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## **ETIP PV SECRETARIAT**

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# **Mid-term ETIP PV Progress Monitoring Report**

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## 1. Introduction

The European Technology and Innovation Platform (ETIP PV) plays a structuring role in shaping the European Research and Innovation debate around photovoltaics. To that end, ETIP PV has been very active in ensuring that the European R&I framework for PV evolved in line with the rapidly increasing ambition and market dynamics of the PV sector over the 2022-2023 period. This notably led to a specific focus on the question of integrating PV R&I within the efforts to bolster the European PV industrial value chain, evaluating R&I efforts in that field and liaising with ongoing initiatives and platforms to ensure the emerging European industrial policy for PV is in line with R&I imperatives to guarantee the competitiveness of the European PV industry in the future.

During the year 2023, ETIP PV efforts to ensure the implementation of the IWG PV implementation and progress towards the roadmap laid out in the ETIP PV Strategic Research and Innovation Agenda culminated with the proposal from the European Commission to establish a Co-Programmed Partnership for Photovoltaics, which represents the potential for a higher degree of integration between European PV R&I stakeholders (including research institutes, PV industry, PV developers...) and European research and innovation funding, notably the Horizon Europe.

Meanwhile, ETIP PV undertook a constant effort to guarantee the smooth progress towards the objectives of PV R&I roadmaps and implementation plans, contributing to stakeholders groups, assessing R&I spending at the European and national level, or participating to European public consultations. This work was undertaken in close collaboration between the ETIP PV Secretariat, European associations shaping the European PV sector, and members of ETIP PV, including the Steering Committee of the Platform and members of the various Working Groups active throughout the period.

## 2. The PV R&I Framework

Throughout the past decades, the EU has been a leader in PV innovation. Many key innovations that contribute to the competitiveness of PV today were developed by European companies and research centres. As a result, this R&I effort has contributed to making PV the fastest-growing and cheapest energy source globally. The currently dominating half-cell PERC technology has been developed based on a number of innovations from European research institutes, solar cells and modules in the period 2000-2014, before being adopted by Asian manufacturers. Another recent example of European innovation that is rapidly growing in the market today is the TOPCon technology, developed in Germany by Fraunhofer, but industrialised in China. In the coming decade, we can expect other key innovative technologies developed within Europe to reach the market and transform the PV sector, for instance with cells combining silicon and perovskite for greater efficiency or back contact technologies which are allowing n-type PV to already break many efficiency records, and with ongoing flagship R&I projects such as PILATUS and IBC4EU.

The European Union has demonstrated a strong commitment to advancing energy research and innovation in the last decade, recognizing the crucial role that sustainable energy sources play in addressing climate change and ensuring the long-term viability of energy systems. In the previous multiannual financial framework (2014-2020), the EU invested EUR 4.99 billion towards research and innovation for projects related to the priority "Secure Clean and Efficient Energy" of the programme Horizon 2020. Around EUR 490 million were invested towards PV-related research projects. Horizon Europe, the programme for the 2021-2027 period, enhanced the investment amount to at least EUR 15 billion towards "Climate, Energy and Mobility". Estimates from Eurobserv'ER point to national public support to R&I in PV amounting to around EUR 250 million/year on top of the European Commission's support. The EU's substantial investment in research and innovation has provided significant support for specialized PV research institutes in several countries across Europe. Solar manufacturers can rely on these institutes, such as IMEC in Belgium, Fraunhofer ISE & CSP, FZ Jülich, HZB, ISC, ISFH, and ZSW in Germany, CEA-INES and IPVF in France, TNO in the Netherlands, and CSEM in Switzerland, among others, to provide cutting-edge research and development in the photovoltaic industry.

