SOLAR EUROPE INDUSTRY INITIATIVE (SEII)

DRAFT SUMMARY IMPLEMENTATION PLAN 2010-2012

JANUARY 2010

Table of contents

1. Introduction

The present proposal synthesises an intensive collective effort of the European PV community involving leading representatives from the Industry, from the Research community and from the European and national PV associations represented through the European Photovoltaic Industry Association (EPIA) and the EU PV Technology Platform.

This document describes the PV sector strategy and the immediate actions to be taken in the period 2010-2012 to realise the PV solar energy goals for 2020 and beyond as described in the European Commission PV Roadmap and related documents (such as the European PV Technology Platform's Strategic Research Agenda and its Implementation Plan), as a contribution to the overall targets of the EU.

As input for the SET-Plan and EU 2020 targets, the European industry organised in EPIA developed a **Vision** to establish PV as a mainstream clean, sustainable and competitive energy technology providing up to 12% of the European electricity demand by 2020, up to 20% in 2030 and 30% in 2050 (see Figure 1).

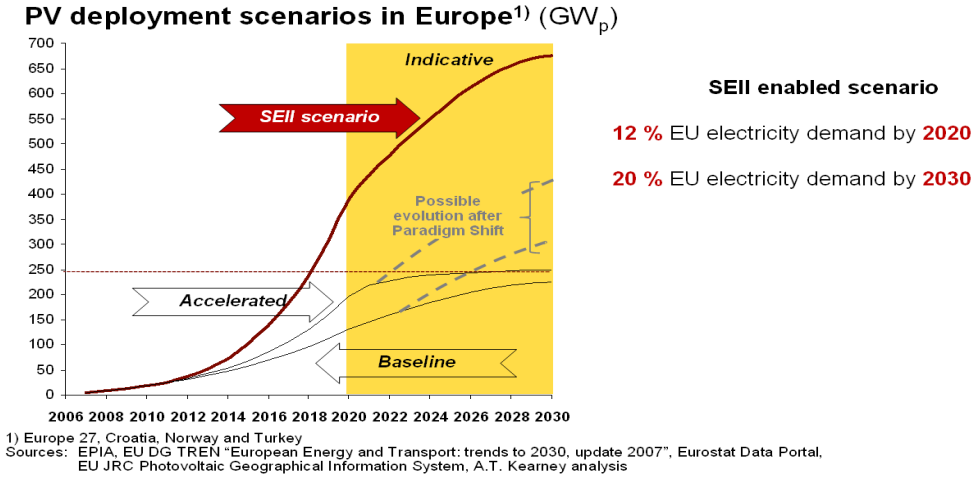

Figure 1. PV deployment scenarios in Europe

In that framework, in 2008 EPIA launched a comprehensive European project **"SET For 2020",** to establish the **industry roadmap to realise this 2020 Vision**.

The "SET For 2020" study was published in March 2009, demonstrating the benefits and implications that the 12% PV target represents for European society, including the PV industry (in terms of growth and consolidating worldwide leadership), the European utilities and regulators (integrating and managing a high-level of distributed PV generation, as well as other sources like wind power and CSP) and other related stakeholders (such as the construction sector, architects, glass manufacturers, automobile industry, equipment suppliers) and, of key importance, for the final consumers who will play a crucial active role in the electricity system of the future.

Realising the Vision will require that the right policy framework conditions are set by the Member States, and that continuous public support is provided to the industry in order to carry out the research and development, demonstration and deployment (RDD&D) measures needed (as shown in figure 2). The **Solar Europe Industry Initiative (SEII)** describes the strategic **RDD&D components of "SET For 2020".** Besides the efforts of the PV sector, the success of other Industry Initiatives under the SET-Plan (e.g. Electricity Grid Initiative) is essential for the success of the SEII.

Figure 2. Scope of the Solar Europe Industry Initiative

The SEII clearly identifies the recommended actions and investment areas, their budgetary implications and the resulting expected measurable benefits for the European society.

SEII will achieve 3 strategic objectives:

1. SEII will bring PV gradually to cost competitiveness in all market segments (residential, commercial, and industrial) by 2020 (cost reduction);
2. SEII will establish the conditions allowing high penetration of distributed PV electricity within the European electricity system (integration);
3. SEII will facilitate the implementation of large scale demonstration and deployment projects with a high added value for the European PV sector and society as a whole.

In addition to this, the SEII creates the necessary basis for development beyond 2020 and the 2020 targets, supporting the European industry to also play a leading role on the longer term.

Implementing the SEII will substantially support the European Energy Policy objectives:

- increase security of energy supply;
- substantially cut CO_2 emissions;
- increase European energy competitiveness;
- develop a robust European industry at the forefront of technical innovation, creating sustainable jobs in Europe along the value chain.

The European PV Industry is fully committed to the Solar Europe Industry Initiative, which constitutes a unique and strategic opportunity to accelerate the path to competitiveness, demonstrate the full value of centralized and distributed PV generation and fully realize the PV Industry Vision. The PV Technology Platform, as an independent representation of all PV stakeholder groups in Europe, fully and actively supports the Industry in its efforts to achieve the strategic objectives, and worked closely together with the Industry on the SEII and its draft Implementation Plan.

