PHOTOVOLTAICS IN EUROPE: REALITY, POTENTIAL AND RESPONSIBILITY

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ABSTRACT: We first present the Renewable Energy Progress Report published under the framework of the 2009 Renewable Energy Directive, assessing EU Member States' progress in the promotion and use of renewable energy along the trajectory towards the 2020 targets. We also describe the European policy framework and envisage its development for preparing the right regulatory, industrial and technological configuration and legal instruments for the post 2020 environment. Then we present the results of the 7th Framework programme (FP7), highlighting the newly selected projects and breakthroughs, and discuss the investments operated in the various strands of photovoltaic activities. It is worth to recall that the last calls of FP7 have been already published. Horizon 2020, the next framework programme for research and innovation for the 2014-2020 period, is already in an advanced phase of preparation. Thirdly, we discuss the activities carried out under the second Intelligent Energy Europe (IEE) Programme aiming at transforming the PV market. Finally, we describe the implementation of the Solar European Industrial Initiative of the SET-Plan. The increasing deployment of variable renewables in the EU adds to the challenges for their integration and their balancing in the electricity system. The pioneering phase of "install and forget" is over. We have now reached the phase of responsibility, requiring economic efficiency to integrate the growing share of renewable electricity into the energy market.

Keywords: Photovoltaic R&D and Innovation, and Demonstration Programmes; Dissemination Strategy and Market Transformation; Policy.

1 INTRODUCTION

According to a recent study, 16,5 GW of new photovoltaic capacity was installed in the European Union in 2012 (it was 22 GW in 2011), bringing the cumulative photovoltaic capacity to more than 68,6 GW [1]. In some EU Member States, the PV capacity represents already a relevant share of the total installed capacity. In Germany, for instance, in 2012 renewables accounted for 23% of total power generation. In that year, German solar PV capacity increased by 7,7 GW, bringing cumulative capacity to around 33 GW, while cumulative wind capacity reached about 31 GW. In Italy, in the same year 2012, the photovoltaic cumulative capacity rose to 16,4 GW. Notably, in June 2013, the installations under Italy's FIT scheme reached the annual budgetary cap. In Spain, the economic challenges and the new regulations affecting renewable energy generation have moderated the installation of new photovoltaic power, which has reached a cumulative capacity of 4,5 GW. In France, in 2012, the cumulative PV capacity slightly surpassed 4 GW. The other EU countries with cumulative installed photovoltaic capacity above the 1 GW mark are Belgium (2,6 GW), Czech Republic (2 GW), UK (1,7 GW) and Greece (1,5 GW).

Considering that more than 30 GW have been installed in the world during 2012, it appears that Europe is losing its leading role in driving the global market and that the leadership is migrating towards Asia (mainly China) and America. Incidentally, China is reaching the state of dominating not only supply but also demand for solar products, a situation that will likely last for many years to come. The combined effect of reductions of the support schemes, the introduction of caps, and restricted access to credit has reduced the growth of photovoltaic installations in Europe.

A second element is the harsh and thorough consolidation, with a number of bankruptcies, re-structuring programmes, factory closures and buy-outs, which has hit the European renewable energy arena, and in particular the solar sector. At global level, the Chinese industry also appears less strong than before while the US industry is still in the game. The adopted business model (i.e. vertically integrated companies versus companies specialized on specific segments of the value chain) often makes the difference. Relevant in this regard is the Commission Decision of 2 August 2013 accepting an undertaking offered in connection with the anti-dumping proceedings on imports of crystalline silicon photovoltaic modules originating in China. The settlement sets a minimum price and a volume limit on EU imports of Chinese solar panels until the end of 2015. Chinese manufacturers that take part will be spared the EU duties which are intended to counter below-cost sales [2].