The successes of Europe's specialised PV research centres are always aligned with the research interest of Europe's PV industry. For example, in the last ten years innovation in cell and module technology was driven by specialised tool manufacturers and their strategy to offer new tools and processes against a backdrop of

certified record efficiencies utilising their tools and processes. As the PV manufacturing value chain moved out of Europe however, and as technology innovation in PV manufacturing continued and accelerated globally, there has been a loss of expertise in several key segments of the PV R&I landscape. In the supply chain segment of ingots and wafers, Europe has seen a notable loss of expertise in research and innovation, but also in the capacity to manufacture specialised tools. This knowledge and innovation gap needs to be closed fast to achieve the ambitions put forward by the European Commission. In order to reshore European PV manufacturing it will be crucial to link the high innovation capacity of the European research institutes with the industry production on GW scale along the whole value chain.

Since 2021, the European R&I framework was especially defined by the Horizon Europe Programme which over its first 4 years of operation dedicated around EUR 280 Million to PV projects (around EUR 70 Million per year). Significantly, the Horizon Europe programme differs from the Horizon 2020 with a stronger emphasis on bigger structuring projects with an industrial perspective, reflecting the calls from ETIP PV in past years. The 2023-2024 Horizon Europe programme, published towards the end of 2022, notably focused funding towards key areas of development of the PV R&I landscape, including industrialization of innovative technologies manufacturing (e.g. large area perovskite), new applications of PV systems (including BIPV, IIPV, floating PV, AgriPV, or VIPV), end of life & circularity of the PV value chain, or quality insurance and O&M.

During the year 2023, a Co-Programmed Partnership for Solar Photovoltaics was proposed, with the support of ETIP PV, to further improve the connection between the PV industry and R&I community and European R&I support programmes such as Horizon Europe. This proposal reflects a structural change in the place of photovoltaics in the European research and innovation landscape, wherein it is now considered a structuring strategic priority for the European economy. The proposed Co-Programmed Partnership comes after nearly two decades of relentless work of ETIP PV in shaping the European PV R&I landscape towards unlocking the potential of PV in the European energy sector. It rewards the work of the PV industry & research and innovation community who have shown, with ETIP PV that coordination, exchanges and strategic approach to the industrialisation of PV actively contribute to attaining European energy policy goals of climate mitigation and energy security.

### 3. Progress report assessment methodology

The ETIP PV Secretariat has had a methodical approach to continuously optimise the activities of ETIP PV as a platform in shaping a positive environment for advancing photovoltaics research and innovation at the European level. Various feedback rounds were organised to test the approach of the platform to different policy challenges and ensure synergies with the different actors that also shape the PV sector at the European level.

As a first step, the ETIP PV platform engaged in community building with the PV R&I actors, establishing a regular contact with an EU R&I coordination group made up of key stakeholder associations involved on PV and research and innovation, including notably SolarPower Europe, ESMC, EUREC and EERA-PV. The coordination group has been essential in aligning R&I priorities and policy objectives, showing that the challenges of the ETIP PV SRIA also apply as challenges for other organisations in the PV R&I landscape and need to be overcome. A dedicated coordination group meeting highlighted the collective need for the PV industry to bridge the gap between industry and R&I and emphasizing the creation of specific, cost-effective, simple, and flexible actions and policies that motivate industrial engagement in R&I.

Along improved cooperation between ETIP PV and other stakeholders shaping the PV landscape at the European level, ETIP PV engage thoroughly with the Implementation Working Group on PV, to optimise synergies with this body representing Member States' perspective on the Research and Innovation landscape for PV, and support the finalisation, release and communication of the IWG PV implementation plan for photovoltaics. The synergies are notably built on the participation of the ETIP PV Vice-Chair to the IWG PV activities, and the support provided by the Secretariat in participating to relevant IWG activities, and providing support in dedicated context (e.g. liaison with the PV industry, specific European Commission stakeholders and other ETIP/IWGs).

As part of the process of updating the Strategic Research and Innovation Agenda of ETIP PV, a stakeholder consultation process allowed to evaluate the state of progress in the implementation of the ETIP PV Strategic R&I priorities at the European level. Moreover, regular work as part of the ETIP PV Steering Committee and Working groups (e.g. with the publication of white papers, or the organisation of workshops & webinars) allowed to evaluate the performance of the European R&I efforts for PV. To that end, a dedicated stakeholder workshop was organised in June 2023 with the objective to assess the European R&I landscape for PV with the joint objective of structuring the work in initiating the SRIA update process that ETIP PV is currently pursuing, and understanding the needs of the sector in the run up to 2025 Horizon Programme, and the approaching next programming period for FP10.