2. PV technology roadmap

2.1 State of the art and 2020 objectives

For over 30 years the PV industry has demonstrated its capability to achieve fast price reduction, as evidenced by Figure 3, which shows that the price of PV modules has been reduced by 22% for each doubling of the cumulative installed capacity. This fast decrease of manufacturing costs and selling prices is the result of extensive R&D as well as continued support for PV market development to ensure the required experience and scale effects.

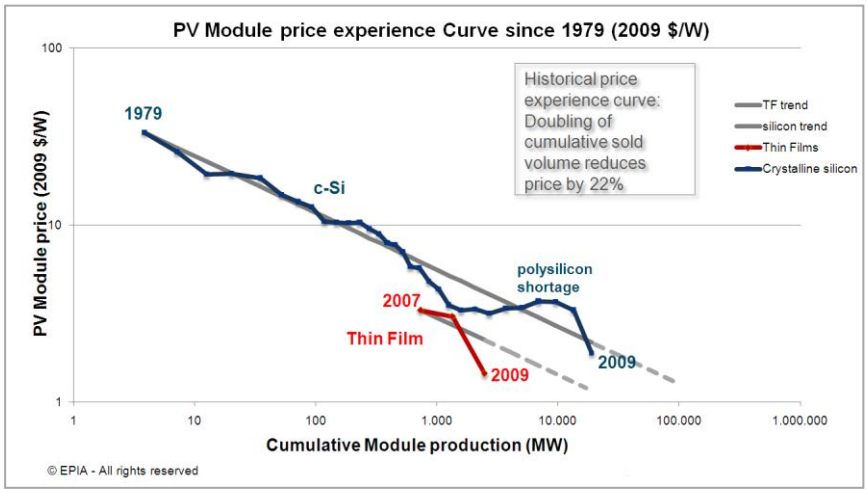

Figure 3. PV Module price experience curve.

Although costs and prices of modules and complete systems are important indicators of the evolution of the technology, the most relevant parameter and actually the one which serves to compare PV electricity with other sources of energy is the cost per kWh generated. PV systems have a very long service life (>25 years) and therefore

the Levelized Cost of Electricity (LCOE) is key to understanding the real generation cost. Depending on the location, the annual output (proportional to the annual irradiation) will vary from 700-800 kWh/kWp in the Scandinavian countries to more than 1500 kWh/kWp in the South of Spain and Italy, Greece and Turkey.

Based on these outputs, and a typical system performance ratio of 80%, Figure 4 shows that current PV electricity generation cost ranges from ~0.22 €/kWh in the North of Europe to ~0.12 €/kWh in the South. These values will decrease significantly during the coming years with expected generation costs in the range of 0.14 - 0.07 €/kWh in almost all of Europe by 2020.

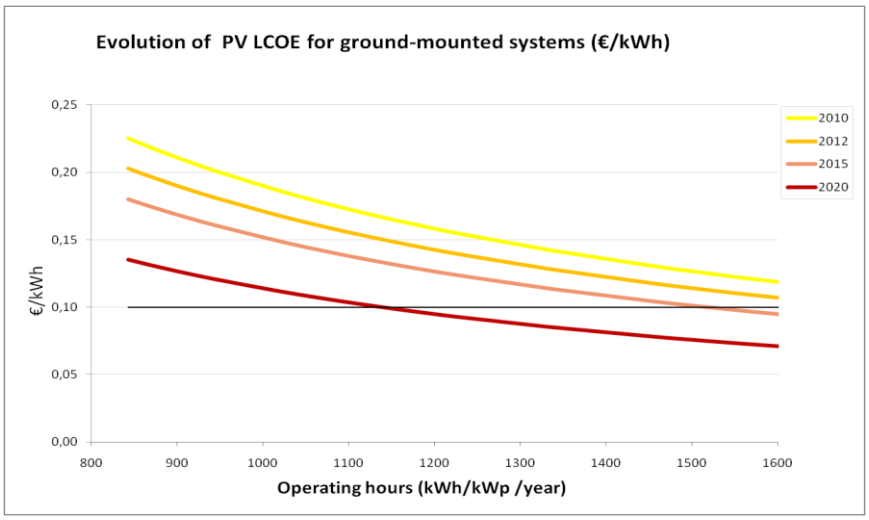

Figure 4. Levelised Cost of Energy (LCoE) evolution for large ground-mounted systems.

The targeted PV technology development in the period 2010 – 2020 is summarised in Table 1 and Figure 5 (next page). The latter is taken from the EC Technology Roadmap developed in the framework of the SET-Plan, which is mostly based on documents published by EPIA and the European PV Technology Roadmap.

Table 1. PV technology state-of-the-art and major objectives/milestones for the next 10 years (numbers and ranges are indicative because of the spread in technologies, system types and circumstances, etc.).

