Feasibility Study Report

Debre Berhan Ethiopia Wind Energy Development Project

100 MW Phase I Development

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1. Executive Summary

This Feasibility Study Report sets forth the results of the feasibility assessment study (the "Feasibility Study") conducted by Terra Global Energy Developers, LLC ("Terra Global") for Ethiopian Electric Power ("EEP") with regard to a 100 MW wind energy facility (the "Project") at a site near Debre Berhan, which is approximately 120 kilometers north of Addis Ababa, pursuant to a Memorandum of Understanding (the "MOU") entered into by Terra Global and Ethiopian Electric Power Corporation in March of 2012. The Project will be owned by EEP.

In summary, Terra Global recommends that EEP proceed with the Project based on the principal conclusions in this Feasibility Study Report which are as follows:

- There are no impediments to the construction and long-term operation of the Project from an environmental, technical, financial, logistical, interconnection, site access, soil condition, construction, operation or other perspective;
- From a levelized cost of energy perspective, wind energy is the best technology that is available to EEP to diversify its generation mix to mitigate its reliance on hydro, and the levelized cost of energy achieved using the recommended wind turbine of Goldwind International Holdings (HK) Limited ("Goldwind") is quite favorable for EEP;
- The Project is at a very advanced stage of development; construction of the Project can commence as soon as the negotiation of the EPC Contract and the financing agreements are complete. The Project will begin filling the energy gap within 16 months following the start of construction;
- The terms of the financing being offered to EEP for the Project by Industrial and Commercial Bank of China Limited ("ICBC") and the Bank of China ("BOC") are commercial in nature but quite close to the terms of a concessionary loan and far superior to those being offered by other lenders; and
- The financing for the Project requires export credit insurance from China Export & Credit Insurance Corporation ("Sinosure") which indicated that it had exceeded its exposure limit for Ethiopia. Through the extensive lobbying efforts of Terra Global, Goldwind, ICBC and BOC and the early requests made for such insurance by Terra Global and Goldwind, Sinosure has agreed to provide the export credit insurance for the Project.

1.1 Approach

Terra Global's approach to the Project was to utilize the wind resource measurements taken at the Project site following its installation of the wind measurement equipment, the extensive experience of its personnel and advisors in connection with the development, planning and construction of wind energy projects and the ongoing evaluation of the wind energy resource to identify proven wind turbine generators ("WTGs") that were optimal for the wind resource and readily available from reputable international WTG suppliers. Once identified, Terra Global solicited preliminary expressions of interest and indicative performance data from the identified wind turbine suppliers.

Based on the responses received from the WTG suppliers that it solicited, Terra Global identified five WTG options for further study and evaluation as part of the Feasibility Study. Table 1 shows a summary of the five WTGs selected for further study and evaluated:

Table 1 List of WTG Options Evaluated

WTG Supplier	Model	WTG Output	Rotor Diam.	Hub Height	GWh/Year
Alstom	ECO 122	2.7 MW	122 m	89 m	237.4
Gamesa	G 114	2.0 MW	114 m	93 m	286.2
G.E.	GE 103	1.7 MW	103 m	89 m	272.9
Goldwind	GW 93	1.5 MW	94 m	85 m	249.8
Vestas	V 110	2.0 MW	110 m	95 m	254.5

Following its selection of these WTGs, Terra Global contacted each of the WTG suppliers to solicit an indicative pricing proposal for the required number of WTGs for the Project, certain technical information and an indication of the financing that such WTG supplier could help make available to EEP for further evaluation.

Terra Global evaluated all of the different WTG options and financing options to identify the best available combination for the implementation of the Project on behalf of EEP, taking into account all of the factors deemed to be important by EEP, including:

- The schedule on which the Project could be implemented, with an emphasis on having some or all of the WTGs commissioned in 2015;
- High quality, high performance, proven and reliable WTGs;
- A highly qualified, experienced EPC Contractor with an excellent project delivery track record to design, build and guarantee the timely completion and performance of the Project for a fixed price;
- Attractive long-term financing for the Project matching the objectives of the GoE; and
- An attractive levelized cost of energy for the Project.

Over time, as more detailed cost and performance information became available from the various WTG suppliers and the terms of the financing available with their WTGs was further investigated, Terra Global continued refining the economic analysis for the five WTG options selected for further study. Based on all these refinements Terra Global reduced the WTGs it was seriously considering to three, Goldwind, Gamesa and G.E. Thereafter, Terra Global pursued the three WTG suppliers for best and final offers, further clarification on their balance of plant costs and, most importantly, the best possible financing terms that could be arranged for their equipment and made its selection as is discussed further below in Section 1.8.

1.2 Project Site Description

The Project site (the "Project Site") is located in Kimbibit Woreda of North Showa Zone in Oromia Regional State and Angolelana Terra Woreda of North Shoa Zone in Amhara National Regional State near the village of Sembo. The village of Sembo is approximately 93 km from Addis Ababa and is situated along the main asphalt road to the nearby town of Debre Berhan, the administrative capital of North Showa Zone of Amhara Regional State. This is in the vicinity of central Ethiopia's Great Rift Valley region, an area well known for its wind resource. The Project Site is rectangular in shape and occupies approximately 340 square kilometers.

The Project Site offers excellent open land for construction of a wind energy project. The Project Site is open, flat and rolling, with steep areas leading to the ridgeline where the WTGs are to be installed. Based on the geotechnical study performed by Terra Global, the soil at the Project Site is suitable for the foundations required for the WTGs. The Project Site is part of a larger area identified by EEP as a site for the development of a wind energy project. It is expected that the larger area would support a total of 400 MW of wind energy and the Project is only 100 MW.

The Project Site is located in close proximity to two existing transmission lines, a 132 kV line and a 230 kV line which run parallel to the overall Project primarily on the east side of Route 1. These lines run to Addis Ababa offering an effective link to the main load center and overall transmission grid. These factors offer a significant advantage for exporting the energy generated by the Project and minimizing its impacts on the stability of the grid. The 230 kV line has hydro generation within a reasonable distance, which offers an added benefit. Both transmission lines are modern, easily accessed and provide for a point of interconnection for the Project. Terra Global consulted closely with the Transmission Planning Dept. of EEP to ensure that EEP's concerns regarding its entire grid were taken into account as opposed to issues relating solely to the Project.

EEP directed Terra Global to focus on the 230 kV line for the Project and potential expansion phases. While it will cost more for the Project to interconnect with the 230 kV line, this line offers higher reliability, less impact on the grid and greater expansion capacity. The grid study considered the ability to connect a total of 400 MW of wind generation to the 230 kV line near EEP's transmission tower #465 located south of Debre Berhan and east of the roadway, including options for connecting the wind generation in three stages of 100 MW, 100 MW and 200 MW. The grid study concluded that up to 200 MW in total may be connected with normal and minimal accommodations and a later addition of 200 MW, while requiring upgrades and modifications as well as other planned actions to be completed within the larger network, is practical and feasible.

1.3 Wind Resource Assessment

As part of its Feasibility Study, Terra Global installed two NRG measurement systems on two 60-meter towers on the Project Site. Terra Global used the data that was collected and the interim reports prepared by SgurrEnergy, Inc. (an international wind resources assessment firm) based on that data to screen and further evaluate which WTG to select for the Project.

The Project Site has a non-turbulent Class III wind resource. The predicted long term mean wind speed at the Sembo 1202 mast location (at an 85 meter hub height) is 6.68 m/s. The predicted long term mean wind speed at the proposed WTG locations extrapolated to the 85-meter hub height is between 6.20 and 7.36 m/s, with an average of 6.66 m/s.

Following its selection of the Goldwind GW 93 1.5 MW WTG for the Project, Terra Global prepared a wind resource assessment report based on the 18 months of data collected from the met masts. The energy yield and site suitability analysis based on an optimized layout using 67 Goldwind GW 93 1.5 MW WTGs at an 85 meter hub height indicated that there are no concerns over predicted annual mean wind speed, turbulence, wind shear or extreme winds at the Project Site.

1.4 Energy Production Estimate

Using the wind resource data initially developed for the Project Site, the technical information provided by the selected WTG suppliers (including the power curve of the WTG), the preliminary WTG layout of the Project Site and standard international wind park planning software, Terra Global calculated the net annual energy production of the Project with each WTG and the results for each WTG are shown in Table 2 below:

Table 2 Energy Production Estimates for Candidate WTG Models

WTG Manufacturer	WTG Model	Net GWh Produced
Alstom	ECO 122	237.4
Gamesa	G 114	286.2
GE	GE 103	272.9
Goldwind	GW 93	249.8
Vestas	V 110	254.5

While the net annual energy production of a project is an important factor in deciding which WTG should be selected, the selection of the WTG depends upon a number of other important variables. The only way to synthesize all these variables and make an "apples to apples" comparison of the five WTG options is to incorporate all of the information developed for each WTG option into a pro forma financial model and forecast the levelized cost of energy using each WTG.

As discussed in Section 1.8 below, Terra Global selected Goldwind as the WTG supplier for the Project using its GW 93 WTG. The calculation of 249.8 GWh net for Goldwind is based on the optimized layout of the Project Site prepared by Goldwind and it represents a capacity factor of 28.4%.

1.5 Site Access and Logistics

The WTGs and related equipment required for the Project will be shipped to the Port of Djibouti and then transported by truck to the Project Site. The infrastructure in Ethiopia and Djibouti offers a limited number of routes to deliver the WTGs and other equipment to the Project Site and present restrictions on the type of equipment that can be delivered.

Terra Global engaged Central Oceans, an international logistics expert with substantial experience in the transportation of WTGs, to prepare a logistics transport study. Central Oceans surveyed the only two major routes between the Port of Djibouti and the Project Site. Based upon the current condition of that infrastructure, only one of those primary routes is possible and recommended for the Project. The logistics study provides full details of the requirements for each alternative route.

All of the internal access roads and other civil infrastructure necessary to transport the WTGs and the other equipment within the Project Site will be newly constructed. Such infrastructure will be designed and constructed consistent with the requirements of the Project.

1.6 Environmental and Social Impact Assessment

An environmental and social impact assessment (the "ESIA") has been performed to identify and assess all reasonably expected environmental and social impacts associated with the construction and operation of the Project and to ensure that the Project will comply with the laws of Ethiopia and any additional requirements that may be imposed by the lenders. Terra Global engaged Environmental Forward Observer, LLC and local Consultant, Addis Environmental Services (collectively, the "Environmental Consultants") to conduct the ESIA.

In accordance with the EIA Guidelines, Pre-screening meetings were held in December 2013 with the following potentially concerned government organizations and potential participating academic institutions: EEP Wind Energy Project Office; the Ministry of Water, Irrigation and

Energy; the Ministry of Mines; the Ministry of Health; the Ministry of Culture and Tourism; Ethiopian Wildlife Conservation Authority; the Ethiopian Civil Aviation Authority; Ethiopian Telecom Agency; Debre Berhan University; Addis Ababa University, Environmental Science Department; and Ethiopian Antiquities Administration.

The principal environmental and social concerns that were identified in the ESIA are: (i) the displacement of residents currently living within the 228 meter radius of each WTG (the design limit based on minimal safety standards of outside fall zone); and (ii) the potential impacts on migratory and indigenous birds.

Impacts to both can be satisfactorily and cost-effectively remediated using current policy tools and technology. In the case of displaced residents, these tools include resettlement and compensation under a Resettlement and Action Plan (the "RAP") as required by the Constitution of the Federal Democratic of Ethiopia Proclamation 1/1995, and as defined by subsequent legislation. The RAP will be administered by EEP.

As part of the RAP assessment carried out, consultations and interviews were carried out with the Project Affected People ("PAP"), with local Administrations both at the Kimbibit and Angolelana Woreda offices. In addition, project area census and socio economic surveys were carried out.

The objective of the RAP is to avoid or minimize the physical and economic displacement of people and the disruption of their livelihoods. The RAP was carried out with the following guidelines in line with the governing laws of Federal Democratic of Ethiopia and relevant international guidelines:

- Involuntary resettlement should be avoided.
- Where involuntary resettlement is unavoidable, all people affected by it should be compensated fully and fairly for lost assets.
- Involuntary resettlement should be conceived as an opportunity for improving the livelihoods of the affected people and undertaken accordingly.
- All people affected by involuntary resettlement should be consulted and involved in resettlement planning to ensure that the mitigation of adverse effects as well as the benefits of resettlement are appropriate and sustainable.

The RAP specifies the procedures and the actions to be taken to mitigate any adverse effects from the implementation of the project. It provides plans for resettlement and rehabilitation of the PAPs so that their losses will be compensated and their standard of living will be improved or at least restored to the Pre-project level condition. To achieve these objectives the plan provides rehabilitation measures so that the income earnings potential of individuals is restored and sustains their lively hoods.

The construction and operation of the Project is expected to bring several significant positive socio-economic benefits to the Project area of influence as well as to the nation at large. The Project will enhance economic and social developments along the corridor of the Project and these developments will likely to lead to a much-improved quality of life for local communities. Because of the expected positive effects of Project construction and operation and current low level of investment in the surrounding area, the Project is highly desirable from social, economic, environmental and political perspectives.

The overall conclusion is that all potential negative environmental and social impacts of the Project could be eliminated or reduced to acceptable levels by implementing good engineering practices and proper environmental management activities, thereby assuring environmental and economic sustainability and social acceptance. Furthermore, any remaining negative impacts will be more than equally offset by positive impacts.

1.7 Need for More Power and Generation Source Diversification

A shortage of electricity is a significant impediment to the economic growth of a country. The Government of Ethiopia (the “GoE”) is working to increase its electricity generation capacity to meet a growing demand for electricity and expand economic growth.

A nation of more than 90 million people, the Federal Democratic Republic of Ethiopia (“Ethiopia”) has experienced an average annual GDP growth rate of 10 percent over the last decade. This double digit economic growth, coupled with a sizable surge in population, has led to a significant increase in total energy consumption over the last few years, resulting in unplanned outages, load shedding and an unmet demand for electricity. In addition to meeting this increasing demand, a further goal of the GoE in expanding its electric generation capacity is to increase exports of electricity to neighboring countries to provide Ethiopia with a major source of foreign currency.

Diversification of its generation resources is another important goal of the GoE. Today, Ethiopia relies on hydroelectric power to provide approximately 90 percent of its electrical energy. In recent decades, Ethiopia has experienced more frequent climatic extremes, which has had a direct impact on power production from its hydro plants. As water levels fluctuate due to changes in rainfall level and increased silting of and evaporation from reservoirs, the electricity generated from hydro resources fluctuates which leads to power shortages, particularly in the dry season. Also, the resulting variations in energy output lead to unwanted uncertainty. To mitigate these risks, the GoE has committed to expanding and diversifying its electric power generation resource mix and is in the process of adding wind, geothermal and solar resources.

In Ethiopia, wind and hydro are counter-cyclical to each other. The hydro generation peaks during the winter and dips during the summer. Conversely, the generation from wind will dip during the winter and peak during the summer. The complementary nature of these two resources makes wind energy development a high priority for Ethiopia. As of 2013, Ethiopia had installed approximately 171 MW of wind energy. The GoE plans to add an additional 1,000 MW of wind generation over the next three years. It also plans to increase installed renewable energy capacity from all sources from the current level of 2,189 MW to 10,000 MW and expand national access to electricity from the current level of 52 percent of the population to 75 percent by 2015. These goals are further outlined in the country's 5-year (2010-2015) economic plan called the Growth and Transformation Plan.

1.8 Economic Analysis Leading to Selection of Goldwind

Beyond confirming all aspects of the feasibility of installing a 100 MW wind energy project at the Project Site, a critical element of the Feasibility Study was to identify the WTG with the best overall economic performance for EEP as the owner of the Project. In order to do this, one cannot rely on simple metrics such as the cost of the WTGs, the total capital cost of the Project, the terms of the financing for the Project or the net output of the WTGs. All of these factors and many others have to be synthesized through a single pro forma financial model to determine which WTG results in the lowest cost of energy to EEP on a levelized basis.

Terra Global performed a detailed economic analysis of the Project for each of the WTG options, based on the early assumptions made with regard to the capital cost of the Project, the performance of the WTG, the operations and maintenance cost, the indicative terms of the financing for each WTG and an extensive number of other assumptions.

Terra Global continued to refine its economic analysis of the five WTG options as more detailed cost and performance information became available from the various WTG suppliers and the terms of the financing for their WTGs. Based on all these refinements, Terra Global reduced the WTGs it was seriously considering to three, Goldwind, Gamesa and G.E. Thereafter, Terra Global pursued these three WTG suppliers for best and final offers, further clarification on their balance of plant costs and, most importantly, improvement of the terms of the financing for their equipment.

Ultimately, because the financing available for the Gamesa and G.E. WTGs was significantly less attractive than the financing available for the Goldwind WTGs, it was impossible for G.E. and Gamesa, despite their attractive net output numbers, to compete with Goldwind on a levelized cost of energy basis. Accordingly, Terra Global pressed Goldwind, as a condition to its selection as WTG supplier and EPC Contractor for the Project, for a further price concession on its WTGs and to pressure the lenders to improve the terms of the financing being arranged by Terra Global, both of which occurred. Based on those further concessions, Goldwind was selected as WTG Supplier and EPC Contractor for the Project.

Set forth below is a table showing certain key assumptions regarding the Project using each of the five WTGs, including the levelized cost of energy (the "LCOE"), which is the only way of comparing the WTG options. In the case of Goldwind, the numbers are based on the terms negotiated to date with Goldwind, ICBC and BOC. In the case of the four other WTG options, the numbers reflect the pricing proposals and performance date from each WTG supplier, but the financing terms reflect what Terra Global believes are the best financing terms that are available for such WTGs based on the present market conditions. While improvements might be possible, particularly in the case of the Export Import Bank of the United States ("US EX-IM"), significant additional time would be required to get that improvement and a final approval for the Project and success is not guaranteed. In the case of US EX-IM, there has been talk for more than a year about extending the tenor of the loans for Ethiopia from 7 to 14 years, but this has not materialized.

The economic analysis of the five WTGS is based on the 2% rate of return case to EEP as shown in Table 3 below.

Table 3 Economic Indicators of Candidate Turbines

	Alstom	**Gamesa**	**GE**	**Goldwind**	**Vestas**
WTG Model	ECO 122	G 114	GE 103	GW 93	V 110
WTG Output	2.7 MW	2.0 MW	1.7 MW	1.5 MW	2.0 MW
Number of WTGs	37	50	59	67	50
Annual Net Energy	237.4 GWh	286.2 GWh	272.9 GWh	249.8 GWh	254.5 GWh
Capacity Factor	27.1%	30.7%	31.6%	28.4%	29%
Capital Cost	US$257.2 M	US$249.6 M	US$259.4 M	US$238.8 M	US$279.7 M
WTG O&M/year	US$2.2M	US$1.9 M	US$2.9 M	US$1.0 M	US$2.1M
Lender	HERMES	US EX-IM	US EX-IM	ICBC/BOC	EKF
Debt Percentage	85%	85%	85%	85%	85%
Equity Percentage	15%	15%	15%	15%	15%
Interest Rate	6.6%	6.6%	6.6%	2.9945%	6.6%
Grace Period	22 months	22 months	22 months	30 months	22 months
Repayment Period	10 years	7 years	7 years	12.5 years	10 years
Residual Value	10%	10%	10%	10%	10%
LCOE per kWh	11.4 cents	9.33 cents	10.5 cents	7.54 cents	11.34 cents

Based on the pro forma, the only realistic option for the Project at this time is the Goldwind WTG and that option is highly economically feasible for EEP.

1.9 Clean Development Mechanism Assessment

The clean development mechanism ("CDM") assessment for the Project shows that the Project is suitable for registration as a CDM activity, but the economic benefit to be derived by registration is marginal. The net annual energy production of the Project with the Goldwind GW 93 WTGs is 249.8 GWh per year. The clean electricity generated by the Project will reduce greenhouse gas ("GHG") emissions through the displacement of fossil fired power plants in the national power grid. The Project will help reduce 7,221 tCO2e (tons of carbon dioxide equivalent) annually; it will reduce a total of 50,547 tCO2e during the first 7 year crediting period.

The Ethiopian national power grid is dominated by large hydropower plants which constituted 91% of total generating capability of the system at end of June 2013. Fossil fired and wind power plants constituted the remaining 5% and 4% of installed capacity respectively. Energy generation contributions from fossil fired power plants on the grid varied from zero to 11% in the past five years. The Project will mainly replace fossil fired power plants on the grid which are used for emergency power supply during generating power short falls.

Emission reduction is a product of the electricity generated by the Project and combined margin (CM) for the Ethiopian national power grid. The CM has two components: the operating margin (OM) and the build margin (BM). CM, OM and BM are computed using procedures specified in ACM0002 (Consolidated baseline methodology for grid-connected electricity generation from renewable sources, version 15.0)

1.10 Financial Analysis

A pro forma financial model (the "Pro Forma") was developed to analyze the performance of each of the WTG options on an economic basis and to determine the financial feasibility of the Project based on the WTG ultimately selected. Because the Project will be owned and operated by EEP and not a private party with a Power Purchase Agreement that sets the price of power over the term of the agreement, the Pro Forma determines the levelized cost of energy based on myriad cost and operating assumptions, the terms of the financing and a specified internal rate of return to EEP on its equity investment (here, 0%, 2%, 4%, 6% and 8%). In essence, the levelized cost of energy is equal to the sum of (i) the operations and maintenance costs plus (ii) the interest payments plus (iii) the principal payments, but all levelized over the 20-year term of the Pro Forma to come to a single price per kWh. Obviously, the price of electricity to EEP each year will vary from this levelized number based on the facts and circumstances of such year.

The following are certain of the key assumptions used in the Pro Forma for the Project based on the Goldwind WTG:

- The EPC Contract Price is $238.8 million;
- The net annual energy output is 249.8 GWh of electricity;
- The financing provided by the consortium of banks led by ICBC and BOC will (a) cover 85 percent of the EPC Contract Price and 85 percent of the Sinosure export credit insurance fee, (b) have a total term of 15 years, (c) have an interest rate of 2.6 percent over the 6-month LIBOR rate and (d) have an interest only grace period of 2.5 years and a principal/interest repayment period of 12.5 years;
- EEP will make an equity investment, all in BIRR, equal to 15 percent of the EPC Contract Price;
- An inflation rate of 4.5 percent;
- A residual value of the wind energy facility after 20 years of 10 percent;
- The Project will not be required to pay any taxes; and
- Although there will be the possibility of selling certified energy renewal credits in the market, to be conservative in the analysis, Terra Global assumed that the value of such credits would be zero.

Based on the Pro Forma, the levelized cost of energy to EEP will be 7.33 cents at a 0 percent rate of return. Considering all of the non-hydro alternatives available to EEP in its continuing effort to diversify its portfolio, this excellent LCOE, particularly for a wind resource which is counter-cyclical to hydro in its generation profile is favorable. Also, the interconnection infrastructure that is being installed as part of the Project will accommodate at least 100 more MW of installed capacity and should therefore allow for a significant expansion of the Project at a later time and at a lower cost per installed MW as compared with a new project.

1.11 Conclusions and Recommendations

Terra Global has concluded that the Project is technically, environmentally and financially feasible as demonstrated by the Feasibility Study and it will help the GoE and EEP achieve a number of important goals and priorities as are discussed below. The continued success of Ethiopia in growing its economy will ultimately narrow the availability of more favorable concessionary loans and require the use of more traditional export credit and commercial loans, which will be on less attractive terms and from lenders whose overall confidence in all aspects of the lending process has to be built. Implementing the Project with the export credit financing from ICBC and BOC will help build the confidence in those other lenders who will ultimately be needed to continue to grow the power sector in Ethiopia, whether the future projects are owned by EEP or by private parties with power purchase agreements.

The pricing and financing terms being offered by Goldwind and ICBC and BOC, respectively, are extremely competitive in the market and the pricing and financing terms for future energy projects may be less attractive. Accordingly, Terra Global recommends that EEP approve the Project and proceed immediately with its implementation.

The Project is at a highly advanced stage of development and can be implemented very quickly; construction of the Project can start as soon as the negotiation of the EPC Contract and financing agreements are complete. Once the Project is approved, EEP and the Ministry of Finance and Economic Development will need to provide a letter of interest to the Lenders and to Sinosure to confirm their interest in moving forward with the Project.

The following goals and priorities of the GoE and EEP will be realized by the implementation of the Project:

- The realization of the Project will further the goal of diversifying EEP's generation resources away from hydro, and the available land adjacent to the Project Site and the planned interconnection infrastructure will allow EEP to expand the Project in a cost-effective manner in the future (to as much as 400 MW in total);
- The realization of the Project and ability to cost-effectively expand its capacity in the future will help to mitigate the growing demand for additional electric power generation in Ethiopia;
- The realization of a large wind energy facility such as the Project, which will have its peak output during the summer months when hydro output is reduced, will help to mitigate the demands on EEP during such months;
- The levelized cost of energy from the Project is substantially lower than it would be from most other renewable energy projects, including solar, and all of the conventional fuel projects (which require the continuous import of fossil fuels which have to be paid for with precious foreign currency);
- The additional power will enhance the GoE's program of selling electricity to other countries to generate foreign currency;
- The Project is well located within the EEP transmission system and close to the major load center in Addis Ababa, and the addition of another generation resource should provide additional stability for the grid;
- The environmental impacts of implementing the Project at and around the Project Site, which has some inhabitants, will be addressed by an appropriate Resettlement Action Plan at a reasonable cost, and the implementation of the Project will bring jobs and have other positive economic impacts in the area;
- The Project can be implemented quickly based on the significant work done to date by Terra Global and Goldwind with respect to the EPC Contract and the scope of work to be performed thereunder and the significant work done to date with ICBC and the BOC; and
- The Project will improve the quality of life and environmental conservation efforts and reduce the environmental impacts associated with non-renewable generation resources.

Glossary

The following terms, whenever used in this Feasibility Report, will have the meanings that are given to such terms below.

α	Wind shear coefficient (alpha)
AEP	Actual Energy Production
BOC	Bank of China
BOP	Balance of Plant
Class I	Wind turbine classification at 200 W/m^2 or less at 50 m altitude
Class III	Wind turbine classification for low wind
CO_{2eq}	Carbon dioxide equivalent
CFSR	Climate Forecast System Reanalysis
Debre Berhan Site	The site of the Debre Berhan Wind Farm
Debre Berhan Wind Farm	The approximately 400 MW wind farm that is contemplated near Debre Berhan in three phases; an initial phase of 100 MW, a second phase of 100 MW and a third phase of 200 MW
DFIG	Doubly Fed Induction Generator
EAPP	Eastern Africa Power Pool
ECA	Export Credit Agency
EEP	Ethiopian Electric Power (formerly known as Ethiopian Electric Power Corporation)
EPC Contract	A turnkey construction contract with a single party for the engineering, procurement and construction of the Project (including the supply of the WTGs and the construction of the balance of the Project)
EPC Contractor	The contractor that will enter into the EPC Contract with EEP
Ethiopia	The Federal Democratic Republic of Ethiopia
Feasibility Study Report	This Feasibility Study Report prepared by Terra Global

Feasibility Study	The feasibility study that was performed by Terra Global with respect to the Project to determine if the Project is technically and financial viable and could be constructed at the Project Site
FDRE	Federal Democratic Republic of Ethiopia
FHH	Female Headed Household
GDP	Gross Domestic Product
GoE	Government of Ethiopia
GRC	Grievance Redress Mechanism
HVTL	High Voltage Transmission Line
ICBC	Industrial and Commercial Bank of China Limited
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEC class III_A	Low wind - Higher Turbulence 18%
kV	kilovolts
kW	Kilowatt
kWh	Kilowatt-hour
Lenders	The lender(s) providing the debt financing for the Project
Lidar	A portmanteau of ‘light’ and ‘radar’
LCOE	Levelized Cost of Energy
mamsl	Meters Above Mean Sea Level
met	Meteorological
MCP	Measure-Correlate-Predict
MERRA	Modern Era Retrospective Analysis for Research and Applications
MOU	Memorandum of Understanding
MVA	Mega Volt-Amperes
MW	Megawatts

MWh	Megawatt hour
m/s	Meters per second
NDA	Non-Disclosure Agreement
O&M	Operations and Maintenance
P50	Level of uncertainty at 50 percent
PAH	Project-Affected Household
PAPs	Project-Affected Persons
PIU	Project Implementation Unit
POI	Point of Interconnection
PESIA	Preliminary Environmental and Social Impacts Assessment
POI	Point of Interconnection
Project	The initial 100 MW phase of the Debre Berhan Wind Farm
Project Site	The portion of the Debre Berhan Site being used for the Project
PTA Bank	Preferential Trade Area Bank, commonly known as the PTA Bank, is a trade and development financial institution in Africa. The PTA Bank is the financial arm of Eastern and Southern African countries
R^2	Coefficient of Determination
RAP	Resettlement Action Plan
RD	rotor diameters
RFP	Request for Proposal
ROW	Right-of-Way
RTI	Representative Turbulence Intensity
SgurrEnergy	SgurrEnergy, Inc., wind resource and technical advisor
SCADA	Supervisory Control and Data Acquisition System
Sinosure	China Export & Credit Insurance Corporation
SRTM	Shuttle Radar Topography Mission

Terra Global	Terra Global Energy Developers, LLC, a limited liability company formed in the State of Delaware in the United States
TI	Turbulence Intensity
US$ or $	United States Dollars
US EX-IM	Export Import Bank of the United States
Weibull c	Weibull Distribution location parameter
Weibull k	Weibull Distribution shape parameter
WAsP	Wind Atlas Analysis and Application Program
WTG	Wind Turbine Generator

List of Figures

List of Tables

Table of Contents

2. Energy Landscape

Ethiopia today is at a crossroads. In 2013, it had the world's 12th fastest growing economy. As the country plans to sustain this level of economic growth, it is imperative that Ethiopia expands its power system rapidly to meet the corresponding growth in electricity demand. Unlike many of the industrialized nations, Ethiopia has made clear that renewable energy will be a key economic driver, emphasizing green growth and clean energy as integral to its growth and transformation plan (GTP), a five-year strategy (2010-2015) to reduce poverty and spur national development. Recognizing electricity as a vital enabler of economic growth and human development, the plan aims to minimize the gap between demand and supply, increase per capita consumption and generate power for export.

Electricity is a critical economic infrastructure. If it is not delivered where and when needed, serious damage ensues for the economy. Considerable potential output has been lost due to power cuts in the past few years. Potential losses from power disruption will increase in the future as the economy grows and the relative contributions of the industry and service sectors increase in the economy. Power supplies must increase as rapidly as demand to avoid such losses and ensure sustained growth. This is the rationale upon which the GoE is accelerating its investment in expanding the power system: system capacity will double within a year and is planned to quadruple before 2015.

Development of power infrastructure is capital intensive and thus difficult to finance. It can also have significant environmental and social impacts and risks. These factors point to the need for sound strategies and planning for the power sector. Shortcomings in sound strategies and plans will result in underinvestment or overinvestment. Both of these reduce benefits: underinvestment curbs economic expansion, overinvestment ties resources that could be invested elsewhere.

Ethiopia, despite its recent rapid growth, is still among the least developed countries in the world. The country's economic and social infrastructure is growing but still considerably lower than the sub-Saharan average. Energy access is considered crucial to reducing poverty and facilitating improvements in education, health, and economic productivity. Ethiopia's GTP sets a goal of increasing power generation capacity from current 2075 MW to 10,000 MW, doubling the number of electricity customers, and raising the national electrification rate to 75%.

At an estimated exploitable capability of 45 GW, hydropower is the most important indigenous resource in Ethiopia. The wind power potential of Ethiopia is estimated to be 1,350 GW. This estimate considers sites with the highest potential and technically, therefore, wind energy could be the second most important resource for power generation in Ethiopia.

Solar energy is abundant throughout Ethiopia and has an estimated reserve of 2.199 million Terawatt hours per annum. In off-grid rural areas solar power is a sustainable option to power homes.

The total geothermal resource of Ethiopia is reported to be 5,000 MW (MME). The proportion of the resource that will be feasible for power production is considerably lower. There are uncertainties regarding the size of the available resource as further studies need to be carried out. However, preliminary assessments done indicate viability of several MW scale geothermal power plants in the Rift Valley Lakes area.

2.1 Power System

Ethiopia is not an oil producing country today, but is well endowed with a variety of renewable energy generation sources. These include first of all hydro energy, but also wind, geothermal, solar and biomass. As of 2012, less than 10% of the total estimated 54 GW of economically exploitable power generation resources available in the country was developed or committed to be developed.

In Ethiopia, electricity is provided by the state power utility. The utility runs two systems: the Interconnected System ("ICS"), which accounts for 98% of capacity and generation, and the Self-Contained System ("SCS"). The ICS is expanding rapidly while the relative contribution of the SCS is shrinking: this is due to interconnection of previously SCS served towns to the ICS and because most new connections are mainly on the ICS.

The ICS consists of 11 hydro, one geothermal and 15 diesel power plants with a total capacity of 2022.2 MW, of which more than 90% is generated from hydropower plants. The SCS consists of three small hydro and many isolated diesel plants located throughout the country with a capacity of 6.15 MW and 30.06 MW, respectively. Ethiopia's total electricity generation in 2010 was 3,981.07 GWh according to figures provided by EEP.

2.2 Energy Portfolio Diversification

Existing power generation on the ICS is highly dominated by hydropower resources (more than 90%). Committed and planned additions into the ICS are also almost exclusively hydro: from the planned addition of 14,000 MW to the year 2027, less than 5% will be from non-hydro resources. Contributions are not balanced since large hydropower plants contribute the lion's share of total capacity and energy in the system. The existing power system has little diversity.

The abundance of the resource and its relatively low cost of energy production make hydropower the first choice for system expansion. However, Ethiopia also has other renewable and non-renewable energy resources that may be utilized for power generation. The renewable resources include geothermal, wind, solar and biomass. Proven reserves of coal and natural gas are also available in economic quantities. The competitiveness of non-hydro resources will improve in the future as the low cost hydropower sites get scarce and higher cost hydro plants must be developed, and the costs and uncertainties regarding the other resources are lowered due to better resource information.

Diversification plays a critical role in reducing vulnerability, not only to supply disruptions, but also to climate change. Ethiopia is highly vulnerable to extreme weather variability, particularly erratic rainfall, with increasing frequency of both flooding and droughts in recent years due to the impact of climate change which poses a significant challenge to agriculture, infrastructure and hydropower generation. Although hydropower provides comparatively cheap base load power, over-dependence on the resource can make a country more vulnerable to drought conditions. Ethiopia has committed to developing wind and solar alongside its hydropower plants as guarantors against power shortages, especially during the dry season, while investments in geothermal and biofuels complement the intermittent resources.

The competitiveness of non-hydro resources will improve in the future as the low cost hydropower sites get scarce and higher cost hydro plants must be developed, and the costs and uncertainties regarding the other resources are lowered due to better resource information.

2.3 Power System Security

Near exclusive dependence on a single type of resource for a critical application, such as power, exposes a country to significant risks. As dependence on the particular resource deepens, vulnerability rises because the impact of the consequences rises. Recent power cuts cost the Ethiopian economy 1% in GDP growth. Future power disruptions will cost more due to increased dependence of the economy on power (due to shifts to manufacturing and services). A similar level of power outage now will cost higher than 1% in GDP growth and a much higher loss in output.

A hydro dominated strategy makes the power system and the economy vulnerable to climatic variation, geo-hazards, economics and politics. Ethiopia is highly prone to climatic variability; variability is increasing while at the same time there is gradual decline in rainfall. Some areas are vulnerable to geo-hazards and this poses problems for the stability of large hydraulic structures such as dams. Trans-boundary rivers can be a source of tension among countries; countries sometimes work against other countries from developing projects on such rivers.

As electricity is an important input to the industry and service sectors, it makes these sectors highly susceptible to climate much in the same way as agriculture. This may compound the economic impact of droughts in Ethiopia.

Vulnerability of the power system and its potential environmental and social impacts can be mitigated through diversification of the power generation mix. Diversity is attained when the generation mix has variety in the number of options it can utilize (the number of power plants in the system), disparity among the options (different generation sources and technologies) and balance in the contribution of the various options. Ethiopia has a number of options for diversifying the power generation mix. In addition to hydropower, Ethiopia has considerable resources in geothermal, wind, biomass, solar, coal and natural gas. It also has the option of power exchange with neighboring countries. Ethiopia's power system security depends on creating a balanced generation mix from these resources.

3. Introduction

3.1 Background

A shortage of electricity is an enormous impediment to the economic growth of a country. The Government of Ethiopia (the "GoE") is working to increase its electricity generation capacity to meet the ever-growing demand for electricity and continue expanding economic growth and to make that generation more reliable.

A nation of over 90 million people, the Federal Democratic Republic of Ethiopia ("Ethiopia") has experienced an average annual GDP growth rate of 10 percent over the last decade. This double digit economic growth, coupled with a sizable surge in Ethiopia's population, has led to a significant increase in total energy consumption over the last few years, resulting in unplanned outages, load shedding and a growing unmet demand for electricity. In addition to meeting this increasing demand, a further goal of the GoE in expanding its electric generation capacity is to increase exports of electricity to neighboring countries to provide Ethiopia with a major source of foreign currency.

Diversification of its generation resources is another critical goal of the GoE. Today, Ethiopia relies on hydroelectric power to provide approximately 90 percent of its total electrical energy. Reliance on a single power resource is risky in general, particularly if that resource is provided by nature. In recent decades, Ethiopia has experienced more frequent climatic extremes, which has had a direct impact on its power production from hydro. As water levels fluctuate due to changes in rainfall level, increased siltation of the reservoirs and increased evaporation from the reservoirs, the electricity generated from hydro resources fluctuates which leads to power shortages, particularly in the dry season. Also, the resulting variations in energy output lead to unwanted uncertainty.

To mitigate these hydro risks, the GoE has committed to expanding and diversifying its electric power generation resource mix and wants to add wind, geothermal and solar resources. The most viable short term solutions to cover the increasing and suppressed demand for electricity are wind and diesel, both of which can be implemented quickly. However, while diesel provides a base load option to EEP and diesel plants can be installed relatively quickly and cheaply, Ethiopia is fully reliant on fuel imports and imported fuel has to be paid for in Dollars. Also, fuel prices have been steadily increasing over the past 10 years and the price and supply are subject to wild market fluctuations due to a variety of international causes, which diminishes the economic feasibility of installing more diesel power plants. Therefore, wind is a primary focus of EEP.

In Ethiopia, wind and hydro are counter-cyclical to each other. Hydro generation peaks during the winter and dips during the summer. Conversely, generation from wind will dip during the winter and peak during the summer. The complementary nature of these two resources and the pricing and risk advantages of wind energy over other renewable resources such as geothermal and solar makes wind energy development a very high priority for Ethiopia.

As of 2013, Ethiopia had installed approximately 171 MW of wind energy. The GoE plans to add an additional 1,000 MW of wind generation in the next three years. It also plans to increase installed renewable energy capacity from all sources from the current level of 2,189 MW to 10,000 MW and expand national access to electricity from the current level of 52 percent of the population to 75 percent by 2015. These goals are further outlined in the country's 5-year (2010-2015) economic plan called the Growth and Transformation Plan.

3.2 Project Site

The Debre Berhan Wind Farm is located in both Amhara and Oromia Regional states. The initial 100 MW phase of the Debre Berhan Wind Farm (the "Project") will be located in Kimbibit Woreda of North Showa Zone in Oromia National Regional State and Angolelana Terra Woreda of North Showa Zone in Amhara National Regional State near the village of Sembo. The Project Site and location are shown in Figure 1 and Figure 2.

The village of Sembo is located at the center of the Debre Berhan Site approximately 93 km from Addis Ababa, the national capital. It is situated along the main asphalt road to the nearby town of Debre Berhan, the administrative capital of North Showa Zone of Amhara Regional State. The Project Site is rectangular in shape and occupies about 339.62 square kilometers. This is in the vicinity of central Ethiopia's Great Rift Valley region, an area known for its wind resource.

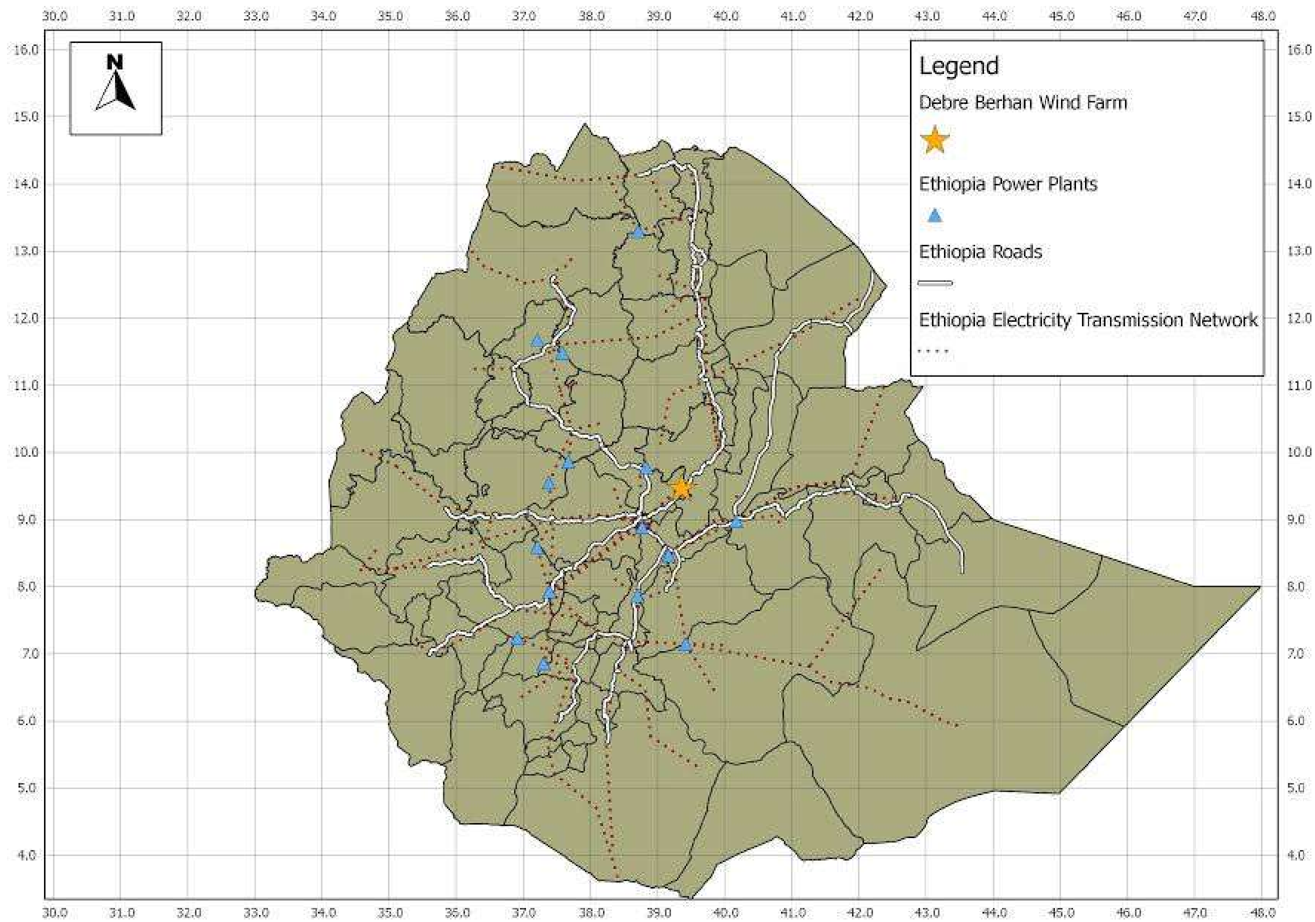

Figure 1 Debre Berhan Wind Farm Site Location

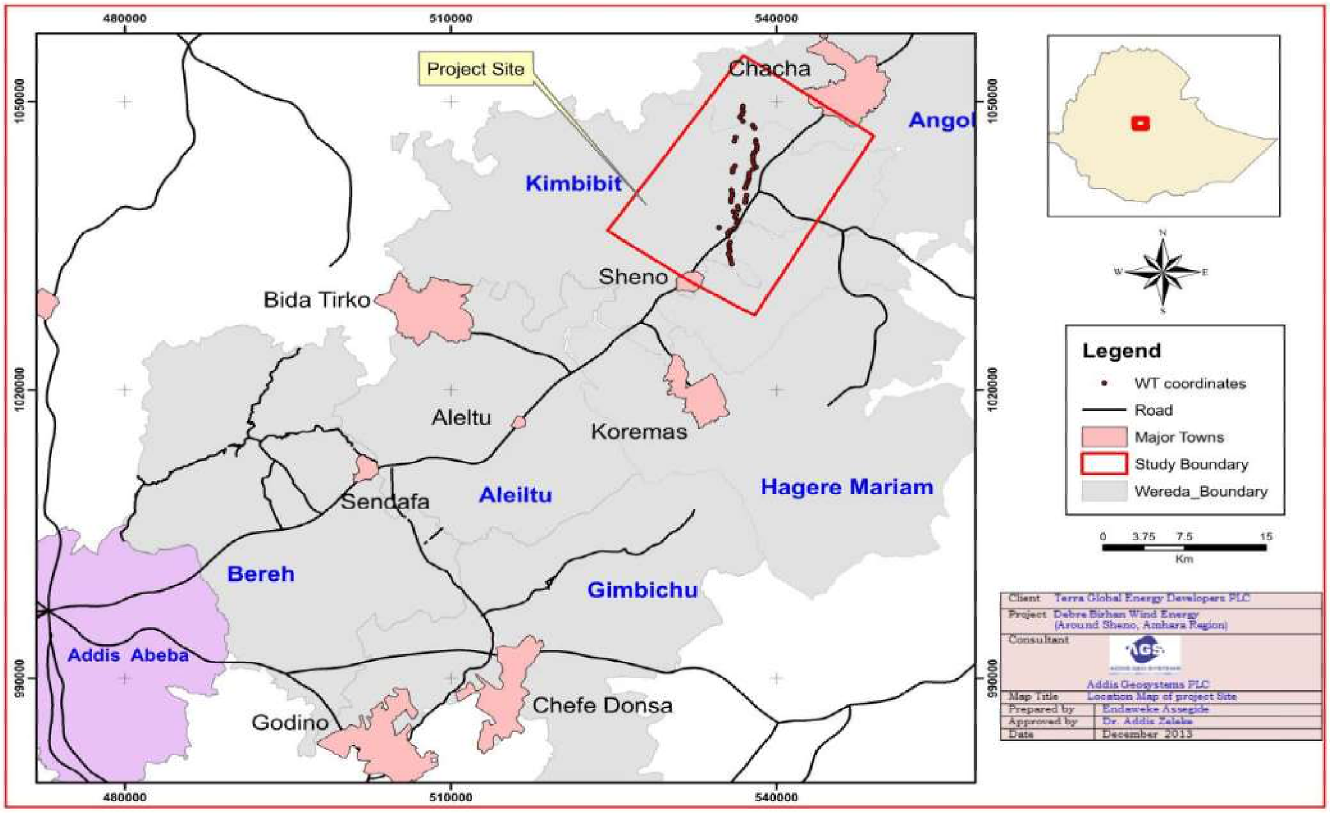

Figure 2 Debre Berhan Wind Farm Location - 9º31.204'N 39º 26.784'E

4. Site Description and Construction

4.1 Site Description

The Project Site:

- Offers excellent open land with a commercial wind resource;
- has access via improved roads;
- is adjacent to high voltage transmission lines;
- is located near the town of Debre Berhan and its university; and
- is a reasonable distance to Addis Ababa with its capabilities and high demand for electricity. Equipment may be brought in from around the world via the Port of Djibouti. Close access to Addis Ababa offers access to EEP operations, air transport and ample ability to maintain the Project on an ongoing basis.

