

# Offtake Strategies for Renewable Energy Projects under Uncertainty

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## **Abstract**

In the recent years, renewable energies (RE) developments are regarded as mainstreaming sustainable strategies that are proposed to deal with the controversial problems between the increase of energy consumption and the inevitable environmental impacts. With continuous development, the RE industry in U.S. evolved from policy-promoted to market-incentivized. With expected expiration of some key regulatory programs, RE developers are seeking for market-based offtake strategies to maintain self-sustainment.

The offtake of a project is defined as the strategy of how project is selling its product and realize the profit. The offtake strategy of a project can be an analog to the sales strategy for a company. While profitability remains the prior objective, another important metric of evaluating the strategy is the stability of the future revenue. For RE projects, the control of the revenue risk is a guarantee for stable revenue streams thus can largely increase the possibilities of the projects' success. Meanwhile, a well-designed offtake plan will help to justify the feasibility of the project in the initial phase, and thus enhance the bankability for project financing.

There are mainly two types of offtake strategies for RE projects, one is a short-term strategy that sells the electricity directly to the spot wholesale market; the other one is a long-term strategy that signs bilateral Power Purchase Agreements (PPAs) with buyers. In particular for wind energy projects, American Wind Energy Association (AWEA) reports that 85% of the wind power capacity installed in year 2012 by Independent Power Producers (IPPs) was contracted under long-term power purchase agreements (PPAs), and 15% was sold on the short-term or spot market. Both strategies are viable and being applied in practice, thus why there is a market preference for the selection, and how to specifically apply them become the key questions.

This paper starts with the review of each offtake strategy, analyzing their pros and cons. And then two modified stochastic models are built respectively. For the short-term offtake strategy, the model optimized the project developer's bidding and operation strategy in the Day-ahead and Real-time wholesale market. For the long-term offtake strategy, the model helps to design the specific terms in the PPA contract. In order to take the stochastic environment into consideration, a metric of Conditional Value at Risk (CVaR) is utilized to measure the risks of project revenues, and a chance-constraint is proposed to address the opportunity cost of the electricity production related to the market value. Finally, the models are applied to and justified by a case study of the Cape Wind offshore project in US. The optimized project revenues through different strategies are solved and compared.

## **Key Words:**

Renewable Energy Projects, Offtake Strategy, Power Purchase Agreement (PPA), Stochastic Programming