Grant Agreement number 842547

PV IMPACT

Actual execution of the Implementation Plan for Photovoltaics and monitoring the Implementation Plan's delivery

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Deliverable 4.2
Journal articles on R&D spending

Lead beneficiary: EURAC

Disclaimer of warranties

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About PV IMPACT

PV IMPACT will try out a variety of approaches to stimulate PV research, development and innovation initiatives in Europe. The first part of the project will focus on inviting companies to matchmaking events so they can find partners with whom to work on future projects under EU and/or national funding schemes. The project will also target two specific industrial companies: ENEL Green Power and Photowatt. Another important part of the project will be to monitor progress in PV. Data will be collected on public spending in the EU, on private spending, on the kinds of projects being funded and on the overall performance of PV technology. Forecasts for future spending will be made according to various scenarios. The project will track whether improvements in the performance of technology are keeping pace with expectations and will make recommendations to European funding authorities.

PV IMPACT Partners

EUREC The Association of European Renewable Energy Research Centres

enel Green Power

Photowatt

eit InnoEnergy Knowledge Innovation Community

Fraunhofer ISE

3E

Consiglio Nazionale delle Ricerche

BECQUEREL INSTITUTE

imec

eurac research

WIP RENEWABLE ENERGIES

Project acronym	PV Impact
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PU	Public	X
RE	Restricted to a group specified by the Consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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Executive summary

This document provides the abstracts and the key findings of the articles published within the activity "Detailing public and private spending on PV". The aim of the task was to get detailed understanding of past R&I expenditures for the PV sector and related research topics, current levels and potential future trends. The task was divided in the following subtasks:

- Baseline for public sector spending on PV R&D
- To establish a baseline of R&I expenditure by SET Plan countries and the European Union (European Commission Framework Programme) available databases
- Public sector spending and forecasts under different scenarios

Second, in order to create R&I scenarios until 2020/2030, a business as usual (BAU) and 3 advanced scenarios with different ambition levels will be created and compared:

- Achievement of EU target 3% of GDP on R&D by 2020
- National targets to double public annual spending on energy R&D in the period 2015-2020 under Mission Innovation
- A scenario taking into consideration the achievement of the climate and energy targets for 2020/2030 and showing the gap between these goals and baseline trajectories.

These scenarios are based upon GDP forecasts, future potentials of innovative PV systems and the PV deployment scenarios.

Private sector spending

Besides public R&I expenditures, investments by the private sector also play an important role. Data on private R&I expenditures are much more fragmented than public R&I expenditures, with limited availability and lacking consistent time series. These expenditures will nonetheless be covered with regard to R&I recommendations.

Two open-access journal articles were published with the titles:

1) PUBLIC RESEARCH AND DEVELOPMENT FUNDING FOR PHOTOVOLTAICS IN EUROPE – PAST, PRESENT, AND FUTURE, to be published in Green Energy and Technology as proceedings of SSPCR2019.

   https://www.sspcr.eurac.edu/2019/07/25/special-session-on-energy-economics-for-smart-and-sustainable-cities-and-regions/

2) A Comprehensive Analysis of Public and Private Funding for Photovoltaics Research and Development in the European Union, Norway, and Turkey, De Negri, JF, et al, Energies 2020, 13(11), 2743 https://doi.org/10.3390/en13112743

