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Hydrogen Production by Wind Power: An Economic Analysis

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Abstract: *Hydrogen systems have been undertaken in this study. As The study utilizes the yearly energy production of a privately-owned wind power plant in Izmir Cesme as a reference. Calculations are based on the facility's annual electrical power curves and the potential hydrogen and electrical power output. The hydrogen power plant operated at approximately 50% load factor, resulting in a hydrogen cost of 0.043 $/MJ. Graphs illustrate potential electricity costs for various load factors. At a 0.40 load factor, the unit hydrogen cost is 0.98 $/MJ, while at 0.70, it decreases to 0.40 $/MJ. The findings are examined, and visual representations are used to elucidate the impact of enhanced power and load factor of the unit cost of hydrogen.*

Keywords: *Economic analysis, Hydrogen energy, Wind energy, Renewable, Battery*

I. Introduction

Research on wind hydrogen systems is ongoing. According to Sherif et al [1], wind-hydrogen systems can be implemented alongside wind power facilities and prove highly efficient, whether operating independently or as part of a network. The wind power potential of Izmir Cesme has been measured by Ozdamar et al. [2], and emphasized as much more economical when wind technologies mature. Grabovski Research conducted by M. Et al. has examined the emissions from these facilities. Their findings indicate that emission levels for plants of comparable power output are significantly decreased, correlating with the reduction in emission values from natural gas thermal power plants. Criteria have been established to determine the optimal power source. They are not damaging to the environment, they are easy to obtain in nature, they can be used in simple and low-cost systems easily, easily implemented in applied science fields .

II. System Introduction

The process requires electrical power to function. The research aims to utilize wind-generated electricity to produce hydrogen gas through electrolysis. Wind turbines typically supply electricity to their surrounding areas, but they may also be connected to the broader energy grid. As illustrated in Figure 1, the system comprises wind turbines, buildings, and electrical equipment.

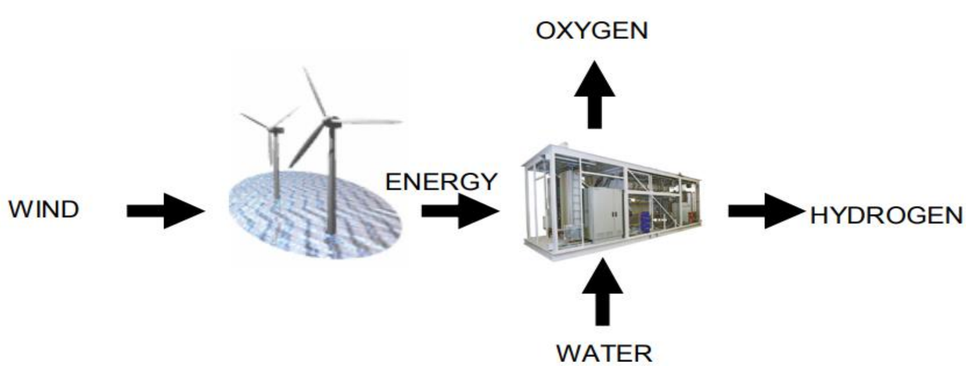

Figure 1: General configuration of the Model System

III. Analysis of the Location

The wind power plant from which this thesis obtains its data is situated in the Germiyanli village of Cesme, Izmir. The location of this facility is depicted on the map shown in figure 2.

