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Taming uncertainty for wind project financing

Construction next year won't match the boom years of 2011 and 2012, but let's be positive. Reducing project uncertainty is one way for a bank to loosen its purse strings. There are others, and financial terms you should know.

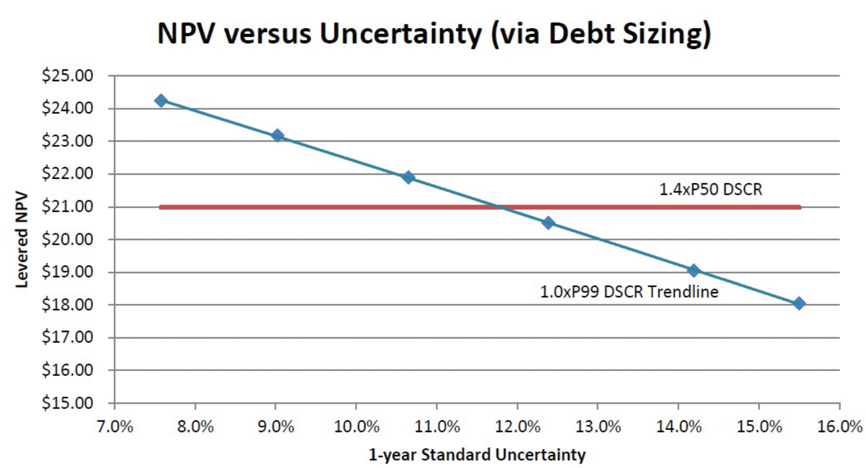
Paul Dvorak/Editor

Consultants and financial institutions agree that lowering the uncertainty surrounding a proposed wind farm makes the lenders agreeable to better terms At AWEA's recent Wind Resource & Project Energy Assessment Seminar, Errol Halberg, a wind resource engineer with consulting firm GENIVAR, based in Montreal , Canada, spoke on taming uncertainty and introduced the audience to a wind project's financial perspective.

Uncertainty in a wind project is typically calculated as part of the wind resource assessment where statistical methods are used to predict the probability distribution of yields. The more uncertainty, the more likely the actual yields may differ from the yield estimate. It's usually due to a variety of things, such as the variability in wind speed and equipment performance.

To discuss project uncertainty, it's also necessary to introduce financing terms such as net present value (NPV) and internal rate of return (IRR). "Net present value is a present-day dollar-figure of costs and revenues over the lifetime of the project adjusted for

Debt service coverage ratio: 1.0 for P99; 1.4 for P50



NPV versus uncertainty
The graph represents the debt service coverage for a ratio of 1.0 for P99 in blue and 1.4 for P50 in red.

inflation," says Halberg. "IRR is an internal rate of return akin to the interest a bank would pay on an account. An IRR answers the question: If an investment is made, what percent return will it provide?" One goal here is to quantify how reductions in uncertainty result in increase in IRR and NPV.

