Project Plans & Project Specifications Report

Offshore Wind Turbine

Team 12 Members:

Jason Davis
Stephen Davis
Kevin Foppe
Margaret Gidula
Mark Price
Matthew Robertson
Nicholas Smith

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Problem Statement

From the project description:

"The energy potential of offshore wind farms is much greater than that of land based farms thanks to the reduced surface roughness of the sea. For some states the entire electricity could come from offshore wind farms. With such enormous energy potential, offshore wind turbines will contribute to the national energy security.

Although the floating offshore wind turbine has advantages, the cost is still prohibitive. The most important project objective is to reduce the cost compared to existing ideas. The approach is not limited to innovative design --you may come up with innovative construction method, logistics, or any other approach that you can think of."

The purpose of this project is to expand a future renewable resource in the hopes of making it available for the commercial market. The largest problem facing the current development is expense. If it were able to have grid parity, the benefits from offshore wind power would grow the renewable energy market tremendously. The greatest cost hindrance comes from the transmission lines as well as construction. The overall goal is to modify existing designs to minimize cost, while maximizing output and sustainability with the goal of reaching a levelized cost of electricity with respect to total grid production.

Project Scope

There are two primary goals:

1. According to Dr. Jung, "The primary objective is to minimize costs compared to preexisting ideas."

2. The second goal is to harness the power of wind offshore to produce energy.

Project Objectives

The primary objective of the project is to come up with an innovative way to cut the cost of building an offshore wind turbine compared to its preexisting counterparts by the end of the spring semester, 2014.

The main goals for FALL SEMESTER include:

1. Completion of full design of both structure and turbine
2. Build turbine to sense and turn with wind currents
3. Establish efficient floating/anchoring system
4. Pour concrete for the structure to allow time to set

Methodology

The overall floating wind turbine has been broken down into sub-components to assist in the design process and delegation. The main sub-components are: anchor, structure (floating frame), controls and sensors, blades, and gearbox. The wind sensing control will be developed and refined before implementation on the whole turbine. It will take time to optimize the blade shape and size. Once the group has agreed upon a design for the actual turbine and its loads have been calculated, work will commence on developing the design of the floating structure. Due to limited funding the gearboxes will be made by hand or the one from last year will be reused. Designing all of these sub-components will ensure the bulk of our funding goes to innovative design. Luckily, through professional connections, our group will be able to acquire most of the floating concrete and steel free of charge. Furthermore, throughout the design process, we will be using a local pond to test our prototypes and modify them as necessary.

Project Constraints

Time Management: The Floating Wind Turbine must be designed, built and tested before the last week of the spring semester (as of now April 25th 2014). Time management will be necessary in order to batch and cure the concrete foundation, build the steel structure and manufacture the blades and gears before the project deadline. Proper scheduling will be essential to the overall success of the Floating Wind Turbine.

Budget: As of now our budget is 2,000 dollars that is being supplied by Dr. Jung's research grant. Supplies will also be donated from Florida Rock and Cives Steel which will alleviate some of the financial burden from acquiring materials. Blades, gears, motors and sensors will be restricted to the 2,000 dollar budget. The team will track expenditures in order to stay on budget and provide a quality product with a marginal cost.

Team members: The team consists of seven members from three disciplines of engineering. There are three mechanical, three civil and one electrical engineering majors assigned to this project. It is imperative that the three disciplines communicate and schedule effectively amongst each other to make the Floating Wind Turbine a reality. Due to differing schedules, the team must overcome scheduling conflicts and resolve a meeting time once a week that can accommodate the team. This is critical to meet objectives and benchmarks determined by faculty and the team members.

In order to overcome scheduling conflicts, much of the work will be broken into task that will completed remotely by the team members. Proper file organization will minimize confusion and ease collaboration of report writing. Drop box and the File Exchange in the EEL4911 Blackboard Course site will be utilized to share, retain and organize documents. Tasks will be tracked and benchmarks will be set using a Gantt Chart created in Microsoft Project. The specified timeline will be utilized to track progress, goals, due dates. This timeline will govern the progression of the project.

