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european energyinnovation

GREEN PORTS

GAS

LIGHTING

PHOTOVOLTAICS

Country profile

DENMARK

Includes editorial contributions from:

Jakub Adamowicz
Spokesman for Transport and Regional Policy, European Commission

Isabelle Ryckbost
Secretary General, ESPO

Diederik de Stoppelaar
Lighting Europe

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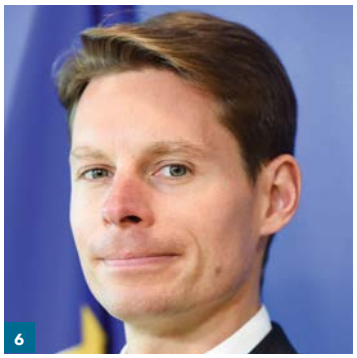
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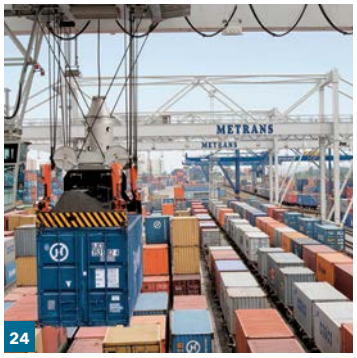

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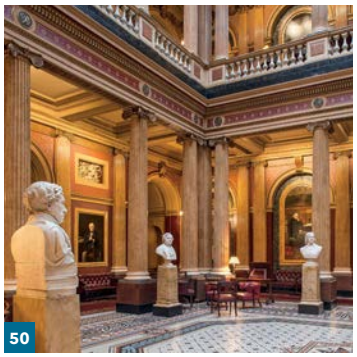
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Foreword

As we go to Press, Europe confronts many important and potentially dangerous issues, perhaps illustrated up by EU Commission President Juncker's comment: "We can't go on with business as usual". EEI is dedicated to innovative technologies, perhaps the means by which many of these problems may be surmounted.

In our Shipping feature in this issue, Jakub Adamowicz from the EU Commission discusses the potential role of LNG as a promising means of lowering the sulphur content of marine fuels, and so lowering emissions. Meanwhile, the Federation of European Private Port Operators (FEPORT), which speaks on behalf of more than 1200 large terminal operators and stevedoring companies, operating in over 400 seaports across the EU, reviews the role of the voluntary EEEG Guidelines in reducing the greenhouse gas emissions footprint for container terminals. Isabelle Ryckbost, Secretary General of the European Sea Ports Organisation (ESPO) emphasises the importance of Ports, which "supply, produce, use, store, import, transport, save, clean energy" Ms. Ryckbost goes on to explore the opportunities and challenges facing ports as they face up to climate change policy goals, geopolitical developments and volatility of energy prices.

In his excellent article, Dr.Arnulf Jäger-Waldau from the European Commission sounds note of caution about photovoltaic energy. Noting the rapid growth in installation, which appears set to continue as far as 2020, he nevertheless points to a future stagnation in the European market. Unrealistic FITs , a less than perfect legal framework point and variations in non-technical costs across the EU point to investment uncertainty. Nevertheless, he suggests that future reductions in the price of the technology might spur growth, particularly if both the legal and electricity distribution infrastructure are overhauled. Meanwhile, James Watson and Kristina Thoring of SolarPower Europe describe COP21 as an opportunity for global leaders to promote solar power. Climate change, they say, is "the urgent and defining issue of our time". They set out the rationale for photovoltaic energy in clear terms, which is based upon the falling cost of the technology and the high level of popular support.

In a time of increased global uncertainty, Angela Marlovits from Gas Infrastructure Europe (GIE) explains the rationale behind a methodology to increase security awareness (MEISA). Most companies, she points out, are conscious of the need to build a security awareness culture within their organizations, but better awareness among senior management and employees is needed. Identifying 23 methods to increase security and 11 methods to measure security awareness, she describes how MEISA has been developed for the gas network industry.