The Project Site is open, flat and rolling, with steep areas leading to the ridgeline where the wind turbine generators (WTGs) will be installed. The specific topography of the Project Site is largely characterized by a flat plateau, in the Central Highlands of Ethiopia, with an average elevation of from 2,600 meters to 3,050 meters above mean sea level and with some undulating ridge chains and dissected valleys.

The area is predominantly subsistence agricultural land with rotating croplands in the valley areas, and various crops and grassland used for grazing. Dwellings are centered by and near wind bluffs and tree clusters. Current access off the main road is dirt and gravel track.

The ridge tops are relatively flat, offering good space for WTGs, as well as suitable soils for the WTG foundations.

4.2 Geotechnical Conditions

4.2.1 Soil Description

The soil of the Project can be categorized into two main groups: a soil unit which is composed of soil of alluvial and residual origin and a rock unit which is comprised of porphyritic basalt, aphanitic basalt, scoriaceous basalt, tuff and fissure basalts as sills or dikes.

The descriptions of the soil are based on visual inspections. Most of the soils on the ridges and low slopes are residual, and the colluvium soil is mostly found on the lower slopes, foot of ridges and saddle morphologies between ridges. The alluvium and residual soils occupy most of the lower flat lands commonly along streams sides. The soils in the area are derived from gradual weathering of the porphyritic and aphanitic basalt. There are various contents of basaltic rock fragments within the colluvium-alluvium soils. The thickness of the soil on the ridges and slopes is shallow, commonly less than one meter while thickness increases to about three meters at lower topography. The soil on the rides and higher topography is silt to clay sized, light/dark gray to reddish brown. The local people intensively cultivate these soils. The alluvial deposit at lower topography and sides of streams commonly is dark colored, silty clayey soil with high plasticity and fertile.

4.2.2. WTG AND POI SITE SOILS

From the point of view of morphologic feature, geology and soil type, the Project can be divided into three cluster groups as described in the following sections.

4.2.2.1 A) GROUP - 1 (SOUTHERN CLUSTERS)

These sites are located northeast of Sheno town at Etisana Ejifono and Fitonaala Mesino localities. The sites in this group include Sites 1, 7, 19, 25, 26, 28, 29, 36, 38 and 43. These sites are located on relatively flat topography and the depth of weathering intensity has been investigated based on outcrop nature and along streams and gullies that had exposed the depth of weathering. The typical representative sites for this group are Site 36 and Site 29. A partial view of southern cluster is shown in Figure 3 and 4.

The rock unit at this site is aphanitic basalt, fine grained, dark grey, slightly weathered at the surface, some soil cover, jointed, hard, with columnar jointing with narrow spacing. The surface exposure is in blocks and boulder form intercalated with soil nearly at equal proportion. Exfoliation weathering is common. Joint systems are nearly north south and east west with some deviations.

Under station 29, steep cliff towards the southeast has exposed very thick basalt that show about six different distinct flows with estimated total thickness of ~100 meters. Each flow makes benches and cliffs separately. Thickness of each flow varies from 2 meters to 10 meters. The following plate shows the series of flows and the weathering depth.

The depth of weathering for this group of sites, including residual soil minor colluviums and moderately weathered bedrock, has been estimated to two meters.

Figure 3 Partial View of Southern Cluster (Group 1)

Figure 4 Partial View of Southern Cluster (Group 1)

4.2.2.1 B) GROUP 2 (MIDDLE CLUSTERS)

Group 2 clusters lie at Wentu, Tukana Koraweha and Dalota Suke localities. The physiography of this area is generally discontinuous ridges with flat on top and moderate slope to both east and west. The best representative sites for depth of weathering and bedrock conditions were two quarry faces for this group.

The sites in this group include Site 0, 3, 4, 6, 9, 12, 13, 14, 15, 17, 18, 20, 30, 37 39, 40, 42, 45, 50 and 54.

The depth of weathering for this group of sites, including residual soil minor colluviums and moderately weathered bedrock, has been estimated at two meters. In general, the test pit representing this group is TP-3.

Overburden thickness on both quarry sites at 537500E/1040088N and at 536525E/1037515N locations south of station 17 is locally variable but estimated at two meters. Soil thickness at WT II (station 17) and the rest of the sites in this group is estimated to be similar to the top of both quarries with soil cover not more than two meters.

4.2.2.1.1C) GROUP 3 (NORTHERN CLUSTERS)

The sites are located at Dalota Korke, Adena Daleti and west of Cheki localities. The sites include Site 4, 5, 8, 10, 21, 23, 24, 27, 31, 33, 34, 40, 46, 47, 49, 52 and 54.

This area is dominantly ridge forming with more or less rough morphology with local picks and high slopes particularly at Sites 10 and 21; the rest of this group lies at relatively flat and low angle slop rolling topography. The thickness of soil is thin (<1 meter) on ridge tops and relatively thicker (up to 2 meters thick) on flat areas. The bedrock beneath is commonly jointed and moderately weathered.

4.2.2.1.2D) SUBSTATION

The substation site is located on a relatively flat to slightly sloping area where silty clay soil of residual and alluvial origin has developed. The soil profile at the substation site is represented by TP-3.

4.2. 3. SUMMARY

The geological study area forms discontinuous undulating ridges trending roughly north to south directions and rolling slopes that gradually makes relatively monotonous flat lands.

- Engineering geological unites within the Project Site can be categorized into two main groups, a soil unit composed of soil of alluvial and residual origin and a rock unit comprised of porphyritic basalt, aphanitic basalt, scoriaceous basalt, tuff and fissure basalts as sills or dikes.
- Most of the soils on the ridges and low slopes are residual and the colluvium soil is mostly found on the lower slopes, foot of ridges and saddle morphologies between ridges. The alluvium and residual soils occupy most of the lower flat lands commonly along streams sides. Generally, soil cover on ridges is very thin with a maximum depth of 1.5 meters.
- The proposed substation site is slightly sloped to flat with soil thickness about two meters.
- Some of the WTG sites are located on sloped terrain, narrow ridge tops with difficult access and adjustment or relocation may be required to find working area for WTG installation and accessibility. Such area is also exposed to landslide hazard.

- Generally speaking, problems related to expansive soil, shallow ground water, very low bearing capacity is not anticipated for WTG foundations considering the location of WTGs, soil type and thickness and bedrock characteristics.
- The project site is located in the seismic risk region of the country (Zone 4- a national micro zone designation for high seismicity regions located within the Great East African Rift Valley system). Therefore, the structural and foundation design has to consider the seismicity of the area.
- Aphanitic basalt, which is a source of very good aggregate, is abundant at the Project Site. Further investigation is required for other construction materials such as sand.

4.3 Access to Project Site

Route 1, the main paved road running adjacent to and through the Project Site, is a north south byway from Addis Ababa, recently improved, offering weight bearing requirements and smooth access.

This road allows direct access to the Port of Djibouti via existing roads with reasonable modifications and consideration of improvements already in progress.

The transport route, while practical, will require careful planning and be a significant milestone within Ethiopia, as the intended WTGs are state of the art Class III machines that have the largest class of blades and would be larger than any blades transported previously in Ethiopia. The size of these blades is the primary transport challenge.

The logistics transport study for the Project conducted by Central Oceans, a worldwide logistics expert, on behalf of Terra Global in November 2013, provides two alternatives and full details of the requirements. The general route from the Port of Djibouti to the Project Site is shown in Figure 5.

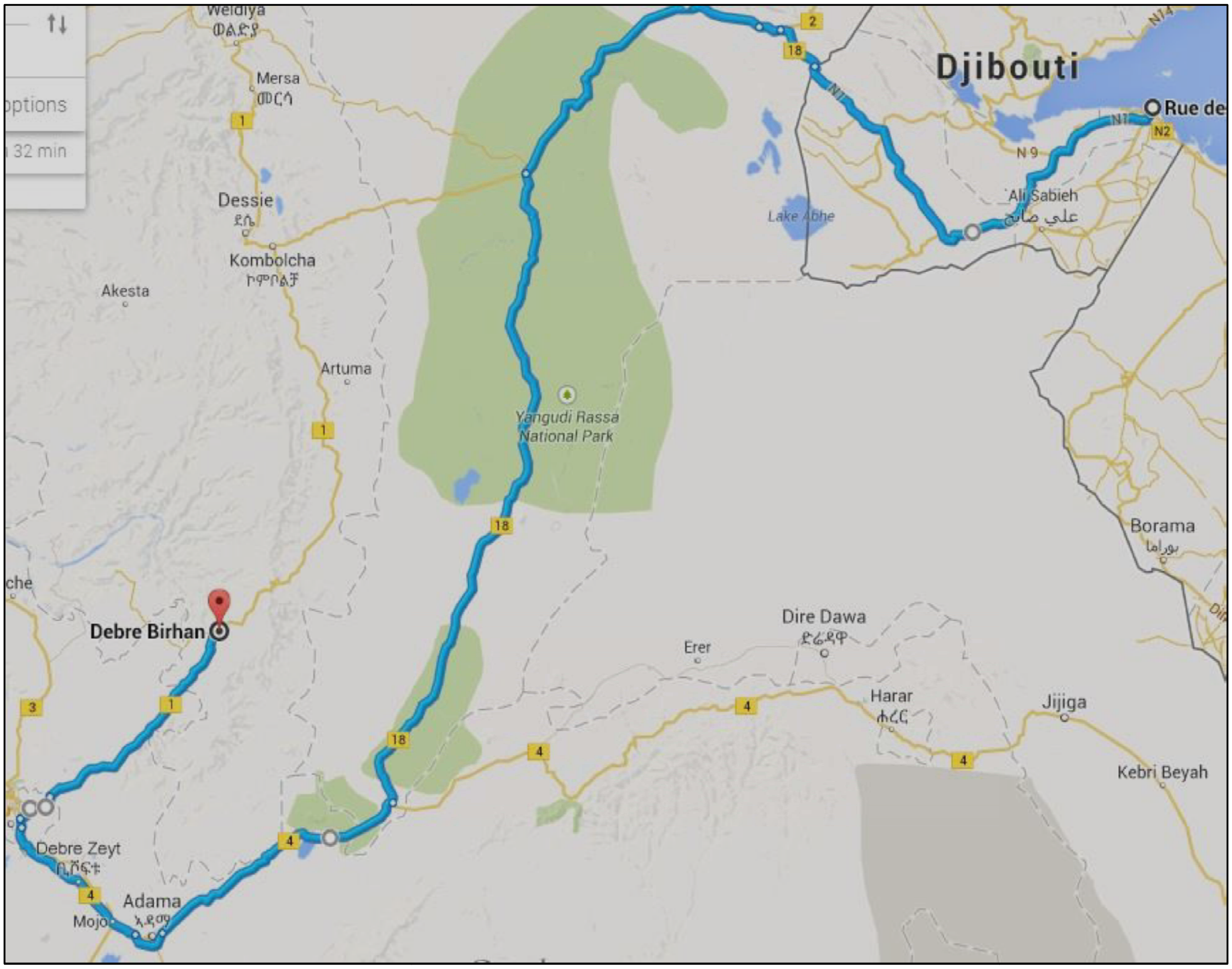

Figure 5 Port of Djibouti to the Project Site Route

4.4 Route Survey

The infrastructure in Ethiopia and Djibouti offers a limited number of routes to deliver the WTGs and other equipment to the Project Site and present restrictions on the type of equipment that can be delivered to the country. Central Oceans surveyed the only two major routes between the Port of Djibouti and the Project Site. Based on the current conditions of that infrastructure, only one feasible route is possible and recommended for the Project; referred to herein as the "Primary Route."

4.4.1 PRIMARY ROUTE: TOTAL DISTANCE APPROXIMATELY 1,004 KM

Port Exit; Rue de Venice S; Djibouti N1 W; Border cross into Ethiopia; Ethiopia-18 S to Awash; Ethiopia-4 W to Addis Ababa metro; Junction with Ring Road N; From this point, 3 current route options through Addis Ababa roads:

1) Ring Road N; Right at traffic circle to Asmara Road E (Ethipiopa-1 E); Slight right to Ethiopia S-1 E; Traffic circle back to Ring Road N; Merge back to Ethiopia-1 N to the Project Site.

2) Ring Road N; Right on Ring Road 2 (N 9°0’30” E 38°48’13”); Right at traffic circle to Ethiopia S-1 E; Traffic circle back to Ring Road N; Merge back to Ethiopia-1 N to the Project Site.

3) Ring Road N; Right at traffic circle to Asmara Road E (Ethipiopa-1 E); Ethiopia-1 E to the Project Site.

4.4.2 ALTERNATIVE ROUTE SURVEYED PER CURRENT CONDITIONS: (NOT ADVISED)

1) Port Exit; Rue de Venice S; Djibouti N1 W; Border cross into Ethiopia; Right turn in Mile W to Weldiya, Ethiopia-1 S to site via Weldiya, Dessie, Kombolcha, Debre Sina, Debre Berhan.

i. Alternate: Ethiopia-18 S, Ethiopia-2 W to Kombolcha, Ethiopia-1 S to the Project Site.

ii. Alternate: Ethiopia-18 S, Weldiya Road W to Harbu, dirt road south to Bati / Ethiopia-2; Ethiopia-2 W to Kombolcha, Ethiopia-1 S to the Project Site.

2) Route Issues:

a) All route options utilizing Ethiopia-1 from the north must cross the mountain pass/tunnels via Debre Sina. Trucks of any kind are not recommended via this mountain pass. Steep grades and hairpin turns on the climb out of Debre Sina are not suitable for wind cargo with any length, limiting the blades and tower top sections.

b) In addition, the tunnel at N 9°60’48” E 39°44’46” has a max height of 5.0 meters, limiting tower base and mid sections and potential nacelle units.

c) Impassable bridge for out-of-gauge cargo at N 10°19’04” E 39°59’29”. Bridge is likely not rated for any truck weight of significance. In addition, the bridge is only 2.8 m / one lane wide. It is possible a new bridge will be constructed, but no signs were present.

4.4.3 GENERAL TRAFFIC STANDARDS

4.4.3.1 CONSTRUCTION ZONE COMMONALITIES

When highways are under construction, improvised dirt roads usually parallel the existing highway to accommodate the traffic. The roads are generally not stabilized beyond the natural compaction of the soil with the slight assistance of a steamroller. These roads can be rutted, filled with potholes, or contain humps/dips. In addition, these dirt roads may have tight turns, especially from the highway access and egress, which is not suitable for large equipment. During the survey, no turn issues were noted. Low visibility conditions are common due to the abundance of dust from truck traffic in the dry season. These roads could become difficult to navigate, if not impassible, during heavy rainy season storms.

Road upgrades are expected between Addis Ababa and Dire Dawa over the next several years, including the Addis Adama Expressway to reduce transit time and thin congestion. It is likely that these dirt road detours will be commonly found during transportation as the GoE improves its road infrastructure.

4.4.3.2 Current Major Construction Projects

Once completed, the road upgrades will likely benefit Project deliveries. The completion of both roadways prior to delivery would reduce transportation times, reduce the potential for traffic related damages and likely allow for larger WTGs for future expansion phases.

- **Addis Ababa - Adama Expressway:** The expressway is the first of its kind in Eastern Africa. Built to accommodate the heavy commercial truck traffic from the Port of Djibouti to Addis Ababa, it will reduce transit time and stimulate the economy. The new six-lane highway will be 12 meters wide with a fence on either side of the highway to prevent pedestrians and animals from accessing the roadway. Projected completion of the Expressway is in second quarter of 2014.
- **Sembo-Sholagebeya-Gorfu-Gobensa Road:** This road will connect Modjo directly to the Project Site in Sembo through Arerti and Sholagebeya. The roadway is projected to be 7 meters wide with 1.5-meter wide shoulders on each side of the road in rural sections and up to 19-meters wide through towns to allow for parking lanes. The road had a projected completion date of October, 2013; however, it is 65% to 70% complete at the time of this Feasibility Study Report.

A copy of the study entitled “Debre Berhan Route Study and Market Study” is attached to this Feasibility Study Report as Section 19, Appendix A. It provides further details, ample photographs of road junctions, turning radius, slope constraints and planned roadway improvements currently underway or planned that are required for the transportation of the WTGs and other equipment to the Project Site.

4.5 Crane and Equipment Availability

Ethiopia has several crane contractors, existing heavy equipment and modern gear that are available through competent contractors based on the significant construction activity, traditional hydro generation and recent wind projects placed in operation in Ashegoda and Adama. Several WTG manufacturers provided details to Terra Global via their submittals to offer erection services and outline crane availability. The Class III WTGs could require additional blade trailers and a main erection crane to be brought into the country for the Project. This is not an obstacle and may be easily addressed via the EPC Contract. Another option that should be considered is the purchase of a construction crane for the construction of the Project that would later be available for the maintenance of the Project, the expansion of the Project and for the construction and/or maintenance of other wind projects.

5. Wind Resource at Site

5.1 Introduction

The wind resource is the driving factor of any wind energy project. As such, the assessment of the wind energy resource was the first task undertaken by Terra Global in performing the Feasibility Study. Based on the initial countrywide wind energy site investigation that considered the area south of Debre Berhan to have a potential resource, steps were taken to confirm this assumption. These steps included collecting actual site measured data, correlating this to long-term data, conducting modeling and arriving at a practical determination of a wind farm based on the latest wind industry practices.

Two professional grade 60 meter meteorological (met) masts were installed on site in 2012 near the northerly (Chacha) and central part (Sembo) of the potential phase I 100 MW Debre Berhan Site. During a site visit, an experienced installation team determined two suitable met mast locations, assessing the overall consideration of the staged development of the facility, topography, available grid infrastructure and access. These two met masts had very high data collection rates and remain in operation.

Data collected from the two met masts was used to conduct an overall consideration of the proposed 100 MW Debre Berhan Site development. For the Project, only the output from the met mast that is adjacent to the village of Sembo was considered; this location is approximately 35 km southwest of the town of Debre Berhan and 85 km northeast of Addis Ababa on Highway 1.

The Sembo met mast site is located in the western portion of the Debre Berhan Site on an elevated hilltop along a ridgeline. The ridgeline runs broadly north to south and is characterized by undulating hills. Beyond this ridge, there are relatively deep valleys that are somewhat sheltered from the prevailing easterly wind. With respect to wind flow modeling, no significant obstacles or topographical features are present within the vicinity of the mast locations. The analysis is based on a 67 wind turbine generator (WTG) layout optimized by SgurrEnergy. The Goldwind 93 1.5MW WTG at 85 m hub height has been used in the analysis. The WTG layout is shown in Figure 6.

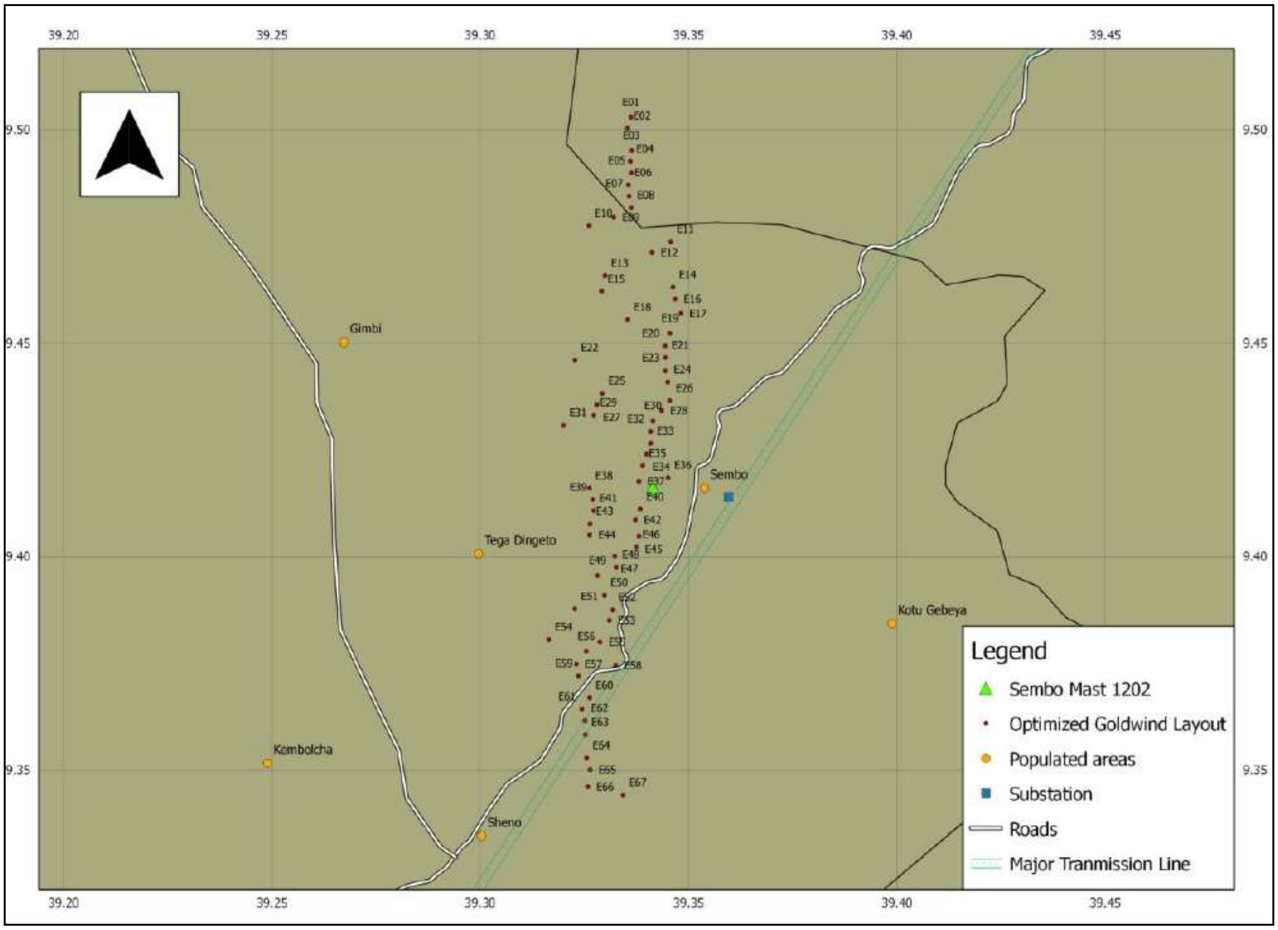

Figure 6 Map of Proposed Debre Berhan Goldwind GW93 WTG Layout

5.2 Analysis of Measured Wind Data

An 18-month met mast measurement campaign has been undertaken at the designated wind farm development area. Two 60 m tubular masts (Chacha 1201 and Sembo 1202) were commissioned on 26 October 2012. There is a distance of approximately 15 km between the two mast locations and, as such, it is not considered appropriate to use both datasets in this study, which considers a WTG layout in proximity to the Sembo 1202 mast location.

An optimized WTG layout for the Project was created broadly centered on the Sembo 1202 mast location. Wind speed measurements and modeling indicated that the wind resource at and surrounding this mast was superior to the wind resource at and surrounding the Chacha 1201 location. Therefore, other than for the purposes of data verification, only the Sembo 1202 dataset was used in the energy yield analysis.

5.3 Mast Configuration and Instrumentation

A commissioning sheet[1] for the Sembo on site mast was provided to SgurrEnergy detailing the mast set-up. The mast was installed with six anemometers at three different heights (40, 50 and 58 m) and two wind vanes (46 and 54 m) with two temperature sensors at two different heights (59.5 and 3 m) and a pressure sensor installed at a height of 3 m. The data from the instruments on the mast were logged with a NRG Symphonie Plus data logger on a 10-minute basis.

Details of the instrumentation installed on the mast located at the Debre Berhan site are given in Table 4.

Table 4 Sembo (1202) Mast Layout Details

Commissioned	26 October 2012
Measurement Period Available	26 October 2012 – 16 May 2014
Meteorological Mast Height (m)	60 meters
Location (WGS84)	9° 24.976' N 39
Location (UTM)	537485 1040892 Zone 37
Elevation (mamsl)	3030 meters
Anemometer Type, Height, and Boom Orientation	NRG Class 1, 58 m, 135°
	NRG#40C, 58 m, 315°
	NRG Class 1, 50 m, 135°
	NRG#40C, 50 m, 315°
	NRG Class 1, 40 m, 135°
	NRG#40C, 40 m, 315°
Wind Vane Type, Height, and Boom Orientation	NRG 200P, 54 m, 45°
	NRG 200P, 46 m, 45°
Temperature Type and Height	NRG 110S, 3 m
	NRG 110S, 59.5 m
Voltmeter Type and Height	iPack Voltmeter, 3 m
Pressure Type and Height	NRG BP-20, 3 m
Logger Type and Height	NRG Symphonie Plus data logger, 3 m

[1] Harness Energy, Met Mast Installation Log Debre Berhan 1202, October 2012.

Figure 7 Project Site – 104 MW Layout and Sembo Met Mast Location

Figure 8 Sembo Met Mast – Facing South

During the site visit conducted by SgurrEnergy, the wind resource, technical and engineering advisor to Terra Global, the mast configuration was checked against the commissioning sheet and IEA Recommended Practices[2]. The observed heights and boom orientations were found to be consistent with those reported in the commissioning sheet. From the information available to SgurrEnergy and the observations made during the site visit, the present instrument set-up on Sembo mast (1202) were considered to be compliant to the International Energy Agency ("IEA") recommended practices.

The ratio between the mast measurement height (58-meters) and the hub height (93-meters) is slightly below the standard industry recommended ratio of two thirds. While it is common practice to utilize 60-meter masts at a project at the feasibility stage, the large extent of the vertical extrapolation increases the uncertainty in the hub height wind speed accuracy. It is therefore recommended that these masts later be supplemented with taller masts or a temporary remote sensing device (e.g., Lidar) as the Project is designed to reduce the uncertainty associated with factors such as wind shear.

Three primary NRG Class 1 anemometers and three NRG #40C anemometers are installed on both masts.

Temperature and pressure readings are used to measure air temperature at the Project Site to define the Project Site air density.

5.4 Review of Measured Wind Data

The measured wind data was collected on a 10-minute interval basis in line with industry standards. The 18-month dataset (from October 2012 to May 2014) from the 60-meter wind monitoring mast was screened and reviewed in order to identify potential problems or anomalies within the data.

5.4.1. Missing and Anomalous Data

A summary of missing (from source) and anomalous anemometer wind speed ("WS") and wind vane ("WD") data recorded at the Sembo 1202 mast is presented in Table 5 and Table 6 respectively.

[2] "Hunter R. S. et al (1999). 11. Wind Speed Measurement and use of Cup Anemometry. Expert Group Study on Recommended Practices for Wind Turbine Testing and Evaluation. 1st edition. Renewable Energy Systems Ltd

Table 5 Review of Missing and Anomalous Data

Mast	Instrument	Number of Records Missing/Removed	
		Missing	Anomalous
Sembo 1202	58m WS 135°	6	0
	58m WS 315°	6	10
	50m WS 135°	6	0
	50m WS 315°	6	34
	40m WS 135°	6	0
	40m WS 315°	6	61
	54m WD 45°	6	46
	46m WD 45°	6	54
	Temperature at 3m	6	26
	Temperature at 59.5m	6	36
	Pressure at 3m	6	0

There were very few anomalous records in the dataset. Therefore, data coverage and quality after the screening process were found to be very good with over 99% data availability for all instruments.

The monthly averaged wind speed and wind direction (with respect to true north) at all anemometers and wind vanes are presented inTable 6 along with availability figures for the 58 m 135° orientated anemometer.

Table 6 Review of Monthly-Averaged Sembo 1202 Mast Data

Month	V58 135° (m/s)	V58 315° (m/s)	V50 135° (m/s)	V50 315° (m/s)	V40 135° (m/s)	V40 315° (m/s)	D54 45° (°)[1]	D46 45° (°)[1]	T3 (°C)	T59.5 (°C)	P3 (mbar)	Data Recovery (%)[2]
Oct-12[3]	7.69	7.76	7.45	7.60	7.18	7.19	86	89	10.3	10.2	708.3	17.1
Nov-12	6.83	6.88	6.64	6.68	6.40	6.37	98	101	11.2	11.2	709.3	100.0
Dec-12	6.35	6.37	6.21	6.22	6.00	5.87	113	115	10.7	10.8	708.9	100.0
Jan-13	5.93	5.93	5.79	5.82	5.60	5.50	117	120	11.8	11.9	710.0	100.0

Month	V58 135° (m/s)	V58 315° (m/s)	V50 135° (m/s)	V50 315° (m/s)	V40 135° (m/s)	V40 315° (m/s)	D54 45° (°)[1]	D46 45° (°)[1]	T3 (°C)	T59.5 (°C)	P3 (mbar)	Data Recovery (%)[2]
Feb-13	6.65	6.66	6.52	6.57	6.32	6.30	117	120	12.6	12.6	709.6	100.0
Mar-13	6.05	6.03	5.92	5.91	5.74	5.68	117	120	13.2	12.9	709.4	99.9
Apr-13	5.92	5.94	5.79	5.85	5.62	5.61	101	104	13.5	13.3	709.6	100.0
May-13	6.91	6.98	6.72	6.82	6.51	6.47	85	88	13.7	13.6	710.1	99.9
Jun-13	5.47	5.47	5.37	5.40	5.22	5.15	62	65	13.5	13.5	709.4	100.0
Jul-13	5.49	5.43	5.46	5.36	5.35	5.21	339	341	11.0	10.9	708.6	100.0
Aug-13	4.59	4.49	4.54	4.36	4.45	4.21	358	359	10.9	10.8	708.6	100.0
Sep-13	6.05	6.03	5.88	5.88	5.68	5.56	83	86	11.9	12.0	709.6	100.0
Oct-13	6.76	6.79	6.55	6.63	6.31	6.28	91	94	10.6	10.7	709.8	100.0
Nov-13	6.82	6.86	6.63	6.74	6.40	6.38	95	97	10.3	10.3	709.0	100.0
Dec-13	5.61	5.65	5.49	5.58	5.31	5.34	127	130	10.2	10.6	709.5	100.0
Jan-14	5.75	5.76	5.63	5.68	5.45	5.45	130	132	11.4	11.4	709.6	100.0
Feb-14	5.52	5.47	5.42	5.39	5.27	5.20	144	147	12.0	11.9	708.7	100.0
Mar-14	6.59	6.59	6.44	6.48	6.23	6.20	110	113	12.5	12.3	709.5	100.0
Apr-14	8.12	8.20	7.94	8.10	7.71	7.72	95	98	12.8	12.2	710.1	100.0
May-14[3]	7.79	7.83	7.59	7.73	7.36	7.36	88	92	13.5	13.1	709.9	51.5
Average	6.25	6.25	6.11	6.14	5.92	5.86	102	105	11.9	11.8	709.4	100.0

[1] Direction averages are vector averages and are a direct representation of the average monthly direction.
[2] Shown as a percentage of possible 10-minute records in a complete month at 58m height.
[3] Partial data months.

The average wind speed (after the screening process) over the 18-month period since the Sembo 1202 mast was commissioned is 6.25 m/s at the 58 m 135º anemometer.

The monthly-averaged wind speed and wind direction for the Sembo 1202 mast are illustrated in Figure 9. It can be seen that the prevailing wind direction is observed to be from the east.

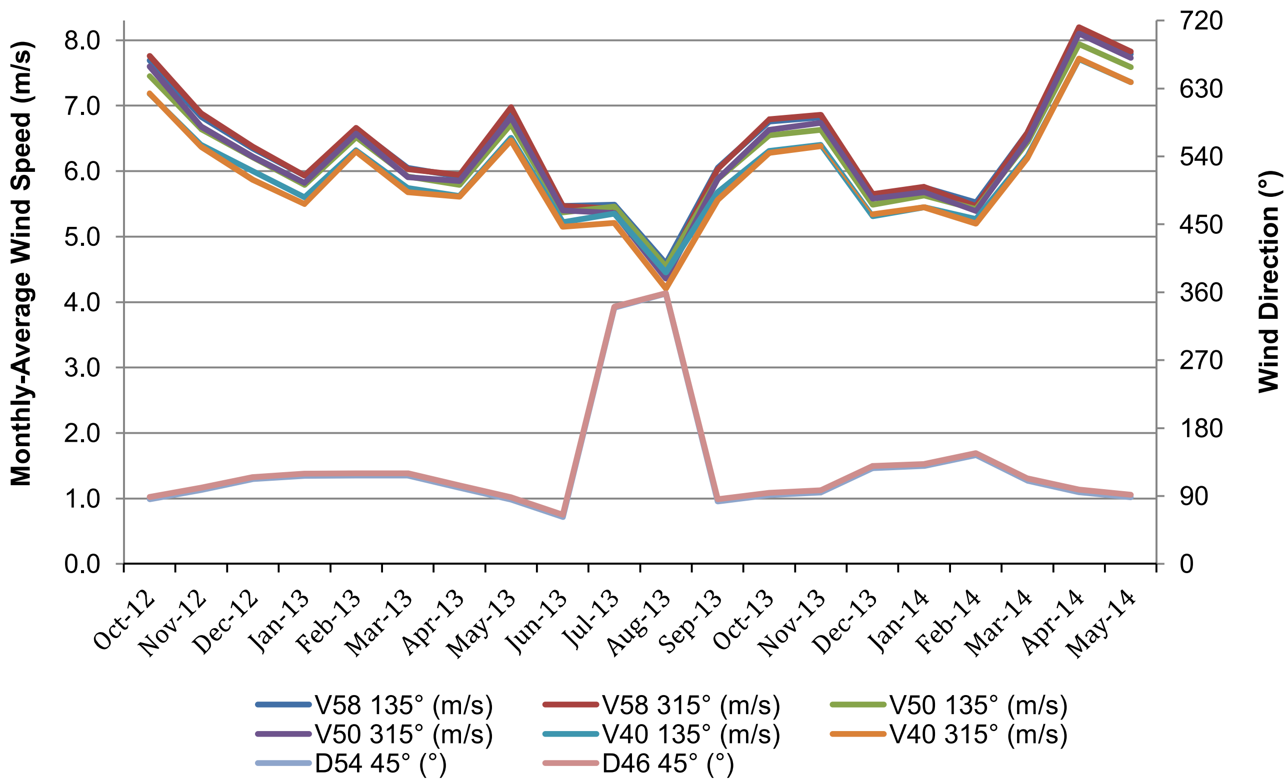

Figure 9 Monthly Average Wind Speed and Wind Direction for Sembo 1202 Mast

5.5 Short-Term Measured Wind Speeds at Mast Height

The average measured wind speed at 58 m height for the Sembo 1202 mast was 6.26 m/s. The monthly wind distribution during the 18-month period is relatively unidirectional (with the exception of July and August). This diurnal variation is illustrated in Figure 11 by plotting wind shear coefficient, α, by hour of day for the measured dataset.

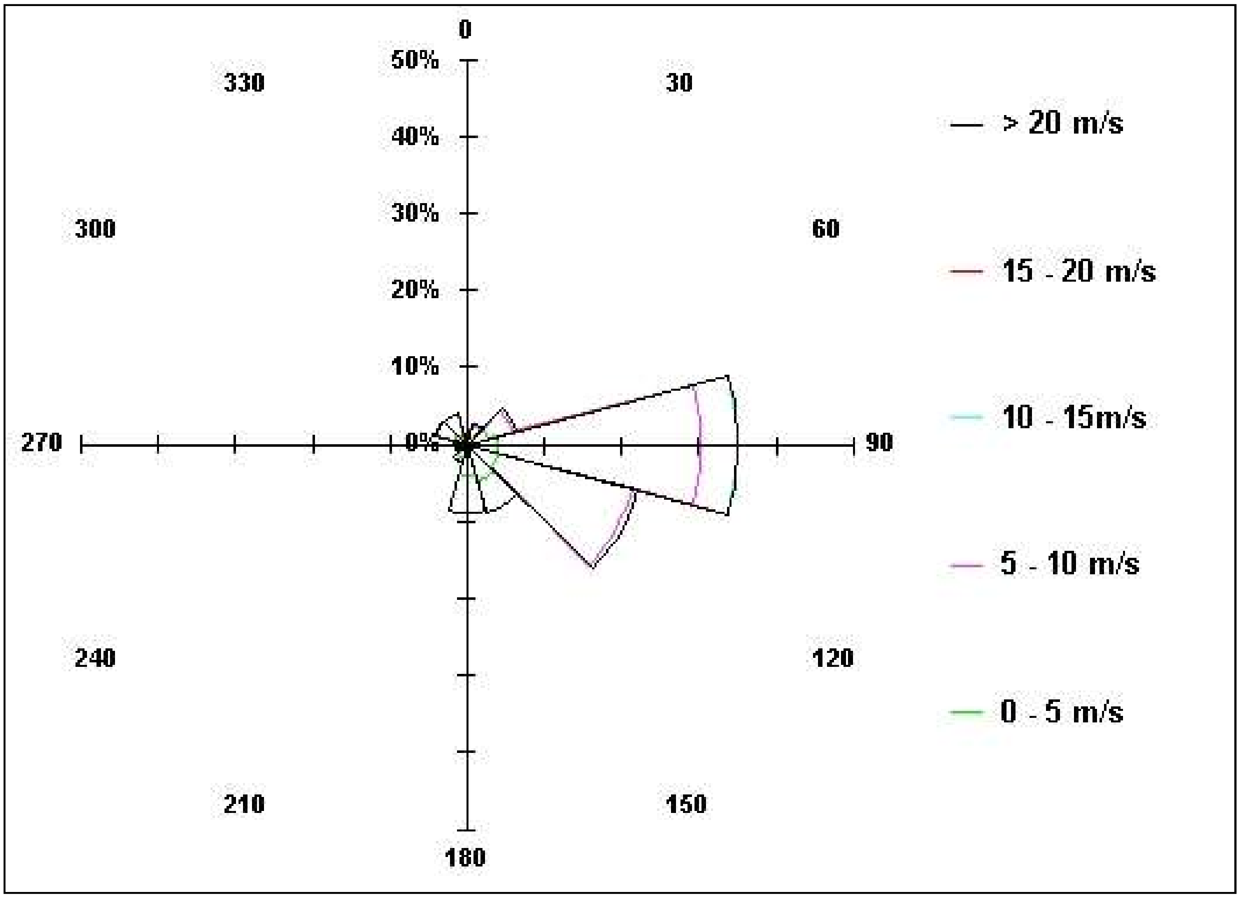

Figure 10 Short-term Wind Rose for Sembo 1202 Mast at 85m Hub Height

5.6 Site Specific Site Characteristics

The Debre Berhan Site is in a new region for wind power development with minimal historical met measurements in the area. Historical and industry standard wind farm development techniques and wind turbine generator design have been based on a Western European wind regime. Meteorological conditions can vary significantly from this standard, and when assessing a new region, it is essential that differences in the meteorology be considered to ensure that the wind farm is optimized correctly to minimize failures and maximize production. After analysis of the short-term datasets, the following considerations are made.

5.6.1 ATMOSPHERIC STABILITY

The site-measured data indicates a strong diurnal wind shear cycle, presented in Figure 11 in addition to very low turbulence at the site with an average 10 m/s turbulence intensity (TI_{10}) of 9.1% at Mast 1202.[3] This indicates that the site has a stable atmosphere.

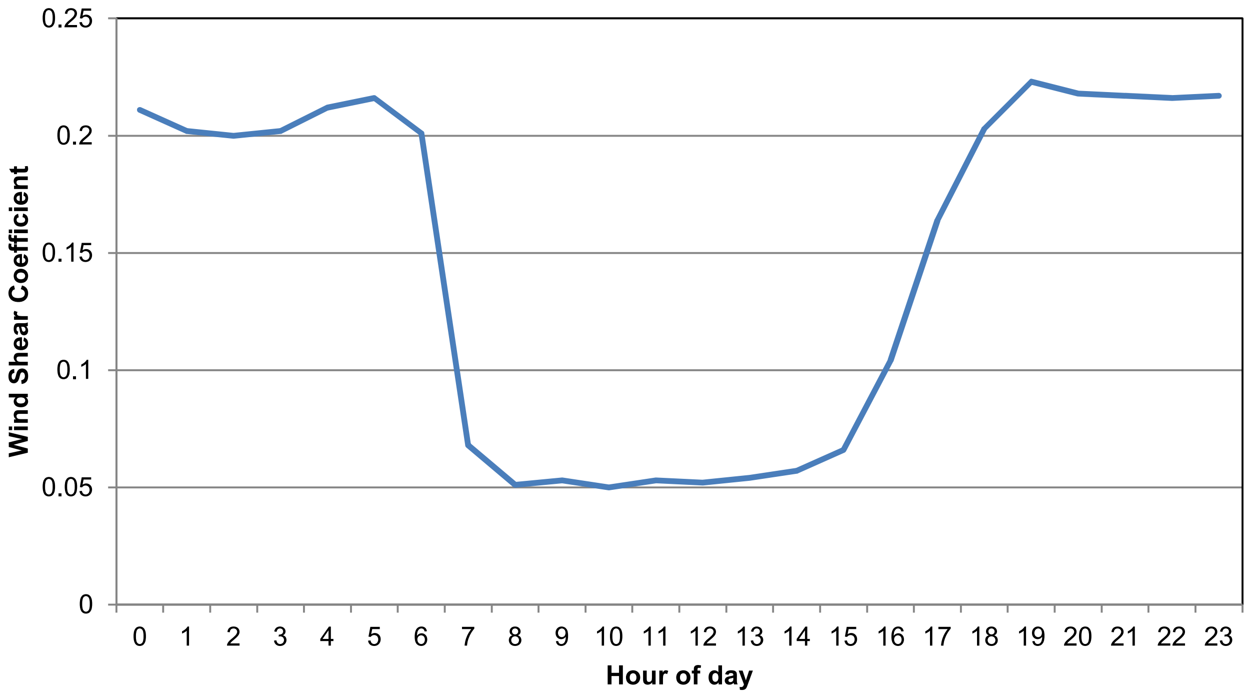

Figure 11 Sembo 1202 Mast Diurnal Wind Shear Coefficient Variation (between 58/40m)

This indicates that the site has a stable atmosphere, which may present the following two issues:

- A stable atmosphere minimizes mixing of the wind. Disturbances in the wind from WTGs cause wakes, which in stable environments take longer than typical distance to recover, as the wake does not easily mix with the undisturbed wind around it. Therefore, stable atmospheric conditions can lead to large wake losses, which linear flow models such as Wind Atlas Analysis and Application Program (WAsP) cannot accurately represent. WAsP is designed for neutral atmospheric stability. SgurrEnergy has attempted to account for this

[3] Note that 10m/s data is referenced instead of the IEC standard 15m/s, as few 15m/s records exist in the measured dataset.

effect in the WTG layout design by aligning the WTGs perpendicular to the prevailing wind direction.

- Highly stable atmospheres can be associated with low-level jets where the boundary layer of the atmosphere can become very low compared to neutral stability conditions. This can cause high wind shear loading events across the swept rotor area of the WTG. As the Project is developed further, SgurrEnergy recommends deploying a remote sensing device e.g. Lidar to assess the height of the boundary layer and the wind shear profile across the WTG swept area.

5.7 Measured Wind Shear

Wind shear coefficient values for Sembo 1202 mast were calculated using the variation in wind speed between the selectively averaged (to eliminate mast shadow effects) anemometer pairs at different heights. For each 30º direction sector, a wind shear coefficient value (α) was calculated.

The 40 and 58 m anemometer data were selected as suitable anemometers, as they are separated by the greatest vertical distance and, as such, considered appropriate for assessing wind shear. The wind shear rose for Sembo 1202 mast is presented in Figure 12.

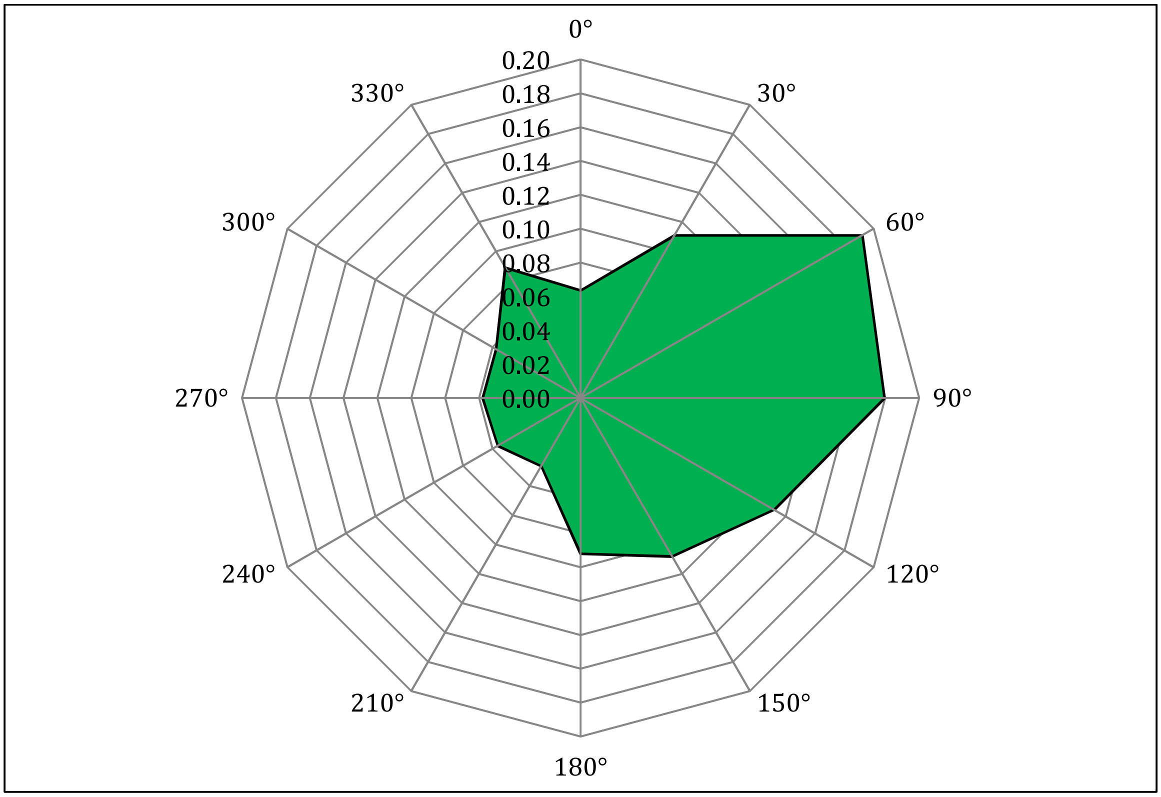

Figure 12 Sembo 1202 Mast Wind Shear Rose

The wind shear coefficients calculated between the anemometers at 40 and 58 m heights are presented in Table 7 below, which also details the frequency of incidence in each direction sector. Wind shear is observed to vary from 0.05 to 0.19 on a sector wise basis and at a level acceptable for typical WTG design criteria, with a weighted average value of 0.15 across all sectors. The higher shear values to the west are likely to be caused by a ridgeline running from north to south in that direction.

Table 7 Measured Wind Shear Coefficients for Sembo 1202 Mast

Direction Sector (°)	Wind Shear Exponent (α) (58/40m)	Frequency (%)
0	0.06	2.6%
30	0.11	3.6%
60	0.19	7.6%
90	0.18	38.1%

120	0.13	20.3%
150	0.11	7.7%
180	0.09	7.8%
210	0.05	1.8%
240	0.06	1.0%
270	0.06	1.2%
300	0.06	3.5%
330	0.09	4.6%
All Sectors	0.15	100.0%

Wind shear is important when considering the fatigue loading of WTGs. A wind shear coefficient of 0.2 is referred to as typical design value in the IEC 61400-1 guidelines[4]. At Sembo 1202 mast all sectors have wind shear coefficient values lower than 0.2, which does not raise concern for site suitability with respect to wind shear at the proposed WTG locations.

