

# Managing Price Risk for Merchant Renewable Investments

PRESENTED TO  
EIA Electricity Pricing Workgroup

PRESENTED BY  
Onur Aydin  
Bente Villadsen

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THE **Brattle** GROUP

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# Overview

**In this presentation, we demonstrate how renewable generators could use electric and gas forward contracts to manage their market risk when a utility PPA is not available**

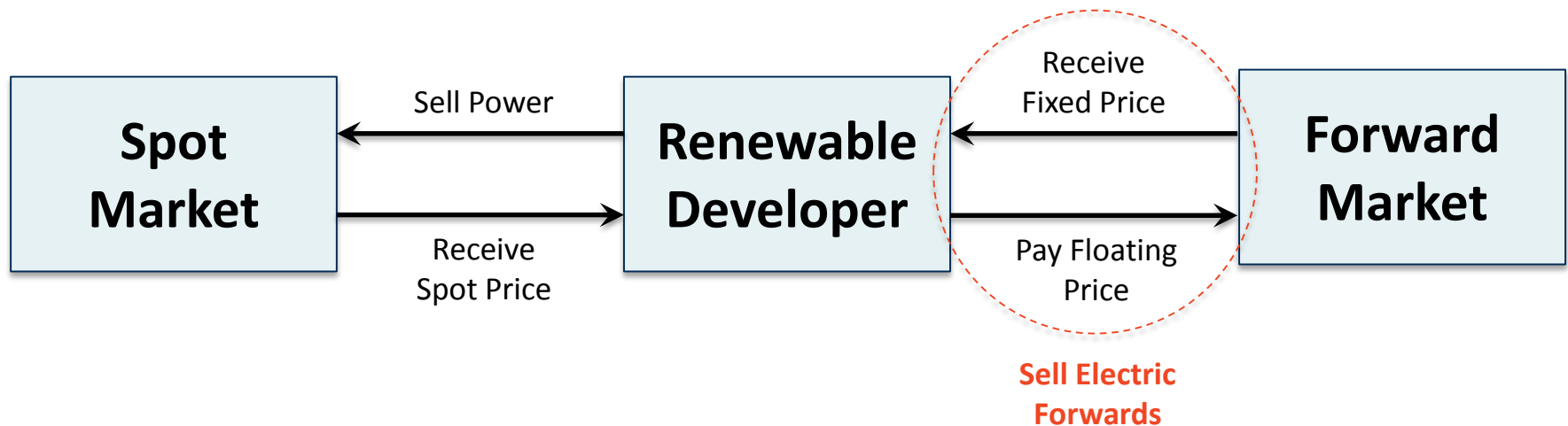
## Key Points :

- Increasing amounts of renewables developed as merchant assets not secured under long-term PPAs
- Virtual PPAs are gaining popularity among corporate buyers as a bilateral hedging instrument; however, these arrangements can be offered at a discount relative to forward prices, which can be detrimental to value captured by developers
- Using standardized forward contracts can be a more cost-effective way to manage risks and achieve the level of revenue certainty needed; but there are many complex nuances to consider
- We developed a case study focusing on wind assets in ERCOT—although many of the concepts would also apply to solar energy and the framework can be used in other regions

# Hedge Structure using Electric Forward

**An electric hedge for a renewable plant would involve selling forward contracts to receive a fixed price in exchange for a “floating” price set based on average spot price at the settlement point**

- Goal is to lock-in price by having changes in spot revenues to be offset by the changes in floating contract payments



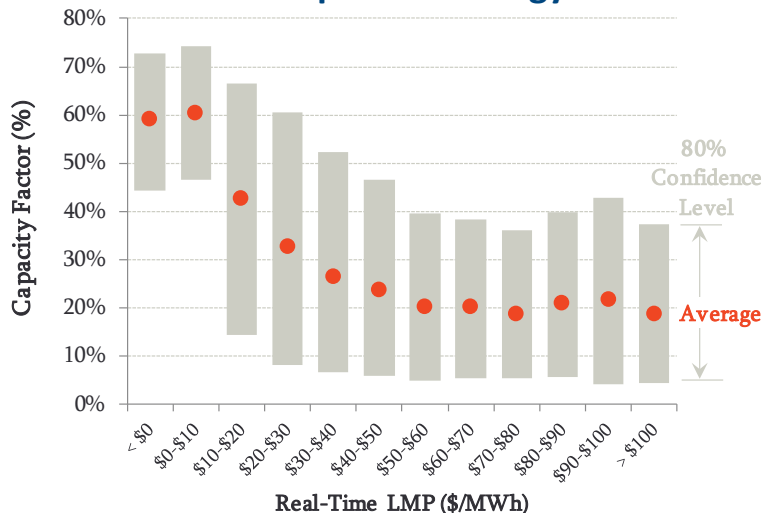
# Setting the Hedge Quantity

## Uncertainty in total amount and timing of renewable output creates some irreducible volume risk, which needs to be considered when hedge ratios are set

