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Modeling the Wind Farms into the Sea Considering Reliable Indicators

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Abstract-Researchers in recent decade considered renewable energies especially wind energy as far as considered sea and ocean waters a suitable place for turbine installation.in this study first we completely introduce a new phenomenon namely wind farms into the sea then modeling it by considering availability rate of production as an index of reliability assessment of wind farms into the sea and will introduce an optimal function that will be able to help this energy to decrease costs and increase reliability. Categorized expense is one of the elements which by optimizing it can attract investors. Thus in this study first model categorized expense wind farms into the sea and then pay attention to the optimal placement of wind turbines at sea and indicate that how we can have correct prediction of related expenses and proper placement for turbines into the sea by using proper modeling and genetic algorithms.

Key words: Wind energy, wind farms into the sea, reliability, Availability of rate production, categorized expense, and placement.

I. INTRODUCTION

Climate Change Convention in the 90s decade considering excessive rise in global temperatures, climate changes, rising sea levels and upcoming completion of fossil fuels raised the Kyoto Protocol which by virtue of that industrialized countries are required to reduce emissions of greenhouse gases. And the main goal of this convention is achieve stabilization of greenhouse gas concentrations in the atmosphere to a level that prevent dangerous human activities with climate system [1].

On the other hand renewable energies undertake a greater share of the world energy supply system. Thus renewable energy resources have taken a greater roles in international policies and programs [2].

Development of environmental attitudes and saving strategies in the use of renewable energy sources has resulted to increasing using of wind energy in comparison with other energy sources in many countries of the world. Using wind turbines technology could be a good choice compared to other renewable energy sources with some major reasons which among them we can refer to low price of wind power turbines in comparison with other new energy forms and helping to employment and lack of environmental pollution in developed countries such as America, England and Germany. Using wind technology in the previous year's in windy areas of the world and in dry areas has done and so many research and articles has done about this great and endless resource [3].

Wind energy is one of the most valuable and cost-effective renewable energy sources which now is used in most countries in many ways for energy production. From the other cases to take advantage of wind energy has been the focus of attention we can refer to no need for fuel supply a part of the electricity, high maneuverability in operation and no need for water. Besides the renewable and cost-effectiveness of wind energy in dry lands some challenges have been raised about this type of energy included Lack of an appropriate location for installation, some problems about noise visual effects and also lack of continuity in wind speed. Which lead researchers to optimization of this energy.in order to achieve this goal from 1972 some researches had started about using wind turbines into the sea. And then Europeans had performed extensive studies about this new phenomenon until the first wind farm was launched in 1990 at Sweden [4]. For the results of performed researches we can refer to speed, power and more continuity at a height above sea in comparison of drought.in fact that they founded that wind speed increases with distance from the beach and as a result produces more power in comparison with drought. Beside of Many benefits of wind farm into the sea we would be faced with many challenges in relation with high costs associated with the turbines into the sea.as predictable some problems such as less access, delays in maintenance due to climate conditions and high costs of this wind farms has raised by installing wind turbines into the sea especially in deep parts [5]. The experts came to the conclusion after 40 years of research that if some situations and necessary optimizations provided in cases where it can be costly and problematic, the sea wind farms would be more effective than wind farms on drought [6].

In the last decade more attention has been focused on cost reduction which this is related to properly design of electrical system of wind farms into the sea and through the many efforts of many different organizations for this issue is ongoing. However, due to the

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new character of this technology further and more researches will be necessary to make the most effective use of this emerging phenomenon. The main objective of this study is accessibility rate of production of this renewable resource so that is economically cost effective.

II. ANALYSIS METHODS

Reliability basic methods$\left(SB-RAI\right)$ and State space reduction algorithm is identified and has been done as analysis basis.

A. Considerations for calculations

1-basis method: as an approximate method a collection of $\{U\}$ in addition to collections of $\{A\},\{B\}$ is placed. For each case of wind farm in the collection of $\{U\}$ the status of each component is unclear ((It is called non-classified).thus it wouldn't be that GR of these states is bigger or smaller than GR_C .In these circumstances the states of $\{U\}$ collection can be ignored as long as the possibility of the collection is small enough. Another fact that should be considered is that the probability of failure of two components simultaneously (call it $N-2$)is much less than the probability of failure of a component(call it $N-1$). Probability of fail three or more components simultaneously is very much less than the N-1 status.

2-sequence selection: a status of N-1 $\left(s_j, w_J\right)$ with C_j is indicated in the figure (8-3) A