The wind shear shows strong diurnal variation in values, with high shear during night time and lower shear during the day. This diurnal variation is illustrated in Figure 13 as a plot of wind shear coefficient, α, by hour of the day for the measured dataset. Due to the strong diurnal trend observed in wind shear, the short term measured wind speeds for Sembo 1202 mast were extrapolated to the proposed 85m hub height using mast measured average wind shear values by month and hour of day. Following shear extrapolation the 85m wind speed at the mast location is 6.58m/s.

[4] (2005). Wind Turbine Generator Systems – Part 1: Design Requirements. International Electrotechnical Commission. Document No: BS EN 61400-1:2005

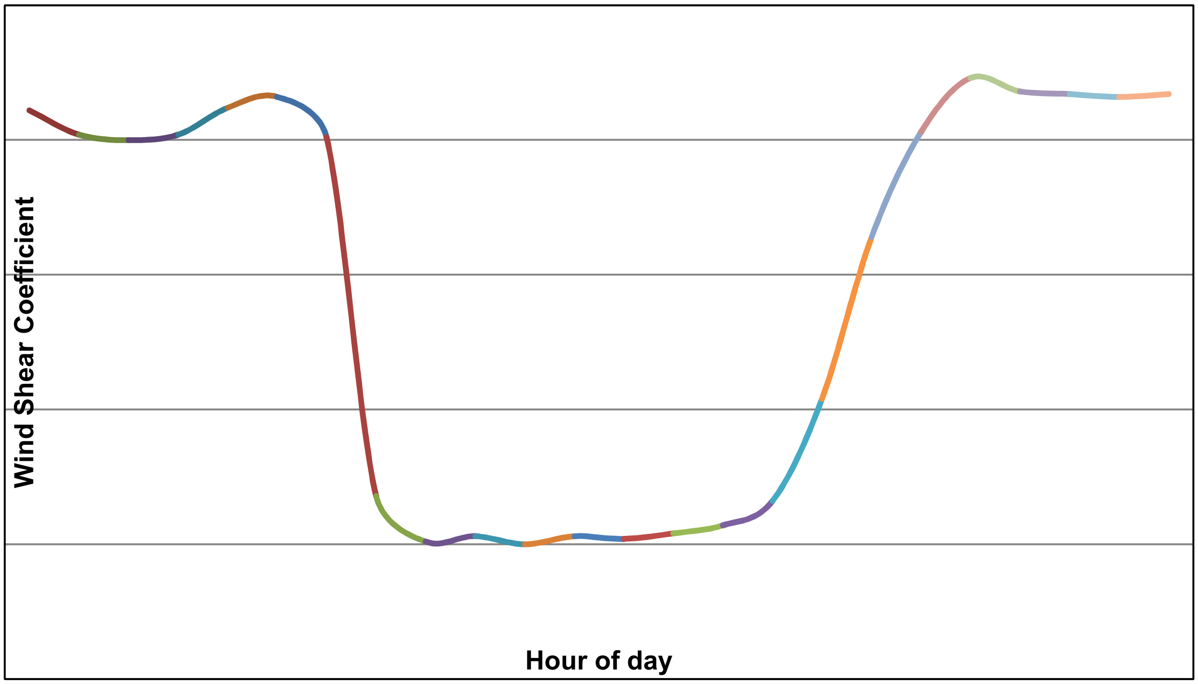

Figure 13 Sembo 1202 Mast Diurnal Wind Shear Coefficient Variation (between 58/40m)

5.8 Creating a Long-Term Wind Distribution

To ensure that the measured 58-meter site mast dataset more accurately represents the long-term wind distribution, a measure-correlate-predict ("MCP") procedure is typically carried out with a suitable reference dataset. SgurrEnergy completed a desktop review of the available historical stations and undertook a site visit to one nearby met station; however, no suitable measured reference station was identified.

Modern Era Retrospective Analysis for Research and Applications ("MERRA") products[5] and Vortex's Climate Forecast System Reanalysis ("CFSR") data were considered as modeled reference long-term wind datasets. Reanalysis products are four-dimensional datasets representing historical states of the Earth's atmosphere. The data are created through the assimilation of observations with a numerical weather prediction model. Values of met

[5] Uppala, S., P. Kallberg, A. Simmons, U. Andrae, and V. Bechtaolk, "The ERA-40 re-analysis", *Quarterly Journal of the Royal Meteorological Society*, 131, pages 2961-3012, 2005.

variables from initial outputs of the numerical model are compared with observations. The model bias is calculated, where observations are available, and this is used to adjust the numerical model during a subsequent iteration. In this way, the simulated representation of the Earth's atmosphere follows the observational records. However, there is some uncertainty in the long-term consistency of reanalysis datasets in some regions and wind regimes at sites that have strong local-scale influences may not be well characterized. For these reasons, reanalysis datasets produce results that typically have higher associated uncertainties than measured data.

The correlations observed on an hourly basis between the measured site data and the concurrent MERRA/Vortex data were found to be unsuitable for a typical MCP procedure.

However, based on initial analysis of regional Vortex CFSR and MERRA data, it was found that the 18-month period concurrent with the site measurement period observed slightly lower wind speeds, approximately 5% and 3%, respectively, than the historic ten-year regional average. Therefore, SgurrEnergy elected to use the short-term data with a monthly weighted, long-term correction to account for the short-term nature of the measured site data.

5.8.1 Reference Station Selection

A concurrent dataset was created containing the site met data and the modeled reference datasets. The concurrent data were averaged on an hourly and monthly basis and seasonally balanced to eliminate any seasonal bias. The seasonally balanced short term wind speed at Sembo 1202 mast extrapolated to 85m hub height is 6.48m/s. The key parameters for selecting reference stations are specified in Table 8.

Table 8 Long-term Reference Selection Parameters

Reference Source	Concurrent Mean Wind Speed (m/s)	Monthly R^2 Correlation	Historical Data Available (years)	Distance from Sembo Mast (1202) (km)
Vortex CFSR 60 m (39.34 E, 9.42 N)	5.26	0.82	10	At mast location
MERRA 50 m (39.34 E, 9.50 N) [1]	4.24	0.18	10	10

[1] Results are only presented for the MERRA 50 m node at 39.34°E, 9.5°N as this nodes' statistics demonstrated the strongest correlation with the site data.

The MERRA node was omitted from further consideration due to the low quality of correlation (R^2= 0.18) with monthly wind speeds recorded at the mast. The monthly quality of correlation (R^2= 0.82) obtained using Vortex data was observed to be reasonable. However, based on initial analysis of regional Vortex CFSR initiated meso-scale data and MERRA data, it was found that the 18-month period concurrent with the site measurement period observed slightly lower wind speeds (approximately 5% and 3% respectively) than the historic ten-year regional average in both datasets.

5.8.1 Wind Speed Correlation

The monthly average 58m wind speed data from the Sembo 1202 mast were plotted against the concurrent monthly average Vortex 60m wind speed CFSR initiated meso-scale data. Table 9 presents this correlation and confirms that the relationship between Sembo 1202 mast and the Vortex CFSR wind speed data is reasonable on a monthly basis. It is noted that the reference wind speed dataset has low mean wind speeds in two months and that the quality of correlation in these months is relatively poor. The sensitivity of the long-term wind speed prediction to these two low wind speed months has been assessed. Through exclusion of these two months from the monthly long-term correction procedure, the impact on long-term wind speed was observed to be less than 1%.

The correlation coefficients for hourly and monthly-averaged wind speed Vortex CFSR data and the site mast 58 m data (extrapolated to 85 m hub height) are presented in Table 9 below

Table 9 Vortex CFSR 60m Correlation Coefficients

Averaging Period	Quality of Correlation (R^2) with Sembo 1202 85m Wind Speeds[1]
Monthly	0.82
Hourly	0.31

[1] 18-month correlation, not including May 2013 for long-term wind speed correction.

The correlations observed on an hourly basis between the measured site data and the concurrent Vortex data were found to be poor and unsuitable for a typical MCP procedure. Therefore, SgurrEnergy elected to use the short-term data with a monthly weighted long term correction to account for the short term nature of the measured site data.

The short-term wind roses for the concurrent Vortex CFSR is presented above in Figure 14 below.

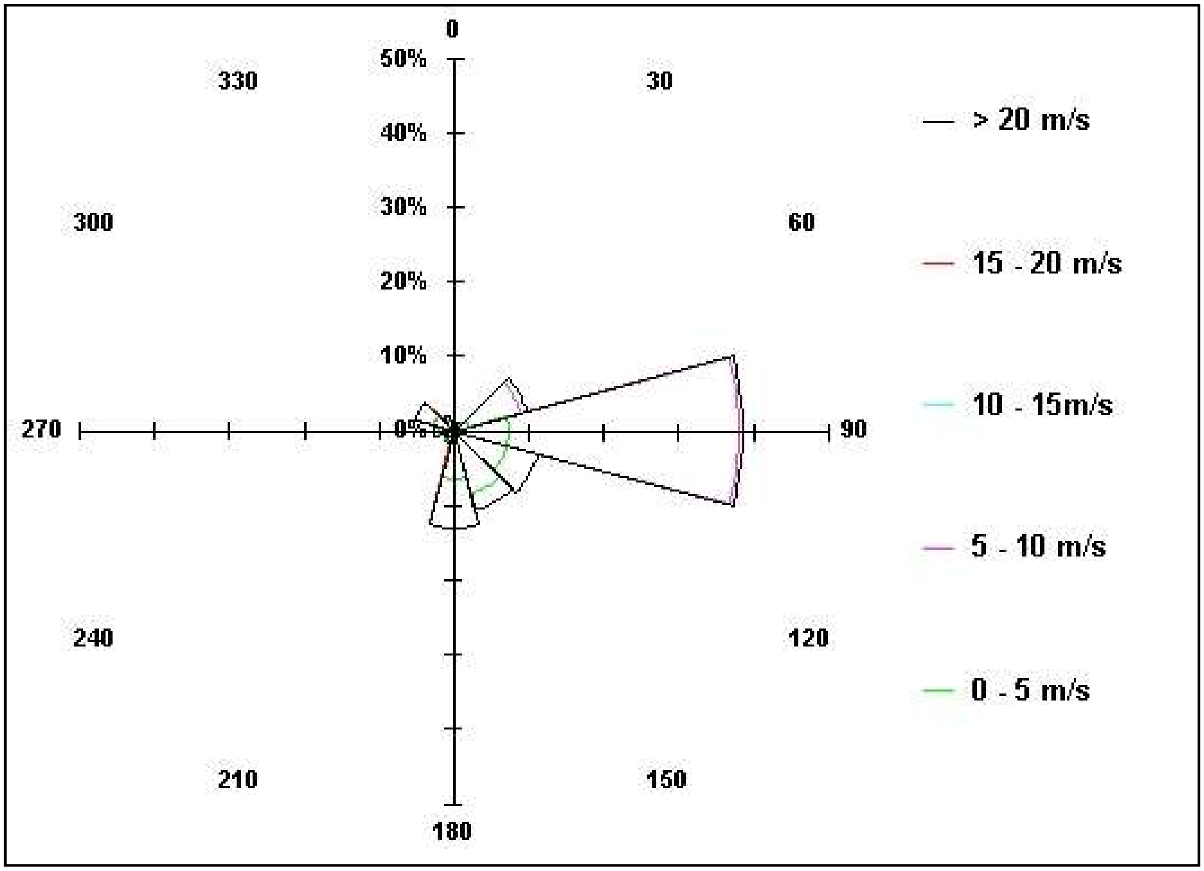

Figure 14 Short-term Wind Rose for Vortex CFSR 39.34°E, 9.42°N at 60m Height

5.8.2 Long Term Correlation Methodology

There are multiple methods to complete a long-term prediction and the most suitable methodology is dependent on the quality of the correlation between the onsite data and the reference source.

Ideally the reference data should be correlated with the site data on an hourly basis, such that wind speed distributions and direction data are also corrected during the long-term wind speed prediction. However, due to a poor quality of correlation with Vortex CFSR data on an hourly basis (R^2= 0.31), this method is not considered appropriate or robust for this site. Rather, a monthly long-term correction method was used.

By using the relationship of the best-fit line in the monthly mean wind speed correlation, the long term wind speed at Sembo 1202 mast can be estimated from the Vortex CFSR long term wind speed. The prediction obtained using the best-fit line method is 6.68m/s at 85 m hub height, which is an upward correction to the short term mean (6.48m/s) of +3.2%. The key inputs and results of this analysis are presented in Table 10.

Table 10 The Long Term Predicted Wind Speed at Sembo 1202 Mast

Description	Value
Mast	Sembo 1202
Monitoring Period	26 October 2012 to 16 May 2014
Number of Balanced Data Months	14
Hours Ratio (Summer / Winter)	50%/50%
Mast 85m Concurrent Short Term Wind Speed (m/s)	6.48
Vortex CFSR 60m Concurrent Short Term Wind Speed (m/s)	5.26
Vortex CFSR 60m Long Term Wind Speed (m/s)	5.42
Predicted Mast 85m Long Term Wind Speed (m/s)	**6.68**

The long-term wind rose for the 10-year Vortex CFSR dataset is presented in Figure 15. The resulting long-term wind rose for the Sembo 1202 mast at 85m height is presented in Figure 16.

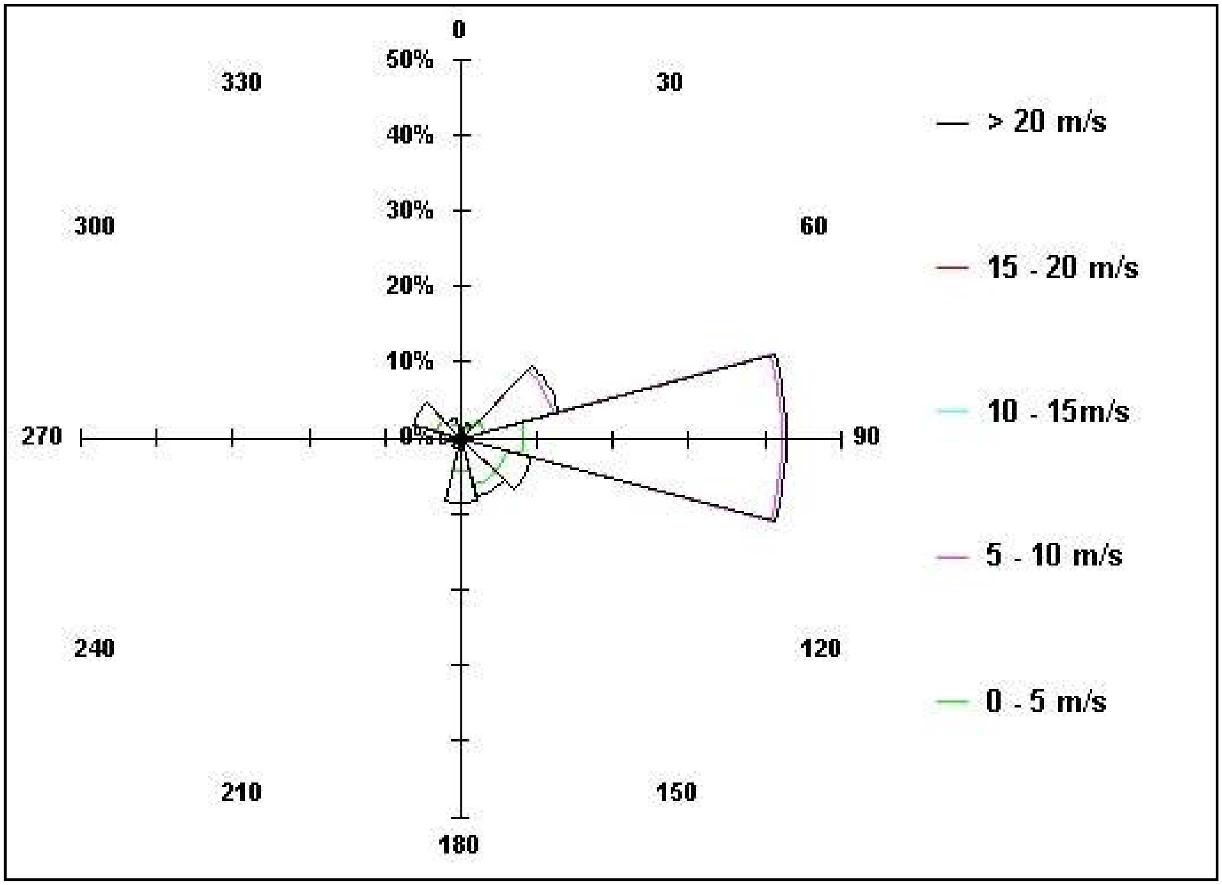

Figure 15 Long-term Wind Rose for Vortex CFSR 39.34°E, 9.42°N at 60m Height

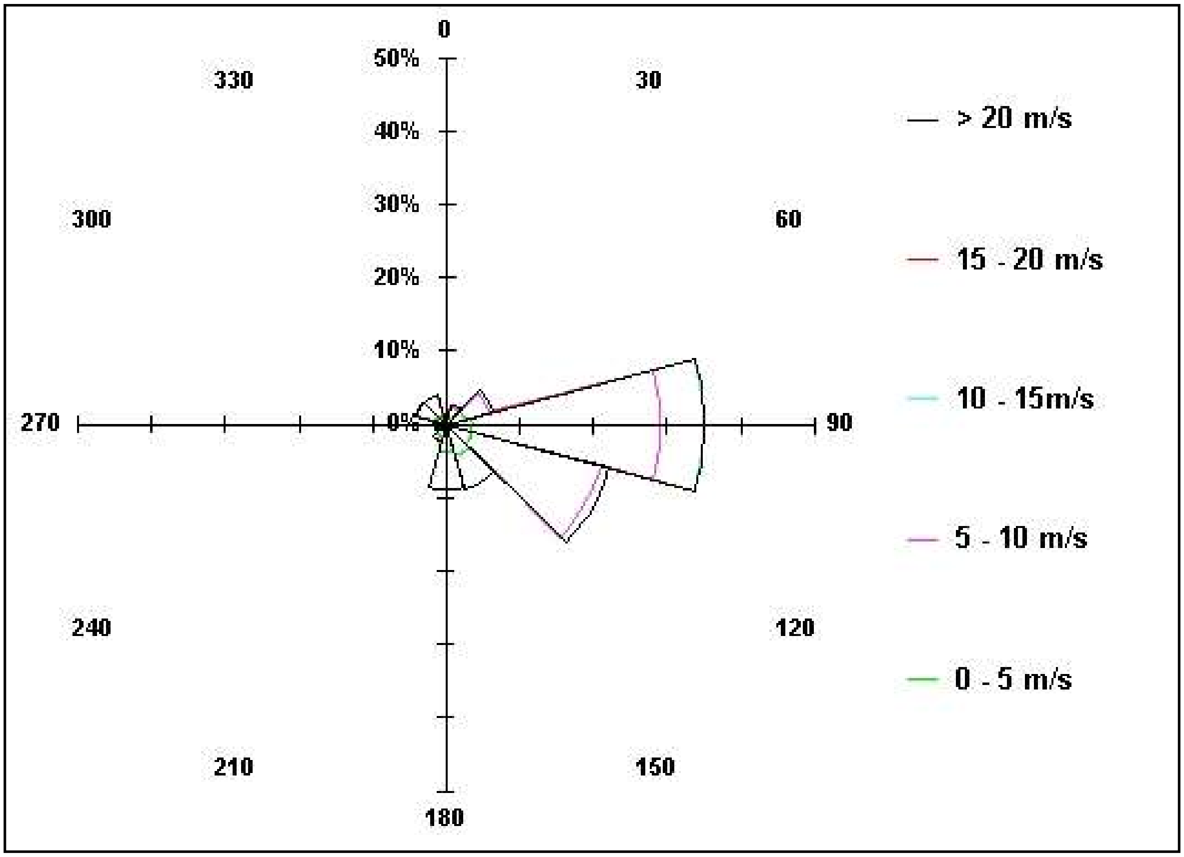

Figure 16 Long-term Wind Rose for Sembo 1202 Mast at 85m Hub Height

The short term measured wind direction distribution at the Sembo 1202 mast location was used as the long-term distribution. The additional uncertainty arising from the assumption that the short-term wind direction distribution is representative of what may be expected over the long term has been included in the analysis of uncertainties.

5.8.3 Long-Term Correlation Methodology and Wind Speed and Distribution Prediction

There are multiple methods to complete a long-term prediction and the most suitable methodology is dependent on the quality of the correlation between the onsite data and the reference source.

Ideally the reference data should be correlated with the site data on an hourly basis, such that wind speed distributions and direction data are also corrected during the long-term wind speed prediction. However, due to a poor quality of correlation with Vortex CFSR data on an hourly basis (R^2= 0.31), this method is not considered appropriate or robust for this site. Rather, a monthly long-term correction method was used.

By using the relationship of the best-fit line in the monthly mean wind speed correlation, the long term wind speed at Sembo 1202 mast can be estimated from the Vortex CFSR long term wind speed. The prediction obtained using the best-fit line method is 6.68 m/s at 85 m hub height, which is an upward correction to the short term mean (6.48m/s) of +3.2%. The key inputs and results of this analysis are presented in Table 11.

Table 11 Long-term Predicted Wind Speed at Sembo Mast (1202)

Mast	Sembo 1202
Monitoring Period	26 October 2012 to 16 May 2014
Number of Balanced Data Months[1]	14
Hours Ratio (Summer / Winter)	50%/50%
Mast 85 m Short-term Wind Speed (m/s)	6.48
Vortex CFSR 60 m Short-term Wind Speed (m/s)	5.26
Vortex CFSR 60 m Long-term Wind Speed (m/s)	5.42
Predicted Mast 85 m Long-Term Wind Speed (m/s)	**6.68**

The short-term measured wind direction distribution at the Sembo 1202 mast location was used as the long-term distribution. The additional uncertainty arising from the assumption that the short-term wind direction distribution is representative of what may be expected over the long term has been included in the analysis of uncertainties.

5.9 Debre Berhan Wind Farm Energy Yield Prediction

5.9.1 WAsP Wind Flow Model

WAsP software was used to model the wind flow across the Project Site. The wind flow was calculated by taking the long-term wind rose for the mast location and extrapolating this across the site using the topographic and roughness maps. As part of this process, WAsP creates a "regional wind atlas," whereby the observed wind climate (long-term wind rose) is extrapolated to a height above the effects of roughness and topography. This wind atlas is then reapplied to the topographic and roughness maps to create a wind flow model for the area.

5.9.2 WTG Layout

The WTG layout was then introduced into the wind flow model to calculate an energy yield. The proposed Project WTG layout consists of 67 WTGs. The WTG type used in the energy yield model was the Goldwind GW 93 1.5 MW WTG with 93 m rotor diameter and 85 m hub height. The power and thrust curves for an air density of 1.225 kg/m^3 are presented in Section 19, Appendix G. The WTG locations are also listed in Section 19, Appendix M.

No neighboring wind farms have been considered in the energy yield analysis.

5.9.3 Method

Initially, a "base" (ideal) energy yield for the wind farm was calculated, based on all WTGs being located at the mast location. The WAsP wind flow model was then used to calculate the topographic/roughness effects and the wake losses at each proposed WTG location.

5.9.4 Wind Farm Energy Yield

The topographic, roughness and wake losses were applied to the "base" energy yield, and these results were then modified by the application of a series of calculated and nominal effects and losses, in order to produce a final energy yield for the Project at the specified hub height.

The losses which have been applied to the energy yield reflect a combination of nominal losses based on Industry experience of losses on operating wind farms and losses calculated on known site values as discussed in section 8

The results of this exercise are illustrated in Table 12. The three output values for the specified scenario are:

- **Overall Conversion Efficiency:** The product of all the losses/effects listed in the table.
- **Wind Farm P50 Yield:** The final predicted output of the wind farm, after all losses have been applied.
- **P50 Capacity Factor:** The final output of the wind farm as a proportion of the gross yield if all WTGs were working at rated capacity all the time and no losses occurred.

Table 12 Debre Berhan Wind Farm Energy Yield

Description	Values
Wind Rose	58m Sembo 1202 (extrapolated to 85m and corrected to long term)
Gross Yield	Based on WAsP values
WTG	Goldwind GW 93 1.5MW
Hub Height (m)	85
Rated Capacity (MW)	1.5
Number of WTGs	67
Site Capacity (MW)	100.5
Mast Measurement Height (m)	58
Mast Location Short Term Wind Speed at Measurement Height (m/s)	6.21
Mast Location Long Term Wind Speed at Hub Height (m/s)	6.68
Mast Location Long Term Weibull k at Hub Height	2.97
Mast Location Long Term Weibull c at Hub Height	1.12
Mast Location Energy Production at Hub Height (GWh/annum)	5.60

Description	Values
Ideal Wind Farm Energy Production (GWh/annum)	375.0
Corrections & Losses	
Topographic/Roughness/Obstacles Effect[1] Wake Losses1	0.991 0.962
Electrical Transmission Efficiency (Wires, WTG & Grid Transformers)2	0.970
Substation Availability (48 hours Downtime Assumed)2	0.995
Grid Availability and Disruption (2.0% Downtime Assumed)2	0.980
WTG Availability2	0.970
Power Curve Density Correction3	0.775
Power Curve Performance2	0.975
Extreme Temperature Effects on WTG1	1.000
Wind Hysteresis (in Shut Down and Start Up)1	1.000
Blade Contamination, Degradation & Off-design2	0.990
Ancillary Systems2	1.000
Wind Speed Inter-annual Variability1	0.999
Grid Compliance Control Loss2	1.000
Wind Sector Management2	1.000
Overall Conversion Efficiency	**65.4%**
Wind Farm P50 Yield (GWh/annum)	**245.2**
P50 Capacity Factor	**27.9%**

[1] Calculated loss.
[2] Nominal loss.
[3] The Goldwind GW 93 1.5MW WTG power curve for standard air density of 1.225 kg/m^3 was utilized in the gross energy yield prediction and a correction applied to account for the long term predicted site air density of 0.86 kg/m^3 at hub height.

5.10 Corrections and Losses

The losses applied in Table 12 are described below:

- **Topographic and Roughness Correction:** A base energy production is determined from the WAsP wind flow model. This base energy production compares energy production at all WTG locations with the ideal production that might be expected at the site mast location. Thus, topographic and roughness effect can be either a negative or a positive value and reflects position of WTGs in relation to the site measurement mast. The predicted topographic/roughness correction for the Project is -0.9%.
- **Wake Losses:** A number of models can be used to calculate wakes, although validation of these models, particularly in complex environments, is problematic. This prediction uses the WAsP wake model predictions, which are supported by published research papers. SgurrEnergy has attempted to minimize the impact of wake losses within the wind farm

layout by aligning WTGs perpendicular to the prevailing wind direction. The predicted wake loss for the Project Site due to internal wakes is 3.8%.

- **Electrical Transmission Efficiency (Wires, WTG & Grid Transformers):** This loss can be calculated once the design is finalized and a detailed electrical loss calculation is undertaken. A nominal 3.0% loss has been applied based on SgurrEnergy's experience.
- **Substation Availability (48 hours downtime assumed):** This loss is based on an assumption that the substation will be down for 48 hours in any one year and that this will occur during periods of average production, giving a loss of 0.5%.
- **Grid Availability and Disruption:** This loss is based on an assumption that the local grid will be down for 2.0% of the time in any one year and that this will occur during periods of average production.
- **WTG Availability:** SgurrEnergy has found 97.0% availability to be realistic for most WTG types with a good track record and quality assurance regime operating in countries with well-developed infrastructure. However, due to the Project being located in an area of limited infrastructure development, it is strongly recommended that a further investigation is made to establish whether a more conservative value should be adopted.
- **Power Curve Density Correction:** This figure is calculated for average WTG hub height altitude, based on:
  - Measured 18-month average air temperature and sea level pressure at the Sembo 1202 mast location.
  - Average WTG hub height altitude.
  - Goldwind GW 93 1.5 MW WTG power curve for 1.225kg/m^3.
  - Short-term site wind distribution data at 85 m hub height corrected for long term wind speed.

SgurrEnergy has assessed the short-term temperature and pressure site data against the long-term 10-year CFSR dataset from Vortex and found the short-term data to be representative of what may be expected over the long term. For this reason, the measured short-term site temperature and pressure data were adopted to calculate air density at the site. For Debre Berhan the air density calculation is based on the average WTG hub height altitude of 3071 mamsl, short-term, average 12.1ºC temperature and average air pressure of 709.4 mbar (representative of the long term regional averages) at the Sembo 1202 mast location. This resulted in an average WTG location air density of 0.86 kg/m^3 and a significant calculated air density loss of 22.5%.

Power Curve Performance: It is assumed that WTGs will perform at a nominal loss of 2.5% to the sales power curve performance based on a performance review of wind farm production. SgurrEnergy has also included a nominal uncertainty in the power curve performance.

Extreme Temperature Effects and Icing on WTG: This loss reflects periods where WTGs are performing at less than ideal efficiencies because of extreme temperatures or icing. However, SgurrEnergy found no such low or high temperature instances in the site measured met data. For the Project, no loss has been applied due to extreme temperature effects.

Wind Hysteresis (Start up and shut down): When site wind speed exceeds the WTG maximum operational speed for a predefined period of time the WTG shuts down and does not start up again until the wind speed drops to a lower level, again for a predefined period of time. Exact cut-in and cut-out protocols vary from WTG to WTG and are based on wind speed data measured at a higher time resolution than the 10-minute averages recorded for energy yield prediction. However, the resulting loss can be estimated based on the site wind speed distribution and the WTG power curve. For the WTG type selected at the Project, the wind hysteresis is calculated to be negligible.

Blade Contamination, Degradation and Off-Design: During operation, a WTG can become contaminated by dust particles or insects in the air. Degradation and off-design are considered more of an issue than this and will have a much greater effect towards the end of a project compared to the start. The magnitude of the loss will be dependent upon the diligence of the maintenance personnel. This loss can be mitigated through maintenance programs that assess power curve condition and that are designed to maximize wind farm power production. For the Project, a loss of 1.0% has been applied.

Ancillary Systems: The WTG power curve supplied by a manufacturer gives the WTG power output which can be expected to be measured at a given reference point on the WTG. An additional system loss must be taken into account where a site production measurement point varies from this manufacturer's reference point. This loss accounts for electrical and system losses between the site measurement point and the warranted reference point. Normally these points coincide and no additional loss is required. For the Project, no loss has been applied.

Wind Speed Inter-annual Variability: This loss results from the fact the energy in the wind is not linear. Hence, a low wind speed year tends to result in a reduction in energy yield that is greater than the increase in yield resulting from a high wind speed year, or vice versa. This loss/gain can be calculated from the site wind speed distribution and the WTG power curve. At the Project, the effect of inter-annual variability has been calculated as a 0.1% loss.

Grid Compliance Loss: This parameter accounts for the energy that will be lost through the wind farm having to comply with grid code requirements. For the Project, no loss has been applied.

Wind Sector Management: From the wind shear and turbulence intensity analysis at the mast location, SgurrEnergy does not expect that any WTG locations require curtailment for certain wind directions in order to avoid excessive shear (caused by steep slopes) or turbulence (caused by nearby WTGs). Therefore, no loss has been applied.

5.11 Uncertainty Analysis

The uncertainty in an energy yield prediction is difficult to quantify, as it is a function of many independent factors[6]. Furthermore, many of the factors that influence uncertainty cannot be adequately quantified by calculation and rely on estimates based on judgment and experience. Where calculation has not been possible, estimation and judgment have been adopted in this uncertainty analysis.

5.11.1 Uncertainty in the Energy Yield Prediction

In order to gain an understanding of the experiences of wind farm developers and operators with regard to observed uncertainties in wind farm energy yield prediction, a review of appropriate literature was conducted. From this review it is clear that uncertainty in an energy yield prediction is estimated to vary from 10% for a flat ”Danish” type-site, up to between 18% and 25% for a complex terrain site[7]. The latter figures are extreme and most likely result from a combination of using wind flow models outside their design envelope and lack of knowledge. In a survey wind farms were shown to produce from 10% under to 8% over the predicted energy yield, with a maximum variation in any one-year of 14%. This provides a reference for the level of uncertainty that can be expected from an uncertainty analysis.

The accuracy of a prediction comes down to the approach taken during the measurement phase and the quality of the correlation and the resolution of the wind flow model. SgurrEnergy personnel have been involved in wind farm energy yield prediction for many years and we have developed a robust energy yield prediction methodology that minimizes the errors in each of the phases of energy yield prediction. Much of this approach is outlined in earlier sections of this report.

Table 13 lists the various sources of uncertainty associated with energy yield prediction and values attributed. Combined uncertainty values are given at the bottom of the table.

[6] Dekker J.W.M. & Pierik, J.T.G. (1996). Wind Turbine Standards II. European Commission. ISBN: 9282779483

[7] It is the opinion of SgurrEnergy that sites with complex roughness can have as much influence on the energy yield prediction as those with complex terrain.

The uncertainties associated with the onsite wind measurement accuracy are slightly higher than typical as a result of additional uncertainties in the wind speed and direction measurements at Sembo 1202 mast (due to the short height of the mast relative to the proposed WTG hub height). Although the mast height is within industry guidelines, there is still increased uncertainty associated with the vertical extrapolation from mast height to proposed hub height due to the relatively large distance.

The uncertainties associated with the long-term wind speed prediction are higher than typical due to the lack of a suitable reference dataset to perform an hourly MCP analysis. There is also a significant level of uncertainty in the correlation of the reference and measured datasets, which has been determined by statistical analysis. A higher than typical uncertainty has been included to reflect that a meso-scale modeled product (based on reanalysis data) was used as the reference dataset.

The WAsP wind flow model uncertainty is calculated based on the terrain and roughness complexity. The uncertainty is slightly increased due to the resolution of SRTM topographic data used in the wind flow model.

The uncertainties associated with flow model accuracy have been adjusted to account for the position of the mast relative to the proposed WTG locations (approximately between 0.5 km and 10 km), the quality of the model's Weibull fit and the complexity of the site's topography and roughness.

The array loss modeling uncertainty is associated with modeling wake losses. The accuracy of this prediction depends on the model, the spacing of the WTGs and the accuracy of the wind rose. For the Project Site, the smallest WTG spacing is 3.0 rotor diameters. Wake modeling within WAsP software is stated to be accurate to approximately 4.0 rotor diameters, thus the wake model is working out with recommended parameters. Due to this factor and the fact that the short-term wind direction distribution has been assumed to be representative of the long-term wind distribution, wake loss modeling uncertainty has been increased.

A power curve uncertainty of 3.0% in energy yield has also been included. This uncertainty takes into account that the WTG design power curves are only valid under very specific conditions, which are likely to be different from the wind conditions at the site.

An additional air density correction uncertainty of 2.0% was included to account for the low air density at the site (0.86 kg/m^3) and the fact that only the standard power curve at sea level conditions was supplied (1.225 kg/m^3 air density).

The relationship between uncertainty in wind speed and uncertainty in energy yield is governed by the gradient of the WTG power curve at wind speeds immediately surrounding the mean hub height wind speed for that WTG.

Table 13 Sources of Uncertainty

Wind Turbine Generator (WTG)		Goldwind GW 93 1.5 MW	
Wind Farm Yield (GWh/annum)		245.2	
Wind Farm Capacity Factor		27.9%	
Description	Wind Speed (%)	Energy (%)	Energy (GWh)
Site Wind Measurement Accuracy	3.2	6.4	15.8
Long-term Wind Speed Prediction	3.2	6.4	15.7
Model Terrain Data Resolution & Accuracy	3.6	7.1	17.5
Flow Model Accuracy	4.7	9.4	22.9
Array Loss Modeling	1.4	2.8	6.8
Power Curve Uncertainty	-	3.0	7.4
Air Density Correction Uncertainty	-	2.0	4.9

5.11.2 Annual Variation in Wind Speed

Average wind speed varies on an annual basis. This is not really a prediction uncertainty as we can be certain that the variation will occur. The uncertainty lies with the developer in that the developer does not know what energy yield to expect in any given year. The likely variation can be quantified based on analysis of variation in long-term wind speeds. Inter-annual variability in wind speed using 10 years of Vortex data resulted in 4.5%. In SgurrEnergy's experience, Reanalysis data products tend to under characterize inter-annual variability in wind speed. As Reanalysis data has been used to initiate the meso-scale data product it is assumed that inter-annual variation may also be underrepresented in the Vortex CFSR data product. Therefore, a nominal inter-annual variation of 6.0% has been adopted due to the lack of suitable measured long-term reference wind speed data.

The likely variation around the predicted P50 energy yield that will result from this natural variation in wind speed at the Project site is presented in Figure 17 (green lines). It can be seen that as a result of the inter-annual variation in wind speed, in any one year period the energy yield can vary significantly from the P50 value (± 37.30 GWh/annum), but over 10 years the likely variation will be much less (± 11.79 GWh/annum).

5.11.3 TOTAL UNCERTAINTY

Applying the uncertainties in energy yield and the inter-annual variation in wind speed uncertainty to the WTG energy output gives the results presented in Table 14.

The uncertainties are given in three ways:

- Uncertainty: This includes only the uncertainty present in the measurement and prediction methodology, and no uncertainty from the inter-annual variation in wind speed.
- Uncertainty over 1 year, including annual wind speed variation: This includes both the prediction uncertainty and also the inter-annual variation uncertainty for a single year.
- Uncertainty over 10 years, including annual wind speed variation: This includes both the prediction uncertainty and also the inter-annual variation uncertainty for a 10-year period.
- Figure 17 presents the combined uncertainties in the Project's energy yield prediction. The red dashed lines show the predicted P50 yield for the Project Site. The blue lines represent the P10/P90 uncertainty in the measurements and the energy yield prediction methodology; this uncertainty remains constant through the lifetime of the wind farm. The green lines represent the uncertainty in the yield due to the inter-annual variation of wind speed. The red solid lines represent the total uncertainty in energy yield when inter-annual variability is combined with the uncertainty in the yield prediction. This total uncertainty decreases over the lifetime of the wind farm. The lower limit on the graph corresponds to the P90 and the upper limit corresponds to the P10.

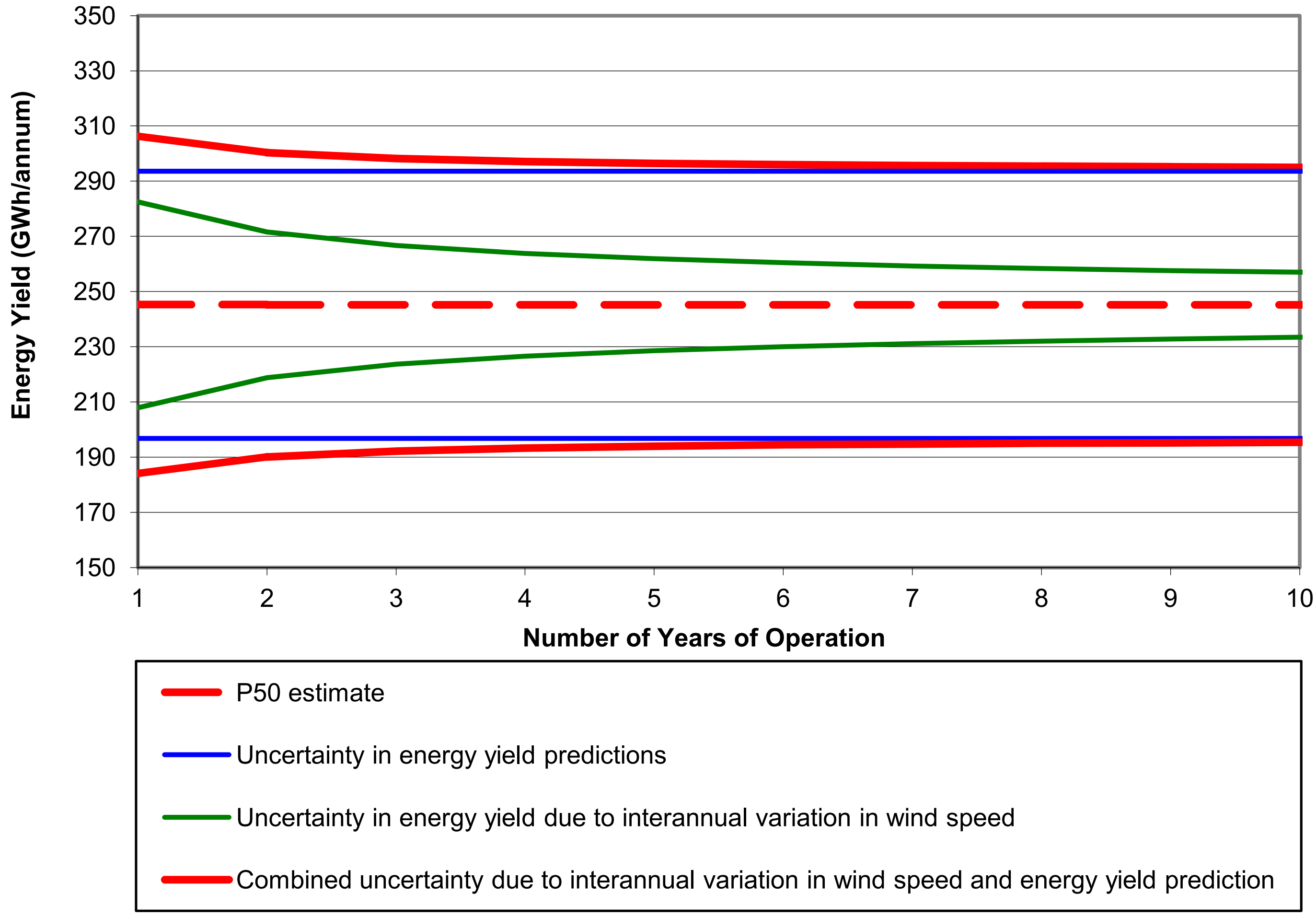

Figure 17 Debre Berhan Energy Yield Uncertainty

Table 14 Debre Berhan Wind Project Uncertainty Summary

WTG	Goldwind GW 93 1.5 MW
Project Yield (GWh/annum)	245.2
Capacity Factor	27.9%
Uncertainty	
Standard error in energy yield value	15.5%
Standard error in energy yield value (GWh/annum)	38.1
75% exceedance in energy yield value (GWh/annum)	219.5
75% exceedance capacity factor value	24.9%
90% exceedance energy yield value (GWh/annum)	196.4
90% exceedance capacity factor value	22.3%
99% exceedance energy yield value (GWh/annum)	156.6
99% exceedance capacity factor value	17.8%
Uncertainty over 1 year, including annual wind speed variation	
Standard error in energy yield value	19.6%
Standard error in energy yield value (GWh/annum)	47.9
75% exceedance in energy yield value (GWh/annum)	212.9
75% exceedance capacity factor value	24.2%
90% exceedance energy yield value (GWh/annum)	183.8
90% exceedance capacity factor value	20.9%
99% exceedance energy yield value (GWh/annum)	133.7
99% exceedance capacity factor value	15.2%
Uncertainty over 10 years, including annual wind speed variation	
Standard error in energy yield value	16.0%
Standard error in energy yield value (GWh/annum)	39.2
75% exceedance in energy yield value (GWh/annum)	218.8
75% exceedance capacity factor value	24.8%
90% exceedance energy yield value (GWh/annum)	195.0
90% exceedance capacity factor value	22.1%
99% exceedance energy yield value (GWh/annum)	154.0
99% exceedance capacity factor value	17.5%

5.12 Wind Regime Analysis

It is essential to define a site's wind regime, failure to do so could result in WTG underperformance and/or the WTG failing to operate for its design life. WTGs are typically certified or at least designed to IEC 61400-1 Wind turbine generator systems – Part 1 Design Requirements (2005), which specifies WTG classes as listed in Table 15.

Table 15 Basic Parameters for IEC 61400-1 (2005) WTG Classes

Parameter	Class I	Class II	Class III	Class S
V_{ref} (m/s)[1]	50.0	42.5	37.5	Defined by Manufacturer
Annual Average Wind Speed (m/s)	10.0	8.5	7.5	
V_{e50} (m/s)[2]	70.0	59.5	52.5	
Subclass A I_{ref}[3]	16.0%			
Subclass B I_{ref}[3]	14.0%			
Subclass C I_{ref}[3]	12.0%			
Inflow Angle	± 8°			
Wind Shear Exponent	0.2			
Air Density (kg/m^3)	1.225			

[1] V_{ref} is the maximum average 10-minute 50-year wind speed

[2] V_{e50} is the maximum three-second gust wind speed
[3] I_{ref} is the expected level of turbulence intensity at 15m/s.

The following wind regime analysis is specific to Goldwind GW 93 1.5 MW WTG with an 85 m hub height. Therefore, SgurrEnergy's assessment has evaluated the Project's wind regime to IEC class III_B values, as per WTG IEC classification.

IEC design parameters are not independent functions and a WTG may be suitable for a site even when some operating conditions are above their design value if other conditions are more benign, such as a high wind speed site which has a low turbulence value. The site conditions are not absolute values and they should be presented to the WTG manufacturer for discussion.

5.13 Air Density

If the air density is above the design value 1.225 kg/m^3, the loading at the site is increased and the WTG may not be able to operate to its standard classification. If the density is below the design value, the WTG may be able to operate in more onerous conditions.

The proposed Project layout is located at an average WTG hub-height altitude of 3,086 mamsl. SgurrEnergy calculated the average air density to be 0.87 kg/m^3 based on an average temperature of 12 ºC and an average air pressure of 709.4 mbar at mast site. Standard air density at which WTG performance is assessed is 1.225 kg/m^3. The Project Site value is low, which will have the following impacts on the Project:

- The lower air density will enable lower classification WTGs to operate in a higher wind speed environment.
- The mast anemometer accuracy may be impacted. It is expected that this will cause the anemometer measurements to be conservative with respect to the actual wind speeds at the site. NRG was contacted regarding this matter. Its response states that the Class One sensor used for this application follows IEC61400-12-1 standards, which specify air density ranges from 0.90 – 1.35 kg/m^3. NRG expects that even though the average air density at the site is below the certified threshold, the value is so close to the limit that any increase in measurement uncertainty will be minimal and not enough to drop the anemometer rating to a lower classification. In SgurrEnergy's opinion, there is not enough industry experience and verification in this area to rule out the potential uncertainties associated with these low air density measurements. It is therefore recommended that a remote sensing device (e.g., Lidar) be utilized in conjunction with the existing meteorological mast for a short time-period in order to firm up the wind speed measurement accuracy. This additional data will offer greater degree of data during final design, although, as stated above, the impacts of the low density tend to under predict the wind speed, not over-predict providing comfort that the energy yield would improve if anything.
- The WTGs performance will deviate significantly from the standard air density sales power curves. WTG manufacturers generally only present power curves down to air densities of 0.95 kg/m^3. SgurrEnergy has consulted WTG manufacturers regarding expected WTG performance in these specific conditions. General opinions indicated that WTG performance should still adhere to IEC standards. Nevertheless, SgurrEnergy recommends that Terra Global discuss the air density site conditions with the WTG manufacturer and review the power curves for final modeling. It is understood that Terra Global has done this.

5.14 Site Temperature and Pressure

Vortex CFSR meso-scale data shows that short-term period is representative of long-term period (shown in Table 16). Therefore, SgurrEnergy considers that the site short-term temperature and pressure averages are representative of long term averages. For this reason, the short-term values were used to calculate air density with no long-term correction being applicable.

