THE VALUE OF WAITING FOR THE WIND

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Overview

The actual siting of new renewable energy production can greatly influence the profitability of the project. Assessment of the distribution of the (stochastic) production is an important variable in the investment decision about a particular project. However, the assessment itself is uncertain as it is derived from a finite number of observations at the site. This uncertainty can be reduced over time by additional observations of on-site conditions. The investor in a project is faced with the choice of abandoning the project now, developing the project now, or wait with the decision while gathering more information.
This paper details the decision making process with the wait and learn option in addition to the abandon and develop options. The value of waiting is given a precise definition and Bayesian methods are developed for the actual calculation of the value of information. The model is applied to the investment decision at a number of potential sites in Norway.

Methods

We are considering the investment decision in a wind mill with known investment costs and fixed prices (for simplicity).Wind speed at a site is modelled with a log-normal distribution. The prior is specified as the conjugate normal-gamma prior resulting in a normal-gamma posterior distribution for the wind speed. The predictive posterior distribution for wind speed is used to calculate electricity production and hence the expected present value of the revenue stream from the wind power plant. The value of postponing the decision to develop or abandoning this project is the difference between expected net present value of the project after observing more wind speed data and the expected net present value of the project with the current estimates (Howard, 1988; Yokota and Thompson, 2004). Postponing the project for a period allows for the recording of more wind speed data and the updating of the wind speed model. However, this evaluation is performed prior to any new observations and the expected value of the project after observing more wind speed data is taken with respect to all possible wind speeds.
The statistical model is estimated using MCMC (Markov Chain Monte Carlo) methods and the resulting predictive posterior distribution is used to predict the expected net present value of the project, and to calculate the expected net present value of the project using updated parameter estimates from additional observations of wind speeds. The MCMC method is a standard Gibbs sampler from the posterior distribution (Robert and Casella, 2004).

Results

We are using 12 years of detailed wind speed data from 60 different locations in Norway. There are three categories of sites: i) sites that are immediately abandoned, ii) sites that are immediately developed, and iii) sites with a substantial expected value of additional information for which postponing the abandon/develop decision is optimal. We find that the value of additional information is declining as more wind speed data is available for estimation of the model. If the decision maker has little, or only limited, information about the conditions at a specific site this is reflected in a vague prior distribution. Compared to a case with a more informative prior it is optimal to postpone the decision and gather data for a larger fraction of the projects.

Conclusions

The investment decision in new projects with intermittent electricity production depends upon uncertain information about the underlying production potential. The value of gathering more data and obtaining better estimates for the production potential is positive and is particularly large for marginal projects. The paper gives a rigorous definition of the value of waiting (and gathering more data), and describes the necessary MCMC algorithms for estimation and calculation the expected value of information. Although the example used in this paper is wind power production, the method is applicable to many other types of projects, for example solar power and hydro power.

References

Howard, R. A. (1988): Uncertainty about Probability: A Decision Analysis Perspective, *Risk Analysis*, **8(**1):91—98.

Robert, C. P. and G. Casella, (2004): *Monte Carlo Statistical Methods*, Springer-Verlag.

Yokota, F. and K. M. Thompson, (2004): Value of Information Analysis in Environmental Health Risk Management Decisions: Past, Present, and Future, *Risk Analysis*, **24(**3):635-650.