J. Viet. Env. **2016**, Vol. 8, No. 2, pp. 141-145
DOI: 10.13141/jve.vol8.no2.pp141-145

JOURNAL of VIETNAMESE ENVIRONMENT

Matlab application on ecotechnic analysis of Vietnam wind power project

Ứng dụng Matlab trong phân tích kinh tế kỹ thuật các dự án điện gió của Việt Nam

Research article

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Vietnam has fundamental advantages to implement the wind power project. Because of being surrounded by sea areas, wind power projects in Vietnam have a promise future. However, implementing an ecotechnic analysis of a wind power project has a fairly challenge because of seasonal change as well as input data's fluctuation. The paper presented a method based on Matlab programming utilized for ecotechnic analysis the wind power projects. The math diagram built with the consideration of all input data's changing will be shown to make the ecotechnic analysis easier and faster. The results deducted from Matlab programming will be compared with ones made by expertise method. The conclusion about advantages of method is pointed out to help project managers have another choice in making ecotechnic analysis of wind power project.

Việt Nam có những thuận lợi cơ bản để thực thu các dự án điện gió. Do đặc điểm địa lý, bao quanh bởi khá nhiều các vùng biển, các dự án điện gió của Việt Nam có tính khả thi và một tương lai đầy hứa hẹn. Tuy vậy, thực thi các phân tích kinh tế kỹ thuật của một dự án điện gió có thách thức không nhỏ bởi những thay đổi của yếu tố mùa cũng như những thay đổi của các yếu tố đầu vào. Bài báo giới thiệu một phương pháp dựa vào quá trình lập trình trên Matlab, ứng dụng để phân tích kinh tế kỹ thuật các dự án điện gió. Lưu đồ thuật toán được xây dựng có xem xét đến sự thay đổi của các yếu tố đầu vào sẽ giúp quá trình phân tích nhanh hơn và dễ dàng hơn. Các kết quả thu được sẽ được so sánh với các kết quả được tiến hành theo phương pháp chuyên gia. Kết luận về những ưu điểm của phương pháp cũng được đưa ra để giúp các nhà quản lý các dự án điện gió có được lựa chọn nữa trong tiến hành phân tích kinh tế kỹ thuật các dự án điện gió.

Keywords: wind power project, ecotechnic analysis, Matlab programming, mathdiagram

1. Wind power projects in Vietnam: general introduction, opportunities and challenges

In world wide, wind power reach very amazing capacity by the end of 2015. The worldwide wind capacity reached 392'927 MW by the end of June 2015, out of which 21'678 MW were added in the first six months of 2015 [2]. The total capacity of wind power in the world is shown in figure 1.

In Vietnam, however, wind power and wind power projects still get great challenges in comparing with fossil energy because of high investment. Going in parallel with the new achievements of modern technology, the price of one kWh wind energy is dramatically decreased. The detail shown in figure 2 brings a bright future for wind power project in Vietnam.

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http://dx.doi.org/10.13141/JVE
ISSN: 2193-6471

