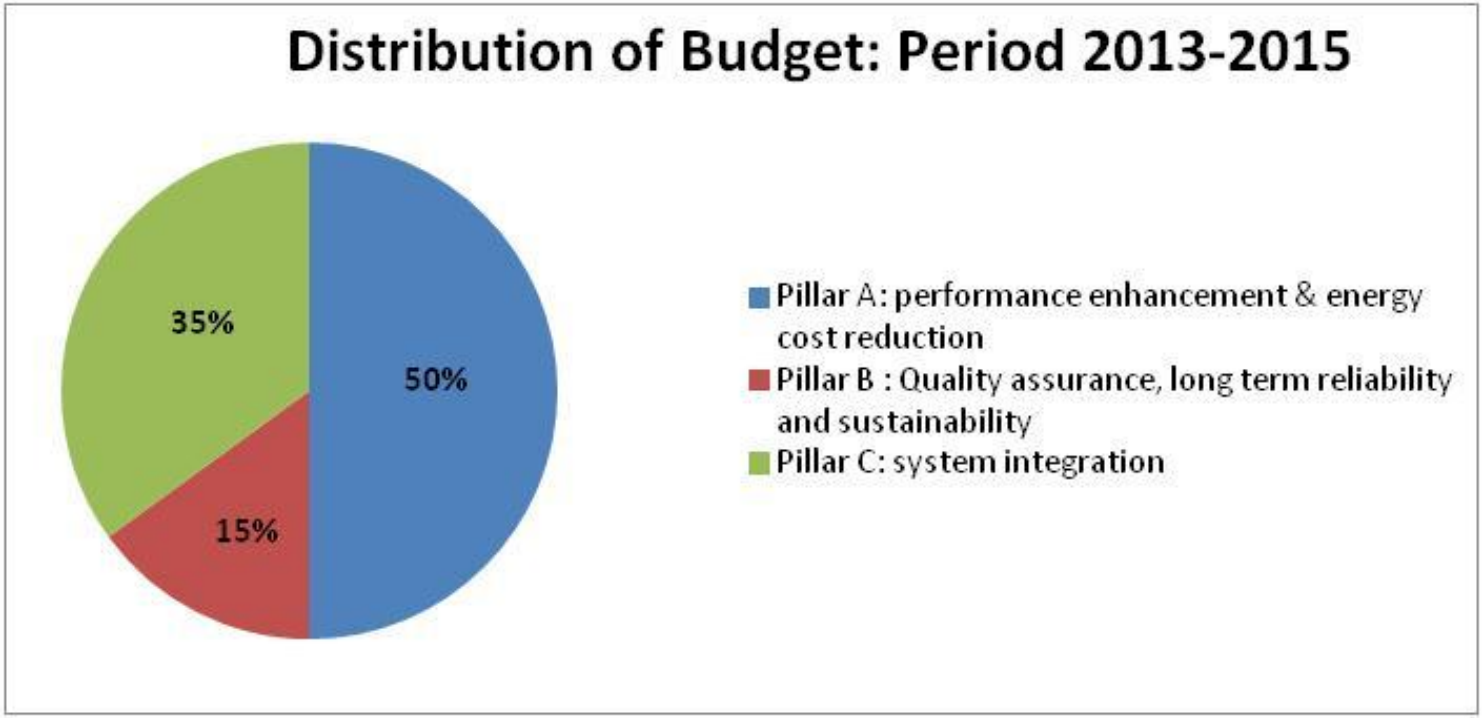
- The R&D topics included should be able to impact on the market within the short-medium term – all the EIIs are focused on the achievement of the 2020 renewable energy targets
- The range of topics needed to address the interests of all the Member States and reach a reasonable consensus on priorities – this resulted in a wide range of companies and applications to consider and a wide range of topics to be included
- The current status of the European and worldwide PV industry had to be considered, alongside the changes in the PV market since the preparation of the first implementation plan
- IP2 had to be consistent with the ambitions and overall approach of IP1

