Selection Bias and the Value of Certainty

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Selection Bias and Industry Performance

For the past few years, investors, owners, and consultants in the US wind industry have been challenged by well-documented cases of wind project underperformance. For the past five or six years, this shortfall has been the subject of much study and discussion among the experts. Early estimates by those who have been tracking this have shown realized generation to be 8-12% below pre-construction expectations. Attention to this issue has yielded many process improvements, and the US gap seems to be closing. But have we truly addressed the problem? While the bias has been well studied, few smoking guns have materialized as major sources of shortfall. Sure, there are many candidates, but there pervades a sense that it is mostly bad luck. But if luck is really a factor, why does it tend to be of the bad variety, resulting in underperformance? Instead of luck, it might be something much more predictable, *selection bias*.

Selection bias theory suggests that there might be less wrong with the energy assessment process than the industry track record of underperformance would imply. Rather, this could be a behavioral, game theory problem caused by the mechanics of how projects are selected for development, combined with a market that has not yet properly valued risk. In the last 10 years, US wind power capacity has increased a monumental 1000%. This achievement was accomplished on the backs of many thousands of transactions and much pipeline shuffling. Projects often changed hands between the single person shops, flip developers, and the utility owner operators. Power purchase agreements, tax equity, debt, and other financial instruments facilitated the process. Every transaction had one thing in common, they all favored projects that yielded higher returns. This, combined with the fact that the energy estimate is a sensitive valuation driver, and that uncertainty of this estimate can be rather high, makes for a perfect selection bias storm. In its pursuit of building projects that will potentially yield higher returns, the industry tends to build projects with biased error that increases the risk of underperformance.

Selection Bias Model

To test this theory a selection model was developed. This model is a simple emulation of the choices a decision maker might face when deciding to advance one project over another. At the core it is a simple economic model. Inputs into this model were chosen to be indicative of a generic, unlevered, 100 MW wind project. This model was used to develop the relationship between expected generation or net capacity factor ("NCF"), energy price, and return. This model was then used in turn by the selection model that considered the following influences.

Energy Estimate Uncertainty – Foremost, the selection model considered the uncertainty surrounding the primary energy estimate. Examining the effect of this was the primary focus of this exercise. As one of the most sensitive components of a valuation model, the generation estimate significantly affects the expected return. The greater the uncertainty, the more likely there will be error towards greater production and increased likelihood of an improper selection. The selection model considered project uncertainties across the range of 5%-15%. This represents the likely range of pre-construction uncertainties, with 5% being a top of the line estimate while, hopefully, no one would consider a project with 15% uncertainty.

Weight of NCF in selection decision – While return on investment is the primary reason that projects are selected, there are often many more. Project momentum could carry a project with lower returns due to risk factors other than generation. These might include an expiring or easy permit, having to take receipt of turbines, and environmental or operational risk. The greater *other* influences are, the lower the risk for selection bias. The selection model analyzed scenarios where NCF weight varied from 0-100%.

