Electricity Pricing and Low Carbon Energy Policies

Harvard Electricity Policy Group

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Resource Adequacy and Reliability

Reliability standard based on “1event-in-10yrs” criterion produces high implicit values of lost load.

(Wilson, *PUF*, April 2010, pp: 34-39. Telson, *Bell Journal of Economics*, Vol. 6, 1975, pp: 679-694.)

0.1 (expected events/year)
x 5 (hours/event)
x VOLL ($/MWh curtailed)
=Net CONE ($/MW-year).

0.1 expected events/year
x 2 (hours/event)
x $400,000 (VOLL)
=$80,000 (Net CONE).

TABLE 1 OPTIMAL LOLEs FOR VARIOUS VOLL AND CAPITAL COST ASSUMPTIONS

Value of service (VOLL)	Net Capital Cost (Net CONE)	Hours per outage event	Optimal LOLE	Optimal Nines
$/MW-year	$/MWH	hours/event	events/yr	
$4,000	$120,000	5	6.0	2.5
$4,000	$80,000	5	4.0	2.6
$4,000	$40,000	5	2.0	2.9
$2,000	$120,000	5	12.0	2.2
$2,000	$80,000	5	8.0	2.3
$2,000	$40,000	5	4.0	2.6
$20,000	$120,000	5	1.2	3.2
$20,000	$80,000	5	0.8	3.3
$20,000	$40,000	5	0.4	3.6

These high VOLLs compare with $1,000 bid caps and $50 average energy prices. There is ample room for improving the determination of prices.

Source: Wilson, 2010.

Resource Adequacy Standards

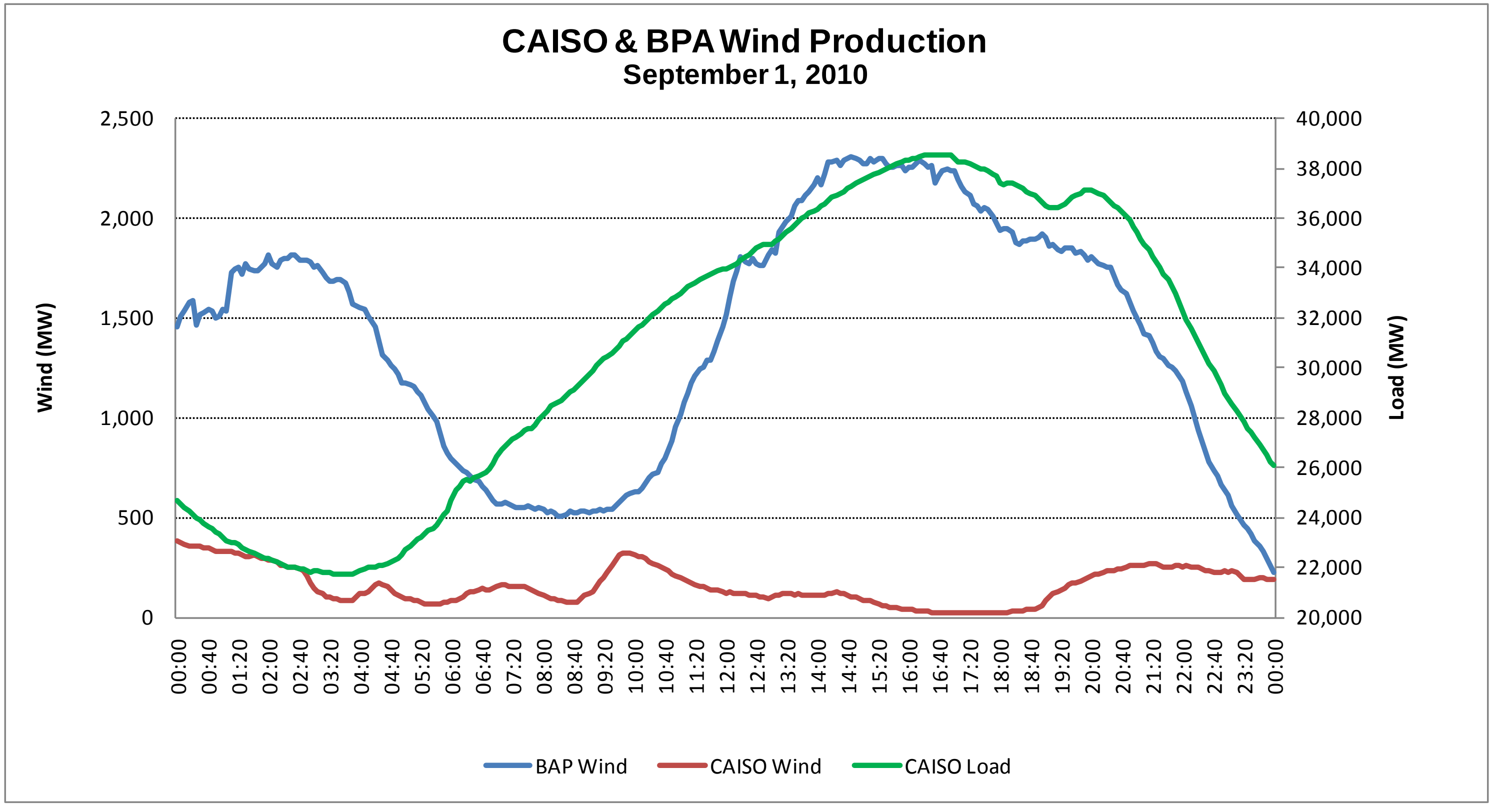
- Loss of load expectation (LOLE) and expected value analysis are only part of the analysis of reliability standards and resource requirements.
- Contingency constraints enter into the analysis directly for large facilities and indirectly through transmission and other limits.
- Contingency constraints are deterministic limits to deal with low probability bad outcomes.
- Both elements could affect variable energy supplies.

