

Photovoltaic waste assessment in Italy



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ARTICLE INFO

Article history:

Received 12 May 2014

Received in revised form

23 July 2014

Accepted 30 July 2014

Available online 6 September 2014

Keywords:

Photovoltaic energy

WEEE assessment

Recovery

Resources

ABSTRACT

At present, photovoltaics is, after hydro and wind power, the third most important renewable energy source in terms of its capacity to be globally installed; furthermore, for two years in a row, it was the number one new source of electricity generation installed in the European Union. Italy became the second country in the European Union concerning the cumulative installed power of PV (in 2013, the Italian PV cumulative power reached over 17,620 MW), which was also the result of the very attractive support policy.

In connection with this development, the issue has emerged about the treatment and disposal of photovoltaic waste when the operative time (approximately twenty-thirty years) of the photovoltaic systems ended. The European Union, to address this environmental impact, passed the Directive 2012/19/EU to increase the amount of waste of electrical and electronic equipment in the form of photovoltaic panels that have been appropriately collected and treated to reduce the volume that become disposed. This paper aims to provide an assessment of the potential waste arising in Italy from the use and end-of-life phases of these renewable energy systems in the coming years and their disposal and/or recycling. Based on the lifetime of 25 years of photovoltaic panels, the estimate has been referred to two periods of waste generation (2012–2038 and 2039–2050). The importance of managing this flow of waste to enhance the correct disposal of the hazardous substances as well as the importance of the recovery and recycling of valuable resources has also been underlined.

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1. Introduction

Photovoltaic (PV) energy, which was used for the first time in space application technology, can be used for many applications that require electricity.

Its versatility as well as the simplicity of its installation and use have made it a popular and environmentally friendly technology. At present, PV is, after hydro and wind power, the third most important renewable energy source in terms of its capacity to be globally installed, and for two years in a row (2011 and 2012), PV was the number one new source of electricity generation installed in the European Union (EU).

The role of the EU regulation in the promotion of renewable energies, driven by the Kyoto Agreements, was relevant as was the

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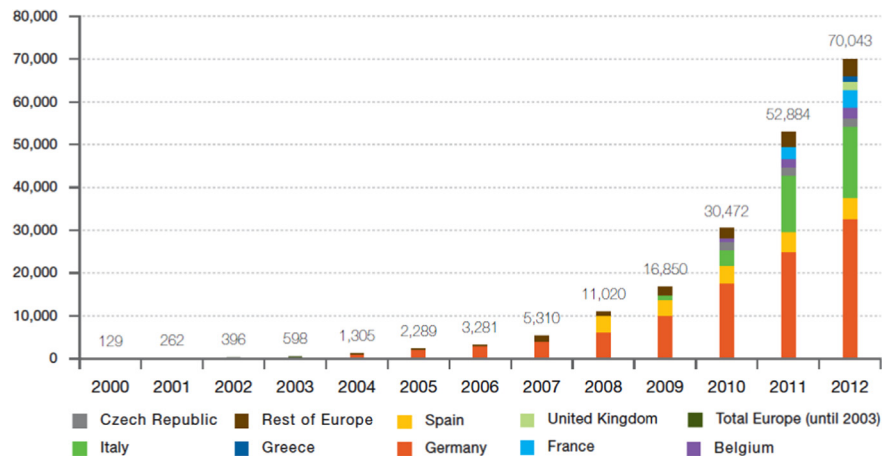


Fig. 1. Evolution of cumulative installed PV capacity in Europe (2000–2012) (MW).

reduction of the costs incurred over the years in the production, assembly and installation of PV panels. Each Member State has adopted a different support policy to compensate for the higher costs of renewable energies in order to develop these energy sources and meet the 20/20/20 renewable energy target provided by the EU Directive 2009/28/CE.