2015 is the International Year of Light: Carlos Lee and Louis Bonnefous review the history of lighting, from the candles and oil lamps of antiquity through arc lamps, incandescent filaments and fluorescents, to electroluminescence and LEDs. They discuss how important LED technology might become in preserving our cultural heritage, lighting buildings such as London's Reform Club, and protecting artwork from UV and IR irradiation. We may not be "in a good place." But innovation can take us to one.

And there is much more for you to read inside..

Michael Edmund
Editor

Does Europe abandon photovoltaics?

By Arnulf Jäger-Waldau, European Commission, Joint Research Centre; Institute for Energy and Transport, Renewables and Energy Efficiency Unit

During the last 15 years, solar photovoltaic electricity generation has grown from a niche market to provide about 250 TWh electricity in 2015, roughly 1% of the world electricity production. The IEA *Medium-Term Renewable Energy Market Report 2014* published in August 2014 estimates, that cumulative installed capacity of solar photovoltaic electricity systems will more than triple by 2020 compared to 2013.

After the world-wide photovoltaic market more than doubled in 2010[1], the market continued to grow steadily and has more than doubled to about 42.3 GW[2] in 2014. For 2015, an increase to more than 50 GW is expected (Fig. 1). This represents mostly the grid connected photovoltaic market. To what extent the off-grid and consumer product markets are included is not clear, but it is believed that a substantial part of these markets are not accounted for as it is very difficult to track them. The rapid growing markets in China, Japan and the USA more than compensated the stronger than expected market contraction in Europe which fell from a record of 18.5GW in 2011 to less than 7 GW in 2014 (Fig.2).

capacity of about 88 GW, the European Union is still leading in PV installations with 49% of the total world-wide 178 GW of solar photovoltaic electricity generation capacity at the end of 2014, but down from the 70% at the end of 2012. According to the IEA *Medium-Term Renewable Energy Market Report 2014* this share will drop below 30% by 2020 due to a stagnant market of 7 to 8 GW between 2014 and 2020.

What are the reasons and main consequences of this development?

Some Member States had introduced support schemes, which were not designed to react fast enough to the very rapid growing market and this led to unsustainable local market growth rates. To counteract, unpredictable and frequent changes of the support schemes as well as legal requirements led to installation peaks before announced deadlines as well as high uncertainty for potential investors. A number of retroactive changes have further decreased investment confidence.

The legal framework for the overall increase of renewable energy sources in the European Union was set with the Directive 2009/28/EC, and in the mandatory National Renewable Energy Action Plans (NREAPs), the

Figure 1 Cumulative Photovoltaic Installations from 2005 to 2015 (data source: EPIA[3], Eurobserver[4], JRC PV Status Reports[5] and JRC analysis)

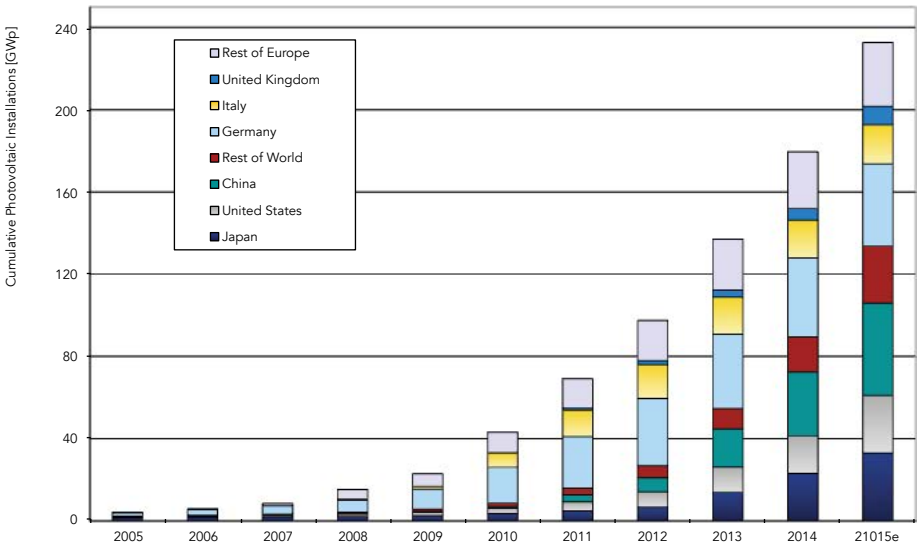


Figure 2 Annual Photovoltaic Installations in the European Union from 2005 to 2015 (data source: EPIA[3], Eurobserver[4] and JRC analysis)

