



Financial Products in U.S. Electricity Markets

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Disclaimer

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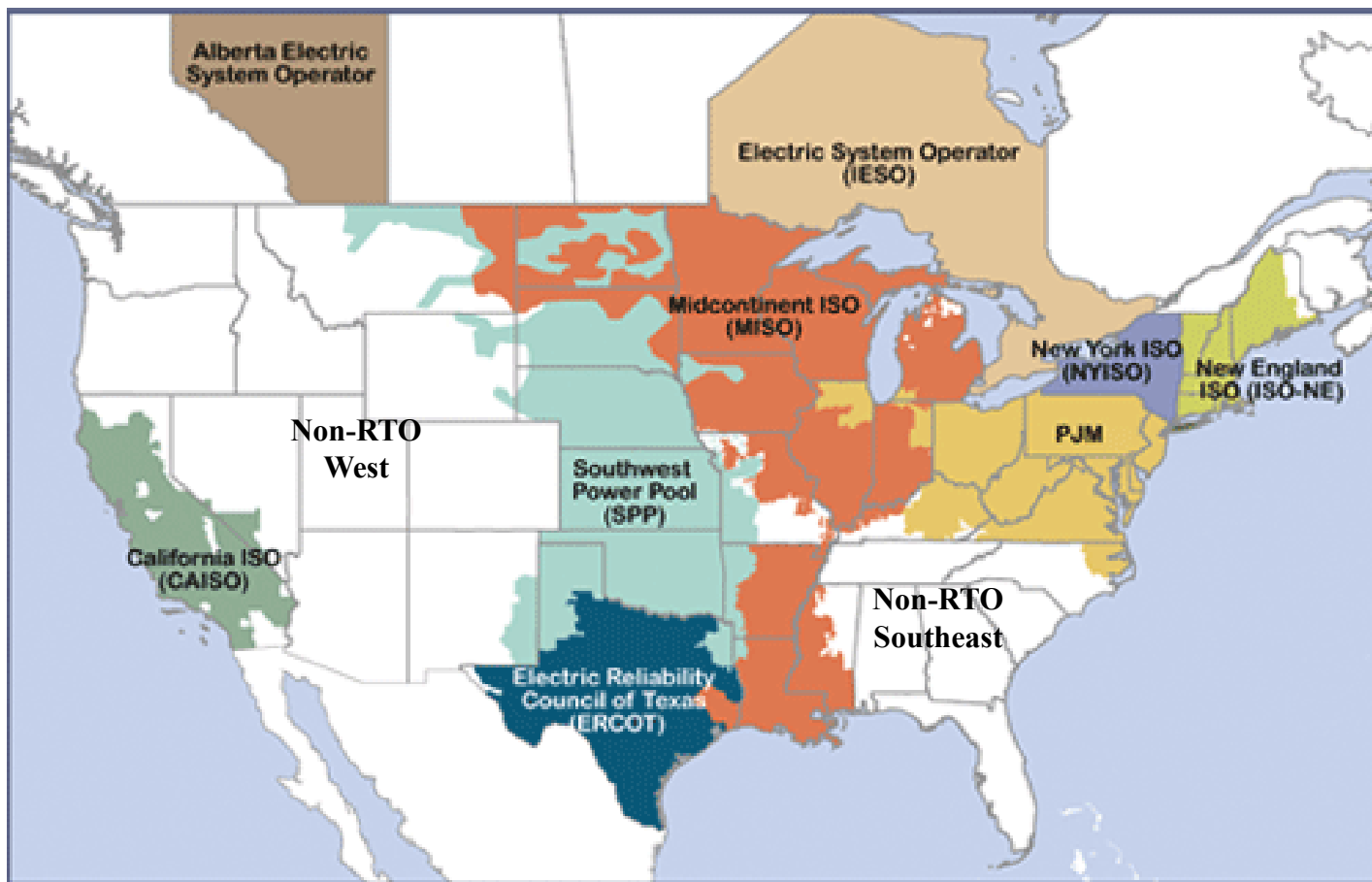