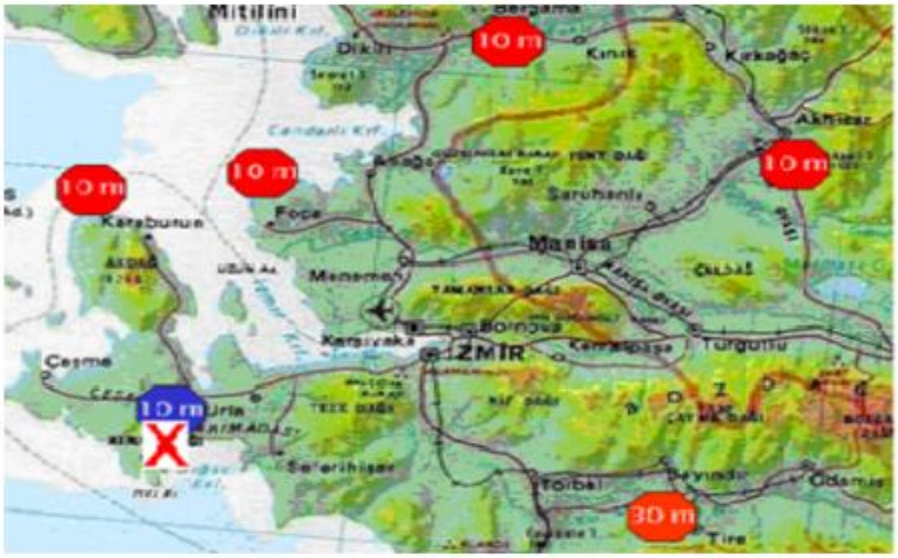

Figure 2: Analysis of the System Location

The wind speed is calculated at higher value than Turkey's wind speed when the wind data is determined. However, wind power plants in Turkey can be installed in this region. Three continuous 500 kW wind turbines are in Germiyanli Village and belong to Demirer AS. It is one of the first wind power plant of Turkey. These are all identical turbines, from Enercon and built since 1998.

III. System Data

Energy data and the power of the Germiyanli Wind power plant for the year 2005 is used to build this study. Fig. 3 contains the initial data, which consists of the annual operation time and annual power production of each turbine. These values come courtesy of the previous Demirer AS that has installed and operates the plant. These figures are then used for cost analysis.

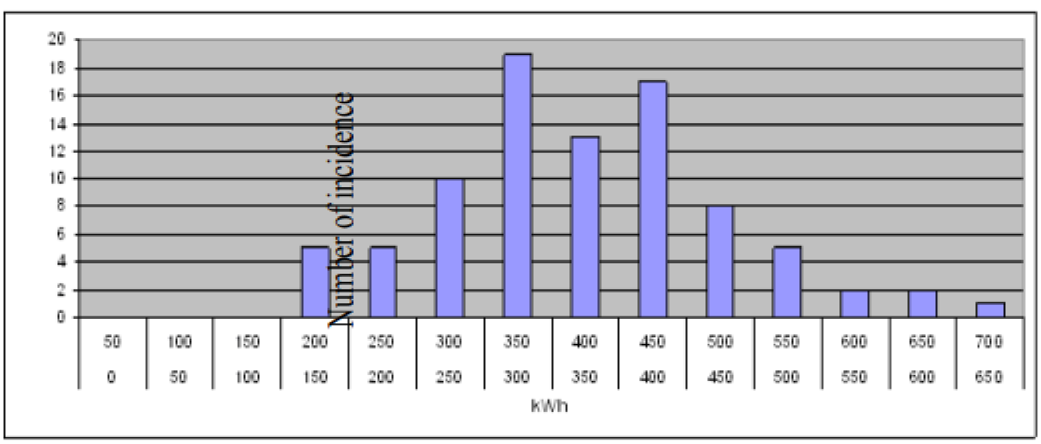

Figure 3: shows the distribution of the turbines overall production over the months

