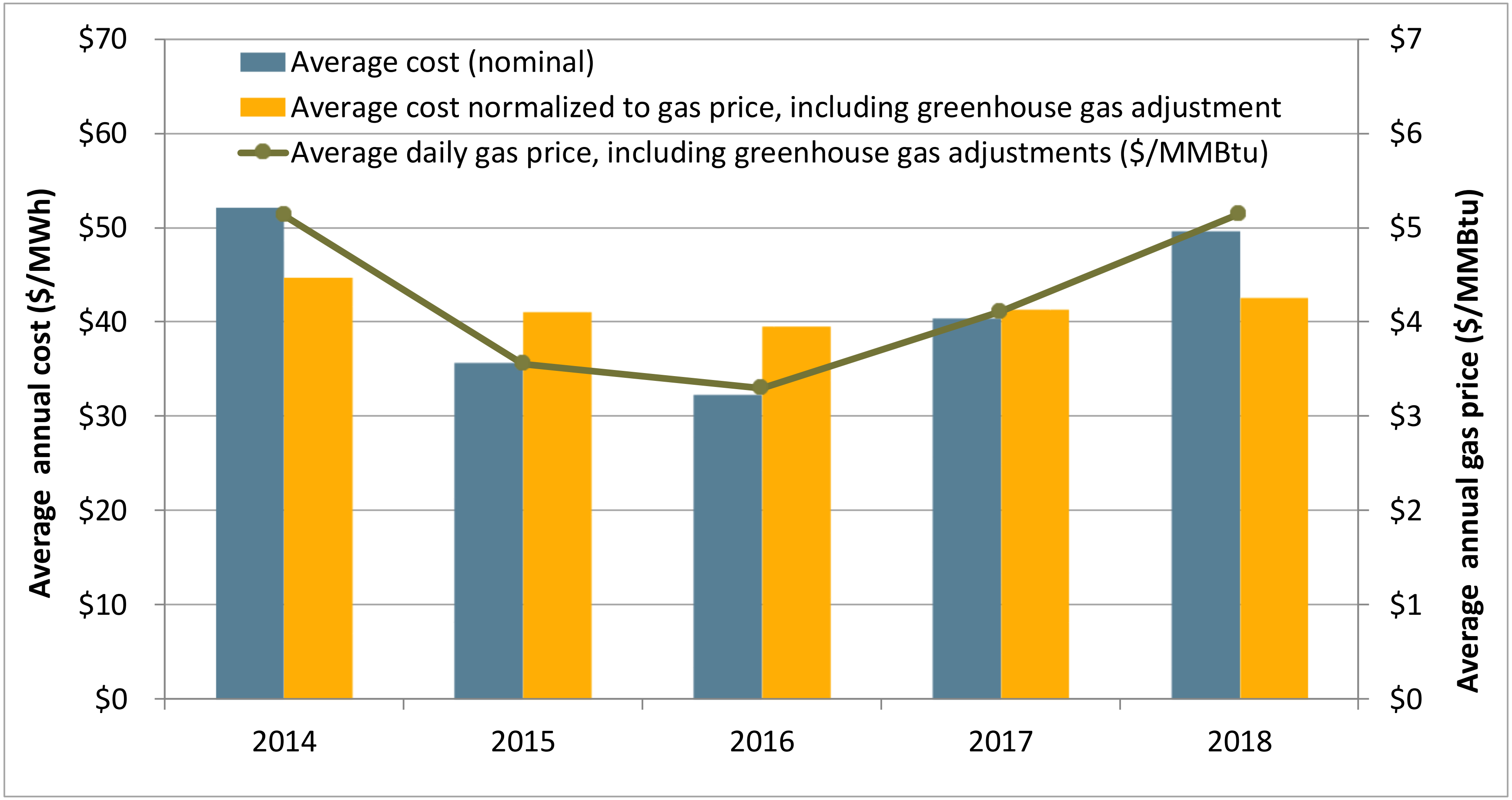
2018 Annual Report

May 23, 2019

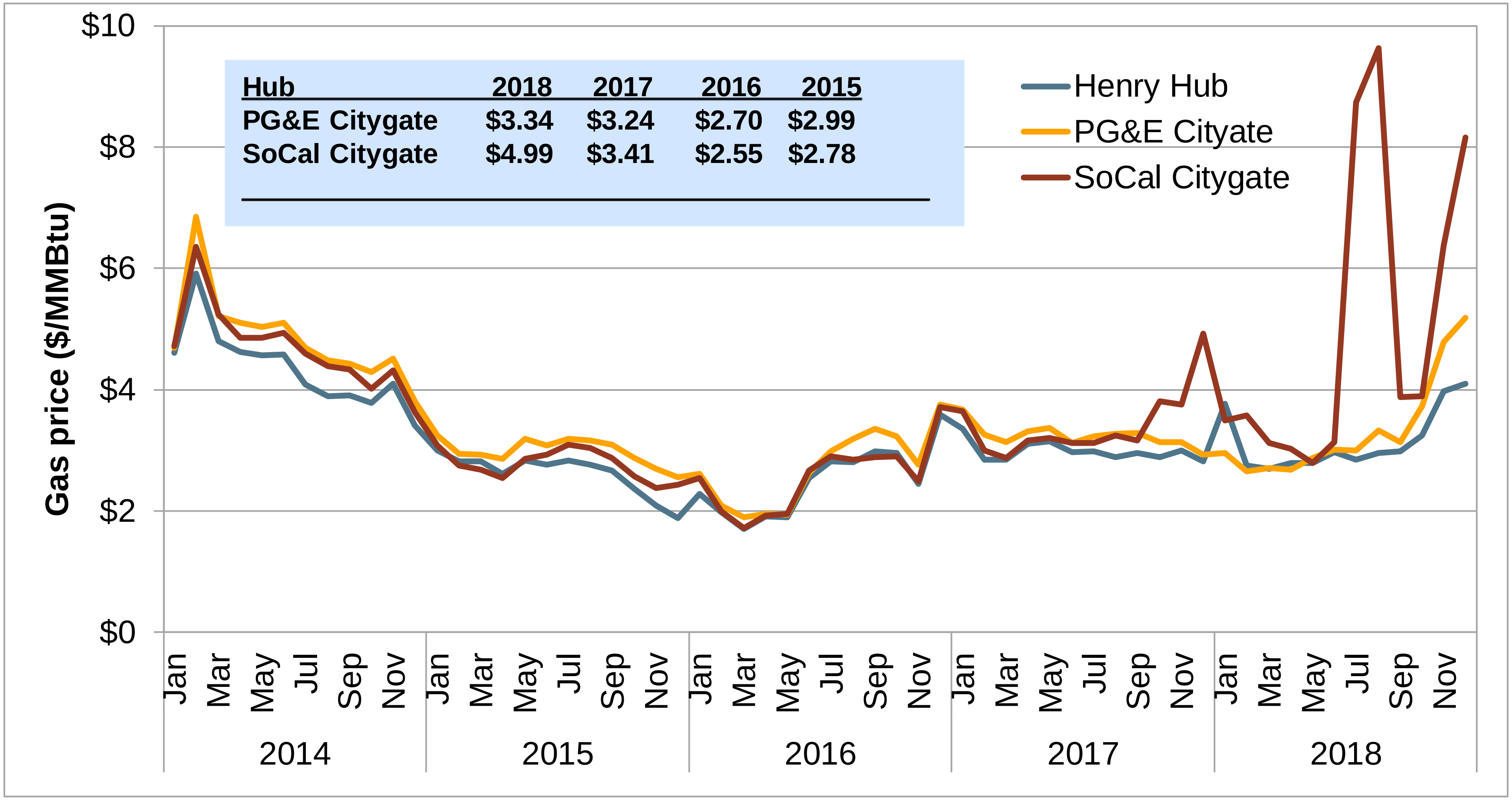
Amelia Blanke

Manager of market monitoring & reporting
Department of market monitoring

Total wholesale costs increased 24% -- or 4% increase after accounting for 25% increase in gas cost



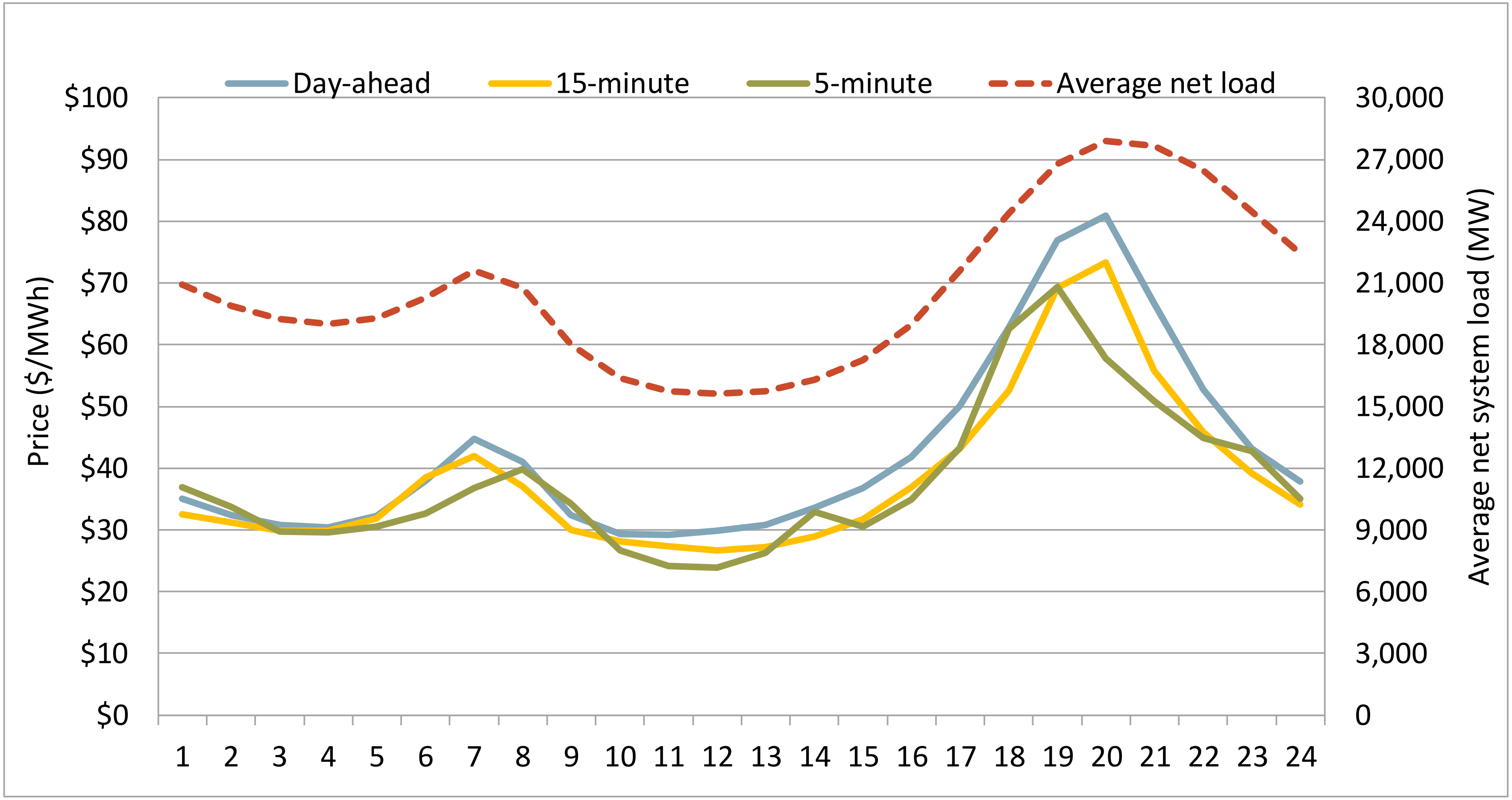
Day-ahead prices were often driven by high gas prices at SoCal Citygate



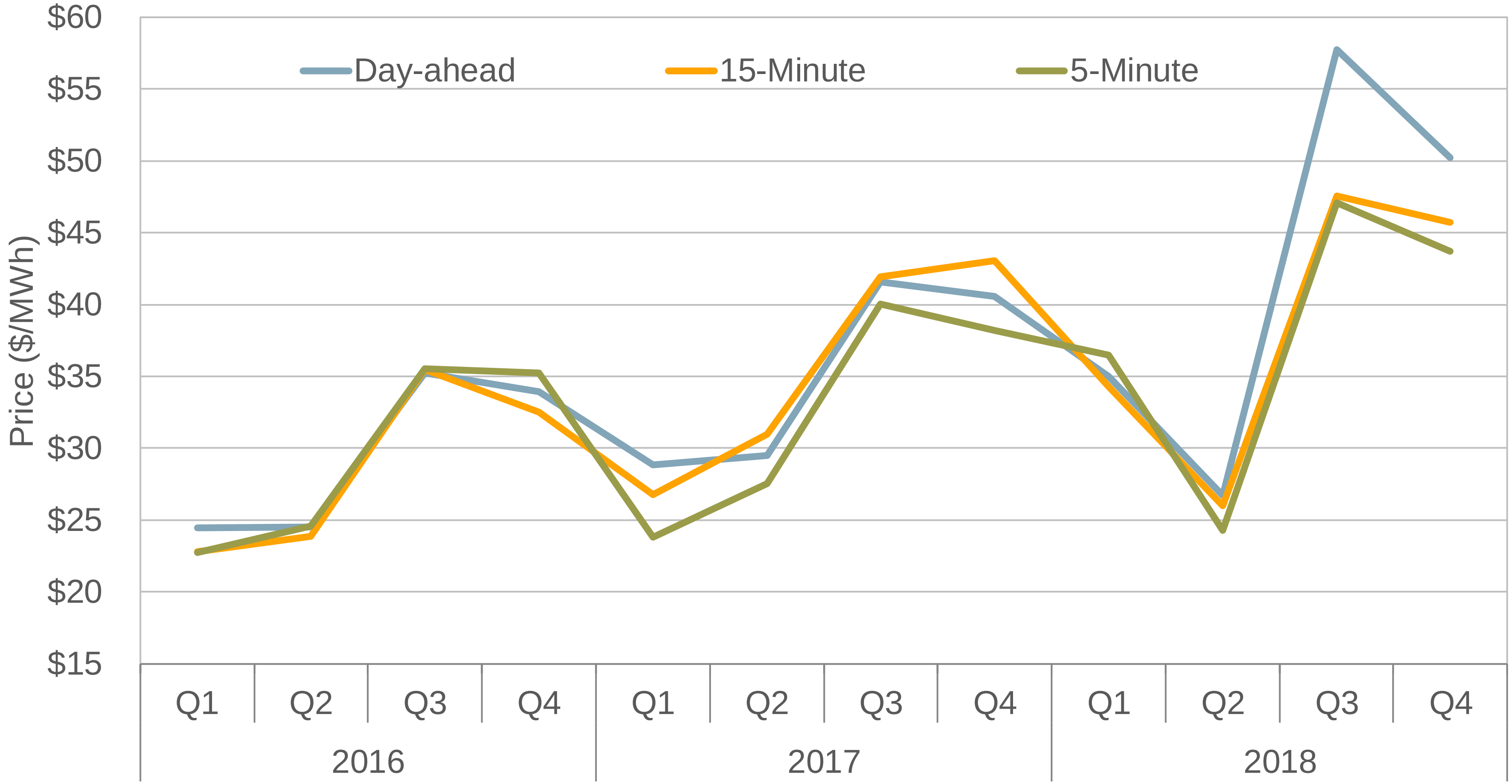
Total CAISO wholesale costs totaled $10.8 billion or about $49.50/MWh

	2014	2015	2016	2017	2018	Change '17-'18
Day-ahead energy costs	$ 49.53	$ 34.23	$ 30.49	$ 37.40	$ 46.06	$ 8.65
Real-time energy costs (incl. flex ramp)	$ 1.19	$ 0.18	$ 0.54	$ 0.90	$ 0.76	$ (0.14)
Grid management charge	$ 0.42	$ 0.42	$ 0.42	$ 0.43	$ 0.43	$ 0.01
Bid cost recovery costs	$ 0.40	$ 0.38	$ 0.30	$ 0.42	$ 0.69	$ 0.27
Reliability costs (RMR and CPM)	$ 0.14	$ 0.12	$ 0.11	$ 0.10	$ 0.73	$ 0.63
Average total energy costs	**$ 51.68**	**$ 35.33**	**$ 31.86**	**$ 39.25**	**$ 48.67**	**$ 9.42**
Reserve costs (AS and RUC)	$ 0.30	$ 0.27	$ 0.53	$ 0.71	$ 0.87	$ 0.16
Average total costs of energy and reserve	**$ 51.98**	**$ 35.60**	**$ 32.39**	**$ 39.96**	**$ 49.54**	**$ 9.58**

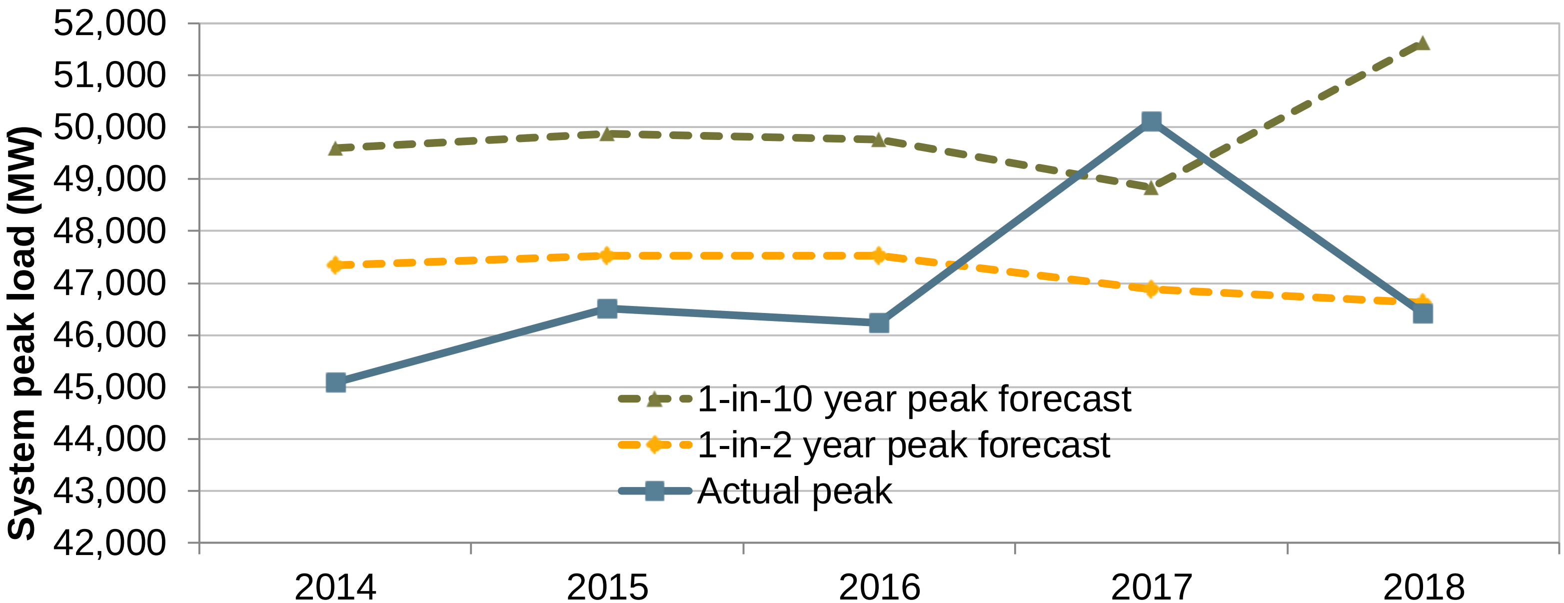
Average hourly prices mirror net load, with day-ahead prices systematically higher most hours.



