-$300 Bid Floor Due to Renewable Subsidies? *Fix the Real Problem: Production-Based Incentives*

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Objectives in Designing Renewable Energy Policies

Not "renewableness" per se, but:

- Reduce emissions
- Improve technology
  - Learning curve effects
  - Accelerate innovation
- Minimize cost

Production-based subsidies that incent negative bids are inferior in terms of these objectives

- *Avoiding large negative bids can lower emissions & costs, and still incent technology improvement*

Subsidies that incent large negative bids are inefficient

- Compare with alternatives:
  1. RECs, tax incentives awarded for availability (no loss if curtailed)
     - Would increase renewable gen profit
  2. (a) Disallow RECs, tax breaks when real-time prices are negative, or (b) allow operator to curtail when price is negative (EU proposals)
     - Would decrease renewable gen profit
- $0 bid would be optimal strategy for (1), (2a)
- Some stakeholder support

Comparison of Policy 1 with Production-Based Subsidy

- 1 *decreases* costs of running system
  - When price is negative, forcing ISO to take renewable power increases costs for thermal generators constrained by unit commitment limits
- 1 may *decrease* emissions (depends on policy)
  - If increased costs associated with thermal generators are fuel costs, fuel consumption increases, so emissions may increase
    - In absence of efficient market-wide emissions cap
  - In efficient cap-based system, emissions would not change if more renewable energy taken
- No obvious differences in incentive for innovation

Example

- Three plants:
  1. Efficient gas 100 MW (Min Run = 30 MW)
     - Start up cost = 12,000 $ (all fuel)
     - $5/MMBTU gas, 7000 BTU/kWh → 35$/MWh
  2. Inefficient gas 100 MW (no Min Run level)
     - 11,000 BTU/kWh → 55 $/MWh
  3. Wind: 10 MW
- Load: 160 MW for 16 hours, 30 MW for 8 hrs
- Result taking wind for 16 hrs:
  – Plant 2 would stay committed for any offpeak price $\geq$ -15$/MWh
  – System cost = $108,400, emissions = 1264 tons CO_2
- Result if 10 MW of wind taken for 24 hrs
  – Decommit #1, system cost = $120,800, emissions = 1409 tons CO_2
  – Most of increase in CO_2 is due to start-up
- **Here, taking wind when P<0 increases cost, emissions**

Appendix: Calculations

Data	SU Cost $/start up	MC $/MWh	Capacity MW	Must Run level MW	Heat rate BTU/kWh
Gen 1	12000	35	100	50	7000
Gen 2	0	55	100	0	11000
Gen 3	0	0	10	0	0

Fuel Cost:	5	$/MMBTU
Emission Rate:	0.0583	tons/MMBTU

Case 1: Take Wind only during day (16 hrs)	Day (16hr)	Night (8hr)	Var. Cost $/day	SU Cost $/day	Total Cost $/Day	Fuel Use MMBtU	Revenue $/day	Profit $/day
Gen 1 MW	100	30	64400	0	64400	12880	84400	20000
Gen 2 MW	50	0	44000	0	44000	8800		
Gen 3 MW	10	0	0	0	0	0		
Load MW	160	30		Total:	108400	21680		
Price $/MWh	55	-15			Emissions:	1264	tons CO2	

Case 1: Take Wind All 24 Hours	Day (16hr)	Night (8hr)	Var. Cost $/day	SU Cost $/day	Total Cost $/Day	Fuel Use MMBtU	Revenue $/day	Profit $/day
Gen 1 MW	100	0	56000	12000	68000	13600	88000	20000
Gen 2 MW	50	20	52800	0	52800	10560		
Gen 3 MW	10	10	0	0	0	0		
Demand	160	30		Total:	120800	24160		
Price	55	55			Emissions:	1409	tons CO2	