Renewable Resources and Wholesale Price Suppression

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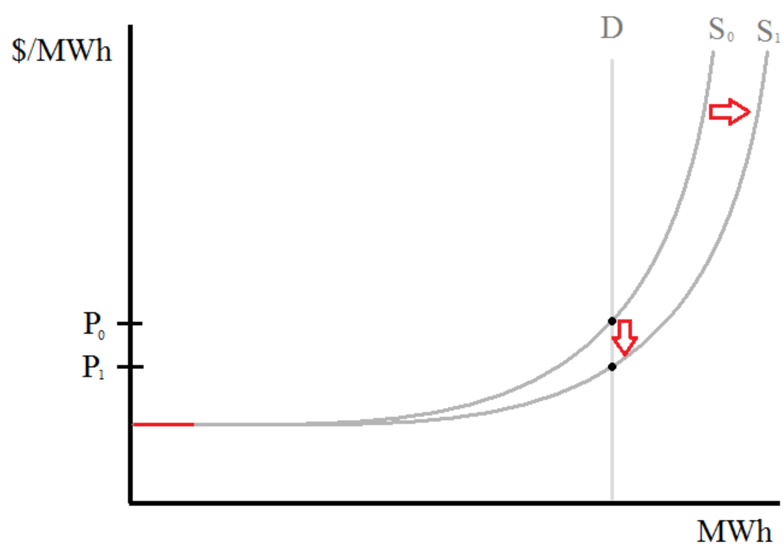
Ohio | Public Utilities Commission

INTRODUCTION
The study examines the relationship between renewable resource additions and wholesale electricity markets in Ohio. The Staff of the Public Utilities Commission of Ohio has conducted this study in an attempt to quantify the changes in *wholesale electricity prices* and *generator emissions* that are likely to occur as a result of the state's Alternative Energy Portfolio Standard (AEPS) requirements. Using the PROMOD IV production cost modeling software, Commission Staff is able to simulate electricity market outcomes and analyze the performance of the grid under various scenarios.

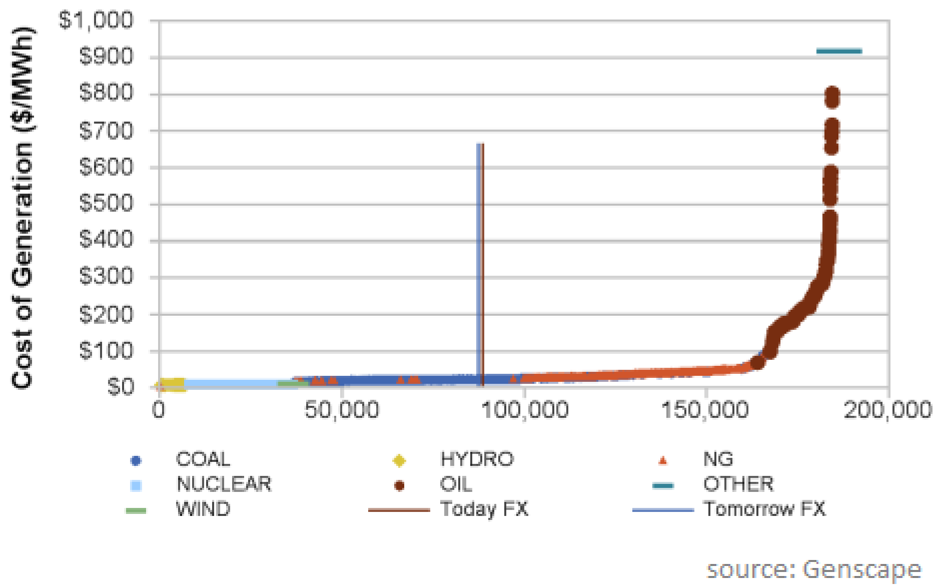
Two scenarios were developed for the purposes of this study. The first scenario considers only the utility-scale renewable resources that have been approved by the Ohio Power Siting Board *and* are currently operational. The second scenario considers all projects that have received a certificate of environmental compatibility and public need from the OPSB.

WHAT IS "PRICE SUPRESSION"?
Price suppression is a widely recognized phenomenon by which renewable resources produce lower wholesale market clearing prices. The economic theory that drives price suppression is actually quite simple. Renewable resources such as solar and wind are essentially zero marginal cost generators, as their "fuel" costs (sunlight and wind) are free. As such, they will always be dispatched first by the grid operator, thereby displacing units with higher operating costs. This results in lower wholesale market clearing prices than would have been experienced in the absence of the renewable resources.

A simple graphical representation appears below. The new renewable resources (depicted by the red line) are added to the dispatch stack, shifting the supply curve out and to the right. This results in a lower cost unit setting the market clearing price, shifting the equilibrium price down from P_0 to P_1.



For reference, an example of a real PJM dispatch curve appears below, with fuel types identified. Notice that Hydro, Nuclear, and Wind resources are all dispatched first on the supply stack.



