Financial Products in U.S. Electricity Markets

Jeremy Larrieu
Division of Analytics & Surveillance
Office of Enforcement
U.S. Federal Energy Regulatory Commission

2nd International Conference on Large-Scale Grid Integration of Renewable Energy in India
September 4-6, 2019
New Delhi, India
The views expressed in this presentation are my own, and do not represent the views of the Federal Energy Regulatory Commission, its Staff, its Chairman, or its Commissioners.
Agenda

- U.S. wholesale electricity markets
- Types of market participants & their exposures
- Hedging products available & financial markets
- Regulatory framework
U.S. Wholesale Electricity Markets
RTO/ISO

- Regional organized market
- Mandatory power pool comprised of nodes
- All generator, transmission, and load buses are associated with a node
- RTO controls transmission grid
- RTO commits and dispatches all generators
- RTO runs least-cost economic optimization auction
- Determines market price at each node (Locational Marginal Prices)
- Determines output level of each generator
- Settles financially with all participants
- Runs a short term forward “day-ahead” market and a spot “real-time” market
- Some administer capacity market
- High transparency (published prices / market reports)
Non-RTO

- Patchwork of balancing authorities
- Dominated by vertically integrated utilities serving native load
- Some cooperatives and municipalities
- Most trading long-term bilateral
- A few exchanges around the country
- Low visibility into prices & transactions
Types of Market Participants

• **Physical asset owners & load serving entities**
  – Vertically integrated utilities
    • Public (cooperatives & municipalities)
    • Private (Investor-Owned Utilities)
  – Independent Power Producers (IPP) / Merchant Generation

• **Speculators**
  – Proprietary traders
  – Hedge funds

• **Liquidity traders**
  – Market-makers
  – Financial institutions
## Vertically Integrated Utilities

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Revenue</th>
<th>Costs</th>
<th>Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generation Assets</strong></td>
<td>Spot Price</td>
<td>Fuel Price + O&amp;M</td>
<td>Spot Price (long) Fuel Price (short)</td>
</tr>
<tr>
<td><strong>Load Obligations</strong></td>
<td>Retail Price</td>
<td>Spot Price</td>
<td>Spot Price (short)</td>
</tr>
<tr>
<td><strong>Transmission Assets</strong></td>
<td>Rate-of-Return</td>
<td>Capital + O&amp;M</td>
<td></td>
</tr>
</tbody>
</table>

### Risks

- **Fuel Price**
- **Net load**
  - generation asset portfolio < load obligations
- **Imbalance load**
  - spot load > forward/forecast load
- **Non-performance**
  - spot output < forward obligation
- **Congestion**
  - spot price at generator node < spot price at load zone

**Spot Price risk**

**Locational/Basis risk**
Independent Power Producers (IPP) / Merchant Generation

<table>
<thead>
<tr>
<th>PORTFOLIO</th>
<th>REVENUE</th>
<th>COSTS</th>
<th>EXPOSURE</th>
</tr>
</thead>
</table>

- Fuel Price
- Spot Price
- Non-performance/forecast error
  - spot output < forward obligation
- Congestion
  - spot price at generator node < spot price at load zone

**RISKS**

- Spot Price risk
- Locational/Basis risk
# Speculators & Liquidity Traders

<table>
<thead>
<tr>
<th>PORTFOLIO</th>
<th>Revenue</th>
<th>Cost</th>
<th>Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Commodity (electricity)</strong></td>
<td>Spot Price</td>
<td>Spot Price</td>
<td>Spot Price (long/short)</td>
</tr>
<tr>
<td><strong>Physical Commodity (gas/coal)</strong></td>
<td>Fuel Price</td>
<td>Fuel Price Storage</td>
<td>Fuel Price (long/short)</td>
</tr>
<tr>
<td><strong>Financial Products</strong></td>
<td>Spot Price Derivative Price</td>
<td>Spot Price Derivative Price</td>
<td>Spot Price (long/short)</td>
</tr>
</tbody>
</table>

- Fuel Price
- Spot Price
- Non-performance/forecast error
- Net load
- Imbalance load
- Congestion

*Rent-seeking from taking on risk of physical asset owners and load-serving entities*
Hedging Products Available

• “Physical” products
  – Power Purchase Agreements (PPA)
  – Tolling Agreements

• Financial Derivatives
  – Futures/Swaps
  – Financial Transmission Rights (RTO/ISO)
  – Virtual trading (RTO/ISO)
Power Purchase Agreements (PPA)

• **Contract between a generation asset owner (seller) and a buyer**
• **Buyer can be generation asset operator or load**
• **Terms of PPA include**
  – Effective dates (usually long-term)
  – Commercial operation & schedule for delivery
  – Price ($/MWh) and volume (MWh)
  – Other scenario-based payment terms
  – Penalties for under-delivery
  – If asset in RTO/ISO, bidding terms
  – Termination parameters
Power Purchase Agreements (Bilateral)

<<<<< PPA Fixed Price <<<<<<

>>>>>> Electricity>>>>>>
Power Purchase Agreements (RTO/ISO)