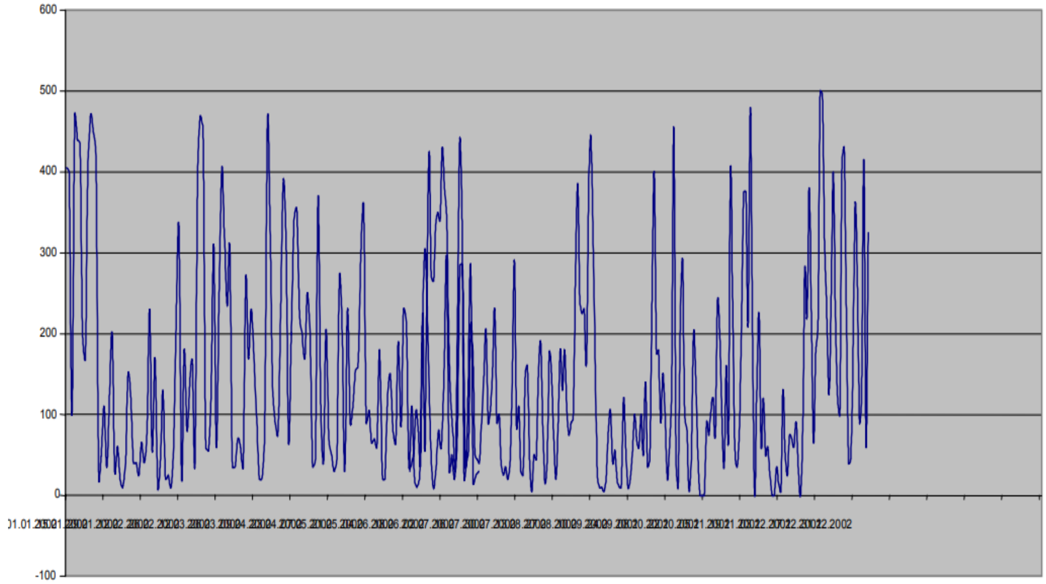

Figure 4: The first turbine's annual power production

Turbines are reported operating on 40% network load factor. The figures given here by Demirer A.S, are fig.3,4,5,6, and the data taken from these figures.

