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RENEWABLE ENERGY BASED ELECTRICITY GENERATION FOR ENERGY PROBLEM SOLUTIONS AND SUSTAINABLE DEVELOPMENT IN EGYPT

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ABSTRACT

The fast growth in energy demand and depletion of fossil fuels represents a severe challenge for the development of the national economy in Egypt. This emphasizes the importance of sustainable development to meet humanity's current needs without compromising future generations' needs. This thesis starts by highlighting the three dimensions of energy problem in Egypt which are the environment, the economy, and the society. For supplying energy demand, Egypt is heavily dependent on fossil fuels which account for about 94% of the fuel mix at the end of 2013. In recent years, Egypt starts facing power shortfall problems due to the declining of the Egyptian crude oil production and natural gas reserve. Furthermore, Egypt's greenhouse gas emissions (GHG) growth is among the fastest in the world. The energy sector is the major source of GHG emissions, contributing about 46% of the national total amount. As a result, the country involved struggle to build the necessary infrastructure to meet the demand and pursued a strategy plan aiming to reduce emissions and achieve contribution of renewable energies by 20% of the total electricity generation by the year 2020, and to diversify its energy source through the development of new and renewable energy resources. This study examines the long-term Solar, Biomass and Wind resources over Egypt to determine the feasibility of these resources as potential sustainable and renewable energy sources and thus its promising potentials for GHG emissions reduction. In this dissertation, three stand-alone studies on this subject are presented that address the future perspective of renewable energy in Egypt, considering technical, economic, as well as environmental aspects of renewable energy systems. **In the first study**, a transient simulation

model is developed to assess the solar energy potential under the Egyptian weather conditions. In this study, performance, economic, and environmental assessment of a solar parabolic trough collector field for stand-alone power plant with thermal storage is presented. This configuration is considered as a promising and sustainable solution to provide electricity and heat for an isolated area satisfying the local loads. Moreover, CSP will help to secure the energy supply, and overcome the electricity cut offs experienced in the summer months in Egypt. On the other hand, the electricity and heat supply from CSP plant will boost the development of the industrial activities, which in turn will improve the Egyptian economy. **In the second study** an investigation of biomass resources is presented. The study finds that it is technically viable to build up biomass power plant fed with rice straw in Delta region in Egypt. This could allow reducing dependency on fossil fuels as well reduction of greenhouse gas emissions. The LCOE is very competitive compared with the country conventional power system. **In the third study** an examination of regional wind energy potential is presented. In this study a technical and economic assessment is conducted for the electricity generation considering the new feed in tariff. This study provides a detailed overview of the wind power potential at different regions in Egypt, along the Mediterranean and Red Sea, and the western desert. A further technical and economic assessment is conducted for the electricity generation with eight different small wind turbines at 17 locations. The results reveal that wind power could be of a significant contribution to electricity supply in Egypt by the near future achieving the country RE strategy and goals. This study was put together to identify issues and opportunities related to renewable energy in the region, since renewable energy technologies are still limited in Egypt because, compared to the cost of conventional electricity in Egypt, the cost of renewable energy-based electricity is very high. However, the abundant availability of solar, biomass and wind energy as clean renewable energy in Egypt offers the country significant opportunities to become a leader in the renewable energy sector.