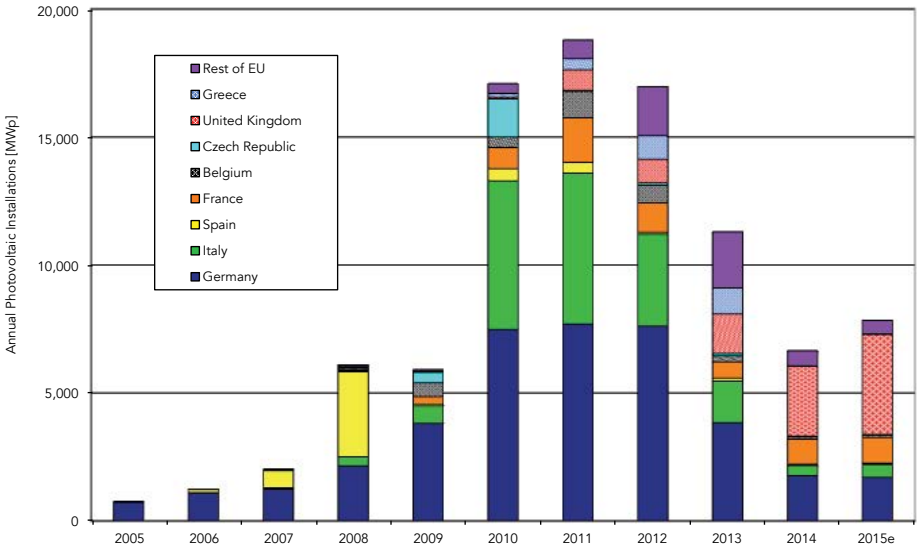
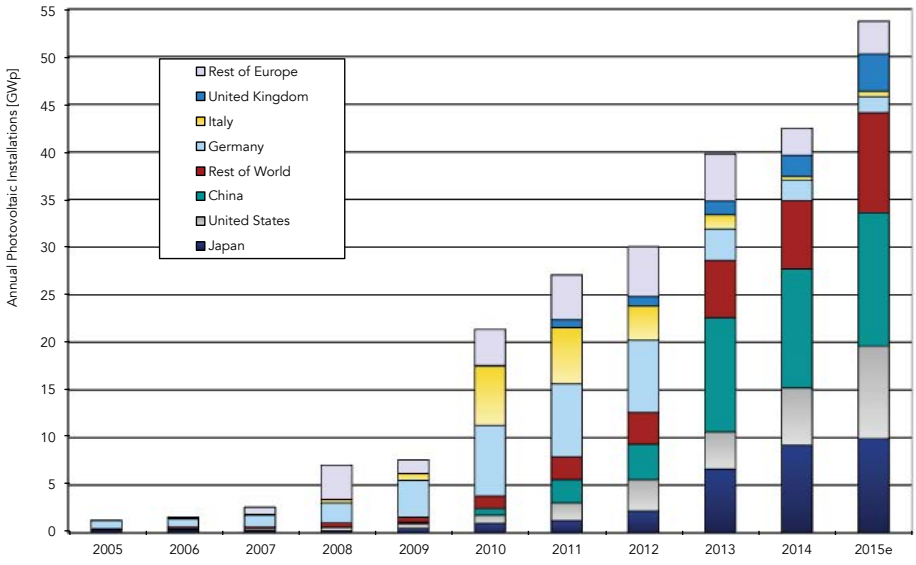


Figure 3 Annual Photovoltaic Installations from 2005 to 2015 (data source: EPIA[2], Eurobserver[3] and JRC analysis)



Member States have set specific photovoltaic solar energy targets, adding up to 84.5 GW in 2020. At the end of 2014, this target had been exceeded in the European Union as a whole (Fig. 4). The absence of mandatory national renewable energy targets for the period beyond 2020, as well as the ongoing changes in the regulatory frameworks give no investment security to potential investors. In addition, some of the European Member States introduced levies on electricity, which the consumer generates and consumes itself instantly at the time of generation.