1	1	1	1	...	0	...	1
					j		

Fig 1: status categorization after one control for 1 status $N-1, s_j$

1	x	1	x	...	0	...	x
m		n			j		

Fig 2: the status of s_j character which must be located in $\{B\,|w_J\}$

If GR belonging of $\left(s_j, w_J\right)$ is bigger than GR_C then $\left(s_j, w_J\right)$ status is placed in the $\{A\,|w_J\}$ .if GR is less than GR_C ,then $\left(s_j, w_J\right)$ is located in the $\{B\,|w_J\}$ categorization and any status of $\{{}^*s_j{}^*, w_J\}$ would be consistent with (7-3) equation in the $\{B\,|w_J\}$. Overall probability of $\{{}^*s_j{}^*, w_J\}$ which is equivalent to $\left(1-A_{Cj}\right)$ will added to $\mathrm{Pr}ob\{B\,|w_J\}$ and it means that a number of states is categorized without calculation .in this case C_j member is named as key member in the wind farm. However if we have another key member of C_k after C_j .an overly appears between $\{{}^*s_j{}^*, w_J\}$ and $\{{}^*s_k{}^*, w_J\}$ status. Thus total status of $\{{}^*s_k{}^*, w_J\}$ cannot placed in the $\{B\,|w_J\}$ state. The probability of overly between $\{{}^*s_j{}^*, w_J\}$ and $\{{}^*s_k{}^*, w_J\}$ creates by means of $\left(1-A_{Cj}\right)$ and $\left(1-A_{Ck}\right)$.so the probability of $\left(1-A_{Ck}\right)A_{Cj}$ should added to $\mathrm{Pr}ob\{B\,|w_J\}$ for C_k member. Generally, a C_j is determined as a key component with $\left(s_j, w_J\right)$ status. A part of states is determined in the figure2 which is placed in the $\{B\,|w_J\}$.m and n bites in the figure 1 states a place of key component which previously specified.it is very valuable which can find very fast key component. Some components are more likely to be a key component such as high-voltage transmission cables, the main transformers.as example high voltage cables and the main bus bars in the figure 3 are the main components.

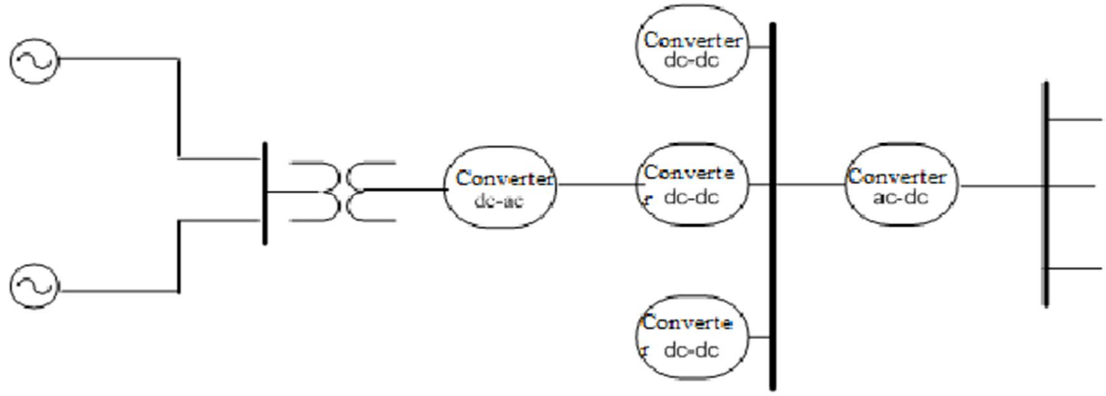

Fig 3: an example of wind farm into the sea

Here, order of selection for finding key component for a wind farm is calculated as following steps:
1:high voltage component: For high voltage bus- High-voltage transformers- High-voltage converters- High-voltage cables.
2: medium voltage bus- Medium voltage transformers- Medium voltage converter- Medium voltage cables.
3: other components
Failure Impact Analysis: for any status of wind farm, has done an analysis of failure impact: analysis of failure impact is consists of following steps:
-closing keys which are open in normal conditions
-tripping component
ts which are overloaded
- Repeating the previous steps as long as nothing is done
B-Calculation process
The process of computation is expressed by the following steps.
Step1: the first initialization is done as: $GRA = 0, \{A\} = \{B\} = \{\ \}$ if all wind turbines were of one type, do the processing in symmetrical mode for wind turbines by means of (3-8) and (3-9) equations.
Step2: place wind status as $J = \mathrm{IX}$ (any turbine is produces its rated power)
Step 2: A: Put all the parts case as active, specifically they belong to $\{A | w_J\}$ collection, so place these states in the $\{A | w_J\}$,set $K = 1$ (K is the number of components which in one state).
Step2: the state of wind farm in the K components place low simultaneously ($N - K$ events)
Step2:B1: Find all high-voltage components, put off all components, do analysis of failure and check the GR for classification states in the $\{A | w_J\}$ and $\{B | w_J\}$ .if a state is placed in the $\{B | w_J\}$ then place the mode-character in the $\{B | w_J\}$ (except of status of overly)
Step2,B2:IF $1 - \mathrm{Pr}ob\{A | w_J\} - \mathrm{Pr}ob\{B | w_J\} < \varepsilon$ go to step 2 /c:here ε is tolerance.
Step2.B3: repeat the step2,B1and B2 for medium voltage.
If $K > 1$ (event) $N - K$:
Step2,B4: on the basis of available states in the $\{A | w_J\}$ find all the inactive simultaneous possible compounds of K components .
Step2,B5:if $1 - \mathrm{Pr}ob\{A | w_J\} - \mathrm{Pr}ob\{B | w_J\} < \varepsilon$ go to step2/C.
Step2, B6: Repeat the step2,B4,B5 for medium voltage component and other components.

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Step2,C: repeat $K = K + 1$ and steps 2/B and C.

Step2,H: $GRA = GRA + \rho_J \times \mathrm{Pr}ob\{A|w_J\}$

Step3: If you encounter in the previous step with overvoltage then set the wind speed on the next state repeat the $J = J - 1$ and step 2 and step3 ,otherwise go to step 4.