		2007	2010	2015	2020
Turn-key price large systems (€/Wp)		5	2,5	2	1,5
PV electricity generation cost in Southern EU (€/kWh)		0.30	0.13	0.10	0.07
Typical PV module efficiency range (%)	Crystalline silicon	13-18%	15-20%	16-21%	18-23%
	Thin films	5-11%	6-12%	8-14%	10-16%
	Concentrators	20%	20-25%	25-30%	30-35%
Inverter lifetime (years)		10	15	20	>25
Cost of PV + small-scale storage (€/kWh) in Southern EU (grid-connected)		--	0.35	0.22	<0.15
Energy pay-back time (years)		2-3	1-2	1	0.5

2.2 SEII structure and priority areas

The Solar Europe Industry Initiative (SEII) is based on the idea of *"Creating an Energy Revolution through Accelerated Evolution"* and moving beyond a business-as-usual scenario.
Based on an intensive exchange of views and ideas which were worked out in close collaboration between EPIA and the European PV Technology Platform, involving stakeholders from the whole PV industry (cell & module manufacturers, BOS suppliers), the research community (universities, research centres) , PV-related industries (glass, plastics/encapsulants, raw materials, metals) and, last but not least, equipment suppliers, two major initiatives have been defined:

- **SEII 1: Cost Reduction**
- **SEII 2: System integration**

Following the R&D activities in the two sub-initiatives, **demonstration and deployment projects** will be carried out to assure a large and successful implementation of the results.

The SEII also recognizes the need to undertake an important program for ***education & training*** in Europe in order to keep the leadership of the European industry and avoid a shortage of qualified PV professionals. Activities should be focused on educating scientists, engineers, installers, technicians, etc. based on the specific needs of the industry. The same principle applies for ***awareness & communication*** activities. The environmental, social, economical and technical benefits of PV need to be disseminated to the wider public, national and European policy-makers, utilities, architects, construction sector and other important stakeholders. These two areas, however, are beyond the scope of Industrial Initiatives and should be covered by parallel actions.

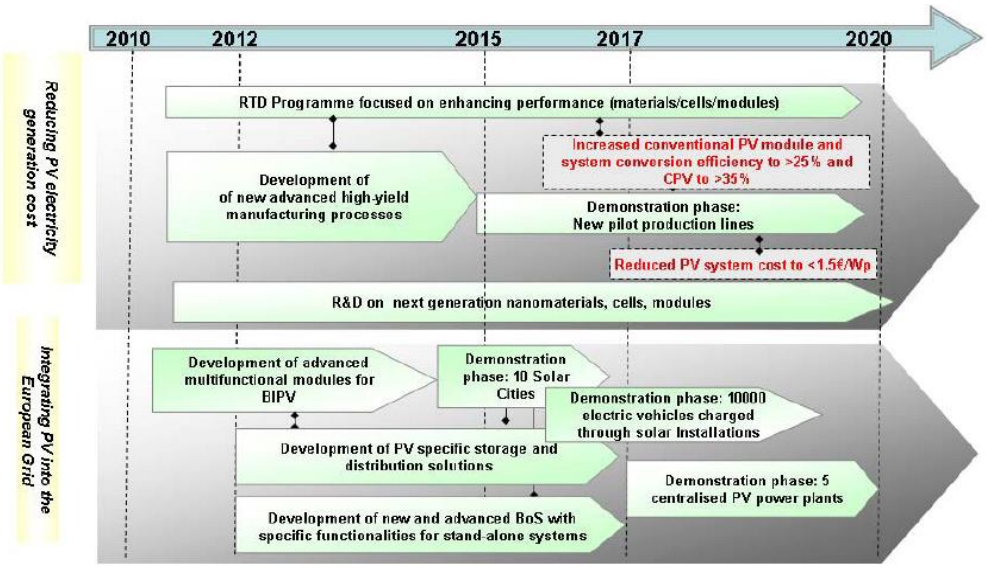

Figure 5. Overview of PV technology development in the period 2010 – 2020, taken from the EC Technology Roadmap (SEC(2009) 1295, 7 October 2009).

Figure 6 presents the structure of the SEII and indicates the major priority areas for R&D and demonstration under the 2 sub-initiatives. The interaction that will take place between the SEII and other major Industrial Initiatives is also shown. While the success of the *SEII 1 Cost reduction* depends mainly on the capacity of the PV industry to scale up and reduce cost, the success of the *SEII 2 System integration* will be conditioned by, among others, an effective cooperation with the Electricity Grid Initiative and the Energy Efficient Building Initiative.

