# Congestion and Marginal Losses

The locational marginal price (LMP) is the incremental price of energy at a bus. The LMP at a bus is made up of three components: the system marginal price or energy component (SMP), the congestion component of LMP (CLMP), and the marginal loss component of LMP (MLMP).[1]

SMP, MLMP and CLMP are products of the least cost, security constrained dispatch of system resources to meet system load. SMP is the incremental cost of energy, given the current dispatch and given the choice of reference bus, or LMP net of losses and congestion. Losses refer to energy lost to physical resistance in the transmission network as power is moved from generation to load. Total losses refer to the total system-wide transmission losses as a result of moving power from injections to withdrawals on the system. Marginal losses are the incremental change in system losses caused by changes in load and generation. Congestion occurs when available, least-cost energy cannot be delivered to all load because transmission facilities are not adequate to deliver that energy to one or more areas, and higher cost units in the constrained area(s) must be dispatched to meet the load.[2] The result is that the price of energy in the constrained area(s) is higher than in the unconstrained area.

Congestion is neither good nor bad, but is a direct measure of the extent to which there are multiple marginal generating units dispatched to serve load as a result of transmission constraints.

The energy, marginal losses and congestion metrics must be interpreted carefully. The term total congestion refers to what is actually net congestion, which is calculated as net implicit congestion costs plus net explicit congestion costs plus net inadvertent congestion charges. The net implicit congestion costs are the load congestion payments less generation congestion credits. This section refers to total energy costs and total marginal loss costs in the same way. As with congestion, total energy costs are more precisely termed net energy costs and total marginal loss costs are more precisely termed net marginal loss costs.

The components of LMP are the basis for calculating participant and location specific congestion and marginal losses.[3]

## Overview

### Congestion Cost

- **Total Congestion.** Total congestion costs increased by $1,050.2 million or 564.8 percent, from $185.9 million in the first three months of 2013 to $1,236.1 million in the first three months of 2014. Total congestion costs increased because of the cold weather in January, which caused higher load and prices and an increased frequency of congestion.
- **Day-Ahead Congestion.** Day-ahead congestion costs increased by $1,101.5 million or 331.9 percent, from $331.9 million in the first three months of 2013 to $1,433.3 million in the first three months of 2014.
- **Balancing Congestion.** Balancing congestion costs decreased by $51.3 million or 35.1 percent, from -$145.9 million in the first three months of 2013 to -$197.2 million in the first three months of 2014.
- **Monthly Congestion.** Monthly total congestion costs in the first three months of 2014 ranged from $165.2 million in February to $825.2 million in January.
- **Geographic Differences in CLMP.** Differences in CLMP among eastern, southern and western control zones in PJM was primarily a result of congestion on the AP South Interface, the West Interface, the Breed – Wheatland flowgate, the Cloverdale transformer, and the Bedington - Black Oak Interface.
- **Congested Facilities.** Congestion frequency continued to be significantly higher in the Day-Ahead Energy Market than in the Real-Time Energy Market in the first three months of 2014. Day-ahead congestion frequency increased by 39.7 percent from 81,378 congestion event hours in the

1 On June 1, 2013, PJM integrated the East Kentucky Power Cooperative (EKPC) Control Zone. The metrics reported in this section treat EKPC as part of MISO for the first hour of June 2013 and as part of PJM for the second hour of June through June 2013.

2 This is referred to as dispatching units out of economic merit order. Economic merit order is the order of all generator offers from lowest to highest cost. Congestion occurs when loadings on transmission facilities mean the next unit in merit order cannot be used and a higher cost unit must be used in its place. Dispatch within the constrained area follows merit order for the units available to relieve the constraint.

3 The total congestion and marginal losses were calculated as of April 18, 2014, and are subject to change, based on continued PJM billing updates.

first three months of 2013 to 113,666 congestion event hours in the first three months of 2014. Day-ahead, congestion-event hours increased on all types of congestion facilities.

Real-time congestion frequency increased by 71.3 percent from 5,923 congestion event hours in the first three months of 2013 to 10,144 congestion event hours in the first three months of 2014. Real-time, congestion-event hours increased on all types of congestion facilities.

The AP South Interface was the largest contributor to congestion costs in the first three months of 2014. With $436.9 million in total congestion costs, it accounted for 35.3 percent of the total PJM congestion costs in the first three months of 2014.

- **Zonal Congestion.** AEP had the largest total congestion cost among all control zones in the first three months of 2014. AEP had -$710.8 million in total load congestion payments, -$1,088.3 million in total generation congestion credits and -$53.5 million in explicit congestion costs, resulting in $324.1 million in net congestion costs. The AP South interface, the West Interface, the Breed – Wheatland, Monticello - East Winamac and the Benton Harbor – Palisades flowgates contributed $253.4 million, or 78.2 percent of the total AEP Control Zone congestion costs.
- Ownership. In the first three months of 2014, financial companies as a group were net recipients of congestion credits, and physical companies were net payers of congestion charges. UTCs are in the explicit cost category and comprise most of that category. Explicit costs are the primary source of congestion credits to financial entities. In the first three months of 2014, financial companies received $190.8 million, an increase of $162.4 million or 571.9 percent compared to the first three months of 2013. In the first three months of 2014, physical companies paid $1,426.9 million in congestion charges, an increase of $1,212.6 million or 565.8 percent compared to the first three months of 2013.

