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Market financial analysis and cost performance for photovoltaic technology through international and national perspective with case study for Egypt

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ABSTRACT

This paper presents the photovoltaic technology, the world's market trends in the past few years and its future map till 2050. The paper shows the PV market development in the world in terms of cumulative installed PV capacity from 2000 to 2013 as actual PV installation in all the world in terms of total installed PV capacity (135 GW), annual installed PV capacity (37 GW) and PV electricity energy generated in each year. According to the forecast of global PV generation, China is expected to be the largest producer of PV electricity soon after 2020. By contrast, the United States' share is expected to remain at about 15% starting 2020 onwards, while Europe's share is expected to decrease constantly from 2015 to 2045. The paper also shows that almost all of the energy consumption in Egypt was met by oil and natural gas at 41% and 46% respectively. The remainder was supplied by coal and renewable energy sources. The current demand forecast expects a six percent demand growth per year over the next seven years. Egyptian Electric Holding Company is currently implementing new generation projects to produce 7000 MW over the next few years. For the purpose of designing and sizing PV systems the paper presents the five relevant economic methods of financial analysis that are often used for making building investment decisions. These methods are payback analysis, net benefit analysis, saving-to-investment ratio, adjusted internal rate of return and life-cycle cost. In the same manner, the paper presents two case studies of the financial assessment analyzing PV systems in Egypt. The first case is relates to the on-grid PV 10 MW power plant for different sites, while the second paper describes the finance analysis of a standalone off-grid PV system generating electricity to feed a residential house in rural area of Egypt.

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1. Introduction

Current trends in energy supply and use are unsustainable – economically, environmentally and socially. Without decisive action, energy-related greenhouse-gas emissions would lead to considerable climate degradation with an average 6 °C global warming. Hence, we can and must change the path we are treading now. Sustainable and low-carbon energy technologies will play a crucial role in the energy revolution required to make this change happen. Energy Efficiency, many types of renewable energy, carbon capture and storage, nuclear power and new transport technologies will all require widespread deployment if we are to achieve a global energy-related CO_2 target in 2050 of 50% below current levels and limit global temperature rise by 2050 to 2 °C above pre-industrial levels [1]. This will require significant global investment in decarburization, which will largely be offset by reduced expenditures on fuels. Nonetheless, this supposes an important reallocation of capital. To address this challenge, the world studied the development of a series of technologies which identify the steps needed to accelerate the implementation of technology changes.

PV technology has grown over the past decade at a remarkable rate – even during difficult economic times – and is on the way to becoming a major source of power generation for the world [2]. After record growth in 2011, the global PV market stabilized, with capacity additions in 2012 slightly above those achieved in 2011.

By the end of 2009, the world's cumulative installed PV capacity was approaching 24 GW. One year later it was 40.7 GW and at the end of 2011 it was 71.1 GW. In 2012, more than 100 GW of PV were installed globally — an amount capable of producing at least 110 TW h of electricity every year. This energy volume is sufficient to cover the annual power supply needs of over 30 million European households [3].

The year 2012 was another historic one for solar photovoltaic (PV) technology, which has experienced remarkable growth over the past decade and is on the way to becoming a mature and mainstream source of electricity. The world's cumulative PV capacity surpassed the impressive 100-gigawatt) GW) installed electrical power mark, achieving just over 102 GW. This capacity is capable of producing as much annual electrical energy as 16 coal power plants or nuclear reactors of 1 GW each.

2. Methodology

PV can help Egypt meet its sustainable development goals through provision of access to clean, secure, reliable energy. The paper explains removing the main barriers of financing and starting to introduce peak, medium load and base load segments market of power supply.

The paper also aims to obtain a range of data sources with the objectives of developing PV technologies as conventional energy sources are limited and will gradually be depleted, which will create a shortage in energy supply in the near future. This could be resolved by decreasing the gap between e supply and demand through energy efficiency and utilize alternative energy sources which will be most likely Renewable Energy sources especially PV technology.

Added to this, the paper presents a strategy for the market introduction of Photovoltaic (PV) in Egypt. In the first section, the paper explains international and national PV market development and represents economics methods for PV financial analysis. In the second part, the cost development of PV is calculated on the basis of expectations for the expansion of PV on the national level.

3. PV market development

Europe remains the world's leading region in terms of cumulative installed capacity, with more than 70 GW as in 2012. This represents about 70% of the world's cumulative PV capacity (compared to about 75% of the world's capacity in 2011). Next in the ranking are China (8.3 GW), USA (7.8 GW), followed by Japan (6.9 GW). Australia (2.4 GW) and India (1.2 GW), have addressed only a very small part of their enormous potential. Several countries from large Sunbelt regions like Africa, Middle East, South East Asia and Latin America are on the brink of starting their development. Even so, the cumulative installed capacity outside Europe reached 30 GW as in 2012. Fig. 1 shows evolution of global PV cumulative installed capacity in the world (MW), while Fig. 2 demonstrates the evolution of global PV annual installations [3].

Europe's market has progressed rapidly over the past decade: from an annual market of less than 1 GW in 2003 to a market of over 13.6 GW in 2010 and 22.4 GW in 2011, even in the face of difficult economic circumstances and varying levels of opposition to PV in some countries. But the record performance of 2011, driven by the fast expansion of PV in Italy and again a high level of installations in Germany, was not repeatable in 2012 and the market went down to 17.2 GW, as shown in Fig. 2. For the first time in the last 12 years, the PV market in Europe decreased in terms of new connected capacity [3]. Even so, in 2012 the PV market in Europe again exceeded all expectations. However, due to variable delays in connecting PV systems to the grid depending on the country, some installations from 2010 were not connected until 2011 and this repeated again in 2012. This has an impact on market perception.