Finally, the ETIP PV Secretariat worked in close cooperation with other ongoing R&I projects and participated to discussions on the R&I landscape for PV in relevant conferences to gather a suitably diverse array of perspectives, to adapt the trajectory of ETIP PV activities to reflect achievements, challenges and barriers perceived by the PV industry and R&I communities. This for instance included participation in events including EUPVSEC, PVinMotion, HJT Workshop, Intersolar or the SET Plan conference.

#### 4. Evaluation of the success of the ETIP PV Approach in shaping the R&I agenda for PV

During the period 2022-2024, the focus of the ETIP PV activities was on three key priorities that shaped the European R&I landscape for PV, with an especially high relevance for high TRL applications.

##### European PV manufacturing and Research & Innovation: improving the R&I pipeline

One key priority involved improving the research and innovation pipeline within European PV manufacturing. This entailed active engagement with the European Solar Innovation Alliance (ESIA), where ETIP PV played a pivotal role in advocating for the integration of innovation within the alliance's activities. Additionally, the production of two white papers on the PV industry aimed to explore the resilience of the European PV value chain and its long-term economic impact on energy prices in Europe. These papers focused on the role of innovation in European industrial policies to capitalize on the region's diverse landscape of research institutes and innovative companies, promoting long-term competitiveness and resilience for the European PV industry. Among the topics explored by the papers, among of R&I funding for PV in Europe and types of R&I support available were mapped out, as well as understanding expertise gaps within the European value chain for scale up and innovative applications. The second iteration of the paper had a more specific focus on exploring national policies for high TRL applications of PV on the supply side (industrial manufacturing, bringing new technologies to market) and understanding the impact of industrialization policies on R&I efforts, notably from the perspective of the "lab-to-fab" process of industrialising innovation, notably with the case of producing machine for innovative manufacturing processes. Moreover, contributions to discussions surrounding PV manufacturing led to the proposal of a European Co-programmed Partnership aimed at accelerating high TRL activities.

The 2022-2024 period saw a structural shift in the approach to European policy making for photovoltaics, with the emergence of a focus on the consolidation of a European PV industrial value chain in consequence of the 2021-2023 energy price crisis. The establishment of the European Solar PV Industry Alliance (ESIA) introduced a momentum in favour of a stronger European PV industrial value chain. For ETIP PV, engagement with this issue and with ESIA is a strategic challenge as in the PV sector research and innovation are closely intertwined with industrial value chain and deployment capacity. The period was notably marked, for European programmes such as the Innovation Fund, by a new tender design that better rewards renewable energy technology manufacturing projects, which led to 2 large scale PV projects and one small scale PV manufacturing project receiving support in the 2023 call (compared to only 1 large scale PV manufacturing project having been eligible for funding until then).

##### Co-Programmed Partnership for Photovoltaics preparation process

As part of this structural shift, the Co-Programmed Partnership for Photovoltaics preparation process emerged as a focal point. This involved various engagement efforts, including collaboration with the European Commission to enhance the "lab-to-fab" pipeline for high TRL PV technologies. Additionally,



concerted efforts were made to engage European Member States, aiming to gain support for the relevance and necessity of a PV-specific Co-Programmed Partnership. These efforts served to streamline research and innovation efforts and position the European PV sector for long-term resilience and competitiveness amidst evolving energy dynamics. Promoting the establishment of a Co-Programmed Partnership for PV, notably included gathering a deeper understanding of the impact of R&I funding allocation in enabling the market uptake process of innovative technologies, for instance liaising with the PV Impact process, and accurately mapping Horizon Europe, Innovation Fund and Horizon 2020 dedicated to PV projects.