Deliverables

Fall Semester 2013 Overview

- Start
- Initial Set Up Contact
  - Week 3-6
  - Introduce ourselves to all parties, create mode of communication, scheduling issues
  - Sponsor: Sungmoon Jung
  - Email: sjung2@fsu.edu
- Build/ Maintain Website
  - Week 4-16
  - Create initial mock website. Will be updates and maintained over the next few months, with pictures and project updates
  - C:\Users\Megs\Downloads\Website\Website\Home.html
- Needs Assessment
  - Week 3-5
  - Milestone: Prepare and complete Needs Assessment
  - Due Friday, September 27
- Product Research
  - Week 4-7
  - Now that Needs Assessment is complete, can now focus more on research and innovative ideas
- Concept Generation
  - Week 6-8
  - As a team, or sub-teams, we can finally begin to make decisions on the concepts our turbine will rely on (At least one unique idea from every group member)
- Design Matrix
  - Week 7-8
  - Each concept will be compared to decide on a final design
- Project Plan/ Project Specs
  - Weeks 5-8
  - Milestone: Prepare/ complete Project Plan and Specifications Report
  - Due Friday, October 11, 2013
- CAD Drawing
  - Week 7-9
  - With final design chosen, a detailed CAD drawing can be made
- MIDTERM Presentation
  - Week 7-9
  - Milestone: Prepare/complete Midterm Presentation
  - Due Friday October 25, 2013

- Market Analysis
    - Week 8-10
    - By this time parts that need to be manufactured should be known and we should start pricing them in the industry
    - Concrete and steel ware should all be acquired
- Order Parts
    - Week 10-16
    - Any electrical/ mechanical parts necessary for the construction of the complete turbine should be ordered now
    - Concrete: Cement, Aggregates and other additives will be donated by Florida Rock.
    - Steel: The steel for the nacelle structure will be donated by Cives Steel.
    - Form materials: Form materials will be purchased at Home Depot. Form materials should not exceed 500 dollars.
    - Tools: Tools will be provided by the mechanical and civil department. The group also has access to the FAMU-FSU ASCE Student Chapters tools.
- Mold Construction
    - Week 12-18
    - The mold for the concrete to be poured in should be constructed by this time
- Midterm Presentation
    - Week 10-13
    - Milestone: Prepare/ complete Midterm II Presentation
    - Due: Friday November 15, 2013
- Pour Concrete
    - Week 13
    - Pouring the concrete over the winter break will allow at least 21 days to set
- Simulation/ Analysis
    - Week 12-16
    - Testing smaller prototypes and anchors in body of water
    - Computer Analysis will be conducted to make sure all calculations are correct and the plans made will not lead to failure
- Final Design Report
    - Week 13-16
    - Milestone: Prepare/ complete Final Design Report
    - Due Friday December 6, 2013

Assign Resources

In today's wind turbine technology, there are three full scale models that have been developed. The locations of these turbines are in Maine, Portugal, and Norway. These three models are very similar and consist of relatively the same components. Some of these components are the blades, 3-phase motors, wind and wave activity sensors, and similar gear box design. This design is a typical American or European design. When looking at around the world at different designs we see that this is not the only way to accomplish harnessing the wind and creating power. Some innovations that use a different approach are the following:

Japanese researchers are developing a cheaper and more efficient way to create wind farm. This technology creates almost like a mini island of hexagons that have roughly three turbines on each hexagon. This cuts down the cost and allows reducing impact of wave activity.

Another approach that has been developed for lower forms of energy is a process known as wind belts. Wind belts consist of a taut membrane fitted with a pair of magnets that oscillate between metal coils. Right now the technology is only used to produce lower forms of power, but bigger scale models can be developed. The only fault with this technology right now is that some researchers do not believe that it can withstand winds of over 50 miles per hour.

As we see in these two other approaches there are many possibilities and different ways to approach the development of a wind farm.

Per our recent discussion with our sponsor Dr. Jung there is no real assigned tasks to each individual or department. Our job is to take each part of the project and look at it through our own individual experience and come up with our own innovative idea. As a group once we figure out which task is best for each individual we will select a person to focus on a certain task, however everyone will still be responsible to contribute to that task.

As a model, of what is currently developed Civil Engineers will focus on the structure, Mechanical Engineers will focus on the Nacelle, and Electrical Engineer will focus on the motor, generator, and power electronics of the turbine. This is a rough outline of what would be assigned to each subgroup if a normal approach was to be taken. However, as mentioned above, as a project team, we do not feel as if this is an efficient approach and are going into this project believing everyone will be contributing to each individual part of the turbine.