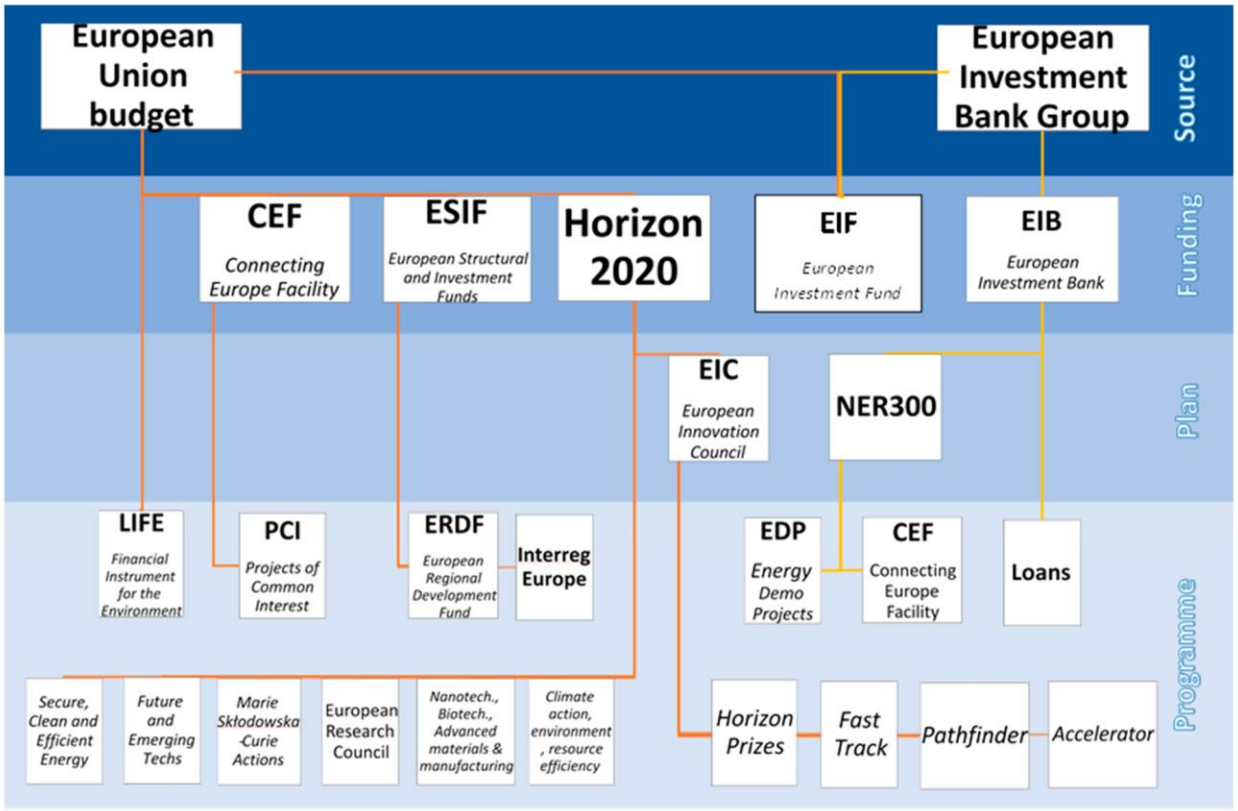

Figure 1: Public sources of photovoltaics research and development funding in the European Union (2019). The last level "Programme", indicates the name of the fund providing the financing resources which can be in the form of grants or loans

To answer one of the research questions, a comparison between total public and private funding was done. The results, which indicate a predominance of the private sector funding, ranging roughly between 60-70% (Figure 2). This is in line with what was presented by other sources, which provided similar ranges concerning RES in general, or for PV but at a world scale. Finally, large corporations, as well as small and medium businesses, depend on contributions made in the form of public grants or loans for PV R&D. Any contributions that come at a low cost will be most welcome as these companies need to keep producing innovative goods and services but at the same time spend the lowest possible in doing so. Smaller companies will especially seek funding from a diversity of sources. This normally also involves private capital investors that take on substantial financial risks. Public offerings and bank loans are more uncommon because they are in general more costly. The way companies finance their operations is varied and might give further indications for R&D investing performance, but no further analysis was carried out as part of this study.