Step4:suppose that step 4 is stops on the wind state $(\mathrm{II} <= J <= \mathrm{IX})J$,this means that no overload is happened in the $\{A|w_J\}$ and $\{B|w_J\}$ states. Please note that this is not means that there is no possible of happening J state. This means that the possibility of overload is very low .according to (5-3) equation the remained wind states $L(L = J-1, J-2, \ldots, \mathrm{II})$ have the same component states in the A.. $\{A|w_L\} = \{A|w_J\}$ .By using of if state in the $\{A|w_J\}$ we can calculate $\mathrm{Pr}ob\{A|w_L\}$ and then $GRA = GRA + \rho_{J-1} \times \mathrm{Pr}ob\{A|w_{J-1}\} + \ldots + \rho_{\mathrm{II}} \times \mathrm{Pr}ob\{A|w_{\mathrm{II}}\}$

III.OPTIMIZED MODEL

The purpose of optimized model is that the minimum LPC is determined by required reliability. The optimizing is described as follows:

(10-3) $Minimize \quad OBJ = LPC + \beta R_s$

(11-3) $Subject \quad to \quad V_{low} \le V_i \le V_{up}$

(12-3) $S_{branch} \le S_{max}$

(13-3) $P_{WT} = P(v)$

(14-3) $f(V, \theta, P, Q) = 0$

Which here, LPC is the categorized production cost, β Fines ratio of Reliability, R_s reliability for wind farm, V_i ,the volume of bus voltage, V_{low}, V_{up} is voltage limit, S_{branch} is apparent power of a branch, S_{max} the volume of power of branch, v is wind speed, $P(v)$ is a diagram of power of wind turbine which is made by factory, P_{WT} is power of wind turbine in the wind speed, $f(x)$ is the equation of load current in the wind farm.

IV.RESULTS

A. Power generation model

The required inputs in order to obtain a production model has shown in the table below:

Table1: inputs for Power generation model

Input unit	description	input
KW	Rated power turbine	P_{rated}
m	Rotor diameter	D
kg/m^3	Air density	ρ
m/s	Wind speed	U
m/s	Input Speed Wind for Turbine	U_{cut-in}
m/s	Output Speed Wind for Turbine	$U_{cut-out}$

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When information of turbine power is available from the factory, otherwise the following estimated equation is used:

$$P = \begin{cases} 0 \quad ; \quad 0 < U < U_{cut-in} \\ \frac{1}{2}\rho A U^3 C_p \eta \quad ; \quad P < P_{rate} \\ 0 \quad ; \quad U > U_{cut-out} \\ P_{rate} \quad ; \quad otherwise \end{cases}$$

Where ρ is air density, A is the rotor swept area

C_p Is power ratio (its value is supposed 0/4)

η Power ratio (its value is supposed 0/9)

P_{rate} is Rated power of turbine

Model validation

For validation of model to forecast power generation, a comparison between power curve of 3 generator and predicted value has been done by means of equation 4:

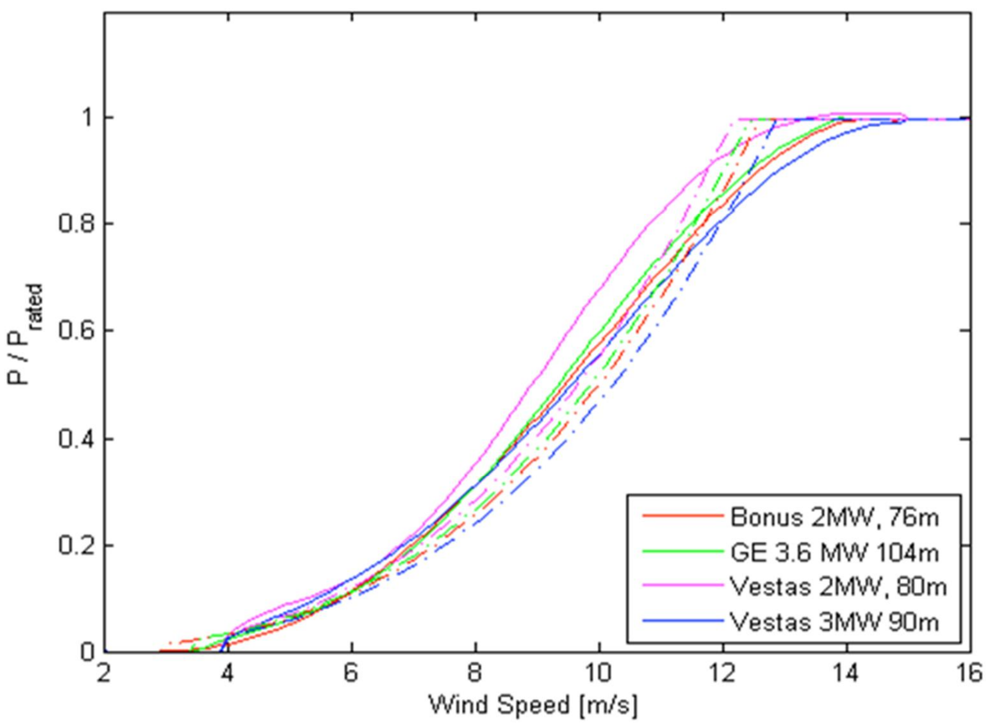

Diagram1: Power generation model validation

As it is observed the true produced energy (simple line) and Power curve modeled (cut off line) are specified by $c = 8m/s$ and $k = 2$ (in the Weibull distribution) they have fault between 5 or 11 percent and this is indicates good accuracy of the model. After offering available models for a wind farm in the sea, in this session implement expressed models for a wind farm into sea .our purpose in this study is finding a place in the sea for 4 wind turbine with a capacity of 3 MW .the simulated place in the America and Massachusetts coasts are shown in the following figure:

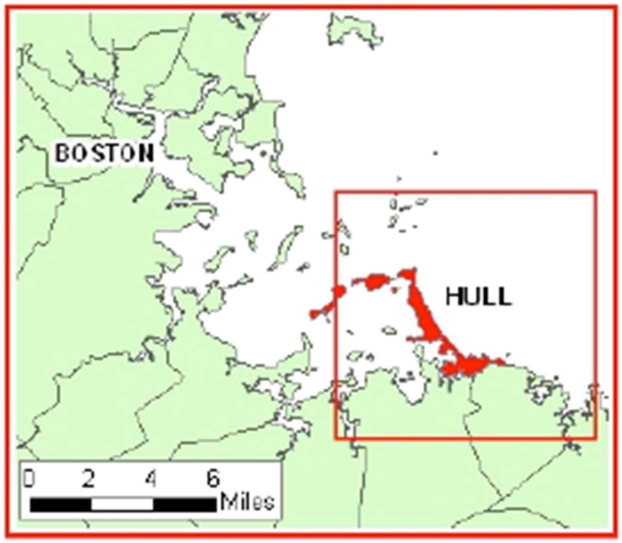

Fig 4: sea area suitable for placing sea wind farm

B. Weather conditions

The information about wind is supplied through part 64.a part of information which is obtained from the top of Radio Tower (WBZ), according to these information the speed of wind At an altitude of 61 meters top of the tower is 7/6 m/s .using the available information and converting this speed ,we can calculate the wind speed as 7/1 m/s in the beach. Wind histogram in this region is shown in the following figure:

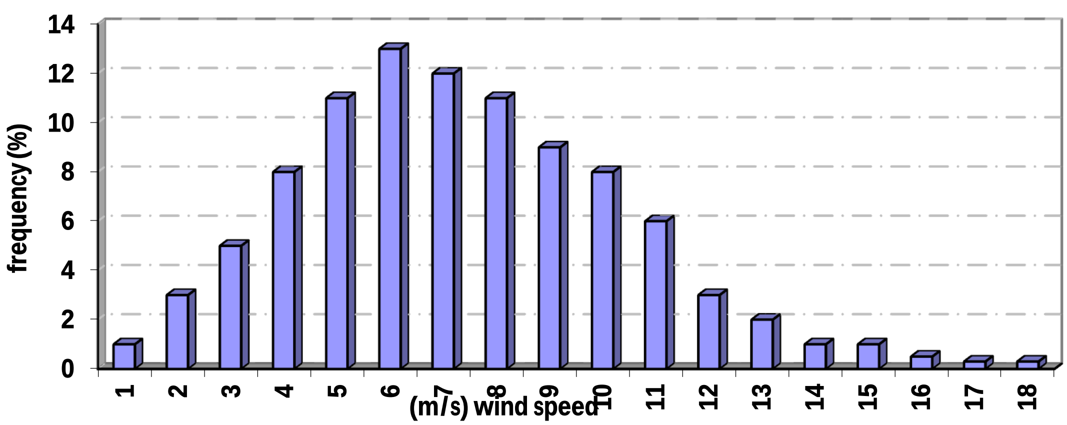

Diagram2: wind speed histogram

Using this histogram we can obtain the approximate relationship of wind speed in the sea and its instance to beach which is as follows:

$$U(x) = U_{x=0}[-0.17\exp(\frac{-x}{3.21}) + 1.17] \quad (87\text{-}4)$$

Where x is distance to beach and is measured in kilometers and $U_{x=0}$ is wind speed in the sea which is equal to 7/1 m/s.

2) Sea floor conditions

The sea in most parts, is made of stone and rock and only in a part of the sea floor is made of sand. Thus here we divided the floor sea information into 2 part, Sandy and rocky half,its shown in the following figure:

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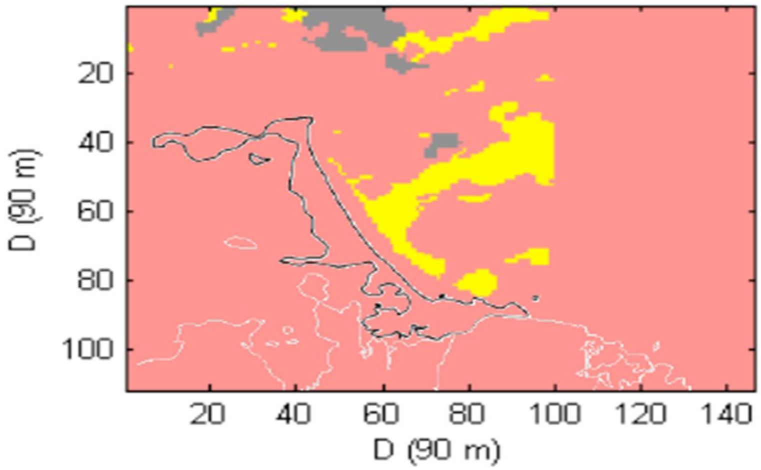

Fig 5: seabed type, yellow areas are sand and others are Semi-rock

The information related to sea floor conditions has come in the following table:

Table2: parameters of sea floor

Soi l type	ϕ g rees]	γ' J / m^3]	C Pa]	μ_c [–]	f_s Pa]	
Se mi-rock	34	11/5	0	5 0/5	75	10
san d	30	12/2	0	5 0/	65	10

Sea floor information is also provided by available information, and its overall shape is as follows:

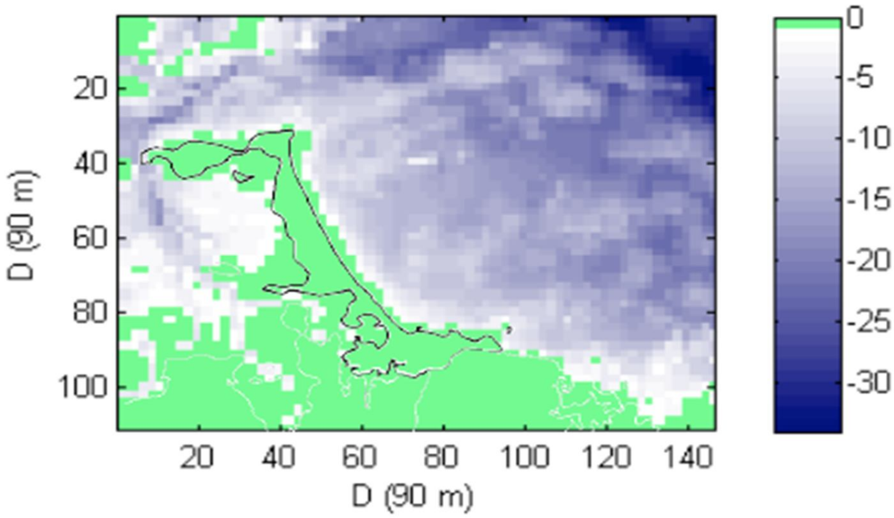

Fig 6: A view of the sea floor in various parts

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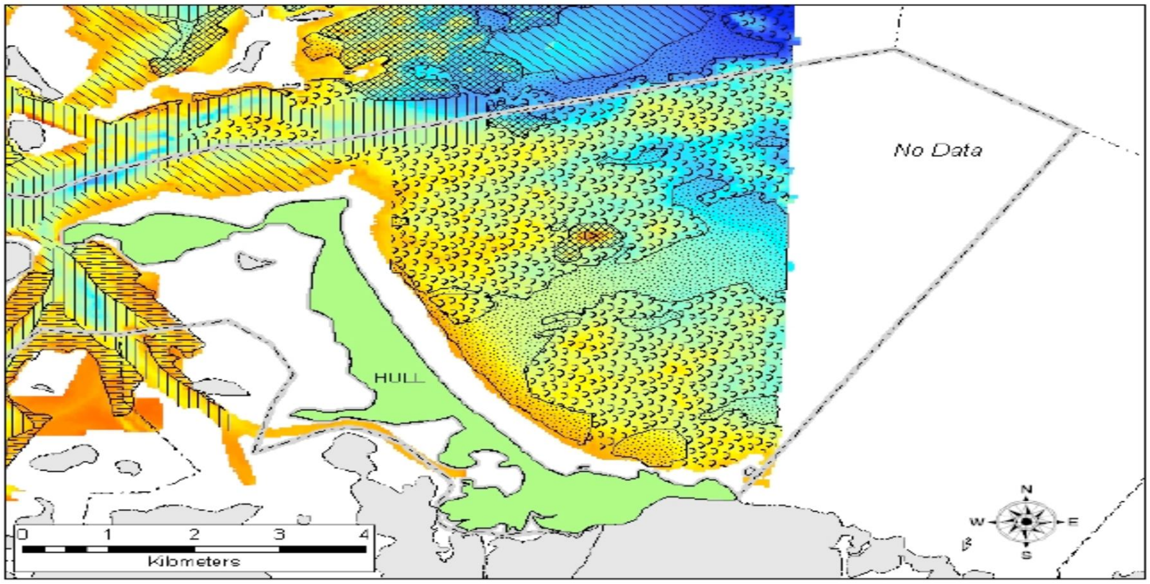

Fig 7: the area of study

In the following table the required information for simulation is presented:

C. Optimization

After full modeling of target function, in order to using of results we are used from genetic Algorithm for optimization. The purpose of optimization finding places in the sea which should optimized states for installing 4 turbines.

In this study the matlab software 13 version has used for modeling and optimization. The optimizing method is in this manner that first for calculation spending cost its details should be evaluated. Thus implement the expressed model in this session of matlab software. Then define the target function for optimizing project and apply the desired data. In addition to the parameters listed in the previous section, has used Geographical maps of Massachusetts to specify the location profile, depth and soil type.in this study we has used two bound and free solution for implementing results. For finding the best place for installing 4 turbines some provisions is provided: the distances of turbines to the beach is more than 1/5 Metter and also depth of water is not more than 15 meter. First determine a coordinate plane with zero point then by using data repeat the process until the optimal solution is resulted. But the other method is free which include all coordinate of the sea then by finding the best points with algorithm evaluate them which if results were outside of our limits we can repeat them to the extent that it is come to our range.