METHODOLOGY

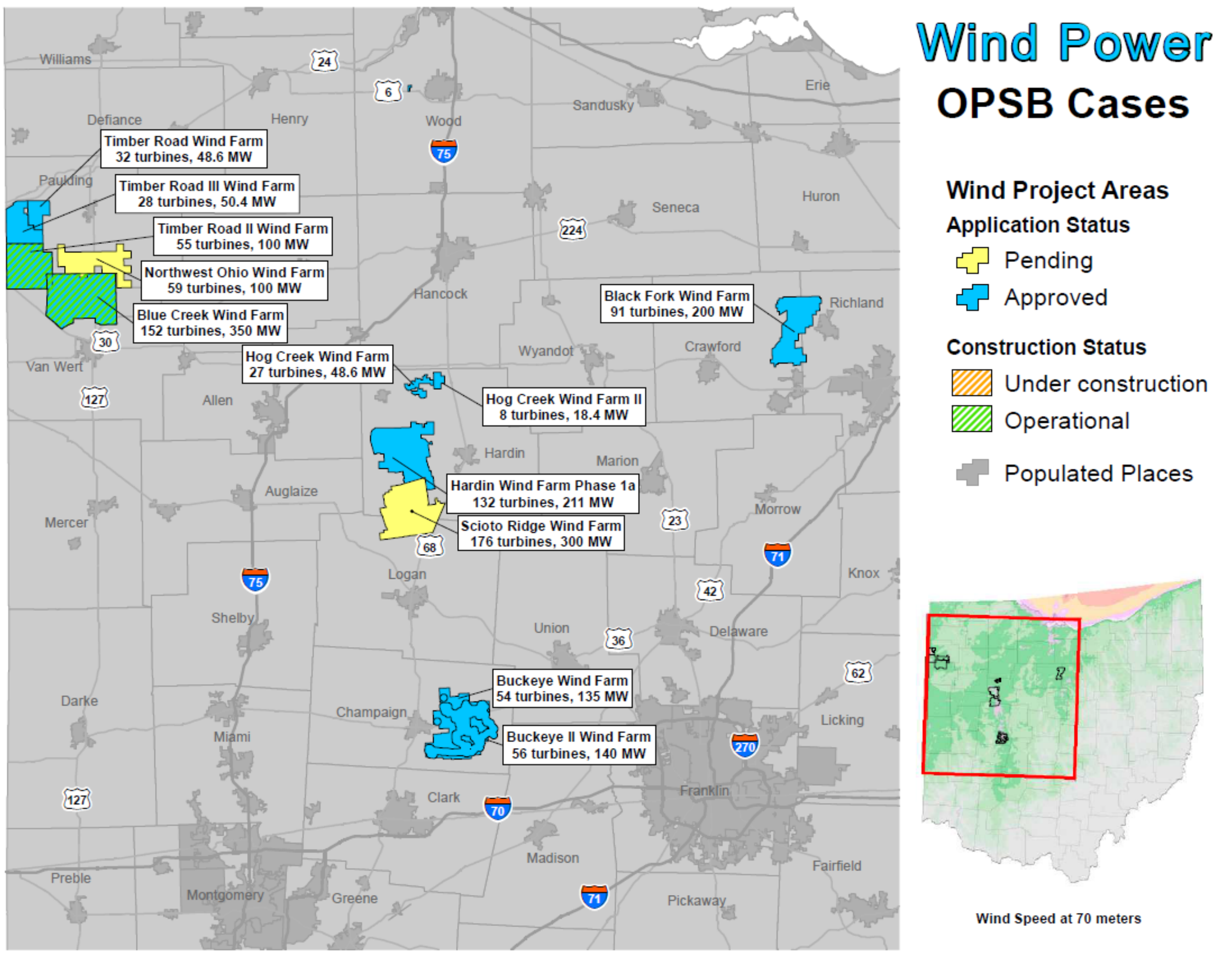
This analysis was performed with Ventyx's PROMOD IV electricity market modeling software. PROMOD IV is a detailed nodal market simulation tool that utilizes a security constrained unit commitment and dispatch algorithm to model generation, transmission, and market settlement across the Eastern Interconnection. The PROMOD IV software is one of the most powerful tools available to Commission Staff to analyze wholesale electricity markets and has been utilized by Staff and its consultants in various proceedings before the Commission.

Wholesale energy prices, known as locational marginal prices (LMPs), are calculated hourly for each transmission zone within Ohio and include generation, transmission congestion and loss components. To the extent that new renewable projects contribute to (or alleviate) transmission congestion or energy losses, these costs (or benefits) are captured by the model. For each scenario, total load costs are calculated using hourly price and load data and are aggregated to an annual value. This annual load cost is compared to a base case scenario in which no RPS mandate is in effect and therefore no utility-scale renewable projects are assumed to have been built in Ohio.

It is important to note that this study only attempts to quantify the price suppression effects that are associated with new utility-scale renewable projects and does not purport to comprise an overall cost-benefit analysis of these projects. While PROMOD IV is the industry standard in modeling production cost scenarios, it is not the proper tool to use when conducting least-cost capacity expansion analysis or integrated resource planning. To conduct such an analysis, it would be necessary to consider additional variables such as capital and capacity costs, renewable energy credit (REC) prices, and transmission upgrade expenses.