A further element is that the increasing deployment of variable renewables in the EU adds to the challenges for their integration and their balancing in the electricity system. The pioneering phase of "install and forget", was mostly focused on capacity growth and kWh-generation, with limited orientation to consumer demand. During that phase, renewable electricity was easy to integrate because it was a minor share of total production. We have now reached the phase of "responsibility", which requires economic efficiency to integrate the growing share of renewable electricity into the energy system. The situation is not homogeneous in Europe. There are countries which are already integrating and balancing well significant shares of variable electricity. Robust interconnections,

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both internal and with neighbouring countries, are a crucial enabler to deployment. But they might not be sufficient. Additional technical and regulatory solutions are to be implemented to effectively handle increasing shares of renewable electricity [3].

A fourth element to consider is the economic break-even point for residential photovoltaic installations, which is impacting directly on current reflections concerning the feed-in tariff schemes. The price parity of solar with the retail price of electricity is diverse, in accordance with the heterogeneity of the European electricity market and the quality of the solar resource [4]. The so called grid parity for photovoltaics - defined as the moment when PV LCOE becomes competitive with retail electricity prices - has likely been reached in several countries, including a relevant portion of Italy, Spain, and Southern France. This fact does not mean that photovoltaics does not need policy measures anymore. On the contrary, policy measures are still needed to reduce administrative barriers and improve regulatory mechanisms in order to allow PV self-consumers to feed their excess generation into the grid in exchange for compensation (either monetary compensation or energy compensation). In a nutshell, wherever grid parity is an economic reality, policy measures should create the proper frameworks to adapt the energy system to the increasing importance of distributed generation. Nonetheless, it is worth recalling that grid parity remains overall a quite ephemeral point to catch. As is well known, LCOE is calculated with simple equations, requiring some data (capital and O&M cost, solar resource, …) and some assumptions (economic lifetime of the installation, interest rate during the lifetime, …). Assumptions can substantially affect the results of the calculations. Additional uncertainties come from the retail electricity prices. In some cases, retail electricity prices are kept artificially low; while real generation costs are higher (several European islands provide examples of this). In summary, while grid parity is an appealing concept for studies and for making quite attractive graphs, it is difficult to handle from policy makers' and regulators' points of view.

In this paper, we first present the Renewable Energy Progress Report [5] published under the framework of the 2009 Renewable Energy Directive [6]. The report assesses Member States' progress in the promotion and use of renewable energy along the trajectory towards the 2020 renewable energy targets. We also describe the European policy framework and envisage its development for preparing the right regulatory, industrial and technological configuration and legal instruments for the post 2020 environment. It seems to us that a strong sense of direction towards 2030 is needed soon, to support long-term investment decisions and to enable markets to integrate higher shares of renewables. A public consultation launched with the adoption of the Green Paper on a 2030 framework for climate and energy policies ended on 2 July [7]. The analysis of the responses feeds into the on-going work on the impact assessment to accompany the Commission's proposals for the 2030 framework. Second, we present the results of the 7th Framework programme (FP7), highlighting the newly selected projects and breakthroughs, and we discuss the investments made in the various strands of photovoltaic activities. It is worth to recall that the last calls of FP7 have been published. The next framework programme for research and innovation for the 2014-2020 period, Horizon 2020, is already in an advanced phase of preparation. Third, we discuss the activities carried out under the second Intelligent Energy Europe (IEE) Programme aiming at transforming the PV market. Finally, we describe the implementation of the Solar European Industrial Initiative of the SET-Plan.

2 EUROPEAN ENERGY POLICY FRAMEWORK AND LEGAL INSTRUMENTS

The adoption of the EU's 2009 Renewable Energy Directive created a strong, stimulating policy framework for the growth of renewable energy. It contains legally binding renewable energy targets for each country of the EU for 2020, as well as requirements to simplify grid and administrative procedures, and to facilitate the growth of renewable energy.

2.1 Renewable Energy Progress Report

The Commission's March 2013 Progress Report [8] showed that all Member States have implemented policies to encourage growth, and renewable energy grew strongly. PV energy production alone has increased from 7,4 TWh/year from just before the Directive, to almost 45 TWh/year in 2011. Total renewable energy production has grown from 1465 TWh to 1725 TWh, ie: 260 TWh/year over the same period. This strong initial growth has raised renewable energy production in every single country of the EU, and puts the majority of countries above the trajectory towards their target established by the Directive[m] (Fig. 1).

