Journal of Al-Azhar University Engineering Sector

Vol.15, No. 56, July, 2020, 828 -844

MODELING ZERO ENERGY BUILDING: PARAMETRIC STUDY FOR THE TECHNICAL OPTIMIAZTION

Dalia Abd El Rahman[1]*, Gihan Mosaad[1], Fahd AbdElAziz Hemeida[1], and Ahmed Ramadan[2]

[1]Architectural Engineering and Environmental Design Department, Arab Academy for Science and Technology and Maritime Transport, Alexandria Egypt

[2]Basic and Applied Science Department –Engineering Physics, Arab Academy for Science and Technology and Maritime Transport, Alexandria Egypt

*Corresponding Author E-mail: daliaa.abdelrahman@gmail.com

ABSTRACT

Wind power is currently the fastest growing form of renewable energy various types of clean energy resources such as solar power, hydropower, and ocean wave power, the purpose of the paper is to establish guidelines for optimizing Existing multi-storey building designs toward green energy building. Integrated vertical axis wind turbines will be added to existing villa in future. Marassi in North Coast is chosen for the Case Study. The used methods comprise literature review. This Paper will conclude with a set of findings that clarify how Savonius wind turbine used to reach higher for the existing building.

KEYWORDS: Wind power, Renewable Energy, Net Energy Building, and Vertical Axis Wind Turbines, and Micro Wind Turbines.

تشكيل بناء منخفض الطاقة: دراسة بارامترية لتحقيق الحل الفني الامثل

داليا عبد الرحمن[1]*،جيهان مسعد[1] ،فهد عبد العزيز[1]، و أحمد رمضان [2]

[1]قسم الهندسة المعمارية، الأكاديمية العربية للعلوم و التكنولوجياو النقل البحرى

[2]قسم العلوم الأساسية والتطبيقية،الأكاديمية العربية للعلوم و التكنولوجياو النقل البحرى

*البريد الاليكتروني للباحث الرئيسي: E-mail: daliaa.abdelrahman@gmail.com

الملخص

تعد طاقة الرياح حاليًا أسرع أشكال الطاقة المتجددة نموًا ، حيث توجد أنواع مختلفة من موارد الطاقة النظيفة مثل الطاقة الشمسية والطاقة الكهرومائية وطاقة الأمواج المحيطية ، والغرض من هذه الورقة هو وضع مبادئ توجيهية لتحسين تصاميم المباني الحالية متعددة الطوابق نحو البيئة الخضراء. بناء الطاقة. سيتم إضافة توربينات الرياح المحور الرأسي المتكاملة إلى الفيلا الحالية في المستقبل. تم اختيار مراسي في الساحل الشمالي لدراسة الحالة. الأساليب المستخدمة تشمل مراجعات ادبية. ستختتم هذه الورقة بمجموعة من النتائج التي توضح كيفية استخدام توربينات الرياح سافونيوس للوصول إلى أعلى كفاءة للمبنى الحالي.

طاقة الرياح صديقة للبيئة أكثر من حرق الوقود الأحفوري للكهرباء .معظم الرياح في يناير وأقل الرياح في سبتمبر وفقًا للرسم البياني الذي يوضح متوسط سرعة الرياح على مدار العام في العلمين .تم اختيار موقع دراسة الحالة بسبب توفر الرياح على مدار العام استخدام نوع التوربينات الهوائية من نوع سافونيوس لتركيب التوربينات الهوائية المدمجة مع المبنى في المستقبل وتعديل حواف المبنى لتكون منحنية: سيصبح المبنى مناسبًا لحركة الهواء ولتزويد التوربينات بالطاقة المناسبة للمبنى وسوف ترتفع كفاءة الفيلا

الكلمات المفتاحية: طاقة الرياح ، الطاقة المتجددة ، بناء الطاقة صفر ، توربينات الرياح المحور الرأسي ، و توربينات الرياح الصغيرة

1. INTRODUCTION

Now it is well understood that, due to greenhouse gases, the burning of fossil fuels in power plants has a significant impact on the global climate. Cost-efficient and reliable low-carbon energy sources are becoming a vital energy policy in many countries. Renewable energy has become an essential for achieving sustainable development in developing countries, particularly in rural areas, by the beginning of the new millennium. Egypt is rich in renewable energy sources, but for many decades it has relied on traditional energy sources such as oil, natural gas and hydropower.

Egypt is characterized by distinguished wind network, according to several studies, enabling it to host large-scale wind projects, especially in the Suez Gulf region where wind speed exceeds 10 m / sec. Because of this, several foreign countries and international donors have been welcomed in Egypt to collaborate and conduct studies and projects. (Taman)

2. Research questions

How can we determine if a wind energy system is a practical choice or not, why wind Energy, and what are the benefits of using wind power with a villa.

3. Research objectives

1. Develop the utilization of unused wind energy in north coast in order to provide reliable and steady supply of electricity & make building **sustainable.**
2. Investigate and analyze the processes and outcomes of adding wind turbine to existing villa in North coast, Egypt.
3. To provide the necessary electrical energy to meet the needs of the compound.

4. Research Methodology

The exploratory nature of the paper requires adopting a qualitative approach as the most logical option to reveal the importance of using wind turbines integrated with building to generate electricity. The study is classified into three parts:

- **Inductive and deductive:** Through a literature review that studies the renewable energy supply & Energy Efficiency Technologies, Wind Energy systems and applications.
- **Analytical Study:** Through analyzing relevant examples that succeeded in using vertical axis wind turbines in buildings, either by adding them to an existing building or being integrated with the building.
- **Field of Work:** Through choosing a study area (Existing villa) and install A vertical axis wind turbine integrated with the building.

5. Renewable energy sources

Renewable energy is energy produced from natural resources, such as wind, water, sunlight, tides and geothermal heat, which are renewable (Gorjian, 2017).