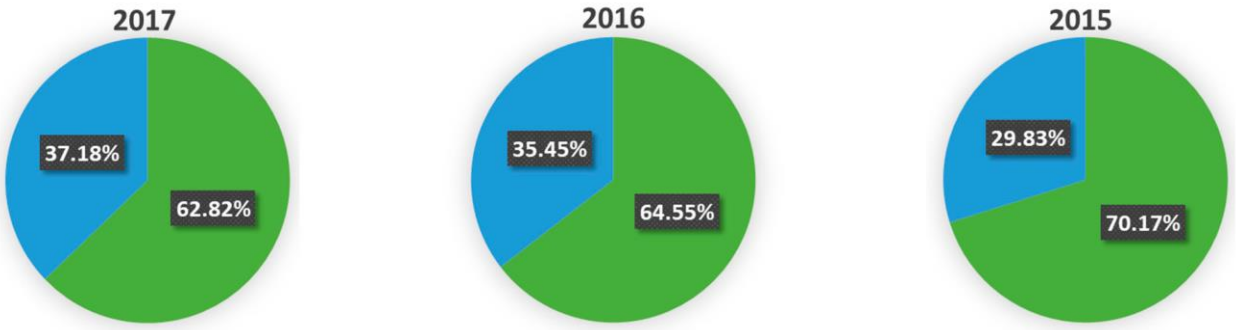

Figure 2: Private funding (green) compared to public funding (blue) by year.

The CORDIS database provides ample data on H2020 projects, allowing the compilation of relevant information. As of December 2019, a total of EUR~323 million have been distributed for PV R&D since 2014. These funds were assigned to seven categories (Building-integrated PV, cross-sectoral research at lower technology readiness level, development of PV power plants and diagnostics, manufacturing technologies, new technologies and materials, others, and technologies for silicon solar cells and modules with higher quality) according to the classification proposed by the SET-Plan PV Implantation Plan. The results are shown in Figure 3, and they provide a very accurate indication as to where future PV innovation will be oriented. A large amount of these funds (EUR~182 million, equivalent to 56% of all the funds) are destined for the sole purpose of improving the module's efficiency levels, whether it is for existing technologies (mainly silicon-based) or experimental ones.

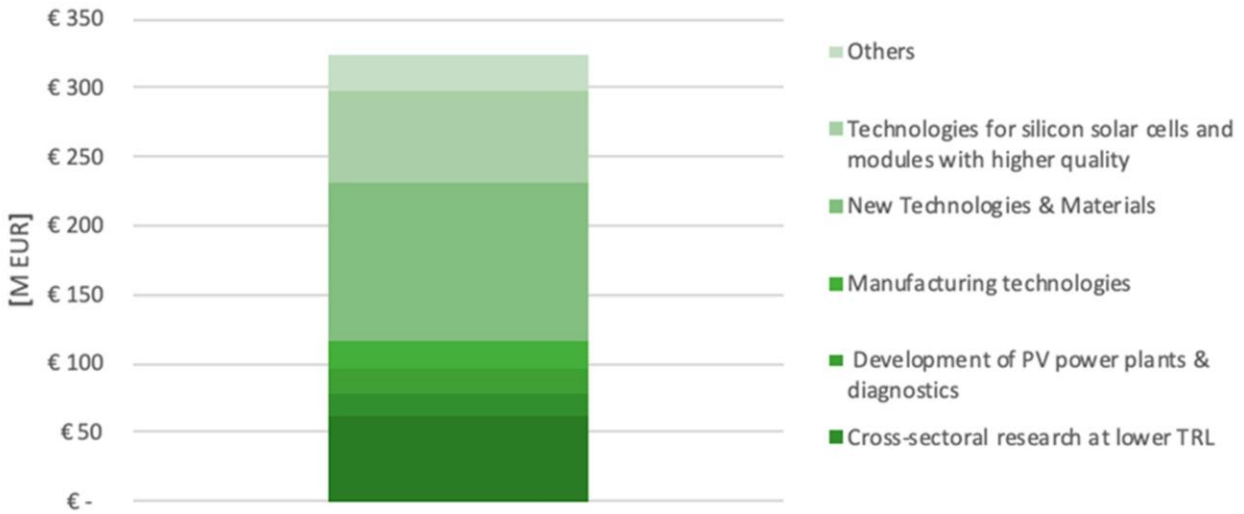

Figure 3: Accumulated photovoltaics research and development funding from Horizon 2020 (2014- grouped into seven categories by activity type as per the PV Implementation Plan (TRL stands for technology readiness level).