# The updated list of R&D priorities

The priorities in IP2 are grouped into **3 main pillars** and **8 chapters**

| Pillar A: performance enhancement & energy cost reduction | Pillar B: quality assurance, long term reliability and sustainability | Pillar C: electricity system integration |
|---|---|---|
| c-Si, TF, CPV, BIPV, BOS | Quality assurance | Enabling large scale deployment |
| Cross-cutting & system perspective | Long term reliability | Solar resources and monitoring |
| | Sustainability | |
| **pillar with updated context & content** | **new as separate pillar** | **pillar with updated context & content and enhanced priority** |

# Proposed distribution by Pillar




The budget split between module development and system integration is similar to the previous IP, but the sustainability and quality portion has been increased substantially and the content of the system portion focused towards high penetration.

# Format of Chapters

- For each chapter of R&D topics, the following information is provided:
  - Context
  - Goals
  - Topics, including priority level, EU added value, level of risk, estimated budget and estimated public contribution percentage
  - Chapter specific KPIs

- For clarity, the next slides contain only the goals and topics (except for the thin film chapter)

# Pillar A: Wafer Silicon Technologies

- Goals

- Sustainably reduced manufacturing costs per watt
- Optimisation of production yield
- Increased cell and module efficiencies
- Increased competitiveness of the EU industry (equipment and products) at a global level

# Pillar A: Wafer Silicon Technologies

- **Topics**
- Silicon crystal growth techniques for high quality and re-use of crucibles. Quasi-mono products are included here.
- Advanced, automated, low/zero-loss wafering techniques for efficient material utilization by reducing silicon usage to 4 g/W by 2015. Wafer-equivalent technologies are included here.
- High-throughput automated processes for manufacturing, advanced, low cost, high-efficiency cells and modules, including process equipment (up to 0.4% multicrystalline and 0.5% monocrystalline, yearly increases on module level). Heterojunction a-Si/c-Si and hybrid IBC cells are included here.
- New low-energy silicon feedstock technologies for reduction of manufacturing costs
- From LAB to FAB: pilot-line demonstration of at least 2 high-efficiency, low-cost approaches from the above priorities.

# Pillar A: Thin-film & emerging/novel technologies

- **Context**
- Thin film technologies offer new application possibilities relating to flexibility, low weight, good aesthetics, partial transparency, short Energy Pay Back Time (EPBT), good high temperature and/or low light performance, low material consumption and integrated manufacturing.
- Higher module efficiencies are required, meaning development of not only the active layers but also relating to module structure (encapsulation, glass plus antireflective layers etc.).
- Ageing behaviour and consequent estimate of lifetime is a critical factor.
- Low cost manufacturing techniques and better material utilisation are also needed.
- Pilot production lines for emerging technologies such as organic (e.g. polymer) should be further supported.
- More emphasis should be given to novel technologies that could possibly overcoming the Shockley-Queisser (e.g. quantum and nanoparticle technologies, where it can be shown that highly competitive products can be developed.

# Pillar A: Thin-film & emerging/novel technologies

- **Goals**
- Advanced application possibilities
- Sustainably reduced manufacturing costs per watt
- Optimisation of production output (power/energy)
- Increased cell and module efficiencies
- Increased competitiveness of the EU industry at global level

# Pillar A: Thin-film & emerging/novel technologies

- **Topics**

- Low cost, large area deposition process equipment, global deployment of laser technology and control methods (e.g. roll to roll, high rate, new precursors, low cost equipment).
- High efficiency thin film cell designs and module manufacturing processes (novel light management concepts and new structures) in order to achieve results of 12-16% on module level considering all TF technologies (a-Si, CdTe and CIGS)
- High efficiency emerging and novel technologies cell designs and module manufacturing processes (novel light management concepts and new structures)
- From LAB to FAB: pilot-line demonstration of at least two 2 novel low-cost, high-efficiency approaches
- From LAB to FAB of at least 2 emerging and/or novel low cost printable PV technology approaches