- Wind
- Solar energy
- Biomass
- Hydropower
- Geothermal
- Ocean energy
- Waste to Energy (Gorjian, 2017)

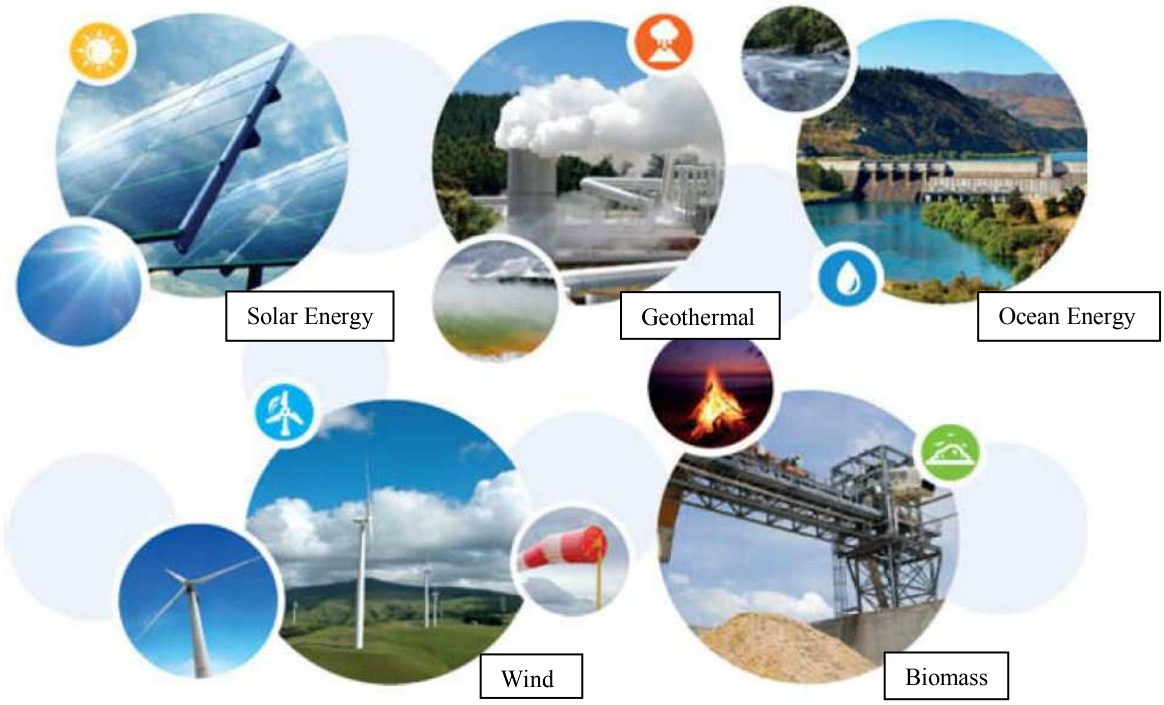


Figure (1) Renewable Energy Sources (Gorjian, 2017)

5.1 Energy Retrofits:

Each building has the opportunity to use passive and active systems in order to provide the user with a comfortable environment and also to protect the environment.

5.1.1. Active strategy: meet human needs in a comfortable environment by means of electrical-mechanical equipment, one of which plays an important role than another. **5.1.2. Passive strategy:** tries to optimize and conserve the use of potential energy and around the building without converting it into electrical energy (Mochtar)

- Building techniques use both active and passive architectural design features to ensure comfortable living environments through the use of energy intensive materials to reduce the overall use of resources. (Rajan Govind ,M Anand ,R Subramanian , Deepa Sathiaram ,S Srinivas, 2013)

5.2 Benefits of Renewable Energy:

5.2.1. Environmental Benefits: Renewable energy technologies are clean energy sources with less impact on the environment than conventional energy technologies.

5.2.2. Sustainability: Renewable energies are not going to run out. Other energy sources are always finite and will be depleted someday.

5.2.3. Jobs and the Economy: Most investments in renewable energy are spent on materials and manufacturing to build and maintain facilities, rather than on expensive energy imports.

5.2.4. Energy Security: Our nation has increased its dependence on foreign oil supplies rather than reducing it after the oil supply disturbances of the early 1970s. This growing dependency has more effect than our national energy itself. (Alrikabi, 2014)

5.3 Advantages of Renewable Energy

- Provides low operating and maintaining costs high up-front investment
- Provides long life period entails long term planning
- Service cost is low entails long term agreements

- Reliable source entails multidisciplinary involvement
- Induces technology development could involve resettlement
- Fosters regional development entails new legal codes
- Provides efficient energy production and safety excessive competition
- Generates revenue and tax
- Creates new employment opportunities
- Protects environment and saves environmental protection costs
- Enhances living conditions
- It is waste- free
- Improves air quality
- Preserves ecosystems
- Helps slow down climate change (Mahmure Övül Arıoğlu Akan ,Ayşe Ayçim Selam ,Seniye Ümit Oktay Fırat, 2016)

5.4 COMPARISON BETWEEN SOLAR VS WIND ENERGY

Table (1) Comparison between solar vs. wind power (Yasser zahra , Mohammed dawood, 2012)

Solar Power	Wind Power
Low maintenance	High maintenance
Long system life span (25 years)	Long system life span (25 years)
Reporting on monthly basis	Reporting every hour
Intermittent	Intermittent power output
Simple installation	Simple installation
Low plant load factor	Moderate plant load factor
High project cost	High project cost
In some areas necessitates the use of a large battery bank and /or alternate power source	Necessitates the use of an alternate power sources
No moving parts	Moving parts eventually wear out
For houses : solar panels depend on sunlight, they only generate power during the hours of sunlight (AGGARWAL., 2019)	For houses : wind turbines aren't dependent on sunlight, they can generate power 24 hours a day (AGGARWAL., 2019)

6. Wind Power

Wind power was the first renewable energy of the second generation to become cheaper than coal, and as a result, in the last 15 years, its popularity has exploded entirely.

For thousands of years, human have used wind power to pump water using sails to propel ships and windmills. However, wind has only been viewed as a viable way to generate electricity on a large scale in the last 40 years. (farris, 2017)

6.1. ECONOMICS OF WIND POWER

- Wind power is the first renewable technology in the second generation to remain competitive with fossil fuels.
- Wind power costs have fallen by 95% over the past 30 years.
- Wind power is now cheaper in many areas than coal and certain forms of gas generation.
- Offshore wind farms are more costly, but with falling prices they are more effective and common. (farris, 2017)

6.2. THE WIND POTENTIAL & POSSIBILITIES

The wind resource — how quickly it blows, how often, and when — plays a major role in its cost of generating power. A wind turbine's power output decreases as a cube of wind speed. In other words, the power output increases eight times if the wind speed doubles. Higher-speed winds are therefore captured more easily and cheaply.

Wind speeds are classified into seven classes — the lowest being in class one and the highest in class seven. An assessment of wind assesses the average wind speeds above a section of land (e.g. 50 meters high) and assigns a wind class to that area.

Over a limited range of wind speeds wind turbines run. They won't be able to turn if the wind is too slow, and if it's too fast, they shut down to avoid damage. Wind speeds are typically required for economic power generation in classes three (6.7–7.4 meters per second (m / s) and above). Ideally, to maximize power production, a wind turbine should be matched to the resource speed and frequency.

The DOE National Renewable Energy Laboratory (NREL) has been collaborating with state governments since 1990s to develop and verify possible state by state evaluations of high – resolution wind resources (How Wind Energy Works, 2013)

Egypt has exceptional conditions for wind energy. High and stable wind speeds are frequent, especially in the coastal regions (up to an average of 10.5 m / s in the Suez Gulf). In addition, the large deserts of the country and sparse thinly populated areas are well suited to large wind farms being installed (Figure 2). (Wind Energy Country Analysis Egypt, n.d.)