System energy prices increased in Q3 and Q4 due to higher gas prices and tighter supply conditions.

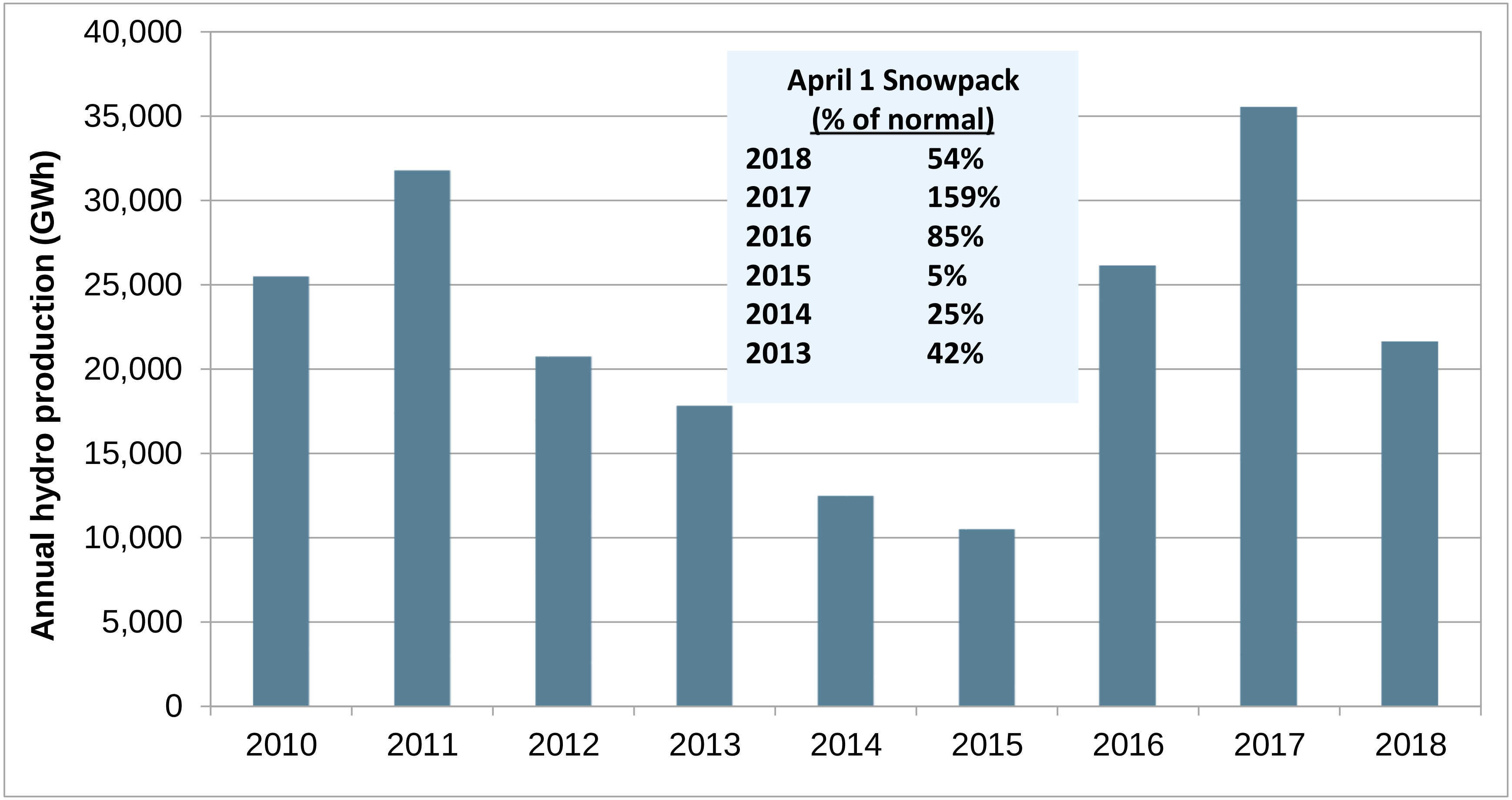


Lower peak loads and lower overall energy loads

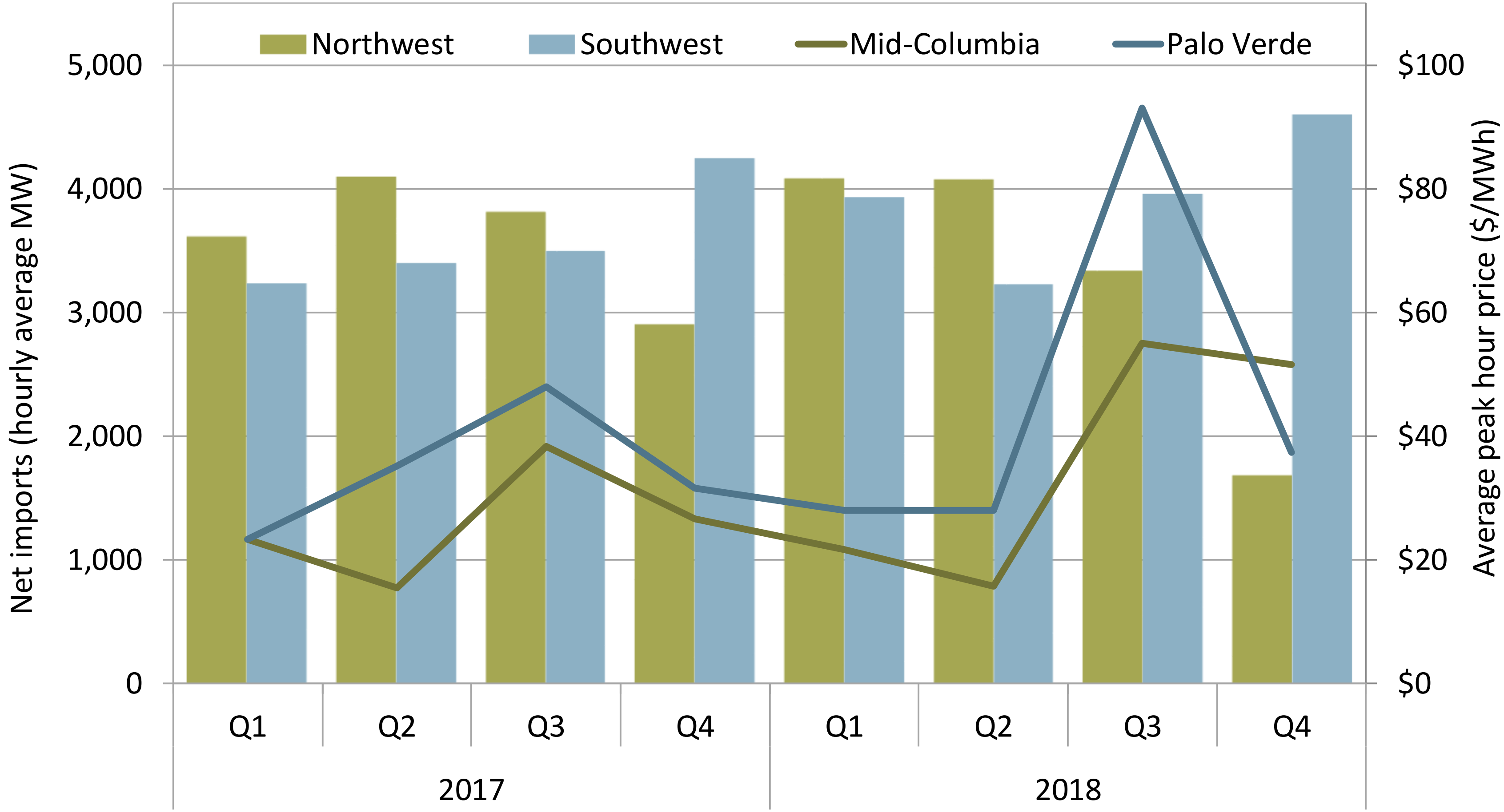


Year	Annual total energy (GWh)	Average load (MW)	% change	Annual peak load (MW)	% change
2014	231,610	26,440	-0.1%	45,090	0.0%
2015	231,495	26,426	0.0%	46,519	3.2%
2016	228,794	26,047	-1.4%	46,232	-0.6%
2017	228,191	26,049	0.0%	50,116	8.4%
2018	223,705	25,537	-2.0%	46,427	-7.4%

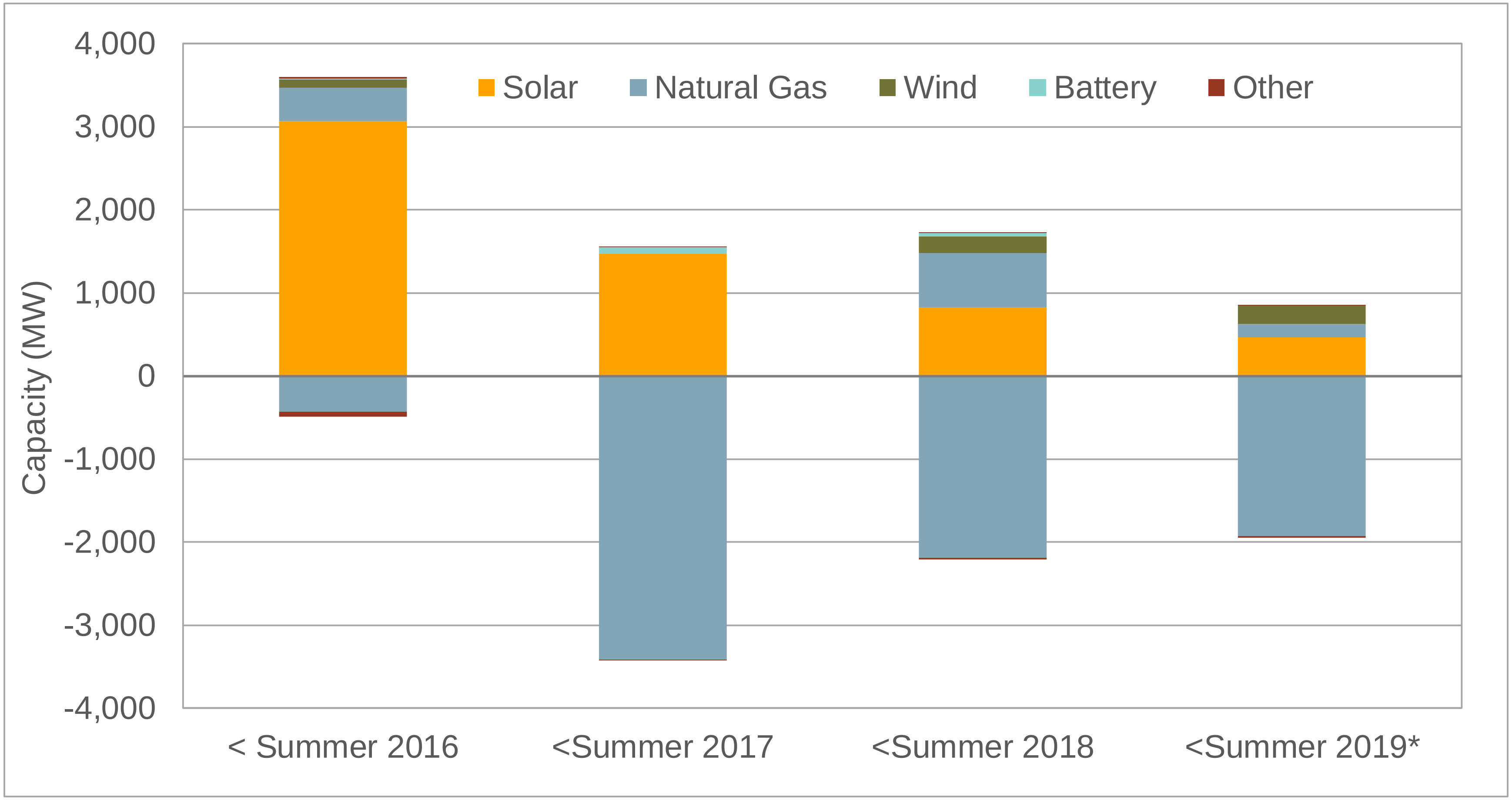
Hydroelectric generation decreased to around 10% of supply, compared to 15% in 2017 and 11% in 2016



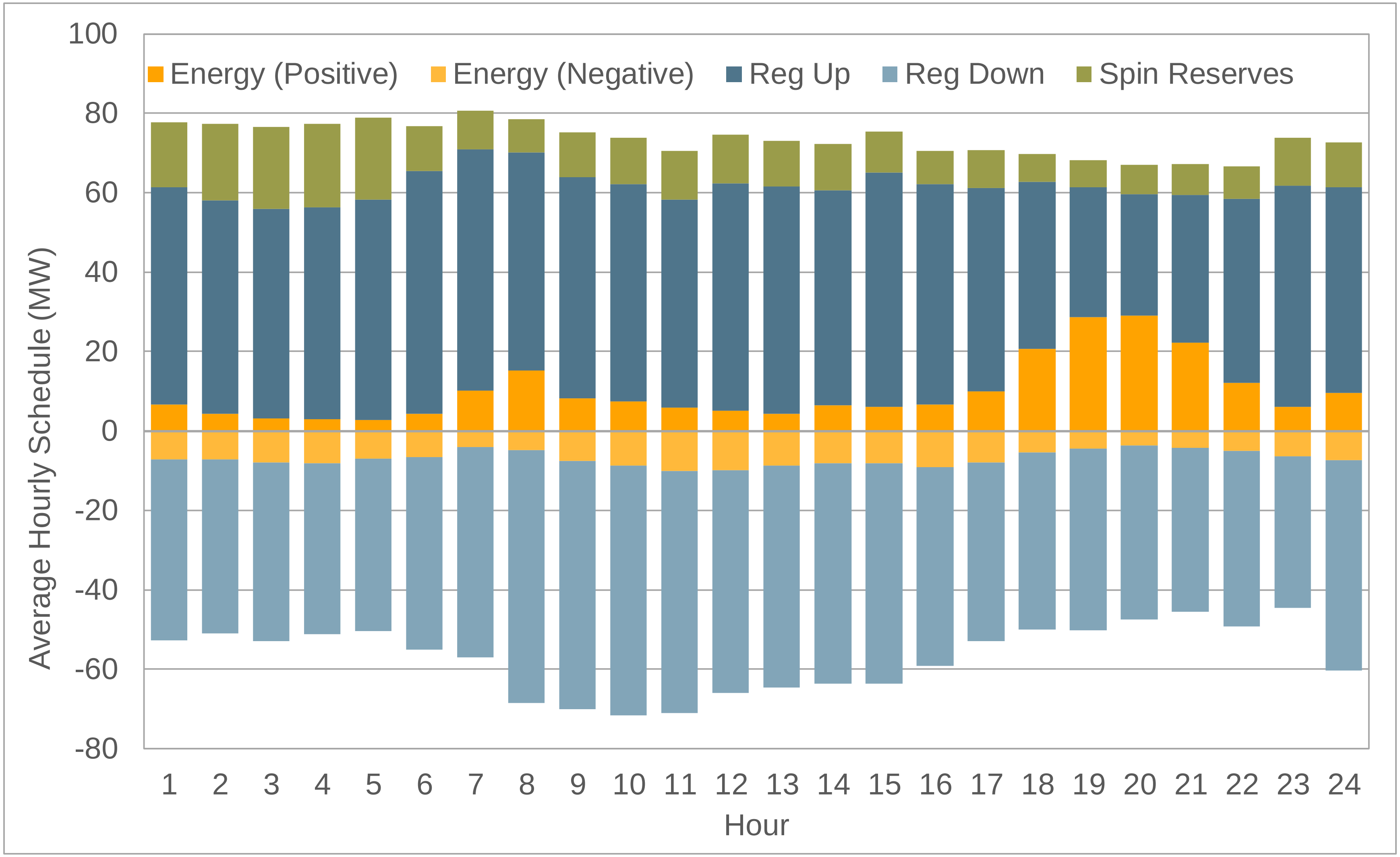
Net imports and average day-ahead prices at regional trading hubs (peak hours, 2017-2018)



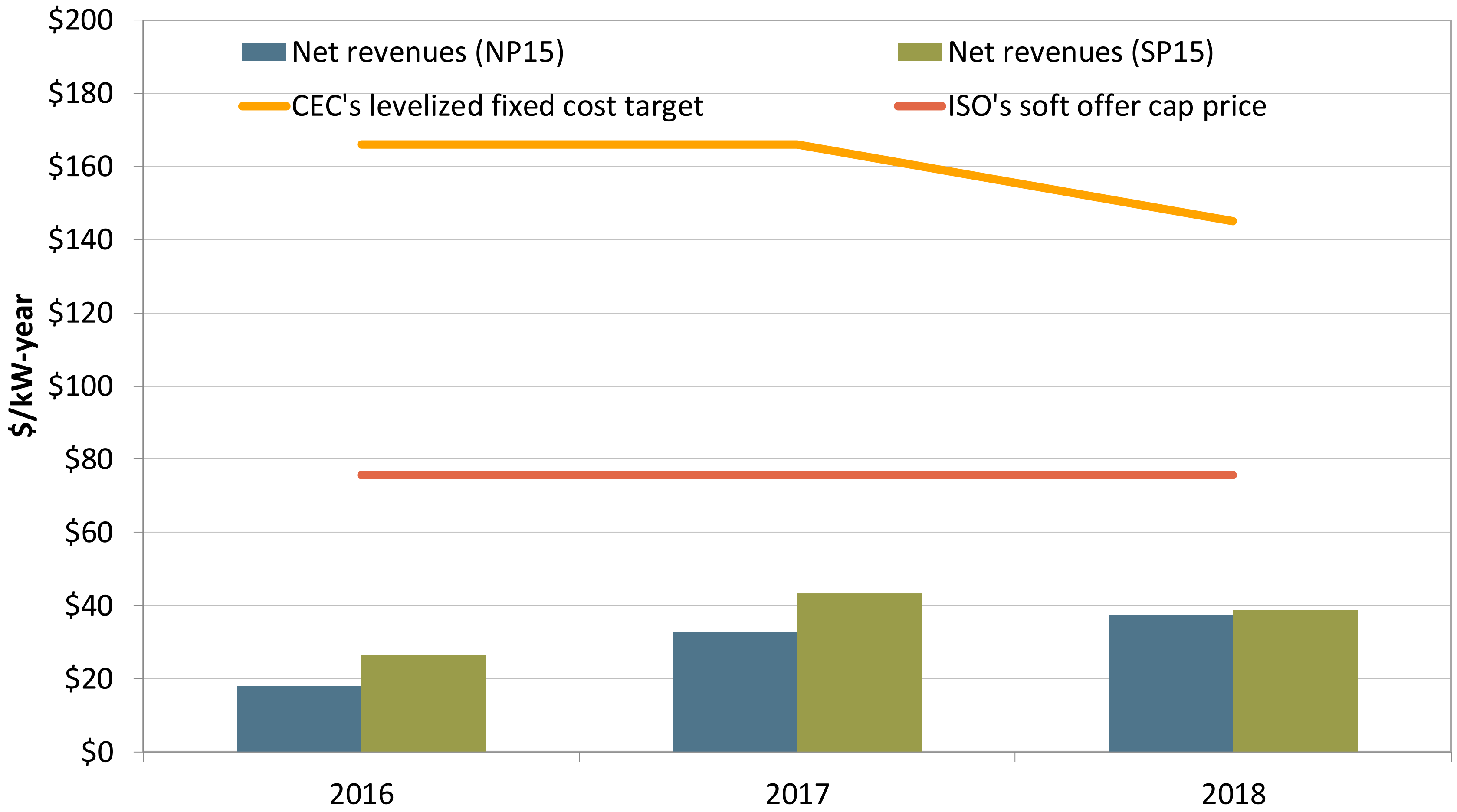
Gas capacity retiring is being largely replaced with renewables (mainly solar).