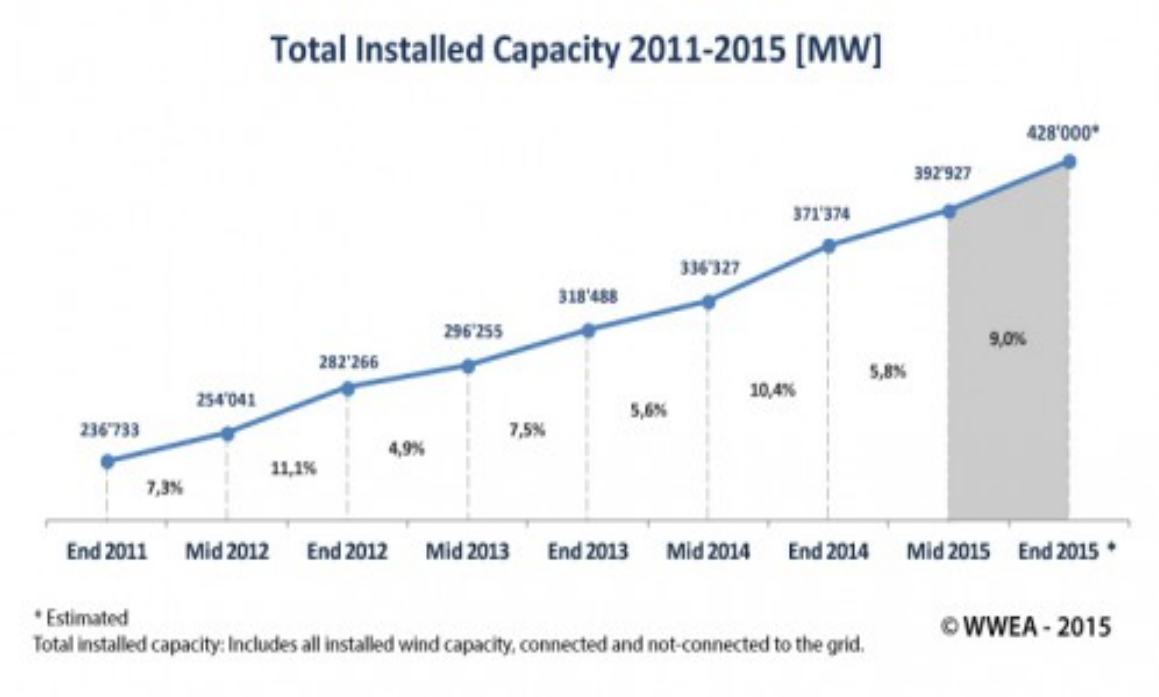

Figure 1: Total capacity of wind power from 2011 to 2015

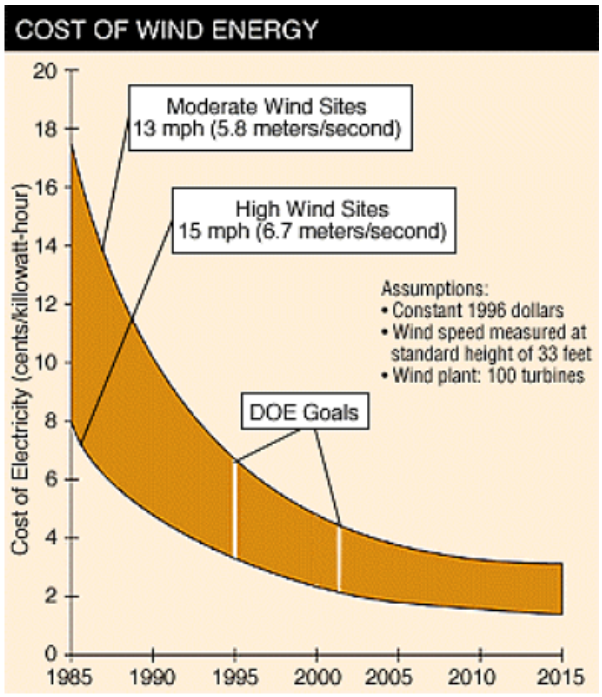

Figure 2: Trend of wind energy's cost [1]

Many provinces in Vietnam have rich wind power resources. Because of their advanced geological characters the potential of wind energy in Vietnam was estimated about 513,360 MW, equivalent to approximately six times higher than the predicted capacity of the electricity sector by 2020. The most promising areas for wind energy development are located in coastal and highland areas in the south-centre and southern parts of Vietnam. The World Bank's study also estimated of about 8.6% of the total land area of Vietnam to have the wind resources from "high" to "very high" potential for the development of large wind energy turbine (wind speed > 7m/s) [7].

For instance, in QuangBinh province, the measurements of wind velocity and wind distribution at the height of 80m show that it is definitely able to build an area of wind generators. However, making an investment in wind power project needs a careful analysis both in technical matter and in economic considerations.

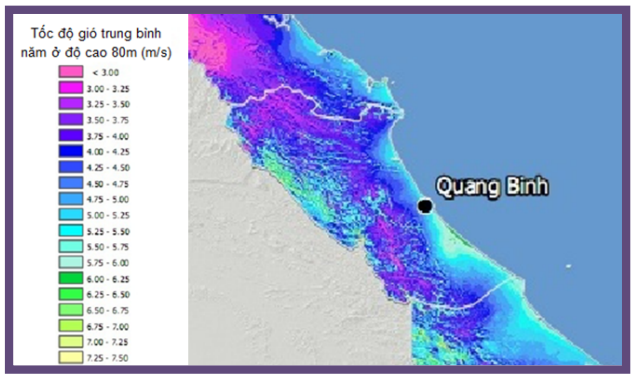

Figure 3: The measurements of wind velocity at 80m [5]

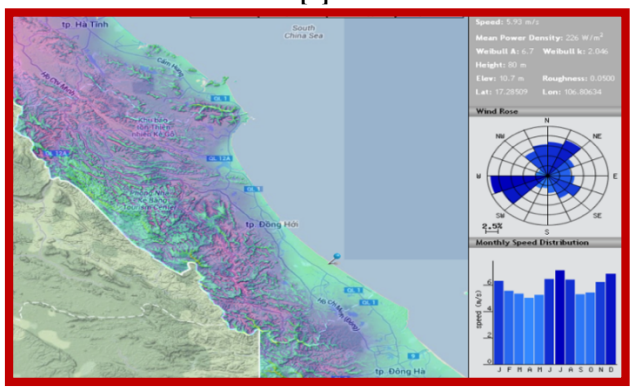

Figure 4: The distribution and direction of wind at 80m [5].