# Pillar A: Concentrator PV (CPV) technologies

- Goals

- Increase cell and module efficiencies
- Sustainably reduced manufacturing costs per watt
- Optimisation of production yield
- Large scale introduction of manufacturing with advanced and flexible production lines
- Development of a systemic approach to improve the whole CPV system efficiency, yield and cost

# Pillar A: Concentrator PV (CPV) technologies

- Topics

- High-throughput, high-precision low-cost assembly technology for CPV modules
- Increase the cell efficiency towards 50% by using new cell architectures and industrial equipment to produce these cell structure
- Proof of concept demonstration projects for optimization techniques of complete CPV systems (module, BOS)

- Industrial low-cost, automated and optimised manufacturing processes for high-efficiency concentrator cells for LCPV and/or HCPV, including process equipment and control methods.
- Industrial low-cost automated manufacturing processes for improved concentrator optics, for achieving optimum concentration factor for specific technology. Process equipment is included.

# Pillar A: Building-integrated photovoltaics (BIPV)

- Goals

- Development of low- cost multifunctional BIPV products that can be used as certified construction materials
- Flexible production lines for manufacturing a wide variety of products, in different scales and on different substrates
- Flexibility of design and improved aesthetics

# Pillar A: Building-integrated photovoltaics (BIPV)

- **Topics**
- Development of new multifunctional PV-based products including new installation concepts.
- Industrial automated low-cost manufacturing process and control methods, including development of new flexible equipment for different production lots with different geometries (e.g. small or large production lots, flexible compounds, different substrates)
- Proof of concept large scale demonstration for BIPV, providing the necessary/traditional building functions, complementary to the European Energy Performance of Building Directive (EPBD) including energy generation and aesthetics and according to relevant building codes.
- Optimisation of cell performance, long term higher energy output and improved optical appearance at reduced costs (Euro/m²) together with inherent security mechanisms

# Pillar A: Balance of system

- Goals

- Increased energy yields/reduced system losses
- Fault prediction and long term reliability of systems
- Lower BoS costs meaning lower system costs

# Pillar A: Balance of system

- Topics

- Low-cost durable mounting structures, cabling and electrical components (e.g. PV connectors, DC switchgears, further safety components etc.) for small or large PV systems. Holistic design of module and mounting structure to minimize cost. Components for reducing system losses e.g. modules and inverters for operation at a system level >1000 V and modules for operation under partial shading are included here.
- Improved lifetime and low-cost power electronics (i.e. inverter lifetime >20 years of operation). PV optimizers, (micro)-inverters, monitoring systems, security devices etc are included here. Inverters for PV hybrid systems may also be included here.
- Low-cost, high-accuracy tracking systems/platforms (single and double axis) for different applications.

# Pillar A: Cross-cutting & system perspective

- Goals
- Increased overall system performance/reduced losses
- Reduced system costs
- Enhanced PV system bankability

# Pillar A: Cross-cutting & system perspective

- Topics

- PV research infrastructures, testing facilities (outdoor and/or indoor) and procedures in order to accelerate innovations and evaluate costs.
- Demonstration project for realization of large scale new PV technology power plants and/or new concepts for PV system technologies (e.g. 1500 VDC) in order to enhance confidence from the financial sector.
- Standardize manufacturing equipment and processes eligible for all PV technologies and standardization of key module components/materials (e.g. glass, encapsulants etc.)
- Develop tools and techniques dedicated for PV modeling, characterization and control purposes for the whole value chain and along all the process steps.

# Pillar B: Quality assurance, long term reliability and sustainability

- Goals

- Increase competitiveness (economical and technical)
- Minimize the environmental impact and use of materials
- Develop recycling processes
- Develop harmonised EU quality standards and/or guidelines

# Pillar B: Quality assurance, long term reliability and sustainability

- Topics

- Develop and apply system design techniques for achieving high outdoor long-term system performance >25 years at 90% of the initial Performance Ratio (PR) at low cost and potential reduction of material use. Includes joint efforts to gain understanding of ageing mechanisms and the development of dedicated accelerated test procedures. Issues like thermal management, natural cooling, optimum orientation etc. are also included here.
- New low-cost, long-lifetime material alternatives (e.g. encapsulation materials, glass, antireflective layers etc) and module designs that will lead to longer-term reliable PV systems and reduce degradation effects (e.g. potential-induced degradation (PID)). Includes studies of ageing mechanisms, development of dedicated accelerated test procedures and PV product designs that will facilitate the dismantling and recovery of materials and components.
- Development of design criteria facilitating low-cost efficient recycling processes according to relevant EU standards and directives for new designs for all PV technologies and BoS components. Development of easy-to-access recycling infrastructure available to all is included here.