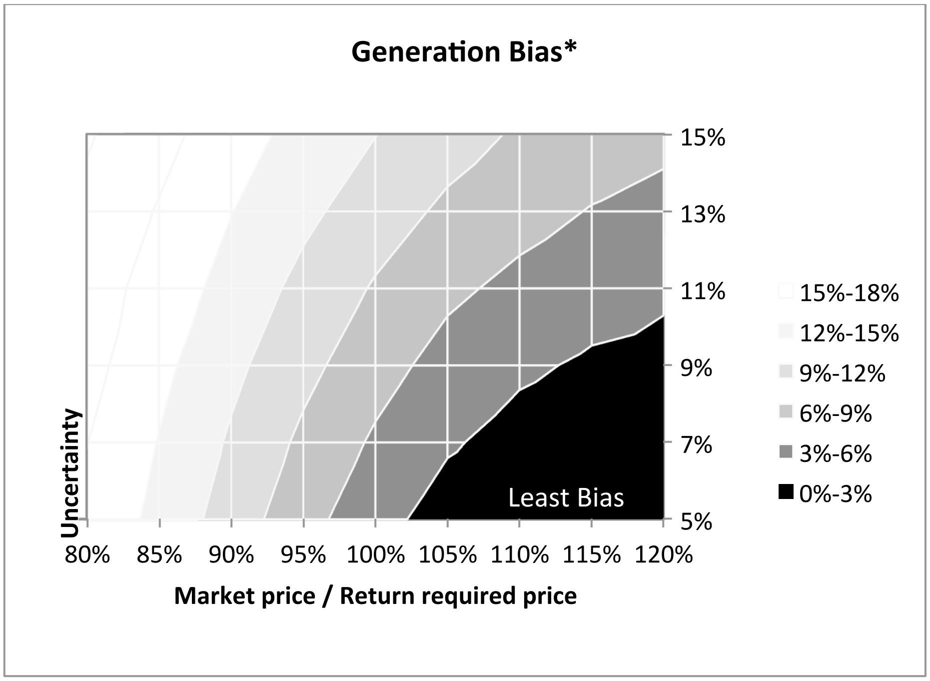
Market pressure – When investing, the desire for maximum return will always run into competition and negative price pressure. For every market opportunity, there is a threshold where the return one desires is not possible due to current pricing in the market. When this price threshold is close to the return threshold one loses the option to receive the desired price. Because these forces compel the decision to be between projects that only meet a minimum price threshold there is less chance that other factors will influence the project to be selected. This increases the likelihood of picking projects that have error on the underperformance side. This was modeled by assuming the market price threshold to be a factor of the ideal price. Factors were assessed across the range of 0.8 – 1.2.

Selection pool size – Selection bias is also a function of the number of feasible projects available to choose from. As the number of projects to select from increases, there is greater risk that the project chosen will have error on the high side. With more projects to choose from there is greater chance that any one of the projects would have greater error that could tempt a selection. The selection pool was modeled between 2 to 10 projects to choose from. Only 2 or 3 projects might represent the options of a small developer while a 10 project selection pool might represent the options available to a utility selecting a power purchase agreement in a competitive process.

Considering the above factors, the model then repeatedly simulates the selection of a "winning" project out of an available pool. The modeled NCF varied randomly as a function of the uncertainty and an assumed "true" NCF. If the NCF was higher, the price was reduced to a level that yielded a desired return. Any price that was above the market threshold was considered not selected. To model the NCF weight, another factor varied randomly to make up the other considerations in the selection decision. This, combined with the lowest price created a selection score. Projects with the highest score and an "in market" price were selected. The model was run through 10,000 decision cycles, for each of the 5346 variable permutations, ensuring all factors would interact across their spectrum of possible values.

