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Assessment of On-Site Solar and Wind Energy at a Manufacturing Facility in Ireland

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Abstract : The feasibility of on-site electricity production from solar and wind and the resulting load management for a specific manufacturing plant in Ireland are assessed. The industry sector accounts directly and indirectly for a high percentage of electricity consumption and global greenhouse gas emissions; therefore, it will play a key role in emission reduction and control. Manufacturing plants, in particular, are often located in non-residential areas since they require open spaces for production machinery, parking facilities for the employees, appropriate routes for supply and delivery, special connections to the national grid and other environmental impacts. Since they have larger spaces compared to commercial sites in urban areas, they represent an appropriate case study for evaluating the technical and economic viability of energy system integration with low power density technologies, such as solar and wind, for on-site electricity generation. The available open space surrounding the analysed manufacturing plant can be efficiently used to produce a discrete quantity of energy, instantaneously and locally consumed. Therefore, transmission and distribution losses can be reduced. The usage of storage is not required due to the high and almost constant electricity consumption profile. The energy load of the plant is identified through the analysis of gas and electricity consumption, both internally monitored and reported on the bills. These data are not often recorded and available to third parties since manufacturing companies usually keep track only of the overall energy expenditures. The solar potential is modelled for a period of 21 years based on global horizontal irradiation data; the hourly direct and diffuse radiation and the energy produced by the system at the optimum pitch angle are calculated. The model is validated using PVWatts and SAM tools. Wind speed data are available for the same period within one-hour step at a height of 10m. Since the hub of a typical wind turbine reaches a higher altitude, complementary data for a different location at 50m have been compared, and a model for the estimate of wind speed at the required height in the right location is defined. Weibull Statistical Distribution is used to evaluate the wind energy potential of the site. The results show that solar and wind energy are, as expected, generally decoupled. Based on the real case study, the percentage of load covered every hour by on-site generation (Level of Autonomy LA) and the resulting electricity bought from the grid (Expected Energy Not Supplied EENS) are calculated. The economic viability of the project is assessed through Net Present Value, and the influence the main technical and economic parameters have on NPV is presented. Since the results show that the analysed renewable sources can not provide enough electricity, the integration with a cogeneration technology is studied. Finally, the benefit to energy system integration of wind, solar and a cogeneration technology is evaluated and discussed.

Keywords : demand, energy system integration, load, manufacturing, national grid, renewable energy sources
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