Investment in wind energy is found in both off-grid and on-grid projects throughout Vietnam. Off-grid wind power projects have been implemented recently in some provinces. These projects are scattered and are on a scale of 20

kW or smaller. Wind projects that were implemented previously are no longer in operation due to equipment longevity or lack of maintenance [7].

On-grid wind power projects are new in Vietnam. Grid-connected projects are concentrated in southern coastal areas especially Binh Thuan and Ninh Thuan provinces. By 2010 there were 37 wind field projects in this area. They belong to 31 investors and are at different investment stages of development with a total registered capacity of 3,837 MW. There is one project in first phase operation (7.5 MW), 2 projects at the technical design stage, and 12 projects that are completing feasibility study reports [7].

The main obstacle for investment in wind power is the electricity purchasing price. Beside this issue, another matter is the right calculation of investment for long energy transmission from wind station. The introduction of Matlab application on analysis the investment is shown below.

2. Matlab application on ecotechnic analysis the wind power project

2.1 Basic concepts and math diagrams

2.1.1 Mathematic basic utilized in forming the cost function

An energy project needs to determine the recovering time. As usual, an assumption of cost function is presented by equation (1) [1].

$$Z = (a_{vh} + a_{tc})K + Y_{\Delta A} \quad (1)$$

Whereas: a_{vh}-the operation factor;
a_{tc}-standard recovery factor.
K-Annual cost
ΔA-Power losses when wind power is transmitted for long distance.

More detail, Z can be also expressed by equation (2):

$$Z = (a_{vh} + a_{tc})C_{đd}m_0\ell + C\frac{(P^2+Q^2)}{U^2}\tau\frac{\delta}{S}\ell \quad (2)$$

The equation above show the relation of Z=f(U,S.) Similarly, a cost function of Investment and its impact factors could be built to make an ecotechnic analysis of a wind project. The detail will be shown in 2.2.2.

2.1.2 Block diagram

To solve the cost function Z for finding the optimal value, many solutions can be applied. One of this is a method utilizing Matlab programming with maths diagram shown in figure 5.

2.2 The results

2.2.1 Results from calculating the cost function

Utilizing the above maths diagram, programming in Matlab, curves shown in figure 6 and 7 are formed to help the finding of Z function's optimal value. The detail of calculation corresponding to some type of conductors is presented in table 1.

Table 1: Some results of Z calculation

Type	Annual cost function Z = f(U^2), (10^6 VND)			
	6kV	10kV	22kV	35kV
AC70	47.446,83	20.912,15	9.070,23	**7.204,83**
AC95	39.741,99	20.190,12	11.464,50	**10.089,99**
AC24	**39.960,928**	**32.221,64**	**28.767,75**	**28.223,67**
0		**8**	**4**	**8**