Product Specifications

A. Design specifications

a) Constraints

The main design requirement of this project is to make sure that this turbine can float and stay in one location while still be capable of lighting up one LED. The expected size of the prototype will be approximately 1m x 1m x 2m. This turbine must be able to withstand loading conditions present by carrying climate conditions such as average ocean waves and powerful winds. Finally, the final design must allow the prototype to remain below our budget of $2000. The most important objective is to reduce the cost compared to existing ideas. The turbine will be tested at a nearby pond to see how it react with the climate and wave conditions.

b) Components

Since no design concepts have been generated thus far, we need to consider all possibilities and technologies in order build this turbine. Below are some of the major components that need to be taken into consideration:

Nacelle Up-Blades

Today’s wind turbine blades use lift to capture the wind’s energy. Their special shape allows the wind to create a pressure as it moves behind the blade, causing the turbine to rotate. The nacelle houses the gearbox and generator which are connected to gears to spin the blades. The blades from the prior senior design team still remain at the FAMU/FSU College of Engineering so our team might be able to reuse material used in previous years but commercially available blades are a possibility.

Rotor

The rotor will be constructed by the team. In order to insure safety and cost effectiveness, a low voltage DC generator will be purchased. Our team is presented with two options: a direct drive or gearbox turbines. Direct drive has been known for offshore developments but have been heavy and expensive options up until recent years. Since this is an offshore floating turbine, weight becomes an important factor. The blades, in a traditional gearbox-operated turbine, turn a shaft that is connected through a gearbox to a generator. An important point that we need to consider is the stress on the wheels and bearings in a gearbox design. They will suffer tremendous stress due to the large offshore wind turbulence conditions. If any material fails, the entire turbine will shut down. This is one of the most important components that we need to consider for our cost savings and productivity.

Hub

The blades are connected to the hub which covers the gearbox and turns the generator in the turbine. One of the most important factors with the hub is the distance from the water level. Winds speeds increase as you move farther away from the water so we will want to maximize the hub distance for maximum performance (1).

Motor & Sensors

Although a particular motor has not been selected yet, we believe that a DC motor will be used in order to light up one LED. Sensors and controllers will be used to improve the stability of the platform while the turbine is suspended in the water. It must be able to float and stay in one location so writing a program in order to account for average annual wave loading and wind conditions is crucial. By installing sensors this will hopefully reduce our costs on other potential design ideas in order to keep the platform stable (2).

Foundation

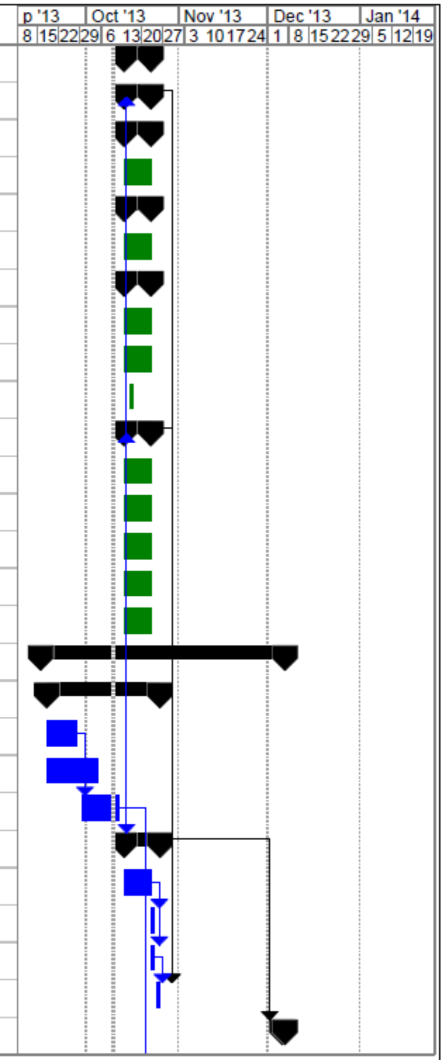
The design and fabrication of all support structures on this project will require specifications of some of the upper elements of the turbine. Due to there being no specifications available for the upper part of the turbine, specifications for the lowers will be broad and geared towards laying a groundwork on which future specifications can be built upon. However, in the past similar floating structures consider four factors: Stability in the water, Structure supporting the mast, the buoyancy, and the mooring system. Carbon fiber mesh reinforcement would be ideal but due to budget constraints, galvanized mesh will be utilized as reinforcement. The walls will be doubly reinforced to prevent both positive and negative bending moments caused by weather, waves and the point load. The base structure will be designed to support a conservative 100 lb. point load that will be centered on the base (1).