1. Public Research and development funding for Photovoltaics in Europe

Abstract: The use of photovoltaic technology is crucial to meet Europe´s ambitious climate and energy objectives set for 2030. To facilitate this shift, technological innovation is a key prerequisite, and the provision of public funding for related research and development an important trigger. For this study, a vast set of data has been collected to explore how the EU, its Member States, Norway and Turkey have so far invested in photovoltaics research and development. Based on historic values and actual trends, the authors additionally outline the possible future evolution of investigated public funding. The study aims to shed light on the development of funding from the early 1970s until 2017 (most recent data available) and provide a forecast for 2030 (based on a business as usual scenario). According to results, at national level, public funding had a considerable and steady rise after the OPEC´s oil embargo in 1973, reaching a first peak in the mid 1980´s. The authors predict that according to the most recent trends, by 2030 these will surpass 200 Mln. € annually. In comparison, EU funding steadily increased since its inception in the late 1980´s up until 2007, but its evolvement is distinctively different, evidencing high fluctuations. The cumulative stock is also examined. National sources outweigh EU programs by a factor of almost five times, and the stock should surpass 7 Bn. € by 2030. Based on the analysis and related insights, recommendations have been elaborated on how the development of funding could inform policy strategies and actions, to support research and development for photovoltaic technology.

1.1 Key outcomes

Figure 4, Figure 5, Figure 6 show the cumulative funding stock from public research and development investment of the Member States, European Union and the sum, respectively

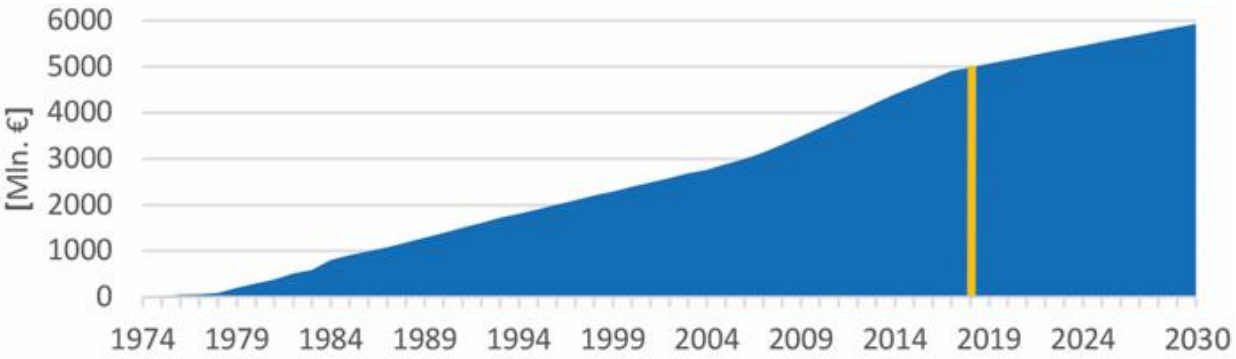

Figure 4: Cumulative funding stock for photovoltaics originated from research and development investment of the European Union Member states plus Norway and Turkey (Mln. €, BAU scenario, 2018 exchange rates and prices)