One of the consequences/are the effects on local jobs and the local economy as already described in last year's edition[6]. Between 2011 and 2013 the PV jobs in Europe halved from over 260 000 in 2011 and this trend continued in 2014 and early 2015.

More than 75% of the 260,000 jobs were related to operating and installing solar photovoltaic electricity systems. Almost all of these jobs were local European jobs contributing to the European gross national product. The steep drop in new installations since then has led to a dramatic reduction of these local jobs and with it the positive effect on the local European economy.

The second main consequence of the decreasing solar photovoltaic electricity system market in Europe is the fact, that European citizens are not harvesting the fruits of electricity below the residential retail price, which is now available for a large number of them[7].

For over 40 years, governments all over the world have spent billions of Euros on R&D to lower the hardware costs of photovoltaic systems. The increasing market has enabled the industry to follow the price-experience or "learning" curve with an average learning rate for solar modules of about 80%, i.e. the average selling price (ASP) of solar modules fell by 20% for each doubling of the production volume. PV system prices have followed the lowering of module prices but at a slower pace. The reason for this is that non-technical costs have not

decreased at the same pace or sometimes even increased.

Despite the fact that a global market exists for the hardware components of a PV system, e.g. modules, inverters, cables, etc., and prices are very similar worldwide, the prices for installed PV systems still vary significantly. The reasons for these differences are manifold and range from the different legal requirements for permitting, licensing and connection to the grid to the different maturity of the local PV market, with impacts on competition between system developers and installers.

In July 2015 the European average price of a residential system was 1.25 €/Wp[8] including installation but without tax and administrative and connection costs. However, there is a wide spread in the costs of PV systems for home owners. A price survey showed that prices for installed PV systems between 1 and 10 kWp in the European Union varied from quotes as low as EUR 1000 per kWp to more than EUR 2600 per kWp. At the same time different VAT rates between 0% and 25% applied throughout the Union. Administrative and connection costs as well as fiscal and financing conditions are a further source of huge differences in the European Union. These non-technical costs vary much more within in the European Union than the solar radiation and can make PV use in sun-rich countries less attractive than in countries with an average solar radiation, but low non-technical costs.

Already at 5 % return on investment (ROI) the financing costs are the largest single cost factor. Together with fees and permit costs, they comprise about one-third of the electricity-generation costs from a residential PV system for the first 20 years. The influence of financing costs is shown in Figure 5. Therefore, reasonable financing is key to low-cost photovoltaic electricity.

The introduction of fixed network charges or levies to be paid on electricity generated with a PV system and self-consumed at the place and time of generation further add to a diversification of the attractiveness to install

Figure 4 Cumulative Photovoltaic Installations in the European Union from 2005 to 2015 (data source: EPIA[3], Eurobserver[r4] and JRC analysis)

