Mini-Project in Evaluation of the Project:

Installed 100 KW Wind Turbine – Diesel Hybrid System for Manara Dairy Products Factory

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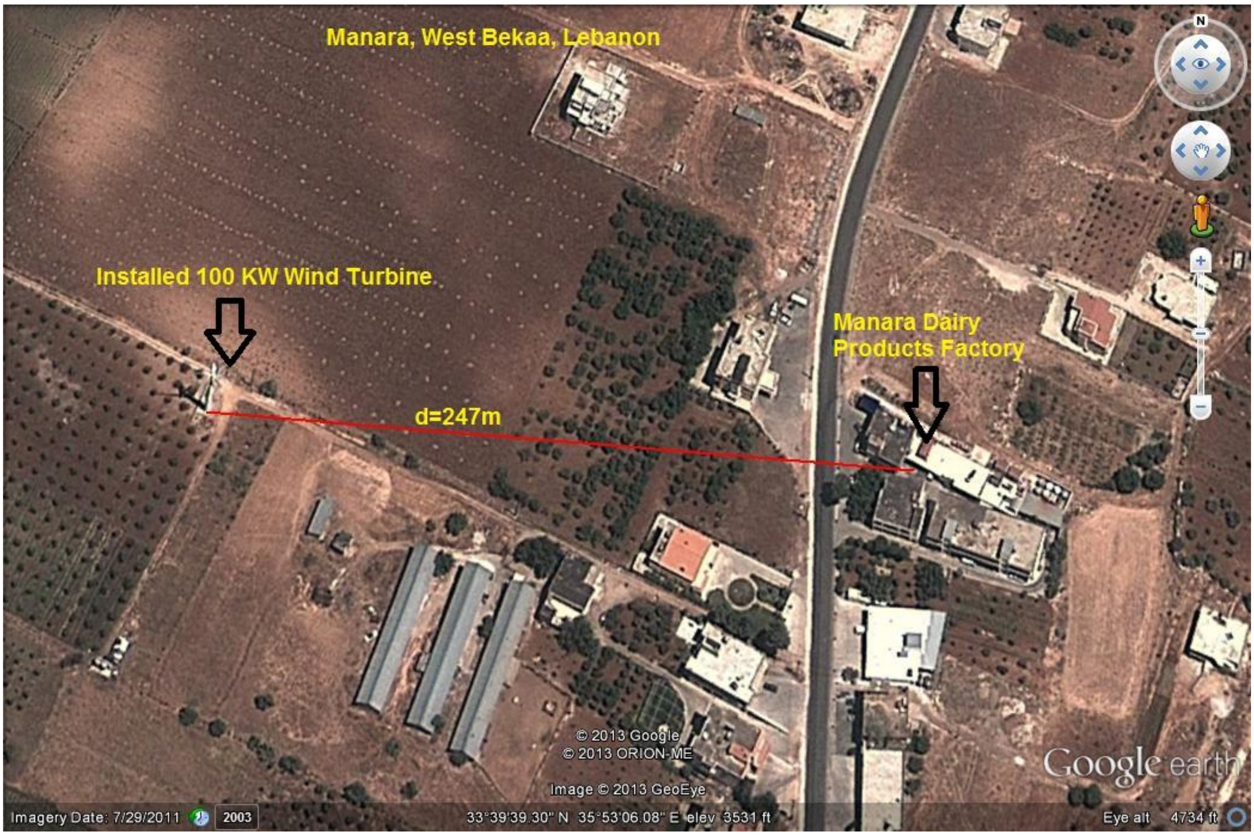
Introduction

Every successful project must have Project evaluation, either the project was installed or not or in the installation phase. The evaluation can detect these strong points and Give low rectification, improvement or change of plan. Aspects covered by the evaluation are: economic, environmental and social.

Project definition

Location

The project is located in Manara, West Bekaa, Lebanon at an elevation 1072 meter above the sea level



Decision

Manara dairy products factory has high consumption of electricity for different processes for dairy products, they decided in 2006 to install a 100 KW wind turbine to decrease the electricity bill by an environmentally friendly source of energy.

At 2007 the installed wind turbine has started working and it gave great results concerning the predicted energy production.

Properties

The wind turbine was brought from NordTank by Vestas from Denmark, this wind turbine was not new, it was used for 10 years in a wind farm in Denmark and it has the following properties:

- Wind turbine name: NTK100/20
- Nominal power: 100 KW
- Rotor diameter: 20 m
- Number of blades: 3
- Hub height: 24 m
- Rated wind speed: 12 m/s
- Cut-in wind speed: 4 m/s
- Cut-out wind speed: 25 m/s

Economic impact

The diesel generator was already installed and the wind turbine has been added to the overall system so that all the economic study will be done only on the wind turbine and its effects.

Project properties

Initial investment

Initial investment is the amount of money which should be paid for the installation at the beginning of the project without taking into consideration the other investments throughout the project lifetime.

number	Item	Price (USD)
1	Turbine	55000
2	Shipping + Tax	13000
3	Installation	27000
4	Electric cables	15000
	Total	110000

Operation and maintenance costs

The Danish Wind Turbine Manufacturers Association (1998) states that annual operation and maintenance (O&M) costs for wind turbines generally range from 1.5% to 3% of the original turbine cost. They also point out that regular service to the turbine constitutes most of the maintenance cost. The original cost for 100 KW wind turbine is about 180000 USD and we will take 2% as an average percentage.