Resource Adequacy and Wind

- Wind is a (relatively) low cost source of new renewable energy.
- Variable nature of wind presents operating challenges for ramping and operating reserves.
- Geographic diversification provides a portfolio effect reducing the aggregate volatility of wind.
- Reliability under contingency planning presents different challenges for resource adequacy.

Wind Portfolio Effect

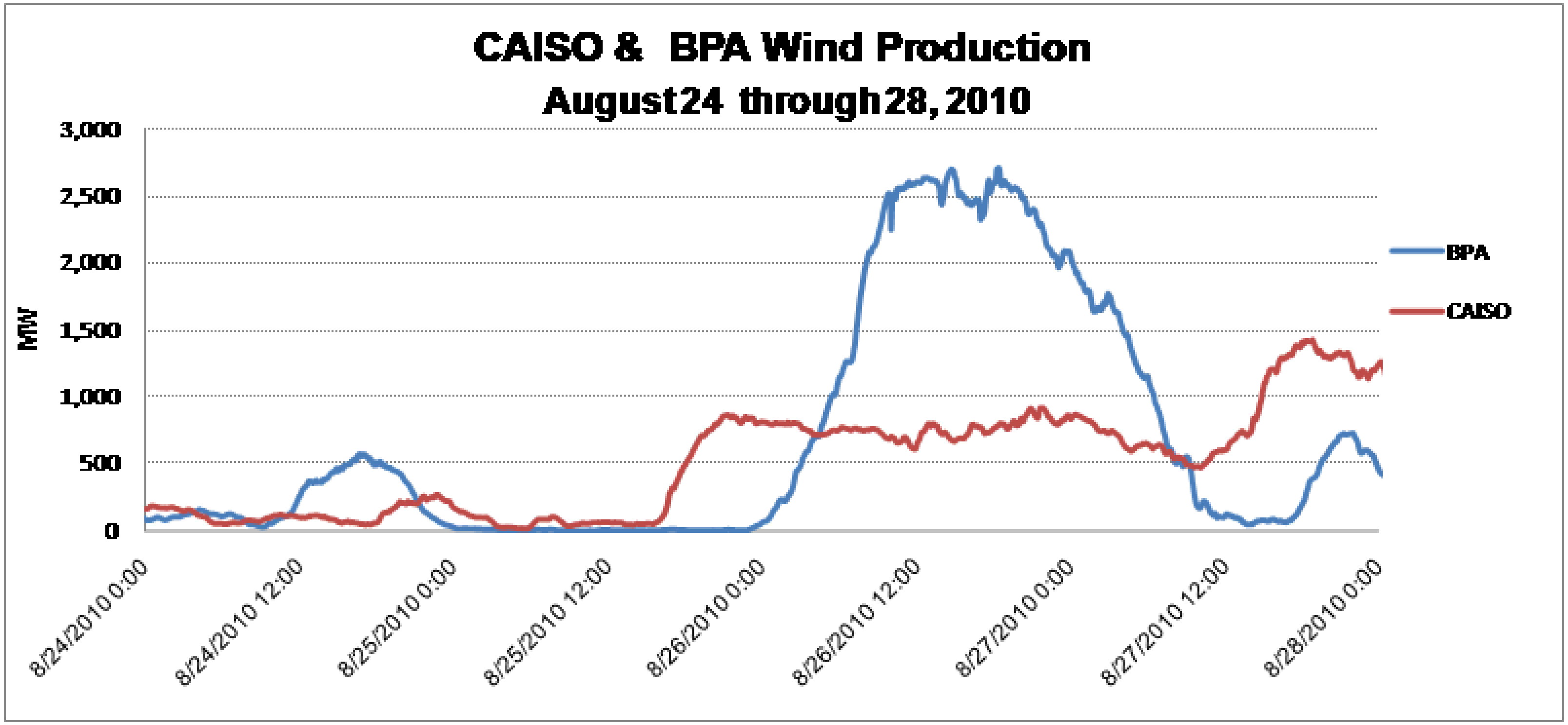
Wind imports could compensate for low local wind at high loads.



Source: CAISO, 2010.

Wind Contingency Challenge

Wind production can drop to low levels for days over large areas.