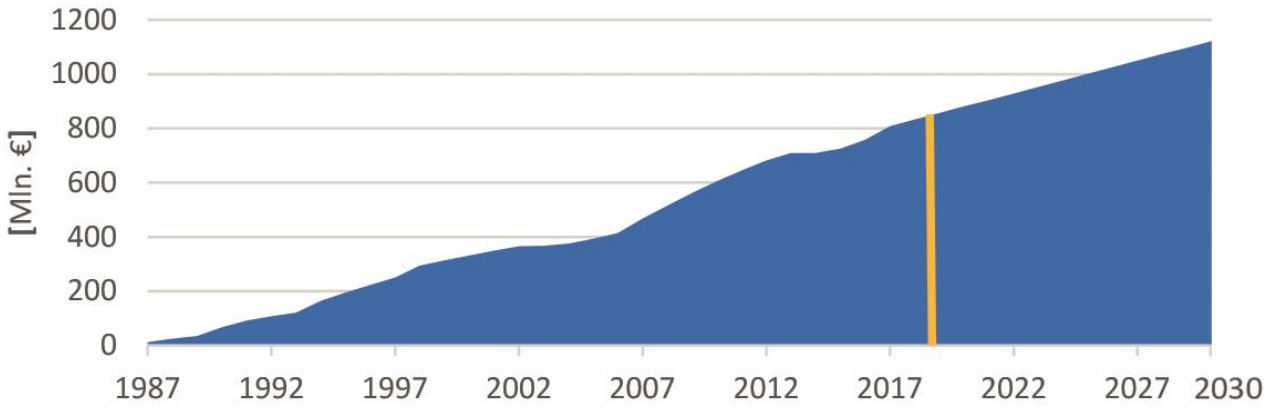

Figure 5: Cumulative funding stock for photovoltaics originated from research and development investment of the European Union (Mln. €, BAU scenario, 2018 exchange rates and prices)

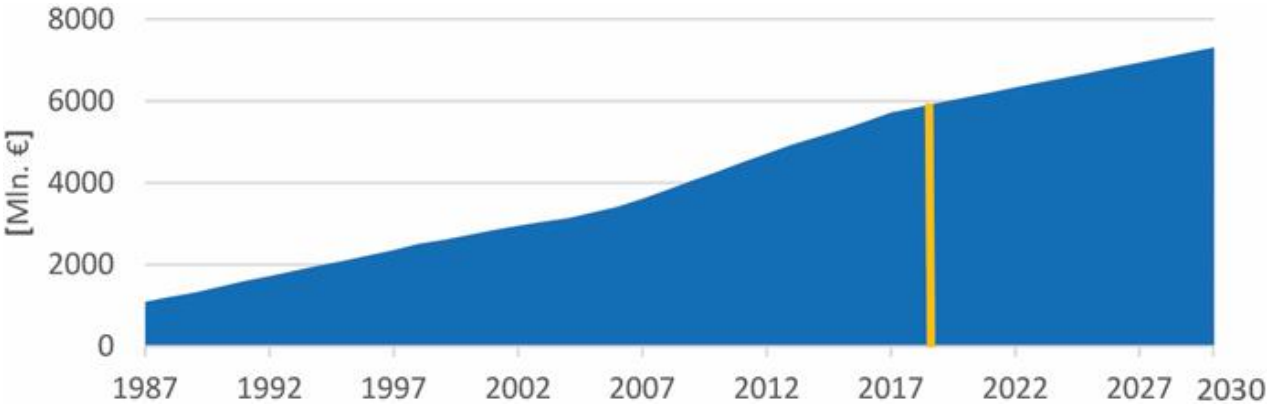

Figure 6:Accumulated funding for photovoltaics originated from research and development investment of the European Union Member States plus Norway and Turkey and at the European Union level (Mln. €, BAU scenario, 2018 exchange rates and prices)

2. A Comprehensive Analysis of Public and Private Funding for Photovoltaics Research and Development

Abstract: This study aimed to examine the financing of photovoltaics research and development by analysing funding from public (European Union and national budgets) and private sources (enterprises), Strategic Energy Technology Plan participating countries being the main focus (European Union Member States plus Norway and Turkey). In the coming years, photovoltaics are expected to heavily contribute towards the achievement of audacious climate and energy objectives. Continuous monitoring of the effects is of great importance to assess a course of action taken at such a large scale. It will be revealed that the distribution of funding provided by national budgets highly concentrates on a few Member States, which is part of a general trend in