Generation Asset Owner

Spot Price Electricity

RTO/ISO

<<<<<< Spot Price

>>>>>> Electricity

PPA Fixed Price

Spot Price

Buyer
Tolling Agreements

- **Contract between a tolling party and a generation asset owner to supply fuel in exchange for electricity**

- **Terms of tolling include**
  - Effective dates
  - Commercial operation & schedule for delivery
  - Fixed conversion price
  - Volumes
  - Other scenario-based payment terms
  - Penalties for under-delivery
  - If asset in RTO/ISO, bidding terms
  - Termination parameters
Tolling Agreements

TFERG  Federal Energy Regulatory Commission

Generation Asset Owner

<<<<<< Tolling Fee <<<<<<
<<<<<< Input Fuel <<<<<<
>>>>>> Electricity>>>>>>

Tolling Party

<<<<<< Spot Price <<<<<<
<<<<<< Electricity <<<<<<

Customer / RTO/ISO
Financial Futures, Swaps, and Options

• Financially-settled derivative contracts tied to an underlying physical commodity price during a specific timeframe at a specific location
  – Typically fixed-for-floating
  – Some floating-for-floating (index swaps)
  – Some cross-commodity (spark spreads, heat rates, weather)

• Futures
  – Standardized contracts terms, typically traded on exchanges

• Swaps
  – Customized bespoke contract terms, typically traded bilaterally

• Options
  – Buyer purchases right to either purchase (call) or sell (put) an underlying commodity at a fixed-price (strike)
Future/Swap

Buyer (long)

PPA Fixed Price

Floating Price

Seller (short)

Index price
Simple average price
Weighted average price
Financial Products in RTO/ISO

- **Financial Transmission Rights (FTR)**
  - Derivative equivalent to a future
  - Buyer pays fixed-price to acquire the right to receive the “congestion” price difference between two nodes within RTO/ISO
  - Administered in auction by RTO/ISO who is counterparty
  - Long-term (monthly is shortest term available)
  - Available at individual generation nodes, not just hubs/zones

- **Virtual trading**
  - Designed to arbitrage price differences between short term forward price (day-ahead) and spot price (real-time)
  - **Virtual Supply**: pay the day-ahead price, receive the real-time price
  - **Virtual Demand**: pay the real-time price, receive the day-ahead price
  - Virtuals taken into account in RTO/ISO optimization, impact the market prices
Financial Transmission Rights (FTR)

FTR Revenue = [day-ahead congestion price @ sink – day-ahead congestion price @ source] * MW
Virtual Trading

**Day-Ahead**

**Real-Time**

Virtual Supply revenue = \([\text{day-ahead price @ A} - \text{real-time price @ A}] \times \text{MW}\)

Virtual Demand revenue = \([\text{real-time price @ A} - \text{day-ahead price @ A}] \times \text{MW}\)
# Using Financial Products to Hedge

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>RISK HEDGED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Purchase Agreement (PPA)</td>
<td>Spot Price</td>
</tr>
<tr>
<td>Tolling Agreement</td>
<td>Fuel Price, Spot Price</td>
</tr>
<tr>
<td>Future/Swap/Option</td>
<td>Fuel Price, Spot Price, Congestion</td>
</tr>
<tr>
<td>Financial Transmission Right (FTR)</td>
<td>Congestion</td>
</tr>
<tr>
<td>Virtual Trading</td>
<td>Spot Price, Non-Performance/Forecast error, Imbalance Load</td>
</tr>
</tbody>
</table>
U.S. Financial Marketplaces

• Exchanges
  – Intercontinental Exchange (ICE) Futures/Swaps/Options
  – Nodal Exchange Futures
  – New York Mercantile Exchanges (NYMEX) Futures

• Bilateral market-makers
  – Institutional banks Swaps/Options
  – Hedge funds Swaps/Options
  – Large energy companies Swaps/PPA/Tolling

• RTO/ISOs FTR/Virtuals
Settlement Prices

Underlying price of electricity used to settle the floating-price component of financial products

Intercontinental Exchange (ICE) index
Weighted average price of all physical trades consummated on the exchange

PLATTS index
Weighed-average index from market participant self-reported prices

RTO/ISO published prices
Simple average of Locational Marginal Prices (LMP)
Regulatory Framework

Federal Energy Regulatory Commission (FERC)
- Jurisdiction over interstate physical wholesale electricity transactions (RTO/Non-RTO)
- Jurisdiction over financial products administered by RTO/ISOs (FTR/Virtuals)

Commodity Futures Trading Commission (CFTC)
- Jurisdiction over financial futures and swaps in commodity markets (including electricity and natural gas)
Regulatory Framework

Coordination between FERC & CFTC

- Enforcement investigations involving both physical electricity & financial futures (cross-market manipulation)
  >>>> agencies cooperate
- Although FERC has jurisdiction over physical commodity and CFTC has jurisdiction over financial futures, agencies’ respective statutes allow them to consider all positions when bringing a case against a market participant

https://www.ferc.gov/enforcement/civil-penalties/civil-penalty-action.asp
Thank you!

Jeremy Larrieu, Ph.D.
Branch Chief
Division of Analytics and Surveillance
Office of Enforcement
Federal Energy Regulatory Commission
Jeremy.Larrieu@ferc.gov | +1 (202) 502-8234