## Horizon Europe: preparation of the next programming period and assessment of the 2021-2024 programmes

Significant attention was also directed towards the preparation for the next HE programming period. This involved a comprehensive evaluation of HE PV spending by priorities and amounts, aimed at assessing the effectiveness of the 2021-2024 programmes. Based on these evaluations, recommendations were provided for the 2025 programme, along with preliminary suggestions on structuring provisions for the upcoming FP10. Additionally, efforts were initiated to update the SRIA to contribute to the preparation process for FP10. These efforts were particularly relevant to ensuring alignment with emerging priorities and challenges while maximizing the impact of funding allocations within the HE framework.

R&I in PV is supported under the Horizon Europe Cluster 5 Destination 3: Sustainable, Secure and Competitive Energy Supply. Today, the overall funding for PV in Work Programmes 2021-22 and 2023-24, stands at EUR ~280 million, across 17 topics at various TRL levels. It should be noted that this figure comes at the inception of a major industrial policy drive at the European and national level, to bolster the European Union's resilience vis-à-vis Solar Photovoltaics supply chains.

In the private sector, European PV companies across the value chain are also investing in R&I large share of their revenue to be able to survive on a rapidly evolving market. According to EurObservER, private R&D investments in EU-27 on 'Solar Energy' amounted to EUR 767 million in 2019. However, due to the smaller size of European PV companies, individual research budgets are smaller than global competitors, highlighting the strategic importance of public R&I support. For example, for a solar cell manufacturer with a production capacity of 2 GW it is much more challenging to run an R&D line with 500 MW capacity than for a manufacturer with 40 GW production capacity. This has an impact in the capacity of European manufacturers to industrialise innovative technologies, and keep up with global competitors. For example, 3 leading Asian manufacturers R&I budgets have an aggregated stated R&I expenditure of more than 1 billion Euros in 2021, amounting to 2% to 4% of their total budget. It is worth noting that the amount spent by just one leading Chinese PV manufacturing company on R&I in a single year is in the same order of magnitude (or far greater) than the total public EU spending on PV R&I for the 2014-2020 period under the Horizon 2020 programme (or for 2021-2024 under the Horizon Europe programme).

Many key innovations that contribute to the competitiveness of PV today were developed by European companies and research centres. As a result, this R&I effort has contributed to making PV the fastest-growing and cheapest energy source globally. The currently dominating half-cell PERC technology has been developed based on a number of innovations from European research institutes, solar cells and modules in the period 2000-2014, before being adopted by Asian manufacturers. More recent examples of European innovation that is rapidly growing in the market today include TOPCon technology, developed in Germany by Fraunhofer, but industrialised in China or Heterojunction, first industrialised in Europe. In the coming years, we can expect other key innovative technologies developed within Europe to reach the market and transform the PV sector, for instance with cells combining silicon and perovskite for greater efficiency, where European research centers and companies have been achieving significant progress from low TRLs to mid/high (including OxfordPV, HZB, CEA, Fraunhofer ISE...). Analysing findings from the PV impact project and the ITRPV report, we can also flag the importance of innovative applications in the market uptake of R&I for PV in Europe, most notably with AgriPV, BIPV and Floating PV. Meanwhile, sustainability and circularity concerns have emerged as a structuring topic throughout the PV R&I process, which is a consistent feedback across stakeholders consultations, whether in the aforementioned publications, or as part of the SRIA update process of ETIP PV that is taking place in 2024.

## 5. Conclusion & key priorities for the 2024-2025 period of ETIP PV activities

Over the 2022-2024 period, PV R&I has undergone a structural shift at the European level. The 2023-2024 Horizon Europe Work Programme created a new dynamic for R&I funding, while changes in the Innovation Fund programmes and extension of EIC focus on PV improved the European R&I environment for PV. The structure of projects also evolved, with a greater emphasis on larger structuring projects with industrial partners. The period also paved the way for major new evolutions that will shape the European R&I landscape for PV in the 2024-2025 period including:

- Implementation of the co-programmed partnership on photovoltaics
- Preparation and implementation of 2025 Work Plan + FP12 in Horizon Europe
- Shift towards larger structuring R&I projects to accompany industrialization/market uptake of innovation
- Monitoring of industrial policy impact on R&I efforts (assessment of gigafactory projects + technology interaction)