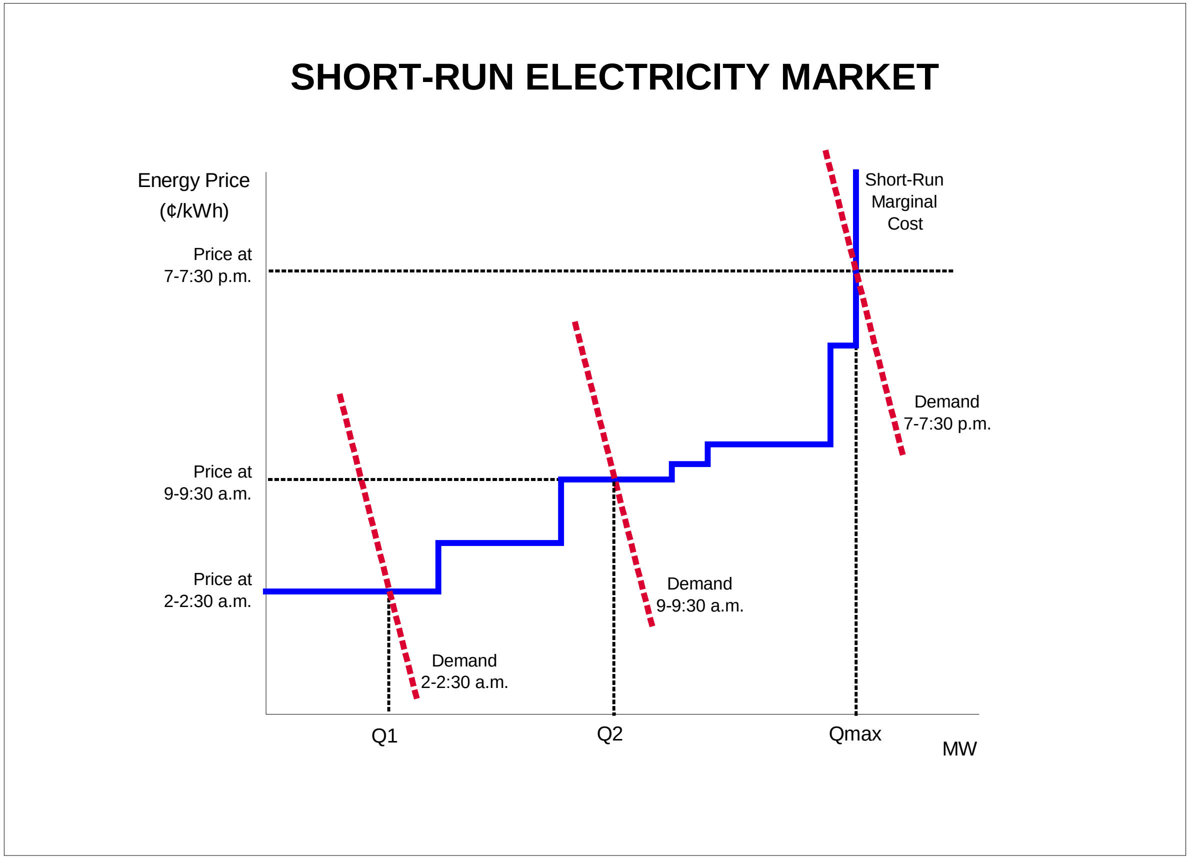


Source: CAISO, 2010.

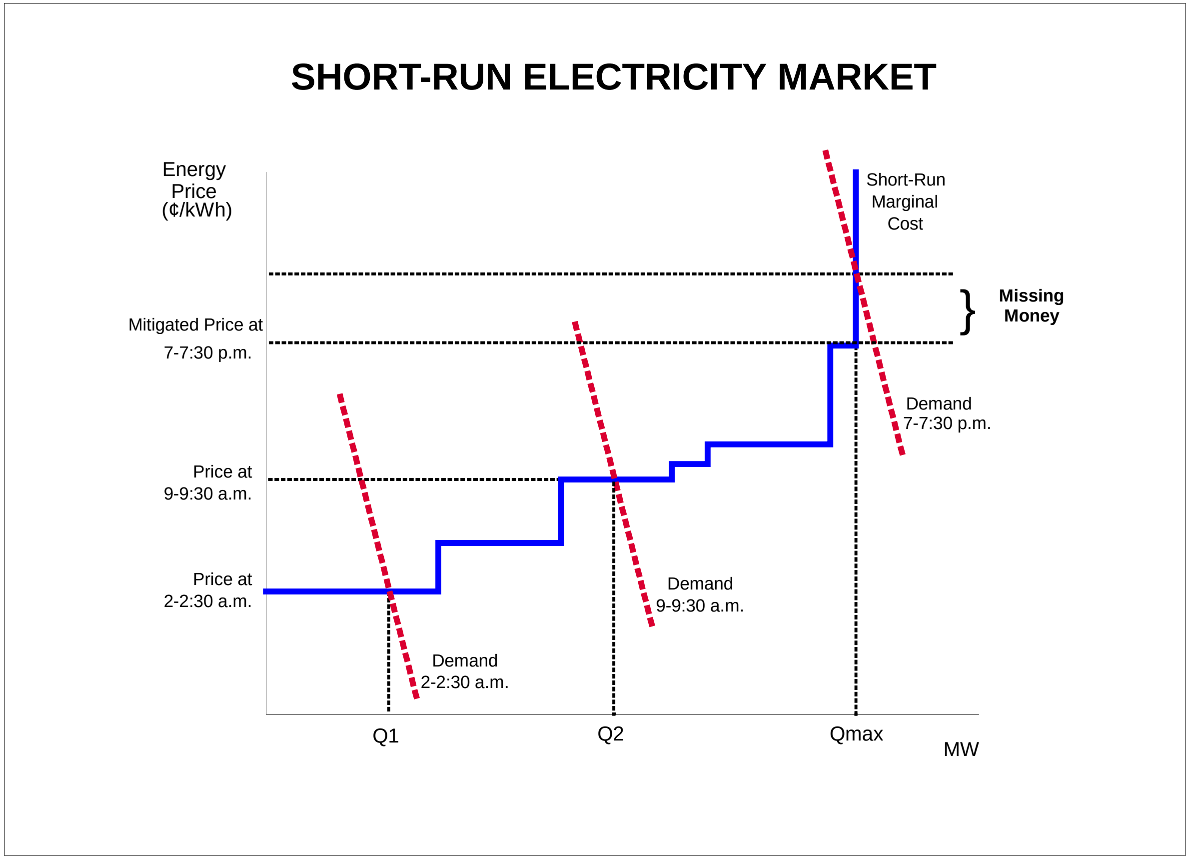
Variable Energy and Reliability

- At small penetration levels, the “no wind” contingency can be met with other capacity sources or demand response.
- At high penetration levels, the “no wind” contingency could be a binding constraint, even with perfect forecasting and no ramping limits.
- If the probability of “no wind” is small but still high compared to the LOLE, how will reliability planning and scarcity pricing adapt?