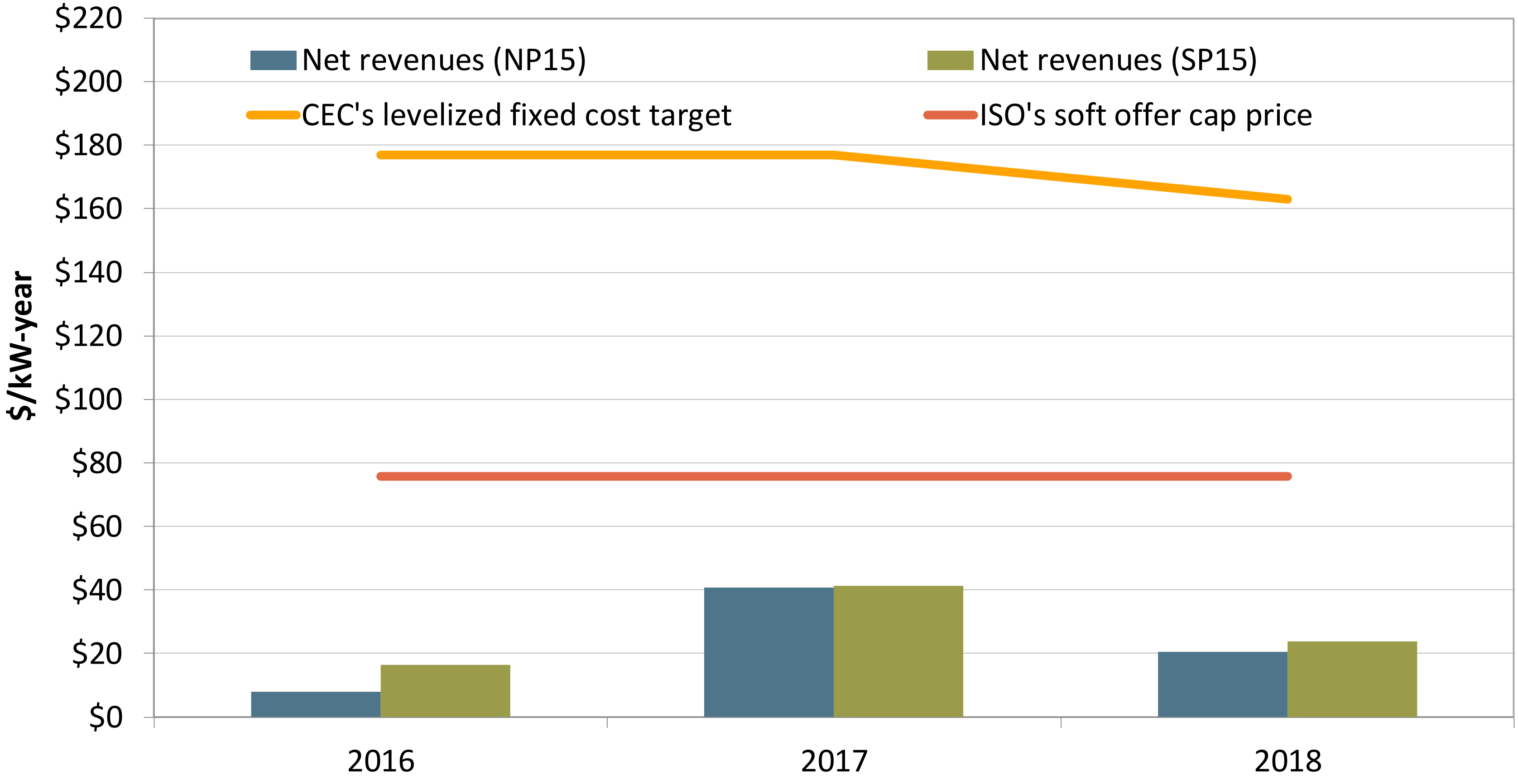
Average hourly schedules for battery resources.



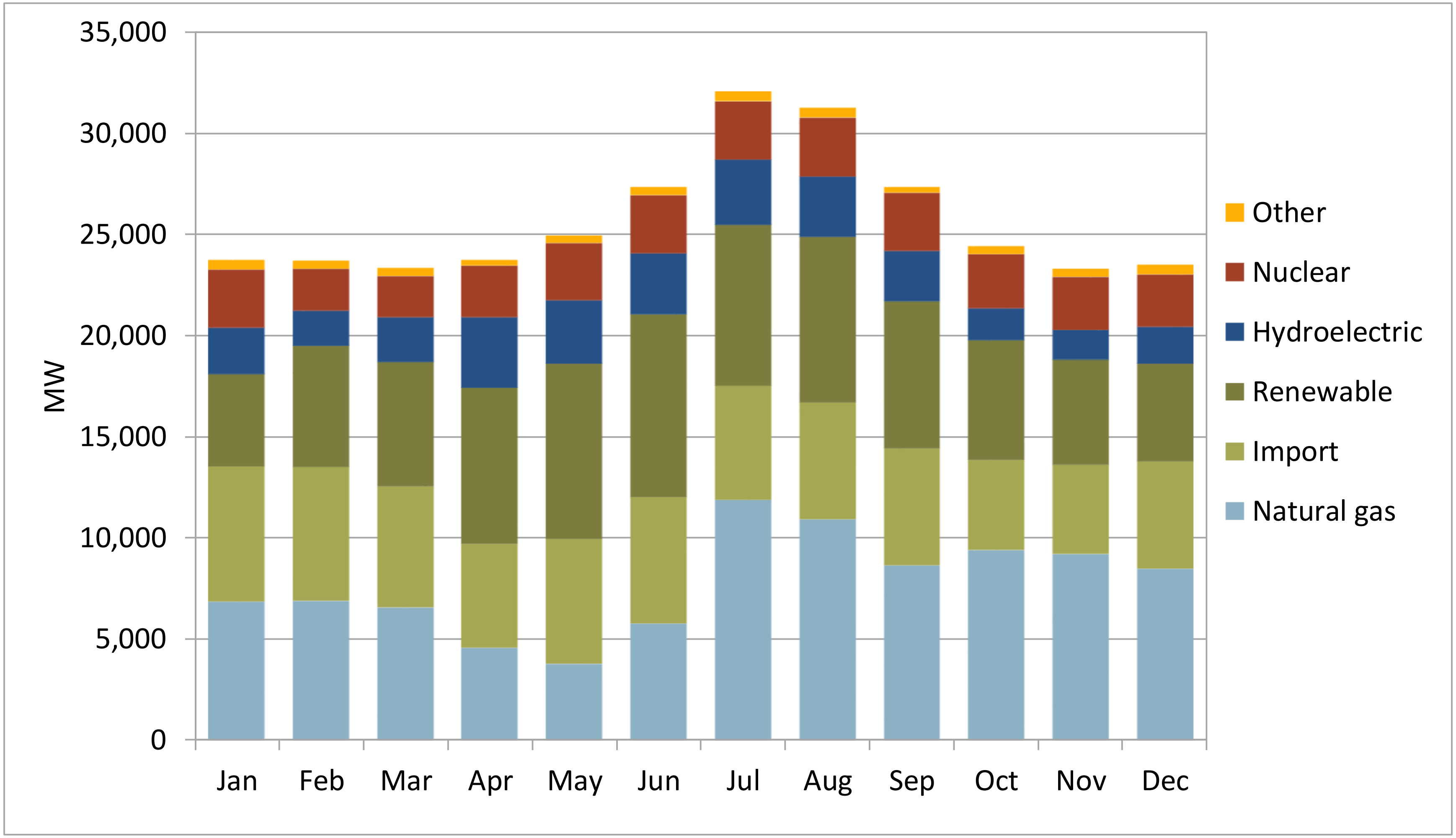
Estimated net revenue of hypothetical combined cycle unit in NP15 and SP15 was about $38/kW-year.



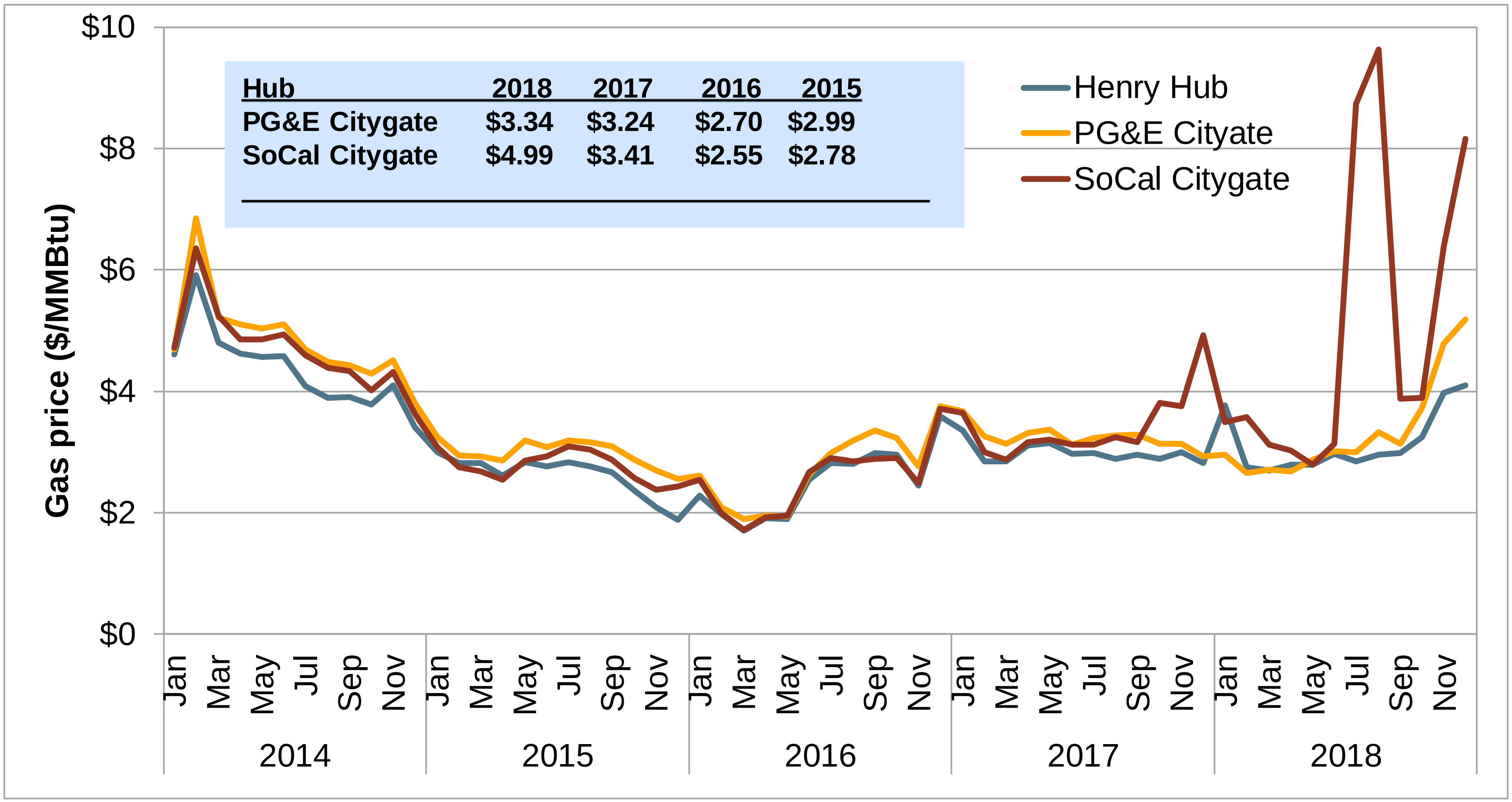
Estimated net revenues of hypothetical combustion turbine dropped to about $22/kW-year.



Reliance on gas is higher during months with higher loads

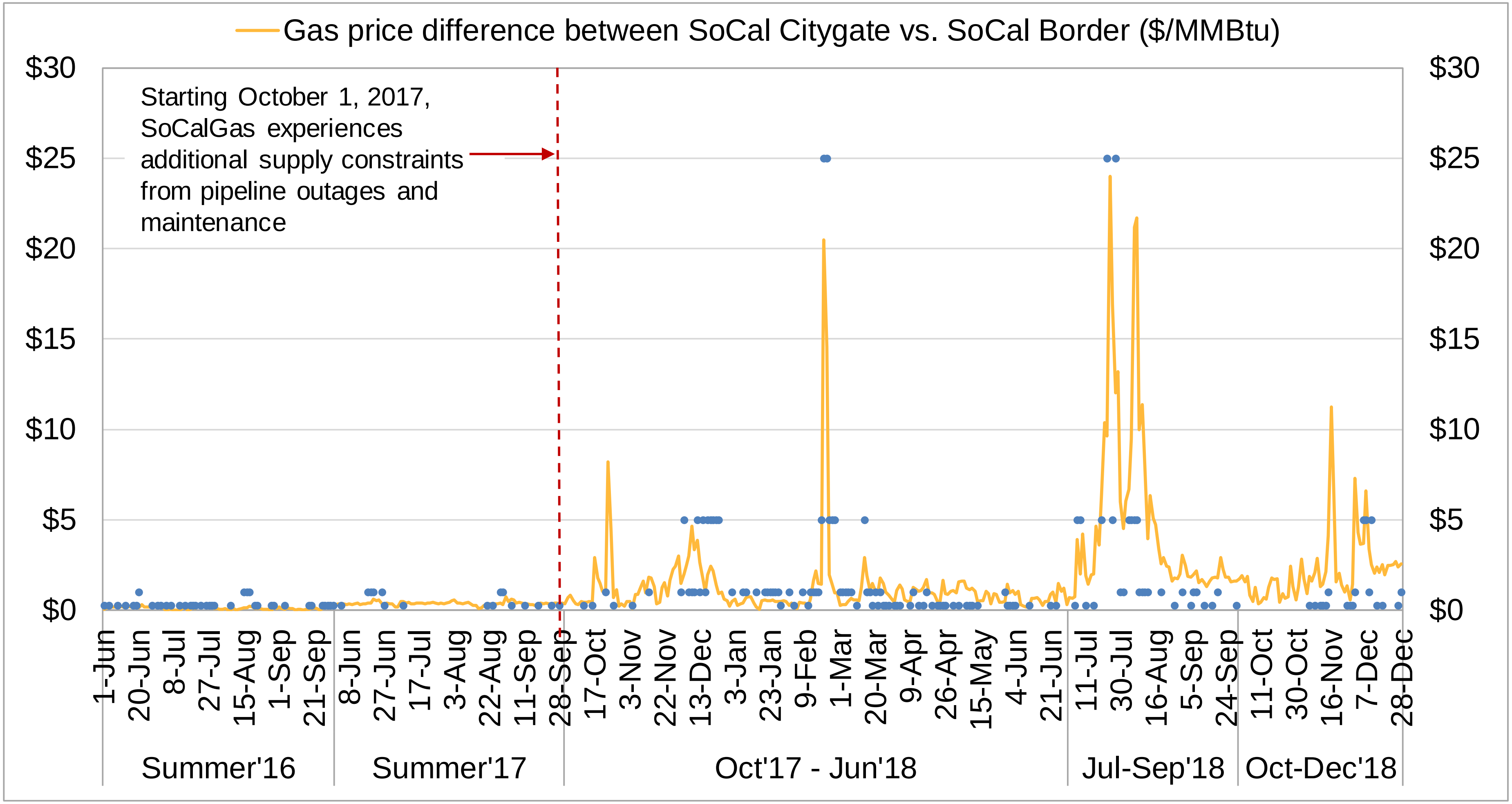


Day-ahead prices were often driven by high gas prices at SoCal Citygate.