That said, analysis suggests that further measures will be needed for Member States to stay on track towards their target. The legal transposition of the Directive has been slower than desirable and the trajectory grows steeper in the coming years, so that in reality most of Member States' effort will be needed towards the end. Other reasons for concern include the failure to fully address barriers to the uptake of renewable energy: administrative burdens and delays still cause problems and raise project risk for renewable energy projects; slow infrastructure development, delays in connection, and grid operational rules that disadvantage renewable energy producers all continue and all need to be addressed by Member States.

Deviations from the trajectory towards their target constitute a deviation from Member States' own national action plans, and the Directive requires Member States to immediately revise their plan and to demonstrate how they will return to the trajectory. If the measures proposed are deemed inadequate then the Member State can be taken to court for infringing the Directive.

The changed economic climate has clearly had an impact on the development of new renewable energy projects. One important change is the increased cost of capital in general. Another is the increase in risk resulting from Member State changes to support schemes. The importance of support schemes is such that the Commission is to propose detailed guidance on the reform and structure of support schemes, as discussed below.

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[m] All Member States are on or above their trajectory, with the exception of Malta, Latvia, Netherlands and UK

2.2 Support scheme reform

For PV, more than any sector, the last three years have been a roller-coaster, with volatile growth driven by poorly designed support schemes. To the extent that the EU drive for renewables stimulated a global interest, production capacity, in particular for PV, grew around the world, and production costs dropped significantly. That meant that the support levels provided in several Member States became very generous and attracted huge investment. This boom at a time of economic austerity has triggered hasty reforms – tariff cuts, new taxes, and moratoria which have caused a sudden dip in new investment.

The Commission's planned guidance on support schemes and reform is intended to ensure that such unpredictable reforms are avoided in the future – as always, the renewable energy sector requires a stable, transparent, *credible* support framework in order to build investor confidence. Moreover support schemes must ensure renewables are deployed cost effectively, with incentives to reduce generation costs whilst avoiding *over* compensation and overly generous rates of return.

The support scheme framework can also help to integrate renewable energy generation into the broader energy market. This is important given the expectation that renewable energy sources should compete on a level playing field with a phase out of subsidies as they become more competitive. This is part of what we have called the phase of responsibility, where, with new, harmonised network codes which no longer discriminate against renewable energy, with coupled EU electricity markets, renewable energy producers will be able to bear the costs of balancing grid, together with market costs and risks like all other generators. This guidance will be published in the autumn of 2013.

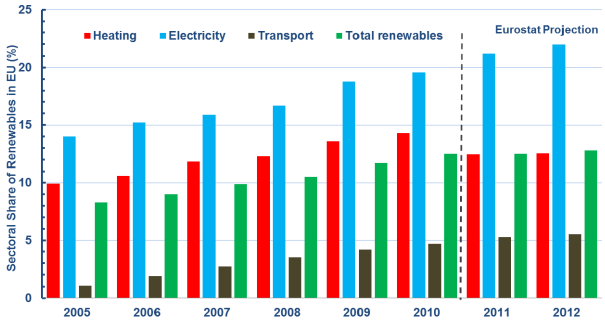

Figure 1: Trend in EU Renewables - Sectoral and total growth of renewable energy in the EU[n]

2.3 A 2030 framework for climate and energy policies

The renewable energy Directive proposes a review to prepare a post 2020 policy framework in 2018 (corresponding to the 2008, 2020 proposals). However it is already clear that indications of the nature of a 2030 policy framework are already needed, to steer investment decisions of today, given the long life of most energy investments. For this reason, the Commission published already in 2013 its Green Paper on a 2030 framework for energy and climate and launched a major public consultation exercise addressing the role of climate policies – notably the EU emissions trading scheme –, the scope for further decarbonisation in different sectors, the interaction with renewable energy and energy efficiency polices, the impact on energy costs, electricity prices and public budgets. All these factors have to be weighed in establishing the new framework. Most of the current discussion is focusing on whether a climate policy and climate instrument – the EU emissions trading scheme – would be sufficient to drive the transformation of the energy sector that is needed for both climate and energy policy objectives, or whether a further renewable energy target is also needed to ensure on going growth of renewable energy markets in the post 2020 world. The Commission intends to propose the new policy framework in a Communication by the end of 2013.