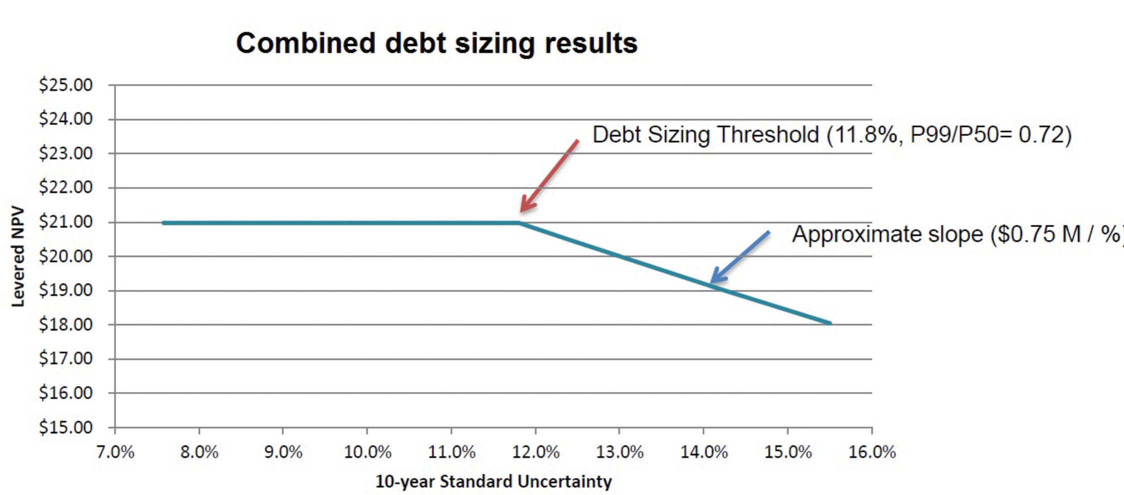
Benefits of lower uncertainty

Others have shown that lower uncertainly results in lower equity requirements. "That means for lower uncertainty you can borrow more," says Halberg. "It improves the project's IRR." To demonstrate, the accompanying graph, *NPV versus uncertainty* (read it from right to left) indicates that reducing uncertainty improves the IRR to a point where it stabilizes.

Other new terms here are P or probability values. For instance, the P value represents the probability of exceedence where there is a 99% chance of yields exceeding the P99. The most likely scenario is the P50 yield which is expected to be acheived 50% of the time. The P99 is typically interpreted as the worst case scenario and is a lower value than the P75 or P50 in terms of energy yield.

Uncertainty is typically communicated in terms of the standard uncertainty, or one standard deviation (P84.1) of the distribution as a percentage deviation from the P50: (P50-P84.1)/P50. The lower the uncertainty, the tighter the distribution, and the closer the P99 and P75 are to the P50.

It is also useful to know how the financial parameters banks use vary throughout the industry. To answer such questions,



Reading the graph
from right to left says reducing uncertainty in a project improves its Net Present Value, at a rate of $750,000 per 1%. From the survey, however, the advantage ceases at about 11.8%.

Halberg conducted a survey of lenders, tax equity banks, and developers. Results are anonymous.

The combined portfolio held by the survey groups includes many thousands of megawatts over hundreds of projects – an adequate sample size. Survey results were applied to a case study of a typical Midwest 100-MW wind farm with a capacity factor of 40%, power purchase agreement of \$47/MWh, and for the ten-year standard uncertainty cases of 5, 7, 9, 11, and 13%.

To qualify results, a typical-project uncertainty is around 11% and maybe less for the 10-year standard uncertainty. Projects with 13% uncertainty do occur, and 15% would be extreme. On the lower side, 9% is also a normal uncertainty value while 7% is low and 5% would be an extremely low case.

"A common financial structure uses debt, so that money comes out of the developer's pocket and is leveraged using (money) from the bank," says Halberg. The amount of debt is decided by a parameter called the Debt Service Coverage Ratio (DSCR) which represents the amount of money coming in and how it will cover the debt responsibility. As an equation:

$$DSCR = \frac{\text{Cash available for debt service}}{\text{Interest + Principle payments}}$$

"A coverage ratio of 1.0 means you are just able to pay all debt responsibilities. A lower figure probably means you will default. Values greater than 1.0 mean you have money left over," says Halberg. The availability of cash to pay debt depends on income and production from the facility.

Results from Halberg's survey shows results in good agreement with each other. There are two service coverage ratio parameters that apply used by banks to size the debt. Take the more conservative of the two, a debt service coverage ratio of 1.0 for P99, which means lenders would expect you to be able to pay your debt in the worst case scenario. The second, a DSCR of 1.4 for P50, represents an expectation for extra cash in the most likely yield scenario.

The blue line on the graph *NPV versus Uncertainty* shows the DSCR of 1.0 for the P99, and reading from right to left, as uncertainty reduces, lenders allow more debt to the developer with lower uncertainty. The red linerepresenting the DSCR of 1.4 for the P50 has a slope of zero since the P50 does not change with uncertainty. Combining these provides the most conservative scenario.