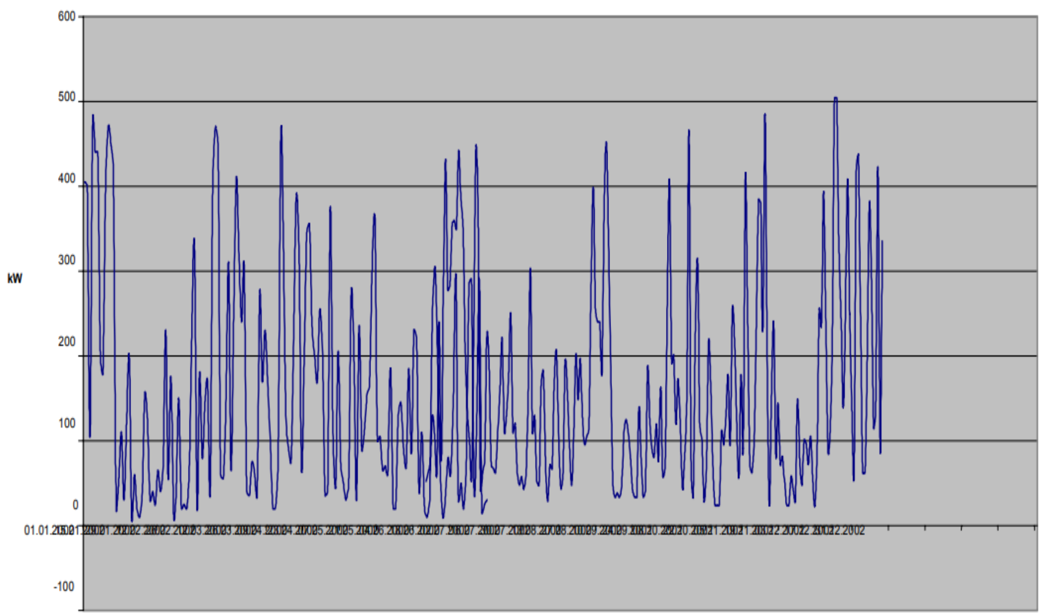

Figure 5: Production of the second Turbine annually

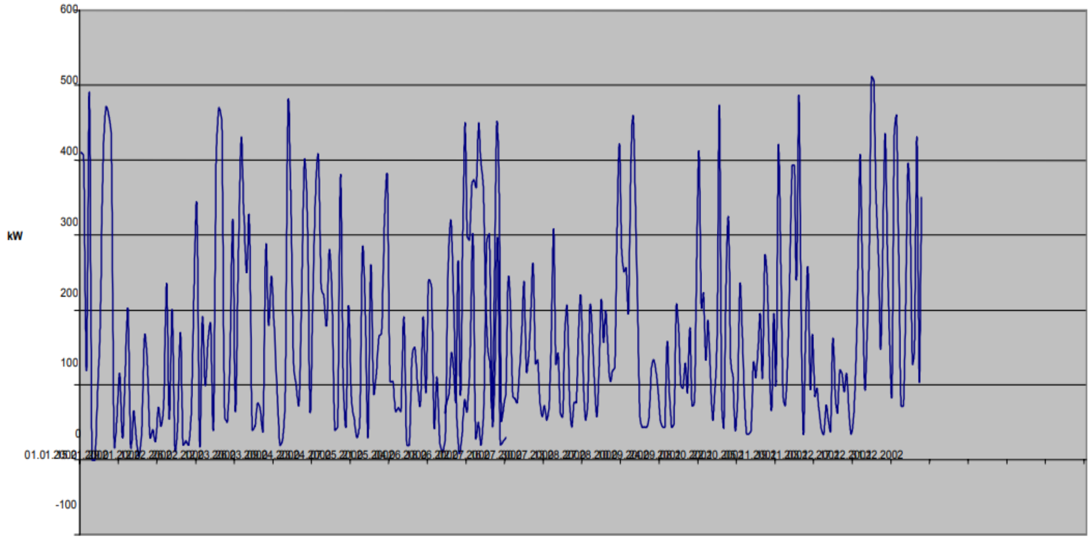

Figure 6: Generation of Power by the Third Turbine annually

III. Economic Analysis of the System

The following would be represented mathematically for the wind power plant's hydrogen potential calculation. There are various ways to calculate energy costs. The constant yearly capital cost technique has been used in this study's computations. 90% of the capital needed for the venture is covered by the investment corporations. Regarding the wind generating projects, the debt has a 17-year maturity date. Table 2 displays the assumptions used in the wind power energy unit cost estimates. An investment value per unit of electricity should be understood in order to appraise the wind power plant's electrical energy costs. Fig. 7-unit investment values also show the unit plant cost curve. The wind farms that were put up around the globe between 2006 and 2010. 3.620 $/kW is described by this curve, which is a product of it. Because of the low power value, the cost of a plant unit is expensive. The point is obvious: as technology develops, expenses will continue to decline. This leads to an update of the plant unit cost curve.

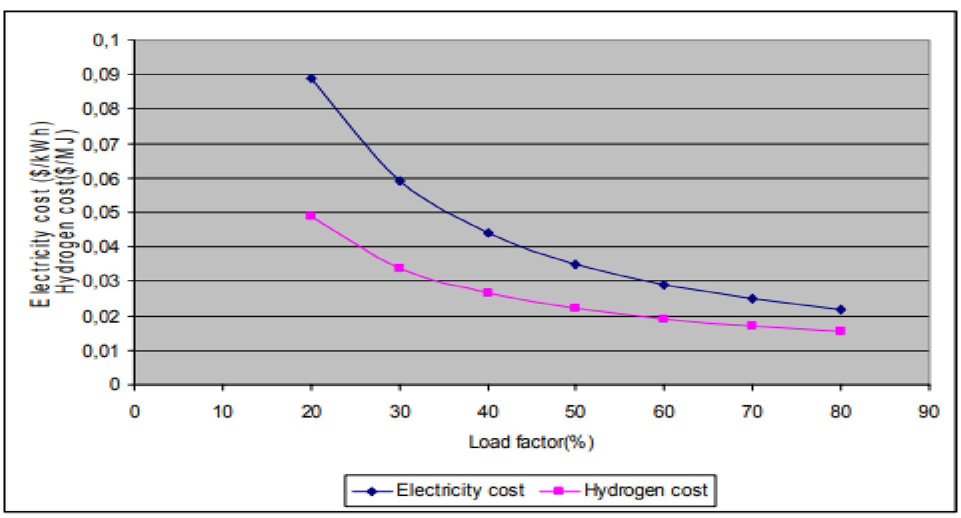

Figure 7: Variation in Hydrogen Production costs with respect to the Net work Load Factor

IV. Conclusion

The three 400 kW turbines have an annual hydrogen potential of 19.421 kg, 19.3421 kg, and 15.834,4 kg, respectively. On average, the plant's load factor is 0.2 annually. The price of hydrogen is 0.044 $/MJ based on this figure. As can be inferred from the graphs, the electrical energy costs of the plant are computed for various load factors. The diagrams demonstrate that the cost of an electrical energy unit reduces as the load factor increases. The cost of hydrogen is 0.48 $/MJ at a load ratio of 0.30 and decreases to 0.5 $/MJ at a load factor of 0.20. Therefore, it is always more cost-effective to run the turbines with a higher load factor if the wind speeds allow. Eventually, hydrogen would become an expensive resource. On the one hand, we have limited possibilities, but on the other hand, given its advantages over natural resources and its consequences on people, the environment, and ecological balance, a lot of research is required to cheaply introduce hydrogen into every application.

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