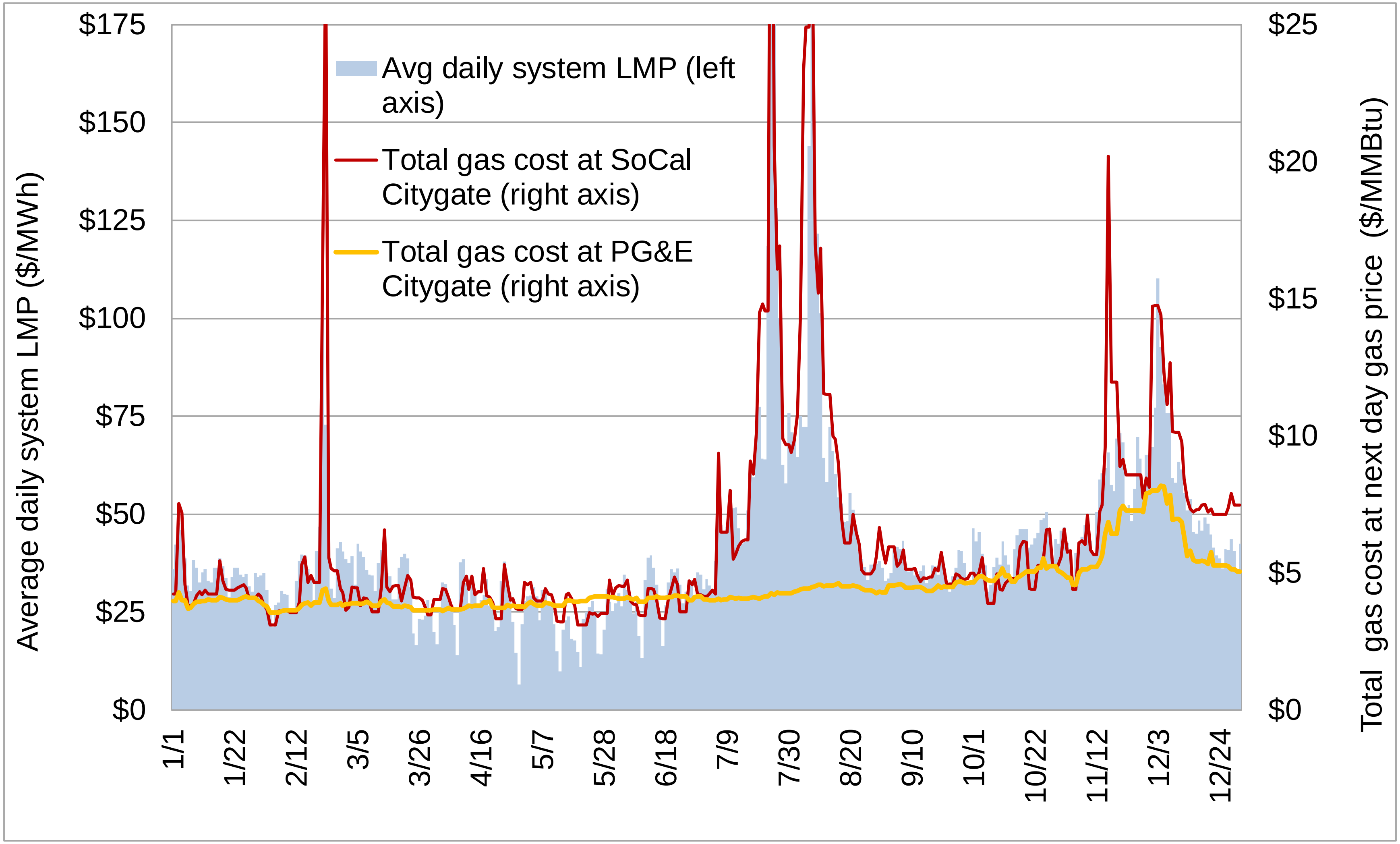


Hub	2018	2017	2016	2015
PG&E Citygate	$3.34	$3.24	$2.70	$2.99
SoCal Citygate	$4.99	$3.41	$2.55	$2.78

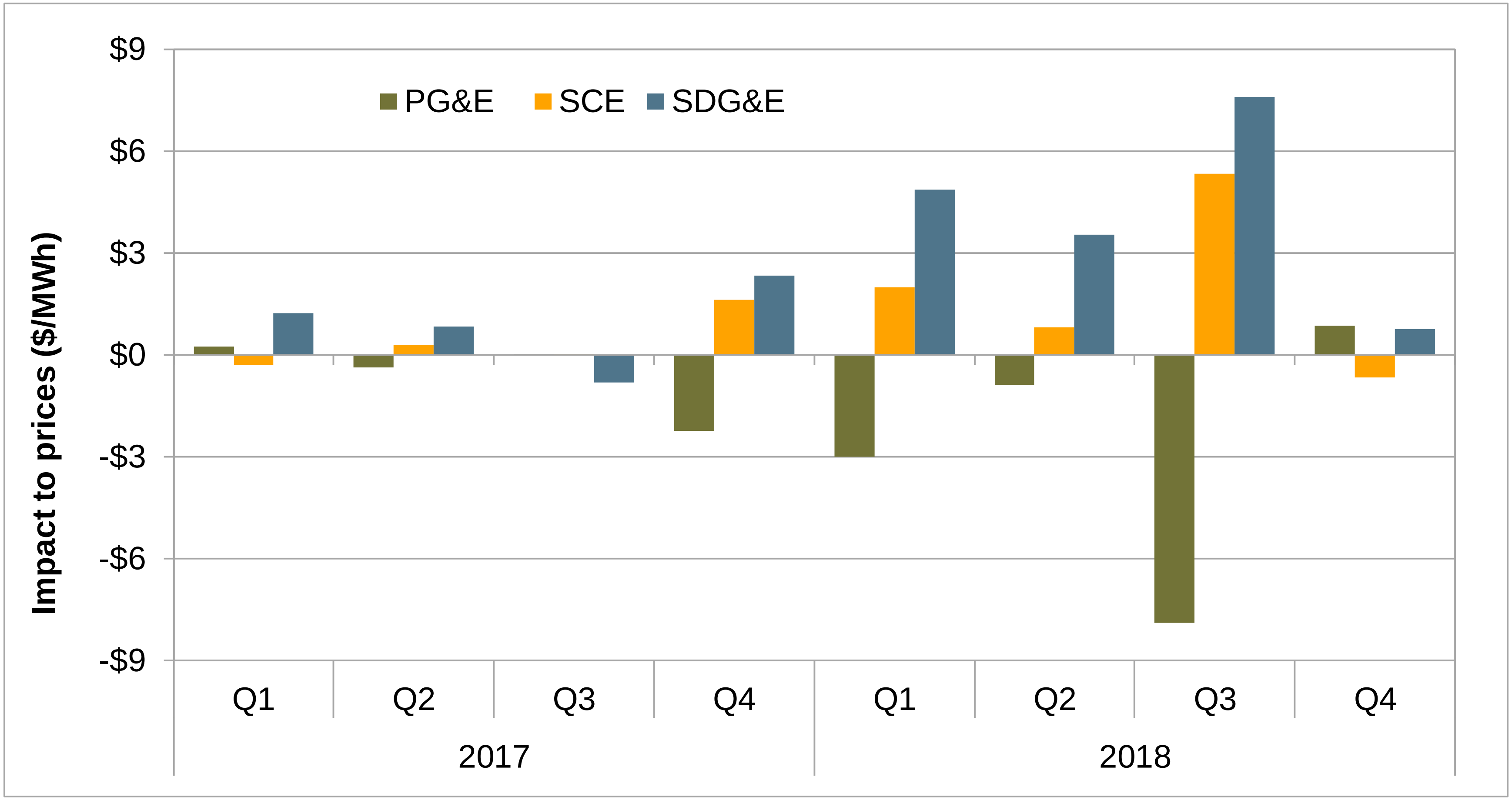
SoCal Citygate price spikes were driven by gas supply limitations and potential for high noncompliance charges (OFOs).



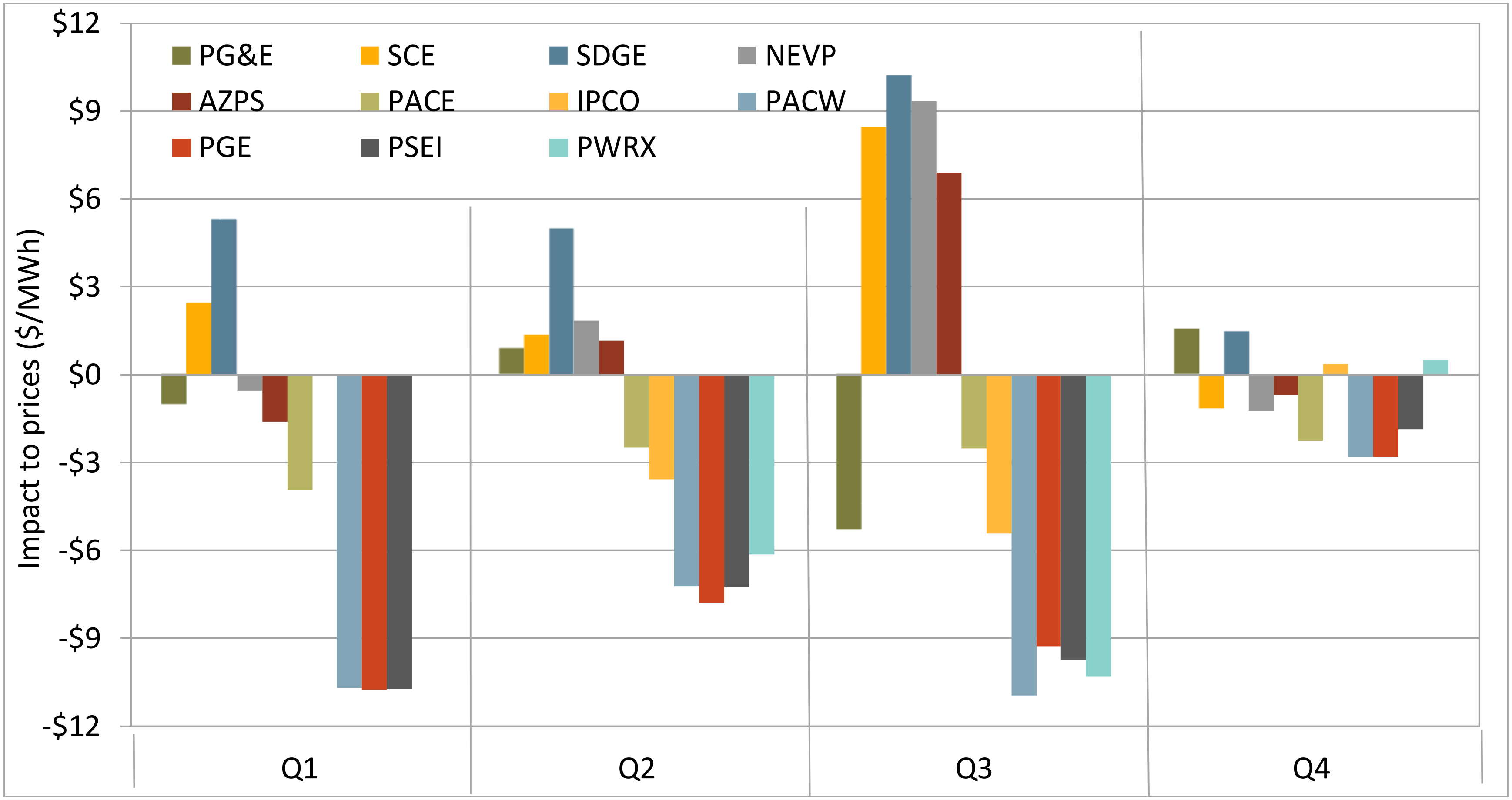
Average daily prices for electricity and natural gas (2018)



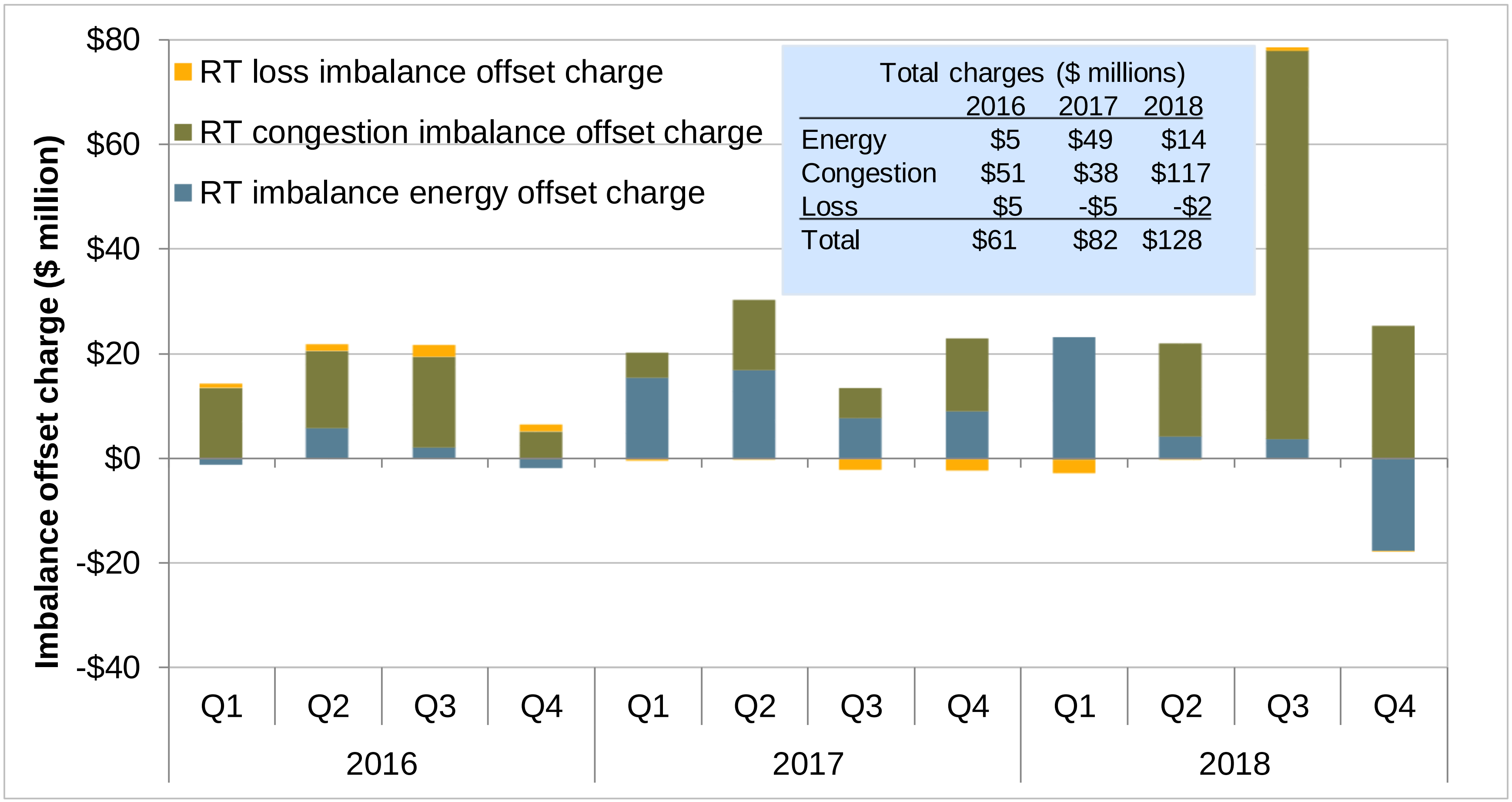
Overall impact of congestion on prices in different areas increased in the day-ahead market.



Congestion in the 15-minute market tended to lower prices in northwest EIM balancing areas relative to southern EIM balancing areas.



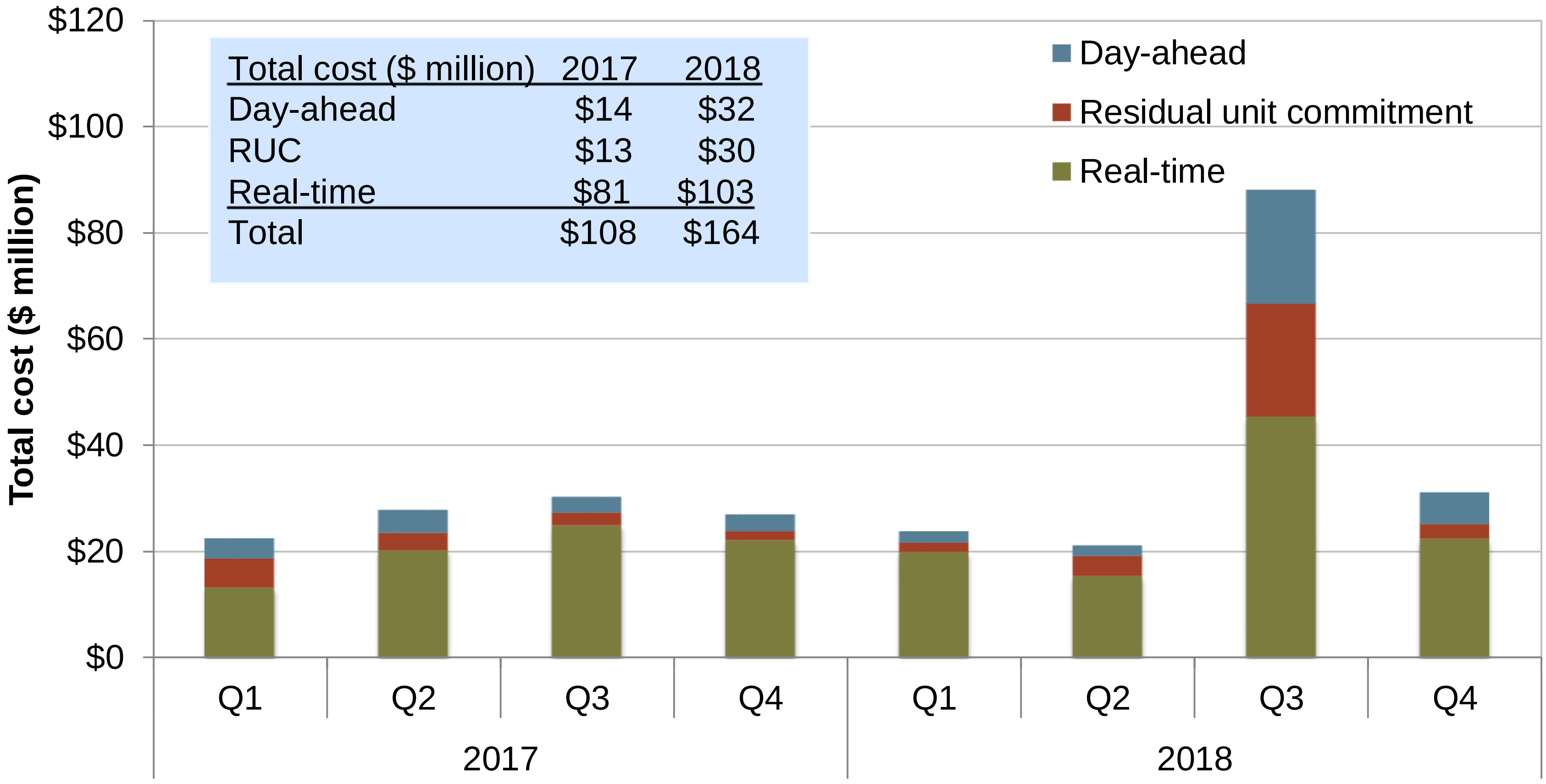
Real-time imbalance offset costs increased by 56% to $128 million.