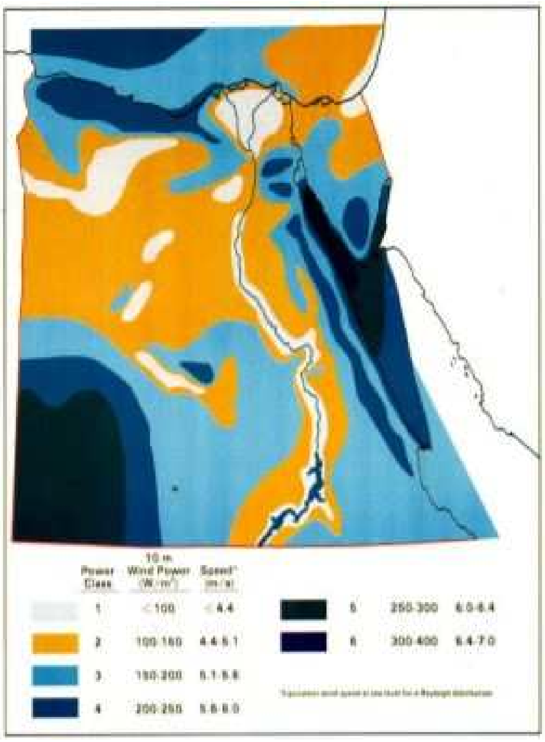


Figure (2) Egypt wind power map in 1987 ***(Aziz, 2013)***

6.3. WIND POWER BY 2030

According to a report by the International Renewable Energy Agency (IRENA), Egypt could raise the share of renewables in its electricity mix to 53% by 2030. Considering renewable energy, heat and fuels, renewable energy could provide 22% of the country's total final energy supply in 2030, compared to 5% in 2014.

IRENA said that while this would entail increased investment, Egypt's energy bill would fall by USD 900 million (EUR 783 million) per year in 2030, reflecting a cost reduction of USD 7 per MWh. Reduced air pollution will also provide health benefits. The latest goals for Egypt are to provide 20% of the energy mix by 2022 and 42% by 2035 for renewables.

6.4. AERODYNAMICS OF WIND TURBINES

Over the past 20 years, wind turbines have grown exponentially, with turbines increasing in size from 100 kW in the early 1980s to more than 2500 KW today. It is expected that the development of wind technology will continue over the next decades, resulting in a continuous improvement in performance and energy capture with a gradual reduction in costs. Improvements in blade design and materials, advanced rotors, drive systems, towers and controls are expected to enable this continuing improvement in wind technology's cost-effectiveness. With the cube of wind speed, the amount of energy available in the air for use by the turbine increases; thus a 10 percent increase in wind speed means an increase of 33 percent in available energy. The long-term push to build larger turbines stems from a desire to take advantage of wind shear by positioning rotors at higher, more powerful winds above ground (wind speed increases with height above ground). This is a major reason why, as Wiser and Bolinger reported, the capacity factor of wind turbines has increased over time as shown in Figure 3. (Bošnjaković, 2013)

6.5. WIND TURBINE DESIGN

A wind turbine's structural design is made up of two main parts: its tower and its foundation.

- The design of the tower is based primarily on wind and ice loads, rotor loads, nacelles, blades, and additional tower top equipment in addition to wind loads on the tower. The foundation is constructed by moment and axial loads resulting from the layout of the tower and the characteristics of the supporting soil.

The following flow chart in Design Figure details the process of designing the wind turbine

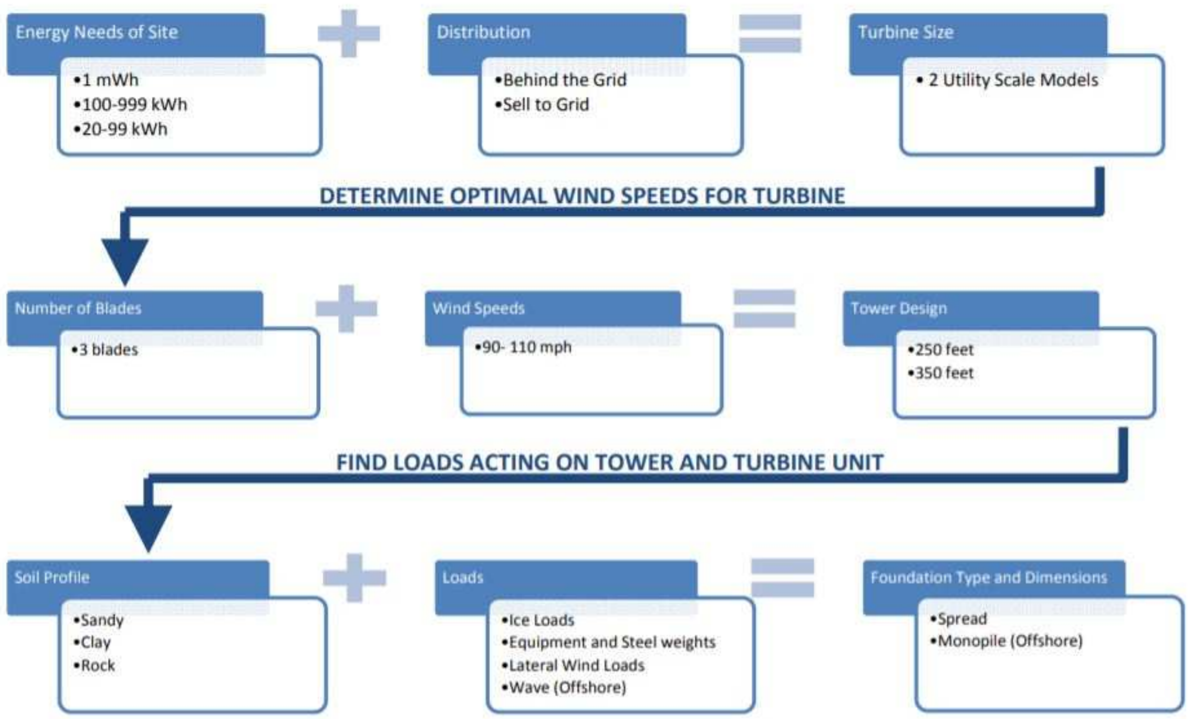


Figure (3) Flow Chart of Wind Turbine Design (Bethany kuhn , Julie marquis , Hilary rotatori, 2010)

7. TYPES OF WIND TURBINES

There are two basic types of wind turbines:

- Horizontal-axis turbines
- Vertical-axis turbines

Wind turbines vary widely in size. The blade length is the greatest factor in determining how much electricity a wind turbine can generate. Small wind turbines that can power a single home can generate 10 kilowatts (kW) of electricity. The largest wind turbines in operation have electricity generating capacity of up to 10,000 kW and the design of larger turbines. Large turbines are often combined to create wind power plants or wind farms that supply electricity grids. (Energy Explained, n.d.)