[n] To note that the EU interim 2011/12 total RES target was 10,7%

3. PV RTD AND DEMONSTRATION PROGRAMME

3.1 The 7th Framework Programme

The EU's 7th Framework Programme for Research, FP7 (2007-2013), received a higher budget than the previous programme, and ran for seven years. Calls for proposals based on topics identified in the work programme have been published on an annual basis. Seven calls for proposals have been published in the years from 2007 to 2013, including the last call in 2013. Material development for wafer-based silicon devices, photovoltaics based on solar concentration, and manufacturing process development have attracted relevant European funding. Significant funding has also been made available for thin-film technology and for the development and demonstration of new concepts and new approaches for building construction elements based on photovoltaic (Figure 2).

The photovoltaic projects granted under the calls from 2007 to 2012 have been described previously [9]. The projects which received grants under the FP7 2013 call are described below.

The FP7 2013 calls for proposals have been published on 10 July 2012. Three main PV topics were addressed: *1. High efficiency c-Si photovoltaics modules* (call: FP7-ENERGY-2013-1; topic ENERGY.2013.2.1.1 - deadline: 28/11/2012), 2. *Support to key activities of the European Photovoltaics Technology Platform (PV TP)* (call: FP7-ENERGY-2013-IRP; topic ENERGY.2013.2.1.2 - deadline: 08/01/2013), and 3. *Integrated research programme in the field of photovoltaics* (call: FP7-ENERGY-2013-IRP; topic ENERGY.2013.10.1.5 - deadline: 08/01/2013).

Topic 1. has resulted in the selection of one proposal which has been retained for negotiation – currently underway – for an overall EU contribution of EUR 7,0 million. The project *PV TP SEC III* has been granted under the topic 2. –funding scheme for Coordination and Support Actions (CSA)- with an EU contribution of about EUR 490.000. The project, coordinated by WIP – Renewable Energies, Germany, has a total cost of about EUR 790.000, will last 3 years, and includes as participants the European Photovoltaic Industry Association (EPIA), the EUREC Agency, and the European Commission's JRC. The main objective of *PV TP SEC III* is to ensure – through the promotion of

cooperation among the project partners and all the relevant actors in the PV sector including industry, research centres, universities, European and national public institutions, civil society organisations - that in the upcoming decisive years the PV TP will still be a point of reference for the state-of-the-art of PV in Europe and worldwide, and will still be able to provide the sector with valuable reference documents. Finally, another project has been retained for negotiation –currently underway– under the topic on the Integrated Research Programme. The estimated EU contribution amounts to about EUR 10,0 million.

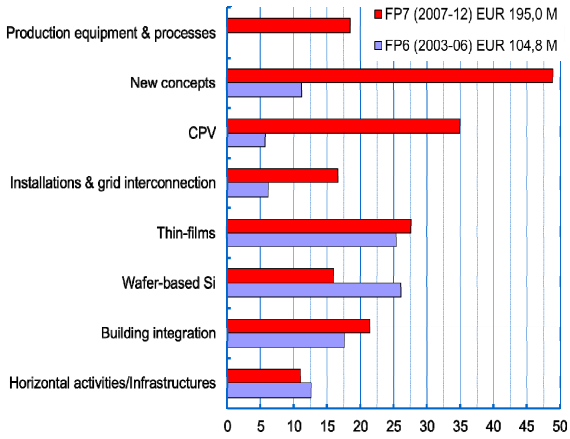

Figure 2: Comparison of the investments in photovoltaics made under FP6 and FP7 in the period 2003-2012 (Euro million)

3.2 Horizon 2020 - The Framework Programme for the 2014-2020 period

Horizon 2020 is the next framework programme for research and innovation for the 2014-2020 period. The overall budget foreseen in the Commission proposals is about EUR 80 billion. The European Parliament and Council are negotiating the terms for the adoption of the legislative acts on the basis of the Commission proposals [10]. The final vote in the European Parliament Plenary is expected for 22 October 2013, while the adoption by the Council will take place in November/December 2013. The adoption of the work programme and the publication of the first calls for proposals are expected to take place in December 2013.

