# *CERTIFICATE*

The project entitled:

***"SELECTING LOCATIONS FOR INSTALLING WIND TURBINES"***

this is being submitted by the following students:

MONYA A. ALMISMARY 15883

HASSAN F. ALSHWIHDE 16107

ASMA A. ALBEERA 16704

in partial fulfillment of the requirements for the award of the B.Sc. degree in Industrial Engineering has been carried out under my supervision and accepted for presentation examination

Date: ……………… Signature:…………………

 Supervisor **: Dr. OMAR ALMABROUK**

Corrected / approved copy for records.

Date : ……………… Signature :…………………

 Supervisor : Dr. OMAR ALMABROUK

Date : ……………… Signature :…………………

 Examiner : **Mr. AHMED ABOFARIS**

***ACKNOWLEDGMENT***

It is hard to even begin writing an acknowledgements section, as there are so many important people to thank for their support and assistance in completing this project. Our heartfelt appreciation is extended to each and every person who has helped us reach this point both professionally and personally.

First and foremost, we offer our praises, gratitude and thanks to ***almighty ALLAH*** for helping us during the courses of our studies in general.

Second, we would like to express our sincere appreciation and thanks to our supervisor ***Dr. OMAR M. EDDNALI*** for has help, guidance and advice during the preparation of this project.

We would like also to extend our great thanks to the academic staff members of the department, secretaries, and engineers in different departments and also to administration for their contribution of academic knowledge.

At last, by no means the least, we would like to extend our great thanks to our families, friends and every one helped us in the preparation of this project.

***CONTENTS***

|  |  |
| --- | --- |
| ***Title***  | ***page*** |
| **Certificate**  | **I** |
| **Acknowledgement**  | **II** |
| **Contents**  | **III** |
| **List of figures**  | **VII** |
| **List of tables** | **VIII** |
| **Abstract**  | **IX** |
| **Abstract (Arabic)** | **X** |

|  |  |
| --- | --- |
| ***CHAPTER ONE*** |  |
| ***INTRODUCTION*** | **1** |
| 1.1Background | **1** |
| 1.2 Wind Conception | **2** |
|  1.2.1 The Wind as a Source of Energy | **3** |
|  1.2.2 Wind Speed | **3** |
| 1.3 Wind Energy | **3** |
|  1.3.1 Advantages of Wind Energy | **5** |
|  1.3.2 Disadvantages of Wind Energy | **5** |
| 1.4 Wind Turbines | **6** |
|  1.4.1 Energy Conversion Mechanism in Wind Turbine | **7** |
| 1.5 Types of Wind Turbine | **8** |
|  1.5.1 Horizontal Axis Wind Turbine (HAWT) | **8** |
|  1.5.1.1 HAWT Advantages | **9** |
|  1.5.1.2 HAWT Disadvantages | **9** |
|  1.5.2 Vertical Axis Wind Turbine (VAWT) | **10** |
| ***Title***  | ***Page*** |
|  1.5.2.1 VAWT Advantages | **10** |
|  1.5.2.2 VAWT Disadvantages | **11** |
| 1.6 Site Investigation | **12** |
| 1.7 The Objective of the Study | **13** |

|  |  |
| --- | --- |
| ***CHAPTER TWO*** |  |
| ***LITERATURE SURVEY*** | **14** |

|  |  |
| --- | --- |
| ***CHAPTER THREE*** |  |
| ***THE MATHEMATICAL & STATICAL APPROACH*** | **19** |
| 3.1 Introduction | **19** |
| 3.2 Energy and Its Forms | **20** |
|  3.2.1 Energy in the Wind | **20** |
| 3.3 Power in the Wind  | **21** |
|  3.3.1 Wind Power Density | **21** |
|  3.3.2 Betz Limit  | **21** |
| 3.4 Power Curve | **22** |
|  3.4.1 Hysteresis and Cut-out Effect | **23** |
|  3.4.2 Impacts of Aggregation of Wind Power Production | **24** |
| 3.5 Weibull Statistic  | **24** |
| 3.6 Numerical Methods for Determine Weibull Parameters  | **27** |
| 3.7 Annual Energy and Capacity Factors | **28** |
| ***Title*** | ***Page*** |
| ***CHAPTER FOUR*** |  |
| ***IMPLETATION OF MATHEMATICAL AND STATSTICAL APPROACH*** | **29** |
| 4.1 Location of Libya | **29** |
| 4.2 Wind Turbine Power Curve | **30** |
| 4.3 Calculation for Wind Speed Data Case Study One (Tobruk) | **32** |
| 4.4 Calculation for Wind Speed Data Case Study Two (Albayda) | **35** |
|  |  |

|  |  |
| --- | --- |
| ***CHAPTER FIVE*** |  |
| ***RESULTS AND DISSCUSION*** | **39** |
|  |  |

|  |  |
| --- | --- |
| ***CHAPTER SIX*** |  |
| ***CUNCLUSION AND SCOPE OF FUTURE WORK*** | **40** |
|  |  |
|  |  |
| ***REFRENCES*** |  |
|  |  |
| ***APPENDIX*** |  |
| A. Daily Wind Speed Data |  |
| ***Title*** | ***Page*** |
| B. Analysis of Daily Wind Speed Data |  |
| C. Monthly Power Curves |  |
| D. Wind Speed Data at Hub Height for Two Sites Tobruk and Albayda |  |