7.1. REASONS FOR CHOOSING SMALL WIND TURBINES

- The local electrical grid may be too weak to handle a large machine's electrical output. For remote parts of the electrical grid with low population density and low electricity consumption in the region this may be the case.
- There is less fluctuation in the production of energy from a wind park consisting of a number of smaller devices as wind variations occur spontaneously and thus appear to cancel. Once, smaller computers in a poor electrical grid can be an advantage.
- The price of using large cranes and constructing a road that is strong enough to carry the turbine components will make some places more economical for smaller machines.
- In the event of temporary machine failure, many smaller machines spread the risk, e.g. due to lightning strikes.
- The use of smaller machines can sometimes be determined by esthetic landscape considerations. Nevertheless, large machines would normally have a much lower rotational speed, meaning that one large machine does not really draw as much attention as many small, fast-moving rotors. (association, 2013)

7.2. MICRO WIND TURBINES

Through spinning turbine blades, micro-wind turbines generate electricity when wind moves over them. A gearbox transforms the low-speed rotation of the input shaft attached to the rotor to high-speed rotation. Then the high-speed shaft powers the generator to generate electricity. To guide the turbine to the blowing wind, a yaw mechanism is used. To convert the turbine's DC electricity into AC electricity suitable for use in dwellings, an inverter is required.

The turbine is believed to be free-standing, mast-mounted (85% of market share in 2010) with horizontal axis layout (98% of the market) in line with UK trends. It is believed that the minimum requirements for a suitable location are established at a location with an annual average wind speed of 5 m / s with no nearby obstructions. The analysis is based on the turbine of 6 kW Proven 11, which generates 7800 kWh a year. (Benjamin Greening , Adisa Azapagic, 2013)

7.2.1. COST OF SMALL WIND TURBINES

The apparent concern are the costs the small wind turbines. First, the production of a given machine should always be considered in terms of investment costs and operating costs, and second, an assessment of the actual total costs is important to make an economic trade-off between the choices of different (renewable) sources of energy.

Cost of Energy

The cost of energy *(COE) is measured using the International Energy Agency (IAE) approved process.*

COE=CRF□IAPE+TOMAPECOE=CRF□IAPE+TOMAPE

Where:

- COE: Cost of energy [€/kWh]
- I Investment*:* wind turbine costs [€]
- CRF Capital Recovery Factor: yearly interest [%/year]*,* depending on interest rate *i and* economical lifetime *n:*

CRF=i · (1+i) n (1+i) n−1CRF=i · (1+i) n (1+i) n−1

- APE: annually produced energy [kWh]
- TOM: total yearly operation & maintenance costs [€]

It results in a CRF OF 0.103 if an interest rate of 6 percent per year is expected as well as an economic period of 15 years. The investment costs of a small wind turbine's main components will be listed below. (Martin Kaltschmitt, Nickolas J. Themelis, Lucien Y. Bronicki, Lennart Söder, Luis A. Vega, 2013)

7.2.2. COMPARISON BETWEEN DIFFERENT SMALL WIND TURBINE SYSTEMS

Table (2) Comparison of different small wind turbine systems based upon their rotor topology (Martin Kaltschmitt, Nickolas J. Themelis, Lucien Y. Bronicki, Lennart Söder, Luis A. Vega, 2013)

	DAWTs (Diffuser Augmented Wind Turbines)	HAWTs (Horizontal Axis Wind Turbines)	Lift-driven VAWTs (Vertical Axis Wind Turbines)	Drag-driven VAWTs (Vertical Axis Wind Turbines)
Advantages	Aerodynamically most efficient	Aerodynamically most efficient Well proven Most widely used	Aerodynamically efficient Wind direction insensitive Easy access to generator	Wind direction insensitive Turbulence insensitive No Noise Easy access to generator Well proven Robust
Disadvantages	Large and expensive duct needed	Wind direction change sensitive Tail vane/yaw system needed Does not perform well in highly fluctuating winds	Needs start-up aid	Aerodynamically inefficient Large amount of rotor material

8. EXAMPLE 1 : HILTON Fort Lauderdale BEACH RESORT

The Hilton Fort Lauderdale Beach Resort located directly on Lauderdale Florida's sandy beaches, the Hilton Fort Lauderdale Beach Resort agreed was chosen to extend and improve its green identity by installing 6.4 KW of Vertical Axis Wind Turbines to the roof in a grid tie network. Wind turbines installed in 2013 (Grozdanic, 2014) Figure 7 and Figure 8

8.1. Demand:

- It is estimated that six wind turbines with 4 Kw will generate 10% of the hotel's electricity.
- The turbines are expected to power lighting in 372 guest rooms and public areas And return $500,000 in investment in less than 10 years. (Grozdanic, 2014)

- The turbines generate approximately 24,000 kilowatt-hour.
- The power generated by the wind turbines is enough to light this building year –round. (Arlene Satchell, Sun Sentinel, 2014)

Figure (4) shows Hilton Fort Lauderdale roof top after installing six vertical axis wind turbines to generate 10% of the hotel's electricity.
Figure (5) shows a schematic diagram of the proposed system of using wind turbines on the roof top of the hotel.

Figure (4) Hilton Fort Lauderdale Beach Resort (Grozdanic, 2014)

Figure (5) Schematic Diagram of the proposed system (verticalwindturbineinfo.com, n.d.)

9. EXAMPLE 2: CHICAGO GREEN WAY PARKING GARAGE

The Chicago Green Way Parking Garage Located at the corner of Kinzie and Clark Streets, Chicago, United States. (Meinhold, Chicago Parking Garage Harvests Energy From Windy City Gusts, 2010)
The Greenway Self Park was built in 2009 to meet the increasing demand for parking in Chicago's River North neighborhood. (GREENWAY SELF PARK, 2019)

9.1.Demand:

- Generate sufficient power to cover the expense of lighting the exterior of the building at night, including the elegant turbine system.
- The two way power meter of the Greenway Self Park allows the garage to provide and transfer electricity back to the Chicago electrical grid when more energy is generated than consumed
- Each turbine can produce a capacity of up to 4.5kW. (Greenway Self Park, 2012)

Figure (6) shows Chicago Green Way Parking Garage 12 self-starting, lightweight aluminum S594 turbines integrated with the building.
Figure (7) shows a schematic diagram of the proposed system (the S594 turbine on the top of the building).