Table 16 Temperature and Pressure for Debre Berhan Site

Data	Temperature (ºC)	Pressure (mBar)	Period
Short-term Site	12.1	709.4	November 2012 to May 2014
Short-term Vortex	11.0	710.8	November 2012 to May 2014
Long-term Vortex	11.1	710.9	November 2012 to May 2014

Using mast temperature sensor data, the site average temperature was calculated to be 12.1°C, within the design limit of standard WTG types. The site does not experience extremes with short term temperature datasets ranging from 3.2°C to 24.0°C. Using long term temperature data retrieved from Vortex (at the mast location), similar conclusions were reached by calculating the long term temperature ranges at the site to be between 4.3°C and 17.8°C with an average temperature of 11.1°C. SgurrEnergy does not expect low temperatures to be an issue for WTG suitability. However, cooling of the WTG will be reduced due to the lower air density at the site. Although the site does not experience extreme temperatures, the reduced cooling may impact the operation of the WTG and lead to curtailment during the hottest times of the year. This matter has also been discussed with WTG manufacturers and average site temperature and air density data presented to them. Initial comments indicated that temperature at this site should not pose issues to WTG performance and operation. SgurrEnergy recommends that the WTG manufacturer confirms that the low air density at the site will not result in cooling issues during normal WTG operation and conduct a review of all available onsite measured data, whilst giving consideration to longer term temperature and pressure variations prior to certifying their equipment for this site.

5.15 Site Layout

The WTG spacing is reasonable in the strongly prevailing wind direction. The average turbine spacing is 4.5 rotor diameters (RD) with a minimum spacing of 3.0 RD (between E3 and E4, E27 and E29 and E45 and E46). However, none of these pairs are aligned with the prevailing wind direction.

The layout is considered to be well-aligned for the prevailing easterly wind direction. Wake losses averaged over all wind direction sectors for the wind farm are 3.8%, which is considered low for a wind farm layout comprised of 67 WTGs. The WTG layout was designed considering a minimum setback distance from occupied dwellings, in addition to other constraints such as topographic gradient, proximity to roads and balance of plant costs. Due to the limited onsite information available, it cannot be confirmed that all residential properties have been accurately accounted for. SgurrEnergy strongly recommends that this indicative layout is revisited to account for technical constraints due to social and/or environmental issues.

5.16 Mean Wind Speed

The predicted long term annual mean wind speed at the Sembo 1202 mast location of 6.68m/s at a hub height of 85m is within the threshold of the IEC Class III specification of 7.5m/s. The predicted long-term annual wind speed is 6.66 m/s averaged across all WTG locations and is highest (7.36m/s) at WTG E34. These wind speeds are all within the IEC Class III WTG threshold.

5.17 Wind Shear

5.17.1 Wind Shear at Mast Location

The overall measured wind shear (between 40-meter and 58-meter heights) at the Sembo mast (1202) is 0.15, which is below the design value of 0.2 stated in IEC61400-1 guidelines. Some direction sectors show slightly higher shears, up to 0.2, but are not expected to lead to curtailment situations. In addition, WTG manufacturers may regard sites with higher wind shear and lower long-term average wind speeds as being acceptable. Figure 18 depicts the shear comparison.

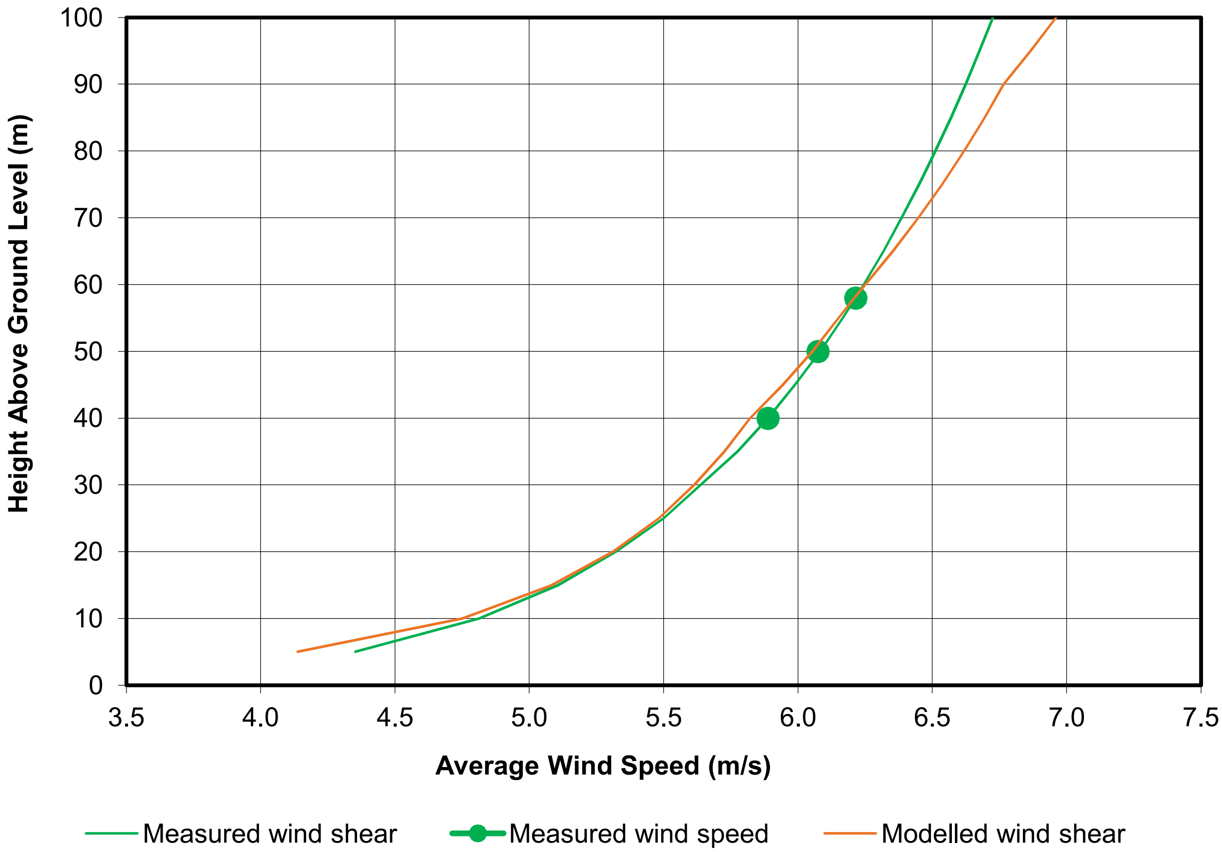

Figure 18 Sembo 1202 Mast Modeled and Measured Wind Shear Comparison

5.18 Extreme Winds

Extreme gusts and 10-minute mean wind speeds can have a significant contribution to WTG failure. Characterization of this factor at a potential wind farm site enables correct specification of a WTG.

5.18.1 Extreme Winds at Mast Location

The method selected to predict extreme wind speeds for uni-directional sites uses the measured wind speed data to predict the 50-year extreme, 10-minute mean wind speed, which is then converted to a 3-second gust wind speed using a gust factor. There are two methods of deriving gust factor, either from on-site measurements of turbulence intensity, or preferably from on-site measurements of gust wind speeds. In this case, the gust factor was derived from gust wind speed data measured at the Project Site.

The method is based on separating the data corresponding to extreme events from the general wind speed distribution. The input is measured wind speed data at hub height, extrapolated to 85-meter hub height and corrected for long-term. The results, predicted for a height of 85-meters at WTG hub height, at the mast location are summarized in Table 17.

Table 17 Extreme Wind Values at Sembo Mast (1202) at 85m Hub Height

Mean wind speed (m/s)	50-yr extreme 10-minute wind speed (V_{ref}; m/s)	50-yr extreme 3-sec gust wind speed (V_{e50}; m/s)
6.25	26.8	31.5

The gust analysis indicates that the maximum predicted 50-year, 10-minute extreme wind (V_{ref}) at the Sembo mast (1202) is 20.1 m/s, which is well within the IEC class III threshold of 37.5 m/s. The maximum predicted 50-year, 3 seconds gust extreme wind (V_{e50}) is 38.0 m/s, also within the IEC class III design limit of 52.5 m/s.

It should be noted that the mast measurements have been obtained significantly below hub height at 58-meter height and for a period of approximately one year, which cannot be considered wholly representative of long-term conditions. Results should be viewed as indicative values that qualitatively highlight areas of higher risk, rather than providing quantitative results. Nevertheless, the predicted values at the mast location are low and provide a reasonable safety margin with respect to the IEC Class III thresholds.

5.18 Turbulence Intensity

Turbulence can have significant effects on the fatigue loading on a WTG structure.

5.18.1 Ambient Turbulence Intensity at Mast Location

Turbulence at the onsite mast has been analyzed on a sector-wise basis. The Turbulence Intensity (TI) for each data record has been calculated from wind speed and the standard deviation of the wind speed. These values have then been binned on a sector-wise and wind speed basis.

The TI analysis was performed using the 10-minute values from Sembo 1202 mast, as specified in IEC 61400-1 (2005). In the IEC 61400-1 standard, the reference turbulence intensity (TI_{15}) is taken from the 15m/s wind speed bin. However, the 8 and 10m/s wind speed bins have been utilized due to the low number of records (most direction sectors with frequency equal to zero) in the 15m/s bin. The results of the TI Sembo 1202 mast analysis are presented in Table 18 and are also illustrated in Figure 19 against the IEC WTG TI subclasses.

IEC 61400-1 (2005) WTG design specification standards state the maximum recommended TI toleration for a subclass B WTG is 14% at 15 m/s.

From Figure 19 it can be seen that the Sembo 1202 mast TI_{10} is well within the IEC subclass B threshold at all measured wind speeds. From Table 18 it can be observed that on a sector-wise basis, there are no instances where the TI_{10} exceeds the recommended design threshold. The Sembo mast (1202) TI_{10} is well within the IEC subclass A threshold at all measured wind speeds.

Table 18 Sembo Mast 1202 Sector-Wise Turbulence Intensity

Direction (center of 30° sector)	Values at 10 m/s		Values at 8 m/s	
	Number of Records	**TI (%)**	**Number of Records**	**TI (%)**
0	40	10.2	123	10.0
30	77	10.7	153	11.1
60	162	7.1	461	7.0
90	2116	9.0	5037	9.3
120	479	10.0	2209	9.8
150	0	-	60	11.0
180	2	9.5	172	8.8
210	0	-	58	8.2
240	0	-	4	10.3
270	2	7.6	15	10.6
300	15	8.4	120	8.9
330	18	9.9	147	9.9
All Sectors	**2911**	**9.1**	**8559**	**9.4**

TI normally decreases with increasing height, and so these 58 meter ambient conditions are a conservative approximation of the 85 meter hub height. In addition, TI increases with decreasing wind speed. Therefore, the 8 m/s and 10 m/s values presented can also be considered conservative. It should also be noted that these values are for ambient TI at the mast locations and do not include wake-induced turbulence. The TI will increase within an operational wind farm as a result of WTG wakes. Although for the Project, the wake-induced TI values for the WTG locations are not foreseen to exceed recommended IEC Class A thresholds.

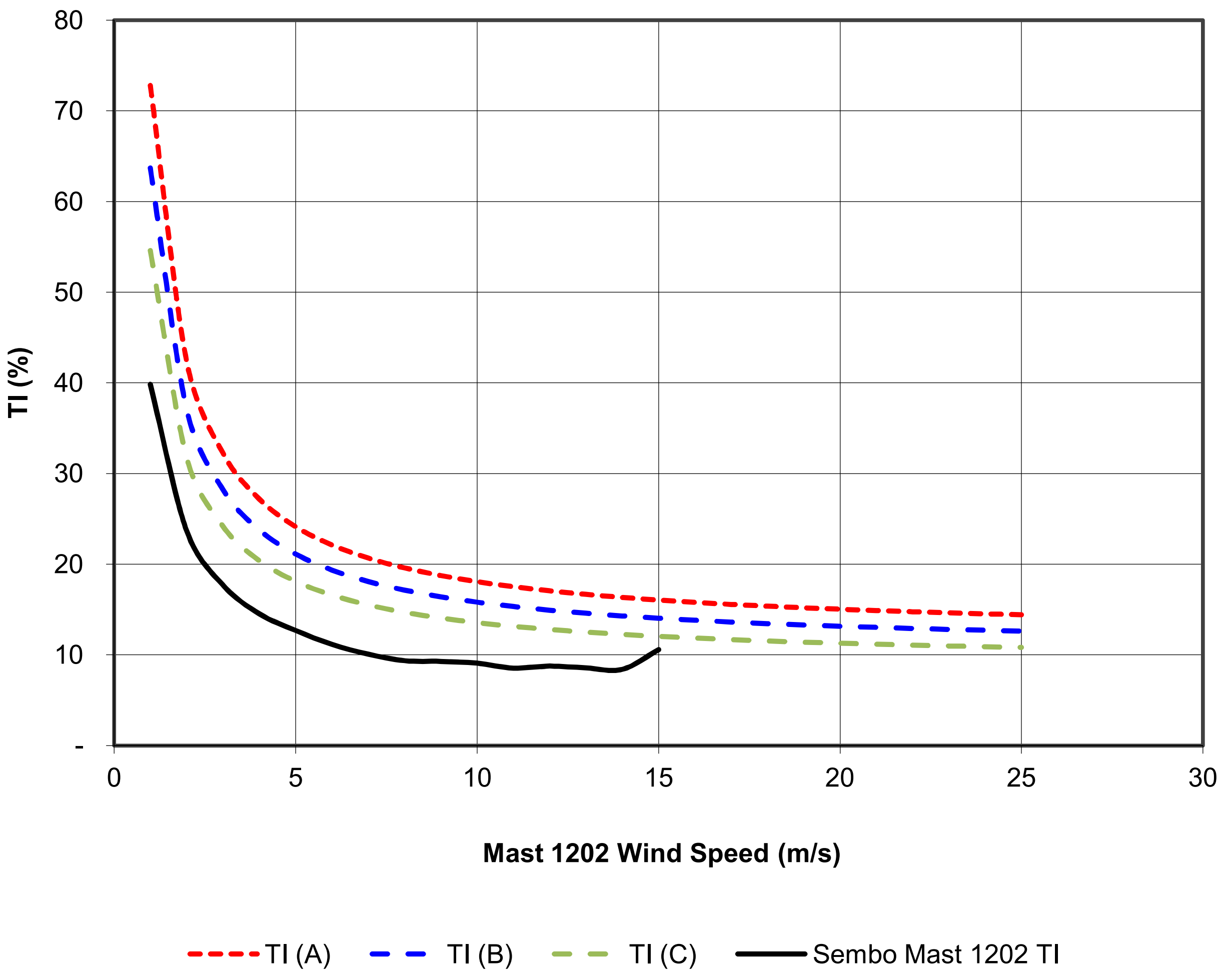

Figure 19 Sembo 1202 Mast Ambient TI against IEC WTG Subclasses

5.18.2 Representative Turbulence Intensity at Mast Location

Representative Turbulence Intensity (RTI) which is defined as the mean ambient turbulence intensity plus 1.28 times the standard deviation of 10-minute measurements is not expected to exceed the recommended IEC Class A thresholds, either.

From it can be observed that on an average sector-wise basis, there are no values where the Sembo mast (1202) RTI_{10} exceeds IEC design limits.

Table 19 Sembo Mast 1202 Sector-Wise Representative Turbulence Intensity

Direction (center of 30° sector)	Values at 10 m/s		Values at 8 m/s	
	Number of Records	RTI (%)	Number of Records	RTI (%)
0	40	15.8	123	14.6
30	77	16.6	153	18.6
60	162	12.9	461	12.8
90	2116	13.4	5037	14.9
120	479	14.1	2209	15.0
150	0	-	60	17.4
180	2	11.9	172	14.3
210	0	-	58	12.8
240	0	-	4	15.1
270	2	9.2	15	16.2
300	15	10.9	120	13.5
330	18	15.4	147	14.8
All Sectors	**2911**	**13.6**	**8559**	**14.9**

5.19 Summary

- The Project is located in Ethiopia, approximately 35 km southwest of the city of Debre Berhan. One onsite 60 m mast, named Sembo 1202 has been installed on the site since October 2012. Meteorological data recorded at the mast from commissioning up to May 2014 have been analyzed in this assessment.
- The on-site met mast was visually inspected to confirm the mast configuration information provided and to allow comparison with industry good practice guidelines. Instrumentation mounting was found to be in line with industry best practice.
- The on-site met mast was instrumented with three primary NRG Class 1 anemometers, three NRG #40C anemometers and two NRG #200 wind vanes. NRG anemometers are considered to be of relatively lower quality than some other anemometry available, but are considered adequate for wind resource assessment. Class 1 anemometer measurements were prioritized over the NRG #40C instruments.

- The measured short-term 58 m wind speed at the Sembo 1202 mast location, corrected for mast shadow effects, is 6.26 m/s.
- The topography and roughness of the site are considered to be simple, due to the absence of steep slopes and forestry in the immediate surroundings of the Project area.
- Wind speeds were extrapolated vertically from measurement height to the proposed 85 m hub height using measured wind shear exponents. This vertical wind speed extrapolation was conducted on a monthly and hourly basis due to the strong diurnal wind shear variations observed in the measured wind speed dataset.
- Vortex meso-scale CFSR data and MERRA Reanalysis data at nodal locations close to the site were assessed during a 12-month period concurrent with the site measurement period. This analysis showed that the short-term average wind speed at the onsite met mast location was approximately 3% to 5% lower than the historic 10-year average.
- Meso-scale data from Vortex CFSR (39.34° E, 9.42° N at 60m height) was identified as the most suitable long-term reference dataset. A linear regression of monthly wind speeds was carried out to correct the Sembo 1202 mast data to the long-term wind resource (10 years). The monthly correlation derived for the concurrent mast and reference datasets and concurrent Vortex CFSR data was found to be $R^2 = 0.82$, which is considered suitable for this type of analysis. The predicted long term extrapolated wind speed at proposed hub height of 85 m is 6.68 m/s.
- The onsite mast measured and WAsP modeled wind shear profiles at the mast locations showed reasonable agreement. However, due to the strong diurnal wind shear trend and divergence of extrapolated profiles above mast height, measured wind shear coefficients were used to extrapolate wind speeds from mast height to the proposed 85 m hub height.
- An energy yield prediction has been carried out using the Goldwind GW 93 1.5 MW WTG at 85 m hub height. The proposed WTG spacing is considered reasonable with respect to the strongly prevailing easterly wind direction.
- The P50 energy yield prediction value for the Project Site is 245.2 GWh/annum with an associated capacity factor of 27.9%. The 10-year P90 energy yield prediction value, including inter-annual variation of 6.0%, is 195.0 GWh/annum with an associated capacity factor of 22.1%.
- The air density calculated at the Project Site based on measured site data is 0.86 kg/m^3. The low air density may pose issues regarding the accuracy of the mast wind speed measurements, WTG power curve validity and the ability of the WTG to remain sufficiently cool in warm weather. The calculated air density loss at the site is 22.5%.
- Uncertainties for the energy yield analysis are higher than expected for a typical onshore wind farm development. Uncertainties were increased to account for vertical extrapolation of wind speeds, long term modeled reference data accuracy, air density correction, significant horizontal extrapolation of wind speeds; the quality of correlation between measured and reference concurrent datasets and the assumption that the short term wind distribution can be considered representative of the long term direction distribution.

- A site suitability analysis at the mast location was completed for the Project optimized layout and the Goldwind GW 93 1.5 MW WTG at 85 m hub height. The analysis indicates that there are no concerns with wind shear, extreme winds and turbulence for this layout. In particular, the wind shear coefficient in all direction sectors is within the IEC design value of 0.2, with an average value of 0.15. Ambient turbulence intensity (at 10 m/s) is lower than the IEC subclass B threshold of 14.0% at the onsite mast location and is not expected to be a concern at the proposed WTG locations.
- A strong diurnal trend in the wind shear profile and low ambient turbulence intensity indicate that the Project site experiences stable atmospheric conditions. This may lead to higher than typical wake losses and potentially low boundary layer occurrences, which have the potential to result in damaging high wind shear events across the WTG rotor diameter.

6. Wind Farm Considerations

The following is a discussion of various considerations regarding the Project Site and its potential and limitations. While specific details from the various studies are provided in the individual sections of this Feasibility Study Report, this section gives an overview of certain wind farm considerations for the Project.

EEP engaged Terra Global to perform a feasibility study of the Debre Berhan Site based on the assumption that it was a high quality wind resource with the potential for installing approximately 400 MW of wind power generation. The Feasibility Study has determined that EEP should proceed with the installation of the Project.

6.1 Wind Potential and Limitations

The open rolling topography at the Project Site is ideal for wind farms as it allows for even wind flow with minimal turbulence, while the relatively flat ridge formations provide the space to locate wind turbine generators (WTGs) in the higher wind speed regime. These ridge top areas are limited in number and, as the WTG layout must allow for smooth flow and minimize wind shading from upwind WTGs, the number of WTG locations is limited, essentially increasing the area required for the overall site. The initial 100 MW phase fits well on the Debre Berhan Site, and it can easily accommodate the second phase of 100 MW. However, the third phase of 200 MW may reach beyond the intended boundaries of the Debre Berhan Site and will likely require cost analysis on additional points of interconnection and collection system transmission.

The Project Site is a Class III site and is not limited by storm conditions, extreme wind or ice loading. The general ground cover of crops and grasses will minimize the level of dust on the blades, and seasonal rain will wash the blades.

The overall average wind speed of 6.7 m/s is a commercial wind resource and with the advent of large swept area of Class III WTGs, it offers a commercially acceptable level of generation.

The high elevation of Ethiopia generally and the Project Site specifically (approximately 2,800 meters above sea level) reduces air density significantly, with a calculated value of 0.87 kg/m^3 versus a sea level value of 1.225 kg/m^3. This reduces the power in the air and therefore generation output by approximately 20%.

The above factors have been included in the financial model along with reasonable losses and uncertainties for a realistic evaluation of the Project.

6.2 Suitable Tower Heights, Shear

The wind shear values for the Project are discussed in Section 5.7 of this Feasibility Study Report. Wind shear is the change in wind speed, and wind direction between slightly different altitudes; typically, this increases the farther from the ground the measured point is located. The wind speed at the Project Site does increase at a typical rate, which validates the use of taller towers to reach this higher wind speed. The current feasibility and financial model assume a hub height of the WTG at 85 to 93 meters. This is a reasonable level, as going higher would induce ever- increasing costs with limiting returns; 85 to 95 meters is a standard tower height for the Class III WTGs being evaluated. Using standard towers ensures that costs are kept lower and all design certifications are in place.

Another cost factor in tower height is the cost of the required foundation. Soil conditions and seismic zone definition determines foundation requirements. The soils are generally suitable and do not present any extra requirements; the Project Site is in Seismic Zone 4, which is the highest classification. This requires a careful evaluation of the foundation design and may require modifications to the standard tower specification.

6.3 Wind Farm Site Land Use

The WTG layout has been assembled to maximize wind generation, while working to avoid obvious impacts to the existing dwellings and land use. While the croplands are more easily avoided, as they are not in the best wind energy locations, and they are often in wetter zones that are unsuitable for roads; this must be considered during the planning for roads and operational facilities.

The grazing lands will not be impacted as the cattle may graze around the WTGs once installed.

The layout considered a setback or exclusion zone of 1.5 times the total WTG height, or 228 meters. This was used as a minimum standard to provide a normalized safety perimeter. The next steps will have to closely consider dwelling relocation or clear guidance on operational safety and noise setbacks with respect to the dwellings. The relocation considerations are reviewed in presented in Section 17 of this Feasibility Study Report.

6.4 Placement of Site Infrastructure

The Project Site is well suited for integration of the various infrastructure additions requirements, including civil and road works, the collection system, the substation and the point of interconnection.

The road design can accommodate slopes and access specification without significant cuts and fills, except for a small number of locations. This can save significantly on construction costs and reduces visual impacts, erosion and storm runoff. The area will have capability for gravel and proper materials, as well as cover and replanting to handle summer rains.

The power collection and communication system is envisioned as both buried and above-ground across the Project Site. This can be constructed effectively either by specialized trenching equipment or by an excavator. The 33 kV above ground tower and conductor configuration can match EEP's typical practice and join the point of interconnection. Crossing Route 1 must be allowed for, as well as any rules for crossing this roadway. This may require a buried power line under the highway if an overhead power line is not suitable.

It is assumed that the point of interconnect is to be located adjacent to the 230 kV line and setback per standard EEP rules. The area is relatively flat and well drained, currently tilled land. The point of interconnection will be large and have the associated multiple transformer bays, control building and communications relay structures. The substation area may be a suitable area to build a maintenance facility especially as EEP has a standard format for building the point of interconnection, control center and service facilities.

6.5 Summary

The attributes of the Project Site are positive and the design challenges and cost factors are minimal. The dwelling locations and site configuration must be part of the overall process to provide the right outcome.

7. Technical Layout and WTG Selection

The micro-siting has been done using the experience of Terra Global's team of consultants using industry standard wind farm planning software WindPRO.

7.1 Wind Potential Map

Based on the long-term corrected data of the wind measurements on site, a wind potential map has been calculated (using WindPRO and WAsP), providing information for the distribution of the average wind speeds over the area foreseen for the implementation of the Project and therefore being a basis for the wind park layout development process.

The ridgelines running generally north south provide optimum wind conditions (the areas shown in yellow colors, followed by light green); wind speeds at the plain (dark blue) are up to 2 m/s lower compared to the ridges, resulting in a concentration of the wind turbines on top of the latter.

The open rolling topography at the Project Site is ideal for wind farms as it allows for even wind flow with minimal turbulence, while the relatively flat ridge formations provide the space to locate wind turbine generators (WTGs) in the higher wind speed regime. These ridge top areas are limited in number and, as the WTG layout must allow for smooth flow and minimize wind shading from upwind WTGs, the number of WTG locations is limited, essentially increasing the area required for the overall site. The initial 100 MW phase fits well on the Debre Berhan Site, and it can easily accommodate the second phase of 100 MW. However, the third phase of 200 MW may reach beyond the intended boundaries of the Debre Berhan Site and will likely require cost analysis on additional points of interconnection and collection system transmission.

The Project Site is a Class III site and is not limited by storm conditions, extreme wind or ice loading. The general ground cover of crops and grasses will minimize the level of dust on the blades, and seasonal rain will wash the blades.

The high elevation of Ethiopia generally and the Project Site specifically (approximately 2,800 meters above sea level) reduces air density significantly, with a calculated value of 0.87kg/m^3 versus a sea level value of 1.225kg/m^3. This reduces the power in the air and therefore generation output by approximately 20%.

The overall average wind speed of 6.7 m/s is a commercial wind resource and with the advent of large swept area of Class III WTGs, it offers a commercially acceptable level of generation.

7.2 Wind Turbine Selection

7.2.1 Determination of the Optimal Unit

The most fundamental consideration in assessing the feasibility of the Project relates to the selection of an appropriate wind turbine generator based on the wind resource at the Project Site and other relevant characteristics. Terra Global carried out a detailed review of potential WTGs for the Project and pursued a number of respected, international WTG suppliers. The selection of the wind turbine type falls into commercial and technical categories, discussed in the following.

The most significant criterion is the levelized cost of energy ("LCOE"), which integrates the capital cost, operating cost, performance and financing terms into a single number.

The key technical criteria are environmental; matching the WTG to the measured and predicted long term wind speed at the site so as to achieve maximum annual energy production while ensuring survival and operation always within the design limits of the WTG. The IEC Standard 61400 is a set of design requirements made to ensure that the WTGs are appropriately engineered against damage from hazards within the planned lifetime. The standard concerns most aspects of the turbine life from site conditions before construction to turbine components being tested, assembled and operated.

WTG suppliers specify the power curve at the standard air density 1.225 kg/m^2 at normal temperature and pressure, and publish a range of power curves at air densities other than this. Air density also affects the efficiency of cooling systems, and most turbine manufacturers specify a maximum altitude of 2,000 m above sea level.

The air density at the Project Site is very low as a result of the altitude, and no turbine standard specification caters for this low air density or high altitude. Therefore, the WTG manufacturers have taken a view as to whether their turbine offering will operate without compromising performance in this environment.

With regard to grid compatibility, not all turbine manufacturers produce 50 Hz machines. For conventional drive trains with asynchronous generators and Double Fed Induction Generator (DFIG) speed regulation, a frequency change is a very significant design change, whereas for a turbine with full power converters, it is usually a simple process.

Turbine performance is comprised of two aspects – technical capability of the design to produce net energy given the wind regime and availability or the proportion of time that the turbine is capable of operating (i.e., not in fault or maintenance mode). There are many subtleties in availability definitions and these are exemplified by some of the turbine suppliers availability contract documentation provided with the quotations.

The product of the environment, technical capability and availability is the actual Annual Energy Production ("AEP") and helps predict a project's generating revenue.

The next most significant environmental parameter is temperature for which a range of operational temperatures and a (wider) range of non-operational survival temperatures are specified. The standard IEC 61400-1 range is an operating temperature of -20°C to +40°C , with extreme survival range of -30°C to +50°C. For sites with higher or lower operating temperature regimes, manufacturers produce high or low temperature packages. It is expected that the standard temperature range will be adequate for the Project.

The capital cost of the Project includes the ex-works price, transportation overseas and inland in Ethiopia, erection and commissioning of the turbines and the balance of plant infrastructure. A complete discussion of the capital cost is given below.

Operating cost includes costs of warranty, annual planned and unplanned maintenance not covered by the warranty, supervision, and maintenance of the substation and site facilities, land rent or royalty payments.

Access and transport limitations are a factor for the Project. Reference is made to the Transport Study carried out by Central Oceans. Given that road infrastructure proceeds as planned, Central Oceans has concluded that rotors in excess of 55 meters could be delivered to the Project Site.

Part of the technical due diligence process is to ensure that the turbine carries suitable certification and is financeable in light of its track record.

Wind turbines in the 3 MW range require a higher level of maintenance to be performed by the turbine manufacturer - compared to proven turbine types in the range of 1.5 to 2.5 MW. In addition, few wind turbine manufacturers offer turbines in the MW class for countries, which are just entering the wind energy market. Wind turbines in the sub-MW range are still available and these were considered, but have the disadvantage of having lower tower heights than required and needing much more space.

In case of Ethiopia, the Project is not the first wind energy project to be implemented in Ethiopia. It is therefore recommended to use proven wind turbines in the range above one Megawatt for the Project, which are standard machines globally. This will have the following advantages when compared to wind turbines with larger capacity:

- More offers from wind turbine manufacturers are available which offers a greater selection and promotes competition.

- For bigger turbines, the transportation logistics might prove even more of a limiting factor, though a detailed road survey has to be performed.
- It can be expected that the delivery time for turbines in the 1.5 to 2.5 MW range will be comparable with smaller turbines, as the main focus of the world's wind turbine production lines is in this range. Initial enquiries indicated several manufacturers that could deliver turbines in the 1.5 - 2.5 MW range in 7 to 8 months.

As a tool for comparison, estimated normalized cost, AEP and specific investment costs in United States Dollars per generated MWh per year for the five candidate wind turbines covering the range of 1.5 MW to 2.7 MW are displayed in the following Table 20. (These numbers are from quotations, are used for illustration and are not intended to replicate final commercial agreed prices).

Table 20 Specific investment costs for selected turbine types

Wind Turbine Model	Total Project ($)	Project AEP (net)	Specific Investment Cost ($/MWh net)
Alstom 2.7 ECO 122	100%	93%	726
Gamesa G114/2.0/93	97%	105%	613
GE 1.7-103	101%	107%	634
Goldwind 93/1.5	92%	95%	581
Vestas 110/2.0/95	109%	100%	728
Vestas V52/65m	50%	50%	966

This calculation shows the lower specific investment costs of 1.5 to 2.5 MW turbines compared to the 2.7 MW turbine class extremes. For comparison sub MW WTGs such as 850 kW show a poor specific investment cost because being stall – regulated and fixed speed, energy capture and project AEP are likely to be significantly lower than those listed above which are all modern pitch controlled variable speed WTGs.

Consequently, it was decided to focus on wind turbines in the 1.5 to 2.5 MW range.

Requests for Expressions of Interest (EOI) on supply of wind turbines for the Project were submitted to the 13 manufacturers given in the following Table. Non-Disclosure Agreements ("NDAs") were executed with 9 manufacturers and 5 responded to a Request for Quotation.

After Terra Global's initial screening, the following five WTG manufacturers remained with the possible WTGs being:

- Alstom ECO 122 with an output of 2.7 MW
- Gamesa 93 with an output of 2 MW
- Gamesa 114 with an output of 2 MW
- GE 103 with an output of 1.7 MW
- Goldwind GW 93 with an output of 1.5 MW
- Vestas V112 with an output of 2 MW

7.2.2 Alstom

The ECO 122 owes its name to its 122 m rotor diameter, one of the largest rotors available today for Class III sites, which enables the capture of even greater amounts of energy.

The wind turbine has been designed following Class III-A specifications of the standard IEC-61400-1. It is suitable for sites with a mean annual wind speed up to 7.5 m/s (A) depending on wind turbulence, and an extreme gust speed with a 50-year repetition frequency of 59.9 m/s.

The ALSTOM wind turbines design is based on the ALSTOM PURE TORQUE™ acquired from the original Ecotecnica design, which is unique in the industry. Rotor deflection loads are transmitted directly to the tower whereas only torque is transmitted to the gearbox, and as a result the gearbox lifetime is extended. See Figure 20

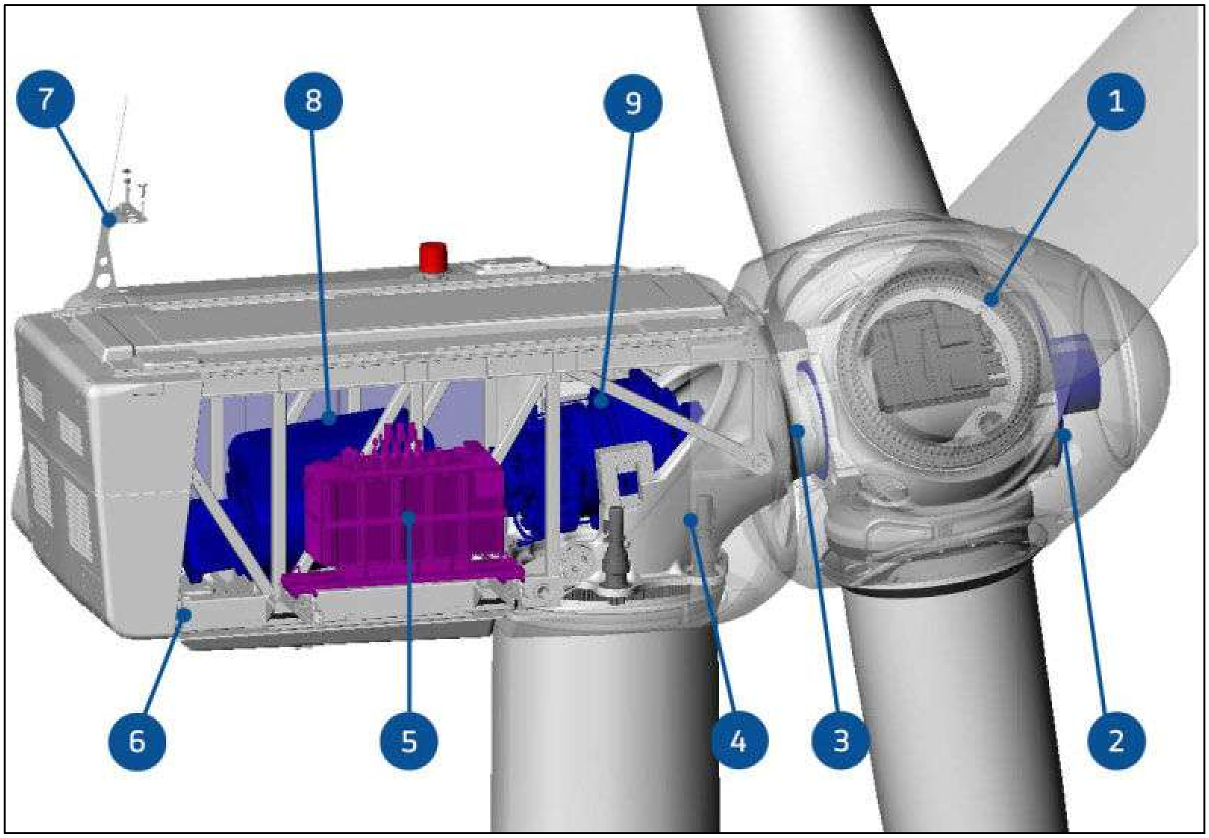

Figure 20 Alstom Eco 122/2.7 WTG

7.2.3 GAMESA

Gamesa has offered its G114 WTGs with a rated output of 2.0 MW. The WTG incorporates many of the technologies developed over 10 years with the Gamesa G9X 2.0 MW platform, retaining the proven track record of the G9x platform, but with a new 114 m rotor, giving the G114 a 38% larger swept area than the Gamesa G97 2.0 MW and produces over 20% more energy annually. The new 55.5 m blade, with state-of-the-art airfoil design, ensures maximum energy production, reduced noise levels and a significantly lower cost of energy. With a rotor specific power of 198 W/m^2 it is a true Class III WTG. See Figure 21

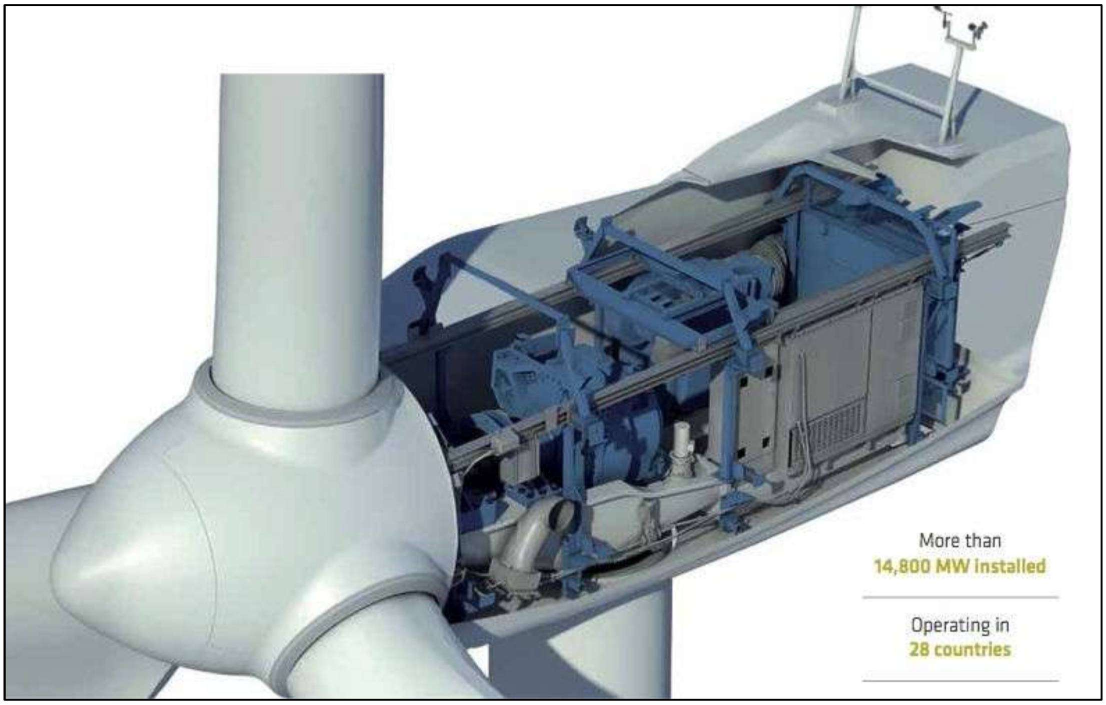

Figure 21 Gamesa G114/2.0

7.2.4 Goldwind

Goldwind is the second leading WTG supplier in the world. Goldwind has offered the GW 93 WTG. This is a derivation of the successful GW 1.5 MW platform such as the GW77 installed at Adama wind farm and uses the same drive train power components. This WTG has a rated output of 1.5 MW. These WTGs use the unique Vensys design permanent magnet (PM) generator, which is gearless and directly driven by a 3-blade rotor and the unique pitch drive system is belt driven, also a Vensys design acquired by Goldwind. The combination of the PM synchronous generator with its full power converter maximizes energy output, making the WTG highly efficient and reliable. See Figure 22

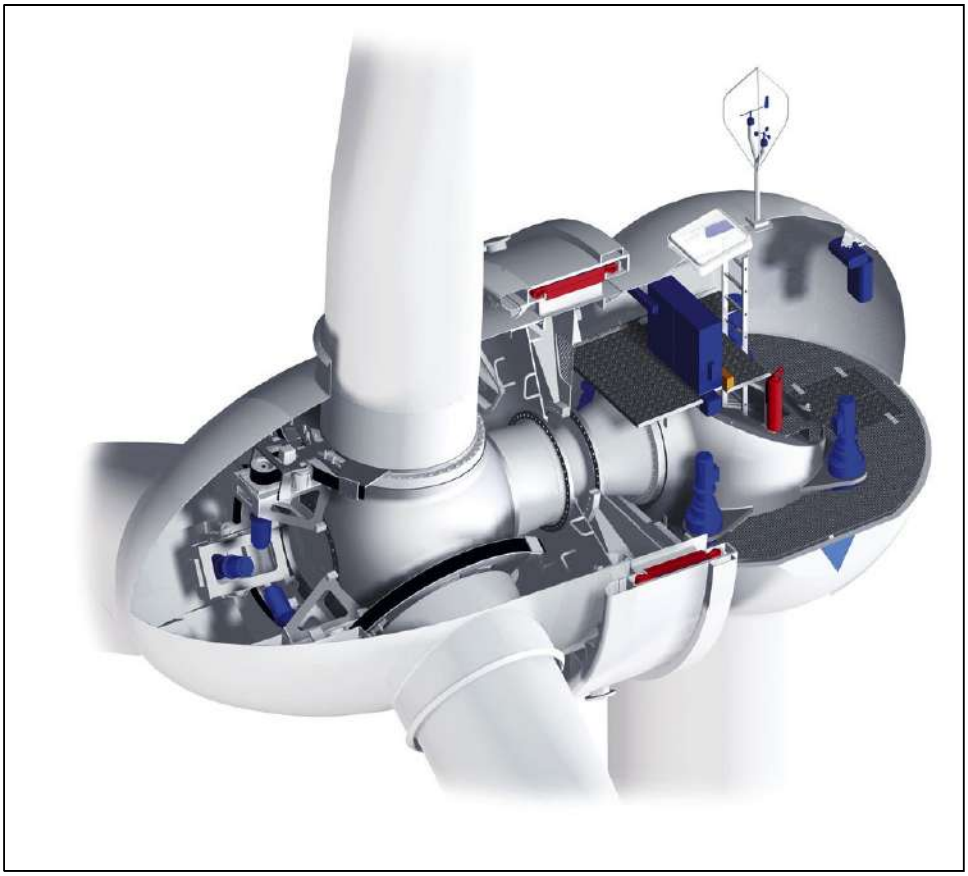

Figure 22 Goldwind GW 1.5/93

7.2.5 GE

GE has offered its 103 WTG with a rated output of 1.7 MW. The WTG is a 3-bladed, upwind, horizontal-axis machine featuring a conventional distributed drive train design and the major drive train components, including main shaft bearings, gearbox, generator, yaw drives and control panel are attached to a bedplate. It is a derivative of the original GE 1.5/70 and has not changed in concept. This is considered as the “workhorse” of the wind power industry in the U.S. See Figure 23

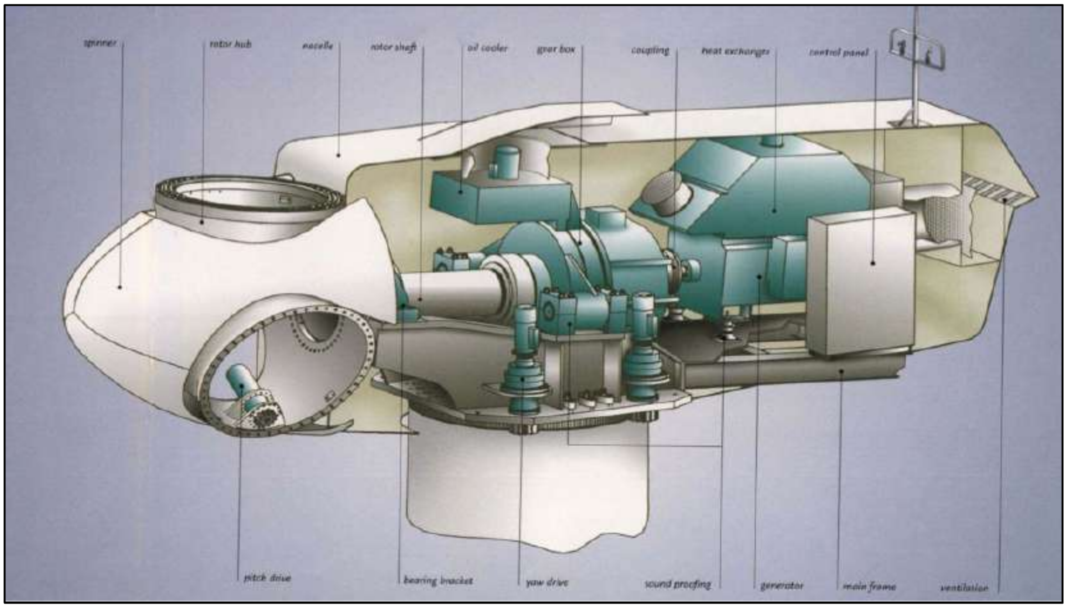

Figure 23 GE 1.7/103 WTG

7.2.6 Vestas

The Vestas V112 wind turbine is a pitch-regulated upwind turbine with active yaw and a three-blade rotor. The turbine has a rotor diameter of 112 m with a generator rated at 2.0 MW. The turbine utilizes a microprocessor pitch control system called OptiTip® and variable speed concept via a DFIG partial power converter system. With these features, the wind turbine is able to operate the rotor at variable speed revolutions per minute (rpm), helping to maintain the output at or near rated power. The drive train is in some respect conventional with a main shaft and 2 point mounted gearbox, driving a high speed asynchronous generator. See Figure 24

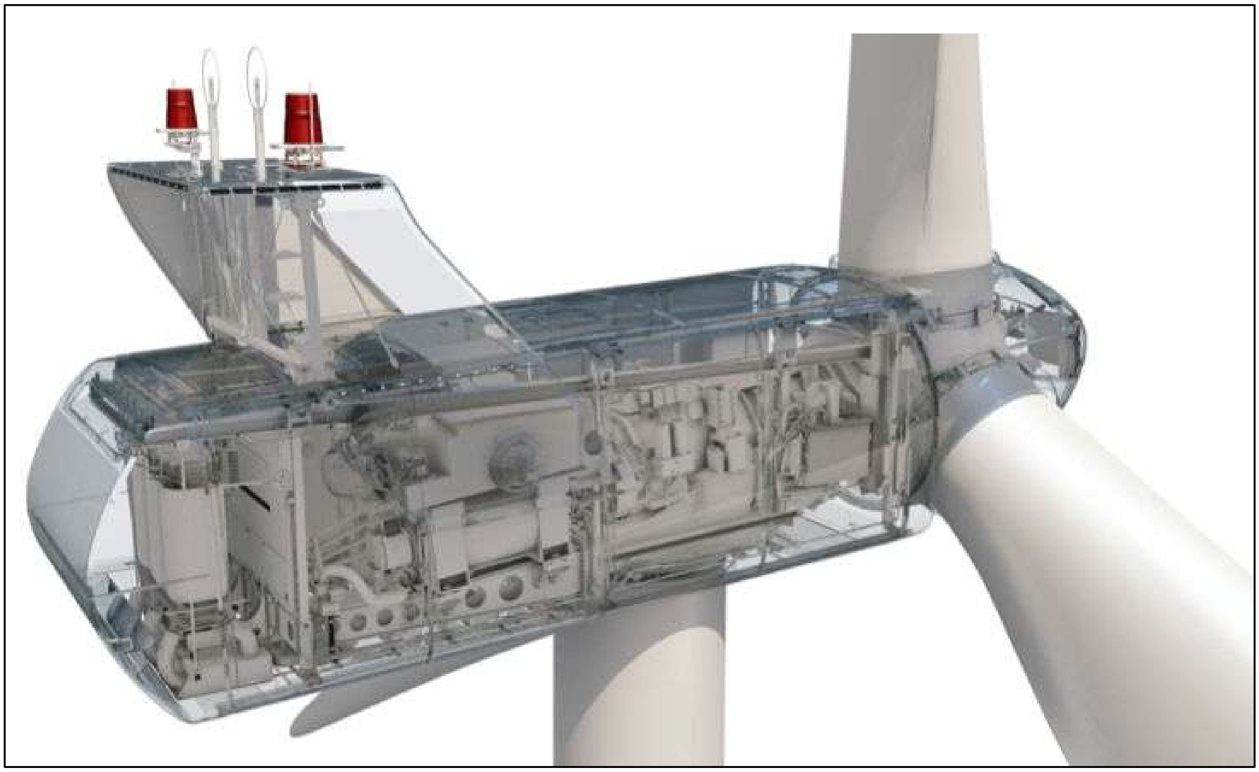

Figure 24 Vestas V112/2.0

The main features of each candidate turbine are presented in Table 21 following:

Table 21 WTGs Technical Feature Comparison

General Specification	Alstom ECO 122	Gamesa G114	GE Wind 1.7/103	Goldwind GW 93/1.5 MW	Vestas V110 2.0MW
IEC Wind Class	IIIA/IIB	IIIA	S	IIIB	IIIB
Rotor Diameter	122m	114m	103m	93m	110m
Rotor swept Area	11690m^2	10207m^2	8332 m^2	6793m^2	9503m^2
Rated power	2.7MW	2.0MW	1.7MW	1.5MW	2.0MW
Rated rotor speed	12.25 rpm	13.07	17.14rpm	16.2 rpm	14.9 rpm
Rotor speed range	7.09 – 12.25rpm	13.07rpm	10 - 17.14rpm	8.4 -16.2rpm	9.3 -14.9rpm
Tower type	89m Steel	93m Steel	89m Steel	85m Steel	95m Steel

	tubular	tubular	Tubular	tubular	tubular
Foundation type	Concrete foundation slab and pedestal, Foundation ring				
Control System	Variable Speed and Pitch Control				
Weight – Blade each	15,000kg	17,200kg	9580kg	7520kg	7,967kg
Weight – Nacelle	83,700kg	88,000kg	66,500kg	11,800kg	66,707kg
Weight - Rotor Hub	58,000kg	60,000kg	28,000kg	15,778kg +44,000kg	18,304kg
Tower Head Mass	186,700kg	199,600kg	123,240kg	94,138kg	108.912kg
Weight – Tower 89m	256,000kg	165,238kg	126,923kg	172,630kg	216,000kg
Tower Base diameter	4.5m	4.5m	4.3m	4.2m	4.4m
Nacelle length inc Hub	14.6m	16.35m	8.8m	10.4m	10.451m
Nacelle Height	4.6m	4.6m	3.8m	4.1m	3.453m
Nacelle Width	6.3m	6.3m	3.6m	4.1m	3.663m
Blade length	59.3m	55.5m	50.2m	45	54m

7.2.7 Suitable Tower Heights

The wind shear values for the Project are discussed in Section 5 of this Feasibility Study Report. Wind shear is the change in wind speed, and wind direction between slightly different altitudes; typically, this increases the farther from the ground the measured point is located. The wind speed at the Project Site does increase at a typical rate, which validates the use of taller towers to reach this higher wind speed. The current feasibility and financial model assume a hub height of the WTG at 85 to 93 meters. This is a reasonable level, as going higher would induce ever- increasing costs with limiting returns; 85 to 95 meters is a standard tower height for the Class III WTGs being evaluated. Using standard towers ensures that costs are kept lower and all design certifications are in place.