ASSUMPTIONS

As described above, two scenarios are considered. The first scenario includes only the utility-scale renewable resources in Ohio that are approved and operational. The second scenario includes all projects that have received a certificate of environmental compatibility and public need from the OPSB, which includes some projects that are not yet operational. The results are then compared to a base case in which it is assumed that no utility-scale renewable resources are developed within Ohio. The projects associated with both scenarios are depicted in the map below, provided courtesy of the Ohio Power Siting Board.



All simulations were modeled for calendar year 2014. Model input assumptions, such as hourly loads and fuel prices, are developed semi-annually by an independent third party. Staff did not make any adjustments to these assumptions.

Great care was taken to accurately incorporate new facilities into the powerflow model. Approved but not yet operational projects were modeled to conform to applications filed with the OPSB and to be consistent with generation interconnection requests submitted to PJM, the regional transmission organization.

Representative hourly profiles were included in the model to capture the intermittent nature of renewable generation. Capacity factors are based upon the geospatial coordinates of each project. For illustrative purposes, examples of these hourly output profiles appear below.

RESULTS – PRICE SUPPRESSION

The model demonstrates that wholesale electricity market prices in Ohio are reduced in both scenarios as a result of incorporating the renewable generation resources. Hourly LMPs are aggregated into a load-weighted average annual price in the tables below.

In the first scenario, which considers only those projects that are already operational, wholesale prices are reduced by approximately 0.15%.

Load Weighted LMPs ($/MWh)

	AEP	FirstEnergy	Dayton	Duke	Ohio
Base Case (no RPS)	$31.91	$32.42	$32.87	$32.22	$32.25
Scenario 1: Operational Facilities	$31.85	$32.37	$32.82	$32.18	$32.20
	-0.16%	-0.15%	-0.16%	-0.12%	-0.15%

In the second scenario, which considers all OPSB-approved projects, wholesale prices are reduced by approximately 0.51%, or just over one half of one percent.

Load Weighted LMPs ($/MWh)

	AEP	FirstEnergy	Dayton	Duke	Ohio
Base Case (no RPS)	$31.91	$32.42	$32.87	$32.22	$32.25
Scenario 2: Approved Facilities	$31.75	$32.25	$32.67	$32.07	$32.08
	-0.50%	-0.52%	-0.61%	-0.47%	-0.51%

The total load cost benefits that arise from lower wholesale clearing prices are calculated below for each utility transmission area and the state as a whole. For these savings to be ultimately realized by customers, one must assume that retail rates are themselves a function of wholesale prices, an assumption that is consistent with Ohio's transition towards a competitive model of generation procurement.

These benefits can be considered a partial offset to the costs incurred by utilities to comply with alternative energy mandates. According to data contained within the 2011 Alternative Energy Portfolio Standard Report to the General Assembly, Ohio investor owned utilities procured 518,992 Ohio non-solar renewable MWHs at an average price per REC of $110.55. The price suppression effect therefore offsets 14.7% of the cost of procuring in-state non-solar RECs for investor owned utilities in scenario 1, and 49.8% of the cost of in-state non-solar compliance in scenario 2.

Total Load Savings (2014)

	AEP	FirstEnergy	Dayton	Duke	Ohio
Scenario 1: Operational Facilities	$3,355,033	$3,213,389	$934,960	$926,272	$8,429,653
Scenario 2: Approved Facilities	$10,216,471	$11,114,557	$3,656,707	$3,605,089	$28,592,824

RESULTS: CARBON EMISSIONS

The model demonstrates that additional renewable generation resources in Ohio also reduce CO2 emissions. PROMOD IV does account for the fact that intermittent resources can cause traditional fossil-fired plants to be ramped up and down more frequently and therefore run less efficiently. However, this effect does not seem to significantly impede overall emission reductions. It is likely that this outcome is facilitated in part by the membership of Ohio utilities in the PJM regional transmission organization, which provides the centralized unit dispatch and flexibility required to avoid significant negative consequences for the efficiency of existing fossil-fired generators. The carbon dioxide emissions reductions for both scenarios are depicted below.

	CO2 Emissions (Metric Tons)	
Base Case (No RPS)	116,364,317	% Change
Scenario 1: Operational Facilities	116,162,271	-0.17%
Scenario 2: Approved Facilities	115,787,677	-0.50%

CONCLUSION

The model simulations indicate that, consistent with theoretical expectations, Ohioans are already benefiting from renewable resource additions through downward pressure on wholesale market prices and reduced emissions. No severe congestion issues or emergency curtailments were observed, even after incorporating all approved projects, which suggests that the electric grid in Ohio is sufficiently robust to support the continued development of utility-scale renewable projects. The modeling demonstrates that Ohio's Alternative Energy Portfolio Standard has already successfully reduced carbon dioxide emissions below a baseline level.

As renewable generation requirements escalate and new projects are required, future model runs can be made to assess the extent to which these outcomes persist. This analysis can be conducted by Commission Staff through PROMOD IV simulation, a powerful, well respected and unbiased tool that is currently at our disposal.