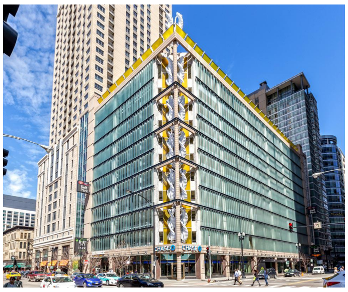


Figure (6) Chicago Green Way Parking Garage (GREENWAY SELF PARK, n.d.)

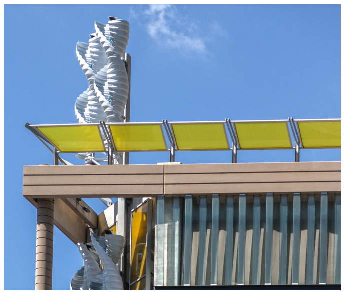


Figure (7) Green Way Self Park Turbine (Greenway Self Park, 2012)

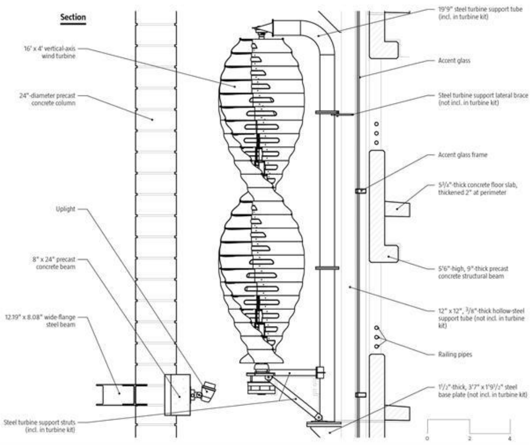


Figure (8) Section for Green Way Self Park Turbine (Greenway Self Park, 2012)

Figure (9) the structure, which is the first of its kind in Chicago, is currently pursuing LEED Certification. *(Cilento, Greenway Self-Park / HOK, 2010)*

Figure (8) shows Detailed Section for Green Way Self Park Turbine Mechanism to integrate.

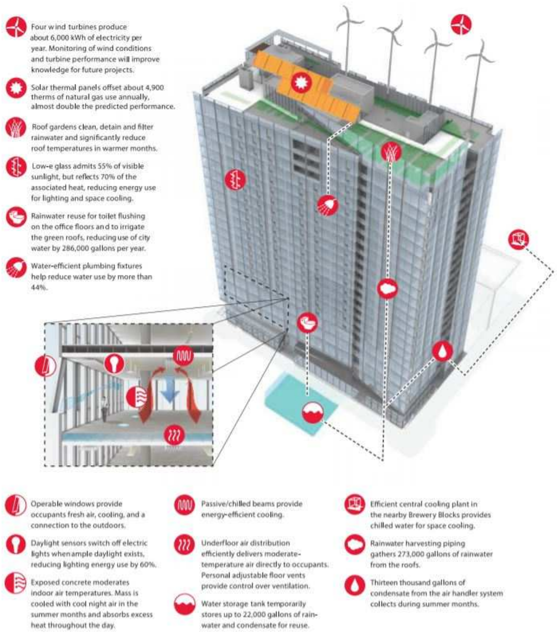
10. EXAMPLE 3: TWELVE/WEST, PORTLAND, OREGON

Twelve/ west is located in Portland's emerging West End neighborhood, directly north of the vibrant mixed-use Pearl District, east of the downtown business district, and south of the city's arts and university districts. Due to the central, transit-rich position and the ability to help connect these different districts and stimulate more dense development in the urban core of Portland, the site was chosen. (Twelve West, n.d.)

10.1. Demand:

- Twelve reflects a suitable layout at the top of the building with four, 14m wind turbines.
- The Sky stream 3.7 turbines produce 9,000kW / h annually. (Twelve West, n.d.)
- Wind turbines provide the building with a second source of renewable energy. (BY PETER VAN DER MEULEN, AIA, AND CRAIG BRISCOE, 2013)

Twelve West in Portland, Oregon, USA is a sustainable mixed-use project. The 23-storey building consists of first floor: retail space, four floors: office spaces (two to five) and 18 residential apartment floors (six to 23) called Indigo @Twelve|West. The development's total area is 51,300m².



A schematic diagram of the proposed system is shown in Figure 11

Figure (10) Twelve|West Building (Twelve|West, Portland, Oregon, n.d.)

Figure (11) Twelve West Building Sustainable Features (By Peter Van Der Meulen, Aia, And Craig BRISCOE, 2013)

11. Case Study: Marassi, North coast

Egypt possesses an abundance of high wind speeds, land and sunny weather and, making it renewable energy sources prime location. (Bissada, 2019)

Egypt has outstanding wind energy conditions. Stable and high wind speeds are frequent in the coastal regions (up to 10.5 m/s) in the Gulf of Suez. Moreover highly populated areas and large desserts are suited for large wind farms construction. (Wind Energy Country Analysis Egypt, n.d.)

Egypt has many points in wind power development:

- In the major cities Air quality considerations are one of the key environmental concerns;
- Electricity and other sources of energy Demand is increasing significantly;
- Ample land with low economic value is available;

0.7 % of Egypt's electricity supply is generated from wind. (Mohamed ElSobki ,Peter Wooders , Yasser Sherif, 2009)

- Figure 12 shows the mean monthly wind speed over the year in El Alamein, Egypt (meters per second) (CLIMATE AND AVERAGE MONTHLY WEATHER IN EL ALAMEIN (MATRUH), EGYPT, n.d.) & The Area of El Alamein was chosen according to the measurements in the graph and this graph shows the measurement of wind energy over the year in El Alamein.

AVERAGE WIND SPEED IN EL ALAMEIN (MATRUH)

- The most wind is seen in March.

- The least wind is seen in October and November.

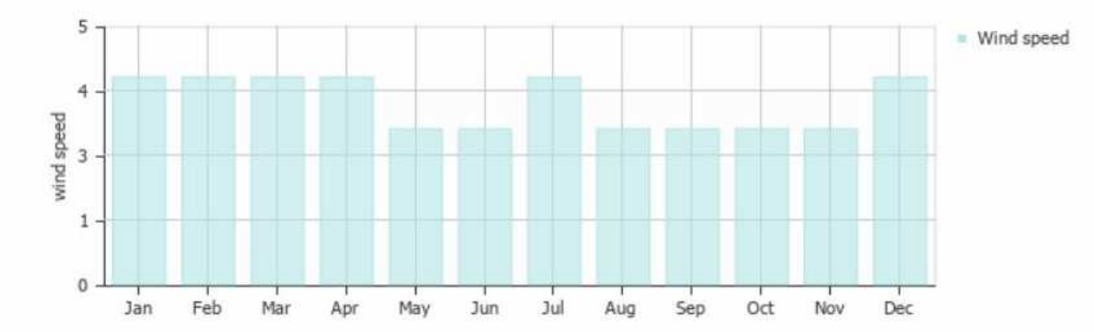


Figure (12) Average Wind Speed Over The Year In El Alamein (Matruh) (Climate And Average Monthly Weather In El Alamein (Matruh), Egypt, N.D.)

