Chapter 1 : Introduction................................................1

**1.1 Renewable energy..........................................................................................2**

 **1.1.1The types of renewable sources of energy…………………………….3**

 **1.1.1.1 Hydropower………………………………………………………….3**

 **1.1.1.2 Tidal power…………………………………………………………..4**

 **1.1.1.3 Solar energy………………………………………………………….5**

 **1.1.1.4 Biomass………………………….……………………………………6**

 **1.1.1.5 Geothermal energy…………….…………………………………….6**

 **1.1.1.6 Wind power..…………………………………………………………7**

**1.2 Advantages of wind power…………………………………………………8**

**1.3 Distribution of wind speed in Egypt………………………………………9**

Chapter 2 : Construction…………………………………………….….**11**

**2.1 Main parts…………………………………………………………………11**

 **2.1.1 The up-frame…………………………………………………………11**

 **2.1.2 Nozzle smoothing……………………………………………………..13**

 **2.1.3 Generator chair………………………………………………………13**

 **2.1.4 The base……………………………………………………………….15**

 **2.2Movement of the base……………………………………………………..16**

**2.3 Connection between nozzle and base…………………………………….17**

**2.4 The complete construction….……………………………………………18**

Chapter 3 : Blade Design…**……………………………………………..20**

**3.1 Blade design……………………………………………………………….20**

 **3.1.1 Axis.........................................................................................................20**

 **3.1.2 Horizontal-Axis Wind Turbines……………………………………..20**

 **3.1.3 Vertical-Axis Wind Turbines………………………………………...21**

**3.2** [**Darrieus wind turbine**](http://en.wikipedia.org/wiki/Darrieus_wind_turbine)**…………………………………………………….21**

**3.3** [**Giromill**](http://en.wikipedia.org/wiki/Giromill)**……………………………………………………………………22**

**3.4** [**Savonius wind turbine**](http://en.wikipedia.org/wiki/Savonius_wind_turbine)**…………………………………………………….22**

**3.5 Differences between VAWT & HAWT………………………………….22**

 **3.5.1 Installation…………………………………………………………….22**

 **3.5.2 Coefficient of wind power use………………………………………..22**

 **3.5.3 START OF OPERATING (SELF START)……………………….. 23**

 **3.5.4 RATIONALITY OF POWER STRUCTURE OF WIND TURBINE…..23**

**3.6 DESIGN OF BLADE……………………………………………………………23**

 **3.6.1 SWEPT AREA ON THE UNIT OF BLADE LENGTH………………….24**

 **3.6.2 HIGH-SPEED DEGREE…………………………………………………...24**

 **3.6.3 Maintenance…………………………………………………………..24**

 **3.6.4 Recommendations…………………………………………………….24**

**3.7 Advantages & Disadvantages…………………………………………….25**

 **3.7.1 Advantages of vertical wind turbines………………………………..25**

 **3.7.2 Disadvantages of vertical wind turbines……………………………..25**

 **3.7.3 Advantages of horizontal wind turbines………..……………………26**

 **3.7.4 Disadvantages of horizontal wind turbines………………………….27**

**3.8 Why did we select HAWT in our project………………………………..27**

**3.9 Number of blades………………………………………………………….28**

 **3.9.1 Advantages of 5-blade over 3-blade wind turbines…………………29**

 **3.9.2 Blade materials..………………...…………………………………….30**

**3.10 Wind turbine blades material…………………………………….……..30**

**3.11 Wind turbine aerodynamics…………………………………………….30**

**3.12 General Aerodynamic Considerations…………………………………31**

**3.13 Typical Parameters used to characterize wind turbines………………32**

 **3.13.1 Maximum power of a drag based wind turbine………………….33**

 **3.13.2 Maximum power of a lift based wind turbine…………………….34**

**3.14 Horizontal Axis Wind Turbine Aerodynamics………………………...35**

**3.15 Generator Choosing……………………………………………………..36**

 **3.15.1 Generator Cooling System…………………………………………38**

**3.16 Gearbox…………………………………………………………………..38**

Chapter 4 : Computational fluid dynamics**…………………………40**

 **4.1 Computational fluid dynamics……………………...……………………41**

**4.2 Background and Applications……………………………………………41**

**4.3 Applications………………………………………………………………..41**

 **4.3.1 Automotive…………………………………………………………….41**

 **4.3.2 Aerospace……………………………………………………………...43**

 **4.3.3 Turbo machinery……………………………………………………...45**

**4.4 Methodology……………………………………………………………….45**

**4.5 Results of Ansys…………………………………………………………...47**

**4.6 Simulating the Nozzle……………………………………………………..50**

**4.7 CFD for a nozzle with 3 blades…………………………………………...52**

**4.8 CFD for a nozzle with 5 blades…………………………………………...54**

**4.9 Effect of tunnel with nozzle………………………………………………55**

Chapter 5 : RESULTS**…………………………………………………….58**

**5.1 Results……………………………………………………………………...58**

**5.2 Betz' Law…………………………………………………………………..59**

**5.3 Measurement devices……………………………………………………..61**

 **5.3.1 Wind speed device………………………………………….…………61**

 **5.3.1.1The laser Doppler techniques…………………………...………61**

 **5.3.1.2 Anemometer…………………………………………...………...61**

 **5.3.2 RPM Measurement…………………………..………………………62**

 **5.3.3 Volt measurement device…………………………………………….63**

 **5.3.3.1 Voltmeter……………………………………………………………63**

 **5.3.4 Torque measurement device…………………………………………64**

Chapter 6: Optimum design…………………………………………….**66**

**6.1 Green Energy Technologies Compact Wind Turbine…………………..66**

**6.2 Advantages of the WindCube…………………………………………….66**

**6.3 Fundamentals of the Technology………………………………………...67**

**6.4WindCube Components…………………………………………………...68**

**6.5 How it works………………………………………………………………68**

**6.6 American Wind cube overview…………………………………………..72**

**6.7 Applications……………………………………………………………….73**

**6.8 American wind cube design………………………………………………75**

**6.9 Our wind cube design……………………………………………………..76**

Chapter 7 : Future modifications**…………………………………..….79**

**7.1-Control system…………………………………………………………….79**

**7.2-Safety system................................................................................................79**

**7.3-Electric system…………………………………………………………….80**

 **7.3.1 Blocking diode…………………………………………………………80**

 **7.3.2 Battery…………………………………………………………………80**

 **7.3.3 Charge controller……………………………………………………..80**

 **7.3.4 Dummy load…………………………………………………………...81**

 **7.3.5 Electric inverter……………………………………………………….81**

**7.4-Dealing with the torque problem………………………………………...81**

**7.5-Nozzle on large scale……………………………………………………...81**

**7.6. Adding scoop to the Tunnel……………………………………………..82**

Chapter 8 : MOST EFFICIENT TECHNOLOGY**…………………..84**

**8.1 Characteristics of a highly efficient propeller type small wind turbine with a diffuser…………………………………………………………………84**

**8.2 Simulation results…………………………………………………………84**

**8.3 WindTamer………………………………………………………………..87**

 **8.3.1 Clean energy with fewer concerns…………………………………..88**

 **8.3.2 Silent and vibration free……………………………………………..88**

 **8.3.3 Safe for birds — and people…………………………………………88**

 **8.3.4 MINIMAL MAINTENANCE……………………………………….88**

 **8.3.5 EASY ACCESS……………………………………………………….88**

Conclusion………………………………………………………………….91