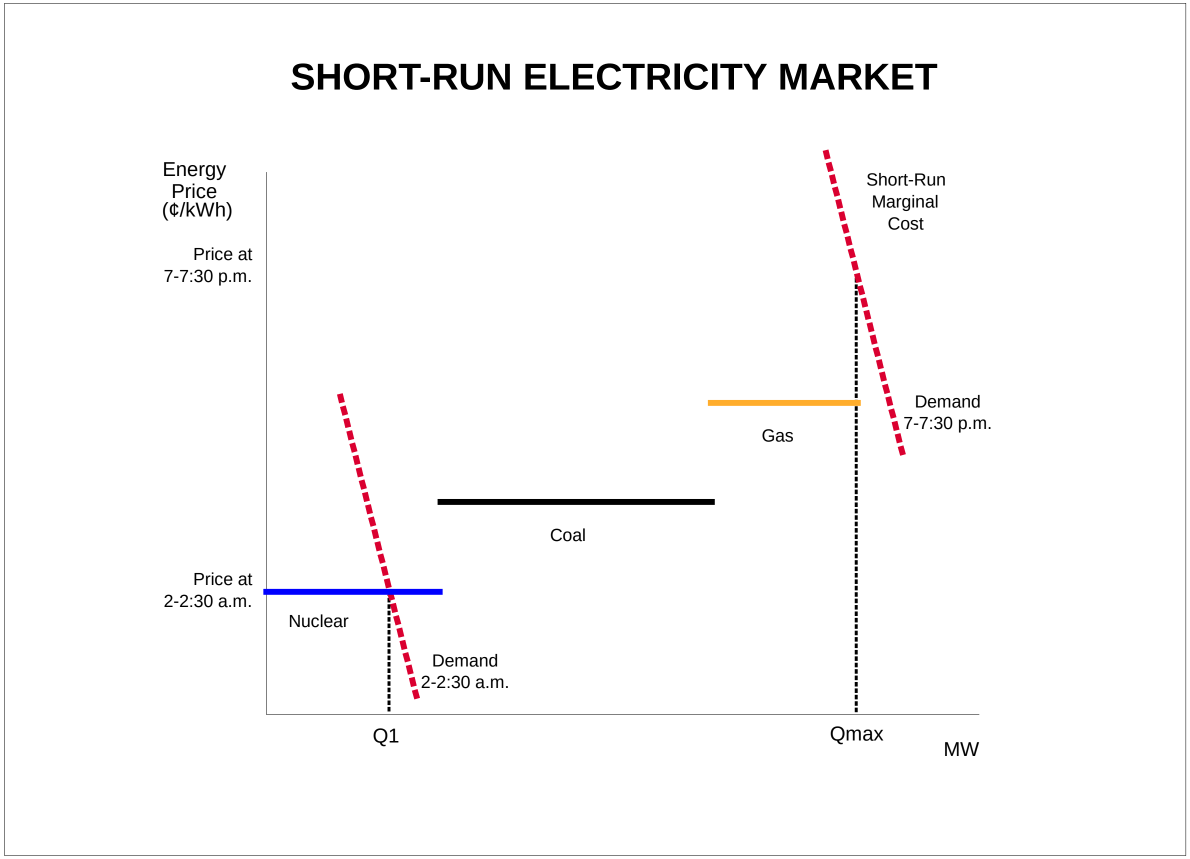
Simplified Electricity Market



Price Limits and Missing Money

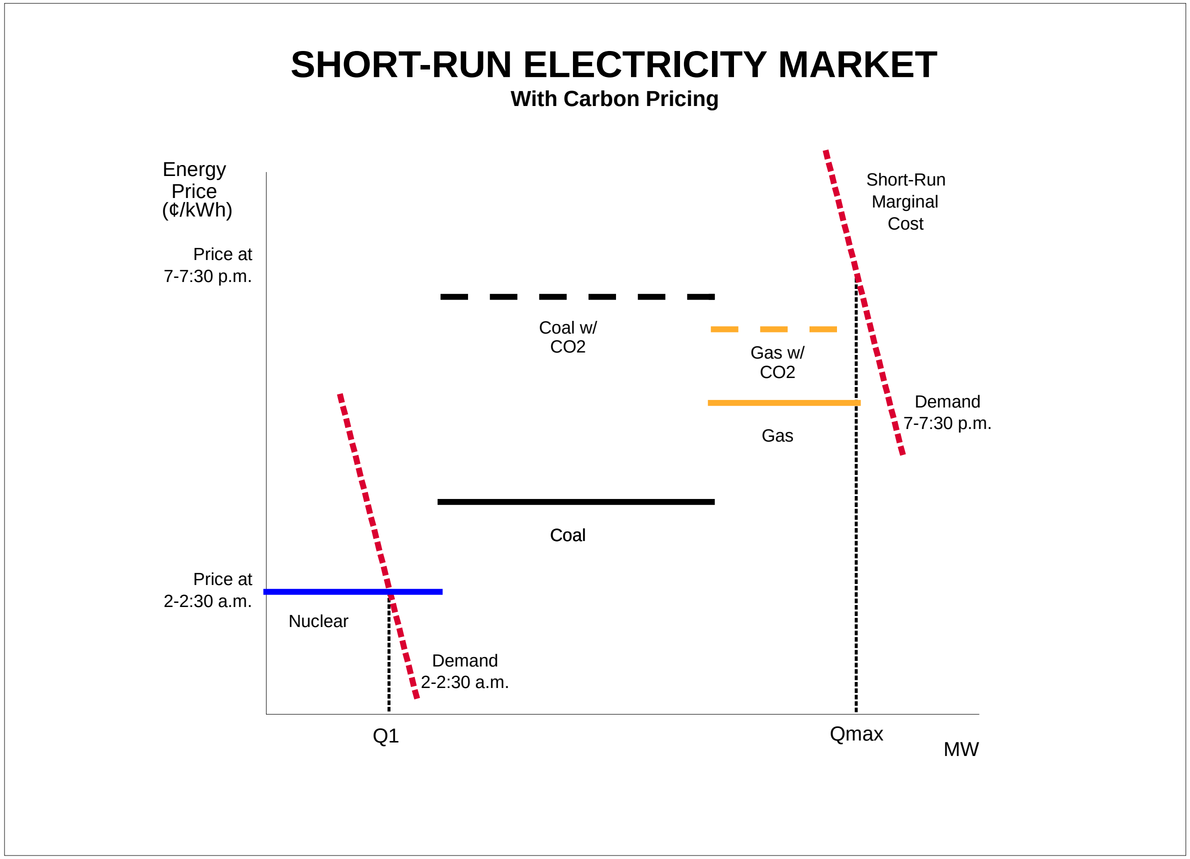


A Simpler Electricity Market

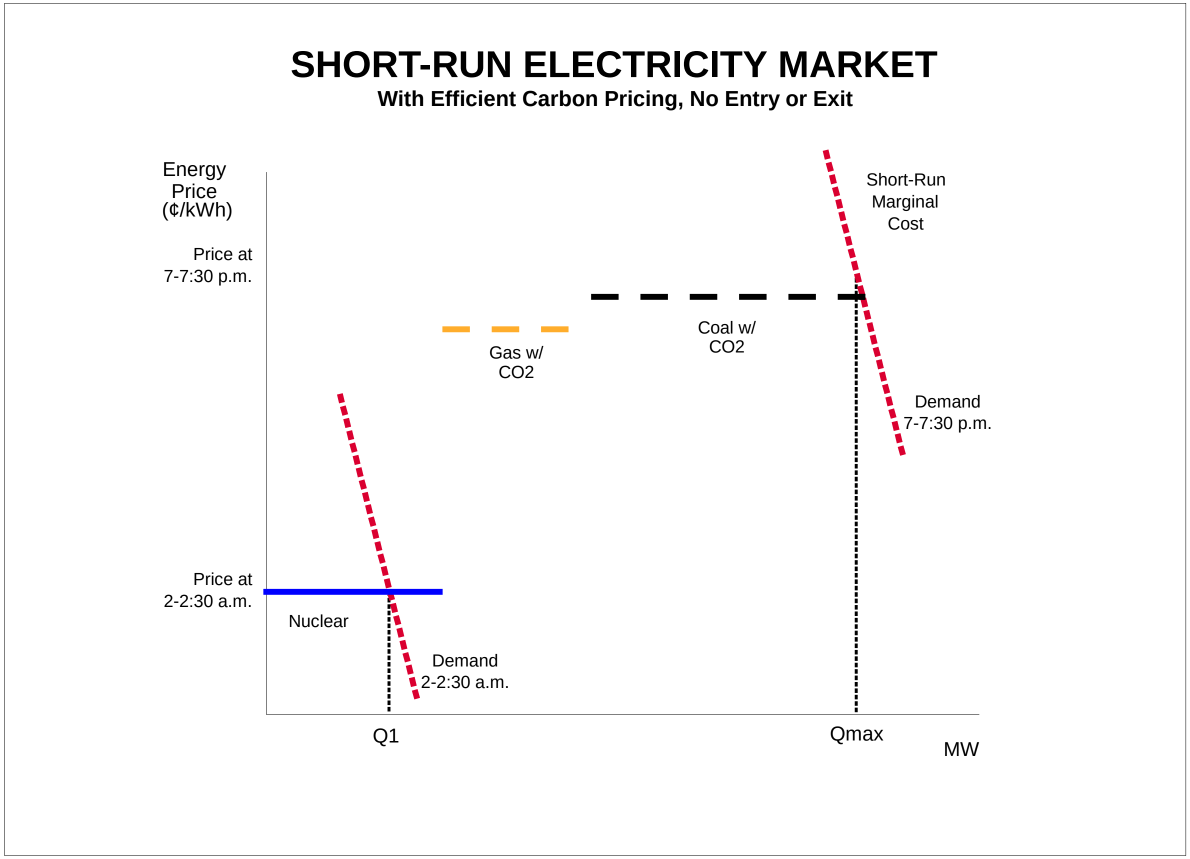


Efficient CO2 Pricing and Dispatch