El Alamein was selected as a study area due to availability of wind over the year and average wind speed in august 2019 according to figure 13: 9.2 (m/s) & maximum wind speed 11.6 (m/s).
Figure 13 shows average wind speed over the year in El Alamein, Matruh.

WIND

Average Wind Speed — Years on Record: 112

	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
mph	9.8	10.9	11.4	11.6	10.3	9.8	8.9	9.2	9.2	8.7	8.5	8.5	9.6

Figure (13) Average wind speed in El Alamein (EL ALAMEIN, EGYPT, 2019)

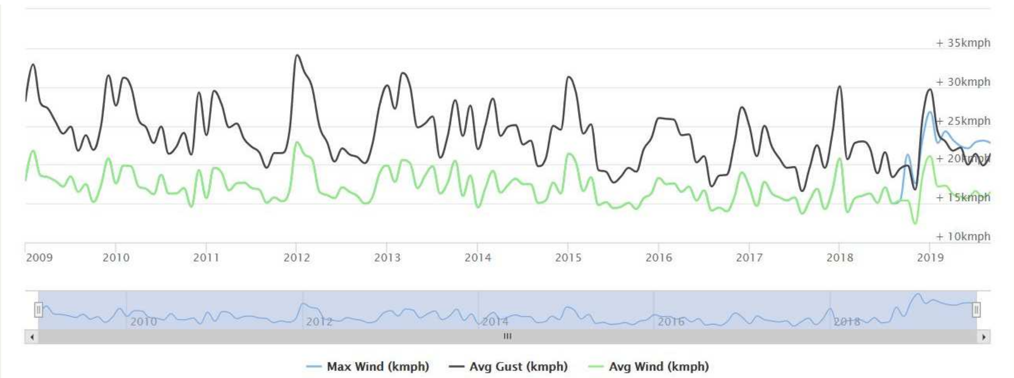


Figure (14) Maximum and Average wind speed and wind Gust in El Alamein (El `Alamein Monthly Climate Averages, n.d.)

Figure 14 shows Maximum and average wind speed and wind Gust in El Alamein, Matruh.
Over 2,300 years the north coast has been the hub of sea travel between the Mediterranean Sea and the Nile Delta
The northern coast of Egypt is the strip located in the far north of Egypt and extends at a distance of 1050 km from the city of Rafah in eastern side of Sinai to Salloum in the far west of Egypt on the Libyan border on the Mediterranean coast, and is characterized by blue waters and soft golden sand. It is one of the longest Mediterranean coastlines in North Africa. (Northern coast of Egypt, n.d.)

According to average wind speed over the year as shown in figure 12, Marassi was chosen as a study area.
Location: 125 km from Alexandria and not more than a few kilometers from Al-Alamein, it will become Egypt's main entrance through the Mediterranean and its international fame sends tourist invitations to all parts of the world.

Figure 15 shows master plan of marassi, it's divided in to 14 different zones: Vectoria, Valencia, Blanca, Celia, Verdi, safi, Salemo, Veneto, Isola, Catania, Verona, Arezzo, Marina and the Greek Village. Each zone has its own character.

Reflecting the warm white sands of the Mediterranean, Blanca homes too boast white exteriors and an exuberantly warm interior. Contemporary Mediterranean and Spanish architecture dominate this island that is overflowing with walkways, passages, greenery and a swimmable lagoon. (marassi-egypt.com, n.d.)

- **Villa Type 14 in Blanca zone was chosen as a study area Because of its proximity to the sea**.

11.1. THE PROPOSED STUDY VILLA 14 BLANCA ZONE BEFORE

Figure (16) Blanca Zone in Marassi (marassi-egypt.com, n.d.)

MODIFICATION

The location of the villa was chosen as a study area due to its nearness to the sea and wind speed.
The following drawings shows ground, first floor and Pent House Roof architectural plans of the villa before modification of adding wind turbines.
Figure (18), (19) & (20) shows Roof, Ground and First floor plan of the villa.
Figure (21), (22), (23) & (24) shows four elevations of the villa before modifications: North, South, East and West Elevations.

Figure (17) villa Type 14 (marassi-egypt.com, n.d.)

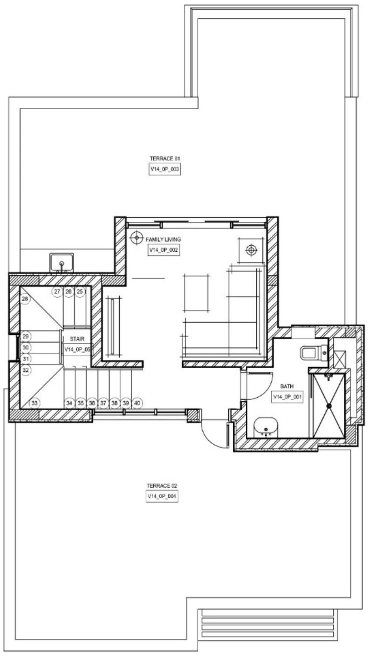
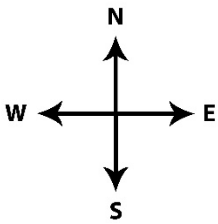


Figure (18) Pent House Roof Plan of Villa Type 14 (Emmar Misr for Development, SAE, 2019)



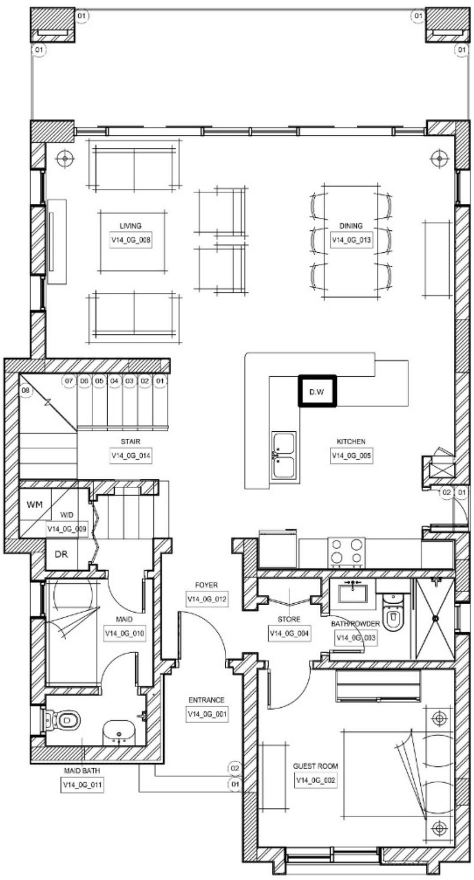


Figure (19) Ground Floor Plan of Villa Type 14(Emmar Misr for Development, SAE, 2019)