Research and Development within Europe. Approximately 85% of the current European investment provided by the EU budget is administered in the framework of the Horizon 2020 (2014–2020) program; private investment behaves differently. The European photovoltaics manufacturing market has been obliterated by low-budget imported goods. A major characteristic is that the remaining companies are almost exclusively privately held. Gathering data has consequently been a challenge, as opposed to the readily available public datasets.

2.1 Key outcomes

The knowledge stock method is a way to reach an approximate economic value of the accumulated know-how of PV.

$$KS_{R\&D}=(1+\rho)(1-\delta)\times KS_{(1-t)}+R\&D_{(t-x)}[EUR] \quad (1)$$

Equation 1

- ρ: Spillover.
- δ: Depreciation
- t: Time period
- X: Time lag.

Based on Equation1, only data of public PV R&D funding was used, because it has proven difficult to construct an equivalent dataset for the entire EU private sector. Compiling all the data (Figure 77), the result is influenced by the predominance of national funding. By 2030 the total projected value exceeds EUR 4000 million.

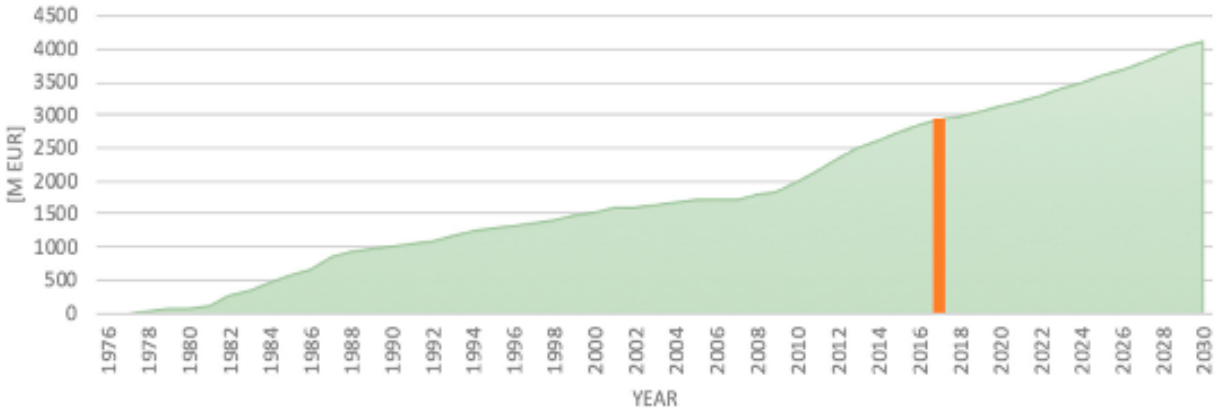

Figure 7: Knowledge stock calculations for photovoltaics research and development originated from investment by the European Union member states, Norway, Turkey, and the European Union in M EUR (2018 prices and exchange rates).

A comparison between the KS (both sources combined) and the production price of solar modules is proposed (Figure 88). A very high negative correlation of −0.84 was the result, indicating a very close relationship between investment in R&D and a drop in PV costs per Watt-peak (Wp). This does not necessarily imply that PV R&D is the main reason for cheaper production costs, rather,

it provides an argument for increased levels of funding to sustain this trend, given also constant innovation is assumed to be beneficial for any technological deployment.

Figure 8: Left axis, blue area: Knowledge stock calculations for photovoltaics research and development originated from investment by the European Union member states, Norway, Turkey, and the European Union in M EUR (2018 prices and exchange rates). Right axis, orange line: solar module price, inflation-adjusted EUR/Watt-peak (Wp) (2018 prices and exchange rates)