

Life Cycle Assessment of an Onshore Wind Turbine in Kuwait

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Abstract : Wind energy technologies are considered to be among the most promising types of renewable energy sources due to the growing concerns over climate change and energy security. Kuwait is amongst the countries that began realising the consequences of climate change and the long-term economic and energy security situation, considering options when oil runs out. Added to this are the fluctuating oil prices, rapid increase in population, high electricity consumption and protection of the environment. It began to make efforts in the direction of greener solutions for energy needs by looking for alternative forms of energy and assessing potential renewable energy resources, including wind and solar. The aim of this paper is to examine wind energy as an alternative renewable energy source in Kuwait, due to its availability and low cost, reducing the dependency on fossil fuels compared to other forms of renewable energy. This paper will present a life cycle assessment of onshore wind turbine systems in Kuwait, comprising 4 stages; goal and scope of the analysis, inventory analysis, impact assessment and interpretation of the results. It will also provide an assessment of potential renewable energy resources and technologies applied for power generation and the environmental benefits for Kuwait. An optimum location for a site (Shagaya) will be recommended for reasons such as high wind speeds, land availability and distance to the next grid connection, and be the focus of this study. The potential environmental impacts and resources used throughout the wind turbine system's life-cycle are then analysed using a Life Cycle Assessment (LCA). The results show the total carbon dioxide (CO₂) emission for a turbine with steel pile foundations is greater than emissions from a turbine with concrete foundations by 18 %. The analysis also shows the average CO₂ emissions from electricity generated using crude oil is 645gCO₂/kWh and the carbon footprint per functional unit for a wind turbine ranges between 6.6 g/kWh to 10 g/kWh, an increase of 98%, thus providing cost and environmental benefits by creating a wind farm in Kuwait. Using a cost-benefit analysis, it was also found that the electricity produced from wind energy in Kuwait would cost 17.6 fils/kWh (0.05834 \$/kWh), which is less than the cost of electricity currently being produced using conventional methods at 22 fils/kWh (0.07\$/kWh), i.e., a reduction of 20%.

Keywords : CO₂ emissions, Kuwait, life cycle assessment, renewable energy, wind energy

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