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An overview of solar photovoltaic energy in Mexico and Germany



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ABSTRACT

Energy is essential for our preservation and the improvement of our life-style. Today all major production of energy is generated from fossil fuels, which are non-renewable and significantly pollute the environment. Access to clean and reliable energy is crucial for assuring the development of countries such as Mexico. Mexico's economy is based on producing energy from fossil fuels¹ and the change to sustainable ways of life is still uncertain. It becomes essential to look at developed countries where the transition to sustainability has been rapidly increasing. This paper gives an overview of energy policies and the potential of solar photovoltaic energy in two countries: Germany, a world leader in the generation and development of photovoltaic technology; and Mexico, a country with great solar photovoltaic potential. It also describes the characteristics, advantages and disadvantages of photovoltaic technology, including BIPV systems.

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¹ 91% of Mexico's energy is produced from non-renewable energy sources. Moreover, 36% of primarily renewable energy corresponds to the use of firewood for cooking used in a non-healthy and non-sustainable way [42]. GTZ is the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH (German Technical Cooperation, German Federal Ministry for Economic Cooperation and Development).

1. Introduction

This paper aims to provide an overview of the current situation of Mexico's energy generation, the existing policies and programmes developed to encourage the use of renewable energy sources (RE) and particularly the potential use of photovoltaic technology. This will be compared to the use of RE systems in Germany with special focus on photovoltaic solar energy for electricity generation, which is one of the most rapidly changing and expanding technologies within the RE industry and whose potential greatly depends on the availability of

solar radiation. This is clearly important in a country with an abundance of sunshine such as Mexico, with an average annual solar radiation of approximately 5 kWh/m²/day [1].

The importance of producing energy from renewable sources such as photovoltaic depends on the following:

- An increasing demand for energy, especially in developed and some developing countries with fast economic growth, such as China and India.
- The need for energy in remote areas.
- A decreasing availability of fossil fuels.
- The reduction of CO₂ emissions and their effects on population health and air pollution.

2. The energy situation in Mexico and Germany

According to the Energy Ministry of Mexico (SENER), in 2011, 92% of Mexico's energy came from fossil fuels, mainly oil (65%) and natural gas (23%),² while just 7% was produced with renewable energy sources, where biomass represented 54%, geothermal 23%, hydroelectricity 20%, wind energy 0.9%, solar energy 0.9% and biogas 0.2% of the energy produced with renewables. In addition, nuclear energy³ represented 1.15% of the total energy produced [2]. In 2012, Mexico had 1411 MW of installed capacity for energy generation based on renewable energy sources without including hydroelectric; this represented 2.6% of the total installed capacity for energy production in the country [3].

SENER has pointed out that reliance on fossil fuels for energy production in the country will not be enough to meet Mexico's future energy demand. From the year 2000 to 2011 Mexico's energy consumption increased 2.08% annually, while the energy production rate decreased 0.3% every year [4]. Hence, the government has predicted that in 2020 Mexico will suffer an energy deficit. Recently, Mexico's President Enrique Peña Nieto has presented a proposal to modify the Constitution in order to allow foreign companies to finance oil extraction from sources that demand advanced technology. In January 2013, total oil reserves in Mexico comprised 44,530 million barrels of crude oil equivalent (MMbpcpe); that figure is integrated by three different kinds of reserves: confirmed oil reserves (13,868 MMbpcpe), probable oil reserves (12,306 MMbpcpe) and possible oil reserves (18,356 MMbpcpe).⁴ According to PEMEX (the government owned oil company) based on the energy production from 2012, Mexico's total oil reserves (also known as 3P) will last 32.9 years; however, if we consider only Confirmed oil reserves, the production will last merely 10.2 years [5]. In order to improve that situation, the SENER has established a number of objectives and actions that will take place during the next 14 years. There are three main strategies:

1. *Energy security*: To ensure Mexico's energy demand will be met with good quality and sufficient energy for its current and future population.