Another cost factor in tower height is the cost of the required foundation. Soil conditions and seismic zone definition determines foundation requirements. The soils are generally suitable and do not present any extra requirements; the Project Site is in Seismic Zone 4, which is the highest classification. This requires a careful evaluation of the foundation design and may require modifications to the standard tower specification.

At the Project Site, a relatively low wind speed characteristic has been found which has been characterized as Class III b according to the IEC regulations.

The terrain at the Project Site can be described as complex. Therefore, the extrapolation of the wind speed at higher hub heights compared to the height of the measuring mast is associated with comparatively high uncertainties. Accordingly, a high hub height has been chosen which allows qualified wind regime predictions.

Based on Terra Global's experience, a meaningful prediction of the wind regime is possible for a site of these characteristics up to hub heights of 85 meters to 95 meters. Today, these towers are of normal height for turbines up to 2 MW and will be available for the proposed wind turbines.

Therefore the hub heights used for the further evaluation have been chosen in this range.

As limited crane capacity is available in Ethiopia, it has been assumed that the EPC Contractor will have to secure crane services from outside of Ethiopia.

7.2.8 Logistic and Crane factors

From the above data, a number of factors relating to Project risk can be derived. Transport logistic studies have shown that the longest component, i.e., the blade, is the gating item in transport feasibility. It is feasible to transport blades longer than 50 meters to the Project Site, however the shorter the blade the lower the associated complexity and associated risk. Of the above candidate turbines only the Goldwind WTG has blades less than 50 meters in length. It also has the shortest tower sections, enabling lower risk transport of these heavy items.

Four of the turbines have tower head mass –a combination of the total weight needing to be lifted on to the tower top – in excess of 100 tons; Gamesa being 199 tons and Alstom 186 tons. The single heaviest crane lift for the Goldwind machine is the lowest at 60 tons, whereas Alstom and Gamesa lifts are 84 tons and 88 tons, respectively.

Goldwind uses the shortest tower, the other 4 being near or in excess of 90 meters. This combined with the weight of the heaviest lift tends to drive crane erection cost.

The Goldwind GW 93 thus offers the least risk and erection complexity and hence cost.

7.2.9 IEC 3 wind class performance

The selected WTG suppliers produce a huge range of machines and have all developed low wind speed IEC Class III machines in the last few years. An indication of the wind class is if the specific rotor power (rated power per rotor m^2) is in the low 200 range. The selected suppliers all produce turbines of MW class in true IEC 3, and the Gamesa G114 has a specific power of under 200W/m^2.

Table 22 Specific Power of Candidate WTG's

Manufacturer	Turbine Model	Rotor specific Power (kW/m^2)
Alstom	ECO122 / 2.7	231
Gamesa	G114 / 2.0MW	196
GE	GE 103 /1.5MW	202
Goldwind	GW 93 / 1.5MW	221
Vestas	V110 / 2.0MW	210

7.2.10 Turbine Distances

For the micro-siting certain minimum distances between the individual wind turbines have to be observed. A common rule of thumb specifies three to five rotor diameters in cross wind directions (less than three is possible under some circumstances) and six to eight rotor diameters in main wind direction as a minimum spacing between the individual turbines. The minimum distance of three times or less the rotor diameter in cross wind direction is only feasible in case the wind direction is strictly perpendicular to the row of wind turbines which can be, due to the given orientation of the ridges on site, be achieved for some parts of the site, and then only if there is no additional rows of turbines within a considerable distance.

The WTG spacing is reasonable in the strongly prevailing wind direction. The average turbine spacing is 4.5 rotor diameters (RD) with a minimum spacing of 3.0 RD (between E3 and E4, E27 and E29 and E45 and E46). However, none of these pairs are aligned with the prevailing wind direction. The WTG layout is considered to be well-aligned for the prevailing easterly wind direction. Wake losses averaged over all wind direction sectors for the wind farm are 3.8%, which is considered low for a wind farm layout comprised of 67 WTGs.

7.2.11 Temperature Specifications

It is expected that the standard temperature range applicable to turbines will be adequate at the Project Site.

Table 23 Operating and Extreme Temperature ranges of candidate WTG's

Manufacturer	Turbine Model	Operating temperature range	Extreme temperature range
Alstom	ECO122 / 2.7	-10 ºC to +40 ºC	-20 ºC to +50 ºC
Gamesa	G114 / 2.0MW	-20 ºC to +40 ºC	-30 ºC to +50 ºC
GE	GE 103/1.5MW	-15 ºC to +40 ºC,	-20 ºC to +50 ºC
Goldwind	GW 93 /1.5MW	-10 ºC to +40 ºC	-20 ºC to +50 ºC
Vestas	V110 / 2.0MW	-20 ºC to +40 ºC	-30 ºC to +50 ºC

The surface coatings should be verified for 20 year design life in high UV index environment. The solar gain might be addressed by suitable surface protection coloring – high albedo white, or if not the internal nacelle cooling during low wind operation should be assessed.

7.2.12 Noise Impact

The target of the noise assessment is to investigate the potential noise impact of the wind turbine operation on sensitive areas in the vicinity of the wind farm. The advisable distances between residences and the proposed wind turbine sites depend on a variety of factors including local topography, eventually background noise and the size of wind farm development. Official demands with regard to noise limit values for the operation of a wind park in Ethiopia are not specified. Therefore a prediction of the sound produced by the proposed wind farm in the surrounding area and an optimization of the micro-siting was made in accordance to the strict German noise limit regulations.

The calculation method is specified in ISO 9612-2 and implemented in the WindPRO soft ware used for the estimation of the noise effects.

The sound emission data used in the calculation and the sound power level of the turbine bases on information given by the turbine manufacturers.

Correspondingly the following standard values for noise emission are considered depending on the utilization of the area:

Table 24 Noise emission values according to EU standards

Utilization	Noise Emission (dB(A)	
	Day Time	Night Time
	06:00 - 22:00	22:00 – 06:00

Regimen and hospital areas	45	35
Exclusive residential areas	50	35
General residential areas	55	40
Village centers, mixed utilization with small trades	60	45
Working areas	65	50
Industrial areas	70	70

Considering that identified noise sensitive areas can be assigned to the Village centers with mixed utilization, the limiting noise standard for the operation of the wind farm is an impact level of 45 dB (A) at night time.

Applying the noise setback constraints to the wind farm layout WindPRO calculations are shows no conflict in terms of noise level, the boundary levels for the noise emissions during the night are not exceeded for the emission points (houses of a village nearest to the wind park, churches) in the vicinity of the proposed wind farm.

7.2.13 Shadow Impact

When the sun is just above the horizon, the shadows of the wind turbine generators can be very long and can move across houses (windows) for short periods of time. If this happens for longer period, it causes stress to the inhabitants.

The exact position and time period of shadow can be calculated very accurately for each location, taking into account the structure of topography and the movements of the sun.

Official Boundary levels are not extant for the shadow flicker effect. Commonly accepted value is the maximum of 30 hours shadow caused by the wind turbines per year, and 30 minutes shadow per day.

WindPRO software has been used for the calculation of the shadow impact.

7.3 Wind Park Layouts

Terra Global performed a bank-grade energy yield prediction, as part of its feasibility assessment of the Project. A site suitability analysis was completed for the Sembo 1202 mast location. The analysis indicated that there are no concerns over predicted annual mean wind speed, turbulence, wind shear or extreme winds at the Project Site.

One onsite meteorological mast, Sembo 1202, was used in the assessment, which provided 18 months of measured wind data. The predicted long term mean wind speed at the mast location (at 85 m hub height) is 6.68 m/s. The predicted long term mean wind speeds at the proposed WTG locations extrapolated to the 85 m hub height are between 6.20 and 7.36 m/s, with an average of 6.66 m/s. This analysis is modeled by wind with a Weibull k factor of 2.74 and Weibull c factor of 1.12.

The energy yield and site suitability analysis is based on a layout consisting of 67 Goldwind GW93 1.5 MW WTGs with an 85 m hub height. This analysis is summarized in Section 7. Energy generation P50, P75, P84 and P95 values, including uncertainty reflecting 10 years of inter-annual variation in the wind resource, are provided.

In addition, Terra Global has carried out an optimized layout for the Gamesa G114 2.0 MW WTG at 93 meter hub height and conducted a formal energy yield analysis for the same.

For the remaining three candidate WTGs (GE, Alstom, and Vestas), for purpose of comparison with Goldwind and Gamesa WTG's, the identical wind speed regime and loss assumptions were applied to potential layouts of these WTGs, without redesign of the wind farm. Identical loss factors enable a comparison of net wind farm AEP.

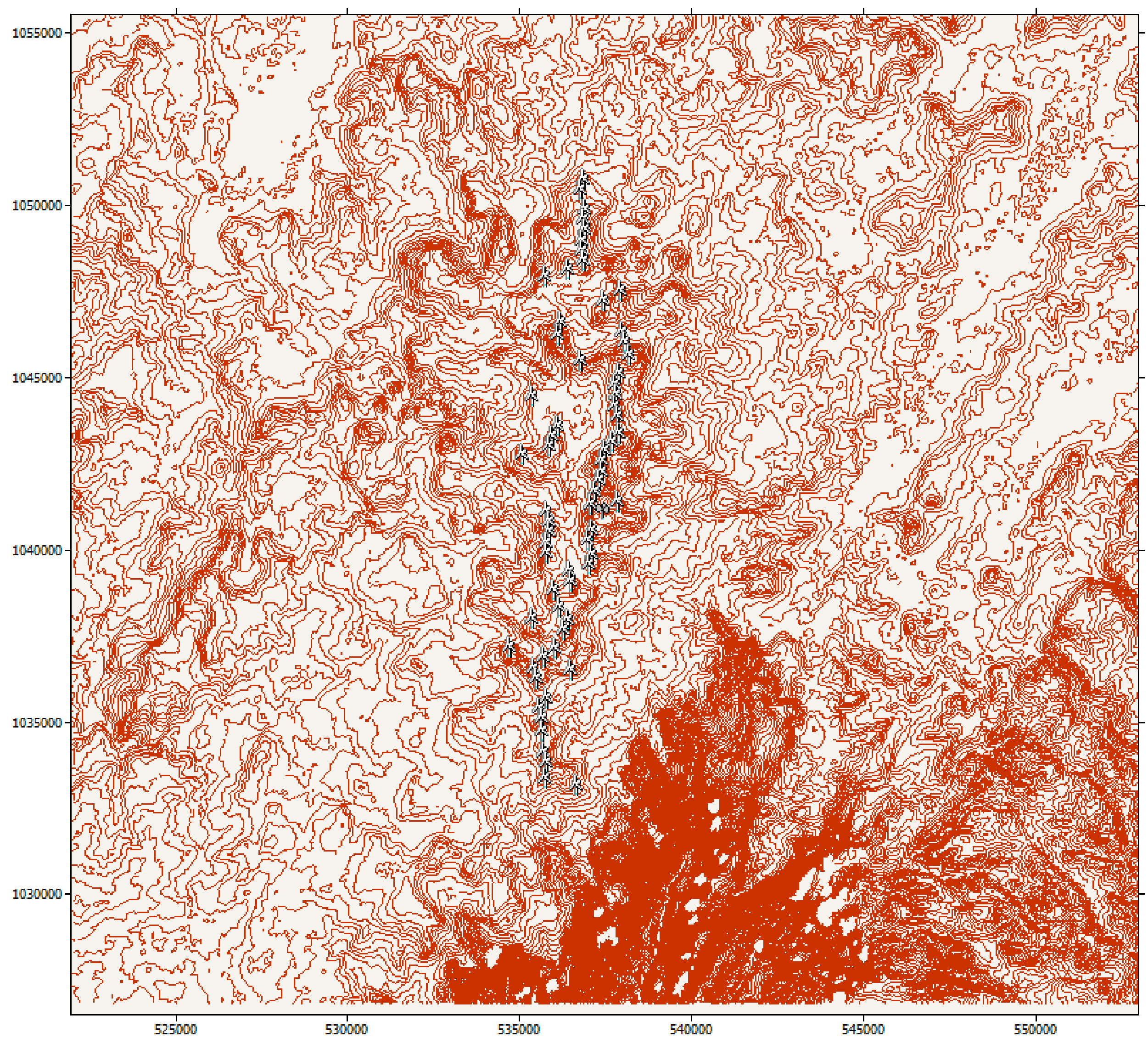

Figure 25 Debre Berhan Project Area WAsP Topographic Map with Goldwind WTG and Mast Locations

The Goldwind layout has been developed on the basis of the wind measurements and the topographical situation taking account of the constraints outlined here.

This layout follows ridgelines and distributes 52 turbines equally north and south of Sembo. In order to minimize the wake losses, given the exceptional wind speed directional frequency distribution, which is predominantly from the East-South-East, single lines of wind turbines with considerable distance between the individual rows are more preferable than clusters of turbines, leading to the layout shown.

7.4 Comparative Project Performance at the Site

An analysis was carried out of the performance of five wind farm layouts each comprising the five WTGs under consideration. The key determinant of value is the levelized cost of energy ("LCOE") per kWh delivered.

In addition, as described above, technical and financial factors must be considered together. In Table 25 below, these key determinants are summarized for the five WTG's considered for the Project.

Table 25 Comparative LCOE for Candidate WTG's

	Alstom	Gamesa	GE	Goldwind	Vestas
WTG Model	ECO 122	G 114	GE 103	GW 93	V 110
WTG Output (MW)	2.7	2.0	1.7	1.5	2.0
Number of WTGs	37	50	59	67	50
Annual Net Energy GWh	237.4	286.2	272.9	249.8	254.5
Capacity Factor	27.1%	30.7%	31.6%	28.4%	29%
Capital Cost $USM	257.2	249.6	259.4	238.8	279.7
WTG O&M/year $USM	2.2	1.6	2.9	1.0	2.1
Lender	HERMES	US EX-IM	US EX-IM	ICBC/BOC	EKF
Debt Percentage (%)	85	8	85	85	85
Equity Percentage (%)	15	15	15	15	15
Interest Rate (%)	6.6	6.6	6.6	2.9945	6.6
Grace Period (Month)	22	22	22	30	22
Repayment Period (yrs)	10	7	7	12.5	10
Residual Value	10%	10%	10%	10%	10%
LCOE (cents per kWh)	**11.434**	**9.333**	**10.527**	**7.547**	**11.341**

It is clear that the Goldwind WTG exhibits the lowest capital cost and operations and maintenance costs, and an AEP in the mid-range of the five candidates.

The key differentiators then are driven by the lenders, where the combination of Industrial Commercial Bank of China (ICBC) and Bank of China (BOC) is able to offer dramatically lower interest rates than any of the other export credit agency lenders as discussed in Sections 14 and 15.

In Figure 26 below, the results are illustrated graphically showing that the LCOE of the Goldwind offering is the clear best option.

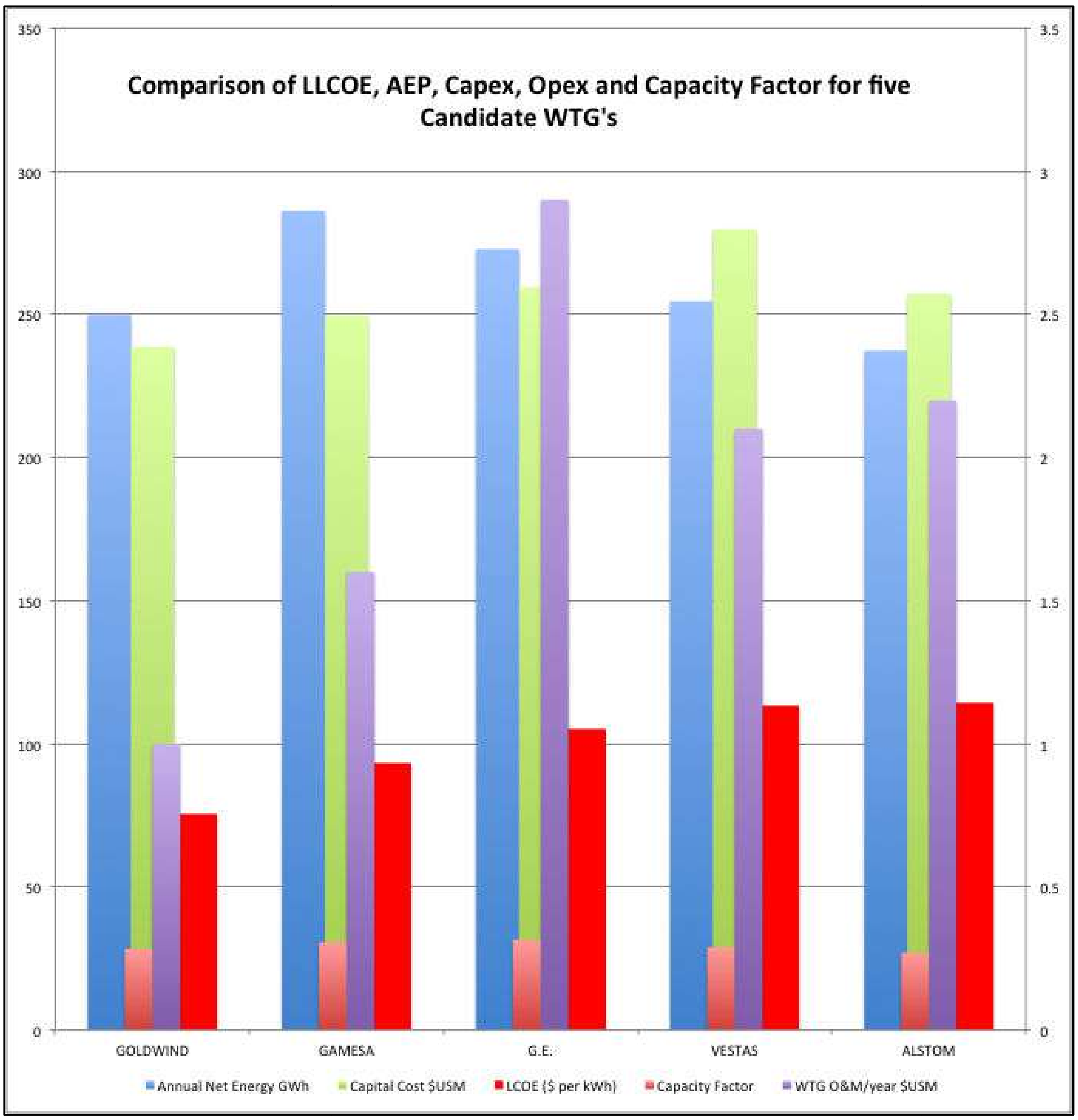

Figure 26 Summary LCOE and contributing factors

7.5 Summary

Terra Global has carried out an assessment of the wind potential in the Debre Berhan region around the Sembo mast in order to design the optimum wind farm. A globally wide selection of possible WTG suppliers was contacted and a down select made to five credible candidates. Expressions of Interest and preliminary quotes for turbine supply were solicited and received from these five, and the details of each WTG are provided. A technical comparison of the offerings was carried out identifying all the relevant technical factors that are part of wind farm design and optimization.

Given two detailed WindPRO layouts and three based upon the same, the annual energy production was estimated for each candidate WTG.

Finally, taking into account the available financing terms for each WTG, the lowest levelized cost of energy is clearly associated with the Goldwind WTG. This is the clear and unambiguous recommendation.

8.0 Energy Production Estimation

8.1 Meteorology

From ground level, our personal observation of wind shows that it is variable over time and complex, that wind speed increases generally with height, that there are gusts (turbulence) both at ground level and higher up.

Global winds above 2 km are driven by differential diurnal and seasonal solar heating of the earth's surface causing pressure gradients, modified by the rotation of the earth, and at these altitudes is called the gradient wind. These very large circulations in each hemisphere transport heat energy around the planet.

Between the gradient wind and the surface is the surface boundary layer which is divided into two. There is an upper layer called the Ekman layer where the wind speed is affected by a shearing stress from surface friction as well as rotation of the earth; and below about 100 m there is a region of constant shear stress, where wind structure is determined by surface roughness and vertical temperature gradient as medium scale thermal effects affect local wind speeds.

Wind turbines operate with rotors between these two regions. The variation of wind speed with height is known as vertical wind shear and within the region up to about 200 m follows a logarithmic law with one variable being the roughness of the ground surface over which the lowest layer of air is passing. The roughness is expressed as a roughness length and varies from around 4 in an urban environment to less than 1 mm over flat mud or ice. For open farm land with few trees and undulating land, the roughness length may be around 0.03 m.

Considering the variation with time, the timescales involved cover about 9 orders of magnitude. At the slowest are the annual changes, followed by macro meteorological variations that are the passage of complete weather systems taking several days to pass and the diurnal 24-hour cycle. Faster variations take place over hours, or most significantly over minutes or seconds, characteristic of turbulence. The power spectral density of the wind, equivalent to the kinetic energy in the wind, shows these are two peaks and is due to Van der Hoven, shown below. The gap in the spectrum around 10 minutes to an hour is a convenient averaging period over which wind energy production measurements are taken.

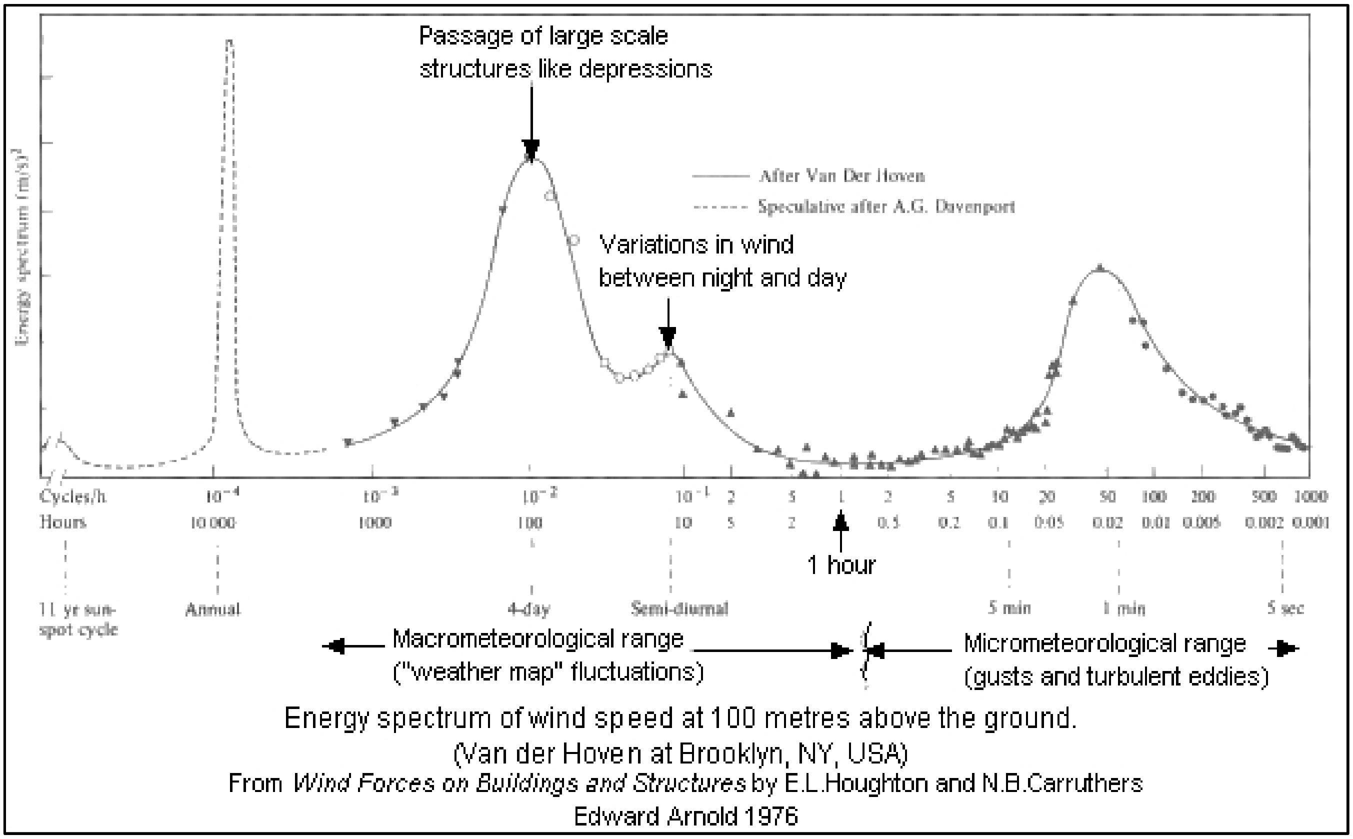

Figure 27 Wind Speed Spectral Distribution - Van der Hoven

A measurement of wind speed at a range of heights confirms these observations. It is clear that mean wind speed increases with height, and in the short term has considerable variation. Figure 27 above shows typical variation of wind speed over time both diurnally and over periods of seconds.

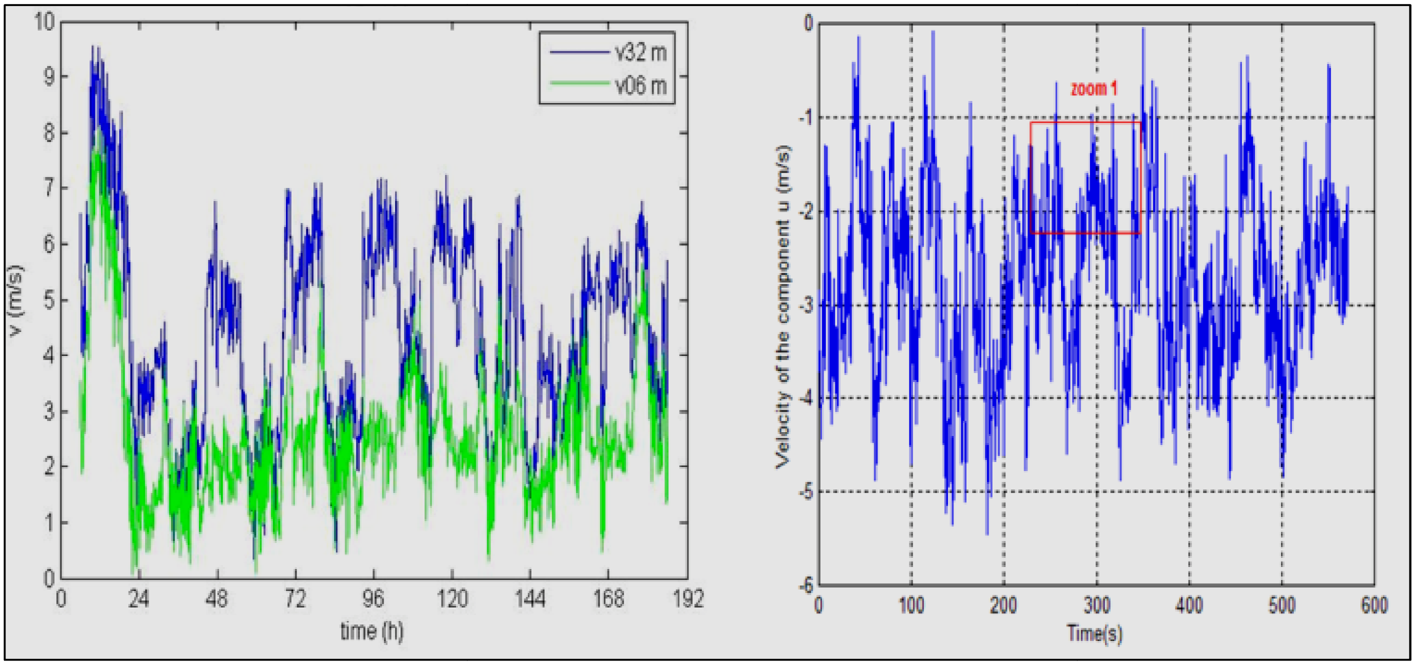

Figure 28 Variation of wind speed with time, typical measurements

Short term wind speed variations of the order of seconds in duration are gusts which occur in all directions – along wind direction as well as transversely and vertically. This is measured as turbulence intensity, which is the standard deviation of the instantaneous wind speed. Turbulence intensity depends upon surface roughness and thermal stability, varies with height, generally reducing with increasing height.

Estimating or predicting the likelihood of a particular wind speed requires a statistical approach and different methods are necessary for mean and extreme. The ideal predictor of long terms wind speed is to measure long term wind speed, however measurement campaigns in excess of 3 years are generally impracticable for power generation projects. For mean wind speeds commonly occurring, research and measurement over decades has shown that the Weibull frequency distribution conforms well with observations. This has parameters related to the mean wind speed and a shape parameter and typically is as in Figure 29. Prediction of maximum gust and extreme wind speeds is in reality only relevant to wind turbine design and need not concern us here.

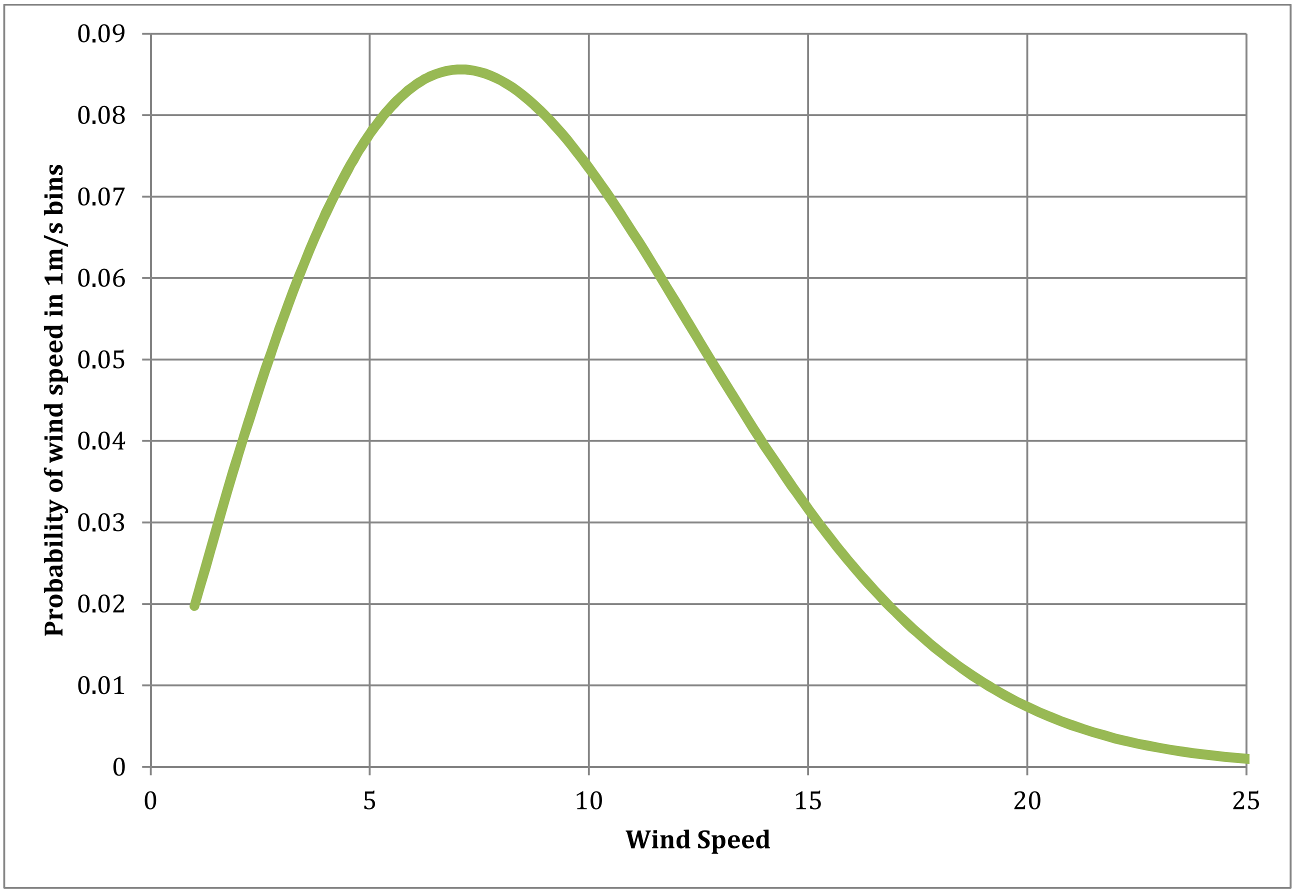

Figure 29 Weibull Distribution of Wind Speed, c=2, k=10

The annual mean wind speed at a point of interest for power production is affected by the mechanism driving the wind and the surface roughness. It is very rare for a site to have uniform roughness over a large area. There are generally multiple changes in surface roughness, each affecting the boundary layer, including rough to smooth and vice versa overlaid upon each other.

Clearly, wind turbines interact with and occupy regions of the atmospheric boundary layer, and their performance depends upon their location and suitability for all the factors discussed.

8.2 Wind flow and wind flow software – WAsP/WindPRO

Specialized software has been developed over decades to model wind and to predict wind turbine and wind farm performance to the level required by investors and lenders. The Wind Energy Department at Risø National Laboratory (DTU Wind Energy) introduced Wind Atlas

Analysis and Application Program ("WAsP") in 1987 and it has been incorporated into many wind farm design software packages, such as WindPRO and WindFarmer.

One of the challenges to modern wind flow software such as WAsP is to model the foregoing meteorological factors in a rigorous mathematical way. In addition they must cope with the influence of the ground roughness and physical objects. Essentially WAsP provides both vertical and horizontal extension of wind climate statistics from one or more points of measurement across a wide area, taking into account wind flow over terrain and obstacles.

Wind flow over terrain - hills and slopes - significantly affects mean wind speed. It is well known that wind speeds near the ground are increased near hill crests, where there is a gradual change in slope. This differential speed-up can be very significant to power production and is central to the wind flow modeling and micro-siting of wind turbines to maximize production. See illustration of this below in Figure 30. However, when slope steepness exceeds about 14%, non-linear effects dominate and flow can separate into large turbulent eddies. WAsP is reliable up to slopes of 30%

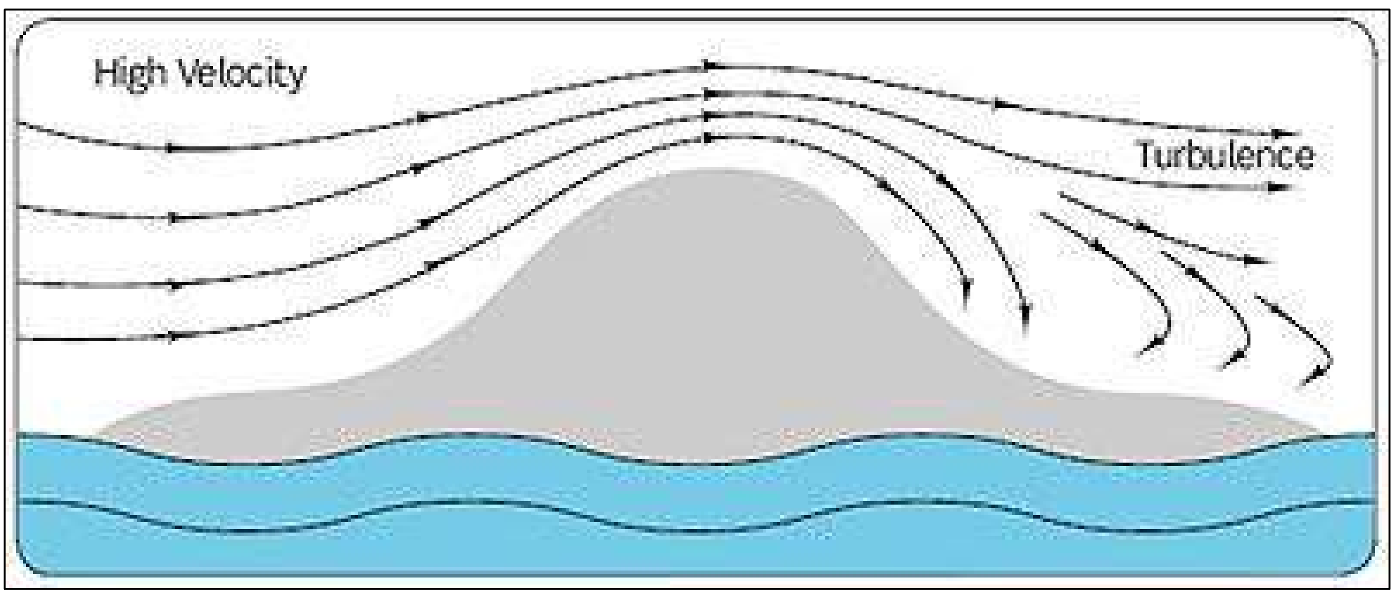

Figure 30 Flow Acceleration and Separation

The analysis of this is complex and WAsP accommodates up to 10 changes of roughness.

Altitude affects air density, which directly impacts power production of a wind turbine and it is necessary to calculate air density at each point of a wind farm.

Wind farm power production requires a statistically accurate estimate of the production over usually 20 years, for generally a number of wind turbines distributed over a wide area, at different altitudes, and surrounded by differing surface roughness. The power production must be calculated from each 10 minute measured wind speed record, extrapolated to the wind turbine hub height and air density; and as the wind can approach each wind turbine from any direction, this must be done taking into account roughness and obstacles accordingly.

Wind turbines abstract energy from the boundary layer and in doing so disturb it, and the wind climate of downstream wind turbines is altered in a very complex way by this so-called wake effect.

The wind farm analysis software packages such as WindPRO and WindFarmer carry out analysis of the measured wind speed, usually site measurements, extend this horizontally and vertically and apply this to a layout of turbines on the terrain taking into account the topography and other constraints such as inter-turbine spacing and habitation setbacks. Given manufacturers power curves for the specific model of wind turbine they predict a gross output. Wake effects and other factors are applied to the output and the placement of the turbines is automatically adjusted iteratively to optimize (usually) annual energy production.

For the energy yield calculation the standard WAsP-WindPRO model has been generated using a digital terrain model in a radius of 20 km around the center of the site. A digitized roughness map has been evaluated also for a radius of 20 km. In a radius of about 1 km all major obstacles have to be considered in the model, but in the case of Debre Berhan site there are no such obstacles.

8.3 WAsP Model Input Parameters

WAsP software was used to model the wind flow across the Project Site. The wind flow was calculated by taking the long-term wind rose for the mast location and extrapolating this across the site using the topographic and roughness maps. As part of this process WAsP creates a “regional wind atlas,” whereby the observed wind climate (long-term wind rose) is extrapolated to a height above the effects of roughness and topography. This wind atlas is then reapplied to the topographic and roughness maps to create a wind flow model for the area.

Key model inputs can be summarized in the following way:

- Input wind speed and direction data is mapped through the position and dimensions of site obstacles into the Sheltering model.
- The terrain classification is input to modify the wind data in the Roughness model.
- Finally the height contour lines are input as a digital terrain map which modifies the wind flow, into the generalized regional wind climatology model to output a final wind climate of the specific location.

8.4 Roughness

The WAsP wind flow model uncertainty is calculated based on the terrain and roughness complexity. (See Section 5) The uncertainty is slightly higher than standard due to the resolution of Shuttle Radar Topography Mission **(**SRTM) topographic data used in the wind flow model.

8.5 WTG Layout

The WTG layout of the Project consists of 67 WTGs and was introduced into the WAsP wind flow model for the energy yield prediction. The Goldwind WTG type was used in the energy yield model. The power and thrust curves were provided by Goldwind for air densities of 0.94 to 1.27 kg/m^3. There are no neighboring wind farms or wake to be considered in the energy yield analysis.

8.6 Candidate Wind Turbine Power Curves

The Power Curves are all given under the standard condition, air density: 1.225kg/m3, without any effect of turbulence. The power curves of each of these WTGs have all been tested by independent testing authorities and are supported by warranty agreements. For the Project, a power curve test is recommended as the air density is below any of the tabulated curves, which are shown below in Figure 31.

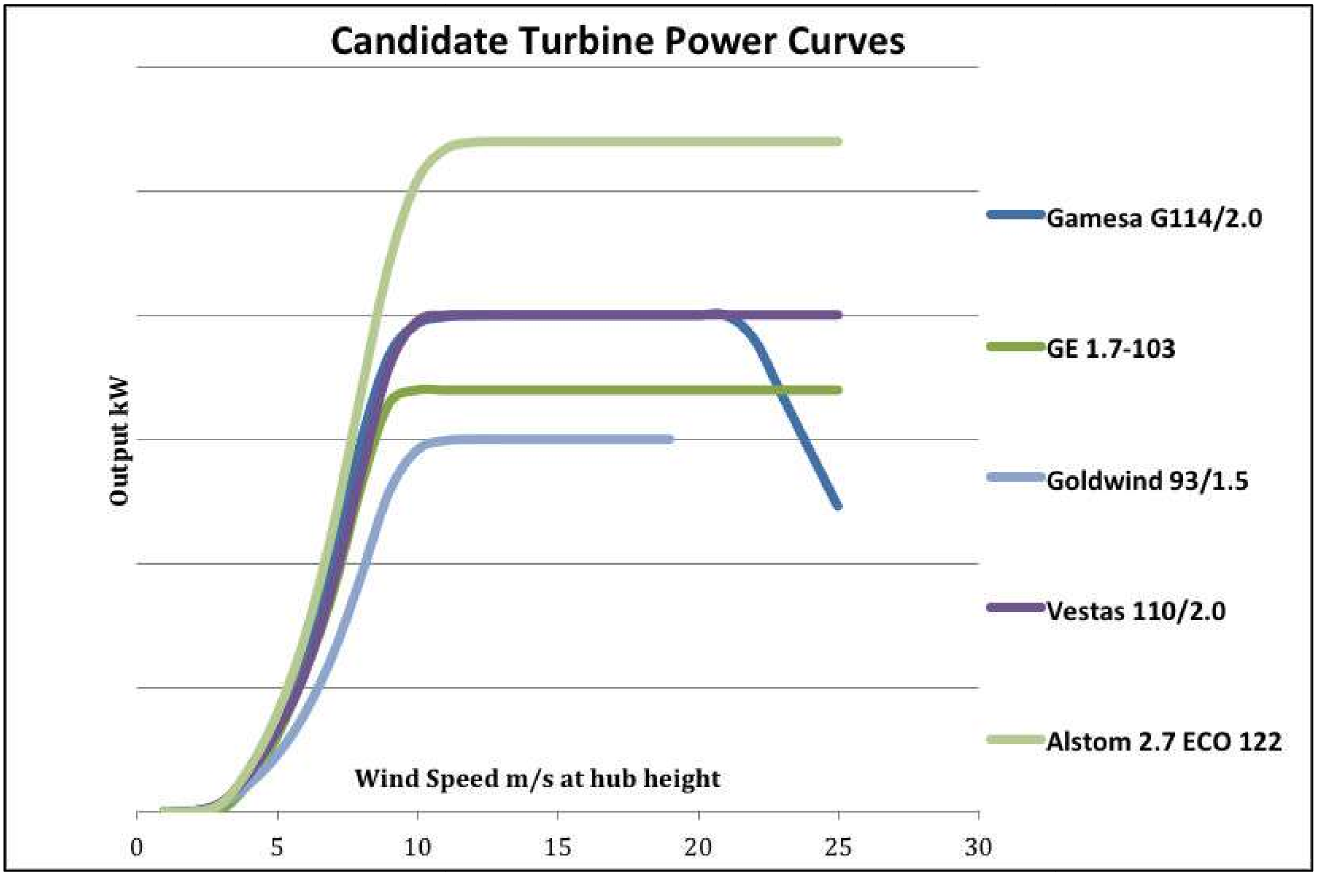

Figure 31 Candidate WTG power curves

When these are matched to the wind regime at the Project Site there are significant differences between the energy capture capabilities of these machines because of their matching to the wind speed frequency distribution, and in addition it is clear that rotor size is the key to energy capture.

A full technical description of the selected Goldwind GW 93 1.5 MW wind turbine is provided in Section 19, Appendix L.

8.7 Wind Farm Energy Yield

Initially, a base (ideal) energy yield for the wind farm was calculated, based on all of the WTGs being located at the mast position. The WAsP wind flow model was then used to calculate the topographic/roughness effects and the wake losses at each WTG location.

A detailed wind farm energy yield was carried out for the Goldwind GW 93 1.5 MW WTG, and in the following data, these details are used for all turbine models.

The ideal energy production was then modified by the application of a series of calculated and nominal corrections and losses, in order to produce a final energy yield for the site. The Goldwind Debre Berhan Project WindPRO Loss & Uncertainty Report is provided in Section 19, Appendix N.