***LIST OF FIGURES***

|  |  |
| --- | --- |
| ***Title***  | ***page*** |
| 1.1 How the Wind Occurs | **2** |
| 1.2 The Importance of Advantages and Disadvantages of Wind Power | **6** |
| 1.3 Wind Turbine Structure | **7** |
| 1.4 Horizontal and Vertical Axis Wind Turbine | **11** |
| 3.1 Typical Power Curve of a 1500kW Pitch Regulated Wind Turbine | **23** |
| 3.2 Examples of weibull Distribution at Different Values of k | **26** |
| 4.1 Map of Libya From Libyan Atlas | **30** |
| 4.2 Vestas V47-660kW Wind Turbine Power Curve | **31** |
| 4.3 Monthly Variation of Wind Power Production for Tobruk | **33** |
| 4.4 Monthly Variation of Mean Wind Speed for Tobruk | **33** |
| 4.5 Calculation of Power Production (Tobruk) | **35** |
| 4.6 Monthly Variation of Wind Power Production for Albayda | **36** |
| 4.7 Monthly Variation of Mean Wind Speed for Albayda | **36** |
| 4.8 Calculation of Power Production (Albayda) | **38** |

***LIST OF TABLES***

|  |  |
| --- | --- |
| ***Title***  | ***page*** |
| 3.1 Methods for Estimating the Weibull Parameters | **27** |
| 4.1 Power Curve Data | **30** |
| 4.2 Maine Characteristics of Wind Turbine Used  | **31** |
| 4.3 Monthly Data of Tobruk | **32** |
| 4.4 Probability Density Function Data for January Month Tobruk | **34** |
| 4.5 Monthly Data of Albayda | **35** |
| 4.6 Probability Density Function Data for January Month Albayda | **37** |

***ABSTRACT***

The large-scale use of [renewable energy](http://en.wikipedia.org/wiki/Renewable_energy) technologies would greatly mitigate or eliminate a wide range of environmental and human health impacts of energy use. Renewable energy technologies include biofuels, solar heating and cooling, hydroelectric power, solar power, and wind power. In this project, the wind power was studied on the base of wind power location. Two locations, Tobruk and Albayda were selected and their wind speed time series data were analyzed to study the best location for installing wind turbine generators.

The Weibull distribution is the standard function used by the wind energy community to study the wind power location by modeling the wind speed frequency distribution**.** The Weibull parameters namely, shape parameter (k) and scale parameters (c) were computed using the empirical method. This study indicates that a large magnitudes of winds at the hub height for power generation occurred during the first months of the year for the two sites, and the annual mean power density was 327.682W/m² in Tobruk, and 285.4917W/m² in Albayda, these locations if utilized, they will provide solution towards power shortage problem of Libya.

***الخلاصه***

ان الاستخدام الواسع النطاق لتكنولوجيات الطاقة المتجددة يخفف إلى حد كبير أو يقضي على مجموعة واسعة من الآثار الصحية البيئية والبشرية من استخدام الطاقة. وتشمل تكنولوجيات الطاقة المتجددة الوقود الحيوي، الطاقة الشمسية والتدفئة والتبريد، والطاقة الكهرومائية، والطاقة الشمسية، وطاقة الرياح. في هذا المشروع، درسنا طاقه الرياح بناءا على موقع قوة الرياح. وقد تم اختيار موقعين، طبرق والبيضاء وجرى تحليل بيانات سلسلة من سرعة الرياح التي سجلت يوميا على مدى سنه واحده لدراسة مدي أمكانية استغلال طاقة الرياح في هذين الموقعين.

توزيع وايبل هو وظيفة قياسية مستخدمة من قبل هيئة طاقة الرياح لدراسة موقع طاقة الرياح عبر الاقتداء بتوزيع تردد سرعة الرياح. حسبت معاملات وايبل، وهي معامل الشكل (k) ومعامل المقياس (c) باستخدام الطريقة التجريبية. هذه الدراسة تشير إلى أن مقادير كبيرة من الرياح في ذروة مركزا لتوليد الطاقة وقعت خلال الأشهر الأولى من السنة للموقعين، وكان متوسط ​​كثافة القدرة السنوية 327.682 وات لكل متر مربع في طبرق، و285.4917 وات لكل متر مربع في البيضاء، هذه المواقع إذا ما استغلت، فأنها سوف توفر حل مشكلة نقص الطاقة في ليبيا.