B. Performance specifications:

While design constraints are important to control the physical model in regards to construction materials and overall shape, there are also certain performance requirements and expectations for the function of the design. With respect to the Offshore Wind Turbine project, the expectations are very broad and because it is a new technology, open to everything and limited by nothing. The goals will be to produce a quantifiable amount of energy from a location other than land by harnessing wind at a cost effective rate. Current energy production methods including turbine/generator technology may be used as well as any innovative or new technologies. Expected production will be able to provide energy to 1,000 homes on the macro scale and the prototype must power a 15W LED. The plant must remain stable and centralized to one location and be able to resist the most extreme environmental occurrences.

Gantt Chart

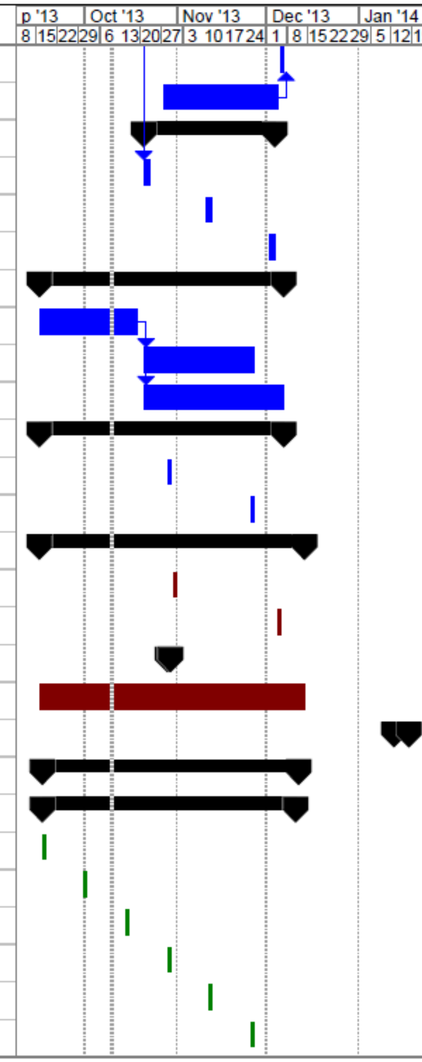
ID		Task Name	Duration	Start	Finish	Predecessors
1		**OWT Project**	**7 days**	**Mon 10/14/13**	**Tue 10/22/13**	
2		**Background Research**	**7 days**	**Mon 10/14/13**	**Tue 10/22/13**	**29**
3		**Cost Breakdown**	**7 days**	**Mon 10/14/13**	**Tue 10/22/13**	
4		Components, Construction, Logistics	7 days	Mon 10/14/13	Tue 10/22/13	
5		**Existing Technology**	**7 days**	**Mon 10/14/13**	**Tue 10/22/13**	
6		Blades, Gearbox, Generator, Tower, Foundation	7 days	Mon 10/14/13	Tue 10/22/13	
7		**Target Site**	**7 days**	**Mon 10/14/13**	**Tue 10/22/13**	
8		Expected Energy Production	7 days	Mon 10/14/13	Tue 10/22/13	
9		**Many Small (<= 2 MW) or Fewer Large (3+ MW)**	7 days	Mon 10/14/13	Tue 10/22/13	
10		**Goal Statement**	1 day	Wed 10/16/13	Wed 10/16/13	
11		**Ideation and Invention**	**7 days**	**Mon 10/14/13**	**Tue 10/22/13**	**29**
12		Floating Mechanisms	7 days	Mon 10/14/13	Tue 10/22/13	
13		Tower	7 days	Mon 10/14/13	Tue 10/22/13	
14		Blades	7 days	Mon 10/14/13	Tue 10/22/13	
15		Gearbox	7 days	Mon 10/14/13	Tue 10/22/13	
16		Generator	7 days	Mon 10/14/13	Tue 10/22/13	
17		**ME Deiliverables**	**60 days**	**Mon 9/16/13**	**Fri 12/6/13**	
18		**Reports**	**28 days**	**Wed 9/18/13**	**Fri 10/25/13**	
27		Needs Assessment	8 days	Wed 9/18/13	Fri 9/27/13	
28		Code of Conduct	13 days	Wed 9/18/13	Fri 10/4/13	
29		Project Plan / Project Spec Report	10 days	Mon 9/30/13	Fri 10/11/13	27
22		**Midterm Report I**	**10 days**	**Mon 10/14/13**	**Fri 10/25/13**	**29**
23		Design Concepts (3 for each ME, CE, EE)	7 days	Mon 10/14/13	Tue 10/22/13	
24		Analysis (Function, Decision Matrix)	1 day	Wed 10/23/13	Wed 10/23/13	23
25		Selection (Loading Conditions, Energy Output)	1 day	Wed 10/23/13	Wed 10/23/13	23
26		Submit Report	1 day	Fri 10/25/13	Fri 10/25/13	25,11,2
108		**Final Report**	**1 day**	**Fri 12/6/13**	**Fri 12/6/13**	**22**