The losses that have been applied to the energy yield reflect a combination of nominal losses based on one's experience of losses on operating wind farms and losses calculated on known site values as in the next Section.

The results of this exercise are listed in the Goldwind Debre Berhan Project WindPRO Loss & Uncertainty Report listed in Section 19, Appendix N. The three output values for the specified scenario are:

- **Overall Conversion Efficiency:** The product of all the losses/effects listed in the table.
- **Wind Farm P50, P84 & P90 Yield:** The final predicted output of the wind farm, after all losses have been applied.
- **P50, P84, P90 Capacity Factor:** The final output of the wind farm as a proportion of the gross yield if all WTGs were working at rated capacity all the time and no losses occurred.

8.8 Corrections and Losses

The description of losses applied is given in the following.

Wake Losses: A number of models can be used to calculate wakes, although validation of these models, particularly in complex environments, is problematic. This prediction uses the WAsP wake model predictions, which are supported by published research papers. The predicted wake loss for the Project Site due to internal wakes is approximately 5.3%.

WTG Availability: Terra Global has found 97.0% availability to be realistic for most WTG types with a good track record and quality assurance regime operating in developed countries.

Substation Availability (12 hours downtime assumed): This loss is based on an assumption that the substation will be down for 48 hours each year, and that this will occur during periods of average production, giving a loss of 0.5%.

Grid Availability and Disruption (0.5% downtime assumed): This loss is based on an assumption that the local grid will be down for 0.5% of the time in any one year, and that this will occur during periods of average production.

Wind Hysteresis (Start up and shut down): When site wind speed exceeds the WTG maximum operational speed for a predefined period of time, the WTG shuts down and does not start up again until the wind speed drops to a lower level, again for a predefined period of time. Exact cut-in and cutout protocols vary from WTG to WTG, and are based on wind speed data measured at a higher time resolution than the 10-minute averages recorded for energy yield prediction. However, the resulting loss can be estimated based on the site wind speed distribution and the WTG power curve. For the WTG type selected at the Project, the wind hysteresis is calculated to be 0.3%.

Electrical Transmission Efficiency (Wires, WTG & Grid Transformers): This loss can be calculated once the design is finalized and a detailed electrical loss calculation is undertaken. A nominal 3.0% loss has been applied based on TERRA GLOBAL's experience.

Facility Consumption. Ancillary energy consumption on site is the energy provided for the services building, lighting, and control systems around the wind farm. An allowance of 0.5% has been included

Power Curve Performance: It is assumed that the WTGs will perform at an average of zero loss to the sales power curve performance based on a performance review of wind farm production. Because power curve performance can vary, Terra Global has included a 5% AEP standard deviation uncertainty in the power curve performance.

Power Curve Density Correction: This figure is calculated for the average WTG hub height altitude, based on:

- Measured one year average air temperature and sea level pressure at the Sembo mast (1202) location;
- Average WTG hub height altitude;
- Goldwind GW 93 1.5 WTG power curve for 1.225 kg/m^3; and
- Short-term site wind distribution data at 85 meter hub height corrected for long-term.

Terra Global has assessed the short-term temperature and pressure site data against the long-term 10-year CFSR dataset from Vortex and found the short-term data to be representative of what may be expected over the long-term. For this reason, the measured short-term, site temperature and pressure data was adopted to calculate air density at the site. The air density was calculated at the Project's average WTG hub height altitude of 3,086 meters above mean sea level for an average 12 ºC temperature and an average air pressure of 709.4 mbar at the

Sembo mast (1202) location. This resulted in an average WTG location air density of 0.87 kg/m^3.

Energy production values utilizing the different power curves of the Goldwind GW 93 1.5 MW WTG were obtained. Based on the relationship of energy production at different levels of air density, the energy production at 0.87 kg/m^3 was estimated. The ratio of the energy output at standard air density and at site's air density values resulted in a significant calculated air density loss of 20.4%. This is included in the Goldwind resources assessment by direct calculation according to proprietary knowledge of the blade airfoil, and is not included below in the table. Terra Global's estimates are in line with the Goldwind results.

Extreme Temperature Effects and Icing on the WTGs: This loss reflects periods where WTGs are performing at less than ideal efficiencies because of extreme temperatures or icing. However, TERRA GLOBAL found no such low or high temperature instances in the site measured met data. For the Project Site, no loss has been applied due to extreme temperature effects.

Blade Contamination, Degradation and Off-Design: During operation, dust particles or insects in the air can contaminate a WTG. Degradation and off-design are considered more of an issue than this and will have a much greater effect towards the end of a project compared to the start. The magnitude of the loss will be dependent upon the diligence of the maintenance personnel. This loss can be mitigated through maintenance programs that assess power curve condition and that are designed to maximize wind farm power production. For the Project Site, a loss of 2.0% has been applied.

Ancillary Systems: The WTG power curve supplied by a manufacturer gives the WTG power output which can be expected to be measured at a given reference point on the WTG. An additional system loss must be taken into account where a site production measurement point varies from the manufacturer's reference point. This loss accounts for electrical and system losses between the site measurement point and the warranted reference point. Normally, these points coincide and no additional loss is required. For the Project Site, no loss has been applied.

Wind Speed Inter-annual Variability: This loss results from the fact the energy in the wind is not linear. Hence, a low wind speed year tends to result in a reduction in energy yield that is greater than the increase in yield resulting from a high wind speed year, or vice versa. This loss/gain can be calculated from the site wind speed distribution and WTG power curve. At the Project Site, the effect of inter-annual variability has been calculated as a net zero loss. Terra Global has added an uncertainty to AEP of 4.8% standard deviation.

Grid Compliance Loss: This parameter accounts for the energy that will be lost through the wind farm having to comply with grid code requirements. For the Project Site, no such curtailment is expected.

Wind Sector Management: From the wind shear and turbulence intensity analysis at mast location, TERRA GLOBAL does not expect that any WTG locations require curtailment for certain wind directions in order to avoid excessive shear (caused by steep slopes) or turbulence (caused by nearby WTGs). Therefore, no loss has been applied.

Table 26 Debre Berhan Wind Farm Energy Yield Correction and Losses

Wind Data	**60 m Sembo Mast 1202 (extrapolated to 85 m and corrected to long-term)**		
Gross Yield	Based on WAsP Values		
Wind Turbine Generator (WTG)	Goldwind GW 93 1.5 MW		
Hub Height (m)	85		
Rated Capacity (MW)	1.5		
Number of WTGs	67		
Site Capacity (MW)	100.5		
Mast	Sembo (1202) 60 m		
Measurement Height (m)	58		
Mast Height Long-term Wind Speed (m/s)	6.24		
Hub Height Long-term Wind Speed at Mast Location (m/s)	6.69		
Weibull k (at Hub Height and Mast Location)	2.94		
Weibull c (at Hub Height and Mast Location)	1.12		
Gross Wind Farm output MWh/y	291,162.4		
Correction & Losses	**Loss (%)**	**Loss (GWh/y)**	**Std Dev (%)**
Wake Losses[1]	0.947	15.4	38.0
WTG Availability[2]	0.970	8.7	
Substation Availability (48 hours Downtime Assumed)[2]	0.995	1.5	
Grid availability and disruption (2% Downtime Assumed)[2]	0.995	1.5	
Wind Hysteresis (in Shut Down and Start Up)[1]	0.997	0.8	
Electrical Transmission Efficiency (Wires, WTG & Grid Transformers)[2]	0.970	8.7	
Facility Consumption	0.995	1.5	
Blade Contamination, Degradation & Off-design[2]	0.980	5.8	
Power Curve Performance[2]	1.000		
Extreme Temperature Effects on WTG[1]	1.000		
Ancillary Systems[2]	1.000		
Wind Speed Inter-annual Variability[1]	1.000		
Grid Compliance Control Loss[2]	1.000		
Wind Sector Management[2]	1.000		
Overall Conversion Efficiency	**85.8%**	**41.4**	**2.0**

[1] Calculated loss.
[2] Nominal losses.
[3] The Goldwind G93 1.5 MW WTG power curve for standard air density of 1.225 kg/m^3 was utilized in the gross energy yield prediction and a correction applied to account for the long-term site air density of 0.87 kg/m^3.

8.9 Uncertainty Analysis

8.9.1 Uncertainty in the Energy Yield Prediction

The uncertainty in an energy yield prediction is difficult to quantify, as it is a function of many independent factors[8]. Furthermore, many of the factors that influence uncertainty cannot be adequately quantified by calculation and rely on estimates based on judgment and experience. Where calculation has not been possible, estimation and judgment have been adopted in this uncertainty analysis.

In order to gain an understanding of the experiences of wind farm developers and operators with regard to observed uncertainties in wind farm energy yield prediction, a review of appropriate literature was conducted. From this review it is clear that uncertainty in an energy yield prediction is estimated to vary from 10% for a flat ”Danish”-type site, up to between 18% and 25% for a complex terrain site[9]. The latter figures are extreme and most likely result from a combination of using wind flow models outside their design envelope and lack of knowledge. In a survey, wind farms were shown to produce from 10% under to 8% over the predicted energy yield, with a maximum variation in any one-year of 14%. This provides a reference for the level of uncertainty that can be expected from an uncertainty analysis.

The accuracy of a prediction comes down to the approach taken during the measurement phase and the quality of the correlation and the resolution of the wind flow model. Terra Global personnel have been involved in wind farm energy yield prediction for many years, and we have developed a robust energy yield prediction methodology that minimizes the errors in each of the phases of energy yield prediction. Much of this approach is outlined in earlier sections of this Feasibility Study Report.

Wind Measurement. The uncertainties associated with the on-site wind measurement accuracy are slightly higher than standard as a result of additional uncertainties in the wind speed and direction measurements at Sembo mast (1202); these are due to deviations from recommended mast set-up guidelines as described in IEC guidelines and are estimated to be 6.9% standard deviation on AEP. Included in this is a higher than typical uncertainty included to reflect that a meso-scale modeled product, based on reanalysis data, was used as the reference dataset.

[8] Dekker J.W.M. & Pierik, J.T.G. (1996). Wind Turbine Standards II. European Commission. ISBN: 9282779483

[9] It is the opinion of TERRA GLOBAL that sites with complex roughness can have as much influence on the energy yield prediction as those with complex terrain.

Long-term Reference. The uncertainties associated with the long-term wind speed prediction are higher than typical due to the lack of a suitable reference dataset to perform a monthly MCP analysis, and a value of 6.9% standard deviation on AEP is included.

Annual Variation in Wind Speed. Average wind speed varies on an annual basis. This is not really a prediction uncertainty as one can be certain that the variation will occur. The likely variation can be quantified based on an analysis of variation in long-term wind speeds. Unfortunately CFSR (sourced from Vortex), and other reanalysis products, tend to under characterize the inter-annual variability in wind speed. Consequently, a nominal inter-annual variation of 2.1% was used.

Measured datasets. There is also a significant level of uncertainty of 4.8% standard deviation on AEP in the correlation of the reference and measured datasets determined by jack knife style analysis.

Vertical Extrapolation. The uncertainty associated with the vertical extrapolation from mast height to the proposed hub height is 10.7% standard deviation on AEP, which is very significant due to the relatively large distance.

Horizontal Extrapolation. The uncertainties associated with flow model accuracy have been adjusted to account for the position of the mast relative to the WTG locations that are approximately between 3.9 km and 8.7 km. Other uncertainties include the quality of the model's Weibull fit and the complexity of the site's topography and roughness. The uncertainty associated with the horizontal extrapolation from mast location to the WTG's is 10.0% standard deviation on AEP, which is very significant due to the relatively large distances.

Power Curve. A power curve uncertainty of 5.0% in energy yield AEP has also been included. This uncertainty takes into account that the WTG design power curves are only valid under very specific conditions, which are likely to be different from the wind conditions at the site.

Other. The WAsP wind flow model uncertainty is calculated based on the terrain and roughness complexity. The uncertainty is slightly higher than standard due to the resolution of Shuttle Radar Topography Mission **(**SRTM) topographic data used in the wind flow model. The array loss modeling uncertainty is associated with modeling wake losses. The accuracy of this prediction depends on the model, the spacing of the WTGs and the accuracy of the wind rose. These two factors are accounted for by a 2.0% uncertainty.

The air density correction included in the calculations by Goldwind according to their proprietary knowledge of the turbine airfoil, to account for the low air density at the site (0.87 kg/m^3).

The relationship between uncertainty in wind speed and uncertainty in energy yield is governed by the gradient of the WTG power curve at wind speeds immediately surrounding the mean hub height wind speed for that WTG. The sensitivity of AEP is 2.3% per 1% wind speed.

Table 27 lists the various sources of uncertainty associated with energy yield prediction and values attributed. Combined uncertainty values are given at the bottom of the table.

Table 27 Sources of Uncertainty

Wind Turbine Generator (WTG)	Goldwind GW 93 1.5 MW	
Wind Farm Yield (GWh/annum)	249.8	
Uncertainty Description	Wind Speed (%)	Energy (%)
Site Wind Measurement Accuracy	3.0	6.9
Long-term Wind Speed Prediction	3.0	6.9
Year to year variability	2.1	4.8
Vertical Extrapolation	4.5	10.7
Horizontal Extrapolation	4.3	10.0
Power Curve Uncertainty	-	5.0
Flow Model Accuracy	0.43	1.0
Array Loss Modeling	0.43	1.0
Uncertainty, total, 1 year average		19.0
Uncertainty, total, 20 year average		18.4

8.10 Total Uncertainty

Applying the uncertainties in energy yield and the inter-annual variation in wind speed uncertainty to the energy output of the WTGs gives the results presented in Table 28

The uncertainties are given in three ways:

- **Uncertainty:** This includes only the uncertainty present in the measurement and prediction methodology, and no uncertainty from the inter-annual variation in wind speed.
- **Uncertainty over 1 year, including annual wind speed variation:** This includes both the prediction uncertainty and also the inter-annual variation uncertainty for a single year.
- **Uncertainty over 10 years, including annual wind speed variation:** This includes both the prediction uncertainty and also the inter-annual variation uncertainty for a 10-year period.

Table 28 Debre Berhan Wind Project Uncertainty Summary

AEP Exceedance level vs time horizon	Goldwind GW 93 1.5 MW			
Project Yield (GWh/annum)	249.8			
Capacity Factor	28.4%			
AEP Uncertainty	1y	5y	10y	20y
50% exceedance	249.8	249.8	249.8	249.8
75% exceedance	217.8	218.4	218.7	218.8
84% exceedance	202.6	203.5	204.0	204.1
90% exceedance	189.0	190.6	190.8	190.9
95% exceedance	171.7	173.8	174.0	174.2

8.11 Annual Energy Production

This analysis uses the predicted hub height long term wind speed at the Sembo mast location of 6.7 m/s, which translates to a wind farm mean wind speed of 6.6 m/s at hub height. Goldwind has carried out an internal energy assessment as a part of its bidding process and has quoted for the GW 93 1.5 MW WTG on an 85 m tower.

Table 29 Summary Annual Energy Production Uncertainty

	Value (GWh/y)	%	Uncertainty (%)
Gross AEP*	**291.2**		**18.3**
Bias Correction	0.0	0.0	0.0
Loss Correction	-41.4	-14.2	2.0
Wake Loss		-5.3	
Other losses		-9.4	
Net AEP	**249.8**		**18.4**

* Calculated Annual Energy Production before any bias or loss corrections

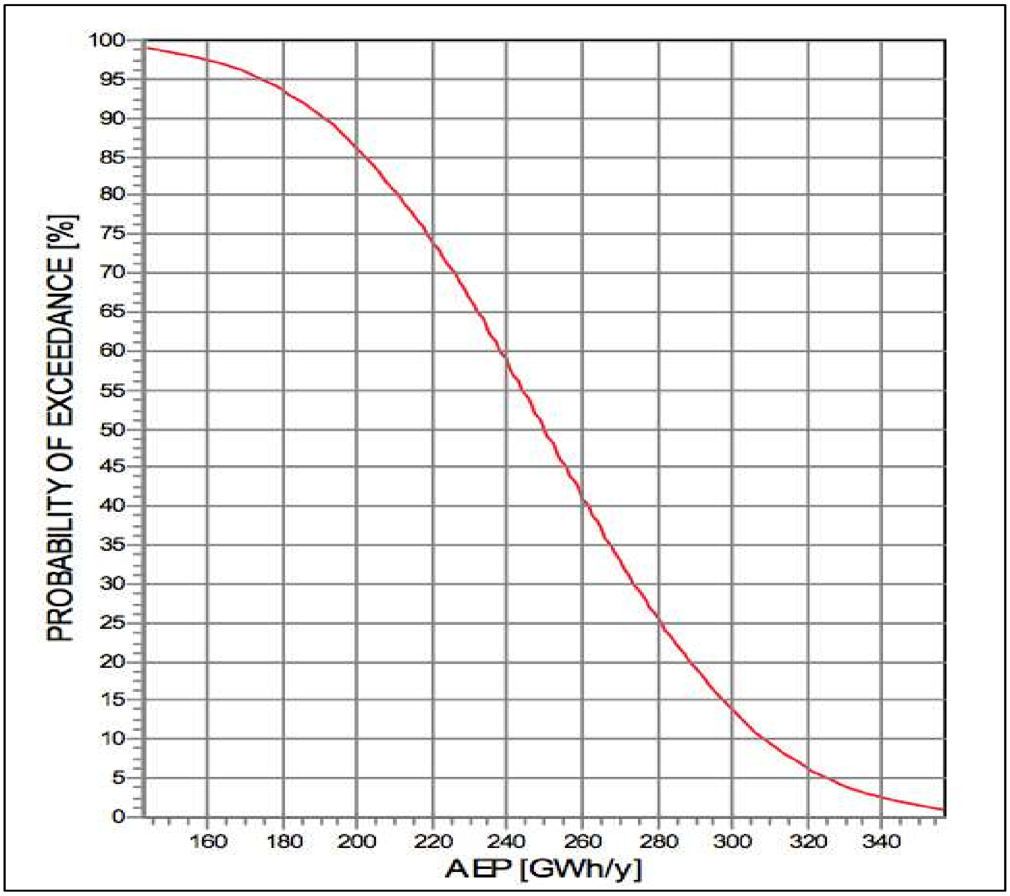

Figure 32 Probability of Exceedance Curve

For a comparison with other suitable wind turbines, Terra Global carried out an analysis using the predicted hub height long-term wind speed at the Sembo mast location of 6.39 m/s with a Weibull K factor of 2.74 and Weibull c factor of 1.12. This was vertically extrapolated to the hub height of each turbine. This is applied as a simplification and means of comparison to all WTGs without redesign of the wind farm. For the same reason, identical loss factors are applied to derive the nominal net wind farm AEP. This process is used to provide AEP numbers for Alstom, GE and Vestas, and as a check on Goldwind.

In the case of Gamesa, the study carried out by SgurrEnergy used the G114 WTGs laid out optimally on the Project Site. Accordingly, the AEP is derived from the SgurrEnergy analysis as shown in Table 30.

Table 30 Nominal AEP Based Upon Weibull Parameters at Sembo

Manufacturer	Turbine Model	Terra Debre Berhan 100 MW Net Production P50 GWh/yr
Alstom	Alstom 2.7 ECO 122	237.4
Gamesa	Gamesa G114/2.0/93	286.2
GE	GE 1.7-103	272.9
Goldwind	Goldwind 93/1.5	249.8
Vestas	Vestas 110/2.0/95	254.5

Goldwind has carried out an internal energy assessment as a part of their bidding process and have quoted the AEP for the GW 93 on an 85 m tower.

9. Internal Wind Park Infrastructure and Cabling

9.1 Overview

Primary Project interconnection substation facilities will include high voltage switchgear, power transformers, MV switchgear and all interconnection equipment. In addition, protection, SCADA and auxiliary systems will be required to ensure that the substation and the Project functions correctly and safely. Electrical infrastructure will be provided to collect the power from the WTGs and step it up to the grid operating voltage. The overall wind farm infrastructure will consist of an MV collection system comprising array circuitry and an interconnection substation, which will step up the collected power to high voltage to allow export onto the 230 kV network.

9.2 Interconnection Facilities

An assessment of the best High Voltage arrangement, transformers and MV arrangement has been carried out. Typical arrangements including spacing requirements have been provided. The assessment considers the first 100 MW phase of the Debre Berhan Wind Farm and also looks at connecting the future phases up to a total of 400 MW. The investigation has taken into account the reliability and cost implications for each arrangement.

9.3 High Voltage Infrastructure

The choice of circuitry for the export of power must be able to export the full power, as well as consider the availability in the event of maintenance and fault conditions. Single and double circuit options for the Project connection are shown in. Figure 33.

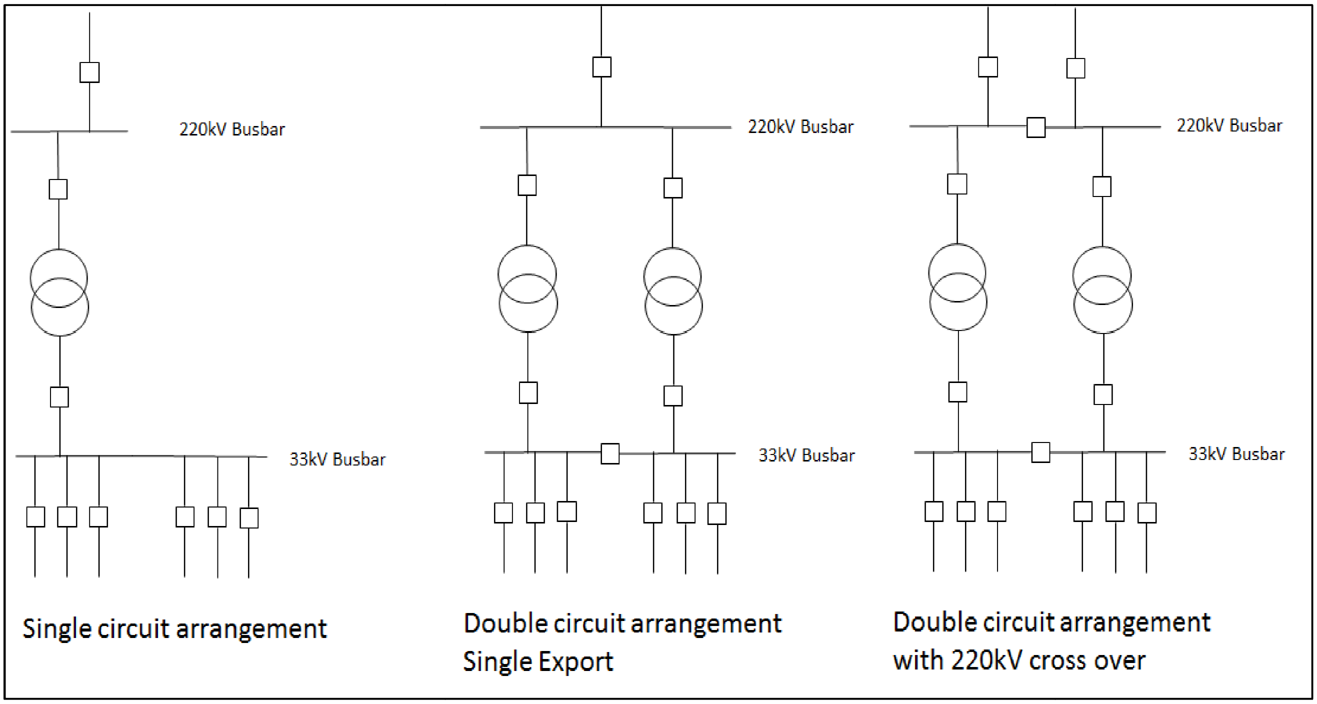

Figure 33 Single and Double Circuit Arrangements

In order to take advantage of the twin overhead line so as to increase project uptime in case of circuit outage, a crossover arrangement on the 230 kV side is proposed. This will also ease the connection of future stages. Installing the bus coupler on the 230 kV side would be a requirement as part of the Project to avoid large maintenance on the system when connecting future phases.

A single circuit leaves the Project exposed to a failure on the transformer. This may result in a severe loss of output while the transformer is repaired or replaced. Typically, double circuit arrangements are utilized in connections of this scale providing availability in the event of transformer failure or maintenance.

It is therefore recommended that a double circuit with cross over arrangement on the 230 kV side is most suited for the Project.

9.3.1 Transformer Arrangement Phase 1, 100MW

A description of the options for transformers is outlined below. Two options assume a double circuit and, for comparison purposes, Terra Global has also investigated a single circuit arrangement utilizing a 100 MW transformer.

9.3.1.1 PHASE 1 OPTION 1 – 2 X 50 MVA TRANSFORMERS:

This is a double circuit option with a cross over connection on the high voltage. This is a relatively standard approach to connecting this scale of wind farm. The connection allows some export of power under a single transformer failure or maintenance. Under short-term maintenance conditions, the transformer can be overloaded to 140%, thereby allowing 70 MW to be exported.

9.3.1.2 PHASE 1 OPTION 2 – 2 X 100 MVA TRANSFORMERS:

This connection option will allow full export from the Project under normal conditions and when one transformer fails or is under maintenance. The arrangement gives an N-1 level of redundancy allowing full export for an unlimited time should a single transformer fail.

9.3.1.3 PHASE 1 OPTION 3 – 1 X 100 MVA TRANSFORMER:

This connection option will allow full export from the Project under normal conditions. The export of power is at risk should a fault occur on the transformer. There will also be no ability to export power during transformer maintenance. This option however doubles transformer and associated switchgear capital cost.

It is therefore recommended that a 2 x 50MVA transformers are most suited for the Project.

A design and arrangement has been carried out for the first 100 MW phase of the Debre Berhan Wind Farm, for which the one-line diagram is shown in Figure 34.

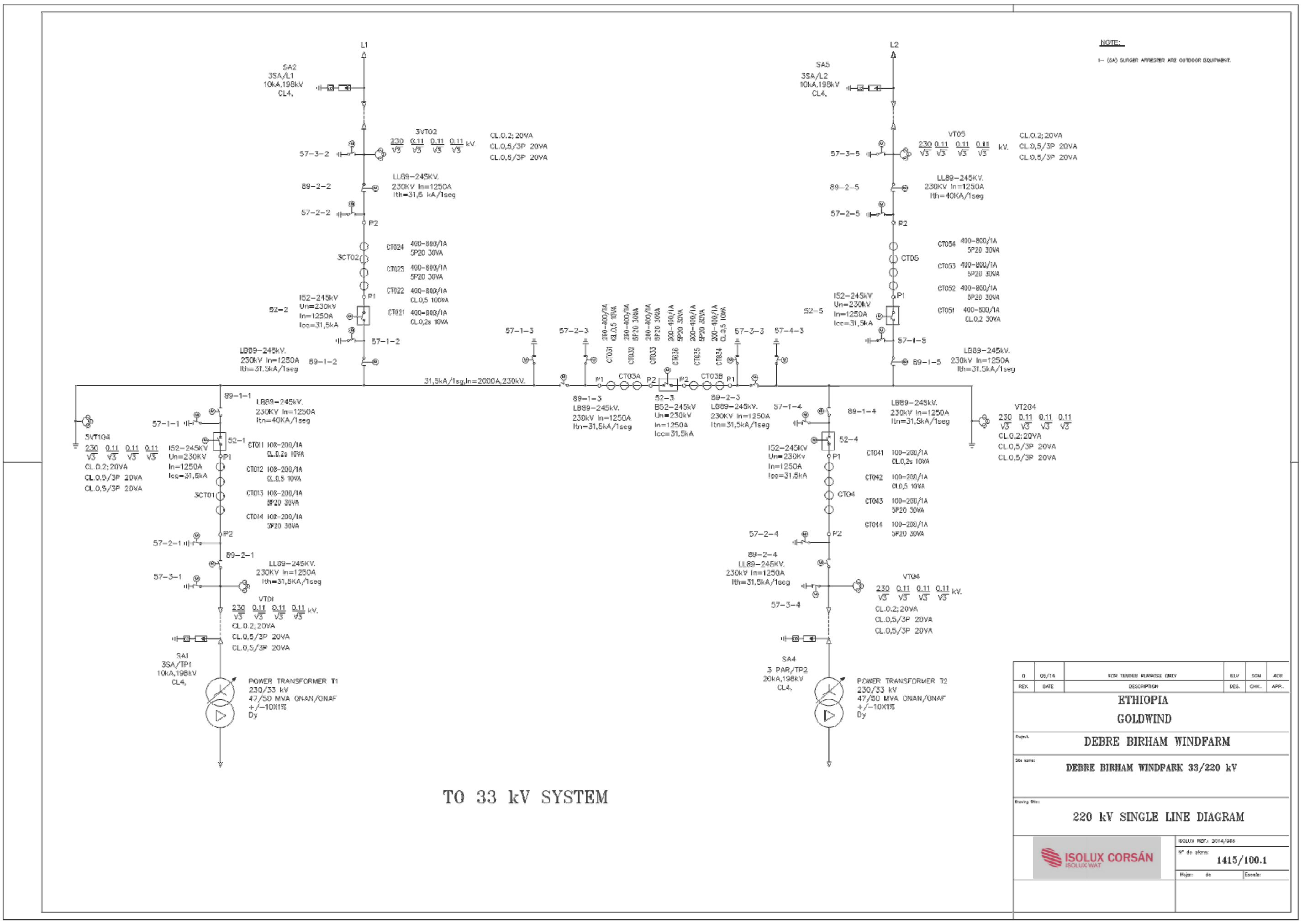

Figure 34 Substation One Line Diagram

The main transformers comprise two 47/50MVA 230kV/33kV oil-filled transformers, having 21 x 1% tappings giving +/- 10% voltage adjustment. Continuous rated power with forced oil and air is 55MVA. Impedance is 10.5% and vector group Dyn11.

The switchyard comprises 230 kV/245 kV Gas Insulated Switchgear using SF6 technology rated at 1250A with current transformers, voltage transformers and lighting arresters. A full bill of quantities is given in Section 19, Appendix O.

The substation is connected to the 230 kV twin-line circuit and is located 2 km North of Sembo as shown in Figure 35

Figure 35 Location of Substation

9.4 Medium Voltage Infrastructure & Collection System

The collection was designed to supply 67 Goldwind 1.5 MW WTGs, which are full converter type. The system operates at 33 kV and is made up of seven arrays.

The MV substation equipment comprises 14 switchgear bays of 33 kV 2000A rated gas insulated, SF6 type. The 33 kV bus includes a bus coupler in bay 8.

The connections to the 220 kV transformers are in bays 6 & 10.

Bays 3, 4, 5, 7, 11, 12 and 13 contain the AC circuit breakers, earthing switches, CT's and VT's each feeding a 33 kV overhead line.

Bays 1 and 14 supply auxiliary power at 400 V via two 160 kVA transformers.

Bays 2 and 13 enable the connection of reactive power compensation and harmonic filters if required. Terra recommends that reactive power compensation will be unnecessary as each of the 67 WTG's is capable of controlling reactive power at the grid side power converter.

The site cabling thus consists of seven collector circuits emanating radially from a two-section bus bar located in the substation. The collector circuits consist of overhead lines running from the substation to each group of WTGs. These overhead lines feed underground cables laid in trenches, which connect the WTGs. The one-line 33 kV diagram of the collection system is shown in Figure 36.

The feeders from the substation to each of the seven groups are 31 km of overhead 33 kV lines. Overhead lines are significantly cheaper than buried cables, although they bring visual impact and are less reliable as they may be subject to disruption during extreme weather. By using buried cable throughout most of the site, road access for maintenance cranes is not impeded. The proposed solution uses an economical combination of overhead and buried cables.

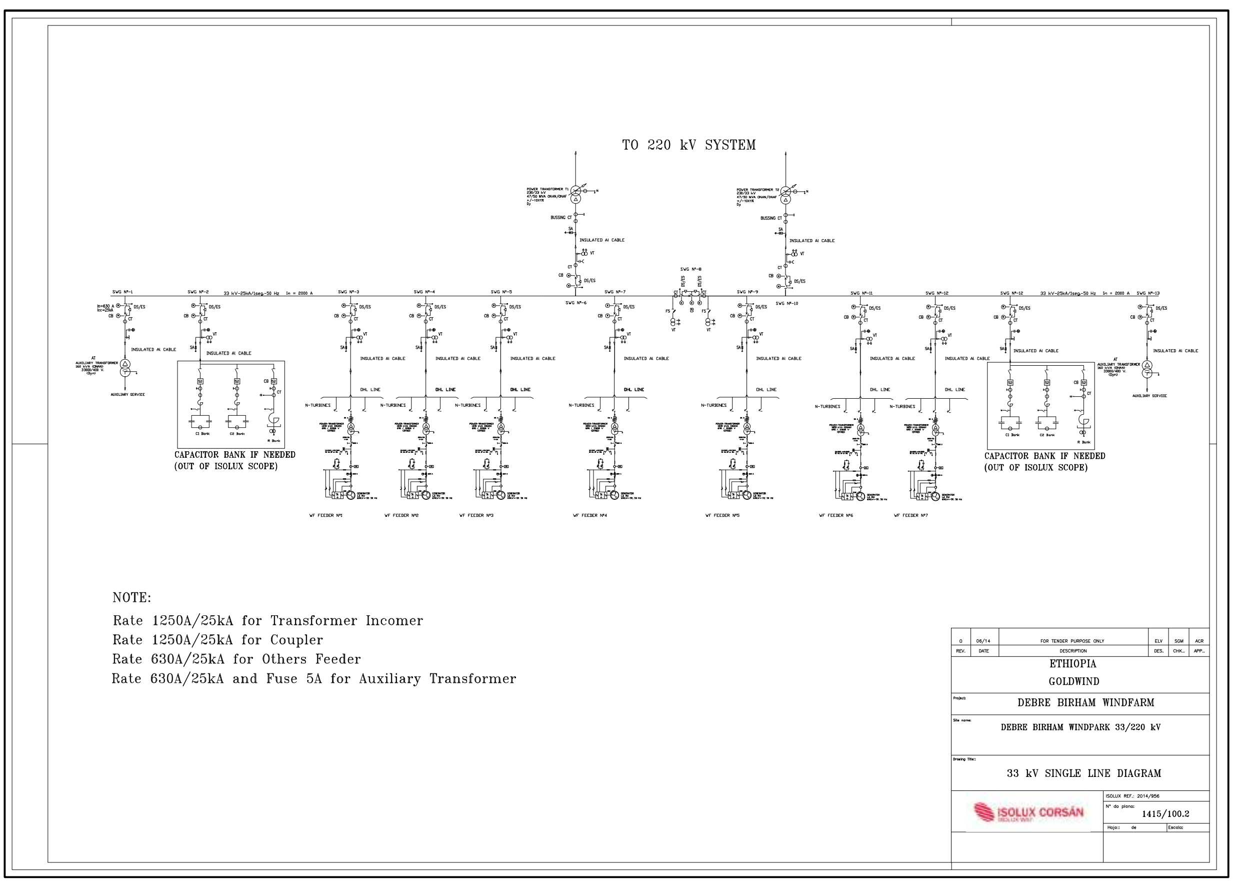

Figure 36 MV Collection System One-line Diagram

This collector circuitry uses the calculated inter-turbine distances plus allowances for pad-mount transformer terminations and for substation terminations. The overall collection system layout is shown in Figure 37. It comprises 111 km of underground aluminum cable of 70, 120 and 185 mm^2 cross section. The earthing cable comprises 61 km of copper and in addition 61 km of fiber optic single mode and multi-mode cable.

The design of the collection system includes fiber optic communication cables and earthing connections required by the WTG suppliers.

Each turbine includes a 690 V 3 phase electrical connection for export power, fitted with a 1600A motorized circuit breaker and protection relays. A short underground cable connects this to the padmount 1600 kVA power transformer, transforming the 690 V voltage to medium voltage of 33 kV. Each padmount transformer is connected to the wind park MV grid through a ring main unit (RMU), a gas insulated SF6 33 kV 630A ac circuit breaker and an isolator which enables the wind turbine to be disconnected and safety earthed without taking adjacent turbines out of service.

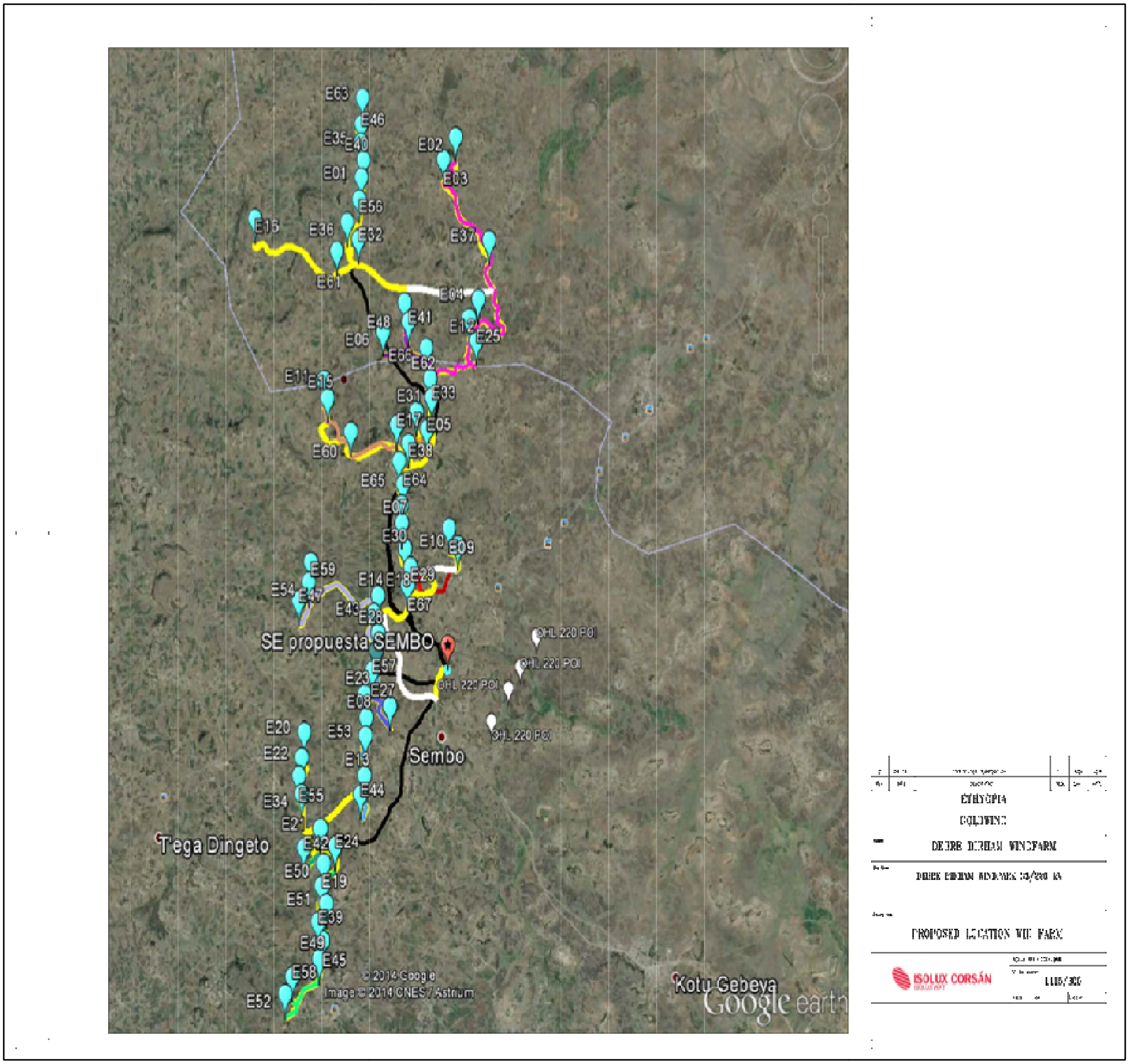

Figure 37 Overall Site Cabling Layout

10. Power Export and Grid Connection

10.1 Grid Infrastructure and Assumed Connection

As described in this Feasibility Study Report, the location of the Project considered the advantage of its close proximity to two existing transmission lines, a 132 kV and 230 kV running parallel to the Project, primarily on the east side of Route 1. These lines run to Addis Ababa offering an effective link to the main load center and overall Ethiopian transmission network. These factors offer significant advantage to export the generation from and minimize the impacts of the Project to grid stability. The 230 kV line has hydro generation within a reasonable distance offering further benefit. Both transmission lines are modern, easily accessed and offer the ability for a Point of Interconnection ("POI"). Terra Global was told that EEP had to be involved in all aspects of the interconnection and grid study, including the design of the study.

An initial meeting was held with the Transmission Planning Dept. of EEP in November 2013 where initial information was provided as well as a contact within the group for the detailed grid stability and network data for examination of feasibility. The determination at the initial meeting was to focus on the 230 kV line for the Project and the follow on phases of the Debre Berhan Wind Farm. While it would cost more to interconnect with the 230 kV line as compared to the 132 kV line, it offers higher reliability, less impact on the grid and a greater expansion capacity. The 132 kV line, while possible to connect to for power export, was considered less desirable for several reasons, including limited capacity and upgrades needed at the substations.

The Project assumptions considered both medium voltage WTGs connected via a 33 kV buried collection system amongst the WTGs and an overhead 33 kV line between clusters and circuit delivery to the POI. This will allow the Project to effectively transmit the energy to a single POI, whereas the later stages of the Debre Berhan Wind Farm will have to consider longer 33 kV runs and an additional POI to avoid incurring sustained losses in the collection transmission.

The typical overhead poles and 33 kV structures already in use nearby are considered suitable for the purpose and the soils lend themselves to cost effective buried conductors and communication cables within the WTG field.

10.2 Interconnection and Export Feasibility

Terra Global commissioned SgurrEnergy to perform a study to consider the feasibility of connecting the Project to the 230 kV line. SgurrEnergy's final report which is entitled "Grid Connection Feasibility" is attached to this Feasibility Study Report as Section 19, Appendix F.

The grid study considered the ability to connecting a total of 400 MW of wind generation to the 230 kV overhead lines near transmission tower #465 south of Debre Berhan and east of the roadway, including options for connecting the wind generation in three stages of 100 MW, 100 MW and 200 MW.

The grid study reviewed the Eastern African Grid requirements and the ability of typical WTGs to meet these, as well as an assessment of the collection system infrastructure report that was issued by Dr. Charles Gamble in November 2013.

The intent was a dynamic review of the immediate EEP network with the assumed wind farm specifications with which to assure that the overall capacity existed and begin a discussion with EEP to establish a path to further grid studies and the eventual POI design.

10.3 Assumptions

The following assumptions were made in the study:

- The point of connection will be near transmission tower #465 on the 230 kV OH line at Debre Berhan as identified on a site visit attended by SgurrEnergy during the week commencing October 28, 2013;
- Initially, wind generation of 100 MW will be installed with a total of 400 MW being installed in two further stages of 100 MW and then 200 MW;
- WTG export power will be collected via 33 kV overhead collector circuits;
- WTGs will be either DFIG or full converter permanent magnet type machines that are rated around 2 MW; and
- EEP will be the Project owner and the transmission system owner, operator and dispatcher.

Figure 38 Pylon and 230 kV Line at the Project Site

The study is based on the following information received:

- PSS power system data received from EEP;
- Future network expansion data from EEP;
- Eastern Africa Power Pool Interconnection code dated January 2011;
- EAPP - Regional Power System Master Plan And Grid Code Study (From EAPP website); and
- Study dated November 8, 2013 by Dr. Charles Gamble.

10.4 Grid Interface

10.4.1 Grid Overview

EEP operates the grid network in Ethiopia, which, as the national electric utility, is responsible for the production, transmission and distribution of electricity throughout the country.

EEP is part of the Eastern African Power Pool, a cross border consortium of national power companies in the region. The consortium coordinates and cooperates in the planning and development of power systems, as well as optimizing the use of energy resources in the region. Other partners in the consortium include power companies from Burundi (REGIDESO), the Democratic Republic of Congo (SNEL), Egypt (EEHC), Kenya (KenGen and KPLC), Rwanda (ELECTROGAZ) and Sudan (NEC).

Ethiopia's present peak demand is about 1,884 GW and the country has interconnectors to neighboring countries including Djibouti, Kenya and Sudan. The EEP transmission network includes infrastructure at 132 kV, 230 kV and 400 kV and has over 10,000 km of transmission lines installed.

Power generation in Ethiopia is dominated by hydro with approximately 2 GW installed as of 2013. A smaller amount of thermal stations (diesel and geothermal) are also connected to the network as are two commercial scale wind farms. The wind farms presently connected are Adama (53 MW) and Ashegoda (120 MW).

A significant amount of generation is due to be connected in the coming years, including the Gibe III and Renaissance Hydro power stations, which are 1,870 MW and 6,000 MW, respectively. In addition there are numerous transmission lines being added to the 132 kV, 230 kV and 400 kV transmission network.

10.4.2 Point of Connection

A possible point of connection has been identified by Terra Global and EEP staff to be near transmission tower #465 on the 230 kV overhead line running adjacent to the Project Site. This line connects the substations at Kotobe and Combolcha and is rated at 300 MVA. At present, there is only one line. However, the pylon has spare capacity for another line to be added in the future. Figure 38 shows the 230 kV line and the pylon at the Project Site.

The line presently has 100 MW transferred between Kotobe and Combolcha. As there is only a single circuit, connection will require a line outage, which will need consideration as the power will need to be rerouted through the network.

10.5. Local Network

Terra Global conducted a high level review of the network in the area where the Project is expected to connect. This review has been based primarily on the load flow model provided by EEP. In addition, a list of future developments on the network has also been reviewed.

Based on the present network configuration and load flow provided, the following upgrades are likely to be required for connection of the various stages of the Debre Berhan Wind Farm:

- Phase 1 – 100 MW
  - None expected
- Phase 2 – 100 MW, 200 MW in total
  - None expected. However, the load flow on the Combolcha to Kotobe line should be carefully considered as it will be at or near maximum rating.
- Phase 3 – 200 MW, 400 MW in total
  - Upgrades expected to avoid overload on the Combolcha to Kotobe line and likely overloads on surrounding network.

We understand that the provision of a second circuit on the Combolcha to Kotobe line is planned, but the date has not been finalized. Assuming that the conductor is rated the same as the first circuit, this would be the minimum works required to allow connection of the third phase consisting of 200 MW. In addition, second conductors on the Combolcha to Alamata and Kotobe to Kaliti substations would likely be required. However, a further load flow investigation would be required to assess this issue.

As a large number of generation projects are due to be completed in the coming years, additional transmission line projects will need to be constructed. These are not included in the PSS model received. The impact these will have on the load flow should be considered prior to the connection of the Project. We understand that it is EEP's intention to conduct a detailed load flow study for the connection of the Project in the near future, which should address this issue.

10.6 Summary of Connections Code Review

The Eastern Africa Power Pool (EAPP) interconnection code puts a number of requirements on users seeking a connection to the EAPP network. This includes the Project. An outline of these requirements, review and description of measures required in order to meet the code dated January 2011 has been undertaken and is described in Section 2.4 of the full report of Debre Berhan Wind Farm Electrical Interconnection Feasibility Report See Section 19, Appendix F.

*Cable losses based on Nexans 19/33 kV single core copper conductor unarmored cable.

10.7 Wind Farm Infrastructure Phases 2 and 3

The Debre Berhan Wind Farm is planned in three phases of 100 MW, 100 MW and 200 MW (in that order). Connecting wind farms of 100 MW or higher in size that are geographically dispersed will require connection to be made at voltage higher than 33 kV. Therefore each subsequent phase will require provision of its own 230 kV substation including switchgear and transformer.

A basic radial connection diagram showing each phase is provided in Figure 39the connection of Phases 1 and 2 being made to the existing overhead 230 kV line. However, Phase 3 will require the addition of the second circuit on the line.