- Selling too little forwards leaves a long position exposed to spot prices, while selling too much forwards creates a short position exposed to spot prices
- An effective hedge aiming to reduce variance in net revenues can be constructed based on expected volume-weighted spot revenues divided by the fixed cost of the forward contract
- E.g., Suppose a wind plant is expected to run at 50% CF in a given month with a forward price at \$25/MWh:
  - *If plant output is randomly and uniformly distributed across hours, it would get the same expected market price as the forward price (\$25/MWh) so you need 0.5 hedge MW for each MW of nameplate capacity*
  - *If plant output is concentrated in hours with lower spot prices (say, averaging \$10/MWh), then you need only 0.2 hedge MW per wind MW*

# Effects of Wind-Price Correlation

**Relationship between ERCOT Regional Wind Output and Energy Prices**



**We see strong (negative) wind-price correlation in regions with high penetration, where expected revenues tend to be lower than expected price × expected volume**

- If the hedge quantity was set to match expected wind output, the payoff would often exceed changes in spot revenues (relative to expected levels)
- A negative adjustment resulting in smaller hedge positions per megawatt of wind is needed to reduce the associated exposure to spot prices

**On-Peak**

	2011	2012	2013	2014	2015	2016
Simple	\$56	\$29	\$35	\$43	\$26	\$25
Wind-Wtd	\$44	\$24	\$32	\$38	\$24	\$22
<b>Diff.</b>	<b>\$13</b>	<b>\$5</b>	<b>\$3</b>	<b>\$5</b>	<b>\$2</b>	<b>\$3</b>
	<b>22%</b>	<b>16%</b>	<b>10%</b>	<b>12%</b>	<b>9%</b>	<b>10%</b>

**Off-Peak**

Simple	\$28	\$21	\$27	\$31	\$21	\$18
Wind-Wtd	\$25	\$18	\$24	\$28	\$18	\$15
<b>Diff.</b>	<b>\$4</b>	<b>\$3</b>	<b>\$3</b>	<b>\$3</b>	<b>\$3</b>	<b>\$2</b>
	<b>13%</b>	<b>12%</b>	<b>10%</b>	<b>10%</b>	<b>13%</b>	<b>13%</b>

\*Calculated based on data compiled by ABB Inc. Energy Velocity Suite.

# Using Natural Gas Swaps

**Gas contracts are often available and liquid for longer delivery periods than electric forwards (especially at Henry Hub) so they can serve as potential hedging instruments over longer horizons**

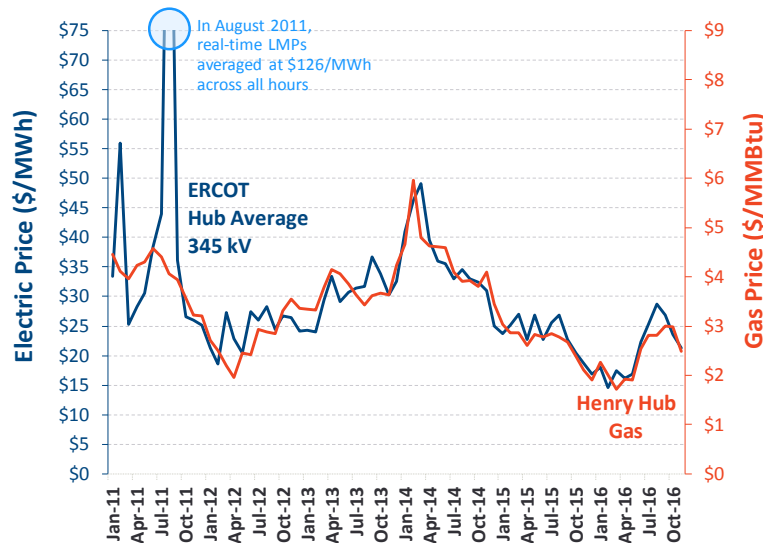
- Main concept is the same, but instead of swapping spot value of wind output for an electric forward, market revenues are used to buy spot gas scaled by expected market heat rate (HR) to settle against a fixed gas forward purchase
- Additional hedge design elements and uncertainties need to be considered, including:
  - Expected correlation of gas and electric prices over time;
  - Uncertainty in the expected long-run market HRs (the ratio of electric to gas prices), which cannot be observed far forward due to limited trading of electric contracts, so they will have to be forecasted; and
  - Gas basis risk between the settlement location of gas contracts and the delivered gas for plants setting prices at the wind production node

