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GHA Clients

via email

Subject: Ramp-Up and Long-Term Availability Assumptions: Garrad Hassan Position

To All GHA due diligence and energy evaluation clients:

GH has always had an active program of validation of all of its prediction tools. Approximately a decade ago, we began to undertake a rigorous comparison of the energy predicted for wind farms with the energy actually produced by them. Such an evaluation is necessarily a very long term project.

Initial evaluation (during the first five years) revealed very close agreement between the predicted energy and the actual energy produced. In more recent years, specifically over the last two to three, it has emerged that there is an apparent tendency to over-predict the energy at least in terms of comparison of the mean production of the wind farms and the predicted P50 values. Meanwhile, the GH predictions of the tails (P99, P95, etc) have been satisfactory. The over-prediction tendency has been particularly apparent in the US and it appears to be a characteristic of the industry as a whole, and not just of GH.

No other consultant has produced comparative results and hence it is difficult to make an absolute statement. However, various others, most namely AWS [4] and DNV/GEC [5], have published papers that reach similar conclusions without reference to their own analyses. GH has attempted to provide a rigorous scientific evaluation of predictions of the performance of many wind farms and thus substantiate any subsequent reactions and avoid any *ad hoc* adjustments.

As a result of these investigations and analyses, GH has re-evaluated and adjusted its position on wind turbine availability for the US market. The GH revised position is summarized below and this note concentrates on availability while other matters are discussed in detail in [3].

Ramp-Up of Availability

Based on its evaluation of wind farm availability data [1], [2], and [3], GH has concluded that the ramp-up period required to reach a consistent long-term availability level in the US market is approximately 3 to 4 years, which is longer than that required in Europe, [1]. Original availability ramp up estimates for many projects were in the order of 1 to 2 years, but actual experience in the market has shown that many projects are taking longer to achieve a consistent long-term turbine availability ($Avail_{LT}$) level. Given these trends, GH now considers that it is more realistic to assume that the ramp-up to long-term turbine availability will require at least 3 full years. Recent years have also seen the demise of availability warranties in the US market which has exacerbated this problem since in the past it was possible to rely on the warranted level as a floor level in the early years of the projects. The following table outlines GH's revised position on the ramp-up of turbine availability in the current US market:

Year of Operation	% of Long Term Turbine Availability	Examples of 2 Long-Term Turbine Availability Levels	
		LT = 97%	LT = 95%
All of 1st Year	97.4% x $Avail_{LT}$	94.5%	92.5%
All of 2nd Year	99.0% x $Avail_{LT}$	96.0%	94.1%
All of 3rd Year	99.5% x $Avail_{LT}$	96.5%	94.5%
All of 4th Year and beyond	100% x $Avail_{LT}$	97.0%	95.0%

A sponsor or client may provide an argument for higher levels by presenting to GH actual data from other relevant projects that demonstrate a better availability ramp-up rate. Ideally, this data set and information would encompass at least 2 projects with turbine models and operating conditions similar to those in the project under review and have at least 3 years of data on each. GH stresses that part of its recent availability evaluation has demonstrated that the reported availability is quite often significantly higher than the "real" availability and hence any such justification will require some detailed evaluation of SCADA data and not just reference to monthly reports.

Turbine Long-Term Availability

Based on the same evaluation[1], [2], and [3], GH has also concluded that even after 4 years of operation many projects in the United States are not achieving a consistent long-term turbine availability greater than 96.5%. While original long-term turbine availability estimates for projects were in the order of 97%, actual experience indicates that many projects are falling short of these projections as well. Given these trends, GH now considers that it is prudent to re-evaluate long term-turbine availability assumptions in the financial evaluation of wind power projects in the US. GH has noted that one important distinction between European availability levels and US values in the long term is the more onerous weather conditions which are found in the US. The following outlines GH's revised position:

GH will consider supporting a long-term turbine availability of up to 97%, but only when a "commercially proven" turbine is used and only when such assumptions are supported by sufficient operational data, both with respect to the turbines and to the owner/operator.

For a turbine which <u>is</u> a genuine evolution from another turbine, the turbine under consideration may be considered "commercially proven" if the following conditions are met:

- It is manufactured by a company capable of performing all the contractual and commercial obligations.
- It carries a current and valid GL or DNV certificate.
- There are a minimum of 100 of these turbines in operation.
- There is at least one turbine with more than 4,000 hours of operation.
- There is a fleet of turbines with a cumulative operation time in excess of 50,000 hours.
- The average availability of the fleet is greater than 95%.