Horizon 2020 is structured along three strategic objectives: 'Excellent science', 'Industrial leadership', and 'Societal challenges'. With a proposed budget of EUR 24,6 billion, the first objective -'Excellent science'- includes funding for the European Research Council (ERC) and the Marie Curie Actions, investments in Future and Emerging Technologies (FET), as well as support for the access to and networking of priority research infrastructures across Europe. With a proposed budget of EUR 17,9 billion, the second objective - 'Industrial leadership'- is intended to help make Europe a more attractive location to invest in research and innovation. It includes major investments in key industrial technologies such as Information and Communication Technologies (ICT), nanotechnologies, biotechnology, and space. It will facilitate access to risk finance, which has a high leverage on private investment and has been shown to be a very valuable tool in fighting the lack of risk capital following the financial crisis. This objective will also provide EU-wide support for innovation in SMEs with high growth potential. Finally, with a proposed budget of EUR 31,7 billion, the third objective -'Societal challenges'- focuses on six key areas for the lives of European citizens: health, demographic change and well-being; food security, sustainable agriculture, marine and maritime research, and the bio-based economy; secure, clean and efficient energy; smart, green and integrated transport; climate action, resource efficiency and raw materials; inclusive, innovative and secure societies. The goal will be more than ever to bring excellent research results to market.
The cost of solar energy, including photovoltaics, should be halved by 2020 compared to 2010 levels. This would require long term research on novel concepts and systems and the demonstration and testing of mass production with a view to large-scale deployment. Along these lines, and within its 'objectives' and 'challenges', Horizon 2020 is expected to continue the EU support for the development of efficient, reliable and cost-competitive solar energy systems.

4. INTELLIGENT ENERGY – EUROPE

The Intelligent Energy – Europe (IEE) programme supports collaborative projects in which EU organizations from at least three different countries cooperate with the aim to reduce non-technological market barriers in the fields of renewables and energy efficiency. IEE projects are selected to contribute to the implementation and further development of EU policies and legal frameworks, by helping to create more favourable market conditions for renewable energy technologies, including PV. The first IEE programme ran from 2003 to 2006 and the second IEE programme (2007-2013), which had a budget of EUR 730 million, has now launched its last call for proposals, but valuable project results will continue to be produced for at least another three years (until 2016). In future, it is anticipated that such "market up-take" projects will be supported by the Horizon 2020 programme.

A series of PV projects has been funded since the beginning of the IEE programme, and an overview of several recent projects was given in 2012 [9], which drew special attention to those IEE projects which have provided valuable resources for others working in the field. Details of all projects supported by IEE can be found in the IEE project database http://www.eaci-projects.eu/iee/page/Page.jsp.

Two PV projects are currently on-going with IEE support: *PV PARITY* (www.pvparity.eu), which started in 2011, aims to provide EU policy makers with a clear definition of the competitiveness of PV in the residential, commercial and utility scale market segments. National competitiveness roadmaps have been developed for each of 11 target countries. The market analysis carried out by the *PV PARITY* team shows that in the residential sector, PV reached cost competitiveness in several EU regions in 2012. More are expected to follow in the next two years and then progressively grid parity will be reached in other countries. By the end of the decade, depending on how prices will evolve but also on the cost of financing, grid parity could be achieved in all target countries of the project. *PV-GRID* (www.pvgrid.eu), which started in May 2012, is expanding the database

(http://www.pvlegal.eu/database.html) which was developed in the PV LEGAL (www.pvlegal.eu) project, and enlarging it to cover not only permitting - including grid and support related procedures - but also to describe the administrative processes to be followed when installing a PV system in almost all countries of the EU PV market. The work has involved hundreds of interviews with market stakeholders, including PV system developers and operators. *PV GRID* project team is also aiming to reduce regulatory and normative barriers to the large-scale integration of PV and other intermittent RES-e generation technologies into the distribution grids of 16 EU countries.