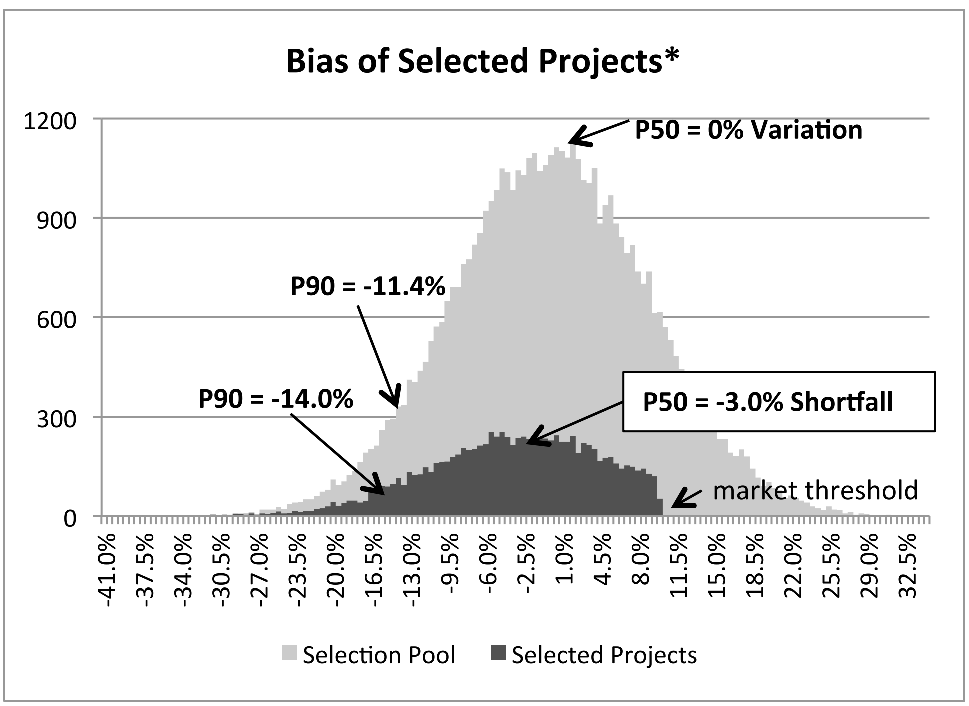
Results

The model results showed that in virtually all selection situations there is a tendency for a biased outcome in which realized generation was less than expected. The only situations that showed no bias were ones where there is very little market pressure and where one does not care about NCF driven returns. Realistically, this might represent decisions in a country with a high feed in tariff where project locations had to be locked down years before construction. Otherwise, it was found that the most important drivers of selection bias were the uncertainty of the production estimate and the strength of competitive market forces. Figure 1 shows the relationship of these two factors for a fixed NCF weight and selection pool size. Figure 2 shows the unlevered loss in expected, net present value from the simple 100MW valuation model. It is interesting that the outcome of this analysis yielded bias that is relatively consistent with empirical underperformance levels in the industry that have been formerly published. This would suggest that it is quite possible that billions of dollars in net present value have been lost to the US wind power industry due to this phenomenon. We should keep in mind that every project that underperforms will have a litany of technical reasons for this underperformance, but selection bias should be seen as a magnet that may attract these errors.



*Assumes 30% NCF Weight and 5 project selection pool

Figure 1.



*Assumes 30% NCF weight, 5 project selection pool, and market threshold of 1.1x expected return.

Figure 2.

Resisting Selection Bias

At its core, this phenomenon is largely a result of being lured into projects with high potential returns based disproportionately on higher uncertainty in the energy assessments, without accounting for the associated risk. While it is nearly impossible to remove selection bias, it is very possible to protect against it. This protection comes in two forms, 1) acting with a suitable level of conservatism and 2) developing greater resistance to uncertain projects.

Since even small levels of uncertainty create bias, it should be considered appropriate to apply conservatism within the energy assessment models. In order to have plants that meet their generation budgets, it is probably preferred to have this conservatism applied within the estimate of production. However, it should be clear that when production estimates are given "haircuts" as has become fairly common practice among investors, there can be two negative effects. First, if the cut double-dips on the conservatism that the energy assessor has already applied there is potential to render projects unduly uneconomical. It reduces the effectiveness of the preferred tool for managing this risk, resistance.

Additionally, greater resistance should be applied to projects with higher uncertainty. This analysis demonstrates that even small reductions in uncertainty can translate into millions of dollars in reduced bias. If one is only applying a conservative factor there is still risk that uncertain projects will lure one into a poor investment. Many in the industry are tempted to invest at the P50 or 50% probability level. This is fundamentally flawed and will contribute to greater selection bias because almost all scenarios create bias, and risk can only be differentiated when looking at other probability levels. Some probability level should be picked that fits a comfortable risk profile. For example, a good choice might be to invest where the P95, or the 5% probable low case, is at least a break even scenario. This way, highly uncertain projects would be priced unfavorably compared to more certain projects. A little resistance goes a long way to combating bias.

Finally, the most critical conclusion to take from this analysis is that uncertainty matters, and reducing it is of paramount importance. With millions of dollars at risk the positive cost benefit of investing in measures to improve project certainty cannot be overstated. Only by creating a program to systematically identify and address sources of energy estimate uncertainty can project developers and investors be able to mitigate selection bias that encourages investment in underperforming projects. This is done with more met towers, higher measurement heights, remote sensing, improved spatial modeling, higher quality long term references, better wake models, research and analysts that comprehend these risks.

For the wind industry to be sustainable it must become more disciplined in appropriately pricing and managing risk.