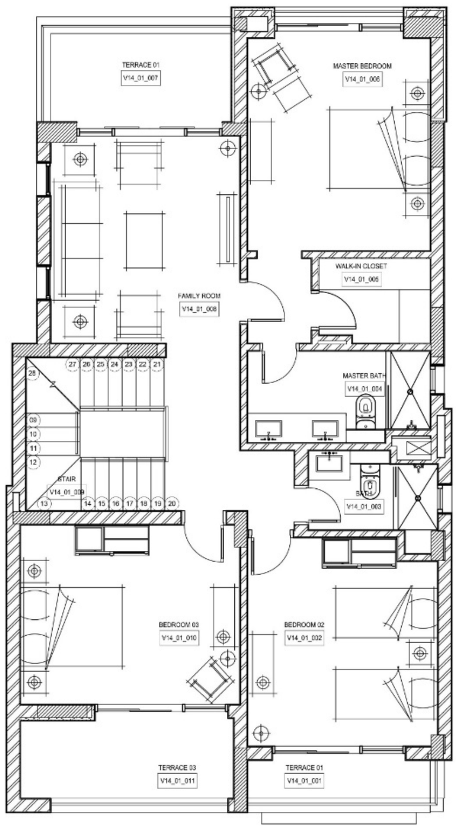


Figure (20) First Floor Plan of Villa Type 14(Emmar Misr for Development, SAE,

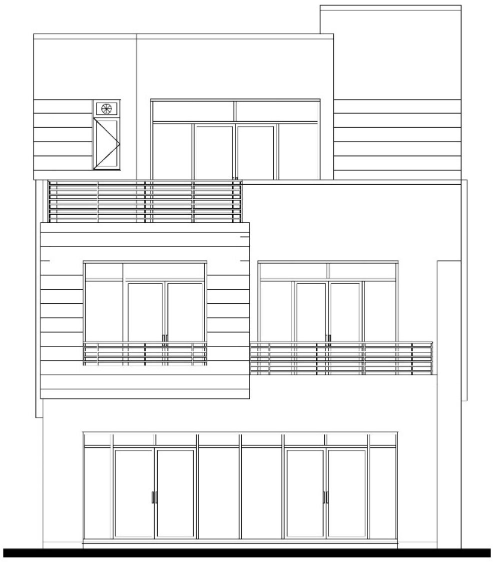


Figure (21) North Elevation of Villa Type 14(Emmar Misr for Development, SAE,

Figure (22) South Elevation of Villa Type 14(Emmar Misr for Development, SAE,

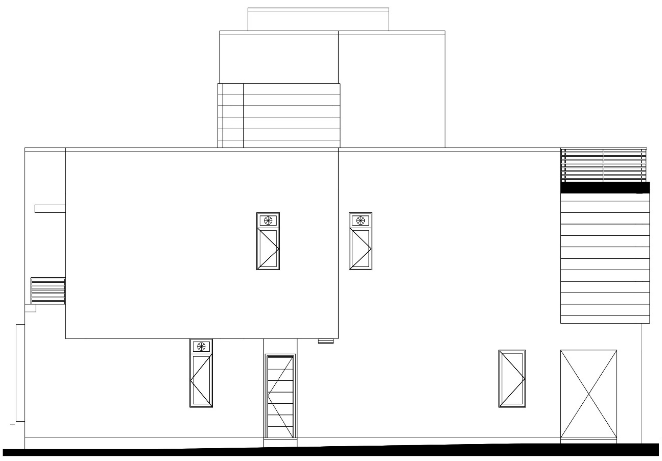


Figure (23) East Elevation of Villa Type 14 (Emmar Misr for Development, SAE, 2019)

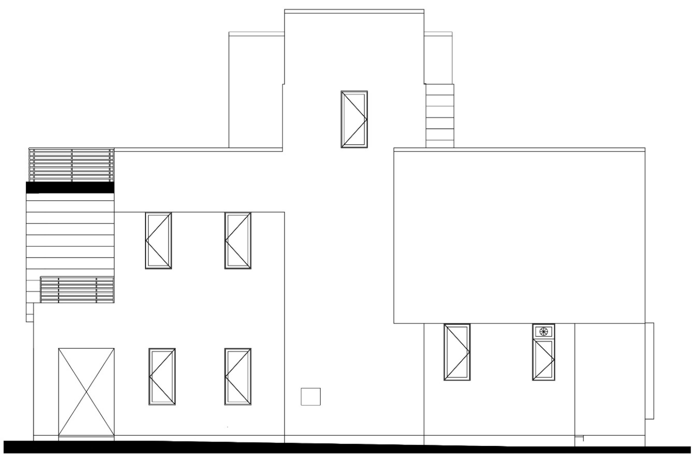


Figure (24) West Elevation of Villa Type 14 (Emmar Misr for Development, SAE, 2019)

11.2. ADDING SAVONIUS WIND TURBINE S-TYPE TO VILLA 14 in Future

This part will present the study of flow through a vertical axis wind turbine of savonius S-type integrated with elevation of villa type 14 in future.

The most appropriate solution to energy shortages is to seek alternative sources of renewable energy to replace fuel. Fossil electricity production is expected to increase the continuous demand for energy, which requires more clean energy.

11.3. PROPOSE OF THE PRESENT WORK

The present design of the villa has poor efficiency for turbine installation because of the sharp edges of the building, and this doesn't help to generate wind power.

Therefore some modifications will be proposed in future to improve performance of the building by using savinous wind turbine s-type, since one of the major advantages of the savinous turbine is its simplicity and corresponding compactness, robustness and low cost .It consist of two “scoops” that employ a drag action to convert wind energy into torque to drive a turbine.

11.4. WIND TURBINE THEORY

Savonius wind turbine works as a simplest turbine because of the difference of forces on each blade. The concave part in the direction of the wind caught the wind from the air and forced the blade to rotate around its vertical shaft.

Instead, the convex portion meets the wind of the air and deflects the blade sideways around the shaft. When moving against the wind or F convex, the blades curvature has less drag force than the blades moving with the wind or F concave as seen in Figure 26. Concave blades will therefore cause the rotor to rotate with more drag strength than the other half pipe.