Project: OWT_Initial_JJD
Date: Thu 10/10/13

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

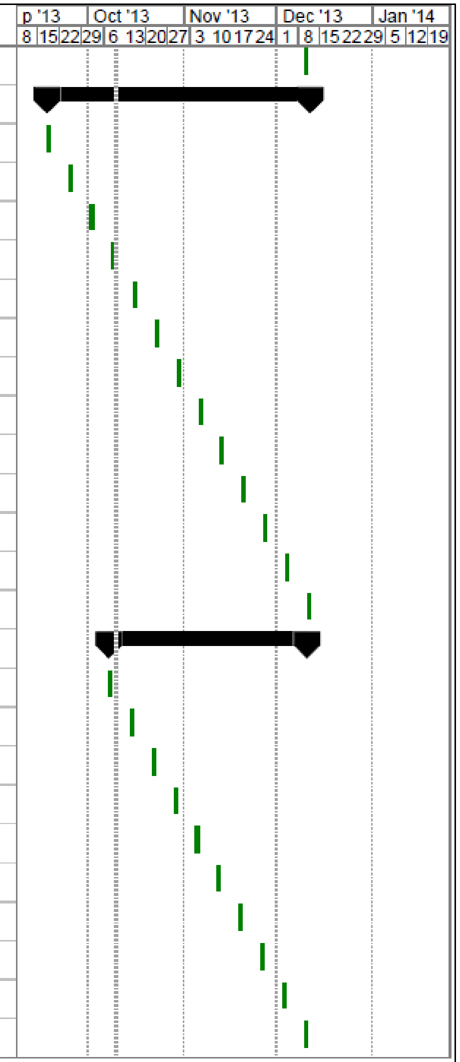
ID		Task Name	Duration	Start	Finish	Predecessors
109		Submit Report	1 day	Fri 12/6/13	Fri 12/6/13	107
107		Detailed Design	28 days	Mon 10/28/13	Wed 12/4/13	
30		**Presentations**	**32 days**	**Mon 10/21/13**	**Tue 12/3/13**	
31		Midterm Presentation I	2 days	Mon 10/21/13	Tue 10/22/13	29
32		Midterm Presentation II	2 days	Mon 11/11/13	Tue 11/12/13	
33		Final Design Presentations	2 days	Mon 12/2/13	Tue 12/3/13	
34		**Website**	**60 days**	**Mon 9/16/13**	**Fri 12/6/13**	
41		Initial Website Design	25 days	Mon 9/16/13	Fri 10/18/13	
42		Final Webpage Design	27 days	Mon 10/21/13	Tue 11/26/13	41
43		Website Maintenance	35 days	Mon 10/21/13	Fri 12/6/13	41
38		**Peer Evaluations**	**60 days**	**Mon 9/16/13**	**Fri 12/6/13**	
45		Peer Evaluation Report	1 day	Tue 10/29/13	Tue 10/29/13	
91		Peer Evaluation Report	1 day	Tue 11/26/13	Tue 11/26/13	
103		**ECE Deliverables**	**65 days**	**Mon 9/16/13**	**Fri 12/13/13**	
106		Professional Engineering Licensing Agreement	1 day	Thu 10/31/13	Thu 10/31/13	
105		HW on Engineering Ethics & Professional Responsibilities	1 day	Thu 12/5/13	Thu 12/5/13	
44		**Peer Evaluation**	**1 day**	**Tue 10/29/13**	**Tue 10/29/13**	
104		Individual Lab Notebook - covers every Fall & Spring week	65 days	Mon 9/16/13	Fri 12/13/13	
46		**Materials**	**5 days**	**Mon 1/13/14**	**Fri 1/17/14**	
68		**Meetings**	**62 days**	**Tue 9/17/13**	**Wed 12/11/13**	
69		**Staff, B210, 4-4:15p**	**61 days**	**Tue 9/17/13**	**Tue 12/10/13**	
70		1	1 day	Tue 9/17/13	Tue 9/17/13	
71		2	1 day	Tue 10/1/13	Tue 10/1/13	
72		3	1 day	Tue 10/15/13	Tue 10/15/13	
73		4	1 day	Tue 10/29/13	Tue 10/29/13	
74		5	1 day	Tue 11/12/13	Tue 11/12/13	
75		6	1 day	Tue 11/26/13	Tue 11/26/13	