# Pillar B: Quality assurance, long term reliability and sustainability

- Topics

- Improvement and/or apply in-line EU-harmonized low-energy processes and production control techniques and procedures and in general introduce the concept of Total Quality Management (e.g. statistical process control, failure testing). Necessary software development is included here, together with analytical tools for rapid onsite quality control of modules.
- Improvement of guidelines for optimum transportation, installation, configuration, fulfillment of safety requirements and monitoring/evaluation for enhancing the energy yield and overall performance at the system level.
- Improved life-cycle assessment (e.g. carbon footprint and EPBT etc) of all PV technologies and BOS under detailed guidelines and feedback of the results to the industry.

# Pillar C: Enabling large scale deployment

- Goals

- Enable high penetrations of PV whilst minimizing the cost impact
- Identify, analyse and valorise fully the potential of PV technology
- Integrate storage solutions in PV systems
- Create a continuum among all the stakeholders (e.g. Transmission System Operators /Distribution System Operators/ PV developers/utilities etc)
- Increase the overall flexibility of the power system
- Overcome bottlenecks in the distribution grid

- Ensure a fair financing of all parties involved

# Pillar C: Enabling large scale deployment

- Topics

- Implementation of technical solutions for improved PV integration. Demonstration of power and energy management strategies, ancillary services and other functionalities required by an inverter based system according to national or European grid technical specifications. The development of such specifications is included here.
- Proof-of-concept for technical feasibility of very high levels of PV penetration either in urban or isolated environment, align with priority *C.1.1.* The concept of "Solar Cities" and "Solar Islands" is included. Field tests, monitoring and evaluation of the compliance of the hardware are also included.
- Increase the overall system flexibility by improved PV forecasting techniques and electricity prediction models applied in large balancing areas and in combination with storage solutions (centralized or decentralized) and/or energy efficiency solutions and/or demand side management solutions. Complementarities with other renewable sources, flexible generation assets and aggregated demand response are included. PV should be the central asset.

# Pillar C: Enabling large scale deployment

- Topics (continued)

- Proof of concept for smart grid projects in combination with smart PV system (meters and relevant hardware/software) that will assess the operation of a wider range of assets/solutions (e.g. storage, heat pump, electric vehicles, demand side management etc) under a common communication standardized protocol and following different management techniques that can increase hosting capacity. Impact on the distribution network and costs should be evaluated. PV should be the central asset. Virtual Power Plant (VPP) concept is included here.