Agenda

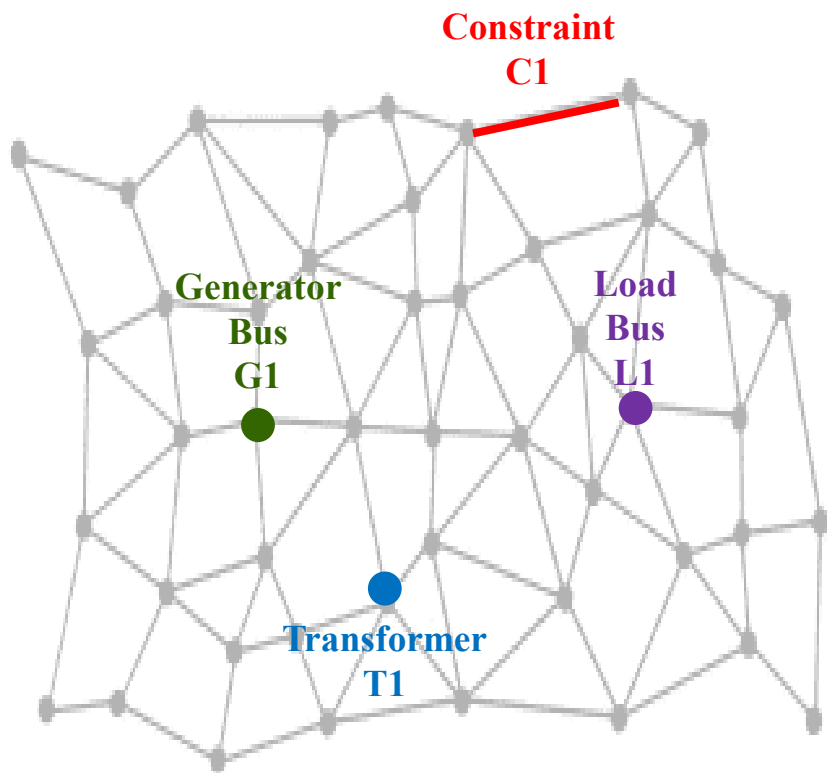
- **U.S. wholesale electricity markets**
- **Types of market participants & their exposures**
- **Hedging products available & financial markets**
- **Regulatory framework**



U.S. Wholesale Electricity Markets

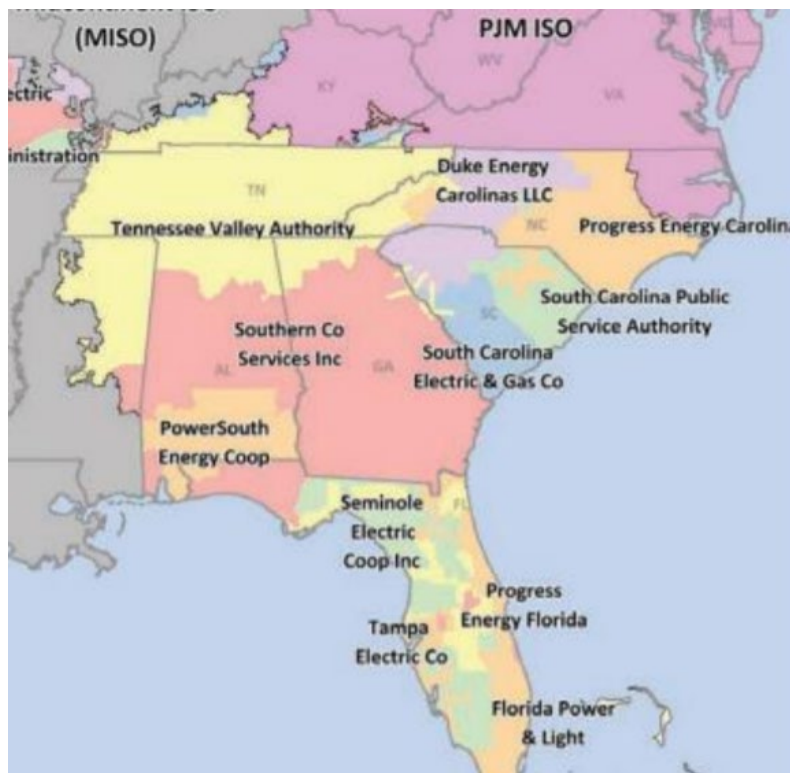


RTO/ISO



- 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

PORTFOLIO

	REVENUE	COSTS	EXPOSURE
Generation Assets	Spot Price	Fuel Price Capital + O&M	Spot Price (long) Fuel Price (short)
Load Obligations	Retail Price	Spot Price	Spot Price (short)
Transmission Assets	Rate-of-Return	Capital + O&M	

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

PORTFOLIO

	REVENUE	COSTS	EXPOSURE
Generation Assets	Spot Price	Fuel Price Capital + O&M	Spot Price (long) Fuel Price (short)