In this context, it must be demonstrated that the relevant turbine(s) has the ability to achieve the projected availability.

For a turbine which is not a genuine evolution from another turbine above, 50,000 hours is replaced by 100,000 hours.

In cases where the turbine is not commercially proven, regardless of the owner/operator information, GH will not be able to support a long-term turbine availability in excess of 95% and may use a lower value depending on the material presented.

In summary, GH's default long-term turbine availability assumptions are as follows:

- Commercially proven turbine models with well-documented availability histories in the US market can be considered for a long-term turbine availability of up to 97%, contingent upon the turbine and owner/operator information provided.
- Commercially proven turbine models with well-documented availability histories in non-US markets but with no material data collected in the US can be considered for a long-term turbine availability of approximately 94%. Consideration for any long-term availability in excess of this, up to 97%, is contingent upon the turbine and owner/operator information provided.
- New turbine models that have only been prototype-tested or those without sufficient data to be considered commercially proven will be given a long-term turbine availability range of approximately 90% to 92%. Consideration for any long-term availability in excess of this, up to 95%, is contingent upon the turbine and owner/operator information provided.

The owner/operator information provided should be similar to that stipulated above for ramp-up availability substantiation along with any other information that can demonstrate the ability of the relevant project to perform (parts procurement and logistics plan, staffing, monitoring of the project 24/7, etc.).

In all cases, the sponsor or client must substantiate its assumption for long-term turbine availability and provide GH with the appropriate level of information to reasonably evaluate the assumed long-term turbine availability values. It will be the responsibility of the sponsor or client to provide any additional information required to validate any availability assumption which they suggest.

Wind Energy Assessment Default Position

The wind energy assessments typically precede technical due diligence efforts and thus a default position must be established to provide a reasonable energy estimate, pending a subsequent engineering due diligence review at a later time. To this end, and based upon the analyses noted above, GH wind energy assessments will assume the following default turbine availability parameters:

Year of Operation	Turbine Availability
All of 1st Year	94.0%
All of 2nd Year	95.5%
All of 3rd Year	96.0%
All of 4th Year and beyond	96.5%

These values are default values. The final financial projections for any specific project are then subject to the independent technical due diligence process (either by GH as described above or by others) to ascertain the appropriate turbine availability ramp-up and long-term parameters to be used for the final energy predictions. Generally speaking, GH wind energy assessments will be updated at the appropriate time to reflect the final agreed upon turbine availability parameters as discussed elsewhere herein.

Summary - A More Accurate Assessment of Financial Performance

These assumptions use lower values than adopted in the past. GH considers that the revised approach to availability projections outlined herein, which will now be standard in GH's due diligence and wind energy assessment processes, provide a more accurate assessment of a project's financial performance. That being said, the sponsors and/or clients will always have the opportunity during the technical due diligence process to justify higher levels if they can be substantiated with operational data. Sponsors are urged to make sure that they collect and report accurate availability data which properly reflect the effect of turbine reliability on the energy generated and do not use an artificial contractual definition. GH's studies have shown that much of the energy lost through poor availability could have been recovered by proper analysis of the data and prompt action taken on the results.

It should be noted that this note discusses turbine availability only. Further deductions will be made for system availability considerations.

Finally we would very much welcome the opportunity to discuss these matters and the contents of the other papers referenced with the recipients of this note.

References

[1] Garrad Hassan, "Why is America's Availability Lower than Europe's?", AWEA Wind Power Asset Management Workshop in San Diego, January 2008.

[2] Garrad Hassan, "Validation of Energy Predictions by Comparison to Actual Performance," AWEA Windpower 2008 Conference, June 2008.

[3] Garrad Hassan, "Understanding Availability Trends of Operating Wind Farms," AWEA Windpower 2008 Conference, June 2008.

[4] AWS Truewind, "Understanding and Closing the Gap on Plant's Underperformance", AWEA Windpower 2008 Conference, June 2008.

[5] DNV / GEC, "Project underperformance: 2008 Update", AWEA Windpower 2008 Conference, June 2008.

All GH papers are available from www.garradhassan.com.