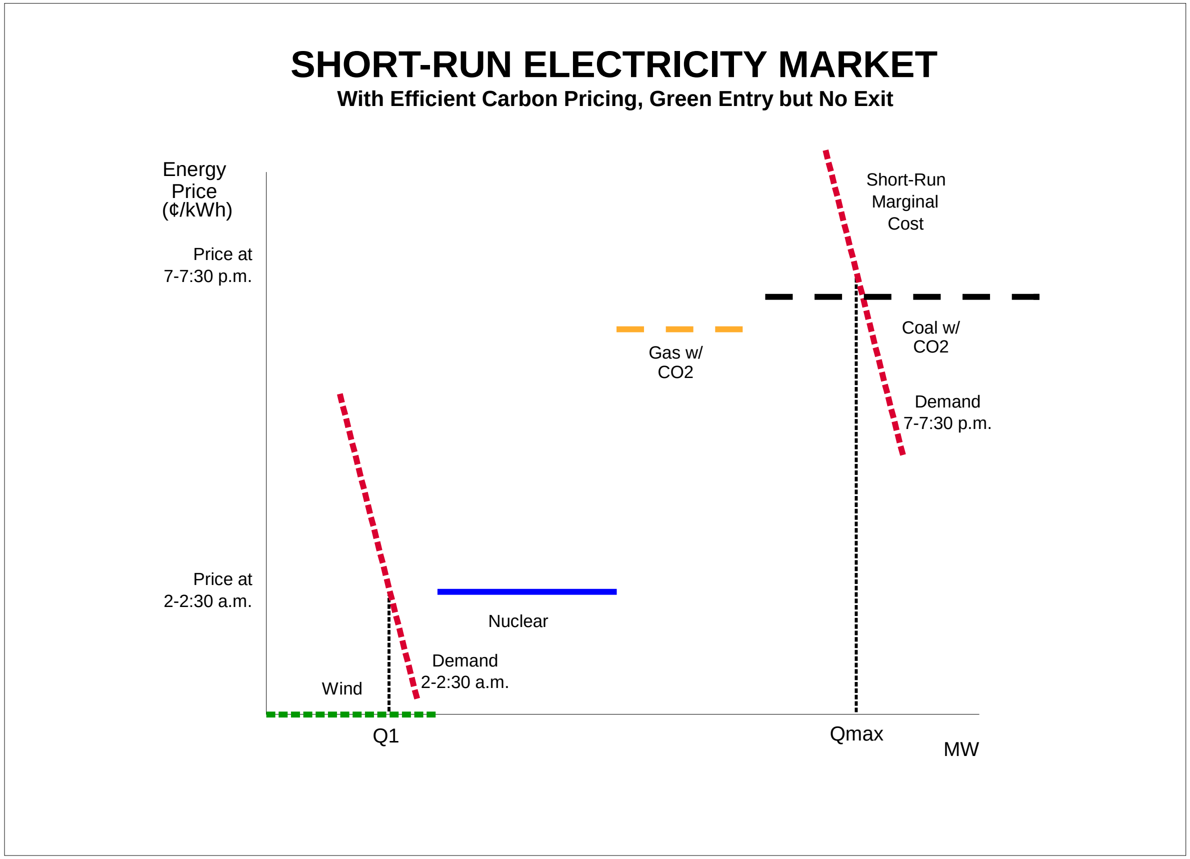
Efficient Carbon Pricing Changes Relative Prices and Dispatch Order



Carbon Pricing Lowers Net Contribution to Fixed Costs for Coal and Gas



Green Entry Lowers Energy Prices

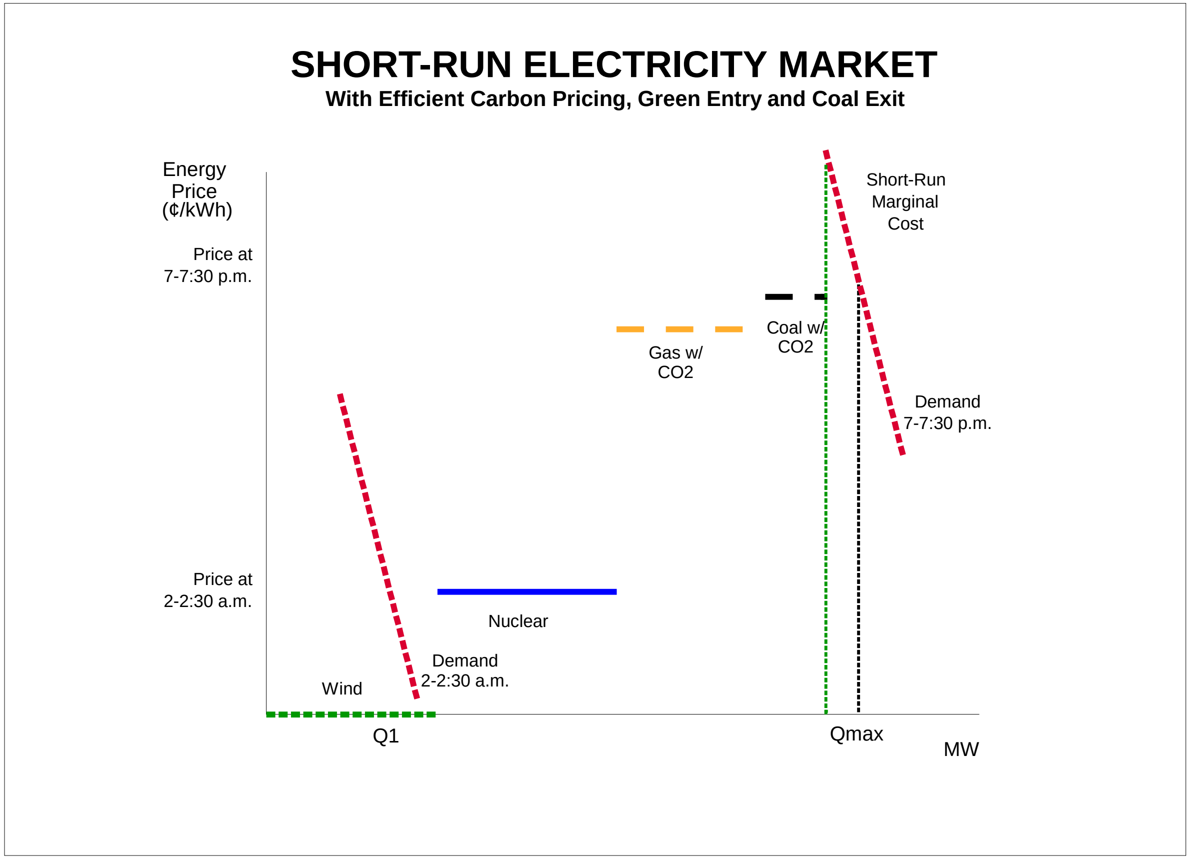


Lower Energy Prices and Exit

- With lower energy margins, traditional units will retire earlier or invest less.
- More of total costs will move from energy market into resource adequacy payments.
- Energy price volatility may increase.
- Details matter and require dynamic simulation over uncertain conditions.