Italy has always been heavily dependent on foreign countries with regard to its energy supply. As a consequence, adequate strategies to solve the problem have been urgently needed. In the last ten years, renewable energies have been developed, particularly wind and photovoltaic ones. With reference to the last energy in 2013, its cumulative power installed reached over 17,620 MW, and the number of plants reached approximately 550,000. Since 2008, the PV power sharply increased by 3591% and the number of plants by 1315%. As a result, Italy became the second country in the European Union concerning the cumulative installed power of PV, as Fig. 1 shows [1].

With a very attractive support scheme, the Italian government has had a relevant role in the decrease of prices and consequent development of photovoltaic energy. The national support programme, called Conto Energia, started in 2005, has become much more favourable since 2007. It consists of a mix of measures, like net metering and a well-segmented feed-in tariff. From 2011 to the present, the central government policy has led to a reduction of these incentives and consequently to a decrease in the growth of these renewable energy systems.

In connection with this development, one issue that has emerged is about the treatment and disposal of the photovoltaic waste when the operative time (approximately twenty-thirty years) ends. In Italy, the new growth of these installations as a result of this concern is just beginning, compared with other countries, like Germany, where the photovoltaic energy has been widespread since more years than Italy and the quantity of the end-of-life panels is becoming a concern, although significant volumes of them will not appear until 2025. The European Union, in an attempt to address this environmental impact, passed the Directive 2012/19/EU to increase the amount of waste of electrical and electronic equipment (WEEE) [2] in the form of photovoltaic panels, which are appropriately collected and treated to reduce the amount that goes to disposal as well as to give Member States the tools to more effectively fight the illegal exportation of waste. Besides, what emerges is the importance of recycling the materials in the photovoltaic panels for many economic, environmental and social implications.

The exponential growth in the installed photovoltaic systems is what stimulated this paper, which aims to assess the potential waste arising in Italy from the use and end-of-life (EOL) phases of

these renewable energy systems in the coming years as well as in their disposal and/or recycling. Thus, after a review of the European Union's regulations about this issue and the description of the main technological innovations of the sector over the years, an overview of the PV market and industry has been provided. Then, I have assessed the quality and quantity of the materials embodied in the PV systems, differentiated by various technologies, particularly those based on crystalline silicon and thin film, which are currently the main PV power systems used worldwide. Based on a lifetime of 25 years of photovoltaic panels, this assessment has been estimated with reference to two periods of waste generation (2012–2038 and 2039–2050). The conclusions of the paper underlined the importance of managing this flow of waste to ensure the correct disposal of the hazardous substances as well as the recovery and recycling of valuable resources.

2. Regulation of photovoltaic waste

As the market continues to expand and innovation cycles become even shorter, the replacement of equipment accelerates, making electrical and electronic equipment a quickly growing source of waste.

In order to manage this flow of waste, boost the recovery and recycling of electronic devices, and limit the hazardous substances, including heavy metals and others, in early 2000, the European Union passed Directives 2002/96/EC and 2002/95/EC. In December 2008, the European Commission proposed to recast the first one, and in 2012, the new Directive 2012/19/EC was passed. For the first time, the photovoltaic systems' installations at the end of the useful life are included in the list of WEEE as a result of their growth and the issue about their proper recycling and disposal.

The Directive aims to improve the collection, re-use and recycling of used electronic devices to contribute to the reduction of waste and the efficient use of resources. It also seeks to limit illegal exports of such waste from the EU and to improve the environmental performance of all operators involved in the life cycle of EEE, e.g., producers, distributors and consumers.

Moreover, the Directive establishes the producer's responsibility as a means of encouraging the design and production of EEE, which take into full account and facilitate repair, upgrading, re-use, disassembly and recycling of this equipment. It also provides for the collection, free of charge to end users, of small WEEE (no more than 25 cm), at retail shops with sales areas relating to EEE of at least 400 m², or in their immediate proximity.

Annex V of the Directive provides for minimum recovery of targets applicable by category and by time frame. As regards the

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