EUROPEAN COMMISSION
RTD - Energy
ENER - Renewables, R&I, Energy Efficiency
JRC – Institute for Energy and Transport
SET Plan Secretariat

ISSUES PAPER No. 2

Initiative for Global Leadership in Photovoltaic (PV) Solar Energy

Purpose of this document

This document[1] is intended to progress the implementation of the actions contained in the SET-Plan Communication[2] and specifically the actions concerned with the priority "Number 1 in renewable energy". It is part of a series of Issues Papers jointly prepared by the services of the European Commission and discussed with the representatives of EU member states and countries part of the SET Plan, working together in the SET Plan Steering Group.

The Issues Papers propose to stakeholders strategic targets in different areas of the energy sector. The input from, and positions of, stakeholders for each area will be used to come to an agreement on targets in a dedicated meeting of the SET Plan Steering Group with a representation of key stakeholders.

Stakeholders are invited to take position on the proposed targets in accordance with the guidelines set out in the paper ***The SET Plan actions: implementation process and expected outcomes*** and submit their positions to SET-PLAN-SECRETARIAT@ec.europa.eu by 20 November 2015 at the latest. All relevant documents and material are available on the SETIS website https://setis.ec.europa.eu/.

1 This document is a working document of the European Commission services for consultation and does not prejudge the final form of any future decisions by the Commission.

2 Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation" (C(2015)6317)

Introduction – Photovoltaic solar energy

All major future energy scenarios forecast a key role for photovoltaic solar energy (PV). PV has a huge global and European potential, making it an important building block for a secure and sustainable energy system. In several European countries PV already provides more than 5% of the annual electricity demand, a level originally anticipated to occur only after 2020. Based on current market trends, Solar Power Europe (previously the European Photovoltaic Industry Association (EPIA)) estimates that PV has the potential to meet 8% of the EU electricity demand in 2020 and 15% in 2030. If achieved, this would result in a considerable contribution to the reduction of CO_2 emissions, since the carbon footprint of PV systems is at least 10 times lower than that of fossil fuel-based electricity, with no CO_2 emissions during operation. However, PV has just reached 1% of global electricity supply and has harnessed only a small fraction of its vast potential. PV deployment could be accelerated by further enhancing light-to-power conversion efficiency, and reducing module and system prices as well as grid-integration bottlenecks. With innovations in these areas, the volume of modules manufactured in the coming decades could eclipse the figures of today's production.

Why taking action now on PV?

The PV industry has changed dramatically over the last few years. In Europe, the rapid growth of the PV market has not resulted in a similar growth of the production capacity of solar cells and modules. Following an initial globally strong position, the EU PV industry has dramatically lost market share in 4-5 years and currently supplies around 5% of the total MWp produced[3], exposed to a strong competition from Asian countries and increasingly from the US. China, in particular, has become the main manufacturing country for solar cells and modules. In 2013, the PV installed in China (12 GW) has also been the highest worldwide, which makes China also at present the first PV market in the world - while its cumulative PV installed capacity still ranks after that of Europe.

The reasons for the crisis of the PV industry in Europe are manifold. Besides foreign competition, the down-pricing of PV products has also played an important role. Down-pricing is partly the consequence of competition itself, partly the effect of a global production overcapacity.

Despite all these difficulties, the EU PV industry is still well positioned along the value chain, especially in the sectors of equipment manufacturing, inverter manufacturing, project business and installation. In addition, Europe still has research institutes on PV that maintain scientific leadership roles. Nevertheless, developing a strategy to build on the existing PV industrial and R&I base in Europe, with a view to re-launching module manufacturing, is an extremely urgent need. Worldwide growth projections for PV are very high, with the cumulative installed capacity expected to triple over the next five years. In this context, Europe must continue to invest in Research and Innovation to be able to play an active role and ensure again a strong industrial position. Managing innovation efficiently, maintaining technology leadership and ensuring a full commitment of industrial stakeholders require a coordinated approach at the European level.

[3] Fraunhofer ISE "Photovoltaics Report", August 26, 2015

Targets

Building on the Integrated Roadmap (IR) of the SET Plan, public (EC and Member States/Regions) and private investment must focus on targeted R&I actions to achieve the following goals in terms of PV system performance and cost-reduction and Building Integrated PV (BIPV) products:

Proposed targets in photovoltaic (PV) solar energy

1. Re-build EU technological leadership in the sector by pursuing high-performance PV technologies and their integration in the EU energy system. Achieve major advances in efficiency and lifetime of established technologies (c-Si and CIGS thin film) and new concepts;
    - **Increase PV module efficiency by at least 20% by 2020** compared to 2015 levels, **and by at least 35% by 2030**;
    - Increase **module lifetime** to a guaranteed power output time (at 80% of initial power) **longer than 35 years, by 2020**;
    - Increase large scale manufacturing concepts and capabilities by **demonstrating PV production capabilities of at least 20 m^2 per minute by 2020.**
2. Reduce the cost of key technologies
    - **Reduce turn-key system costs by at least 25% by 2020** as compared to 2015;
    - **Reduce turn-key system costs by at least 50% by 2030** with the introduction of novel potentially very-high-efficiency PV technologies manufactured at large scale.
3. Make "(near) Zero Energy Buildings" possible thanks to Building-Integrated PV (BIPV)
    - **Develop BIPV modules**, which include thermal insulation and water protection, to replace entirely roofs or facades **at costs below 100 €/m^2 and a module efficiency of** *[we solicit proposals]* **by 2020, and 75 €/m^2 and a module efficiency of** *[we solicit proposals]* **by 2030**
4. Achieve major advances in installation
    - **Develop PV modules designed for fully automated installation** for both ground-mounted arrays and building renovation, **by 2020**.