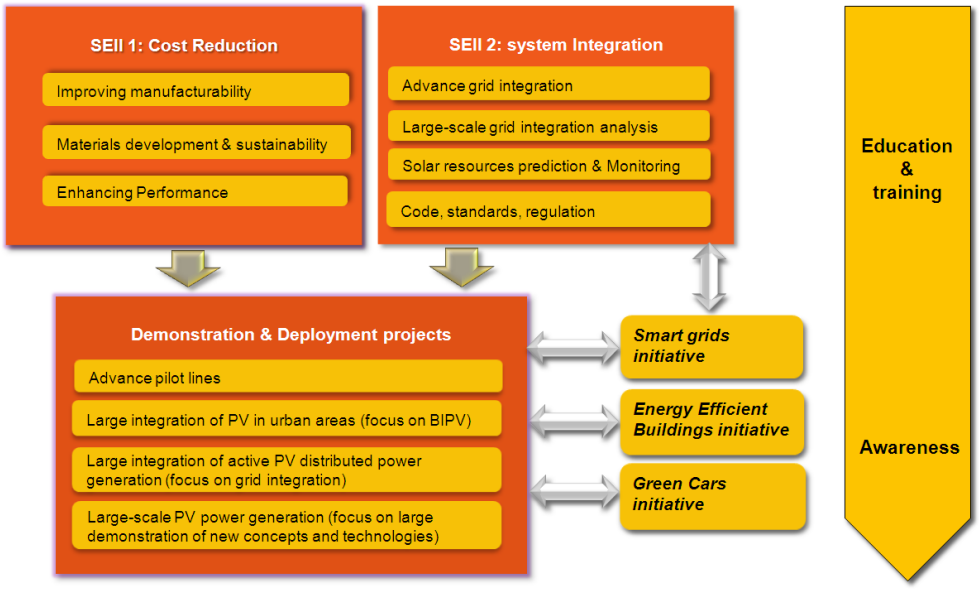

Figure 6. SEII structure: Sub-initiatives, relation to other initiatives and non-technological parallel activities.

2.2.1 SEII 1: Cost reduction

Objectives

The focus of this initiative is to reduce the generation cost of PV electricity (€/kWh) by achieving a cost reduction of the technology itself (€/Wp) and by increasing the lifetime of PV systems. An accelerated cost reduction of the PV technology will be achieved by boosting innovation and economies of scale.

It is crucial to prepare the industry for multi-gigawatt production and to accelerate the process of "from labs to commercialisation". New machinery and processes are needed to afford high-production levels and current and new materials need to be available in sufficient quantities and at low costs. In line with the recommendations of the Strategic Research Agenda of the European Photovoltaic Technology Platform, this step is to be achieved for wafer-based crystalline Si PV, thin-film technologies and concentrator PV.

Expected impact

The implementation of this initiative will lead to faster and cheaper manufacturing processes for all PV technologies with a higher grade of automation while the cell and module efficiencies will continue to increase. The use of high cost materials will decrease and substitutes to the non-earth-abundant materials currently used in the PV industry will be developed and gradually implemented. New encapsulation concepts and materials will be introduced in order to decrease cost at maintained or increased module lifetime.
With lower material usage, increased efficiency, better economies of scale and longer lifetime, the cost of electricity will be significantly reduced, making PV competitive with other energy sources.

2.2.2 SEII 2: System integration

Objectives

As distributed PV and other renewable energy technologies mature, they can provide a significant share of European electricity demand. However, as their market share grows, concerns about potential impacts on the stability and operation of the electricity grid may create barriers to their future expansion. In addition, low cost, high-quality integration of PV in buildings and other objects poses major development challenges. The goal of this initiative area is to unlock the potential of the PV industry in making PV a mainstream energy source, requiring special focus to be placed on system integration aspects.
In order to achieve the target of generating up to 12% of the European electricity consumption by 2020, the PV industry, together with the network operators and building sector, needs to develop economical and technical solutions which will allow a large penetration of PV at a competitive level.

Expected impact

The implementation of this initiative will bring benefits to the PV industry, utilities and regulators. On one hand, the production cost of components like inverters and batteries will decrease whereas the lifetime of those devices will increase making PV systems more economically attractive. On the other hand, grid operation will benefit from the ancillary services (frequency stability, voltage control, reactive power) that PV can bring into the system, as well as the reliability of supply when offering PV systems with energy storage solutions. Communication and control functionalities will be developed, tested and implemented facilitating the overall function of energy management systems.

2.2.3 Demonstration and deployment projects

Objectives

The results of the activities implemented under the priority areas "Cost reduction" and "System integration" will be demonstrated under real conditions. The collaboration with other key stakeholders such as utilities, car manufactures and regulators on the one hand and the building industry on the other is also essential at this level.
A variety of tests and demonstrations are required to understand the effect of a high penetration of PV systems on the grid. Especially important are the subjects of PV grid integration, PV building integration and interaction with other energy sources (such as wind power and other variable electricity production technologies).

Expected Impact

The implementation of this initiative will demonstrate the real value of PV technology and electricity, the potential to interact with other energy sources and the added value to network operators and the building sector.

