

DISSERTATION DEFENSE

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324 GSIA (West Wing)

Essays on Power System Economics

Chapter 1: Optimizing Transmission from Distant Wind Farms

We explore the optimal size of the transmission line from distant wind farms, modeling the tradeoff between transmission cost and benefit from delivered wind power. We also examine the benefit of connecting a second wind farm, requiring additional transmission, in order to increase output smoothness. Since a wind farm has a low capacity factor, the transmission line would not be heavily loaded, on average; depending on the time profile of generation, for wind farms with capacity factor of 29-34%, profit is maximized for a line that is about $\frac{3}{4}$ of the nameplate capacity of the wind farm. Although wind generation is inexpensive at a good site, transmitting wind power over 1,000 miles (about the distance from Wyoming to Los Angeles) doubles the delivered cost of power. As the price for power rises, the optimal capacity of transmission increases. Connecting wind farms lowers delivered cost when the wind farms are close, despite the high correlation of output over time. Imposing a penalty for failing to deliver minimum contracted supply leads to connecting more distant wind farms.

Chapter 2: The optimal baseload generation portfolio under CO₂ regulation and fuel price uncertainties

We solve for the power generation portfolio that minimizes cost and variability among existing and near-term baseload technologies under scenarios that vary the carbon tax, fuel prices, capital cost and CO₂ capture cost. The variability of fuel prices and uncertainty of CO₂ regulation favor technologies with low variable cost and low CO₂ emission. The qualitative results are expected; stringent CO₂ regulation cost leads to more technology with little carbon emissions, such as nuclear and IGCC CCS, while penalizing coal. However, the variability of fuel prices and the correlation among fuel prices are the principal attributes shaping the optimal portfolio mix. We also model a Bayesian approach that allows the planner to express his belief on the future cost of power generation technology.