Key to the graph, *Combining debt sizing*

P50 scenario with investor IRR at 7.75%

	Flip in year: 9	
	Pre-tax	After tax
Developer	10.4%	8.55%
NPV	$10,780,212	$4,014,121

results, is that the slope of the graph is $750,000 per each percent of uncertainty for uncertainty levels above 12%. Of course, after hearing back from various survey people, says Halberg, there are variations on these parameters, so you could have a debt sizing ration of 1.45 for P50, or 1.0 for P90. So what does it mean? "My interpretation is that for most cases it is quite easy to get below 12% uncertainty if you conduct a proper remote sensing and met tower campaign. With an increase of $750,000 in net present value for each percent reduction in uncertainty, if you don't reduce uncertainty below 12%, there is money left on the table. And the relative low cost for improving the figure comes from, for example, $30k to $40k for a remote sensing campaign, $40 to $50k for another met tower, and $120,000 for a tall (100m) tower," he says.

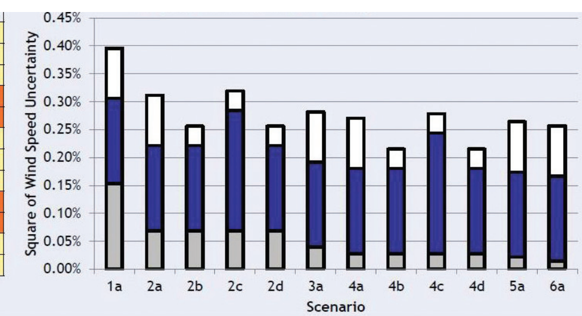
Transferring ownership

Another common financing structure involves a tax equity partner, says Halberg. A benefit of this structure is that, in some scenarios, the developer may pay lesser tax than the value of the production tax credits available, so they might team with a tax-equity partner who would have a bigger finance sheet to take advantage of those tax credits. "Banks are smart and we need them to be because we rely on them. A tax equity finance deal might be structured so that in the first nine or 10 years the tax-equity partner gets most benefit of the tax credits as well as a significant portion of the revenue."

After they get what they want out of the project, such as in their target IRR, the project flips ownership back to the developer, at which time the developer gets a larger portion of revenue and what

A closer look at the scenarios and results

Name	Locations	masts	masts	Sensors
1a	1	1	0	0
2a	2	2	0	0
2b	2	1	1	0
2c	2	1	0	1
2d	2	2	0	1
3a	3	3	0	0
4a	4	4	0	0
4b	4	3	1	0
4c	4	3	0	1
4d	4	4	0	1
5a	5	5	0	0
6a	6	6	0	0



The orange and yellow table lists the met mast and remote sensor combinations for the 100 MW virtual wind project with 50 turbines. The blue bars show wind speed uncertainty indicators for each combination. The lowest wind speed uncertainty came from scenarios 4b and 4d. The big take away: more than four met masts do not reduce uncertainty in this scenario due to vertical extrapolation uncertainty.

How many met towers are enough?

How many met towers and at what heights are they needed to minimize a project's uncertainty? Alex Clerc of **RES Ltd** (*www.res-americas.com*) asked the question and then presented a study that answered it during AWEA's recent Wind Resource & Project Energy Assessment Seminar.

Clerc had completed a survey with several consultants who responded to the conditions on a virtual 100-MW wind farm of 50 turbines, all perched on 100-m towers, and spread over about 90 km^2. Twelve scenarios were considered with up to six measurement locations.

Clerc says overall wind speed uncertainty can be calculated as a root-sum square of the flow model, and from wind measurements and vertical extrapolation. Survey results, compiled in the table and chart above, include a surprise.

The statistical calculations for uncertainty are beyond the scope of this article, so suffice it to say the survey results depend on the calculated uncertainty, a correlation of errors, and sensitivity. Uncertainty further depends on the distance between met mast and turbine, and the speed-up predicted by a flow model. The correlation of errors depends in part on wind direction and distance between the turbines. And sensitivity depends mostly on the shape of the wind distribution and power curves.