3. Key Performance Indicators (KPI's)

In order to be able evaluate the impact of the different (clusters of) projects under the SEII and benchmark the results against the development targets summarised in Table 1 and Figure 5, a set of key performance indicators has been defined. These are structured in two categories:

For commercial technologies (wafer silicon, thin films, concentrators)

- Turn-key system price (€/kWp)
- PV electricity generation cost (€/kWh) - Note: calculation parameters to be agreed upon.
- PV module efficiency (%)
- PV module life time (years)
- Inverter lifetime (years)
- PV + Storage cost (€/kWh)
- Warranty of PV components (years)
- System energy pay-back time (years)
- # of advanced pilot lines

For emerging and novel technologies

- # of advanced pilot lines for ultra-low cost (printable) PV technologies
- # of proofs of concept for very-high efficiency novel PV technologies
- # of patents
- # of start-up companies
- # of proofs of concept for very high levels of PV penetration

4. Governance structure

Introductory remarks

- The SEII is new to all involved and the best governance structure is still to be defined and demonstrated.
- Implementation of the SEII should be based on a flexible and rolling program (able to rapidly evolve based on new situations and funding opportunities).
- Joint programming on a European or multi-country level has been found to be a very difficult and lengthy process. In order not to slow down the implementation of the SEII, the level of ambition on this point should be a realistic one and grow along with the SEII itself.
- It is essential, and the PV sector therefore expects, that dedicated public (on a short term EU, and later MS) budgets and funding instruments will be developed for projects and programs under the SEII.
- Intellectual property rights (IPR) are essential for industry development, but should be handled in a way that optimises progress of the PV industry sector as whole and thus, of the SEII.

→ **A simple governance structure is the best solution to implement *the initial phase* of the SEII.**

4.1 SEII Advisory Board

An SEII Advisory board will be defined with the following role:

- Definition of 3-year Implementation plan: *'When, What, How??'*
  - 'What' & 'When' : activities to be launched,
  - 'How': funding mechanism and budget necessary
- To be the only official body to represent the SEII to Member States (through the SET-Plan High Level Steering Committee (SET-Plan SC) and the Sherpas group) and to European Institutions.

The SEII Advisory board will represent the EU PV stakeholders through 4 seats given to EPIA, 4 seats given to the EU PV Platform, 1 seat to the European Commission and 1 seat to the Member States, see Figure 7. The representative of Member States could be chosen, for instance, based on the Council presidency (therefore rotating every 6th month).

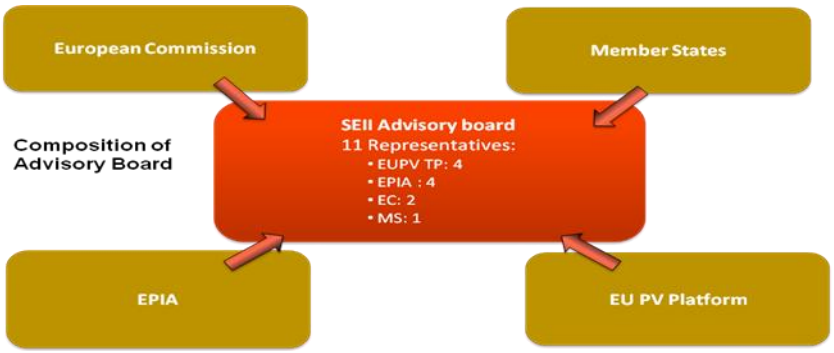

Figure 7. Composition of the SEII Advisory Board

4.2 Definition of a 3-Year Implementation Plan

The SEII Advisory Board has the role of defining a *3-year Implementation Plan* which will be subject to review every second year in light of new opportunities.

In order to build up the ***SEII 3-year Implementation Plan***, the SEII Advisory Board will use as starting point the SEII Roadmap 2010-2020 which has been developed in close cooperation with EPIA, the EU PV TP and the European Commission.

The definition of the SEII 3-year Implementation Plan, as shown in Figure 8, will be carried out in continuous interaction between the SEII Advisory Board and the SET-Plan SC, the Sherpas group as well as with the EC. This interaction will help the SEII Advisory Board to understand the priority areas, the financial resources and the available funding mechanisms of Members States and EC.

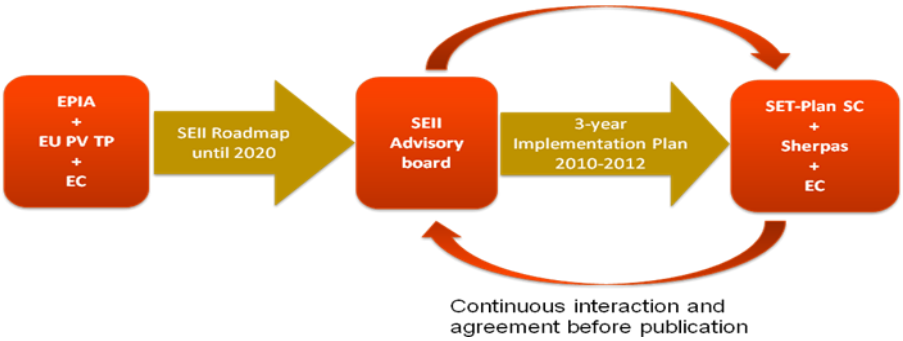

Figure 8. Process for the definition of the SEII 3-year Implementation Plan

The initiation of joint activities and the allocation of funding sources will be done with the support of the Advisory Board and representatives of public funding agencies. Depending on the EU added value and the risk involved in each activity, the funding sources and mechanisms will vary accordingly. This process is represented in figure 9.