RISKS

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



Spot Price risk

Locational/Basis risk



Speculators & Liquidity Traders

PORTFOLIO

	Revenue	Cost	Exposure
Physical Commodity (electricity)	Spot Price	Spot Price	Spot Price (long/short)
Physical Commodity (gas/coal)	Fuel Price	Fuel Price Storage	Fuel Price (long/short)
Financial Products	Spot Price Derivative Price	Spot Price Derivative Price	Spot Price (long/short)

RISKS

- 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)



Generation
Asset
Owner

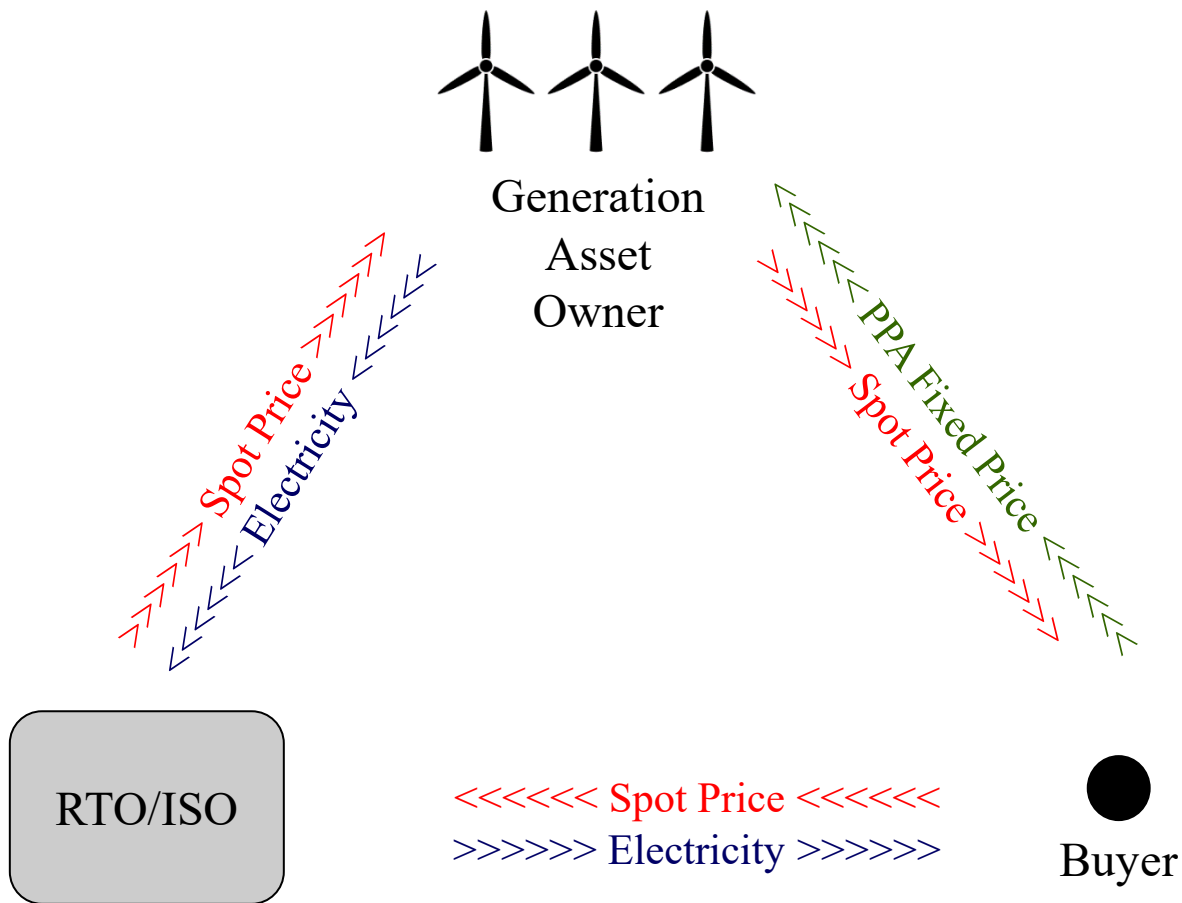
<<<<<< PPA Fixed Price <<<<<<
>>>>>> Electricity >>>>>>



Buyer



Power Purchase Agreements (RTO/ISO)