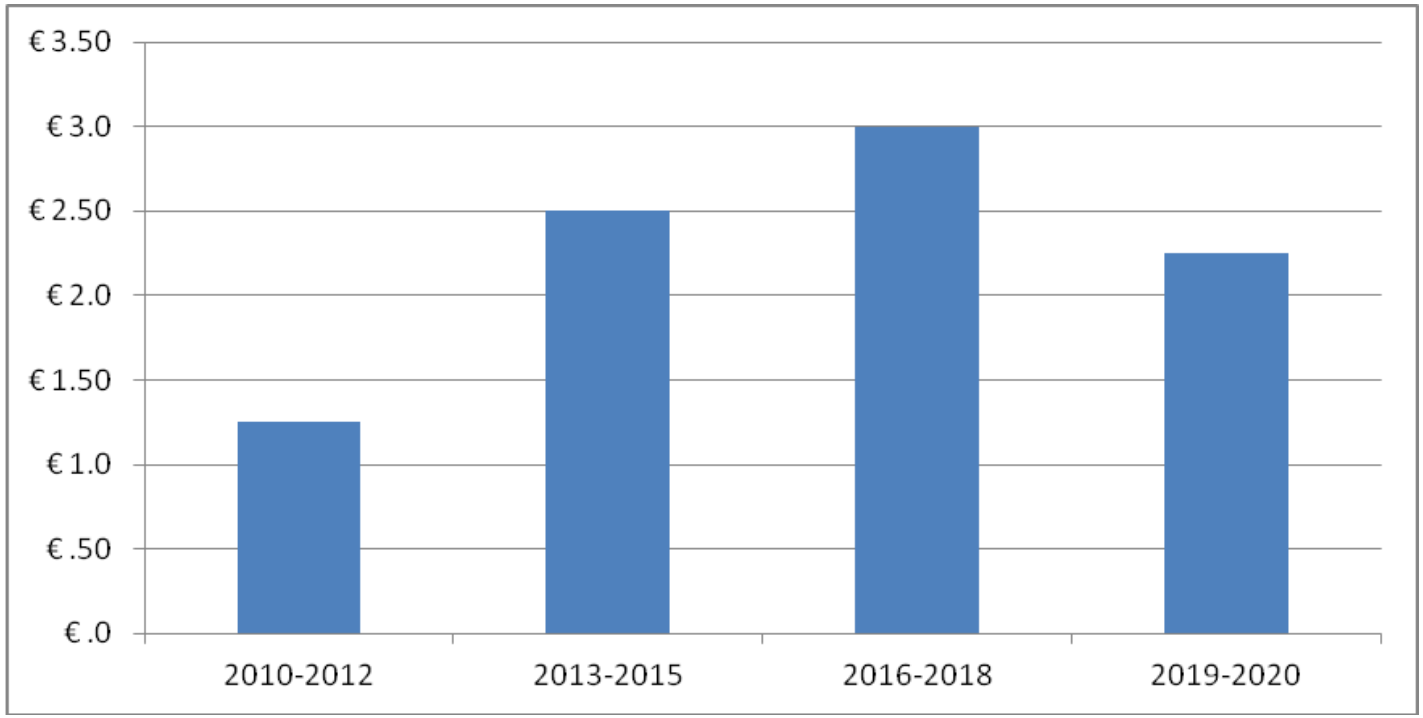
- Identify quantitatively the grid costs generated by high shares of PV into the system and elaborate solutions based on a cost-benefit analysis to minimize the costs. Evaluation of different market models is included.
- Proof of concept for the potential of aggregation. This can refer to aggregating and controlling small PV systems (e.g. roof top) or aggregating several “smart systems” or VPPs. The focus should mainly be on trans-European aggregation and the portfolios aggregated should contain a large share of power from photovoltaics.

# Pillar C: Solar resources and monitoring

- Goals
  - Gather and disseminate information facilitating the integration of PV in the EU energy mix

- Topics
  - European "PV Monitoring Centre", aimed at gathering and disseminating a variety of monitoring data (including information on failure modes) and information for benchmarking, including technology, industry, market and policy aspects (mainly carried out by SETIS).
  - Development of simulation and monitoring tools (early fault detection, weather forecasting, modeling and simulation of ancillary services, etc.). These tools should rely on open communication protocols and ensure compatibility of PV generation with distribution management systems, state estimators for distribution and transmission, protocols related to power market operations and balancing and data collection from regulatory or public agencies and asset management systems.

# Proposed budget split across SEII period




Distribution of budgets by categories until 2020. The budget includes a range of financial tools available at European level (e.g. Horizon 2020, structural funds) , national research budgets and industry investments in R&D (figures in bln €)

# Summary

- This presentation has summarised the content of the second Implementation Plan of the Solar Europe Industry Initiative
- It sets out an ambitious R&D plan, with a focus on short – medium term implementation of the results
- The plan emphasises sustainability, energy cost reduction and facilitating high penetration into the electricity network, including increasing the value of PV.
- The IP will be submitted for final approval in July.

THANK YOU FOR YOUR ATTENTION