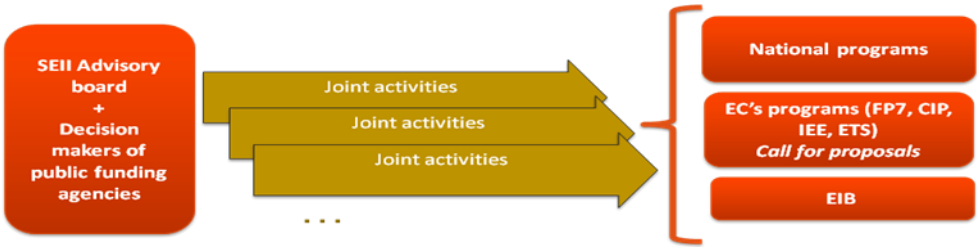

Figure 9. Selection of joint activities and allocation of the different financing schemes**.**

5. Three-year Implementation plan (2010-2012)

Note: the priorities described here are those projects and project clusters which have been defined *in addition to* ongoing projects and programs (on EU and member state levels) and which inherently qualify for the Solar Europe Industry Initiative label. Activities in these areas thus have to be intensified substantially. In other words: the overview below is *not* to be interpreted as a complete overview of PV R&D and demonstration to be carried out in Europe in the next three years. According to the Implementation Plan for the Strategic Research Agenda of the European PV Technology Platform the latter should have a total volume of 2.5-3 billion Euro for R&D alone in order to be compatible with the level of ambition shown in Table 1 and in the EU PV Roadmap in Figure 5.

5.1 Core focus of the SEII 2010-2012: selected priority areas

Table 2. Clusters of projects under the SEII 1: Cost reduction

Cost reduction: paving the way to 2020	
Advanced manufacturing processes for cells and modules	This cluster of projects aims at bringing a selection of key commercial technologies (in particular wafer Si, thin-film Si and CIGS) further to full maturity. This includes performance optimization, but in particular the development of device designs and processes, and the corresponding materials and equipment for very high throughput and yield cell & module manufacturing. Cooperation on laser processing is foreseen with the Photonics Platform. The aim is to enable the European PV industry to compete successfully on the global market, to reach grid parity with retail prices (or beyond) in most of Europe and to be able to supply the required hardware for multi-gigawatt-scale deployment of PV. Key subjects are integrated processing from silicon wafer up to the final module and roll-to-roll as well as high-efficiency glass-based processing of thin-film PV technologies; including pilot line demonstrations.
Performance enhancement and lifetime extension	In addition to the performance optimization and cost reduction on cell and module levels mentioned in the previous cluster, enhancement of the performance *on a system level* and enhancement of the technical lifetime of system components and systems are other ways to reduce the generation costs of solar electricity. This cluster of projects comprises system design optimization and demonstration for increased specific energy output (kWh/Wp·yr), enhanced-lifetime power-electronics for PV (in particular inverters), and PV module materials and designs as well failure mode analyses for ultra-long (40 yrs) lifetime. In addition, the cluster includes projects on commercial very high efficiency approaches, to prepare for >20% efficient modules.
Materials development & sustainability	To further improve the already favorable environmental profile of PV systems, the energy input for manufacturing and installation needs to be reduced and alternatives for some critical (non earth-abundant or hazardous) elements and materials need to be developed. Both aspects are also clearly related to cost reduction. This cluster of projects aims specifically (but not only) at low-energy content processes for solar-grade silicon feedstock and alternatives for silver as metallisation in PV cells. It also addresses the implementation of the end-of-life module collection and recycling system developed by the PV CYCLE association. .

Table 3. Clusters of projects under the SEII 2: System integration

System integration: paving the way to 2020			
Large-scale deployment	*Grid integration*	Although the basic function of inverters is and remains dc/ac conversion, their functionality may be enhanced substantially and they may evolve into "smart" system components, facilitating high degrees of grid penetration, but also interaction with other electricity generators as well as users, etc. In this way they can become key components of the future smart grid. Moreover, PV systems increasingly need to be considered as part of the total portfolio of electricity generators and users, as well as options for storage. Some key aspects are grid stability and control, dispatchability, congestion management, and	This cluster further includes the first phases of "Solar Cities" and "Solar Islands", aimed at demonstrating the many aspects of the

		more. This part of the cluster of projects aims at developing and demonstrating intelligent inverters, combinations of PV with storage and strategies for high penetration.	feasibility of large-scale use of solar energy in urban and isolated environments.
	Building integration	Very large-scale deployment of PV will strongly benefit from (or may even partly depend upon) the availability of multifunctional PV modules for integration solutions for buildings and infrastructural objects (sound barriers and many more). This is because turn-key system costs can be reduced by advanced integration concepts, but also because public support may be fostered or strengthened by the high aesthetic quality achievable with full integration. This part of the cluster therefore aims at developing concepts and hardware for integration of PV.	
Large-scale PV power plants	The development of very large PV power plants aimed at demonstrating the feasibility and reliability of technologies with a high potential but a limited track record, like concentrator PV and advanced thin-film technologies. Analyzing the impact of large PV plants on the grid operability and stability will also support the establishment and construction of a very robust European "smart grid".		
Solar resources, monitoring and simulation	What can we expect and what do we actually get? These are two key questions in relation to large-scale deployment of PV. Projects in this cluster aim at creating accurate & reliable, readily available, and practically useful information on all aspects of PV planning and use, for various stakeholder groups in all EU member states. This cluster of projects includes the "PV Observatory", which aims at gathering and disseminating a variety of monitoring data and information for benchmarking, including technology, industry, market and policy aspects.		