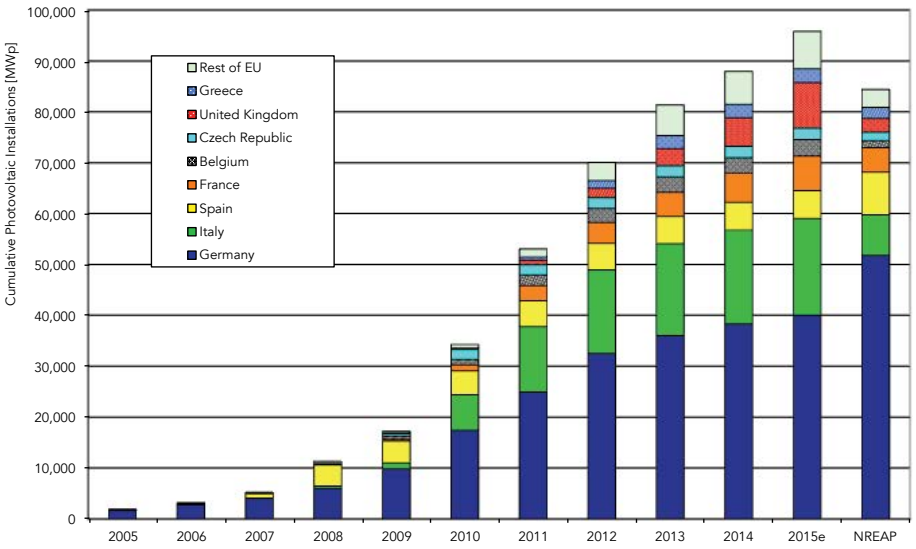
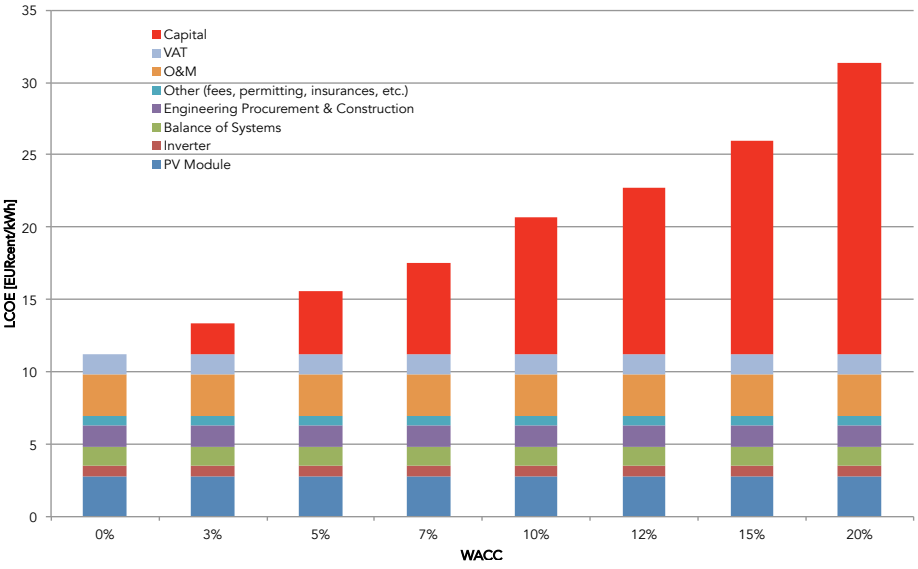


Figure 5 Influence of WACC on LCOE (LCOE of PV-generated electricity for residential systems with a system price of 1 400 EUR/kW, 20% VAT, 2% O&M cost, an annual generation of 1 000 kWh/kWp/year and a financial lifetime of 20 years.)



Dr. Arnulf Jäger–Waldau is a Scientific Officer and Senior Scientist at the Renewables and Energy Efficiency Unit, Institute for Energy and Transport of the European Commission's Joint Research Centre since 2001. He works on the assessment of renewable energy technologies, the effectiveness of their implementation, their integration into energy infrastructures and the role of renewable energy for climate change mitigation.

Since 1987 he works in the field of material research for solar cells and holds patents on semiconductor material deposition for thin film solar cells and solar module design.

He has more than 200 publications in peer reviewed journals and conference proceedings ranging from materials research for PV and solar cell development to market studies and policy evaluations for Renewable Energies. He is the author of the European Commission's annual "Photovoltaic Status Report", which is published annually since 2002.

From 2011 to 2014 he was the Technical Chairman of the European Photovoltaic Solar Energy Conference (EUPVSEC) and the European Co-Chair of the 6th World Conference on Photovoltaic Energy Conversion Kyoto, Japan in November 2014.