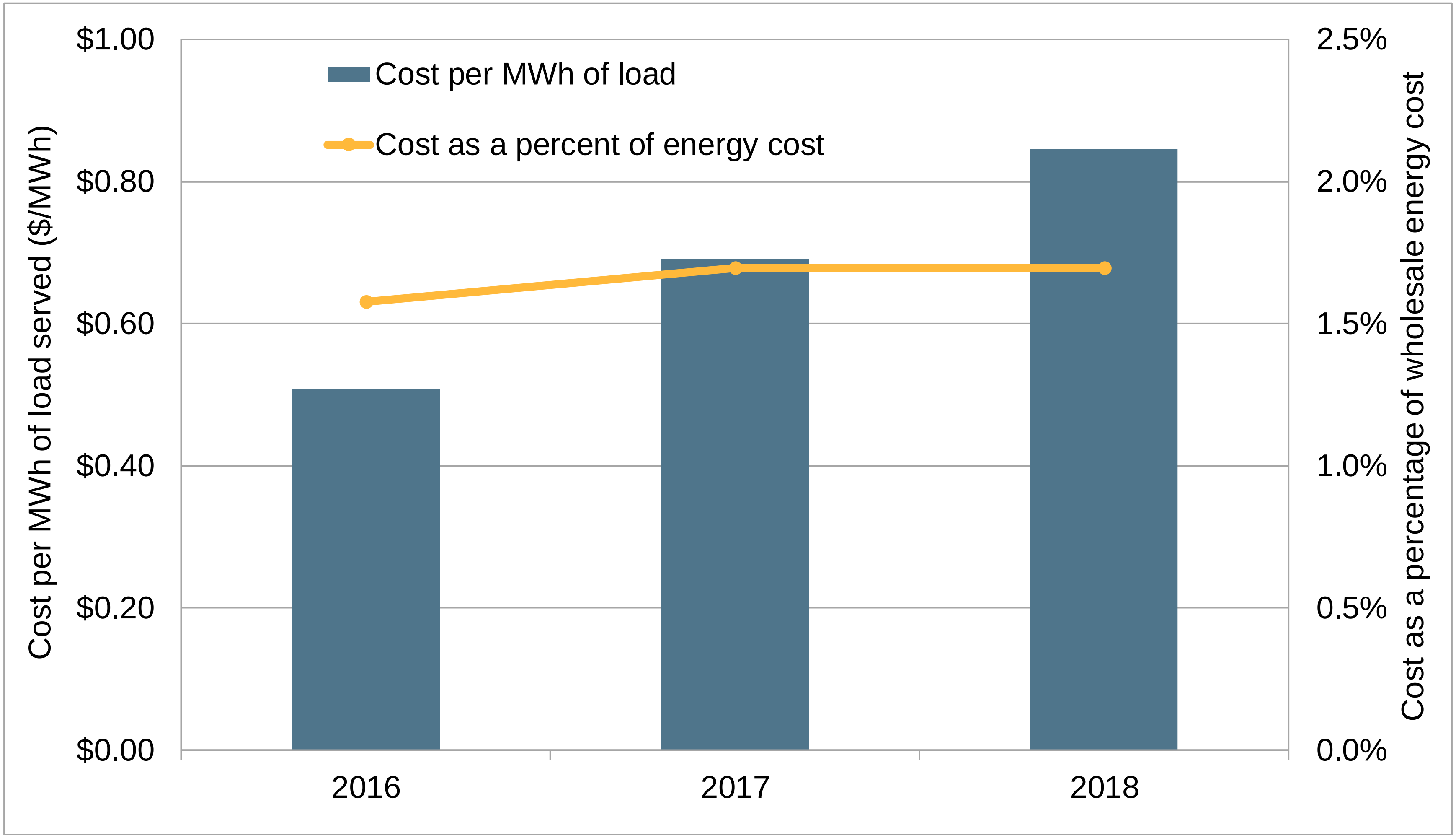
Total charges ($ millions)

	2016	2017	2018
Energy	$5	$49	$14
Congestion	$51	$38	$117
Loss	$5	-$5	-$2
Total	$61	$82	$128

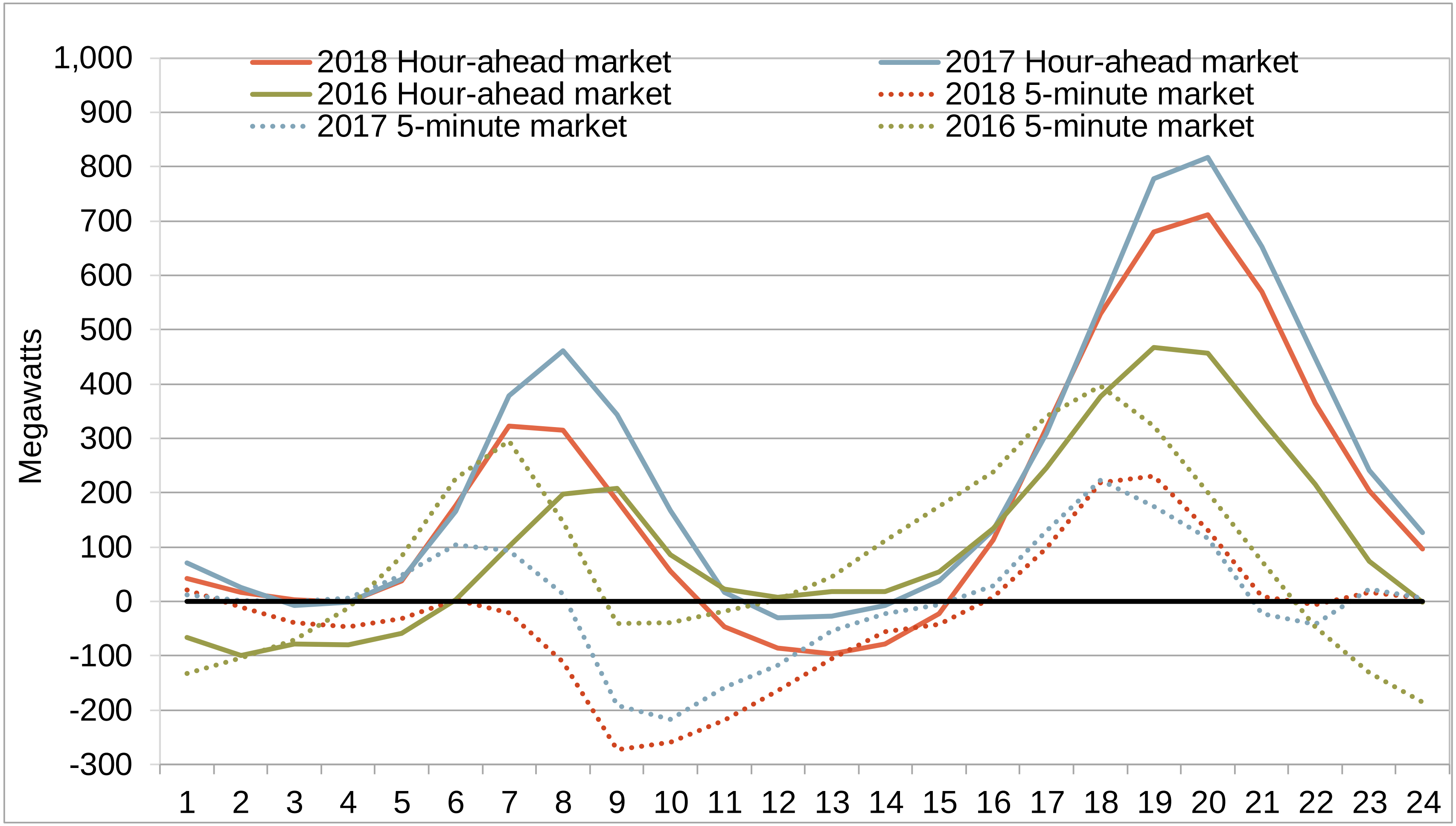
Bid cost recovery payments in the CAISO increased to $153 million or about 1.4 percent of total energy costs.



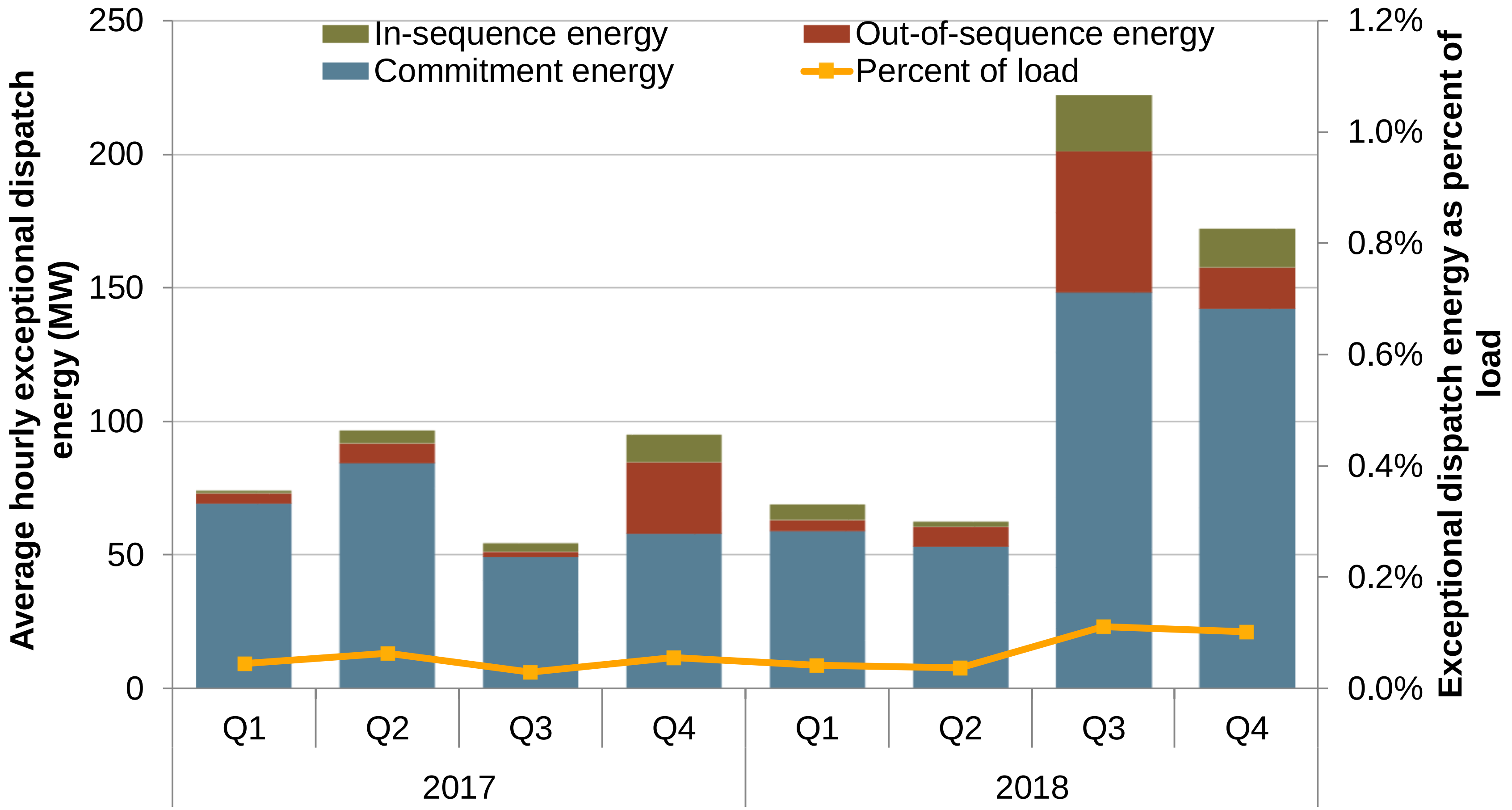
Ancillary service costs increased to $189 million, but remained at about 1.7% of wholesale energy costs.



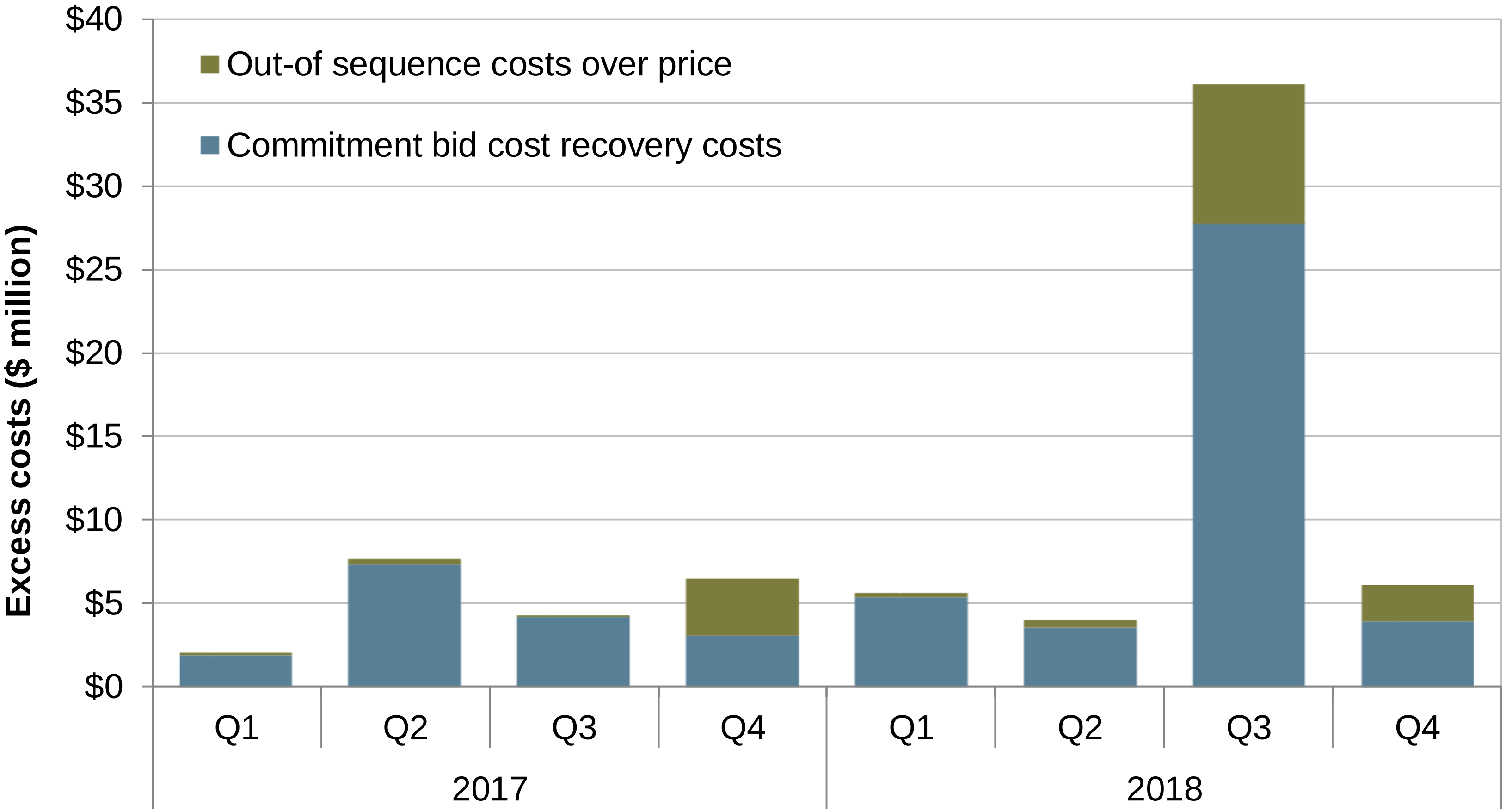
Load adjustment by grid operators remained high, particularly in ramping hours.



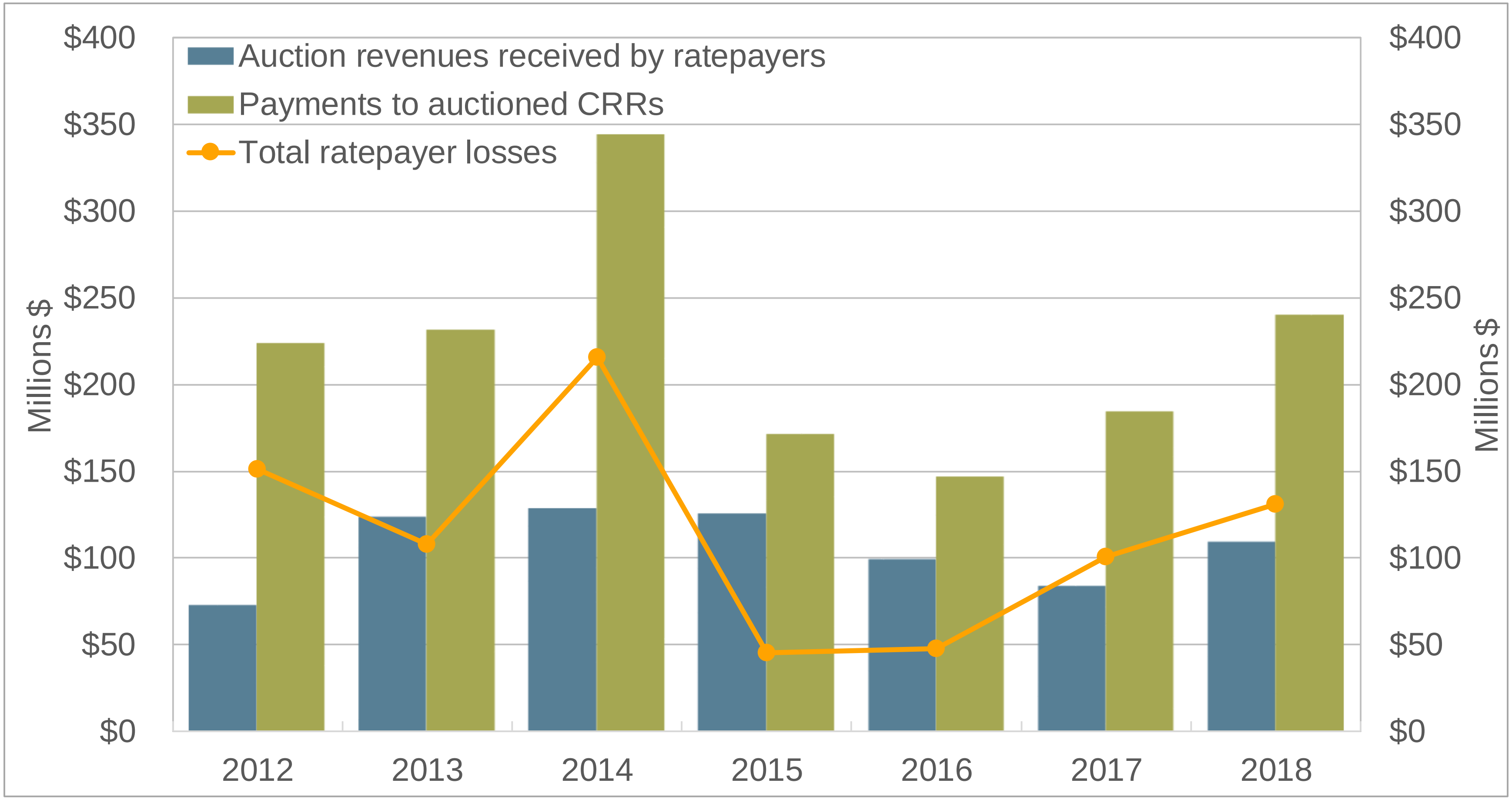
Total energy from exceptional dispatches increased in 2018 but account for a low portion of system load (.07%)



Above-market cost of exceptional dispatch increased over 150% to $52 million, but bid mitigation avoided about $18 million in “as bid” energy costs.