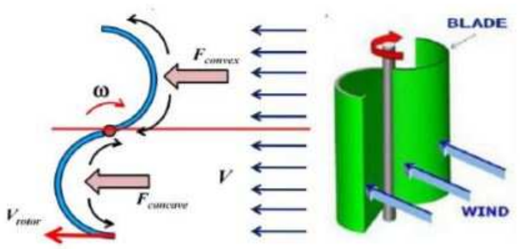


Figure (25) two blades Savonius wind turbine with the drag forces
(Frederikus Wenehenubuna ,Andy Saputra , Hadi Sutanto, 2015)

12. CONCLUSION

- Wind energy is more ecofriendly than the burning of fossil fuels for electricity.
- The most wind is in March and the least wind is in October and November according to the graph that shows average wind speed over the year in El Alamein.
- The location of the case study was selected due to availability of the wind over the year.
- Using savonius wind turbine 2 blade s type integrated with the building in future and modifying building edges to be curved: the building will became suitable for the movement of air and for the turbine to give suitable power for the building& the efficiency of the villa will increase.

REFERENCES

1. Martin Kaltschmitt, Nickolas J. Themelis, Lucien Y. Bronicki, Lennart Söder, Luis A. Vega. (2013). Electricity Generation with Small Wind Turbines. In Renewable Energy Systems. New York, NY: Springer.
2. Alrikabi, N. K. (2014). Renewable Energy Types . Journal of Clean Energy Technologies.
3. Benjamin Greening , Adisa Azapagic. (2013). Environmental impacts of micro-wind turbines and their potential to contribute to UK climate change targets. ELSEVIER, 454-466
4. Bethany kuhn , Julie marquis , Hilary rotatori. (2010). WIND TURBINE DESIGN AND IMPLEMENTATION. WORCESTER POLYTECHNIC INSTITUTE
5. Taman, D. (n.d.). Renewable Energy in Egypt. http://www.afaqscientific.com/.
6. Bošnjaković, M. (2013). WIND ENERGY TECHNOLOGY TRENDS. https://www.researchgate.net/publication/310766589 (pp. 1-2). Research gate.
7. Frederikus Wenehenubuna ,Andy Saputra , Hadi Sutanto. (2015). An experimental study on the performance of Savonius wind. Energy Procedia 68 (pp. 297-304). Elsevier Ltd.
8. Arlene Satchell, Sun Sentinel. (2014, january 30). Hilton Hotel Tries to Reduce Energy Costs by Installing 6 Wind Turbines. Retrieved from skift.com: https://skift.com/2014/01/30/hilton-hotel-tries-to-reduce-energy-costs-by-installing-6-wind-turbines/
9. Aziz, E. F. (2013, April). Egyptian Renewable Energy Activities and Strategy. Retrieved from nrea.gov.eg: http://www.nrea.gov.eg

10. Bissada, D. (2019, september 8). Egypt - Renewable Energy. Retrieved from export.gov: https://www.export.gov/article?id=Egypt-Renewable-Energy
11. Cilento, K. (2010, August 24). Greenway Self-Park / HOK. Retrieved from archdaily.com: https://www.archdaily.com/74468/greenway-self-park-hok
12. farris, A. (2017, february). Wind power. Retrieved from Energy bc: http://www.energybc.ca/wind.html
13. Gorjian, S. (2017, june). An Introduction to the Renewable Energy Resources. Retrieved from researchgate: https://www.researchgate.net/publication/317561674
14. Grozdanic, L. (2014, February 17). Hilton Fort Lauderdale Beach Resort Installs Six Wind Turbines on its Hotel Rooftop. Retrieved from inhabitat.com: https://inhabitat.com/hilton-fort-lauderdale-beach-resort-installs-six-wind-turbines-on-its-hotel-rooftop/
15. Mochtar, S. (n.d.). ROLE OF PASSIVE AND ACTIVE STRATEGY IN GREEN BUILDING CONTEXT. Retrieved from academia: https://www.academia.edu/30538540/ROLE_OF_PASSIVE_AND_ACTIVE_STRATEGY_IN_GREEN_BUILDING_CONTEXT
16. Mohamed ElSobki ,Peter Wooders , Yasser Sherif. (2009, october). Clean Energy Investment in Developing Countries: Wind power in Egypt. Retrieved from iisd.org: https://www.iisd.org/pdf/2009/bali_2_copenhagen_egypt_wind.pdf
17. PETER VAN DER MEULEN, AIA, AND CRAIG BRISCOE. (2013). Twelve | West: Portland. Retrieved from hpbmagazine.org: http://www.hpbmagazine.org/attachments/article/11937/13Sp-Twelve-West-Portland-OR.pdf
18. Rajan Govind ,M Anand ,R Subramanian , Deepa Sathiaram ,S Srinivas. (2013, may 17). Active And Passive Designs In Architecture. Retrieved from glazette: http://www.glazette.com/active-and-passive-designs-in-architecture-431.ht
19. Shahrouz Abolhosseini , Almas Heshmati , Jörn Altmann. (2014, APRIL). A Review of Renewable Energy Supply and Energy Efficiency Technologies. Retrieved from IZA: http://ftp.iza.org/dp8145.pdf
20. Tipperary Institute ,Carlow LEADER. (2007). Renewable Energy Training Manual. Retrieved from ELREN: www.elren.net
21. Woodford., C. (2018, May 18). Wind turbines. Retrieved from explainthatstuff.com: https://www.explainthatstuff.com/windturbines.html
22. Yasser zahra , Mohammed dawood. (2012, january 1). solar vs wind power. Retrieved from ezysolare: https://www.slideshare.net/ezysolare/comparison-between-different-types-of-renewable-energy-sources
23. https://www.aiatopten.org/node/107
24. https://www.architectmagazine.com/project-gallery/greenway-self-park
25. https://www.designbuild-network.com/projects/twelvewestportlandor/
26. https://www.eia.gov/energyexplained/wind/types-of-wind-turbines.php
27. https://energypedia.info/wiki/Wind_Energy_Country_Analysis_Egypt
28. http://www.marassi-egypt.com
29. http://www.sustainablepipingsolutions.com/casestudies/greenway-self-park
30. https://www.ucsusa.org/clean-energy/renewable-energy/how-wind-energy-works
31. http://www.verticalwindturbineinfo.com/fort-lauderdale-hilton-wind-turbine-installation/
32. https://weather-and-climate.com/average-monthly-Wind-speed,el-alamein,Egypt
33. http://www.weatherbase.com/weather/weatherall.php3?s=601784&units
34. https://www.wikizero.com/en/Northern_coast_of_Egypt
35. http://www.windpower.org/en/tour/wtrb/size.htm
36. https://www.worldweatheronline.com/lang/ar/el-alamein-weather-averages/matruh/eg.aspx