² Oil production and exportation in November 2011 represented 39.1% of the national public income of Mexico [43].

³ There is only one nuclear plant in Mexico: Laguna Verde. It is located on the Mexico's Gulf coast in the State of Veracruz. This plant has been operating since 1990.

⁴ *Total oil reserves (3P)* are the sum of confirmed oil reserves+probable oil reserves+possible oil reserves. *Confirmed oil reserves* are the term used to refer to energy sources commercially feasible, which are being currently harvested. *Probable oil reserves* include oil reserves that according to geological and engineering data could be commercially harvested, with at least 50% chance of recovering an amount of oil equal or greater than the sum of confirmed and probable oil reserves. Finally, *possible oil reserves* include those with less commercial harvest feasibility, where there is a 10% chance of reaching an equal or greater amount of oil obtained from the sum of confirmed reserves plus probable reserves plus possible reserves [44].

2. *Economic and production efficiency*: To use Mexico's energy resources as efficiently as possible, producing good quality energy at competitive prices and developing investment in infrastructure with maximum standards of health and safety practices.
3. *Environmental sustainability*: To reduce the environmental impact caused by the production and consumption of energy; making a sustainable use of hydro and soil resources.

On the other hand, in 2011, renewables in Germany accounted for 12.5% of total energy consumption and 20.3% of gross electricity consumption. The latter is expected to rise to 80% by 2050 [6]. In order to expand the use of renewable energy sources in Germany the government has implemented strategies such as the Renewable Energy Sources Act, which assure the acquisition of electricity from renewable sources to producers at a fixed price during 20 years [6].

According to the German Energy Agency [7], due to the increasing number of renewable energy systems installed nationally and increasing exports of technology, the renewable energy (RE) industry in Germany has considerably increased during the last 20 years, becoming an important economic factor. The photovoltaic sector in Germany employed 110,000 full time working people at the end of 2011 [7]; and it is expected to triple by 2030 [8]. This rising employment figure has led to a growing demand for skilled people and therefore, education programmes in this area have expanded within universities offering postgraduate courses, diplomas, or technical courses. The number of people from abroad going to Germany to study one of these specialisation courses is rising, producing a new source of income as well. On the other hand, the estimated PV-related labour in Mexico in 2010 was 146 jobs (including Research and Development, manufacturing of products, distribution of PV products, systems and installation companies and electricity utility businesses and government) [9].

In addition, Germany has become a world reference in the development and installation of RE. Expanding its use worldwide will secure a more sustainable future and a lower reliance on fossil fuels for electricity generation. Hence, in order to build up markets for RE and to expand its use in other countries, Germany has established an international cooperation where businesses, consultants and development cooperation institutions are sharing their experience with other countries. This is the case of Mexico. The *Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH* (German Technical Cooperation, German Federal Ministry for Economic Cooperation and Development) has been working closely with Mexico's government through the SENER, the Energy Regulatory Commission (CRE), the National Commission for Energy Efficiency (CONUEE), the Federal Electricity Commission (CFE), which is the public and only power utility and network operator in Mexico, and the Ministry of Environment and Natural Resources (SEMARNAT). The collaboration project, called "Sustainable Energy in Mexico", began in 2009 and will finish in 2013. The main aim of the project is to expand the use of RE in Mexico and to improve the energy efficiency of the country.⁵ Another aim of the project is to assess the energy and economic potential of Mexico to use photovoltaic technology both in off-grid systems and as a part of the national electricity grid.

Moreover, this cooperative project also intends to encourage the use of one of the recent improvements in PV technology that is currently being widely used in Europe. This is the development of building integrated solar photovoltaic technology (BIPV), which

⁵ More information regarding the "Sustainable Energy in Mexico" project is available at the GTZ web page: <http://www.gtz.de/en/weltweit/lateinamerika-karibik/mexiko/27816.htm> [accessed: 16.02.12].

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