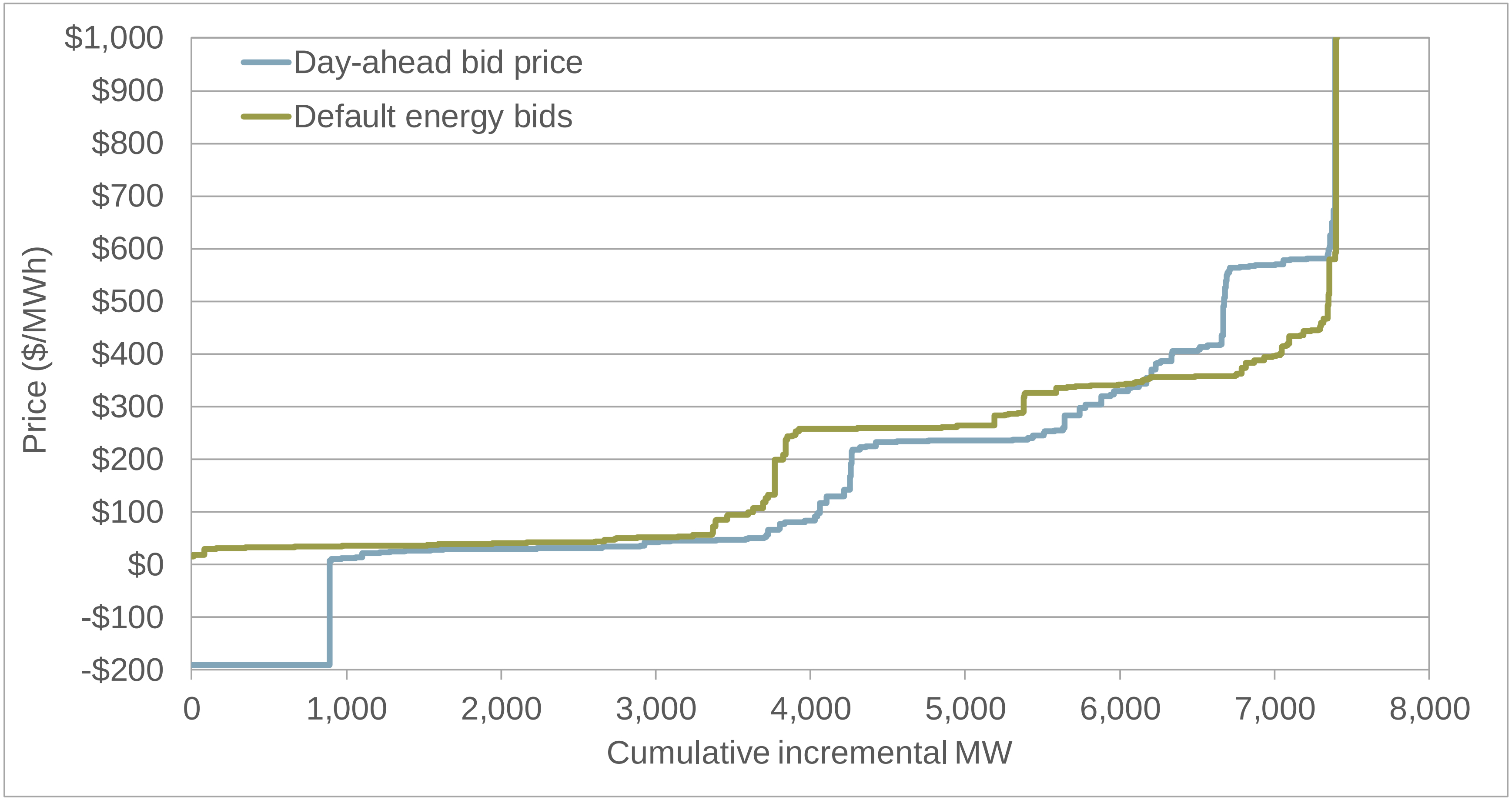
Transmission ratepayers lost over $131 million from auctioned CRRs in 2018 (>$866 million since 2009)



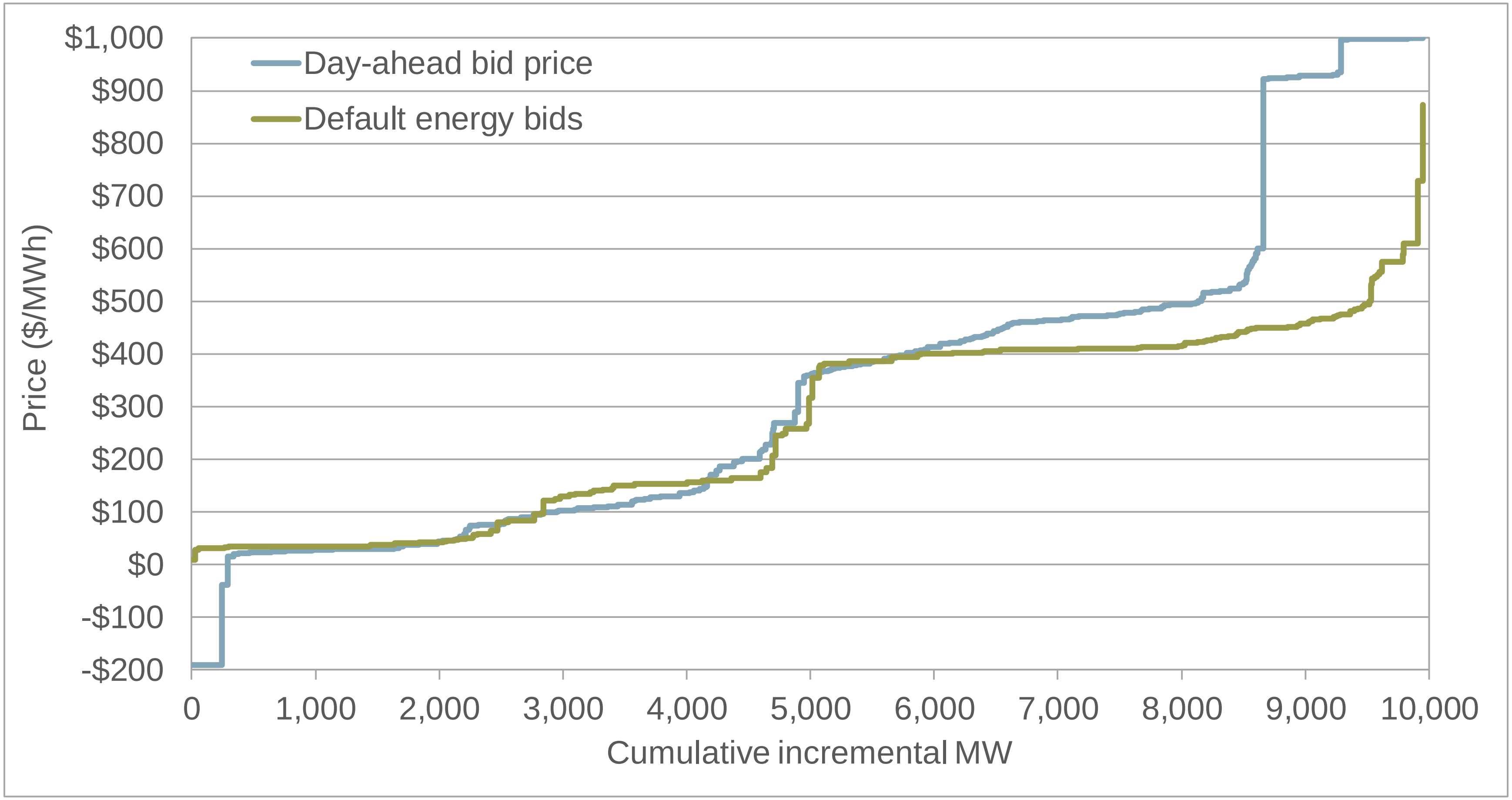
Market competitiveness

- CAISO's energy markets were generally competitive in 2018.
- Prices in the day-ahead market were significantly in excess of competitive levels in some hours when net load that must be met by gas-fired units is highest
  - Price cost markup
  - Highest cost of gas units dispatched
  - Day-ahead market software simulation
- Market for capacity needed to meet local requirements is structurally uncompetitive in almost all local areas.

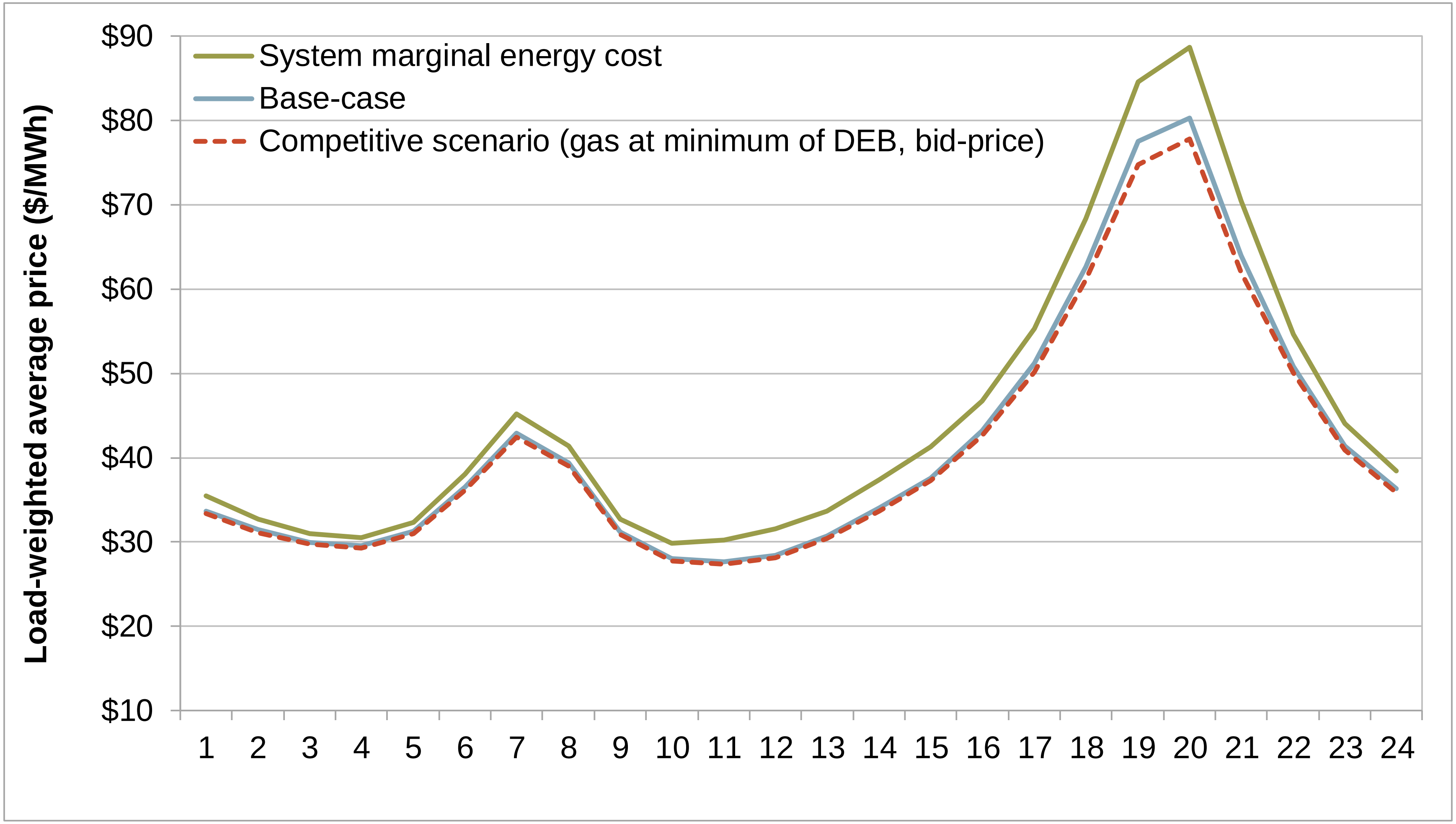
Net buyers' supply bids vs. default energy bids for gas units (July 24, 2018 hour 20).



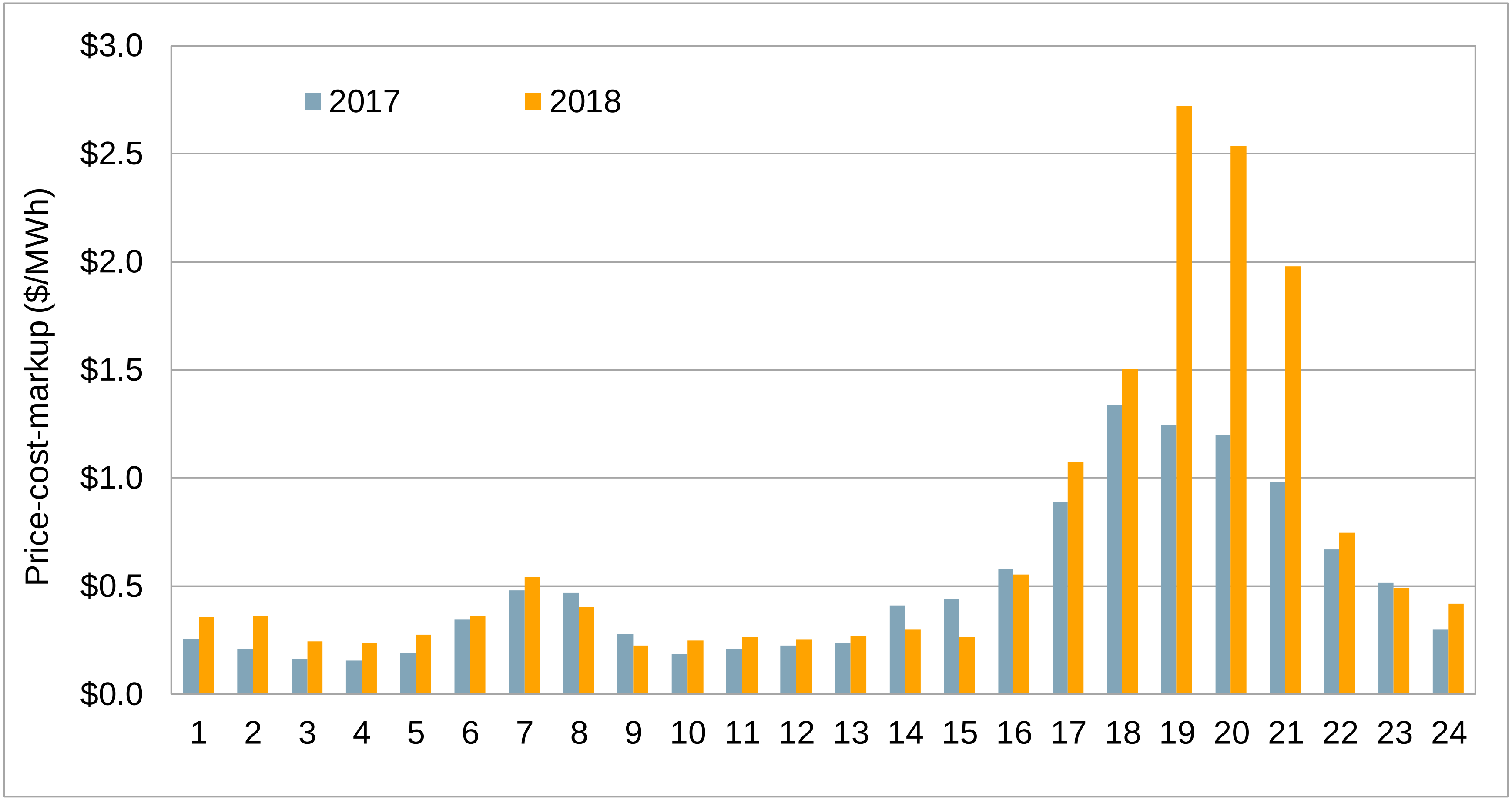
Net seller' supply bids vs. default energy bids for gas units (July 24, 2018 hour 20).