Dr. Jäger-Waldau was a Lead Author for Solar Energy of the Special Report of the IPCC on Renewable Energy and Climate Change Mitigation published in 2011. He served as a reviewer of the Global Energy Assessment Report (GEA) published in 2012 and of the 5th Assessment Report (AR5) of IPCC.

He serves as Academic Committee Vice Chairman member of the Asian Photovoltaic Industry Association (APVIA), member of the International Advisory Board of the Warsaw University Photovoltaic Centre and member of the Scientific Advisory Board of the Solar Research Centre of the Bulgarian Academy of Science. From 2005 to 2013 he was a member of the Executive Committee of the European Materials Research society (E-MRS).

a PV system. The European Commission in a recently published document is advocating the use of "Best practices on renewable Energy Self-consumption"[9]. Amongst other best practices, the paper is calling for an *"Avoidance of discriminatory charges for self-consumption projects" and "Acknowledging the different national conditions, ensuring that possible future grid tariff reforms promote both renewable energy and energy efficiency objectives, are based on objective and non-discriminatory criteria and reflect the impact of the consumer on the electricity grid, while guaranteeing sufficient funding for grid and system costs"*.

As further price reductions for PV systems and rising electricity prices can be expected over the coming years, solar photovoltaic electricity generation offers an interesting option for European citizens if the non-technical costs are minimized. A 30% self-generation of solar photovoltaic electricity of the more than 210 million European households would correspond to 220 TWh or about 8% of the current electricity demand. This would require more than double the current installed capacity and thus could revitalize the European market.

As not all households have the possibility to install a PV system directly on their roof, either because they are tenants, live in multi-family or high rise buildings, or in other buildings which are not suitable, new regulations and legal framework conditions are needed to unlock this potential and revitalize the European PV market. Possible solutions could be the possibility of local electricity co-operatives or other business models, where a number of users would generate the electricity behind one substation, without feeding electricity back to the main grid. To make such a vision come true, a new design of the electricity as well as the distribution of electricity infrastructure costs has to be realized. As long as Europe blocks such new developments and continues to impose new non-technical costs its PV market will remain weak.

1. The 2010 market volume of 20.9 GW includes those systems in Italy, which were reported under the second "conto energia" and installed, but connected only in 2011.
2. The 2014 market volume includes those systems in China, which were installed in 2014 but only connected in 2015. The Chinese New Energy Administration reported over 5GW of new installations for Q1 2015, but it is estimated that between 40 to 50% of this capacity was already installed, but not connected at the end of 2014.
3. European Photovoltaic Market Contracts in a Rapid Expanding Global Market, Arnulf Jäger-Waldau, European Energy Innovation, Autumn 2014, 52 – 56
4. Cost Maps for Unsubsidised Photovoltaic Electricity, T. Huld, A. Jäger Waldau, H. Ossenbrink, S. Szabo, E. Dunlop, N. Taylor, JRC Technical Report 2014
5. PVinsight, 21 July 2015, http://pvinsights.com/SolarSystem/SolarSystemPrice.php
6. Commission Staff Working Document, Best practices on renewable Energy Self-consumption, Brussels, 15.7.2015 SWD(2015) 141 final, Accompanying the document: Communication from the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Delivering a New Deal for Energy Consumer, {COM(2015) 339 final}
7. Cost Maps for Unsubsidised Photovoltaic Electricity, T. Huld, A. Jäger Waldau, H. Ossenbrink, S. Szabo, E. Dunlop, N. Taylor, JRC Technical Report 2014
8. PVinsight, 21 July 2015, http://pvinsights.com/SolarSystem/SolarSystemPrice.php
9. Commission Staff Working Document, Best practices on renewable Energy Self-consumption, Brussels, 15.7.2015 SWD(2015) 141 final, Accompanying the document: Communication from the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Delivering a New Deal for Energy Consumer, {COM(2015) 339 final}