Table 4. Clusters of projects under SEII1 Cost reduction and SEII2 system integration for beyond 2020

Preparing for cost and penetration beyond 2020 levels	
Ultra low cost technologies	In addition to the technologies commercially available today, a range of "emerging" technologies is under development or in the pilot production phase. Prominent examples are the organic solar cells and modules (in particular polymer) non-vacuum deposition of CIGS. The general feature these emerging technologies have in common is that they have potential for very low production costs and new applications. Although advanced versions of commercially available technologies can meet the cost targets for 2020, emerging technologies are an essential part of the R&D portfolio for the next few years because they may bring PV further down in cost on the longer term and because their development towards application maturity requires many years. This cluster comprises projects on emerging technologies which aim (ultimately) at demonstration on a pilot production level.
Very high efficiency approaches	In addition to the commercial and emerging technologies mentioned in previous paragraphs, a wide range of "novel" device and conversion concepts are in the laboratory phase. The common feature of these novel approaches is that they aim at efficiencies far beyond the levels foreseen for commercial and emerging technologies. Another common feature is that it is too early to make useful statements about their (future) cost. Examples are various applications of quantum dots and other nanostructures, intermediate band semiconductors, hot-carrier devices, and more. This cluster aims at exploring the limits of photovoltaic conversion: a strategic activity which is vital for the position of the PV industry sector on the longer term as well as for Europe's global position in the PV field. The USA, Japan, Australia and other countries invest heavily in similar R&D efforts. The aim of the projects in this cluster is to demonstrate the feasibility and added value of the approaches on a device level.
Integration concepts for very high levels of PV penetration	As in the case of cell and module technologies, also the concepts and technologies for integration have to evolve and improve over time in order to comply with rapid, large-scale deployment. To prepare for very high levels of penetration of PV in the grid as well as in the built environment, this project cluster aims at developing and demonstrating new integration concepts (beyond those developed in "Grid and building integration").

5.2 Budget overview

Note: These budgets refer to *new* work in the SEII context (see the note at the beginning of chapter 5) and do not cover existing projects and programs.

The budget needed to cover the core focus of the SEII during the period 2010-2012 (selected priority areas) is presented in the table 9 and figure 10 and 11.

Table 5. Budget breakdown for R&D & Demonstration

R&D & Demonstration cluster	Estimated total budget for 2010-2012 (M€)	Estimated share of public funding required
Cost reduction: paving the way to 2020		
Advanced manufacturing processes for cells and modules	500	40%
Performance enhancement & lifetime extension	100	50%
Materials development & sustainability	50	60%
System integration: paving the way to 2020		
Large scale deployment (Grid and building integration)	200	50%
Large scale PV power plants	200	50%
Solar resources and monitoring	25	50%
Preparing for cost and penetration beyond 2020 levels		
Ultra low cost technologies	100	75%
Very high efficiency approaches	100	90%
Integration concepts for very high levels of penetration	25	90%
TOTAL	**1300**	**45%**

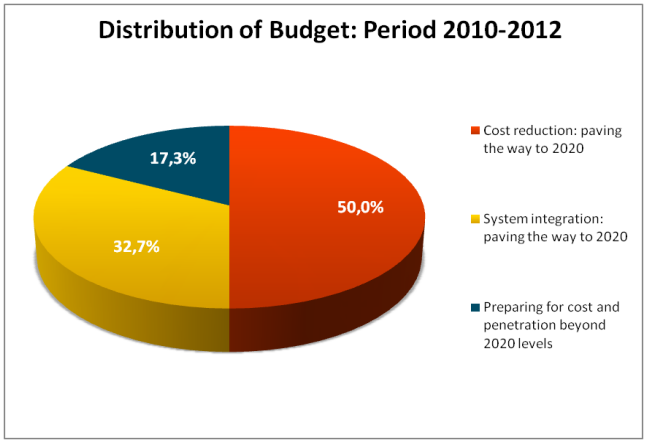

Figure 10. Distribution of budgets.

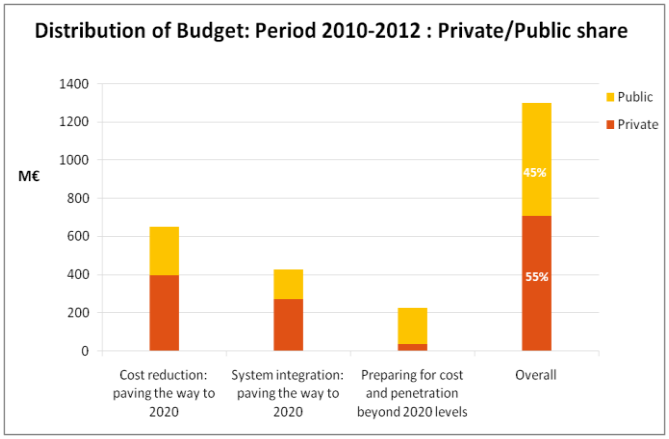

Figure 11. Private/ public share for each category of projects.