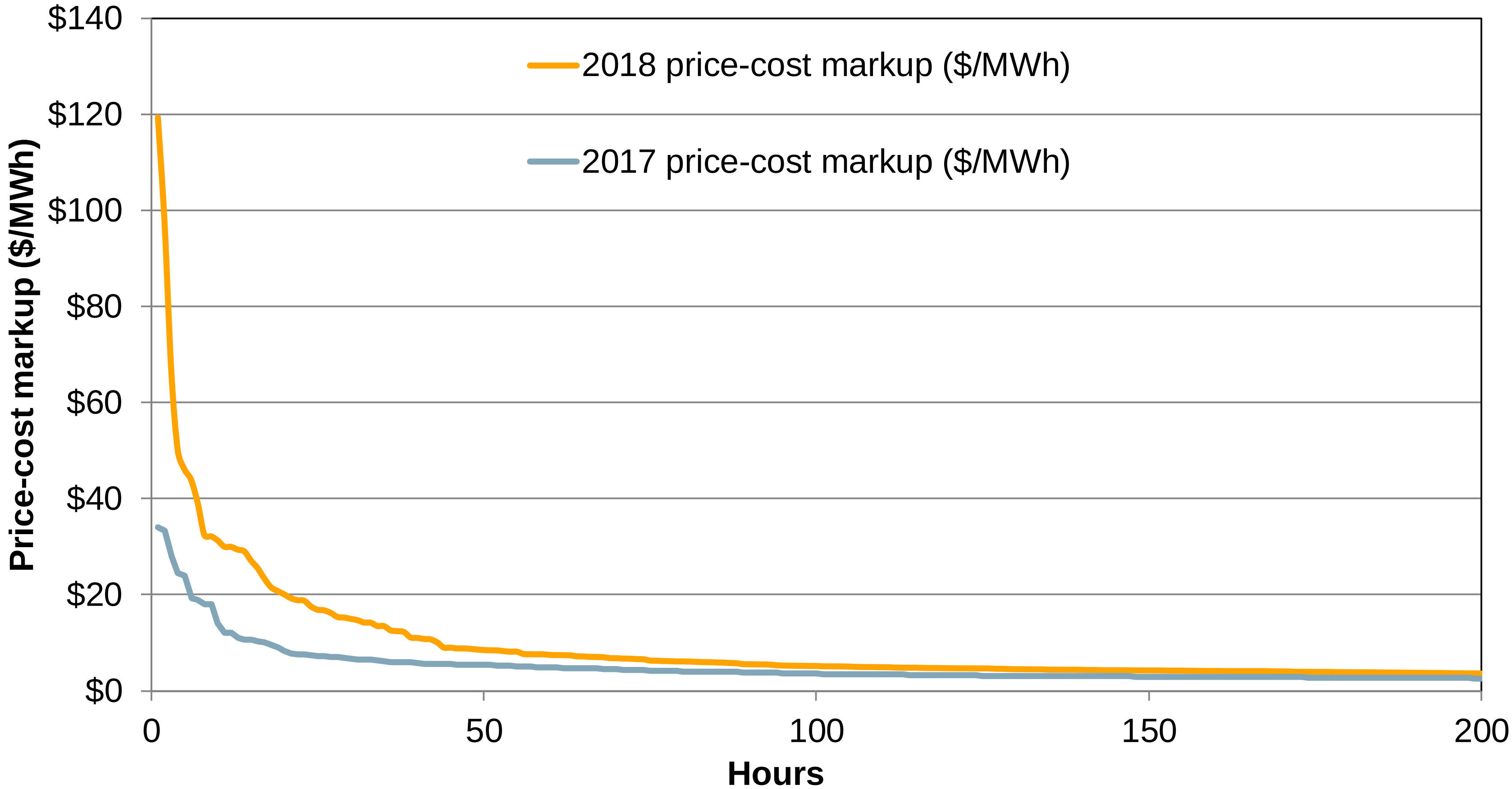
Average system marginal price compared to base case price and competitive scenario price (2018)



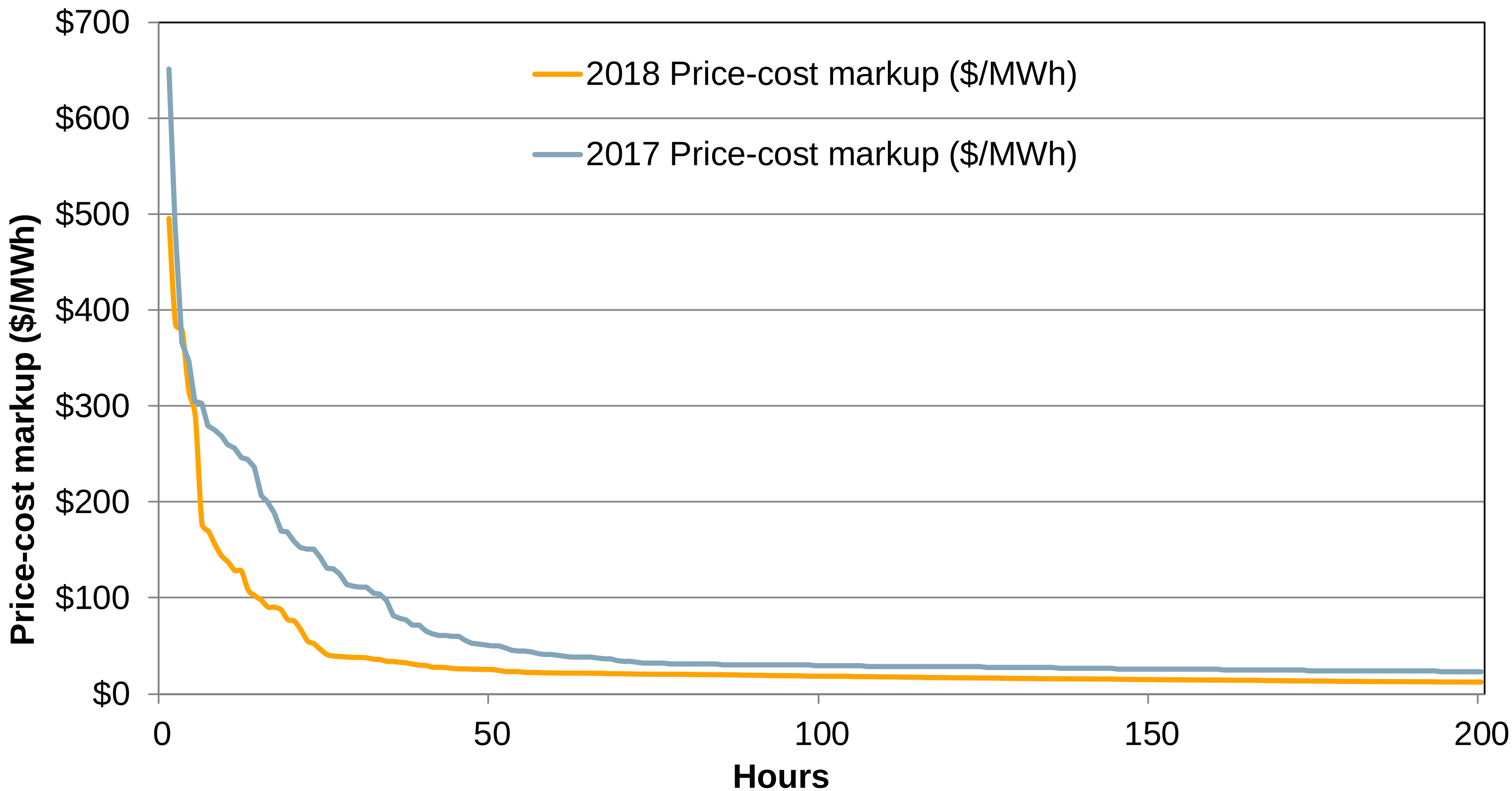
Average hourly price-cost markup is highest in evening ramping hours (HE 17-21).



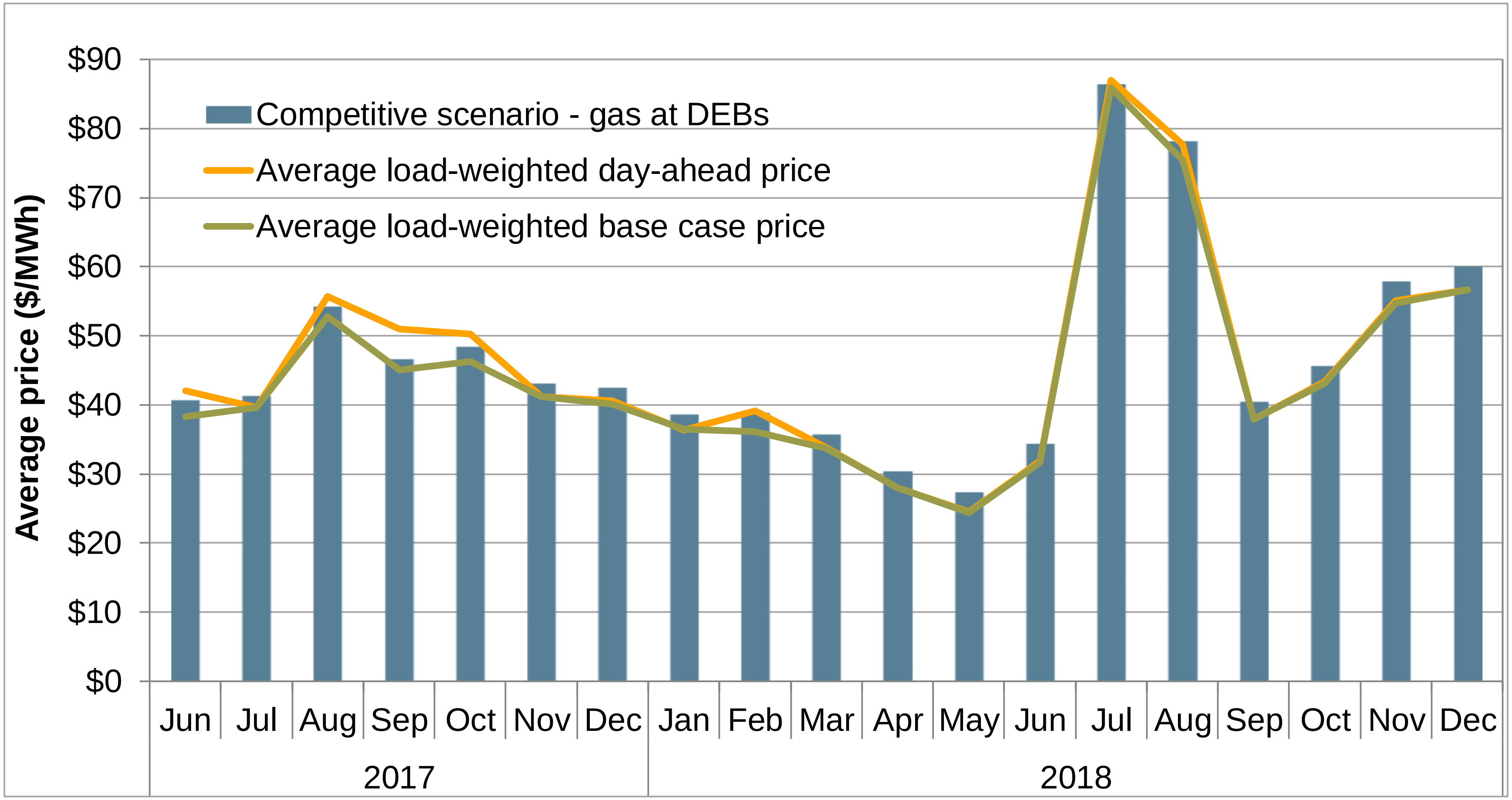
Duration curve of highest hourly price-cost markups



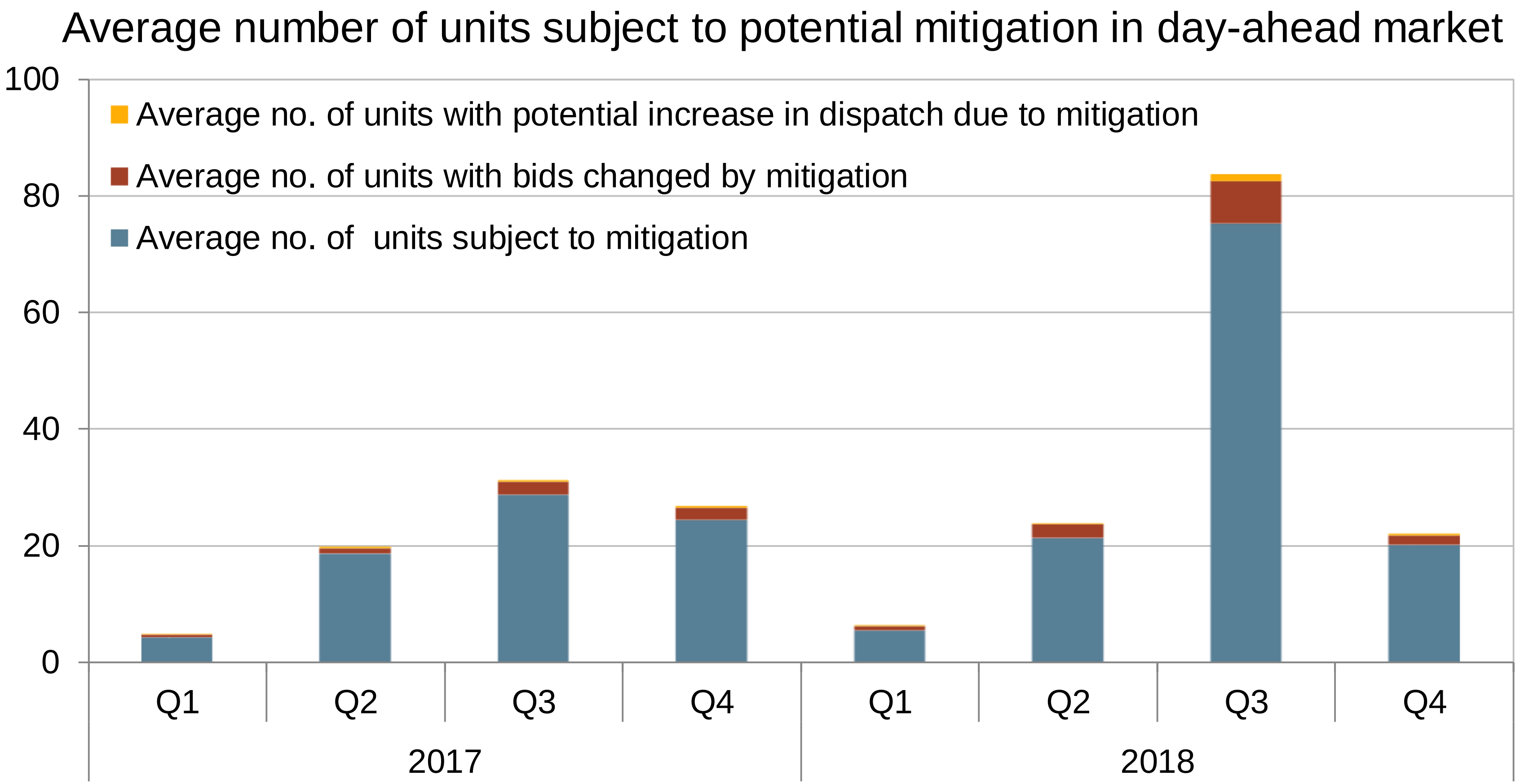
Price-cost markup based on highest cost gas-fired unit dispatched each hour (2017-2018).



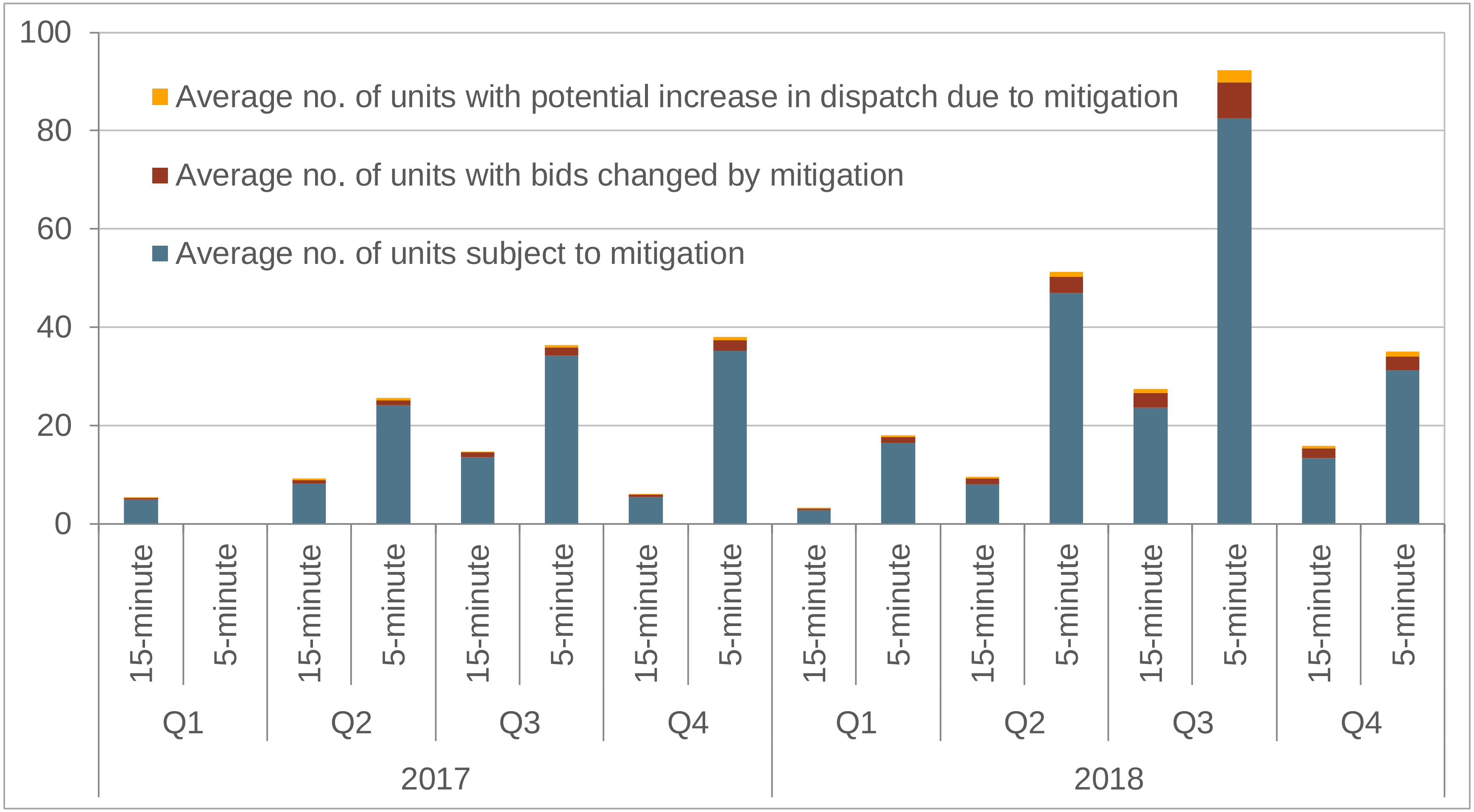
Comparison of competitive baseline price with day-ahead prices (using day-ahead market software).