Project: OWT_Initial_JJD
Date: Thu 10/10/13

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

ID		Task Name	Duration	Start	Finish	Predecessors
76		7	1 day	Tue 12/10/13	Tue 12/10/13	
77		**Team, CE Lab, 7-8p**	**61 days**	**Wed 9/18/13**	**Wed 12/11/13**	
78		1	1 day	Wed 9/18/13	Wed 9/18/13	
79		2	1 day	Wed 9/25/13	Wed 9/25/13	
80		3	1 day	Wed 10/2/13	Wed 10/2/13	
81		4	1 day	Wed 10/9/13	Wed 10/9/13	
82		5	1 day	Wed 10/16/13	Wed 10/16/13	
83		6	1 day	Wed 10/23/13	Wed 10/23/13	
84		7	1 day	Wed 10/30/13	Wed 10/30/13	
85		8	1 day	Wed 11/6/13	Wed 11/6/13	
86		9	1 day	Wed 11/13/13	Wed 11/13/13	
87		10	1 day	Wed 11/20/13	Wed 11/20/13	
88		11	1 day	Wed 11/27/13	Wed 11/27/13	
89		12	1 day	Wed 12/4/13	Wed 12/4/13	
90		13	1 day	Wed 12/11/13	Wed 12/11/13	
92		**Mentor, B202, 4:15-5:00p**	**46 days**	**Tue 10/8/13**	**Tue 12/10/13**	
93		1	1 day	Tue 10/8/13	Tue 10/8/13	
94		2	1 day	Tue 10/15/13	Tue 10/15/13	
95		3	1 day	Tue 10/22/13	Tue 10/22/13	
96		4	1 day	Tue 10/29/13	Tue 10/29/13	
97		5	1 day	Tue 11/5/13	Tue 11/5/13	
98		6	1 day	Tue 11/12/13	Tue 11/12/13	
99		7	1 day	Tue 11/19/13	Tue 11/19/13	
100		8	1 day	Tue 11/26/13	Tue 11/26/13	
101		9	1 day	Tue 12/3/13	Tue 12/3/13	
102		10	1 day	Tue 12/10/13	Tue 12/10/13	



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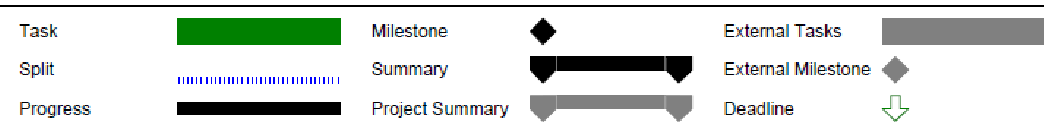

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1. ***Plains Wind.*** **[Online] http://plainswindeis.anl.gov/guide/basics/index.cfm.**

2. ***Environment.*** **[Online] http://cenvironment.blogspot.com/2011/04/wind-turbines-direct-drive-vs-gearbox.html.**