For Phases 2 and 3, double circuit connections similar to the Phase 1 arrangement are shown. The cross connection in this diagram is made at the 230 kV transmission substation. Option to cross connect at the wind farms and run a single 230 kV circuit may result in cost savings.

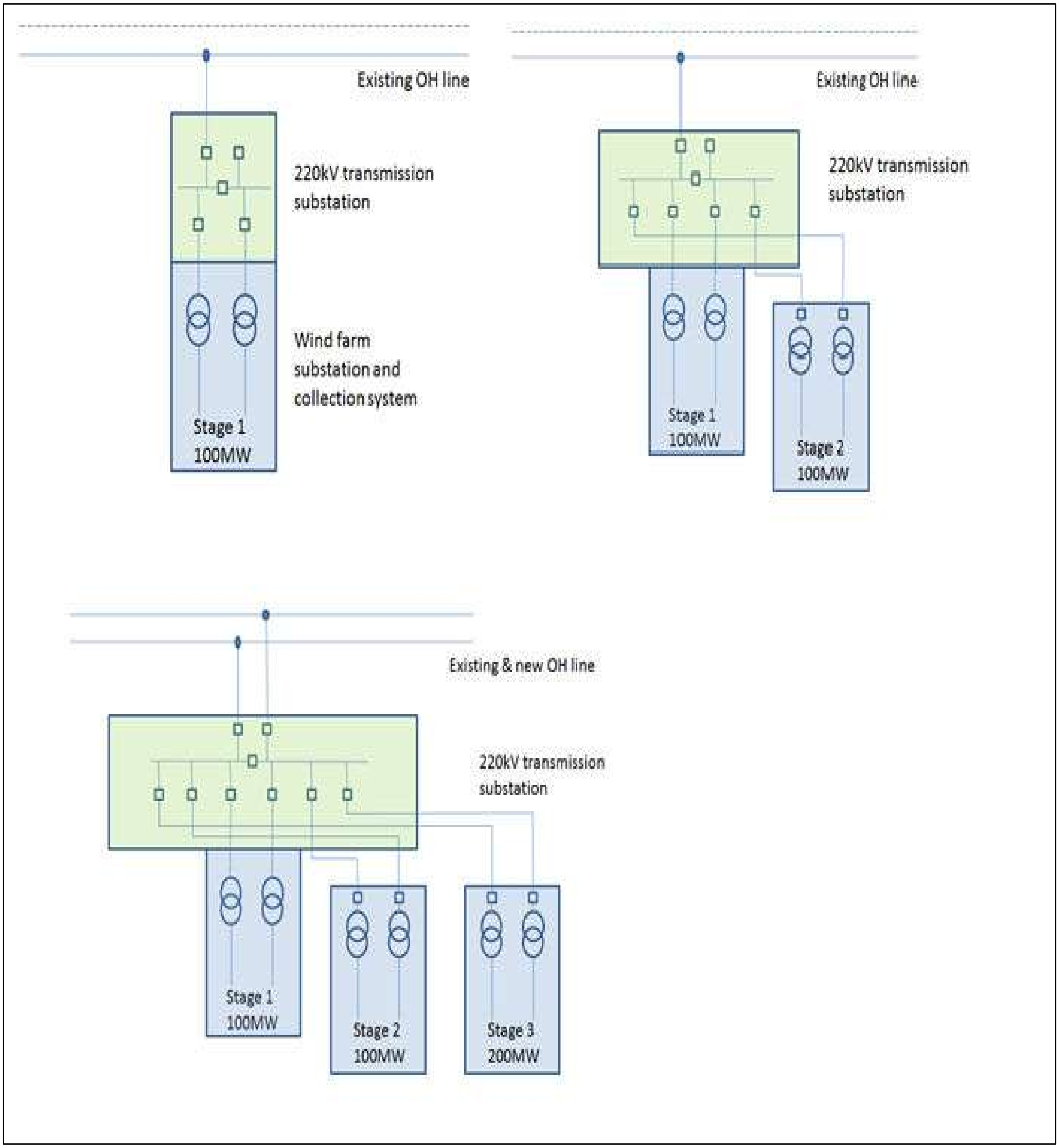

Figure 39 Phase 1 - 3 Connection Plan

10.8 Summary

This assessment of connecting to the 230 kV line for export of the various phases of wind farm development at Debre Berhan is positive.

- Phases 1 and 2 (up to 200 MW) in total may be connected with normal and minimal accommodations;
- Phase 3 (an additional 200 MW for a total of 400 MW), while requiring upgrades and modifications as well as other planned actions to be completed within the larger network, is practical and feasible based on this overall assessment.

The 230 kV line represents an effective export line, has capability for an extra circuit to be added and provides a direct route to the main load center in Addis Ababa.

Multiple design assumptions require clarification and decisions remain to be matured based on EEP practice and the wind farm design. These relate to substation location, practical collection circuits, overhead 33 kV collection lines, length of collection runs as well as substation infrastructure and how much will be built up front for the follow-on phases of the Debre Berhan Wind Farm.

As EEP has adopted the East African Power Pool standards for technical substation interconnect guidance, many of the technical details can be clarified with minimal effort during the design phase, whereas the more important planning, practical design and cost decisions will require further review as well as conduct of formal stability and impact study models and accompanying analysis.

11. Environmental and Social Impacts

11.1 Environmental Policy and Legal Framework

The environmental regulatory framework of Ethiopia is enabled by the Constitution of the Federal Democratic Republic of Ethiopia (FDRE). Adopted in August 1995, the Constitution has several provisions with direct policy, legal and institutional relevance for the implementation of environmental protection and rehabilitation action plans to avoid, mitigate or compensate for the adverse effects of development actions. The concepts of sustainable development and environmental rights are entrenched in the rights of the people of Ethiopia through Articles 43 and 44, which state, among other things, the right to development and the right to live in a clean and healthy environment.

Article 44 provides that all persons have the right to a clean healthy environment and further emphasizes that a discharger of pollutants shall pay in compensation for violating this basic right. Article 92 states that all Ethiopians shall live in a clean and healthy environment with no damage or destruction to impact those basic environmental rights. People have the right to full consultation and the community has the right to express its views in the planning and implementation of environmental policies and as regards the projects that directly affect them. The Government and citizens shall have the duty to protect the environment and mitigate the affected parts.

Subsequent Proclamations and Regulations, all of which the Project will comply with, define Ethiopia's environmental regulatory framework. They are as follows:

- Proclamation on Establishment of Environmental Protection Organs;

  Proclamation No. 295/2002 assigns responsibilities to separate organizations for environmental development and management activities on the one hand, and environmental protection, regulations, monitoring and compliance enforcement on the other. This Proclamation re-established the Ethiopian Environmental Protection Agency as an autonomous public institution of the FDRE. The Proclamation also requires establishment of Regional State independent Regional Environmental Agencies or designate an existing agency that shall, based on the Ethiopian Environmental Policy and Conservation Strategy, ensure public participation in the decision making process and be responsible for coordinating the formulation, implementation, review and revision of regional conservation strategies, and environmental monitoring, protection and regulation;

- Proclamation on Environmental Impact Assessment;
- Proclamation No. 299/2002 makes the performance of the EIA mandatory for specified categories of activities undertaken by either the public or private sectors and is the legal tool for environmental planning, management, monitoring and enforcement;

- Proclamation on Expropriation of Land Holdings and Payment of Compensation;
- Proclamation No. 455/2005 deals with the appropriation of land for development works carried out by the government and the determination of compensation for a person whose landholding has been expropriated;
- Regulations on Payment of Compensation for Property Situated on Landholdings Expropriated for Public Purposes; and
- Regulation No. 135/2007 addresses the payment of compensation for property situated on landholdings expropriated for public purposes. These Regulations were issued by the Council of Ministers pursuant to Article 5 of the Definition of Powers and Duties of the Executive Organs of the FDRE Proclamation No. 471/2005 and Article 14(1) of Proclamation No. 455/2005, with the objective of not only paying compensation, but also to assist displaced persons in restoring their livelihoods.

The Regulations contain provisions on assessment of compensation for various property types (including buildings, fences, crops, trees and protected grass), the permanent improvement of rural land, the relocation of property, mining license, burial ground and a formula for calculating the amount of compensation. In addition, it has provisions for the replacement of urban land and rural land, displacement compensation for land used for crops, protected grass or grazing and provisional expropriation of rural land. Further, the Regulations contain provisions that specify properties for which compensation is not payable and regarding the furnishing of data to compensation committees, records of property, evidence of possession and ownership and valuation costs.

11.2 International Treaties and Agreements

The FDRE is also a party to several international agreements and treaties. The Project will not cause a violation of any relevant treaty or agreement. The following are the treaties and agreements to which Ethiopia is a party that were considered:

- The Basel Convention on Control of Transboundary Movements of Hazardous Wastes and Their Disposal;
- The Convention on Biological Diversity;
- The United Nations Framework Convention on Climate Change (UNFCCC);
- Kyoto Protocol to the United Nations Framework Convention on Climate Change;
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES);
- United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa; and
- The Montreal Protocol on Substances That Deplete the Ozone Layer.

The following Conventions have been signed but not ratified by the FDRE:

- Convention on Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques; and
- United Nations Convention on the Law of the Sea.

11.3 Requirements International Lenders

It is likely that some portion of the financing for the Project will be obtained from one or more of development banks or a bank that is signatory to the Equator Principles. In such case, the environmental and social requirements of the Lenders must also be satisfied.

The ESIA was structured and conducted in a manner in which all environmental and social impact requirements of the GoE as well as those of participating Lenders to streamline the ESIA process and reduce the time and expense required to obtain all of the necessary approvals from the GoE and the Lenders for the commencement of construction and the operation of the Project.

11.4 Physical Environment

Baseline conditions and impacts assessed are separated into the categories of physical and socio-economic. In many instances, one may impact the other. Baseline conditions, possible impacts and mitigation measures are summarized in the following subsections.

11.4.1 Climate

The entire Project corridor is located in the Central Highlands, with an average elevation of 2,850 meters above mean sea level. This along with other factors puts the entire Project corridor in the Dega and Weyna Dega Climatic Zone. The specific study area is typically cool and experiences the "Dega" climate in most months of the year.

The Project area is severely deforested. There are two major rainy seasons, ‘Kiremt’ and ‘Belg’ which also comprise the main source of water for agriculture. The mean annual temperature and rainfall for the plateau area ranges from 20 °C to 25 °C and 500 to 1,600 mm precipitation. (Ethiopian Mapping Agency, 1981).

The Project will have no negative impact on micro-scale, meso-scale and synoptic, regional or global climate. There will be a small net reduction in projected CO_2 equivalent (CO_{2eq}) emissions if offsets of fossil and biomass fuel burning are considered.

11.4.2 Topography

The landform of the Project corridor is dominantly flat and rolling, but also mountainous areas are significant along the ridgeline where the wind turbine generators (WTGs) will be installed. The specific topography of the Project is largely characterized by flat lying plateau and is categorized as the Central Highlands of Ethiopia, with an average elevation of from 2,600 to 3,050 meters above mean sea level and with some undulating ridge chains and dissected valleys. The micro-topography of the proposed WTG sites is an undulating hill landform where the ground on the top of hill is relatively flat and the relative height difference is small.

The Project will result in minimum disturbance of the topography. Primary impacts will be the leveling of the WTG pads and the installation and/or upgrading of the existing roads. The estimated final disturbed area per WTG is < 4 acres according to the Land-Use Requirements of Modern Wind Power Plants in the United States, Technical Report (August 2009NREL/TP-6A2-45834) for a total of approximately 200 acres. Expanding the area to include the recommended buffer area of 228 meters radius around each WTG to protect against possible impacts of tower failure and blade or ice throw results in a total permanent land requirement of approximately 2.6 km^2 or 642 acres.

11.4.3 Geology

The Ethiopia Plateau, including part of the Project Site (NC37-11), is composed of thick Tertiary volcanic successions (Zanettin et al., 1974; Tefera et al., 1996) and the volcanism is classified into three phases separated by a long period of volcanic quiescence; the pre-Oligocene (alkaline to tholeiitic basalts), the Oligocene-Miocene and the Miocene-Pliocene (Zanettin et al., 1978). Zanettin et al. (1980) later reclassified the volcanism as Oligocene-Late Miocene Alaji basalts and rhyolites, and the Tarmaber basalts. Following Zanettin et al. (1978, 1980) classification scheme, Berhe et al. (1987) divided the volcanic rocks of Ethiopian plateau into First Phase (Ashange, pre-Oligocene), Second Phase (Aiba, 34-30Ma), Third Phase (Alaji, 30-26 Ma) and Fourth Phase (Tarmaber, 25-13Ma). The Tertiary volcanic successions are mainly consisting of Ashange basalts, Aiba basalts, Alaji rhyolites and basalts, Tarmaber basalts and Balchi rhyolites (Zanettin et al., 1974; Justine-Visentine et al., 1974; Kazmin, 1979).

The Project will result in minimum disturbance of geology and will be primarily from sand and gravel extraction operations. All such operations will be required to be permitted and operated in accordance with local environmental regulations.

11.4.4 Seismicity

According to the Ethiopian Building Code Standard (EBCS-8, 1995), Ethiopia is divided into five Seismic Zones (Zones 0, 1, 2, 3 and 4). The seismic hazard Zone 0 is the least hazardous Zone or zero seismicity Zone whereas Zone 4 is a very high seismicity zone. Zone 4 is located in the main Ethiopian Rift system and almost all epicenters with Richter scale magnitude of 5 or higher are located in Zone 4. Debre Berhan and the surrounding area are located in seismic Zone 4 and have a bedrock ground acceleration ratio of 0.10. The design acceleration for each Seismic Zone corresponds to a reference return period of 100 years.

11.4.5 Land Use and Land Cover

The predominant land use and land cover along the Project Site is cultivation of annual crops that cover over 90% of the land area along the corridor. Annual crops, mainly cereals, are cultivated, teff, barley and wheat being predominant. Other major crops include peas, bean, haricot bean, lentil and oats. Grazing land, eucalyptus and bush lands and settlement areas cover the remaining land area at the Project Site. The land use pattern is more intensive cultivation and even areas with steeper slopes are under cultivation.

The vegetation in the Project area has been severely modified by human activities. Deforestation particularly for expansion of croplands and settlement areas has seriously degraded the forest resources of the area. As a result, only some patches of remnant and scattered trees are left standing, mostly on steep slopes of the mountainous areas that are considered to be marginal lands for agricultural activities or settlements. The other vegetation type found in the Project area is the exotic eucalyptus plantations, found mostly around local settlement areas as backyard trees and in marginal lands for cultivation. The remnant-scattered trees have essential roles in conservation of flora and fauna, soil and water, and the preservation of a spectacular landscape; the predominant species being *Podocarpus falcatus* (Zigba) which is among the protected or endangered indigenous tree species in the country.

There are a diversity of indigenous tree species and other flora in the project corridor. The major tree species include *Podocarpus falcatus, Olea europaea (Weyra),* Juniperus procera (Tsid), *Croton macrostchayus (Bisana), Ficussur (Shola), Cordiaafricana (Wanza), etc.*

The Project will result in minimum disturbance of ground cover and will likely result in a net improvement based on the mitigation measure of seeding of disturbed or barren areas that currently exist or may be caused by installation of the WTGs, roads and other associated facilities.

11.4.6 Air Quality

There is no existing air quality data for the Project area and there are no major sources of air pollutant emissions in the air shed of the Project area.

The Project will result in minimum air pollutant emissions. Emissions will be primarily as fugitive dust from unpaved roads and diesel emissions of trucks, other heavy equipment and portable generators. Mitigation measures will include wetting of roads during high dust conditions, imposition of Project Site speed limits to reduce re-entrainment of road dust by project vehicular traffic, and proper application of grasses for ground cover and soil stabilization.

11.4.7 Water Quality

The Project is situated in a watershed dividing (Ridge) line where the existing corridor is relatively seen as less liable to major drainage problems. The overall watershed area of the Project has only minor streams. The ridgeline where the WTGs will be situated is a water divide line that divides the western side of the ridge, which drains to west to join the Blue Nile basin, and those originating on the eastern part of the ridge drain to the east to join the Awash River. The Project is located near the west Rift margin with dissected features due to the normal faults and streams while the western part is also dissected by rivers and their tributaries.

There are no major rivers or perennial streams in the Project area. However, although there is no major river, the area experiences erosion as the catchment area is bared and holds runoff during the rainy season.

The Project will result in minimum impacts on water quality. Very little water will be consumed during the construction phase. Proper grading, good engineering practice in site design and soil stabilization by means of ground cover, and proper design of WTG foundations, overhead transmission lines, underground cable installations and access roads will also result in decreased erosion and impacts of run-off on surface waters.

11.4.8 Solid Waste

The Project will result in the minimum generation of solid waste during the construction phase, as utilization of materials will be optimized. Any solid waste generated will be reused, recycled or disposed of in accordance with applicable regulations and good engineering practice. There will be almost no generation of solid waste during the operational phase of the Project other than in connection with maintenance activities.

11.4.9 Noise

There is no information on or baseline data for ambient noise levels in the vicinity of the Project area. However, with the exception of erratic traffic noise along the Addis Ababa- Debre Berhan road, the rural nature of the Project area suggests that noise levels are likely to be below the World Health Organization guideline value of 65 A-weighted decibels equivalent continuous level.

Noise during the construction phase of the Project will result primarily from the operation of heavy equipment, and possibly pile driving and blasting as may be required. Such activities will not be conducted during nighttime hours or during religious activities or celebrations. Operation of the WTGs will result in continuous and impact low frequency noise. Noise impacts will be estimated using vendor-provided sound levels as input to noise attenuation models and isopleth maps generated to show estimated levels of impact as dB(A). Mitigation measures will also include use of low noise blade and power generator design.

11.4.10 Visual

The visual impacts of the Project are obvious, with installation of ~ 85 meter towers and associated nacelles and blade assemblies. Computerized modeling of visual impacts superimposed on existing visual conditions will be performed and results presented for public review. Mitigation measures will include selection of camouflaging colors for the towers, nacelles and blades, so as to better blend in with the environment. Blade glint will diminish over a short period of time, as blade surfaces become soiled and oxidize, thereby becoming less reflective. Blade shadow flicker impacts will be minimized by adherence to the 228-meter radius buffer zone around each WTG. Specific siting of WTGs will also be used to minimize near field visual impacts of glint and flicker.

11.4.11 Biological

There are no areas designated for wildlife conservation in the Project area or its vicinity. Because of habitat alteration by anthropogenic activities, most of the Project corridor has no significant habitat that could support wildlife. However, according to local people, wild animal species that are common in many parts of the country like spotted Serval Cat, hyenas, hare, duiker, warthog and jackal are seen in the Project area with the spotted hyenas most frequently seen. A survey of the International Union for Conservation of Nature’s current “Red List” indicates that there are no rare or endangered animal species known to be in the Project area. The Project area is also neither contiguous with, nor in close proximity to any of the nationally or regionally protected habitats for rare or endangered animal species.

Birds and bats are of particular concern for wind energy projects, particularly migratory birds, raptors, soaring birds and endangered species. There is no area particularly designated for bird life conservation in the Project area or in its vicinity. However, the usual open-country birds like pigeons, cattle egret, crows, seedeaters, birds of prey, etc. are found dispersed throughout the Project area. The intensive cultivated cereal fields in the area are a major feeding place for seedeaters, particularly pigeons, which roost in the city.

The Ethiopian Wildlife and Natural History Society will be consulted with respect to birds, bats, migratory pathways and sensitive habitats in the project area. During the operation phase of the Project, constant monitoring of bird and bat strikes are to be conducted by Project personnel. No remediation measures are expected to be required.

11.4.12 Socio-Economic

Socio-economic concerns are addressed under the areas of demographics, cultural, agricultural, other economic activities, infrastructure and public safety.

11.4.13 Demographics

Based on the 2000 E.C. (2007/08) census projection for 2013, the total population of the two Woredas where the Project is located is approximately 157,954. The Project vicinity is generally densely populated with an average person per square kilometer density of approximately 152. In addition, almost all (more than 93%) of the population in this area is rural, mainly based on a rain-fed agriculture livelihood year round.

Regarding ethnicity, the majority of the population in the Project area is Amhara and Oromo, with Amharic and Oromiffa being the dominant spoken languages. With respect to religion, the majority of the people in the Project area are Orthodox Christians with the balance being primarily Muslim.

No adverse impacts on demographics in the Project area are expected.

11.4.14 CULTURAL

Culture and cultural heritages are reflections of peoples' identity and the objects of their pride. The whole idea of culture, besides encompassing innumerable societal values, has tremendous economic value, both at national and regional levels.

Enquiries to residents in the Project area have indicated that there are no known sites of historical or archaeological significance in the Project area or its vicinity. However, field investigation conducted during this study indicated that there is one Orthodox Church within the Project boundary.

11.4.15 AGRICULTURAL

Smallholder farming is the basis for subsistence for the population of the Woredas in which the Project will be located, and the population of the potentially impacted Kebeles in particular. More than 90% of the population in the Project area depends on both subsistence rain fed farming and/or mixed livestock production and farming.

Crop production is the mainstay of the population in the project area. Various types of crops are cultivated in the Project area, with cereals dominating. Of cereal crops, barley and wheat are predominant. Other major crops include peas, beans, haricot beans, lentils and oats.

Crop yields are generally low primarily owing to the traditional manual, generally non-mechanized means of farming and low level of agricultural input (fertilizers, herbicides and pesticides) and overall degradation of soil fertility. In order to compensate for the low yield and meet the food requirements of the ever-growing population, farmers have put most of the available land under cultivation. This has resulted in destruction of forests, cultivation of marginal lands, lack of a fallowing system and degradation of soil fertility due to soil erosion and depletion of nutrients. There are two cropping calendar in the project area, the Meher and Belg seasons. Meher is the main cropping season. Most cereals are planted beginning in June and harvested from November to January. The major crops cultivated during the Belg season are wheat and barley, which are planted from March to April and harvested from June to July.

Livestock production is an integral part of the farming system in the Project area and is economically complementary to crop production. The main livestock population is comprised of cattle, sheep, goats, equines (donkeys, horses and mules) and poultry. Oxen are the major source of draft power and donkeys, mules and horses are the source of transportation from and to the farm. The livestock resource supplies cash income and serves as an investment against financial risk to the family. In times of famine, the livestock are sold to purchase food.

Major livestock feed sources are primarily the natural pastures, fallow land and crop residues. It is reported that the grassland areas are shrinking year by year due to the need for additional cropland to feed the growing population. The bush/shrub land in the Project area is used for livestock grazing and assumes communal ownership. Considering the increasing livestock population to limited availability of grazing land, care should be taken not to further reduce the available grazing resources in the area.

While there may be small impacts on overall agricultural activities, under the terms of the Resettlement Action Plan (RAP) to be developed for the Project, all the adversely impacted parties will be compensated in accordance with Ethiopian law. The RAP and the implementation thereof will be the responsibility of EEP.

11.4.16 Other Economic Activities

Other economic activities include construction and cottage industries, both of which support very small numbers of the population in the Project area.

The Project will bring a substantial number of jobs to the local workers and supporting businesses during the construction phase, and a smaller number of ongoing employment positions during the operations phase.

11.4.17 Ground Transportation

With the exception of heavy equipment transport to the Project site, no impact on local ground transportation is expected. Proper traffic control and management will be exercised as needed. There will be no impacts on ground transportation during the operational phase except during the performance of major maintenance activities.

11.4.18 Aviation

As confirmed in meetings with the Ethiopia Civil Aviation Authority, there are no low level flight paths, aviation beacons, communications facilities, radar installations or planned development of airfields in or near the Project area. In accordance with Ethiopian and international standards, the WTGs will be installed with proper markings and aircraft avoidance lighting systems.

11.4.19 TELECOMMUNICATIONS

According to the staff of Ethio Telecom staff, there are no Ethio Telecom relay towers or transmission facilities in the Project area, nor is it expected that the WTGs will have any adverse effect on radio, television or telephone communications in the Project area.

11.4.20 PUBLIC ACCESS

Safety issues may arise with public access to the WTGs e.g. unauthorized climbing of the WTGs or to the Project substation. Prevention and control measures to manage public access issues that will be used as appropriate include installing gates on access roads, fencing the individual WTGs and substation to prohibit public access, preventing access to turbine tower ladders and posting of information boards about public safety hazards and providing emergency contact information.

11.5 Conclusions and Recommendations

11.5.1 CONCLUSIONS OF THE ESIA

The construction and operation of the Project is expected to bring several significant socio-economic benefits to the Project's area of influence as well as to the nation at large. The Project will enhance economic and social developments along the Project corridor and these developments are likely to lead to much improve quality of life for the local communities. Because of the expected positive effects of Project construction and operation, and currently low level of investment in the area, the Project is socially and politically highly desirable.

The construction and operation of the Project has the potential to cause a number of significant adverse impacts on both the natural and socio-economic environments. Most of the potential negative impacts will occur mainly in relation to the WTG locations, land acquisition, execution of the construction works and exploitation of material sources for roads. If it is not properly managed, such impacts could include unnecessary additional loss of land under various uses, soil erosion, air and noise pollution, loss of important indigenous trees, disturbance of wildlife, displacement of people and potential safety issues. Many of the adverse impacts will be of temporary nature, and all will be reduced to acceptable levels through good engineering design, good construction methods and integration of environmental mitigation and management measures in to the planning and execution of the Project.

There will also be several permanent impacts on land along the Project right-of-way, including the resettlement of people, who will be adequately compensated in accordance with Ethiopian law and the RAP.

The overall conclusion is that all significant negative environmental and social impacts of the Project can and will be reduced to acceptable levels with good engineering practices and proper environmental management activities, assuring environmental sustainability and social acceptance. Furthermore, any remaining negative impacts will be more than equally offset by positive impacts.

11.5.2 Recommendations of The ESIA

As indicated above, the implementation of the Project has the potential to cause negative but mitigatable impacts on the natural environment as well as the socio-economics of the local community within the direct impact area.

As part of the Resettlement Action Plan ("RAP"), it is strongly recommended that the concerned stakeholders and the local community be properly and promptly communicated with, and involved in the Project's implementation activities starting with the site preparation and pre-construction phase and throughout the construction and operations phases. The key bodies to be involved should include each Woreda Administration Office, Agricultural Offices, Women Affairs offices, Health and Police Offices, Kebele Administration as well as the local community and particularly affected parties.

12. Contracting

12.1 Ownership

EEP, which is wholly owned by the GoE and the sole electric utility operating in Ethiopia, will be the owner of the Project. EEP will enter into a turnkey engineering, procurement and construction contract (the "EPC Contract") with Goldwind (the "EPC Contractor") for the construction of the Project to mitigate certain of the cost and other risks associated therewith. EEP will also enter into a Warranty, Operation and Maintenance Agreement (the "WOM Agreement") with Goldwind for the maintenance of the WTGs during the 2-year period following completion of the construction of the Project to ensure the performance of the WTGs in accordance with the warranties provided by Goldwind and to repair any defects during such period.

A consortium of banks (the "Lenders") arranged by the Industrial and Commercial Bank of China ("ICBC") and the Bank of China ("BOC") will finance 85 percent of the cost of the EPC Contract. EEP will enter into various finance agreements with the Lenders. The loan made by the Lenders will require a sovereign guarantee from the GoE.

12.2 EPC Contract

Pursuant to the EPC Contract, Goldwind will be responsible to engineer, procure and construct the 100 MW wind energy facility comprising the Project for a fixed price and with a firm delivery date. Goldwind will utilize the Conditions of Contract for EPC/Turnkey Projects (Silver Book) as the basis for the EPC Contract with particular conditions to be negotiated by EEP and Goldwind. The final form of the EPC Contract will have to meet the requirements of (i) EEP as the owner of the Project, (ii) the Lenders providing 85 percent of the financing for the Project and (iii) Goldwind as the contractor for the Project.

Upon issuance of a notice to proceed from EEP, Goldwind will provide for and/or furnish all the engineering services, design services, supplies, equipment, materials, consumables, supervision, labor and any other services required to perform the engineering, design, equipment and machinery procurement, quality assurance and inspection of such equipment and machinery, construction, installation, start-up, testing and commissioning of the Project and the training of EEP's personnel. Set forth in the following are the main elements of the scope of work that is to be performed by Goldwind under the EPC Contract:

- Prepare all construction drawings, installation drawings and instructions, tests procedures and other materials and information required to construct, test, start up and commission the Project and deliver the final as-built drawings of the Project to EEP;

- Perform its obligations to cause the Facility to meet all relevant codes and engineering standards as required by applicable law and in accordance with good engineering practices and inspect or cause to be inspected all materials and equipment to be incorporated in the work;
- Procure and cause to be delivered to the site the WTGs and all of the other machinery and equipment required for the Project;
- Supply all labor, utilities, materials, parts, supplies and consumables required in connection with the performance of the work;
- Design all aspects of the Project, including the foundations for the WTGs, all civil works, the interconnection facilities, and install, construct and complete the Project, including all the civil works, the WTGs, the substation, the step-up transformer and the interconnection facilities;
- Commission, test and start up the Project in accordance with all of the requirements of the EPC Contract;
- Secure, if necessary, all of the off-site storage and other facilities required for the delivery of the WTGs and other equipment and materials to the site;
- Provide training for EEP's personnel;
- Delivering the agreed compliment of spare parts and special tools required for the WTGs and balance of plant to the site;
- Working in close cooperation with EEP, complete the interconnection to the grid;
- Secure all permits required for Goldwind to perform the work (all permits required for the construction and operation of the Project to be procured by EEP);
- Erect and maintain, as is required by the condition and progress of the work, all necessary safeguards for the safety and protection of life and property at the site;
- Not manufacture, use, store or dispose of, or deliver to, the site any hazardous materials except to the extent necessary to perform its obligations under the EPC Contract, any such manufacture, delivery, use, storage and disposal to be performed in compliance with all applicable laws;
- Provide EEP each month with a progress report on the conduct of the work, substantially in the form agreed to by the parties, including an updated version of the project timeline, with such additional detail as EEP or ICBC may reasonably request from time to time;
- Timely make payments to all subcontractors and suppliers in accordance with the terms of the applicable agreements with such parties;
- Provide appropriate marine cargo insurance covering the WTGs and all other equipment from the time it leaves the factory until it is delivered to the site and an appropriate all-risk insurance policy covering all normal risks of construction;

- Provide such additional equipment and perform such additional services as needed to deliver EEP a fully functional 100 MW (gross) wind energy facility as contemplated by the EPC Contract and consistent with good engineering practices;
- Delivering the O&M Manuals and all other manuals identified in the EPC Contract to EEP; and
- Remedy all defects occurring within two (2) years of the date of final acceptance of the Project (which will require the execution of the WOM between Goldwind and EEP).

As owner, EEP shall be responsible for securing all of the land rights and all permits required for the construction and operation of the Project from all GoE agencies, managing the community and landowners that are affected by the Project and providing access to its electricity network to enable Goldwind to complete the interconnection of the Project with the network, including performing any outages or switching operations required to achieve such interconnection.

The contract price (the "Contract Price") under the EPC Contract will consist of all the direct costs for the engineering, procurement and construction of the Project, including all of the items of work required to be performed by Goldwind and all customs duties, VAT and other taxes imposed by China and any other governmental authority outside Ethiopia. Goldwind shall be exempt from the payment of all customs duties, import fees, VAT and taxes in Ethiopia. Notwithstanding the foregoing, the withholding of corporate income tax which is levied by the GoE on non-resident subcontractors who are not registered in Ethiopia pursuant to the EPC Contract, shall be treated as a provisional sum and shall be reimbursed by EEP.

Based on the preliminary negotiation of the terms of the EPC Contract with Goldwind to date, the total direct cost of the Project (and thereby the Contract Price) is US$238.8 million. The Contract Price is a fixed price and shall only be adjusted for change orders issued by EEP. A change order will be issued by EEP for the following: (i) an addition to the work required by EEP; (ii) the occurrence of a force majeure event or any delay not due to the fault of Goldwind which entitles Goldwind, pursuant to the terms of the EPC Contract, to an extension of time or an increase in the Contract Price if its schedule is impacted or its costs are increased as a result of such force majeure event or delay; (iii) major increases in the cost of key commodities; and (iv) the occurrence of any other event which entitles Goldwind, pursuant to the terms of the EPC Contract, to an increase in the Contract Price if its costs are increased as a result of such event.

12.3 WOM Agreement

The WOM Agreement shall be for a fixed fee of US$4.1 million per year and will cover all costs of operating and maintaining the WTGs during the two-year period following the completion of construction and any repairs required to correct any defects with respects to the WTGs.

12.4 Finance Agreements

ICBC and BOC will act as the lead arrangers for the consortium of banks providing the financing for the Project (such banks, the "Lenders"), it being agreed that if no other banks agree to join the consortium, 100 percent of the financing will be provided by ICBC and BOC. Two key conditions of the loan from the Lenders are (i) a sovereign guarantee of the loan by the GoE and (ii) export credit insurance from Sinosure.

EEP will enter into a standard package of financing agreements with the Lenders. Typically, ICBC and BOC will not commence the drafting and negotiation of the financing agreements until after Sinosure has received the approval for its issuance of the export credit insurance. However, based on the desire to expedite the start of the construction of the Project, ICBC and BOC are willing to draft and negotiate the financing agreements in parallel with the Sinosure approval process subject to the receipt of a letter of interest to do so from EEP.

13. Derivation and Review of Total Project Cost

This Section 13 discusses the preliminary estimates of total Project cost and its use in the pro forma financial model developed by Terra Global for the purpose of comparing the indicative pricing proposals of the WTG suppliers and all other relevant criteria to make a preliminarily assessment of the levelized cost of energy (the "LCOE") for the Project with each WTG.

13.1 BOP Costs

Table 31 below presents the BOP costs as quoted by Goldwind and estimated by Terra Global for the other 4 suppliers and subject to detailed design and costing by the EPC contractor.

Table 31 Summary of BOP Costs of All WTGs Considered

	Alstom	Gamesa	GE	Goldwind	Vestas
Civil Works and Buildings					
General, Env, Office,	8,172,262	8,177,993	8,134,155	6,818,347	8,154,227
Civils works and roads	19,716,942	19,730,769	19,625,002	16,450,395	19,673,429
Civil Works Total	27,889,205	27,908,762	27,759,156	23,268,742	27,827,656
Crane Cost	Inc. in turbine	Inc. in turbine	Inc. in turbine	Inc. in turbine	Inc. in turbine
Installation	Inc. in turbine	Inc. in turbine	Inc. in turbine	Inc. in turbine	Inc. in turbine
Electrical & Grid Connection					
HV Transmission line*	5,497,843	5,501,698	5,472,206	4,234,157	5,485,709
HV Grid substation	5,834,695	5,838,787	5,807,488	4,868,049	5,821,819
SCADA and Telecomms	4,426,531	4,429,635	4,405,890	3,409,088	4,416,762
Other Direct Costs					
Shipping BOP Equipment	28,296,892	28,316,735	28,164,943	36,161,050	28,234,444
EPC Eng. Service	1,495,818	1,496,867	1,488,843	1,248,002	1,492,517
Training of Customer	1,128,594	1,129,386	1,123,331	941,617	1,126,103
QC, HS&E, etc.	258,490	258,671	257,284	150,749	257,919
TOTAL BOP	**74,828,067**	**74,880,540**	**74,479,142**	**74,281,454**	**74,662,930**

*HV Transmission line provisional sum

The Goldwind bid is characterized by higher overall shipping costs resulting from the longer shipping route from Asia. This is balanced however by lower installation and civils costs resulting from the smaller machine dimensions and weights and crane costs. Some costs such as SCADA & telecoms, EPC service and training are lower it is surmised because of their presence in Ethiopia. Goldwind has included the HV line, at a lower cost than the provisional sum that is used for the other suppliers, based upon length, capacity and transmission per km costs from experience.

13.1.1 Potential for Local/Regional Input – Grid Connection

It is part of the EPC submission by Goldwind that local input to the Project is realized through local Ethiopian contractors responsible and experienced for construction of the substation, grid connection work, and wind farm internal and external cabling.

13.1.2 Potential for Local/Regional Input – Civil Works

Besides this there are some additional tasks to be done by local staff and Ethiopian companies for all other civil works like:

- Road construction;
- Trenching for internal and external cabling trenches; and
- Erection of control building at the site and building of the foundation can be done with local materials and local staff.

13.1.3 Training for O&M

Training measures have to be organized by the manufacturer to train the local experts by beginning with basic knowledge on wind energy. With wind farms established and in process this is proceeding in Ethiopia. Currently Goldwind is training local staff at Adama and no doubt well-experienced wind energy experts in the field of wind turbine technology will increase in Ethiopia. This in turn will help to lower O&M costs.

13.2 Comparison of Operation and Maintenance and Repair Costs

13.2.1 O&M Staffing

The objective of operation and maintenance is to create the highest possible technical availability at reasonable costs. To achieve this goal it is favorable to divide the O&M activities between the manufacturer's staff and local operation staff. Service teams of the manufacturer at the Debre Berhan site will be established in order to fulfill high quality of maintenance during the warranty period and also to shorten the reaction time in case of failures of the wind turbines. It is envisaged that the manufacturer will be obligated to arrange a constant presence for a minimum of 2 years for training of local operational staff in maintenance and repair measures. Typically for a project of this size this would be three experts (usually, one electrical engineer and two mechanical engineers) will be constantly present at the wind park.

Additionally, a team of six local experts has to be established for maintenance tasks and a crane has to be available, at least once per year, to carry out operations.

In the case of Debre Berhan the Goldwind presence at Adama provides a source of experienced foreign and local staff.

13.2.2 Local Spares Holding

The facility built at the Debre Berhan site will include local storage of spares limited to expendable items and spare parts. A SCADA system and sophisticated SCADA-based condition monitoring is increasingly being implemented in order to plan repairs. To maintain the availability on a high level, it is recommended that this aspect is given some attention. Thus the possible failure of components can be identified in advance and transport and installation of spare parts can be organized ahead of time. Storage and investment costs of spares holdings are therefore reduced.

The O&M costs have been quoted for the five different turbines in the first two years, and they differ widely. In the case of Goldwind as shown in Table 32, the costs are smaller since one main component, the gearbox, is not present; therefore a routine oil servicing is not required. The pitch system is entirely electric, so there are no rotating hydraulic systems requiring specialist maintenance.

Table 32 Comparison of WTG O&M/Year Cost

	Alstom	Gamesa	GE	Goldwind	Vestas
WTG Model	ECO 122	G 114	GE 103	GW 93	V 110
WTG Output (MW)	2.7	2.0	1.7	1.5	2.0
Number of WTGs	37	50	59	67	50
WTG O&M/year $USM	2.2	1.6	2.9	1.0	2.1

* After 2-year fix warranty

13.3 Inter-Turbine Comparison for EPC Cost

An EPC offer was provided by Goldwind, and was itemized into BOP and STG supply. The EPC price for the other suppliers combines quotations for WTG supply, and best faith estimates for BOP as above. Combining the WTG supply and BOP costs, the total project capital costs are provided.

Table 33 Summary of Project Costs for Candidate WTGs

	Alstom	Gamesa	GE	Goldwind	Vestas
Wind Turbine Package	176,926,636	169,270,345	179,500,953	160,284,389	199,603,790
Balance of Plant	74,828,067	74,880,540	74,479,142	74,281,454	74,662,930
Interconnection	5,445,297	5,449,115	5,419,905	4,234,157	5,433,280
Total Project Cost	**257,200,000**	**249,600,000**	**259,400,000**	**238,800,000**	**279,700,000**

The lowest capital cost is for the Goldwind WTG, largely due to a lower turbine cost as shown in Table 33.

It is logical and usual in project selection that LCOE is the determining selection criterion as it wraps together capital cost, finance, energy production and operating cost in one parameter. The AEP calculations are given in Table 34 and Figure 40.

A comparison between total projects comprising different turbine and EPC suppliers, of nominal Cost of Energy, AEP and Capacity Factor is given in Table 34 and Figure 40.

Table 34 Annual Energy Production and Capacity Factor

	Alstom	Gamesa	GE	Goldwind	Vestas
WTG Model	ECO 122	G 114	GE 103	GW 93	V 110
WTG Output (MW)	2.7	2.0	1.7	1.5	2.0
Number of WTGs	37	50	59	67	50
Annual Net Energy GWh	237.4(3)	286.2(1)	272.9(3)	249.8(2)	254.5(3)
Capacity Factor	27.1%	30.7%	31.6%	28.4%	29%

(1) WindPRO calculation by Sgurr Energy for defined layout
(2) WindFarmer calculation by Goldwind Technical Staff
(3) Calculation by Terra Global

The highest AEP is from the GE turbines. At Debre Berhan given the wind regime, rotor area is more important than rated power as so little time is spent above rated power in the average year. Naturally rotor area must be effectively utilized via a tuned aerodynamic and control system, and efficient drive train.

It is interesting to observe that the combined rotor area of the 1.7 MW rated GE turbines is 510,000m2, which is lower than that of the turbine with the next highest AEP, and the highest total area, the Gamesa G114 with 531,000 m2. This indicates an aggressive GE power curve, perhaps optimistic. Both the GE and Gamesa turbines utilise doubly-fed induction generator

(DFIG) systems driven by 3 stage gearboxes and there is no obvious reason why they would be significantly different in efficiency. The Goldwind turbine benefits from a direct drive gearless design whose drive train efficiency is higher than the geared DFIG. This promotes the Goldwind AEP despite the lower total rotor area of 455,000m^2.

It is significant that the projects with highest AEP production (Gamesa); and highest capacity factor (GE) do not translate into lowest cost of Energy. Goldwind provides much lower over LCOE.

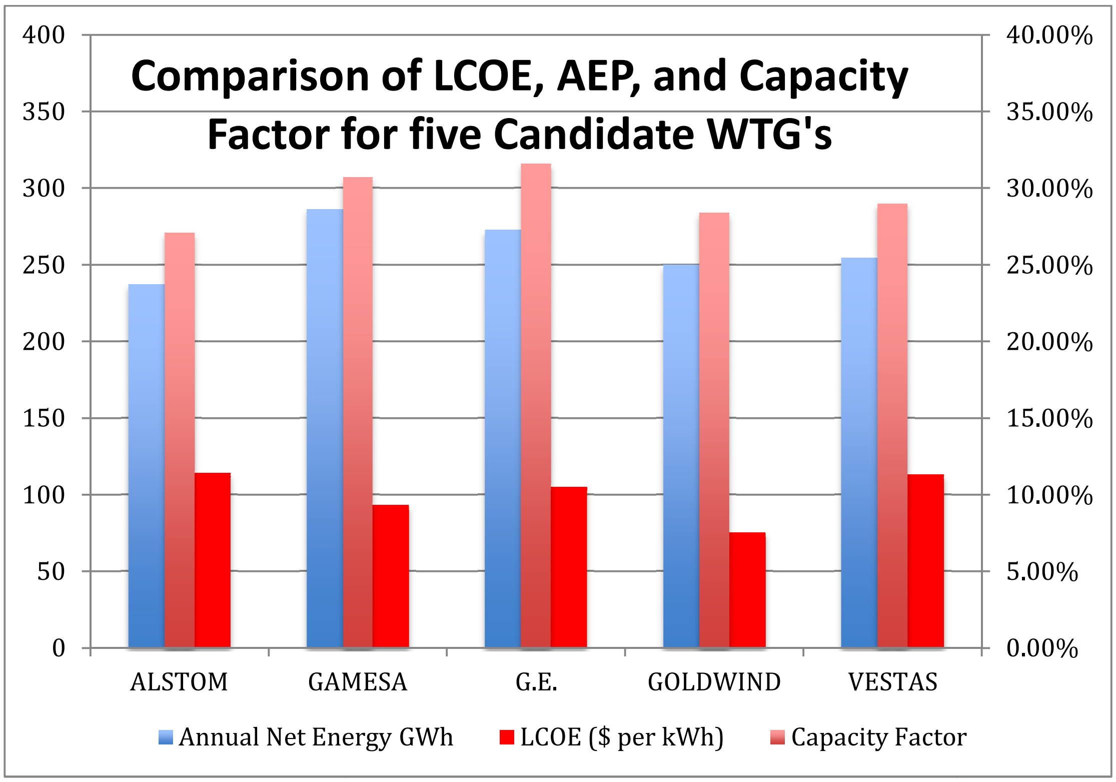

Figure 40 Production and LCOE comparison

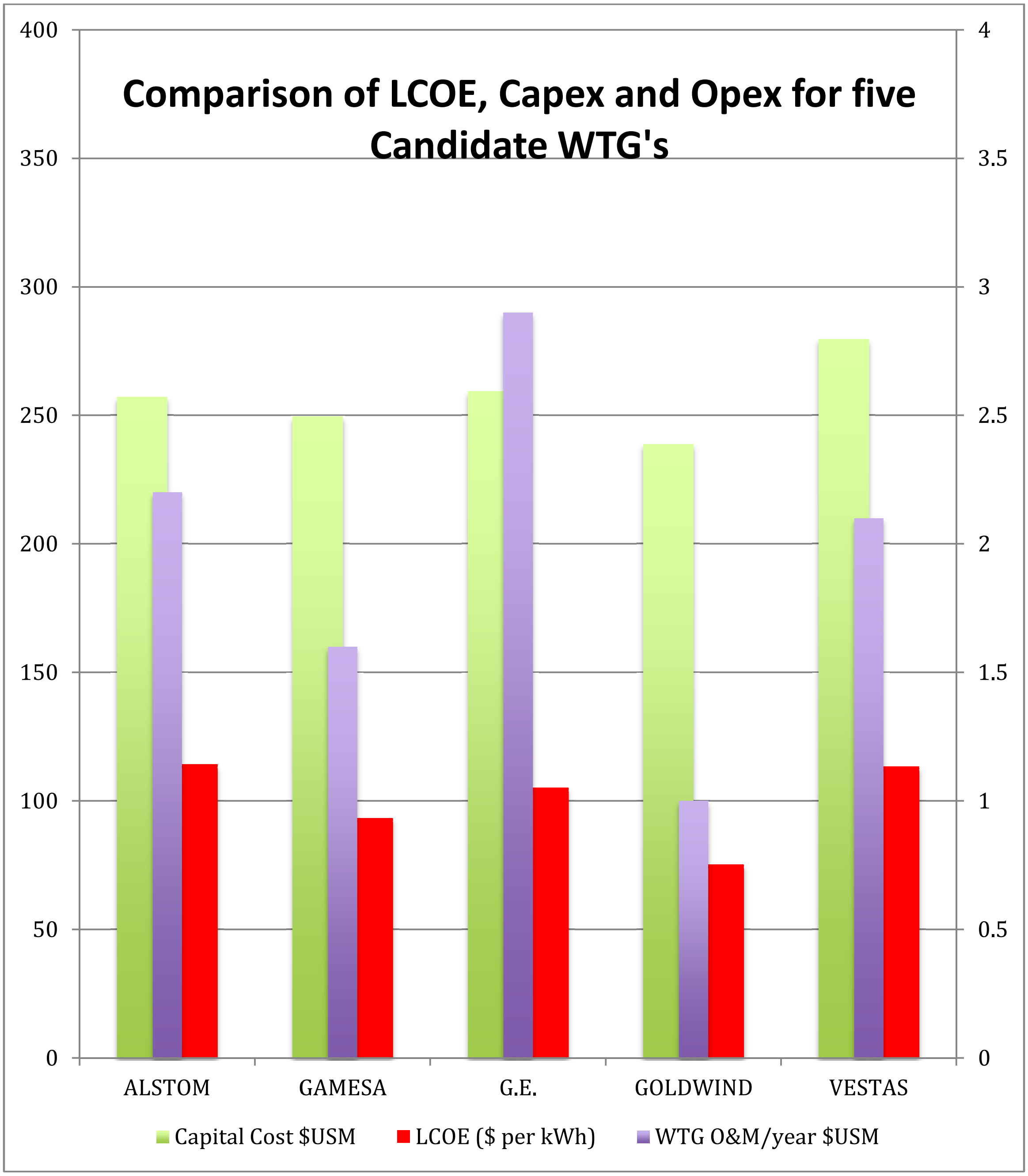

Figure 41 Project Capital Cost Comparison

The total project Capex is compared in Figure 41 showing turbines plus BOP and all ancillaries contributing to the total project cost.