V. REVIEW OF RESULTS

After launching program and 70 time of running the answers are as follows:

In many cases for implementing wind farm the employer offer conditions .in this session the results is for states that which the distance of turbines to the beach is more than 1/5 Metter and also the water depth is not more than 15 Metter. The result of place of turbines is as follows:

Base type	Number of turbines	Total cost (m.dollar)	Annual energy	Capacity coefficient	Classification cost
Momopile	4	21	33/2	31/6	7/1
gravity	4	22	33/1	31/5	7/3

Location of turbines is expressed in the Latitude and longitude.

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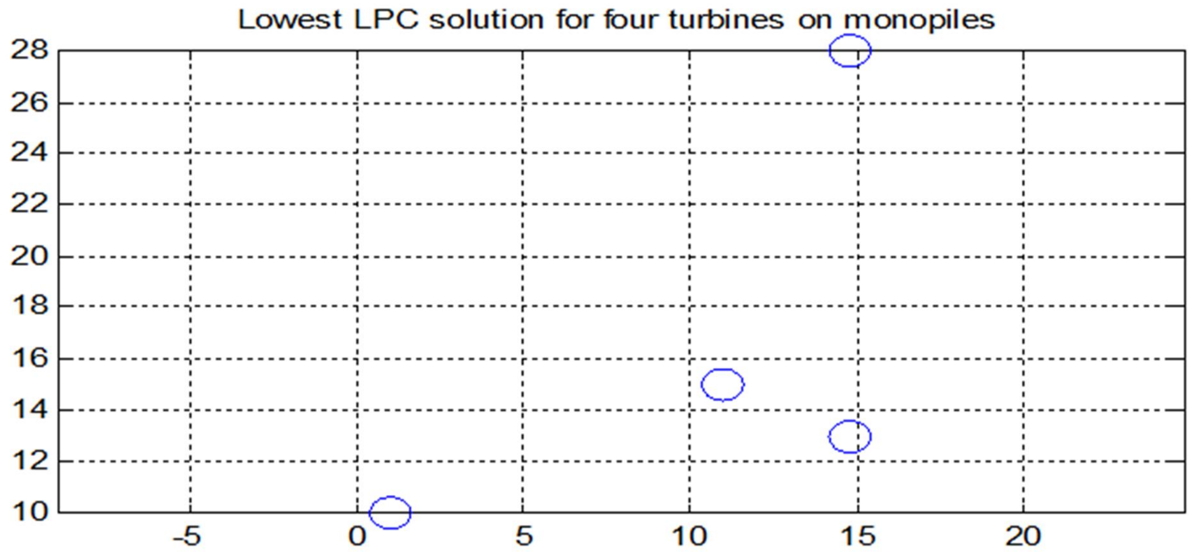

Fig 3: the place of turbines according to monopole

As it is clear in the above diagram the optimized place of turbines is determined according to classified costs.

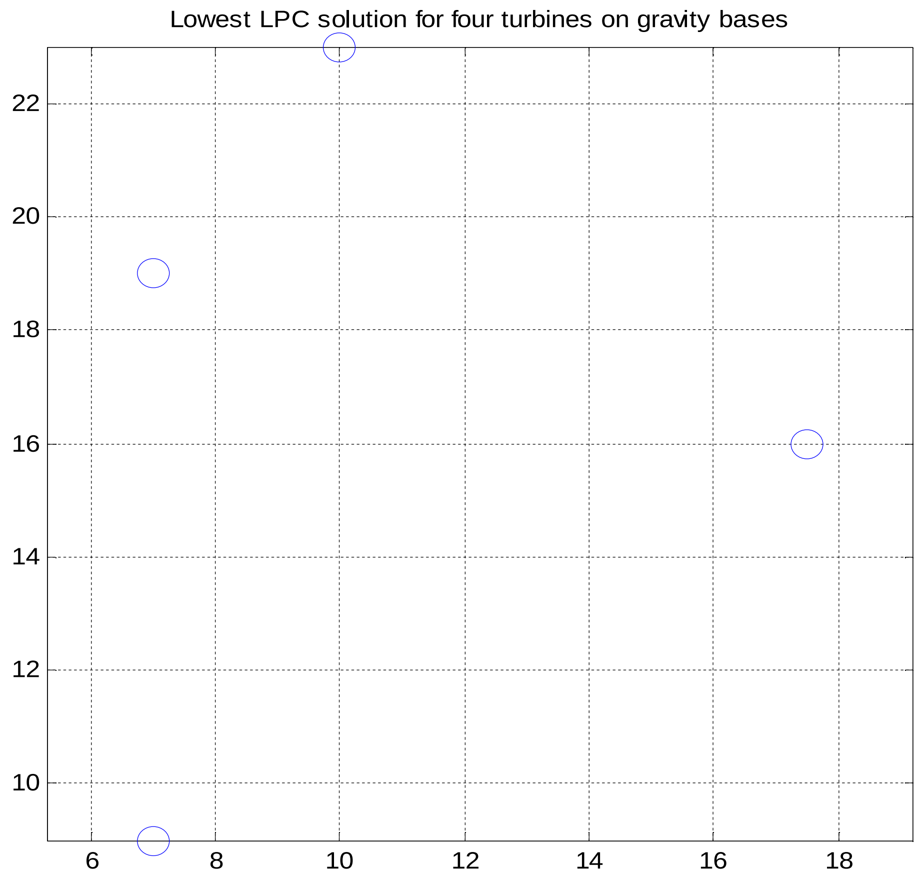

Fig 4: the place of turbines according to gravity

If not consider expressed conditions and also the distance of turbines is low, then the results as follows:

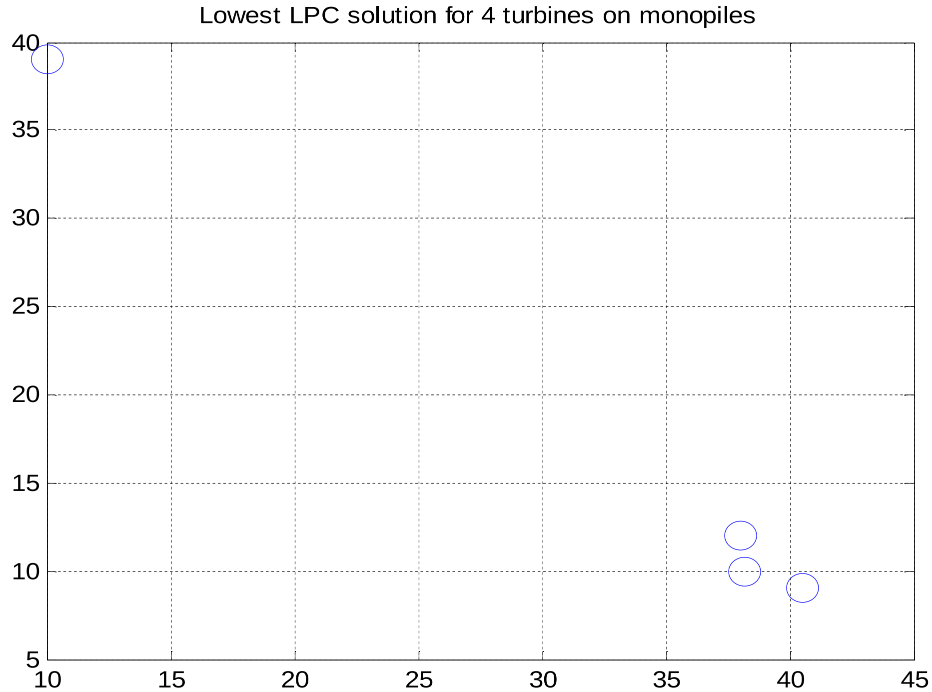

Fig 5:the place of turbines according to monopole without considering restrictions

Finally the process cost reduction after continuous repeats has indicated in the genetic algorithm.

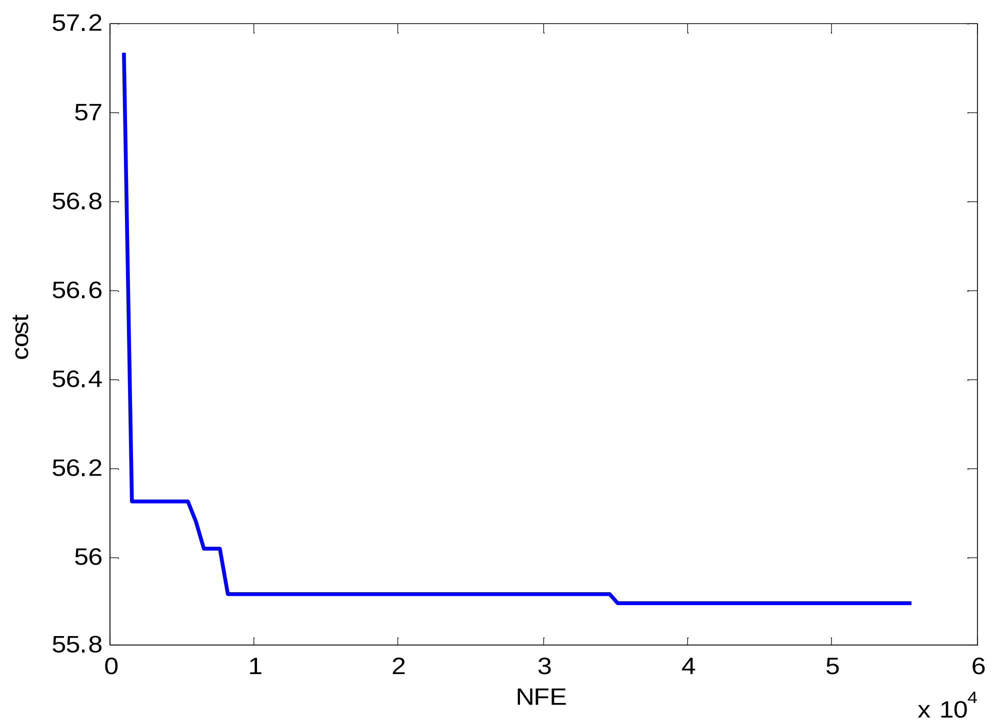

Fig 6: the process of reducing cost by means of optimization

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VI. DISCUTION AND CONCLUSION

This study was performed with a purpose to provide an objective optimization function to reduce the cost of wind farms into the sea. First considering the emerging this type of renewable energy introduced totally the wind farms into the sea. And saw that according to statistics interested in using wind energy is increasing among industrial countries and also the process of turbine installing into the sea is increasing.

Reliability of a system is one of the main steps to utilize a n electronic network. We tried in this research that calculate wind farm into the sea by offering an optimized function which is consist of cost function and reliability. Accessibility production rate was investigated as an index of reliability. And facilitate the utilization of cost function by expressing the details of this index.

