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FACULTY OF ENGINEERING AND ARCHITECTURE

**On-Shore Wind Farm Construction in
Lebanon**

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BACKGROUND, PROBLEM STATEMENT AND JUSTIFICATION

Recently, renewable energy has been highly sought after and related technology has been rapidly increasing due to the high price and diminishing quantity of fossil fuel resources (Burger et al., 2007). Wind power, in use for centuries, has become the leading mechanically-based source of renewable energy (Carns, 2009). Since the 1970s, large interconnected wind-driven turbines and generators have been constructed in “farms” to generate electricity. Europe and North America, in particular Germany, Spain and the United States (USA) (Bolinger and Wiser, 2010), have been leading the world in cumulative wind power capacity capturing nowadays around 75% of the worldwide market (Figure 1).

On the other hand, a number of governments in the Middle East and North Africa (MENA) region have started developing national plans for renewable wind energy (GWEC Report, 2006) and are currently generating around 2 GW. In fact, the geography and climate conditions of the MENA region are highly conducive to the development of renewable energy sources, most notably wind energy production. In North Africa, three countries have emerged as leaders in wind power generation, i.e. Egypt, Morocco, and Tunisia (Allen & York, 2011). Egypt is the one leading the region with the largest addition of a new capacity in 2010 (120 MW), bringing the total up to 550 MW. Morocco comes in a distant second with a cumulative capacity of 286 MW, of which 30 MW were added in 2010. Tunisia added 60 MW of new capacity in 2010, taking the total up to 114 MW. Other promising countries in the region include Ethiopia, Kenya, Tanzania and South Africa, where wind project development is slowly yet firmly underway.

In the Middle East, Iran has been always considered the leader in wind power generation (GWEC Report, 2006). Iran has large fossil fuel reservoirs such as natural gas and crude oil, but due to the limitation of these resources and their environmental pollution, the application of wind energy has developed quickly (Moghaddasi, 2009). Ardabil province, for example, has the capacity of generating up to 500 MW. Jordan has a target of achieving 7% of its primary energy demand from renewable energy by 2015, and 10% by 2020 (El Tawafsheh, 2012). Syria’s target for renewable energy is to make up to 4.3% of primary energy demand by 2011 and includes a proposed tender for two wind turbine parks to generate a total of 130 MW (Picow, 2010). Oman has also considerable wind energy potential, mainly in the south and in the mountains north of Salalah. While the Gulf region may seem an unlikely place for renewable power, given its abundance of fossil fuels, Sir Bani Yas Island, on the western coast of Abu Dhabi, is the site of the Middle East’s largest wind turbine (Al Makahleh, 2012). This turbine, which stands 65

Meters high and has three rotor blades each with a 52 meter wing span, has a production capacity of 850 KW per hour. The energy produced is being used to power the island's facilities alongside conventional supply from the national grid. However, in comparison to the MENA region, Lebanon is considered behind in terms of wind power energy (Hassan, 2011). For the past thirty years, Lebanon has been experiencing cuts in electricity, and thereby has been compelled to both import it and use noisy and extremely unhealthy generators. This quite happened at very high prices with even mediocre quality. Hence, an adequate solution to this shortage in electricity supply can be achieved through the use of renewable energy, in particular wind energy or power produced from wind farm turbines. It is believed that an extensive development of wind energy in Lebanon can play a crucial role towards reaching the set target of 12% of renewable energy by 2020 (Hassan, 2011). One of the current main wind energy sources available in Lebanon is located on Dahr Al Baydar road and other small wind turbines can be seen on the side of the roads but all of these are rarely functioning. Recently, the first rooftop vertical wind turbine was installed on a building near Marina, Dbayeh to feeds it with power.

There is thereby a clear and critical need for addressing the aforementioned complexities presented in Lebanon by fostering the use of renewable wind sources of energy through the design, management, and construction of an on-shore wind turbine farm. While some of the issues associated with other types of construction projects are common to these facilities or plants, large wind farm construction of a magnitude presented in this research effort is relatively new in Lebanon and offers unique challenges (site topography, lack of a paved road network, logistics involved with acquiring and managing resources in remote locations, etc.).