A large part of solar power deployment in Europe until the end of 2014 has been driven by financial incentives or ad hoc support schemes. Future, unsubsidized deployment will depend on the capability of PV systems to compete with conventional sources of electricity.

This can happen only through the achievement of ambitious system, cost and performance targets, as well as, regulatory and market design measures. System cost and performance are to a considerable extent interdependent and represent the actual drivers for the development of the sector. Indeed, increasing the efficiency of PV modules opens one path for reducing costs and allows for new industrial and market opportunities when accompanied by large scale manufacturing (at least 1 GW/year). As module costs account for around 50% of system costs, efforts need to be directed also at reducing the costs of Balance of System (BoS) technologies. Furthermore, manufacturing of PV modules as building materials can develop to a world-wide market with huge opportunities for the European industry. Driven by policies towards Zero-Energy Buildings, the development and manufacturing of PV products as a standard building material for

roof or wall elements requires a multidisciplinary research and development programme involving the PV manufacturing, the building materials industry as well as certification bodies.

The combination of localised PV electricity, storage and local supply and demand management makes buildings the smallest unit of a smart grid of its own. Once the necessary technology and control mechanisms are developed, the step of linking multiple smart buildings will contribute to widespread deployment of the smart grid technology. This requires the development of control systems for grid-feeding, self-consumption and local storage and standardisation of the interoperability of such control systems.

The achievement of the targets will depend not only on technological advances, but also on non-technological factors such as economies of scale (i.e. resulting from an increase in produced and installed capacity), risk-finance for first-of-a-kind manufacturing pilot lines and demonstration of small, commercial-scale PV power plants, the ability to take full advantage of the European Single Market, regulatory conditions, standards etc. In this context, international cooperation in energy research can also bring substantial benefits. These non-technological issues will have to be specifically examined at the subsequent stage of defining how to achieve the agreed targets.

_____

Annex. Relevant actions of the 'Towards an Integrated Roadmap' document of the SET Plan

Concrete targeted R&I actions for the long, medium and short term for wind energy development in general are proposed in the Annex 2 of the 'Towards an Integrated Roadmap' document[4]. Action 1 from the Advance Research Programme, Action 1 and 2 of the Industrial Research and Demonstration programme and Action 1 of the Innovative and Market-uptake Programme seem to be the most relevant ones for realising the targets defined in the Issues Paper.

Advanced Research Programme

Action 1 (see Integrated Roadmap): Novel PV technologies for low costs and/or high efficiencies

Scope: Increasingly advanced versions of existing PV technologies (and combinations thereof) need to be developed to maintain technology competitiveness in a rapidly innovating global sector. Emerging (i.e. pre-industrial) technologies need to demonstrate their added value in terms of cost, performance or unique application options and their viability in terms of manufacturability and stability. Novel, potentially very high efficiency PV technologies with new device architectures and advanced materials need to be developed. Low cost PV technologies and processes should be explored for technical and economic viability and developed to readiness for pilot manufacturing.
Deliverables: actions on device designs and fabrication processes; demonstration of pilot production readiness of emerging and/or novel low cost technologies.

Action 2 (see Integrated Roadmap): Enhanced PV conversion efficiencies and lifetimes

Scope: Increasing module and system electricity production is a key driver to bring down the cost of PV electricity, enhance sustainability and lower the energy payback time. R&D along the value chain, e.g. materials, cells, modules and power converters is necessary to increase the efficiency of modules and systems towards significantly higher values. Further R&D on high-quality and long lifetime products and balance-of-system components are essential.
Deliverables: actions on module efficiency and lifetime for mainstream PV technologies.

Industrial Research and Demonstration Programme

Action 1 (see Integrated Roadmap): Pilot production lines

Scope: To bridge the gap between research and large-scale application, i.e. from LAB to FAB. This action covers the whole value chain from materials, via cells and modules up to power electronics, and addresses manufacturing processes as well as corresponding equipment. Key aspects are: throughput, yield, statistical quality control and large scale manufacturability.
Deliverables: establishment of pilot lines for material processing, very low-cost concepts, high-efficiency technologies.

Action 6 (see Integrated Roadmap): Building-Integrated Photovoltaic (BIPV)

[4] https://setis.ec.europa.eu/system/files/Towards%20an%20Integrated%20Roadmap_0.pdf

Scope: BIPV is a special application of PV technology. Its multifunctional role makes this an important market segment to develop, especially taking into consideration future targets on near zero-energy buildings and smart cities. Specific topics to be addressed are: certification as building construction materials, flexibility in design, variety of products, availability at different scales and on different substrates, and improved aesthetics.

Deliverables: actions on BIPV products, norms and standards, BIPV installations and demonstration applications.

B. Framework conditions – policy measures

Innovation and Market-uptake Programme

Action 2 (see Integrated Roadmap): Implementing regulatory, financial and societal solutions for large-scale, market-based exploitation of PV investments

Scope: To develop regulatory and financial solutions that allow commercially viable business models for PV power generation. In particular, new models for financing and operating PV plants in the built environment have to be established. Moreover, the action addresses the potential societal and regulatory barriers that may arise with high levels of PV deployment, related to e.g. ineffective electricity market design and financing instruments.

Deliverables: development of adjusted market instruments and rules fit for PV electricity.