5.3 Timeline 2010

The Official Launch of the SEII will take place during the Spanish presidency of the European Council, on the 3-4 June 2010 in Madrid. In order to prepare for the official launch, a series of activities need to be carried out in advance, as it is shown in figure 12.

Official Launch of the SEII
The PV sector understanding of an official launch of the Initiative is the start of (among others) a ***large communication campaign*** across Europe, involving policy makers at national and European level, national funding agencies, the industry and research communities, as well as the general public.

For the foreseen communication campaign, a set of elements need to be defined in advance:

1. **Consolidated Structure and Governance**:
   a. SEII Advisory Board
   b. A group of "Decision makers of public funding agencies". Ideally 27, one per MS. At least, 7-9 representing major PV markets and industries. **This needs the leadership/support of the EC.**
2. Consolidated **PV roadmap 2010-2020** (mainly priority areas, KPIs, milestones).
3. Announced **funding plans and mechanisms from the EU side**.
4. **DRAFT "2010-2012 Implementation Plan"** (Budget, KPI's, priority areas + assessment of EU added value and investment risk).

Member States' support for the launch of the SEII
In order to officially launch the SEII, a minimum number of Member States must have shown their (general) support and commitment to the proposal of the SEII. The following list shows an indicative list of countries that should ideally support the Initiative as they are very active in the PV-sector, with a strong industry presence, important R&D programs and/or ambitious market deployment.

- **Required:** Germany, Spain, Portugal, Italy, Greece, France, Belgium, Netherlands, and UK
- **Desired:** Bulgaria, Rumania, Sweden, Austria, Czech Republic, Slovenia, Poland, and Hungary

The process to prepare the launch of the SEII during the Spanish Presidency of the European Council is presented in Figure 12. A big effort needs to be made by the PV stakeholders as well as by the EC in order to properly communicate the objectives and the concept of the SEII to member states; and to translate this proposal into a true European Initiative with full commitment of all parties.

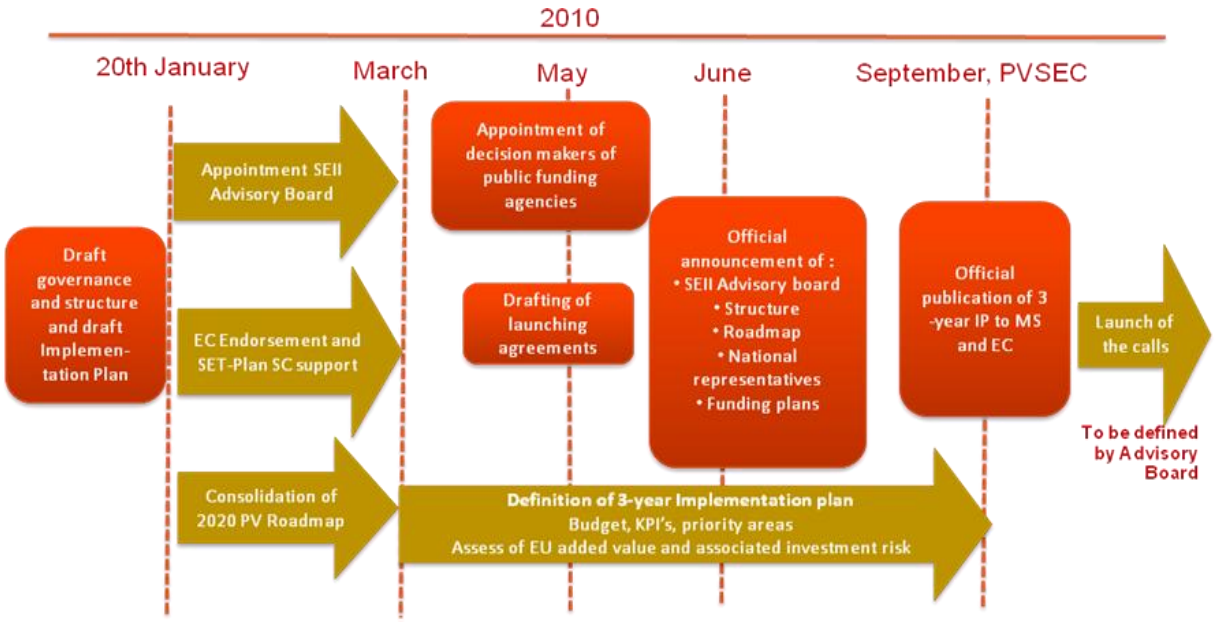

Figure 12. 2010 Implementation plan for the preparation of the launch of the SEII and its follow-up.