As it turns out, the lowest overall uncertainty came in scenario 4b (in the table): three 60-m masts and one 100-m tower, and scenario 4d: four 60-m masts and one co-located remote sensing device, with certain uncertainty assumptions.

To standardize these calculations, RES offers the program, DeltaWindFlow, at no cost from the its website. Find it at *www.tinyurl.com/delta-wind-flow*. The link is at the very bottom of the page under the Software heading.

P75 production realized (10-year standard uncertainty)

		IRR		NPV, assume 5% discount	
Uncertainty, %	Flip date, years	Pre-tax, %	After tax, %	Pre-tax, $	After tax, $
5	13	8.81	7.19	1,611,562	(2,633,845)
7	14	8.10	6.59	(2,047,155)	(5,309,679)
9	14	7.96	6.47	(2,725,384)	(5,856,684)
11	15	7.14	5.78	(6,638,539)	(8,718,392)
13	16	6.46	5.2	(9,522,903)	(10,880,788)

is left over for the protection of tax credits. "Ultimately, the sooner a project flips to the developer, the better," says Halberg.

Banks usually target an IRR of 7.75%. "Some groups target 8% at 10 years, but survey results were consistent in that no one was willing to go as low as 7%. Of course, expectations for returns depend on market conditions," he says.

Banks also conduct a sensitivity test for different probability levels. If the wind farm underperforms, say at the P75, P90, or P99 level, the flip date is delayed, which is bad for the developer. There are different sensitivities depending on the tax equity partner's comfort level with the project. For some banks, a maximum of 14 years till the flip is acceptable for the P90 scenario, whereas, others might be comfortable extending to 15 and 17 years.

Halberg offers this scenario for a developer: For a 9 year flip–an IRR of 7.75% for the bank–means about a 10.4% IRR for the developer, and an NPV of $10.7 million. In the case study, this represents the ideal situation where the P50 is achieved.

What would happen if the project under-performs and achieves only the P75 yield? The premise would be that for lower uncertainty, the problem and severity of underproduction is lower because P75 is closer to the P50 value.

We wanted to see how financial modeling results would it look for 5, 7, 9 and 13% uncertainty. Results showed that the corresponding flip dates extended to 13, 14, 15, and 16 years and the IRR shrinks accordingly. Note that the assumed discount rate here is 8.5%, so every IRR less than 8.5% puts the project in the hole. One thing to point out is that there are multiple millions for every couple percent standard uncertainty in the NPV for these downside risk scenarios.

Final thoughts

For higher uncertainty, there is more severe risk for the probably of underproduction. That is not necessarily acceptable. "I'm saying that everyone should have a probability level they are comfortable they can achieve and then do the financial sensitivity calculations to see if results are sustainable for your finance sheet," he says. From the other presentations at this conference, the consultants feel modern wind resource assessment techniques are resulting in projects that are more consistently hitting their targets. However, developers might attest that, even if the majority of projects are yielding as expected, there are still projects that will underperform, so a risk scenario is good thing to quantify.

Of course, there are other things to consider to justify project investments. One is time constraints, usually at least a year's worth of data from met towers is required for significant uncertainty improvements. With tight development schedules this may not always be sufficient time. There are also budget constraints that may limit the possibility of investments in the meteorological campaign.

"Financial institutions do a lot of due diligence, and not only quantitative analysis of uncertainty levels, but a lot of qualitative assessment such as identifying the main driver of uncertainty and whether they are comfortable with the project," he says.

A consistent resounding comment in the survey was reflection of the importance of the selected turbine equipment. "If lenders are comfortable with the manufacturer's reputations and history then they are more likely to be comfortable with the project. In addition, the reputation of the sponsor-developer, strength of the market conditions, and project specifics such as PPA terms, transmission costs, and risk for curtailment, all contribute to successful financing. **WPE**