The highest Capex is the Vestas offer, although this includes an estimated transportation cost. The GE Wind offer is the next highest, and in this case, both transportation and erection are estimated so there is some uncertainty. All other suppliers quoted for a full turbine supply and installation.

Goldwind offers the lowest Capex by some margin with the GW 93 1.5 MW WTG.

There is a great variety in quoted operating and maintenance costs (Opex) summarised here, with Goldwind offering a significantly lower annual cost.

13.4 Summary

Terra Global has carefully assessed the potential market for all turbines suitable for the Debre Berhan project. This process has been rigorous, detailed and impartial. The factors determining viable turbines and turbine suppliers have been evaluated and 5 globally recognized companies have been qualified. The 5 turbine suppliers' financial and technical offerings have been solicited through a robust pre-tender process and compared in terms of capital cost, annual energy production, (AEP) and operating cost.

When financing considerations are taken into account the Goldwind offer is by a great margin the best value. The key differentiators then are driven by the lenders, where the combination of Industrial Commercial Bank of China (ICBC) and Bank of China (BOC) is able to offer dramatically lower interest rates than any of the other export credit agencies.

The result is shown in Figure 42 graphically illustrates that the LCOE of the Goldwind offering is the clear best option.

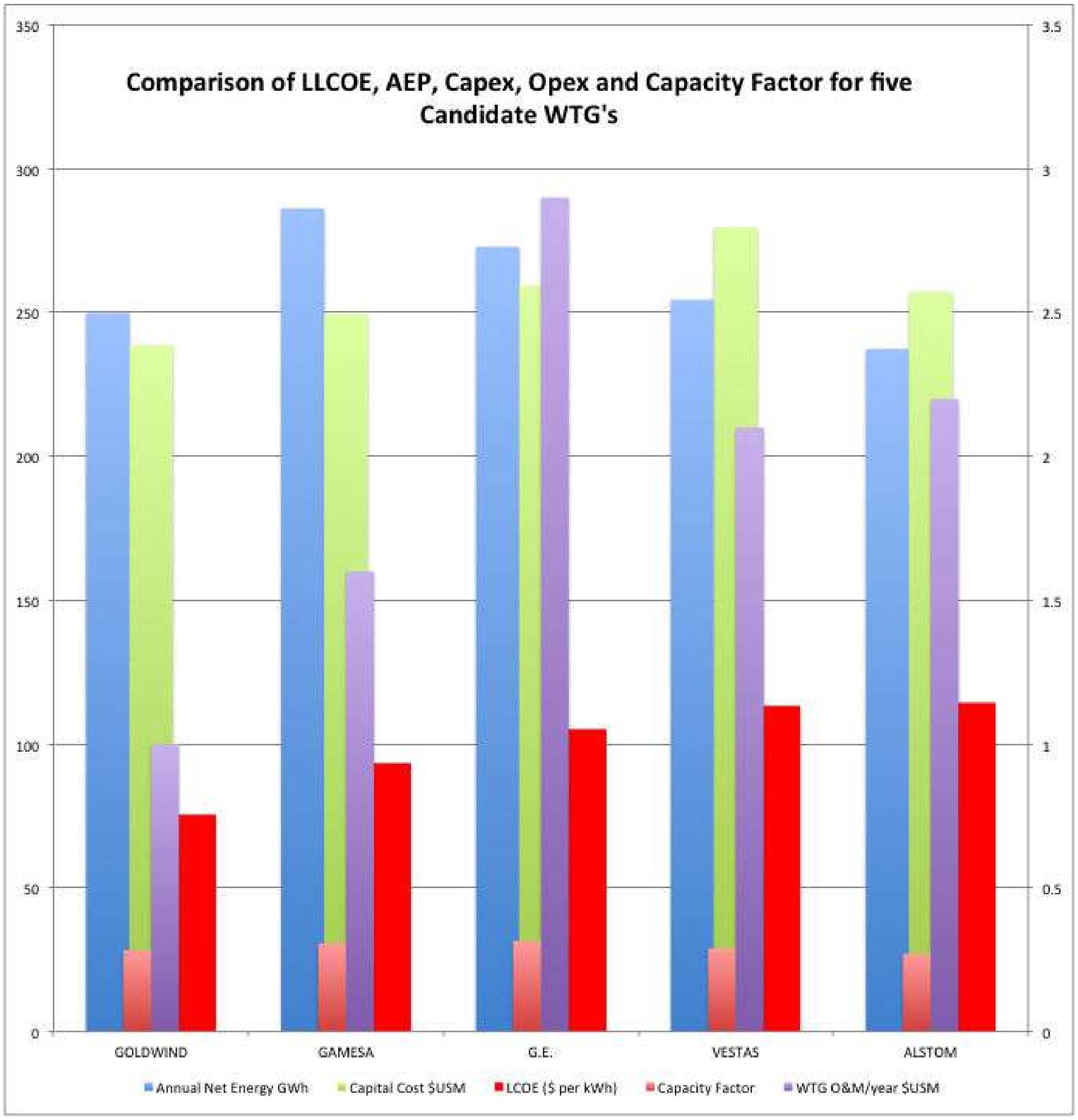

Figure 42 Summary LCOE and contributing factors

It is Terra Global's recommendation that Goldwind offers best value having lowest overall LCOE, Capex and Opex.

14. Pro Forma Financial Model

14.1 Introduction

Terra Global first created a pro forma financial model (the "Pro Forma") to compare the various WTG options being considered for the Project and determine which WTG offered the best overall economic performance for EEP, as owner of the Project, by calculating the levelized cost of energy (the "LCOE") with each WTG Option. A financial model is the only option available to synthesize the myriad factors that are key to selecting the best WTG for a wind energy project, including the:

- cost of purchasing the WTGs;
- cost for the balance of plant (BOP);
- schedule for the construction of the Project;
- guaranteed net annual energy output of the Project based on the wind resource;
- annual operations and maintenance costs for the WTGs and the balance of plant;
- terms of the financing for the Project, including the interest rate, the grace period and the repayment schedule; and
- equity requirement for the Project owner.

Following the selection of the best WTG for the Project from an overall economic perspective, Terra Global further refined the Pro Forma so it could be used to validate the financial feasibility of the Project based on the WTG selected and worked to improve the indicative terms of the proposed EPC Contact and the terms offered for the financing of the Project.

14.2 Comparison of WTG Options

Terra Global used the initial Pro Forma to perform a detailed economic analysis of the Project with each of the five WTG options under consideration. Terra Global started with the indicative pricing provided by each WTG supplier for the WTG and balance of plant, the net annual energy output expected for each WTG based on its power curve, the available wind resource data developed by Terra Global and the preliminary wind farm layout developed by Terra Global, the operations and maintenance cost data provided by the WTG supplier, the initial terms of the financing believed to be available for each WTG and an extensive number of other assumptions.

If the Project were intended to be owned and operated by a private owner selling electricity to EEP under a Power Purchase Agreement, the Pro Forma would have reflected the agreed purchase price for electricity. However, since the Project is to be owned by EEP and the electricity produced by the Project is being blended into EEP's total generation mix, Terra Global designed the Pro Forma to solve for the levelized cost of energy (the "LCOE") over the 20-year operating term of the Pro Forma. Solving for the LCOE using each WTG allowed Terra Global to do a direct economic comparison of the 5 WTGs.

Over time, as more detailed cost and performance information became available from the various WTG suppliers and the terms of the financing available with their WTGs was further investigated, Terra Global continued refining the economic analysis for the 5 WTG options selected for further study using the Pro Forma. Terra Global used the "interim rankings" of the WTG suppliers based on the results of the Pro Forma analysis to encourage pricing and financing concessions to make their proposals more competitive. Based on all these refinements Terra Global ultimately reduced the WTGs it was seriously considering to three; Goldwind, Gamesa and G.E. Thereafter, Terra Global pursued the 3 WTG suppliers for best and final offers, further clarification on their balance of plant costs and, most importantly, the best possible financing terms.

Ultimately, because the financing available for the Gamesa and G.E. WTGs was significantly less attractive than the financing that was available for the Goldwind WTGs as discussed below in the Financing Section, it was impossible for G.E. and Gamesa to compete with Goldwind, despite their attractive net output numbers. Accordingly, Terra Global pressed Goldwind, as a condition to its selection as the WTG supplier and EPC Contractor for the Project, for (i) a further price concession on its WTGs and balance of plant and (ii) to pressure ICBC and BOC to improve the terms of the financing, both of which occurred. Based on those further concessions and with the prior approval of EEP, Terra Global selected Goldwind as the WTG Supplier and EPC Contractor for the Project.

Set forth below is a table showing certain key assumptions regarding the Project using each of the 5 WTGs, including the levelized cost of energy (the "LCOE") which is the only way of comparing the WTG options. In the case of Goldwind, the numbers are based on the terms negotiated to date with Goldwind, ICBC and BOC. In the case of the 4 other WTG options, the numbers reflect the pricing proposals and performance date from each WTG supplier, but the financing terms reflect what Terra Global believes are the best financing terms that are available for such WTGs based on the present market conditions. While improvements might be possible, particularly in the case of the Export Import Bank of the United States ("US EX-IM"), significant additional time would be required to get that improvement and a final approval for the Project and success is not guaranteed. In the case of US EX-IM, there has been talk for more than a year about extending the term of the loan from 7 to 14 years, but there is constant opposition within Congress to doing so. Also, it is now time for US EX-IM to be re-authorized by the Congress and there is a serious question as to whether there are sufficient votes to do so and the latest proposal is for an interim reauthorization of 9 months.

The following analysis is based on the 2% internal rate of return case to EEP.

Table 35 LOCE Comparison of Candidate WTGs

	Alstom	**Gamesa**	**GE**	**Goldwind**	**Vestas**
WTG Model	ECO 122	G 114	GE 103	GW 93	V 110
WTG Output	2.7 MW	2.0 MW	1.7 MW	1.5 MW	2.0 MW
Number of WTGs	37	50	59	67	50
Annual Net Energy	237.4 GWh	286.2 GWh	272.9 GWh	249.8 GWh	254.5 GWh
Capacity Factor	27.1%	30.7%	31.6%	28.4%	29%
Capital Cost	US$257.2 M	US$249.6 M	US$259.4 M	US$238.8 M	US$279.7 M
WTG O&M/year	US$2.2M	US$1.9 M	US$2.9 M	US$1.0 M	US$2.1M
Lender	HERMES	US EX-IM	US EX-IM	ICBC/BOC	EKF
Debt Percentage	85%	85%	85%	85%	85%
Equity Percentage	15%	15%	15%	15%	15%
Interest Rate	6.6%	6.6%	6.6%	2.9945%	6.6%
Grace Period	22 months	22 months	22 months	30 months	22 months
Repayment Period	10 years	7 years	7 years	12.5 years	10 years
Residual Value	10%	10%	10%	10%	10%
LCOE per kWh	11.4 cents	9.33 cents	10.5 cents	7.54 cents	11.34 cents

Based on the pro forma, the only realistic option for the Project at this time is the Goldwind WTG. The economic analysis of the Project with the Goldwind WTG and the financing that is being made available by the Industrial and Commercial Bank of China and China Development Bank shows that the Project is highly economically feasible for EEP.

14.3 Project Pro Forma

The Pro Forma for the Project with the Goldwind as the WTG Supplier and EPC Contractor for the Project and the Lender group that is to be arranged by ICBC and BOC is economically feasible for EEP. The following are certain of the key assumptions used in the Pro Forma for the Project:

- The EPC Contract Price, based on the scope of work provided by Goldwind (which includes 67 of its 1.5 MW WTGs and the balance of plant) and the pricing that has been negotiated to date by Terra Global, is $238.8 million. Except for a limited number of agreed items (such as taxes in Ethiopia, import duties, radical changes in commodity prices and force majeure costs) this cost is fixed and any overruns in cost will be the responsibility of Goldwind;
- A construction schedule of 22 months, with the initial group of WTGs achieving substantial and generating electricity in 16 months. The Pro Forma does not take into account the value of the electricity that will be generated by the Project prior to the completion of construction;
- The net annual energy output of the Project is 249.8 GWh of electricity (reflecting a net capacity factor of 28.4%). The actual energy output of the Project will vary from year to year;
- The financing provided by the consortium of banks led by ICBC and BOC will (i) cover 85 percent of the EPC Contract Price and 85 percent of the Sinosure export credit insurance fee, (ii) have a total term of 15 years, (iii) have an interest rate of 2.6 percent over the 6-month LIBOR rate (which currently is at 0.3345%) and (iv) have an interest only grace period of 2.5 years and a principal/interest repayment period of 12.5 years. Terra Global believes that there may be an opportunity for a small improvement in the interest rate margin, but securing any such improvement will require a strong letter of interest from MoFED and the direct participation of MoFED in discussions with ICBC, BOC and Sinosure;
- EEP will make an equity investment at the commencement of the construction of the Project, all in BIRR, equal to 15 percent of the EPC Contract Price. Such funds will be used to pay for the procurement of materials, supplies and labor during the construction period. To the extent any such funds are ultimately required for goods or services in Dollars, the cost of converting such currency and the risks associated with such conversion shall be the responsibility of Goldwind;
- An inflation rate of 4.5 percent;
- A residual economic value of the Facility after 20 years of operations equal to 10 percent of the original price paid by EEP, which Terra Global believes to be rather conservative assuming proper maintenance of the Project by EEP;
- EEP will not pay any taxes;
- Although there is the possibility of selling the certified energy renewal credits that are generated by the Project in the market place if the Project is registered as a CDM activity, because of the inherent uncertainties in that market place (in both demand and price) and in order to be conservative in its analysis, Terra Global has assumed that the value of such credits is zero; and
- A fixed fee of US$4.1 million per year for the two-years of the WOM. Following the expiration of the WOM, it has been assumed that EEP will become responsible for the operation and maintenance of the WTGs and that Goldwind will supply the spare parts as and when required and provide consulting services only if requested to do so by EEP, thereby reducing the annual operation and maintenance costs for the WTGs to US$1 million for the third year of operations and escalating thereafter in accordance with inflation.

The table below shows Pro Forma calculations of levelized cost of energy based on 0, 2, 4, 6, and 8% internal rates:

Table 36 LOCE Calculation Based on 0, 2, 4, 6, and 8% IRR

Rate of Return	LCOE
0%	7.33 cents per kWh
2%	7.53 cents per kWh
4%	7.78 cents per kWh
6%	8.13 cents per kWh
8%	8.59 cents per kWh

The following table shows the schedule of payments to Goldwind pursuant to the EPC Contract:

Table 37 EPC Schedule of Payments

Funding of Construction

Construction Month	Date	Percent Monthly	Percent Cumulative	$1,000 Monthly	$1,000 Cumulative
0	1-Jan-15	15.0%	15.0%	$35,820	$35,820
1	31-Jan-15	20.0%	35.0%	$47,760	$83,580
2	28-Feb-15	1.9%	36.9%	$4,537	$88,117
3	31-Mar-15	2.8%	39.7%	$6,686	$94,804
4	30-Apr-15	9.5%	49.2%	$22,686	$117,490
5	31-May-15	4.8%	54.0%	$11,462	$128,952
6	30-Jun-15	9.5%	63.5%	$22,686	$151,638
7	31-Jul-15	7.6%	71.1%	$18,149	$169,787
8	31-Aug-15	2.1%	73.2%	$5,015	$174,802
9	30-Sep-15	0.8%	74.0%	$1,791	$176,593
10	31-Oct-15	0.6%	74.6%	$1,433	$178,025
11	30-Nov-15	0.4%	75.0%	$955	$178,981
12	31-Dec-15	0.4%	75.4%	$955	$179,936
13	31-Jan-16	0.5%	75.9%	$1,194	$181,130
14	29-Feb-16	3.0%	78.9%	$7,164	$188,294
15	31-Mar-16	3.8%	82.7%	$9,074	$197,368
16	30-Apr-16	1.9%	84.6%	$4,537	$201,905
17	31-May-16	1.9%	86.5%	$4,537	$206,443
18	30-Jun-16	1.9%	88.4%	$4,537	$210,980
19	31-Jul-16	1.9%	90.3%	$4,537	$215,517
20	31-Aug-16	1.9%	92.2%	$4,537	$220,054
21	30-Sep-16	1.9%	94.1%	$4,537	$224,591
22	31-Oct-16	5.9%	100.0%	$14,209	$238,800
		100.0%		$238,800	

The following table shows the calculation of the LCOE per the pro forma at a 2% IRR:

Table 38 Levelized Cost of Energy at 2% IRR

Levelized Cost of Energy

Scenario #3 = $75.25/MWh LCOE - 2.0% %IRR

Op'g		Net	$/MWh		Cash Flow Projection - $1,000							Sponsor
Year	Date	MWh	Actual	Levelized	Revenue	OM	Net Op'g Income	Principal	Interest	Residual	Sponsor	%IRR
1	1-Nov-16	221,607	$27.56	$75.25	$6,107	($4,800)	$1,307	-	($1,307)	-	-	-
2	1-Nov-17	249,800	$75.40	$75.25	$18,835	($4,827)	$14,008	($8,119)	($5,889)	-	-	-
3	1-Nov-18	249,800	$93.88	$75.25	$23,452	($1,655)	$21,797	($16,238)	($5,559)	-	-	-
4	1-Nov-19	250,484	$92.04	$75.25	$23,054	($1,730)	$21,324	($16,238)	($5,086)	-	-	-
5	1-Nov-20	249,800	$90.71	$75.25	$22,658	($1,808)	$20,851	($16,238)	($4,612)	-	-	-
6	1-Nov-21	249,800	$89.14	$75.25	$22,267	($1,889)	$20,378	($16,238)	($4,139)	-	-	-
7	1-Nov-22	249,800	$87.58	$75.25	$21,879	($1,974)	$19,905	($16,238)	($3,666)	-	-	-
8	1-Nov-23	250,484	$85.81	$75.25	$21,494	($2,063)	$19,432	($16,238)	($3,193)	-	-	-
9	1-Nov-24	249,800	$84.52	$75.25	$21,114	($2,156)	$18,959	($16,238)	($2,720)	-	-	-
10	1-Nov-25	249,800	$83.02	$75.25	$20,738	($2,253)	$18,485	($16,238)	($2,247)	-	-	-
11	1-Nov-26	249,800	$81.53	$75.25	$20,366	($2,354)	$18,012	($16,238)	($1,774)	-	-	-
12	1-Nov-27	250,484	$79.84	$75.25	$19,999	($2,460)	$17,539	($16,238)	($1,301)	-	-	-
13	1-Nov-28	249,800	$78.61	$75.25	$19,637	($2,570)	$17,066	($16,238)	($828)	-	-	-
14	1-Nov-29	249,800	$77.18	$75.25	$19,279	($2,686)	$16,593	($16,238)	($355)	-	-	-
15	1-Nov-30	249,800	$11.24	$75.25	$2,807	($2,807)	-	-	-	-	-	-
16	1-Nov-31	250,484	$11.32	$75.25	$2,836	($2,933)	($97)	-	-	-	($97)	-
17	1-Nov-32	249,800	$11.32	$75.25	$2,828	($3,065)	($237)	-	-	-	($237)	-
18	1-Nov-33	249,800	$11.32	$75.25	$2,828	($3,203)	($375)	-	-	-	($375)	-
19	1-Nov-34	249,800	$11.32	$75.25	$2,828	($3,347)	($519)	-	-	-	($519)	-
20	1-Nov-35	250,484	$11.32	$75.25	$2,836	($3,498)	($662)	-	-	-	($662)	-
21	1-Nov-36	125,927	$11.32	$75.25	$1,426	($1,828)	($402)	-	-	$57,592	$57,190	2.00%
		5,097	< GWh		$299,269	($55,906)	$243,363	($202,980)	($42,676)	$57,592	$55,299	

The loan repayment schedule in the following table provides the payments required to be made to the Lenders to repay the full loan covering 85 percent of the EPC Contract Price and 85 percent of the export credit insurance fee to Sinosure:

Table 39 Loan Repayment Schedule

Loan Repayment Schedule

Interest Only Month	Principal Repayment Month	Date	Interest Only Payments	Principal Repayment Period: Principal	Principal Repayment Period: Interest	Principal Repayment Period: Total
1		Jan-17	$1,443	-	-	$1,443
2		Jul-17	$3,238	-	-	$3,238
	1	Jan-18	-	$8,966	$3,265	$12,231
	2	Jul-18		$8,966	$3,135	$12,101
	3	Jan-19	-	$8,966	$3,004	$11,970
	4	Jul-19	-	$8,966	$2,873	$11,839
	5	Jan-20	-	$8,966	$2,743	$11,709
	6	Jul-20	-	$8,966	$2,612	$11,578
	7	Jan-21	-	$8,966	$2,481	$11,448
	8	Jul-21	-	$8,966	$2,351	$11,317
	9	Jan-22		$8,966	$2,220	$11,186
	10	Jul-22	-	$8,966	$2,090	$11,056
	11	Jan-23	-	$8,966	$1,959	$10,925
	12	Jul-23	-	$8,966	$1,828	$10,795
	13	Jan-24	-	$8,966	$1,698	$10,664
	14	Jul-24	-	$8,966	$1,567	$10,533
	15	Jan-25	-	$8,966	$1,437	$10,403
	16	Jul-25		$8,966	$1,306	$10,272
	17	Jan-26	-	$8,966	$1,175	$10,142
	18	Jul-26	-	$8,966	$1,045	$10,011
	19	Jan-27	-	$8,966	$914	$9,880
	20	Jul-27	-	$8,966	$784	$9,750
	21	Jan-28	-	$8,966	$653	$9,619
	22	Jul-28	-	$8,966	$522	$9,489
	23	Jan-29		$8,966	$392	$9,358
	24	Jul-29	-	$8,966	$261	$9,227
	25	Jan-30	-	$8,966	$131	$9,097
			$4,681	$224,154	$42,446	$271,282

15. Financing

15.1 Financial Objectives

From the outset, EEP told Terra Global that its three principal goals with respect to the financing of the Project were to (i) limit its equity investment in the Project to 15 percent, (ii) fund its equity investment in local currency and (iii) secure the best possible loan terms with regard to interest rate, fees, grace period, repayment period and, if possible, a grant.

15.2 Overview of the Market

The initial effort was to assess the availability of Government to Government financing (a concessionary loan) similar to some of the loans previously secured by Ethiopia for major infrastructure projects. The government institutions approached for concessionary loans indicated that such loans had been exhausted for the country and were therefore not available for the Project.

The next effort was to assess the availability of, and expected terms for, (i) multilateral development bank loans, (ii) export credit agency ("ECA") loans and (iii) commercial bank loans. It was determined early on that the only viable option for the Project was an ECA loan.

Commercial banks willing to make loans for projects in Ethiopia required a high rate of interest and an extremely short overall loan term. Loans from multilateral development banks offered far more attractive terms, but the following factors and/or requirements of these institutions eliminated them from consideration: (i) lengthy appraisal and approval periods that were inconsistent with the goals of EEP; (ii) the fact that the Project was not eligible for either the World Bank or the African Development Bank lending programs; (iii) the fact that the Project would be owned by EEP and not by a private party selling electricity pursuant to a power purchase agreement; and (iv) stringent procurement requirements that were inconsistent with the timeframe of EEP for implementation of the Project. Accordingly, the focus of the financing effort was an ECA loan.

15.3 Identification of ECA Lenders

The purpose of an ECA lender is to facilitate the export of goods by companies that are manufacturing such goods in the country establishing the ECA. Most importantly, ECAs have a much less complicated approval process than multilateral lenders and the ability to underwrite projects within tight timelines like those required by EEP. ECA's also favor the financing of renewable energy projects. ECAs are also typically able to finance up to 85 percent of the contract price so long as substantially all of the equipment being sold is manufactured in the country where the ECA is established.

Preliminary discussions were held with each of the ECAs that could providing financing for the 5 WTG suppliers being considered for the Project so that the preliminary terms of such financing could be taken into account during the screening process for selection of the WTG for the Project. Typically, the financing terms, which are offered by the various ECAs (other than the China's ECAs) are relatively close as most of the ECAs have a gentlemen's agreement to play by the same rules and limit unfair competition and they all have the right to match each other, but the ECAs in China are not bound by these restrictions. While this preliminary information was useful, the ultimate approach to the ECAs would depend on the WTG selected for the Project.

15.4 ICBC and BOC versus US EX-IM

Once the WTGs being considered for selection was reduced to three, Goldwind, GE and Gamesa, the ECAs being considered were reduced to two: (i) the Industrial and Commercial Bank of China ("ICBC") working jointly with Bank Of China ("BOC"), with export credit insurance from China Export & Credit Insurance Corporation ("Sinosure"); and (ii) US EX-IM. For the reasons discussed below, the obvious choice was ICBC and BOC with Sinosure.

US EX-IM is the official export credit agency of the United States. US EX-IM's mission is to facilitate the sale of U.S. goods and services to foreign markets. US EX-IM is very interested in supporting renewable energy projects in emerging markets and Ethiopia is of particular interest to U.S. government agencies, including US EX-IM, as it is one of the six priority countries for the United States "Power Africa" Presidential initiative which is aimed at supporting economic growth and development by increasing access to reliable, affordable and sustainable power in Africa. Despite this, Ethiopia is currently eligible only for medium term financing (i.e., up to 7 years). US EX-IM advised Terra Global that Ethiopia's status would be reviewed in 2014 with the expectation that the country would be eligible for longer term financing, perhaps up to 14 years. However, such review has not taken place. Based on US EX-IM's cost of funds and the risk fee being charged on loans to Ethiopia, the all-in interest rate estimated for a 7-year loan is currently 6.60% and the all-in interest rate estimated for a 14-year loan is 9.01%. Furthermore, the restrictions on the amount of financing available would have put the loan from US EX-IM well below 85 percent of the Contract Price.

Two options were initially explored for financing from China, the Export-Import Bank of China ("China EX-IM") and Sinosure. China EX-IM and Sinosure are both 100% owned by the Chinese government. Their mandates are facilitating exports of Chinese goods and services, providing Chinese companies with advantages in offshore contracts and outbound investments and promoting international economic cooperation and trade. China EX-IM makes direct loans and Sinosure provides export credit insurance and guarantees which are funded by commercial banks in China (here, ICBC and BOC). Based on the intense lobbying efforts of Terra Global and Goldwind (as part of its effort to be selected as WTG supplier and EPC Contractor for the Project), Sinosure agreed to provide export credit insurance for the Project (even though it had reached its credit exposure limit for Ethiopia) and ICBC agreed to improve on the terms offered for the financing of the Project (2.6% over 6-month LIBOR, a grace period of 2.5 years, 12.5 year repayment period and reduced fees and a loan equal to 85% of the EPC Contract price and the Sinosure export credit risk fee).

15.5 Selection of Goldwind, ICBC, BOC and Sinosure

As discussed in Section 7, Goldwind was selected as WTG Supplier and EPC Contractor for the Project for a variety of reasons, including the performance of its WTG, the cost to operate and maintain its WTG, the schedule for the supply of WTGs and construction of the Project and the terms of the financing available for its WTG. It has to be emphasized that the far superior terms of the financing being made available with the Goldwind WTG made it impossible for Gamesa and GE to compete on a levelized cost of energy basis with Goldwind using US EX-IM financing with its current 7-year loan term and it is not very likely that increasing US EX-IM's loan term to 14 years would make it competitive. This made the selection of Goldwind with financing provided by ICBC, BOC and Sinosure the only choice for the Project.

15.6 Status of ICBC, BOC and Sinosure

ICBC, BOC and Sinosure are all quite familiar with the Project. Following the selection of Goldwind, Terra Global and Goldwind have briefed ICBC, BOC and Sinosure about the Project, secured letters of intent for the financing of the Project and secured a commitment to expedite the approval and documentation process for the financing subject to receipt of letters of support for the Project from EEP and the Ministry of Finance and Economic Development ("MoFED"). ICBC and BOC have also agreed to negotiate the terms of the financing agreements in parallel with the Sinosure approval process instead of waiting for the Sinosure approval process to be completed to fast track the close of financing for the Project.

16. CDM Assessment

The clean development mechanism ("CDM") assessment for the Project shows that the Project is suitable for registration as a CDM activity, but the economic benefit to be derived by registration is marginal. The net annual energy production of the Project with the Goldwind GW 93 WTGs is 249.8 GWh per year. The clean electricity generated by the Project will reduce greenhouse gas ("GHG") emissions through the displacement of fossil fired power plants in the national power grid. The Project reduce 7,221 tCO2e (tons of carbon dioxide equivalent) annually; it will reduce a total of 50,547 tCO2e during the first seven (7) year crediting period.

The Ethiopian national power grid is dominated by large hydropower plants which constituted 91% of total generating capability of the system at end of June 2013. Fossil fired and wind power plants constituted the remaining 5% and 4% of installed capacity respectively. Energy generation contributions from fossil fired power plants on the grid varied from zero to 11% in the past five years. The project activity will mainly replace fossil fired power plants on the grid which are used for emergency power supply during generating power short falls.

Total electricity generation on the national grid was 7,586 GWh and sales 5,847 GWh at the end of June 2013. The total amount consumed within Ethiopia was 5,284 GWh (90.4% of the total sold) and export to Djibouti and the Sudan was 563 GWh (9.6%).

Emission reduction from the Project is the product of the electricity generated by the Project and combined margin (CM) for the Ethiopian national power grid. The CM has two components: the operating margin (OM) and the build margin (BM). CM, OM and BM are computed using procedures specified in ACM0002 (Consolidated baseline methodology for grid-connected electricity generation from renewable sources, version 15.0)

The Project will reduce emissions by 50,547 tCO2e over the seven-year crediting period. The annual average emission reduction is 7,221tCO2e. Table 40 below shows the project annual emission reduction.

Table 40 project annual emission reduction

Year	Net electricity delivered (MWh)	Annual emission reduction (tCO2e)
2016	249,800	7,221

2017	249,800	7,221
2018	249,800	7,221
2019	249,800	7,221
2020	249,800	7,221
2021	249,800	7,221
2022	249,800	7,221
Total estimated reductions (tCO2e)		50,547
Total number of crediting years		
Annual average reductions over the crediting period (tCO2e)		**7,221**

The project activity will have the following benefits to sustainable development in Ethiopia:

- Increase power generation capability in Ethiopia to sustain rapid economic and social development in the country; this improves power availability, reliability, and access
- Enhance diversity of the power generation mix on the Ethiopian national power grid thus reduce vulnerability to climate change induced uncertainties of energy availability from Ethiopia's hydropower dominated power system
- Reduce Greenhouse Gas ("GHG") emission from Ethiopia thus contribute towards Ethiopia's endeavor to have a climate resilient and green economy
- Contribute to technology transfer to Ethiopia (or what is called "localization" of technology) in the very important power sector; it will also create skilled and non-skilled jobs
- Improve local infrastructure through the construction of access roads between district and sub-district centers and to the wind park area

17. Resettlement Action Plan

A study for a Resettlement Action Plan ("RAP") was undertaken by Addis Environmental Systems on behalf of Terra Global and a draft RAP plan was prepared in close collaboration with the Project Affected Persons ("PAPs") and the local Woreda Government Administrations. The Resettlement Action Plan describes the results of a detailed and extended resettlement planning program and records the commitments, procedures and actions that will be taken to resettle and compensate the people, households and communities affected by the implementation of the Project.

The findings of the RAP team which included a Survey Team, a Valuation Team and a team of Sociologists who conducted the field assessment summarizes and brings into focus the compensation and resettlement requirements for the Project Affected Persons. The plan quantifies the number of Project of affected people, provides guidelines for mitigation measures, and presents actual calculated compensation amounts.

The RAP was conducted in line with the governing laws of the Federal Democratic Republic of Ethiopia ("FDRE") and widely used international guidelines on resettlement and compensation as follows:

- Involuntary resettlement should be avoided.
- Where involuntary resettlement is unavoidable, all people affected by it should be compensated fully and fairly for lost assets.
- Involuntary resettlement should be conceived as an opportunity for improving the livelihoods of the affected people and undertaken accordingly.
- All people affected by involuntary resettlement should be consulted and involved in resettlement planning to ensure that the mitigation of adverse effects as well as the benefits of resettlement are appropriate and sustainable.

17.1 Legal Framework for Compensation

The initial phase of the Project area covers the village of Sembo which is located in Kimbibit Woreda of North Showa Administrative Zone in Oromia National Regional State and Angolelana Terra Woreda of North Showa Administrative Zone in Amhara National Regional State. The Project Site starts about 12 km northeast from Sheno town. The data obtained during field survey shows that there are ten kebeles (lowest level administrative sections) that will be affected by the Project. The area is characterized by nearly north south oriented undulating ridges that rise up to 3060 m above sea level at the middle and drops with moderate slopes to east and west. Most of the proposed wind turbines of the Project will be located on or at the sides of the ridges.

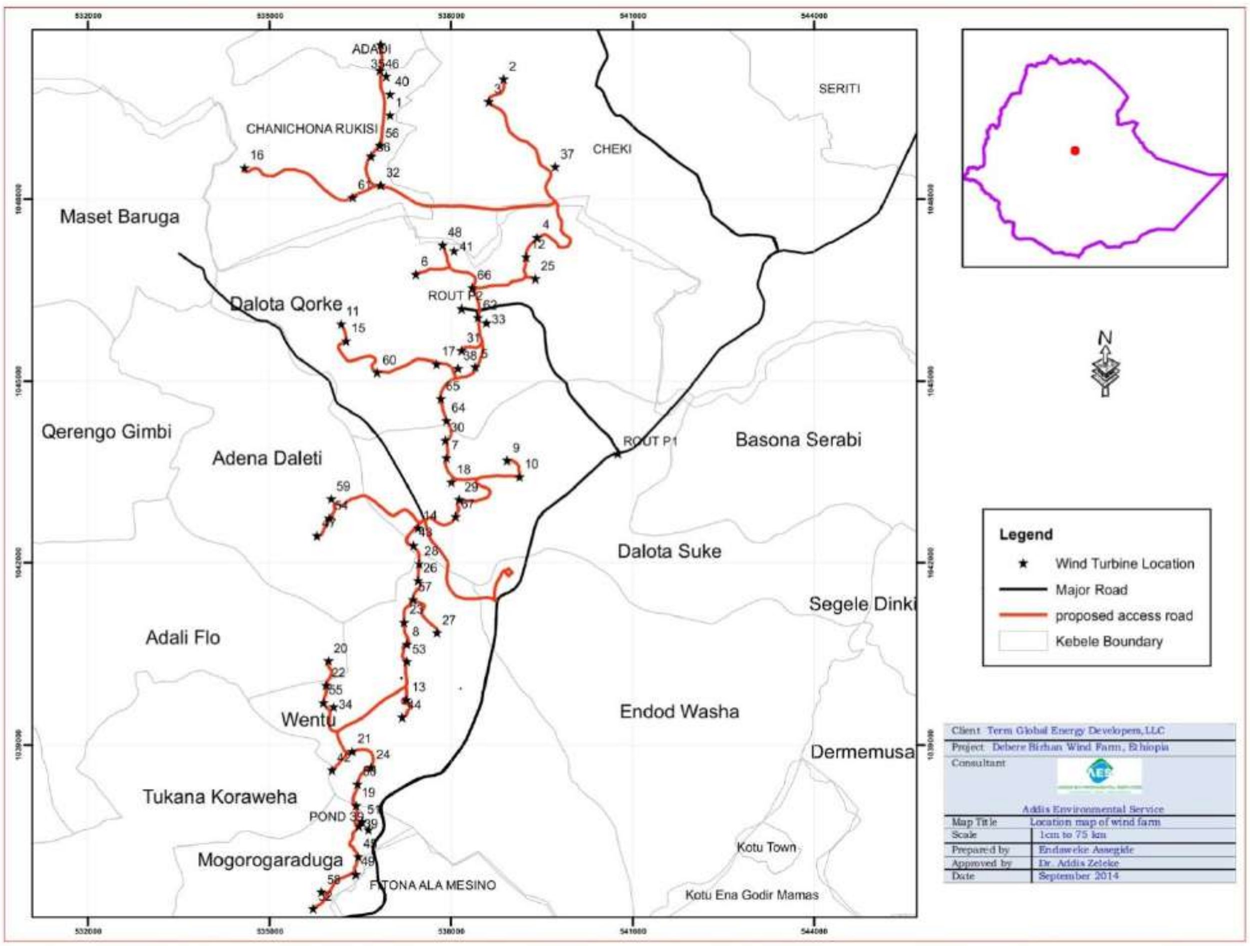

Figure 43 Administrative Map of the project area showing WTGs distributions

Ridge tops of the subject area are covered by grass land and eucalyptus trees while the relatively lower areas are dominantly covered by farm land and some grass land. The lower most flat areas however are seasonally marshy and are covered in most parts by grass lands. None of the wind turbines of the Project will be located on such grass lands. Figure 43 shows the Administrative map of the Project Site and the location and distributions of the 67 Goldwind GW 93 WTGs.

Land around the Project Site is mainly used by smallholder cereal crop production (90%). The remainder of the area is utilized for grazing of cattle and covered with bushes and rural settlements. The area is intensively cultivated and highly deforested.

17.2 Legal Framework for Compensation

This RAP takes into account existing FDRE Legal Framework as well as the key international guidelines on resettlement and compensation. Article 40.3 of Proclamation 1/1995 of the constitution addresses land ownership and holding rights. Ownership of both rural and urban land as well as natural resources of the nation is vested in the state and the people of Ethiopia. In addition; article 4015 of the constitution guarantees the right of citizens to obtain land without payment to the state and right to benefit from the fruits of their labor. It also provides them protection against eviction from their possessions. The FDRE requires appropriate compensations to be paid if land is to be expropriated for public use or if damage is caused to land and other private property due to investments.

Should it be determined that resettlement is necessary to complete the Project, a plan for the implementation process will be drawn up according to local and national legal frame work. For example fair compensation will be agreed upon through direct negotiation with the PAPs based on the applicable law. The plan will contain significant amount of community involvement to ensure a fair and transparent process.

17. 3 Field Survey – Population and Demographics.

Field surveys conducted show that there are 14,177 persons living in the 3 Kebeles near the Project Site.

Socio-economic baseline data collected indicated that the dominant economic activity within the Project area is subsistence agriculture (86%), with only a few people engaged in trade (7%) and earning salaries (7%) from formal employment.

A number of households practice mixed farming; keeping small numbers of livestock alongside cultivation. Findings from the household questionnaires showed that the major source of income for most of the household heads (86.4%) and their spouses (96.1%) was arable agriculture.

17.3.1 Project-Affected Persons age data

A summary of Project-Affected Persons data by age group shown in Table 41 below

Table 41 Summary of PAPs data by age group

Woreda	Age Group	Total	%
Kimbibit	Children (below 7 years)	228	16
	Students (between 7 and 14 years)	403	29
	Workers (14-64 years)	744	53
	Old Persons (above 64 years)	36	2
Total		**1411**	**100**
AngolelanaTerra	Children (below 6 years)	55	11
	Students (7 to 14 years)	205	41
	Workers (15-64 years)	241	48
	Old Persons (above 65years)	0	0
Total		**501**	**100**

17.3.2 Project-Affected area Land Use

A summary of land use of the project area is shown in Table 42 below.

Table 42 Summary of Project area land use and land cover data

Woreda	Kebele	Agricultural land (ha)	Grazing land (ha)	Forest land (ha)	Industry Zone (ha)
Angolelana	Adadi	1778.4	1360	98.15	-

Terra	Ruksi	17904	460	96	7
	Cheki	2005.12	1650	101.15	22
Kimbibit	Mogoro Gara Dega	994	113	--	--
	Wontu	1076	501	--	--
	Adali Fale	1408	214	--	--
	Adena Daleti	943	521	--	--
	Dalota Suki	1216	341	--	--
	Dalota Korki	908	432	--	--

17.4 Project-Affected Persons (“PAPs”)

The RAP plan refers to Project–Affected Persons as being any person who, as a result of the implementation of a project, loses the right to own, use, or otherwise benefit from a built structure, land (residential, agricultural, or pasture land), annual or perennial crops and trees, or any other fixed or moveable asset, either in full or in part, permanently or temporarily.

Based on current conceptual WTG layout of the wind farm and a WTG toppling zone of 228 meters radius established, there are 482 households, whose crops, trees and in some cases structures (houses) will be affected by the project. The majority of the households affected by the project are headed by male (73%) and remaining 17% headed by female. There is also one school, one clinic and one religious establishment that will be slightly affected by the Project.

17.4.1 Efforts to Minimize Resettelement

Project design alternatives were considered that would minimize first phase land expropriation. The EPC Contractor will work with the RAP plan to avoid displacements as much as possible with a revised WTG siting that would still provide optimal energy output but minimize the resettlement of people and the loss of property. If resettlement is unavoidable, then it should only proceed once individual agreements are finalized and compensation payments are made.

The wind farm layout which considered a setback or exclusion zone of 1.5 times the total WTG height, or 228 meters, was used as a minimum standard to provide a normalized safety perimeter. The EPC Contractor will have to closely consider dwelling relocation or clear guidance on operational safety and noise setbacks with respect to the dwellings.

17.5 Funding and Compensation Arrangement

It is the stated objective of Ethiopian Electric Power ("EEP") to avoid the environmental and social impact of its power projects or keep such impact to a minimal level. If adverse impacts are unavoidable, EEP will open formal consultations with PAPs and perform legal compensation procedures for all of their losses of income and properties. EEP shall allocate adequate budget for compensation to PAPs before the start of project implementation. EEP in consultation with the various levels of administrations (Regional States, Zones, Woreda, and Kebele) shall establish property valuation committee to properly implement compensation payment for PAPs on time before the start of project construction.

EEP shall:

- Maintain overall responsibility for the implementation of the compensation process
- Ensure that guiding principles are adhered to
- Ensure maximum participation of the Project Affected Persons
- Establish sufficient funds to provide fair and adequate compensation
- Ensure monitoring and evaluation of the compensation process

17.6 Implementation Budget

The total budget required for compensation payment, i.e. for loss of crops, trees and residential houses due to Right-of-Way, turbine tower foundations, access roads, and substation will be Birr 38,474,793.60 which is equivalent to USD $1,931,466. This budget includes costs for environmental monitoring.

The total resettlement cost related to the implementation of the project is summarized below in Table 43.

Table 43 Compensation Cost Budget Summary

No	Item	Compensation Cost (ETB)
1	Compensation for permanent loss of farm land due to tower foundation	2614421.56
2	Compensation for permanent loss of grass land due to tower foundation	5,441,513.37
3	Compensation for permanent loss of farm land due to access roads	1,777,990.25
4	Compensation for permanent loss of grass land due to access roads	12,956,747.16
5	Compensation for permanent loss of grass land due to substation con.	550,000.00
6	Compensation for loss of eucalyptus tree due to W T foundation and Road construction	375,812.76
7	Compensation for residential houses within 300 meter radius	10,748,600.00
8	Compensation for loss of fence	2,000.00
Sub Total		**34,467,085.09**
Monitoring and valuation		
1	Monitoring and evaluation	500,000.00
2	Valuation committee per diem	10,000.00
Sub Total		**510,000.00**
Total		34,977,085.09
Contingency 10 %		3,497,708.509
Grand Total		**38,474,793.60**

(Exchange rate is 1 USD =19.92; on October 8, 2014)

17.7 Summary

The construction and operation of the Project is expected to bring several significant positive socio-economic benefits to the Project area of influence as well as to the nation at large. The Project will enhance economic and social developments along the corridor of the Project and these developments will likely to lead to a much-improved quality of life for local communities. Because of the expected positive effects of Project construction and operation and current low level of investment in the surrounding area, the Project is highly desirable from social, economic, environmental and political perspectives.

Some persons will be adversely affected by the implementation of the project. All such persons will be appropriately compensated by EEP in accordance with the Resettlement Action Plan.

As owner, EEP shall be responsible for securing all of the land rights and all permits required for the construction and operation of the Project from all GoE agencies, managing the community and landowners that are affected by the Project

The overall conclusion is that all potential negative environmental and social impacts of the Project could be eliminated or reduced to acceptable levels by implementing good engineering practices and proper environmental management activities, thereby assuring environmental and economic sustainability and social acceptance. Furthermore, any remaining negative impacts will be more than equally offset by positive impacts.

18. Study Conclusions, Recommendations

Terra Global recommends that EEP proceed with implementation of the Debre Berhan 100MW wind energy development based on the principal conclusions in this Feasibility Study Report which follow:

- There are no impediments to the construction and long-term operation of the Project from an environmental, technical, financial, logistical, interconnection, site access, soil condition, construction, operation or other perspective;
- From a levelized cost of energy perspective, wind energy is the best technology that is available to EEP to diversify its generation mix to mitigate its reliance on hydro, and the levelized cost of energy achieved using the recommended wind turbine of Goldwind International Holdings (HK) Limited ("Goldwind") is quite favorable for EEP;
- The Project is at a very advanced stage of development; construction of the Project can commence as soon as the negotiation of the EPC Contract and the financing agreements are complete. The Project will begin filling the energy gap within 16 months following the start of construction;
- The terms of the financing being offered to EEP for the Project by Industrial and Commercial Bank of China Limited ("ICBC") and the Bank of China ("BOC") are commercial in nature but quite close to the terms of a concessionary loan and far superior to those being offered by other lenders; and
- The financing for the Project requires export credit insurance from China Export & Credit Insurance Corporation ("Sinosure") which indicated that it had exceeded its exposure limit for Ethiopia.

Through the extensive lobbying efforts of Terra Global, Goldwind, ICBC and BOC and the early requests made for such insurance by Terra Global and Goldwind, Sinosure has agreed to provide insurance for the Project.

The construction and operation of the Project is expected to bring several significant positive socio-economic benefits to the Project area of influence as well as to the nation at large. The Project will enhance economic and social developments along the corridor of the Project and these developments will likely to lead to a much-improved quality of life for local communities. Because of the expected positive effects of Project construction and operation and current low level of investment in the surrounding area, the Project is highly desirable from social, economic, environmental and political perspectives.

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19. Appendices

A. ENERGY YIELD PREDICTION AND SITE SUITABILITY ANALYSIS

SgurrEnergy

B. DEBRE BERHAN ROUTE SURVEY AND MARKET STUDY

Central Oceans

C. FINAL GEOTECHNICAL INVESTIGATION REPORT

Addis Geotechnical Engineering Services

D. FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Environmental Forward Observers, LLC

E. DEBRE BERHAN WIND FARM ELECTRICAL COLLECTION AND SUBSTATION SYSTEMS

Opus Ventus, LTD

F. GRID CONNECTION FEASIBILITY

SgurrEnergy

G. WTG MANUFACTURERS SUMMARY, DATA

Opus Ventus, LTD

H. FINANCING TERM SHEET

Industrial & Commercial Bank of China (ICBC) and Bank of China (BOC)

I. LETTER OF INTENT FOR EXPORT CREDIT INSURANCE COVERAGE

EXPORT & CREDIT INSURANCE CORPORATION (SINOSURE)

J. RESETTELEMENT ACTION PLAN (RAP) REPORT
ADDIS ENVIRONMENTAL SERVICES

K. CARBON DEVELOPMENT MECHANISM (CDM) REPORT

Addis Environmental Services

L. TECHNICAL DESCRIPTION OF THE GOLDWIND GW 93 1.5 MW WIND TURBINE

Goldwind

M. DEBRE BIRHAN_67XGW93_HH85M_WINDPRO PARK REPORT_A0_2014.4.2

Goldwind

M DEBRE BERHAN PROJECT WINDPRO LOSS & UNCERTAINTY REPORT

Goldwind

N BILL OF QUANTITIES

Goldwind/Isolux