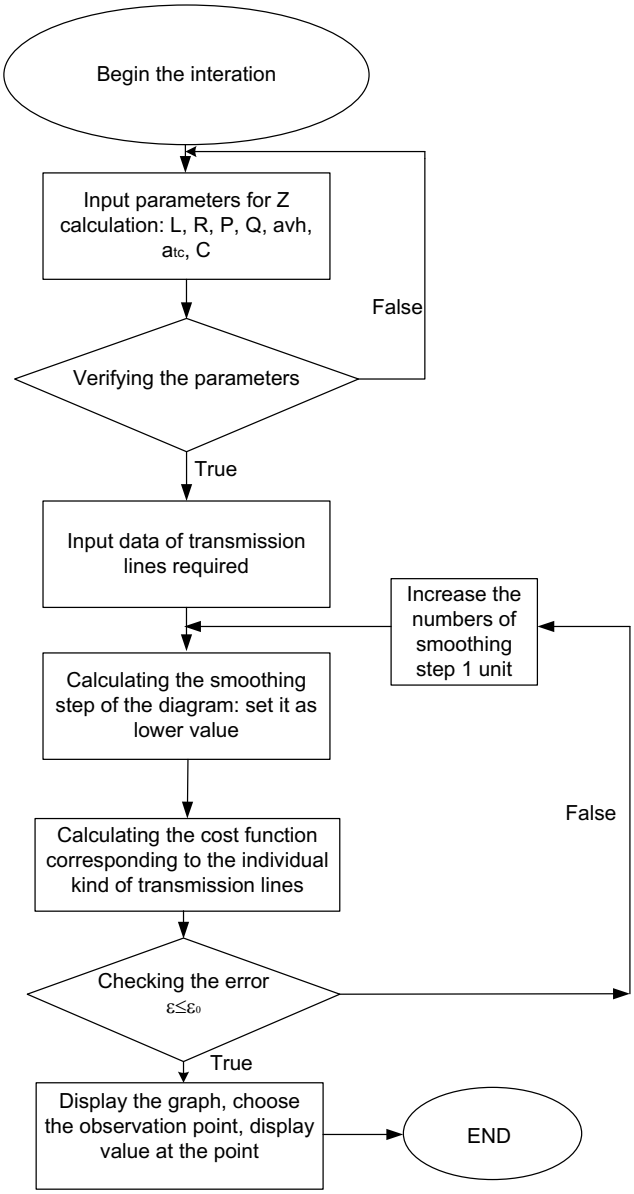

Figure 5. Maths diagram presented the calculation for optimal value of Cost function Z

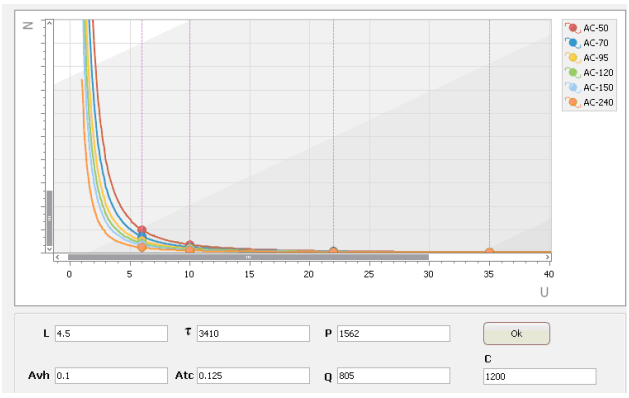

Figure 6: Results corresponding to different type of conductor

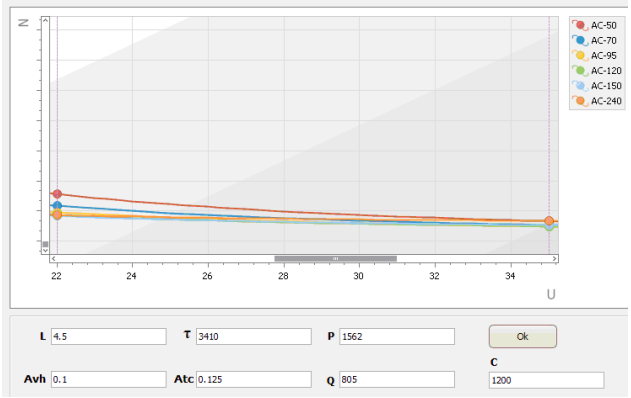

Figure 7: Results corresponding to different type of conductor and different input parameters.

2.2.2 Comparison of results calculated from soft ware and from expertise method

Utilizing the maths diagram in figure 5 and the same input parameters of expertise method, the detail calculation of two methods is shown in table 3 (Quang Ninh) and in table 4 (Le Thuy).

There is a slight difference between two methods (10,48-10,58) and (11,18-11,09). The difference is under 1% and can be accepted some cases.

Table 2. Ecotechnic analysis the wind project in Quang Ninh

TT	Parameter	Unit	Quang Ninh	
			Expertise	Matlab utilized
1	Type of wind Generator	MW	2	2
2	Total capacity	MW	30	30
3	Rated investment	USD/kW	2.150	2.150
	- *Equipment*	USD/kW	1.450	1.450
	- *Installation cost*	USD/kW	800	800
4	Maintenance	(USD/MWh)	30	30
5	Annual generating Capacity	(MWh/year)	73.649	73.580
6	Age	years	20	20
7	Price	centUS$/kWh	**10,58**	**10,48**

Table 3: Ecotechnic analysis the wind project in Le Thuy

TT	Parameter	Unit	Le Thuy	
			Expertise	Matlab utilized
1	Type of wind Generator	MW	2	2
2	Total capacity	MW	30	30
3	Rated investment	USD/kW	2.150	2.150
	- *Equipment*	USD/kW	1.450	1.450
	- *Installation cost*	USD/kW	800	800
4	Maintenance	(USD/MWh)	30	30
5	Annual generating Capacity	(MWh/year)	72.270	72.330
6	Age	years	20	20
7	Price	centUS$/kWh	**11,18**	**11,09**

3. Conclusion

Base on the above calculations, Matlab utilizing method in making ecotechnic analysis proved its self effectiveness. In some cases, that cannot determine or implement expertise method, using Matlab is a smart alternative.

Even a slight error can be get, but Matlab utilizing method has a great advantage of fast computing, reliable result. It also has a flexible calculation, any when an input parameter is changed, the calculation procedure could be done without any requirements;

In the beginning stage of ecotechnic analysis of a wind project, using the method is a good recommendation that give project manager have a general review about the economical effectiveness of the project.

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