# Gas-Electric Price Relationship

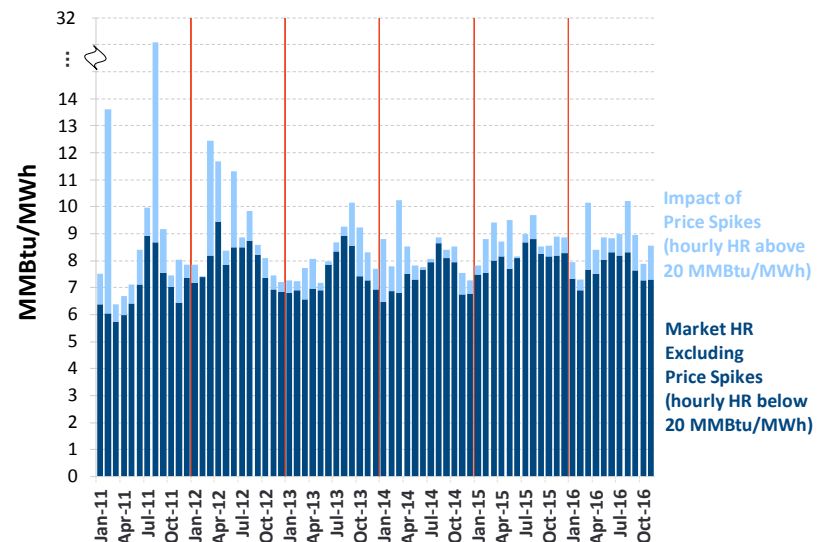
**Spot gas and electric prices have become strongly correlated due to increasing share of gas generators as the price-setting technology**

- In ERCOT, when price spikes during scarcity periods are excluded, the average market HR has historically followed a relatively steady and seasonal pattern (dark blue bars on the right chart)

### ERCOT Historical Gas and Electricity Prices



### ERCOT Historical Market Heat Rates



\*Calculated based on data compiled by ABB Inc. Energy Velocity Suite and SNL Financials.

# Incorporating Market HRs

**If market HRs were known and fixed in future periods, it would be simple to substitute gas contracts for electric forwards to achieve equivalent hedging with either instrument**

- E.g., If wind plant expects to have 50% CF and \$10/MWh spot revenues (below \$25/MWh forward price due to negative wind-price correlation), the effective hedge strategy would be 0.2 hedge MW per wind MW as discussed in previous example
- If gas forwards for that month traded at \$2.5/MMBtu, it would imply a market HR of 10 MMBtu/MWh
- Then the equivalent hedging strategy using gas swaps would be calculated as  $0.2 \times 10 = 2$  hedge MMBtus per wind MW
- Under this strategy, expected spot revenues would match fixed charges associated with gas swap contracts



# Incorporating Market HRs (cont'd)

**However, market HRs are variable over both short and long time frames, creating conversion risk for using gas swaps as a surrogate**

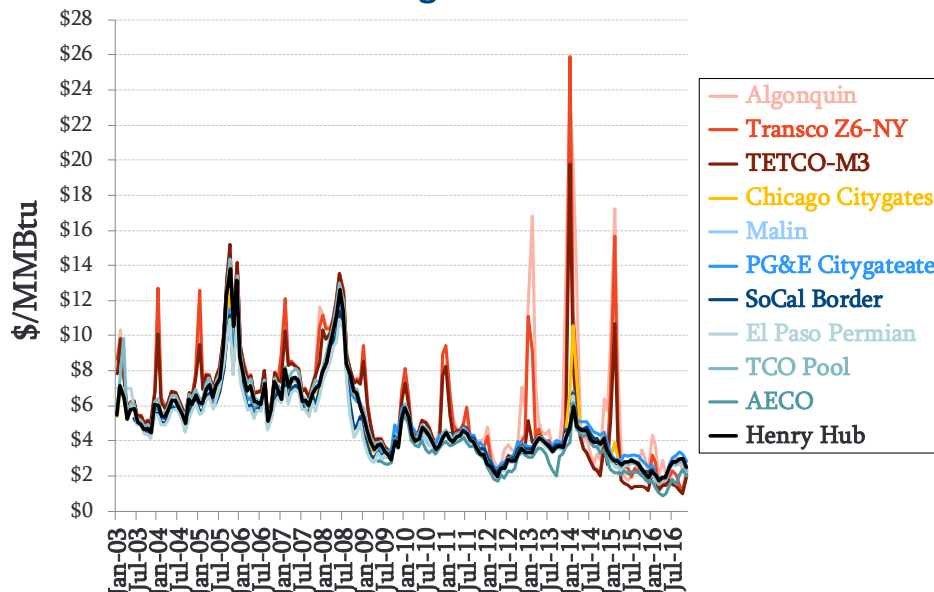
- Expected market HR can be observed directly when both electric and gas forwards trade
- Electric forwards are often traded only near term (up to a few years out) so market HRs and their associated characteristics has to be forecasted considering various market drivers, such as:

Market Driver	Likely Impact
Increased penetration of renewables	(-) Lower HR
Addition of new efficient gas generation	(-) Lower HR
Coal plants retirements	(+) Higher HR
Load growth	(+) Higher HR
CO <sub>2</sub> price	(+) Higher HR

# Effects of Basis Risk

**Price differences between gas at the contract hub and marginal gas resources setting electric prices at the wind production site may create an additional “basis” risk that needs to be considered as a part of the hedging strategy**

**Historical Average Gas Prices**



- If available, selling basis swaps could hedge gas basis price risk but they're often traded only for 1-2 years out
- Without basis swaps, delivery risk could be partially mitigated by adjusting the total amount of Henry Hub (HH) gas contracts sold

*E.g., if HH forwards trade at \$4/MMBtu and gas basis is expected to be \$1/MMBtu, then selling 25% more of HH contracts would lower the risk exposure*

\*Calculated based on data compiled by SNL Financials.

# Summary of Hedging Considerations

Factors Considered/ Hedge	Analytical Implications	Risk Position Adjustment
Electric forward	Hedge expected on-peak/off-peak wind output	
Electric forward w/ wind-price correlation	Incorporate net discount in volume-weighted prices relative to simple average prices	↓ Hedge less than #1
Electric forward w/ wind-price correlation + scarcity prices	Estimate market price premium due to scarcity events and adjust average spot revenues based on expected wind output during scarcity hours	↓ Hedge less than #2
Gas swap	Forecast market heat rates (HRs) to determine gas-electric conversion ratios	↔ Equivalent to #3
Gas swap w/ gas-HR correlation	Characterize relationship between gas prices and market HRs and adjust gas-electric conversion ratios based on probability-weighted market HRs	↓ Hedge less than #4
Gas swap w/ gas-HR correlation + basis risk	Forecast basis differential for marginal resources setting electricity prices at wind production node and adjust the quantity of Henry Hub contracts to match expected spot revenues related to +/- basis differential	↑ Hedge more than #5
Gas swap w/ gas-HR correlation + basis risk + evolving HRs	Monitor key market drivers and dynamically adjust hedge ratios to account for changes in expected market HRs	↑↓ Hedge more/less depending on market HRs

# Presented By



**Onur Aydin**  
Senior Associate, San Francisco

+1.415.217.1084  
[Onur.Aydin@brattle.com](mailto:Onur.Aydin@brattle.com)

Mr. Onur Aydin is a senior associate in Brattle's San Francisco office with more than 10 years of experience in serving clients in the power industry. He specializes in U.S. wholesale electricity markets, system planning, and economic and financial analyses of energy investments and policies. In his work, Onur employs a deep understanding of market fundamentals, market design, and technology trends to help energy companies identify and maximize value proposition associated with their strategic planning and investment decisions. He taps into a wealth of analytical tools for market forecasting and customizes them to meet client-specific needs and provide insights. Onur also collaborates closely with his clients to evaluate and manage their market risk exposure and to support their due diligence efforts.

Onur received his M.S. in Civil and Environmental Engineering from Massachusetts Institute of Technology in Cambridge, Massachusetts, and his B.S. in Civil Engineering (with high honors) from Bogazici University in Istanbul, Turkey.



**Bente Villadsen**  
Principal, Boston

+1.617.234.5608  
[Bente.Villadsen@brattle.com](mailto:Bente.Villadsen@brattle.com)

Dr. Bente Villadsen a principal at The Brattle Group's Cambridge office. She is an expert in regulatory finance with 17 years of experience in the utility regulatory matters. She has experience in electric, gas, pipeline, and water regulatory matters and has testified on cost of capital as well as regulatory accounting and credit issues for regulated entities. She is a co-author, "*Risk and Return for Regulated Industries*," (Elsevier 2017). Dr. Villadsen also provides advice on utility M&A and risk management and a co-author of "*Managing Price Risk for Merchant Renewable Investments: Role of Market Interactions and Dynamics on Effective Hedging Strategies*," Brattle Whitepaper.

She holds a Ph.D. from Yale University's School of Management and joint degree in mathematics and economics from University of Aarhus in Denmark.

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