The IEE programme has also supported projects on capacity building, training and certification of installers of small scale RES systems, including PV [9]. These projects have provided valuable inputs to the EU Member State authorities, helping them to meet their obligations under the Renewable Energy Directive (Art 14). These projects have also provided inputs to the IEE initiative *BUILD UP Skills* (www.buildupskills.eu), which supports the training and qualification of craftsmen, on-site construction workers and systems installers for sustainable energy solutions in buildings. Under this initiative, all EU Member States are developing national roadmaps for training and qualifying their craftsmen on high energy performance solutions for the building sector, including the installation of renewable energy systems such as PV. There is a final deadline for the submission of proposals for IEE funding under the *BUILD UP Skills* initiative on 28 November 2013, to fund the actual setting up or upgrading of training schemes for sustainable energy installers and craftsmen throughout Europe.

Since 2010, IEE has provided "project development assistance" (PDA) funding to local and regional public authorities in order to help them to develop into "bankable" projects the investments which they have foreseen and adopted in their sustainable energy action plans. Such PDA funding was provided initially through the ELENA (European Local ENergy Assistance) initiative of the European Investment Bank (EIB). However, since 2011, a similar initiative MLEI (Mobilising Local Energy Investments) has been launched within each annual IEE Call, and this is managed like other IEE projects by the EACI. Each of these facilities has led to new PV investment opportunities.

Further information on the IEE programme and on-going IEE projects is available at: http://ec.europa.eu/energy/intelligent/

5. EUROPEAN SOLAR INDUSTRIAL INITIATIVE OF THE SET PLAN

The Solar European Industrial Initiative (SEII) of the Strategic Energy Technology Plan (SET Plan) continues to work on the main priorities in the PV and concentrating solar power (CSP) fields.

The ERA-NET action which is called SOLAR-ERA.NET (www.solar-era.net) was launched. The first set of joint calls for proposals was published with a total public funding of EUR 12 million. Several proposals were submitted (47 in the PV field and 13 in the CSP field). The evaluation is currently in progress and the first successful projects are expected to start in early 2014.

The SEII 2013-2015 Implementation Plan for PV was finalised. It focuses on three pillars: performance enhancement and energy cost reduction (with regard to wafer silicon technologies, thin-film and emerging/novel technologies, CPV, BIPV, balance of system); quality assurance, long term reliability and sustainability; and electricity system integration (with regard to large scale deployment and solar resources and monitoring).

The Communication on Energy Technologies and Innovation adopted on 2 May 2013 indicated the development of an Integrated Roadmap under the guidance of the SET Plan Steering Group [11]. The Integrated Roadmap should: (1) address energy system and innovation chain integration, (2) consolidate the updated technology roadmaps of the SET Plan, (3) cover the entire research and innovation chain from basic research to demonstration and support for market roll-out and (4) identify clear roles and tasks for the various stakeholders such as the European Energy Research Alliance (EERA), the European Industrial Initiatives (EIIs), the European Institute of Technology (EIT) and other relevant actors like universities, investors and financiers. The objective of the Integrated Roadmap is to prioritise the development of innovative solutions which will respond to the needs of the European energy system by 2020, 2030 and beyond. It is expected that the Integrated Roadmap will be finalised by the end of 2013.

CONCLUSIONS AND FUTURE PERSPECTIVES

The increasing deployment of variable renewables in the EU adds to the challenges for their integration and their balancing in the electricity system. The pioneering phase of “install and forget” is over. We have now reached the phase of responsibility, requiring economic efficiency to integrate the growing share of renewable electricity into the energy market. This is important given the expectation that renewable energies should compete on a level playing field with a phase out of subsidies as they become more competitive. With new, harmonised network codes which no longer discriminate against renewable energy, with coupled EU electricity markets, renewable energy generators should become increasingly able to bear the costs of balancing the grid, together with market costs and risks like all other generators. Whilst some large scale PV generators in the sunny parts of the EU are already able to do this to a significant extent, it will of course take longer in the North, and special conditions or schemes – possibly providing business opportunities for "aggregators" - may be required to encourage investments in PV systems by individual householders and "PV prosumers" for some time to come.

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