The cost function is totally evaluated in the part 4 and by totally modeling a wind farm into the sea we indicated that we can have true forecasting of related costs.

For optimize use of this target function in wind farms into the sea we located the turbines into the sea and showed that we can by different methods forecast a proper place for turbine installing which leads to lowest costs.

REFERENCES

[1] O.Dahmani, S. Bourguet, M. Machmoum, P. Guérin, P. Rhein, L. Jossé, Optimization of the Connection Topology of an Offshore Wind Farm Network, 2015, IEEE.

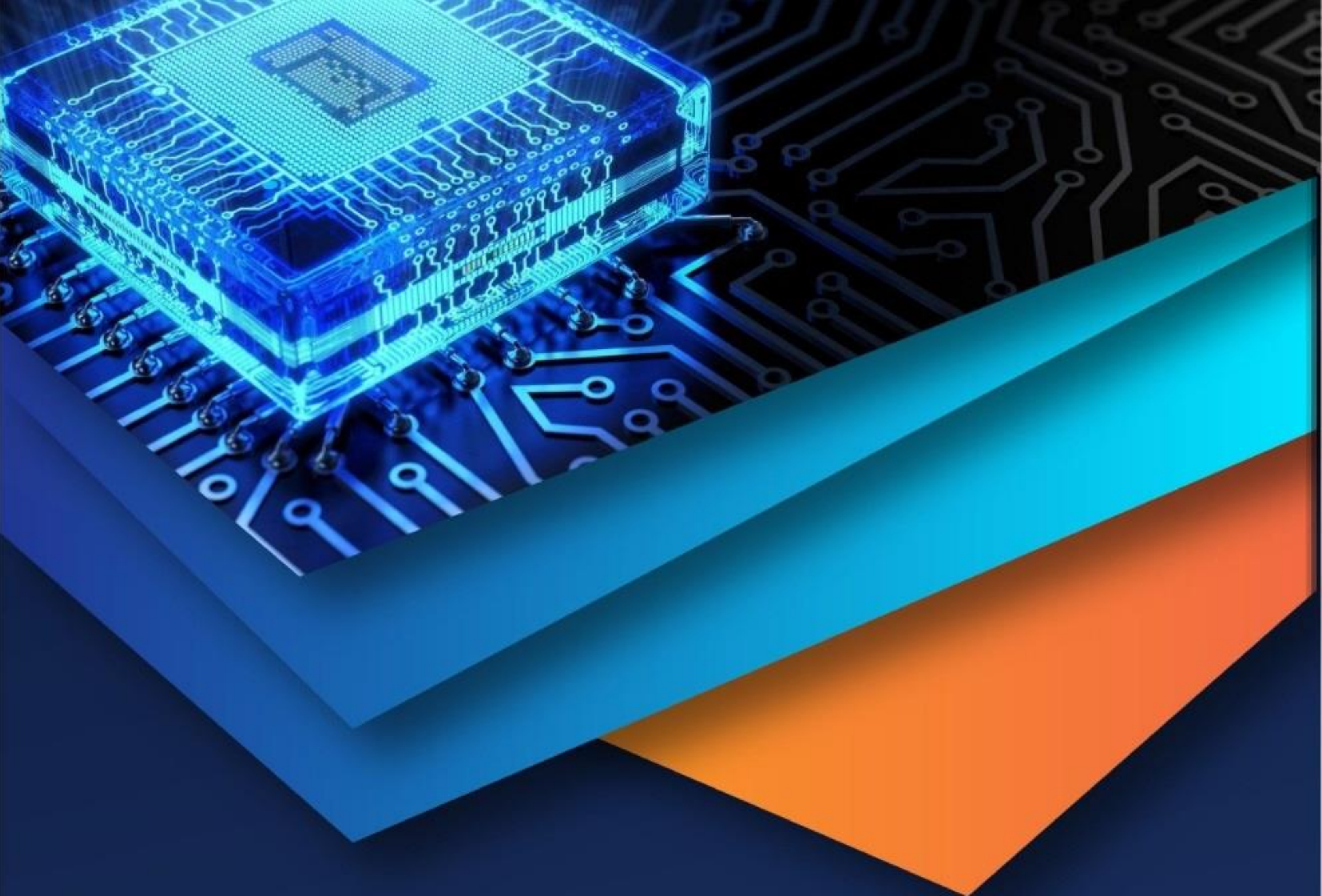
[2] FP. Santos, AP. Teixeira, C. Guedes Soares, Influence of logistic strategies on the availability and maintenance costs of an offshore wind turbine. 2013, European Safety, Reliability and Risk Management (ESREL) Netherlands.

[3] M. Zhao, Z. Chen, F. Blaabjerg, Generation ratio availability assessment of electrical systems for offshore wind farms. Energy Conversion, 2007, IEEE.

[4] Z. Chen, F. Blaabjerg, Wind turbines-a cost effective power source, Przegląd Elektrotechniczny, 2004, 80(5): p. 464-469.

[5] Wright, S.D., Rogers, A.L., Manwell, J.F. and Ellis, A. "Transmission Options for Offshore Wind Farms in the United States", Proc. WINDPOWER 2002 Conference and Exhibition, American Wind Energy Association, Portland, 2002.

[6] S. Afanasyeva, J. Saari, S. Kukkonen, J. Partanen, O. Pyrh€onen, Optimization of wind farm design taking into account uncertainty in input parameters, 2013, European Wind Energy Association Annual Conference Austria.



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