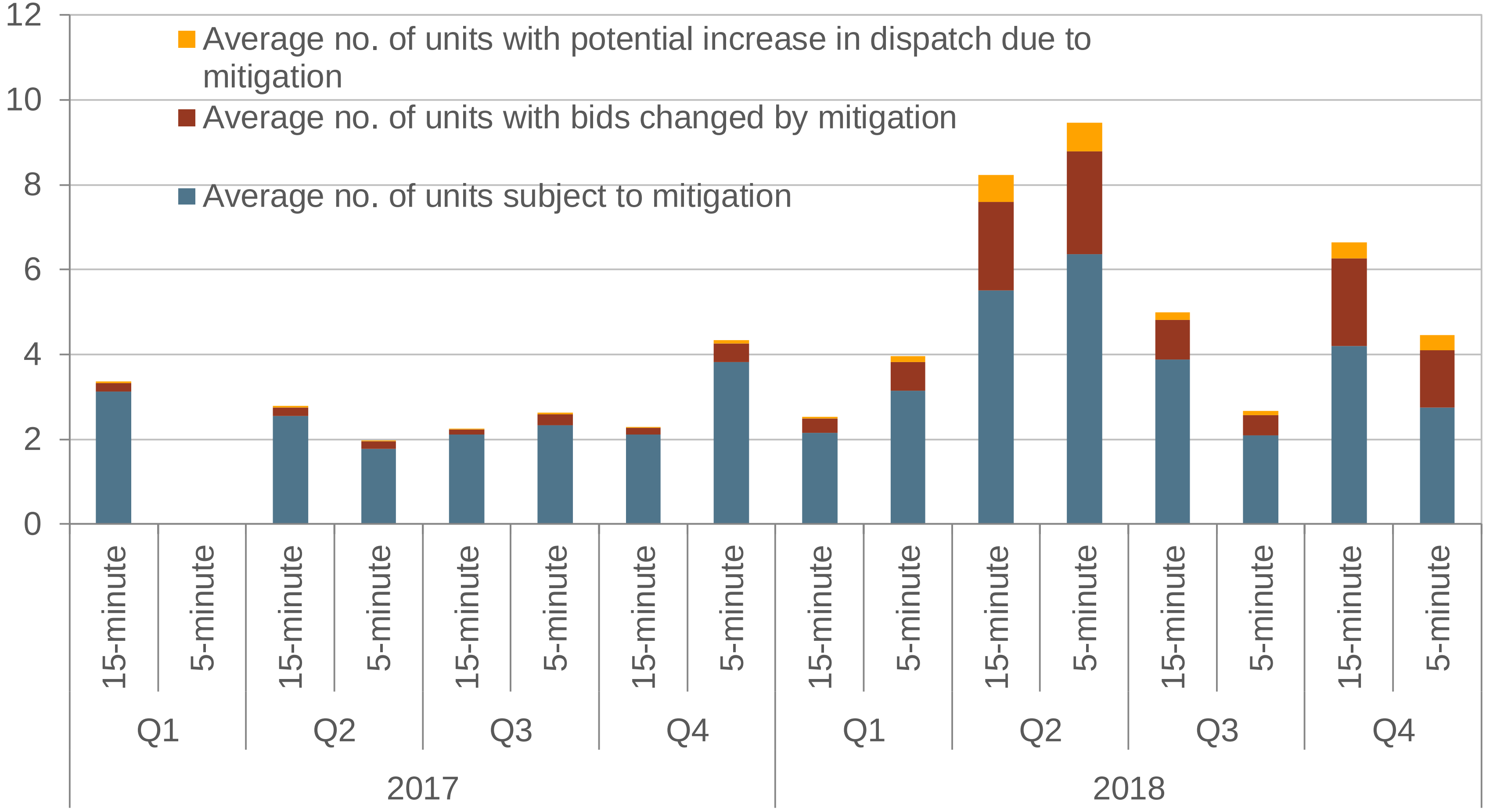
Frequency and impact of local market power bid mitigation provisions increased in 2018, but remained relatively low overall.



Average number of units subject to potential mitigation in 15-minute and 5-minute market (CAISO)

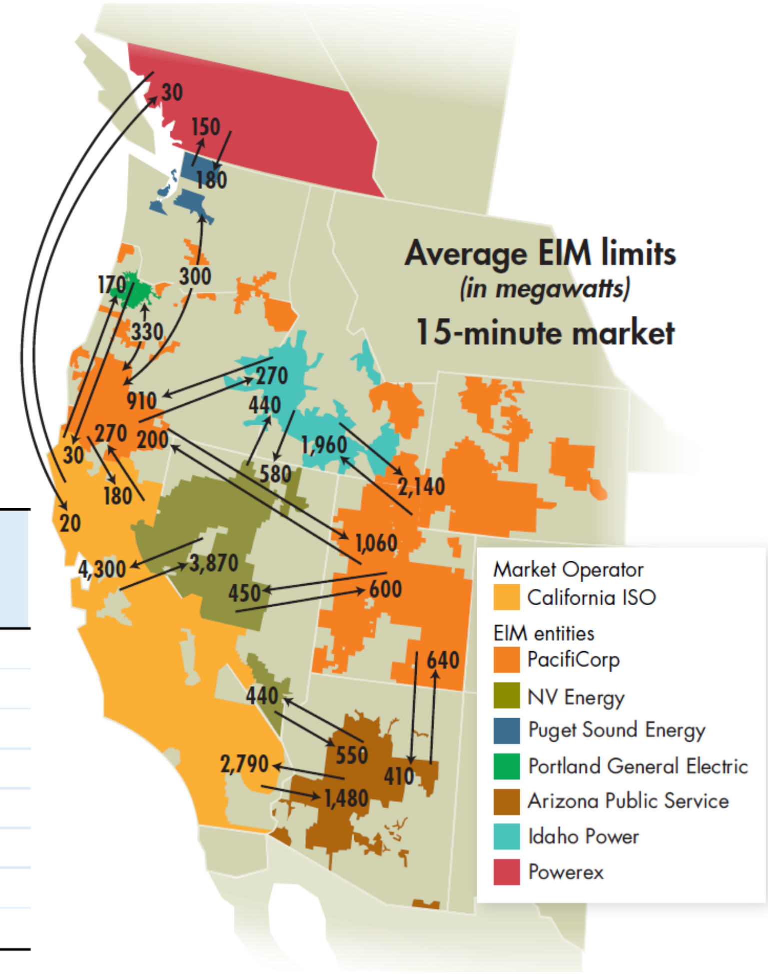


Average number of units subject to potential mitigation in 15-minute and 5-minute market (EIM)

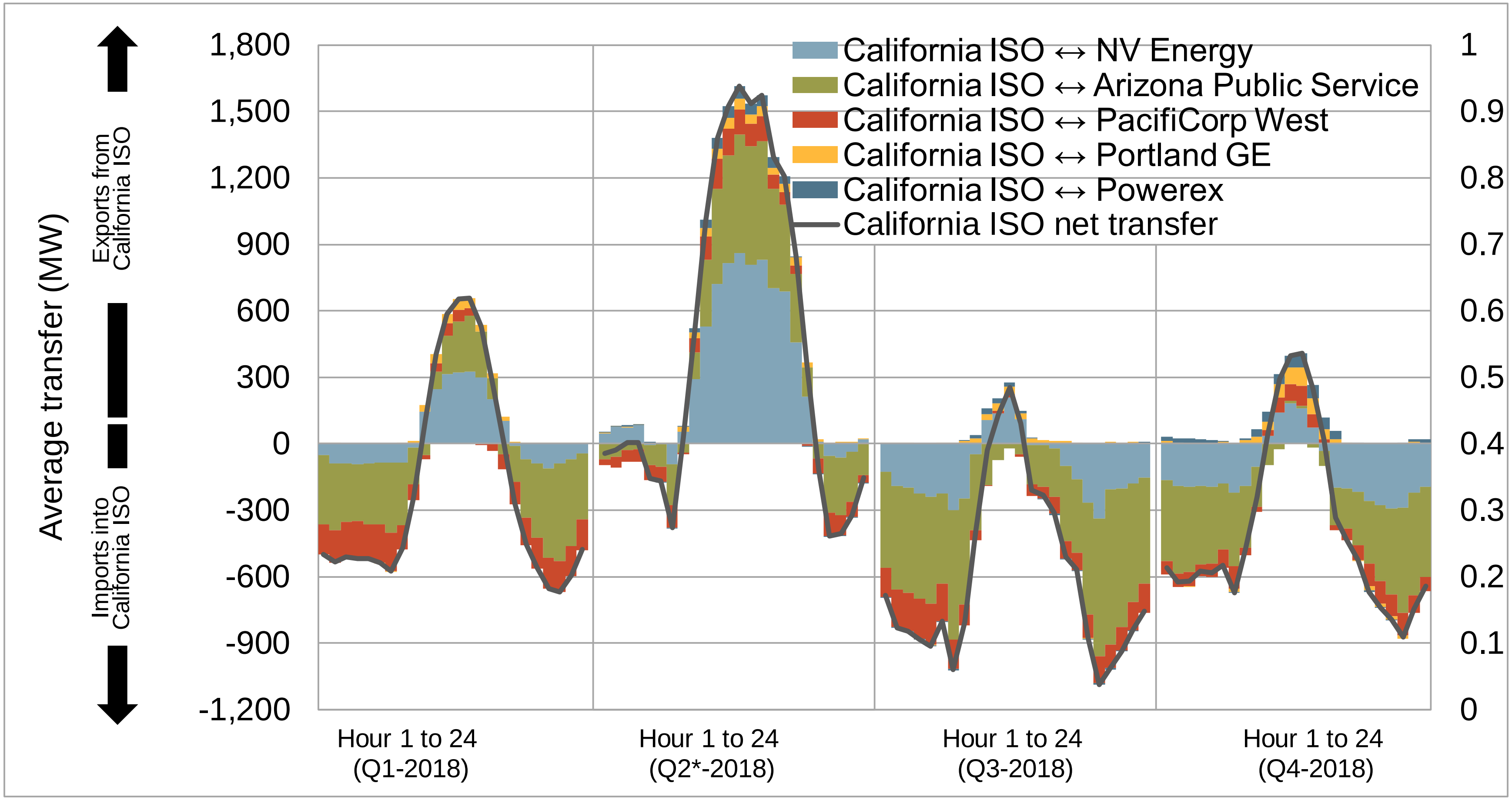


Energy imbalance market expansion improved performance of real-time market.

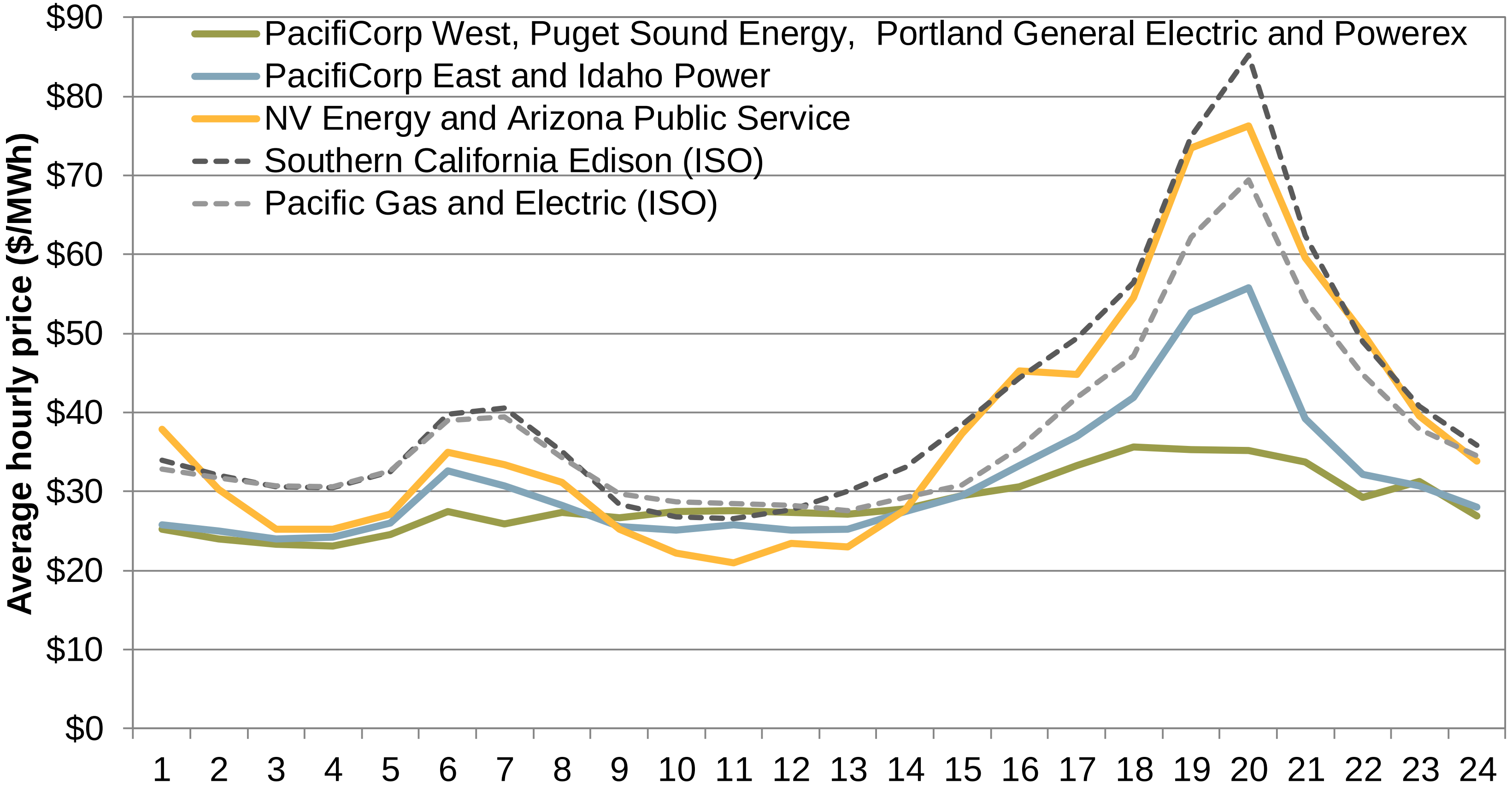
	15-minute market		5-minute market	
	Congested toward ISO	Congested from ISO	Congested toward ISO	Congested from ISO
NV Energy	3%	3%	3%	2%
Arizona Public Service	3%	3%	2%	3%
PacifiCorp East	10%	2%	8%	3%
Idaho Power*	6%	5%	3%	6%
PacifiCorp West	39%	3%	31%	6%
Portland General Electric	39%	4%	32%	7%
Puget Sound Energy	39%	7%	32%	9%
Powerex*	31%	30%	16%	24%



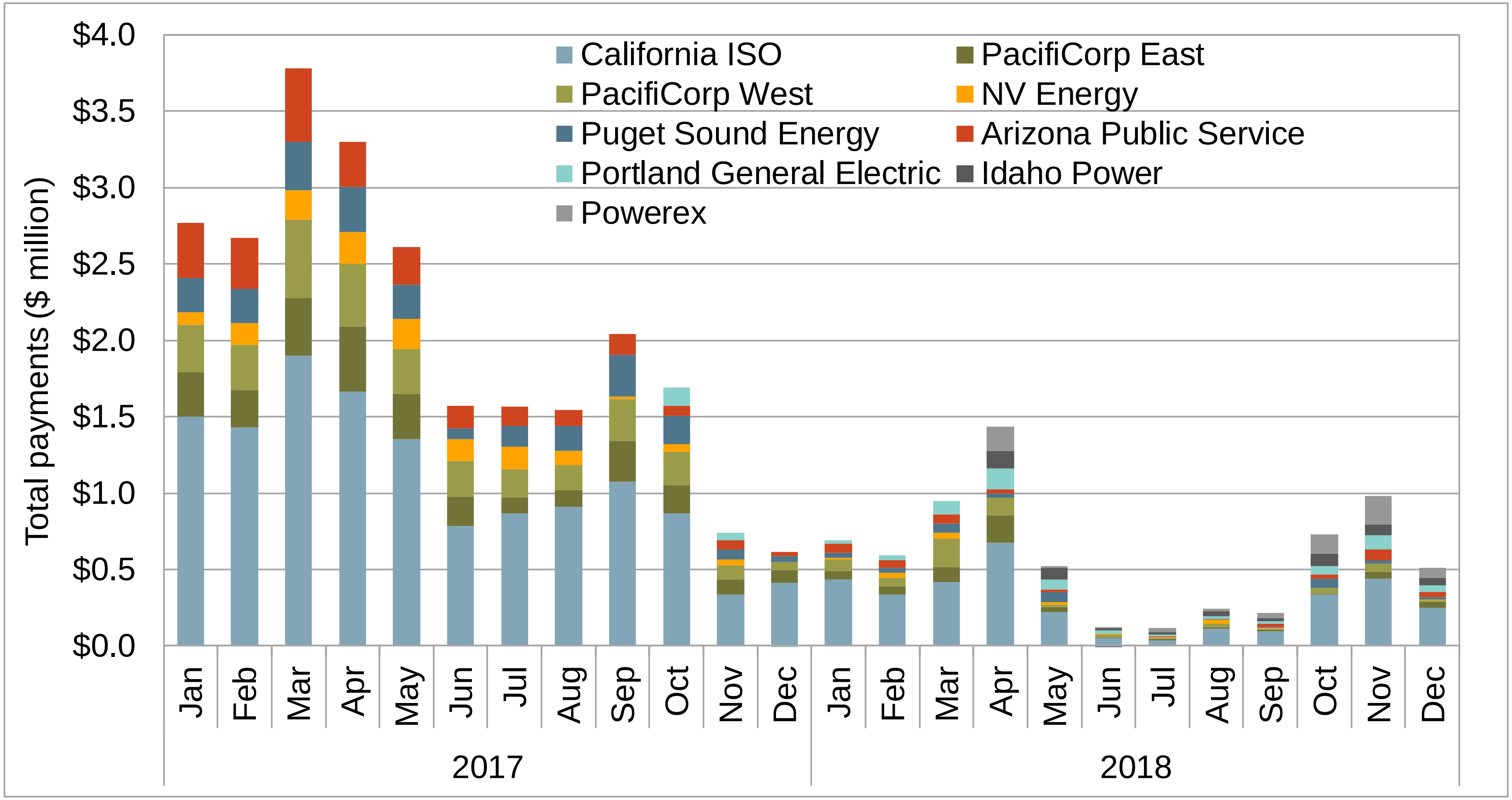
CAISO tends to export energy in EIM during peak solar hours, and import energy in other hours.



Hourly 15-minute market prices in EIM and CAISO (April 4-December 31, 2018)



Monthly flexible ramping payments by balancing area



Recommendations

- Update real-time market bid caps based on same-day gas market prices and conditions.
- Gas usage nomograms need improvement if CAISO plans on continued use of these constraints.
- Clarify/enhance rules for resource adequacy requirements met by import capacity.
- Consider options for reducing/mitigating potential system market power.
- Review/modify capacity procurement mechanism (CPM).
- Begin to develop mitigation rules for battery storage resources.