Clean Energy for Sustainable Economy & Environment (CE)

Offshore Wind Farm Layout Generation using AI model

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A densely packed wind farm will maximize power extraction. But, due to 'Wake Effects', energy availability will be reduced for downwind turbines. Maximizing the total power production of a wind farm is the goal by optimally positioning the turbines within the wind farm using AI.

The AI model built uses Genetic Algorithm which considers the local wind patterns and suggests a wind farm layout which produces more power and has higher efficiency than a layout produced using thumb rule.

Introduction

Wind energy is a rapidly increasing sector. According to MNRE India has an overall potential of 1, 02,788 MW out of which 20,000 MW has been installed by March 2015. This high potential has given way to a shift from single turbine installations to multi-megawatt installations consisting of a large number of clustered wind turbines called 'Wind Farms'. Due to limited land sites, environmental constraints and the increased requirement for alternative power sources, a current trend is the installation of large offshore wind farms. It is expected that a significant proportion of future wind energy capacity will come from offshore installations.

Materials and Methods

- From the scaterometry, buoys, and wind mast data the climatology of wind speeds is created for the site(Palk Strait, India).
- AI model using Genetic Algorithm is built and tested with ideal wind conditions to produce layouts.
- Model is then used to produce wind farms for the site which have higher efficiency and produce more power than the farms created using thumb rule.

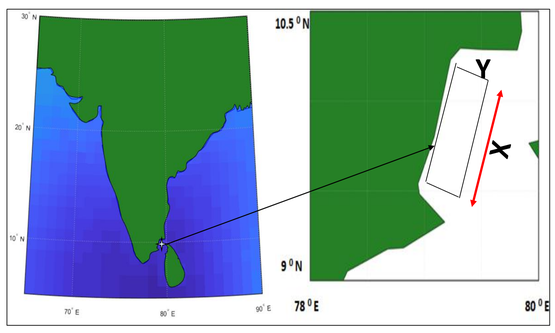

Fig 1: - Location of Palk Strait, India

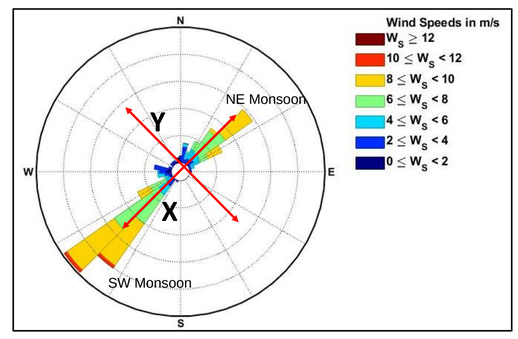

Fig 2: - Wind Rose for Palk Strait, India

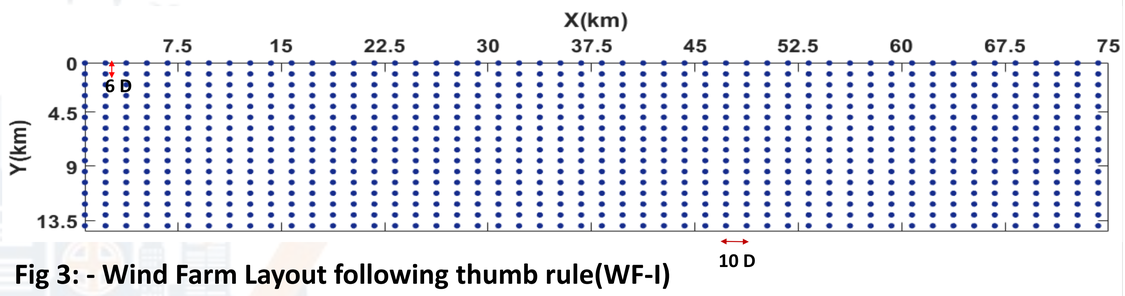

Fig 3: - Wind Farm Layout following thumb rule(WF-I)

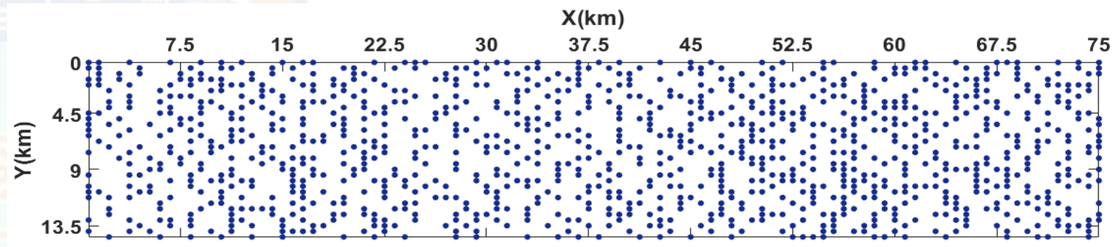

Fig 4: - Wind Farm layout produced by AI algorithm (WF-II)

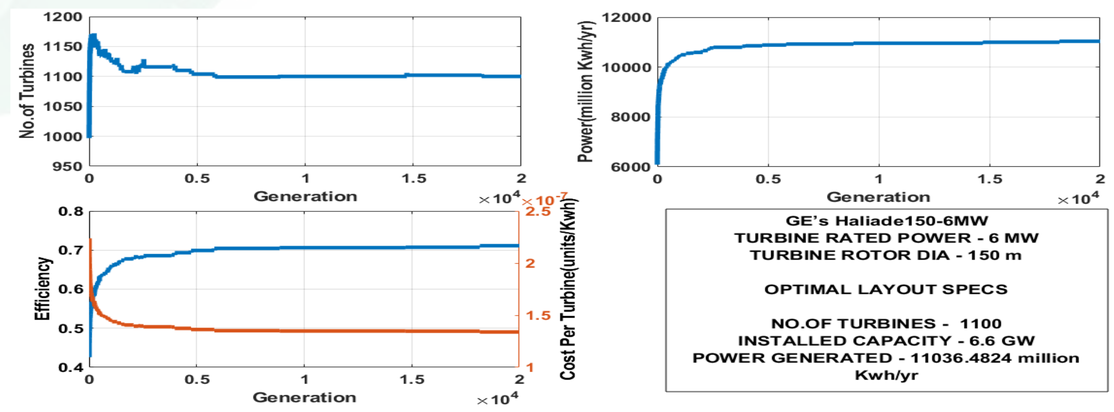

Fig 5: - Evolution of wind farm layout for 20000 iterations

	No.of Turbines	Power Generated (million Kwh/yr)	Efficiency	Cost per Kwh(10^-7)
WF-I	800	1125.7	0.1	9.4
WF-II	1100	11036.5	0.72	1.4

Table 1: - Comparison of layouts.

Conclusions:

An AI model is successfully built and has been able to create layouts that are more efficient and also produces more power than the layouts created using thumb rules.

Industrial Significance:

The developed algorithm will allow the wind energy investors to gain higher profits by setting up an efficient layout.

Technology Readiness Level:

Current product is at TRL-4, which means the product is laboratory tested and to be used in relevant environment(TRL-5)

References

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Acknowledgement

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