So, O&M= $\frac{2*180000}{100}$ = 3600 USD

Lifetime of the system

It is common practice to equate the design lifetime with the economic lifetime of a wind energy system. In Europe, an economic lifetime of 20 years is often used for the economic assessment of wind energy systems (WEC, 1993). This follows the recommendations of the Danish Wind Turbine Manufacturers Association (1998) that state that a 20-year design lifetime is a useful economic compromise that is used to guide engineers who develop components for wind turbines.

This wind turbine was used for 10 years, so we assume that the lifetime of this project is 10 years.

Energy produced

The energy produced during the lifetime of the project is calculated by adding the real produced energy during the 5 years of operation and by prediction for the remaining years.

The real produced KWh from 2007 to 2012 as it was indicated on the KWh meter was: 1183000 KWh.

The average number of operation hours in Manara, West Bekaa is assumed about 2000 hours out of total 8760 hours.

So, the yearly produced KWh= 100 KW*2000 h = 200000 KWh.

Total produced KWh = 1183000 + 5*200000 = 2183000 KWh.

Average produced KWh/year = 2183000/10 = 218300 KWh.

Cost of KWh

The cost of KWh is calculated using the following formula:

Cost of 1 KWh= (Initial investment + O&M + material cost)/ (energy produced during life time of the project).

Cost of 1 KWh = [(113600)/ (2183000 KWh)] = 0.052 $/KWh

The cost of 1KWh from EDL in average is 0.08 $/KWh and from diesel generator it is 0.298 $/KWh → average price of KWh is 0.189 $/KWh based on 50% electricity coverage assumption from EDL and 50% from diesel.

Payback period

A payback calculation compares revenue with costs and determines the length of time required to recoup an initial investment. The payback period (in years) is equal to the total capital cost of the wind system divided by the average annual return from the produced power. It is expressed in equation form as:

PBP = Initial investment/ [(production (KWh/year) x price of KWh (average)) –O&M (yearly)]

Where:

- Initial investment is the amount of money which should be paid for the installation at the beginning of the project without taking into consideration the other investments throughout the project lifetime.
- Production (KWh/year): This is the estimated annual production of the 100 KW PVs installation.
- Price of KWh (average): Is the average cost of KWh from EDL & diesel generator.
- O&M (yearly): is the yearly estimated operation & maintenance expenses

So, PBP = (110000)/ [(218300x 0.189) – 3600] = 2.92 years = 3 years.

The annual gain of the project

G=Energy savings (KWh)*Cost of 1KWh (0.189$) = 218300*0.189 = 41258.7$

Environmental impact

The primary environmental value of electricity generated from wind energy systems is that the wind offsets emissions that would be generated by conventional fossil fueled power plants. These emissions include sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon dioxide (CO_2), particulates, slag and ash. The amount of emissions saved via the use of wind energy depends on

the types of power plant that are replaced by the wind system, and the particular emissions control systems currently installed on the various fossil-fired plants.
We will identify the CO2 emissions of the equivalent conventional energy used (EDL + Diesel generator).

- Diesel produces 270 g CO2 for each produced KWh but the efficiency of an internal combustion diesel engine is maximum 40%. So each 1KWh produced from diesel generator emits (270/0.4) =675 g_{CO2}/ KWh.
- EDL power plants emit 0.8 kg CO2 for each produced KWh but the efficiency of these plants is max. % 35 and the transportation efficiency is 15%. So each 1KWh produced from EDL power plants emit [(0.8)/ (0.35x0.85)] = 2.69 kg_{CO2}/KWh.

Since we are buying the wind turbine not manufacturing it, we can consider that the CO2 emission of this wind turbine is null.
Moreover, the energy generated during the 10 years lifetime of this project is 2183000 KWh. This means that during the whole lifetime of this project we can save:

2183000 KWh x (675 g_{CO2}/ KWh x50%+2690 g_{CO2}/ KWh x50%) = 3670 tons CO2**.** This clearly indicates that the project has great environmental benefits and can reduce considerably the CO2 emissions throughout the project lifecycle.

Social impact

Concerning the social aspect, this wind energy project benefits are numerous and can be summarized by the following:

- Creates new jobs for engineers & installers.
- Creates new jobs for maintenance engineers & technicians.
- Creates full or partial energy self-sufficiency in the region where it's installed.
- Promotes energy efficiency and renewable energy use and benefits in this region where both energy efficiency and renewable energy are still infants.
- Helps promote individual renewable energy projects which are sponsored by the government.

Conclusion

So far, we have identified and analyzed the project and then evaluated the economic, environmental, & social aspects of it. At this stage we can come up with an initial assessment of the project's feasibility and whether it could be considered a sustainable development project or not. That is, for any project to be sustainable (durable), it should meet the economic, social, and environmental conditions altogether. It is proved that this project meet the three conditions.