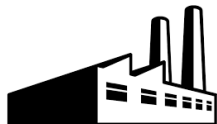


Tolling Agreements

- **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



Generation
Asset
Owner

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



Tolling
Party

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

Customer /
RTO/ISO

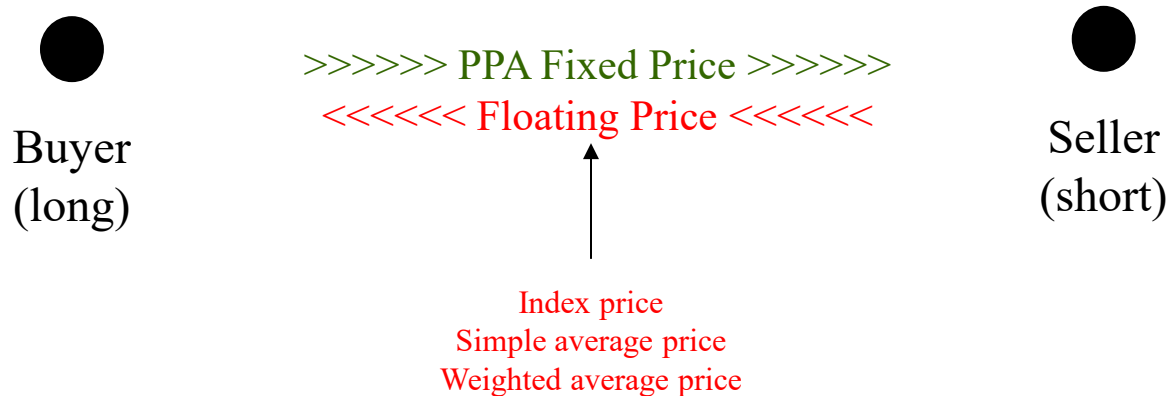


Financial Futures, Swaps, and Options

- **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

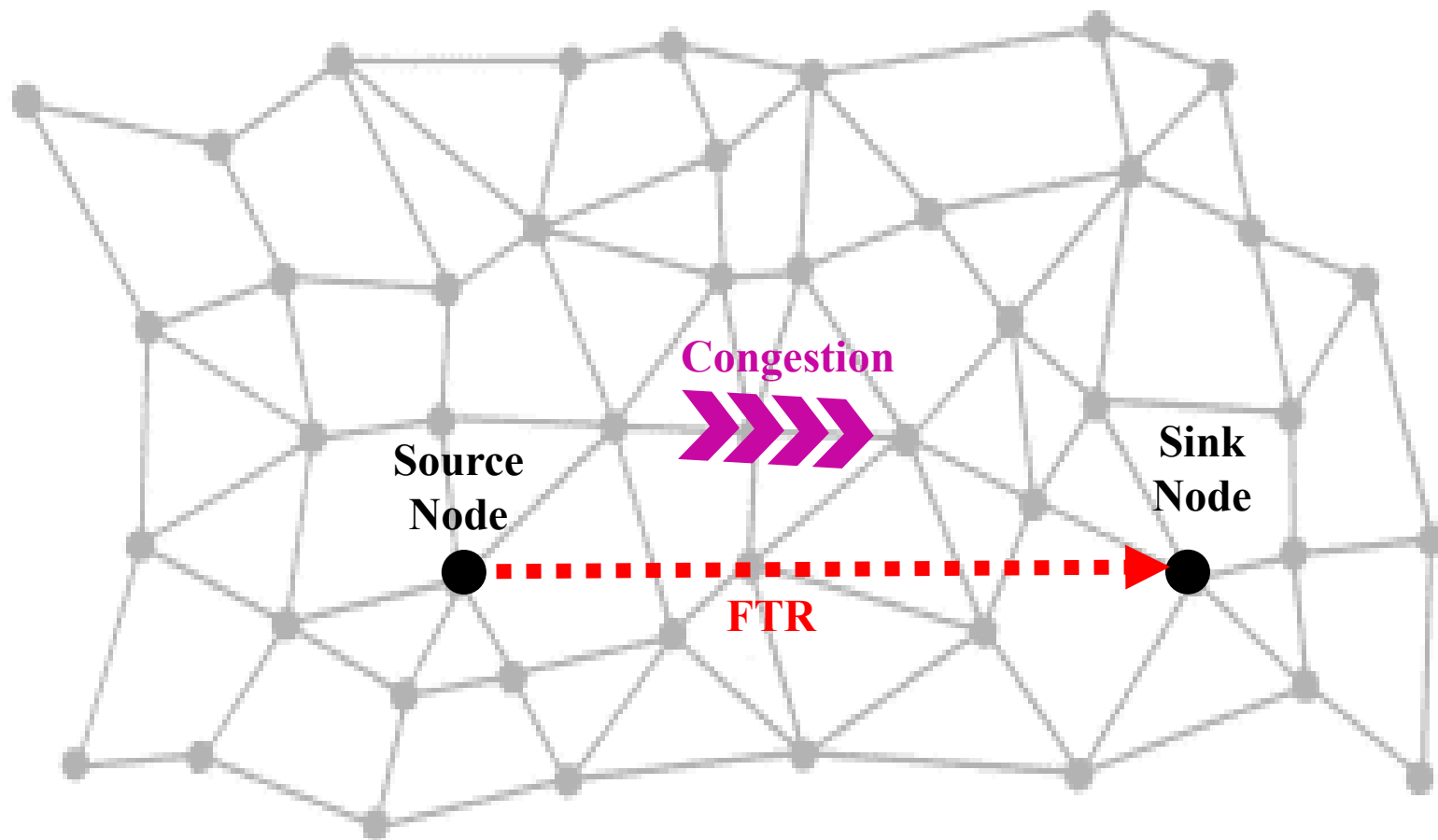




Financial Products in RTO/ISO

- **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

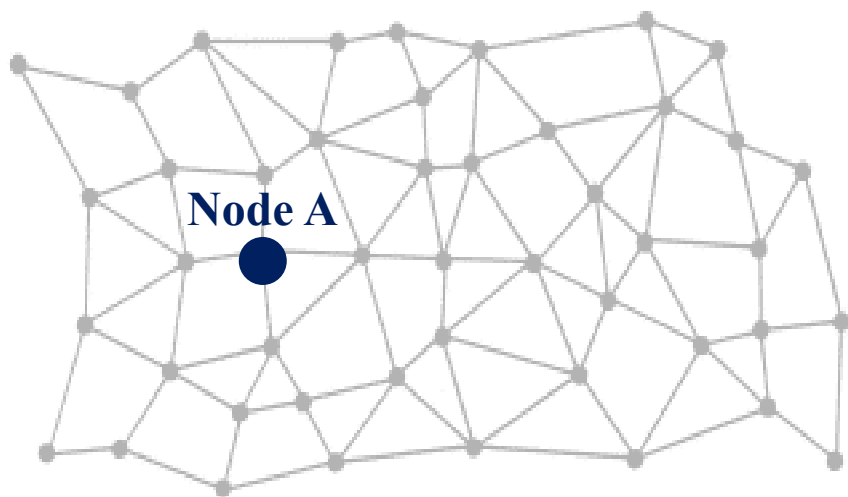
Financial Transmission Rights (FTR)



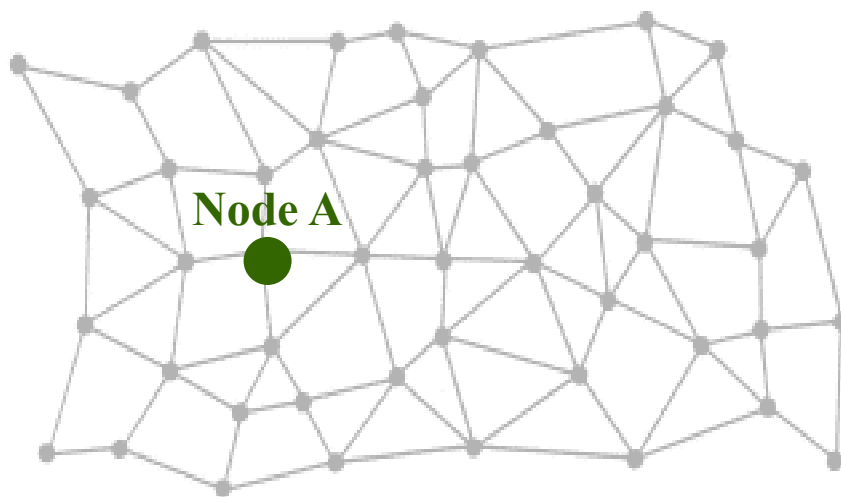
FTR Revenue = [day-ahead congestion price @ sink – day-ahead congestion price @ source] * MW

Virtual Trading

Day-Ahead



Real-Time



Virtual Supply revenue = [day-ahead price @ A – real-time price @ A] * MW

Virtual Demand revenue = [real-time price @ A – day-ahead price @ A] * MW



Using Financial Products to Hedge

PRODUCT	RISK HEDGED
Power Purchase Agreement (PPA)	Spot Price
Tolling Agreement	Fuel Price Spot Price
Future/Swap/Option	Fuel Price Spot Price Congestion
Financial Transmission Right (FTR)	Congestion
Virtual Trading	Spot Price Non-Performance/Forecast error Imbalance Load





U.S. Financial Marketplaces

- **Exchanges**

- Intercontinental Exchange (ICE)



Futures/Swaps/Options

- Nodal Exchange **nodal**

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!

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