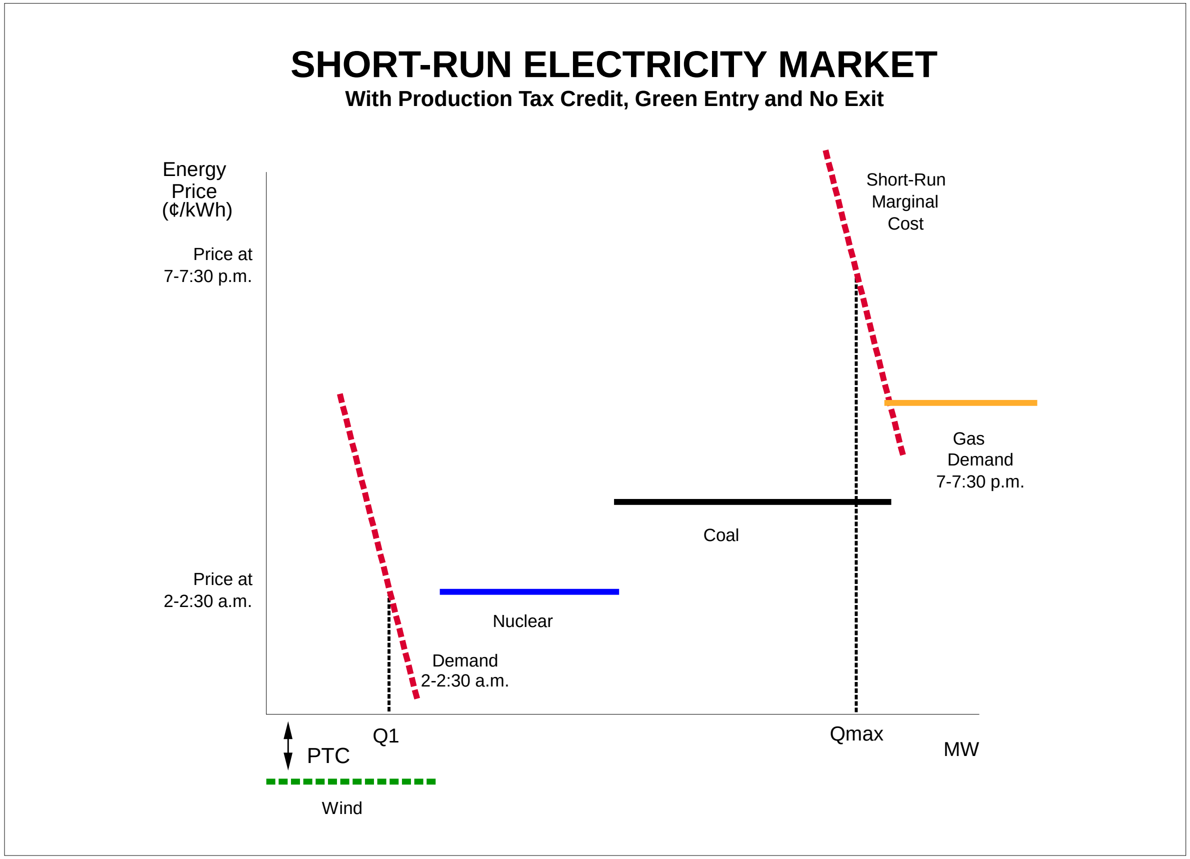
New Equilibrium Reduces Capacity

Higher Peak Prices Support Wind Entry

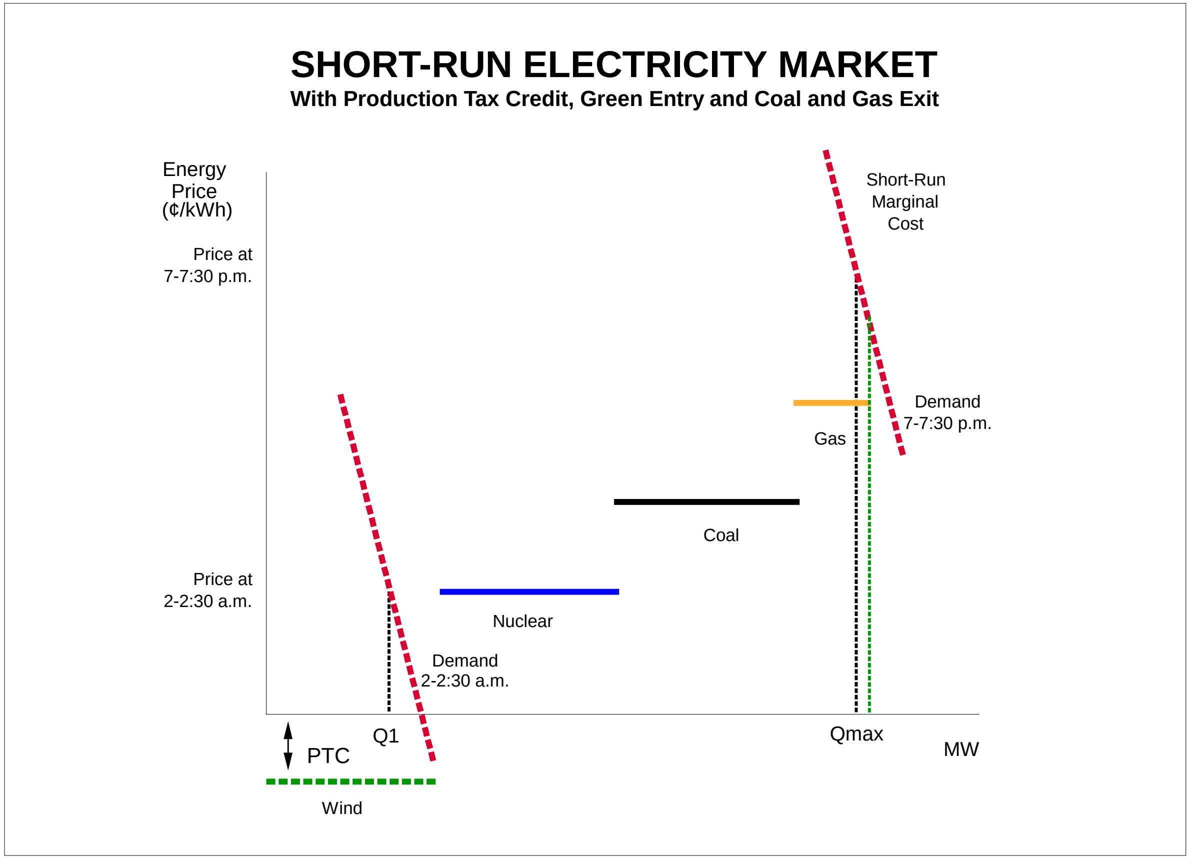


Without Carbon Pricing Energy Prices Fall

Assuming ITC and PTC Support Wind Energy



Exit Restores Equilibrium at Lower Energy Prices

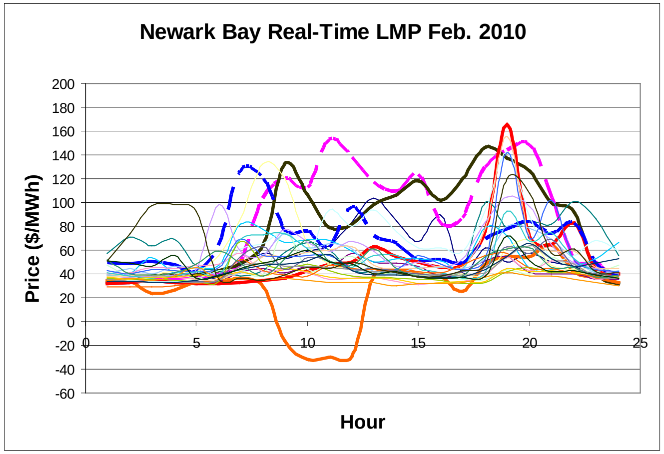


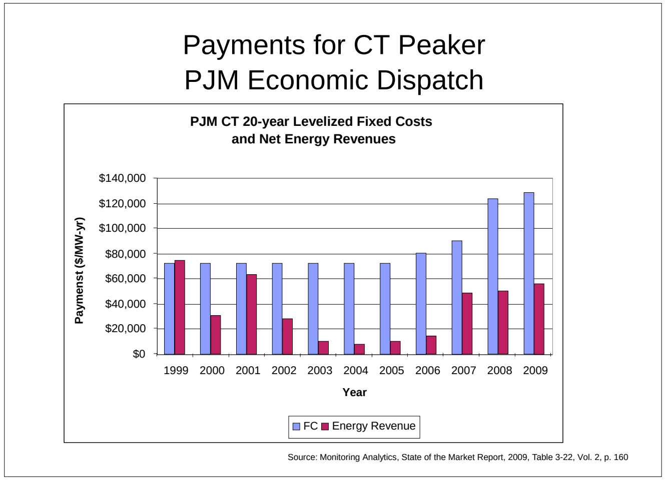
Low Carbon Policy and Energy Prices

- Efficient carbon pricing handles all or most of the impact through the short-run energy market. Well integrated with operations.
- Targeted renewable supports handle the most important payments outside the energy market, and decrease net energy prices in the short-run market.
- ITC and PTC socialize costs and lower energy market prices, putting added pressure on resource adequacy payments through capacity markets or long-term capacity requirements.
- Feed-in tariffs or renewable portfolio standards lower short-run energy prices. Average total load payments may also go down in short-run but up in long run.
- Direct effect of RPS on energy prices depends on implementation, whether imposed on load or generation.
- Low carbon policy could simultaneously decrease peak prices and increase volatility of prices by inducing more negative off-peak prices.

Resource Adequacy and Dynamic Pricing

- Demand response and real-time pricing become more important under a low carbon regime.
- Real time pricing is not the same as time of use pricing.
- The “missing-money” problem will likely increase with further renewable entry.
- Improved scarcity pricing would help support operations and send investment signals, perhaps a great deal.





Improved Scarcity Pricing

- Support demand response in dealing with variable energy sources.
- Use locational operating reserve demand curves to support scarcity pricing without invoking or requiring withholding and market power, without requiring ad hoc price ceilings.
- Bridge some of the gap between reliability standards with implicit VOLL at $400,000 and operational range of $2,000 to $20,000 per MWh.
- Greater volatility of short-run energy prices could have a material impact on the economics of variable energy renewables. Solar (positively correlated with prices) would benefit. Wind (negatively correlated with prices) would suffer. (Joskow, "Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies," MIT 10-013, September 2010.)
- Better scarcity pricing would mitigate but not eliminate the missing money problem and reliance on resource adequacy payment mechanisms.

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