## Marginal Loss Cost

- **Total Marginal Loss Costs.** Total marginal loss costs increased by $498.3 million or 179.5 percent, from $277.6 million in the first three months of 2013 to $775.9 million in the first three months of 2014. Total marginal loss costs increased because of the cold weather in January, which caused higher load and prices and an increased level of losses. The loss component of LMP increased 35.9 percent, from $0.02 in the first three months of 2013 to $0.03 in the first three months of 2014. The loss MW in PJM increased 13.8 percent, from 5,352 GWh in the first three months of 2013 to 4,705 GWh in the first three months of 2013.
- **Day-Ahead Marginal Loss Costs.** Day-ahead marginal loss costs increased by $535.0 million or 180.6 percent, from $296.2 million in the first three months of 2013 to $831.1 million in the first three months of 2014.
- **Balancing Marginal Loss Costs.** Balancing marginal loss costs decreased by $36.6 million or 196.5 percent, from -$18.6 million in the first three months of 2013 to -$55.3 million in the first three months of 2013.
- **Monthly Total Marginal Loss Costs.** Marginal loss costs in the first three months of 2014 increased compared to the first three months of 2013, by 310.3 percent in January, 114.4 percent in February and 95.3 percent in March. Monthly total marginal loss costs in the first three months of 2014 ranged from $175.4 million in March to $414.6 million in January.
- **Marginal Loss Credits.** Marginal loss credits are calculated as total energy costs (net energy costs minus net energy credits plus net inadvertent energy charges) plus total marginal loss costs (net marginal loss costs minus net marginal loss credits plus net explicit loss costs plus net inadvertent loss charges) plus net residual market adjustments. Marginal loss credit or loss surplus is the remaining loss amount from overcollection of marginal losses, after accounting for total net energy costs and net residual market adjustments, which is paid back in full to load and exports on a load ratio basis.[4] The marginal loss credits increased in the first three months of 2014 by $158.0 million or 158.9 percent, from $99.4 million in the first three months of 2013, to $257.4 million in the first three months of 2014.

4 See PJM. "Manual 28: Operating Agreement Accounting," Revision 64 (April 11, 2014), pp 63-64. Note that the overcollection is not calculated by subtracting the prior calculation of average losses from the calculated total marginal losses.

## Energy Cost

- **Total Energy Costs.** Total energy costs decreased by $337.3 million or 189.6 percent, from -$177.9 million in the first three months of 2013 to -$515.1 million in the first three months of 2014.
- **Day-Ahead Energy Costs.** Day-ahead energy costs decreased by $477.1 million or 246.3 percent, from -$193.7 million in the first three months of 2013 to -$670.9 million in the first three months of 2014.
- **Balancing Energy Costs.** Balancing energy costs increased by $146.8 million or 924.9 percent, from $15.9 million in the first three months of 2013 to $162.6 million in the first three months of 2014.
- **Monthly Total Energy Costs.** Monthly total energy costs in the first three months of 2014 ranged from -$272.5 million in January to -$119.6 million in March.

## Conclusion

Congestion reflects the underlying characteristics of the power system, including the nature and capability of transmission facilities, the offers and geographic distribution of generation facilities, the level and geographic distribution of incremental bids and offers and the geographic and temporal distribution of load.

ARRs and FTRs served as an effective, but not total, offset against congestion in 2013. ARR and FTR revenues offset 97.5 percent of the total congestion costs in the Day-Ahead Energy Market and the balancing energy market within PJM for the first ten months of the 2013 to 2014 planning period. In the 2012 to 2013 planning period, total ARR and FTR revenues offset 92.6 percent of the congestion costs.

# Locational Marginal Price (LMP)

## Components

Table 11-1 shows the PJM real-time, load-weighted average LMP components for the first three months of 2009 to 2014. The load-weighted average real-time LMP increased $55.57 or 148.5 percent from $37.41 in the first three months of 2013 to $92.98 in the first three months of 2014. The load-weighted average congestion component decreased $0.15 or 701.0 percent from $0.02 in the first three months of 2013 to -$0.13 in the first three months of 2014. The load-weighted average loss component increased $0.01 or 35.9 percent from $0.02 in the first three months of 2013 to $0.03 in the first three months of 2014. The load-weighted average energy component increased $55.71 or 149.1 percent from $37.37 in the first three months of 2013 to $93.08 in the first three months of 2014. Given that these results are based on system average LMP including offsetting congestion components, a congestion component near zero is expected.

**Table 11-1 PJM real-time, load-weighted average LMP components (Dollars per MWh): January through March of 2009 through 2014[5]**

| (Jan-Mar) | Real-Time LMP | Energy Component | Congestion Component | Loss Component |
|---|---|---|---|---|
| 2009 | $49.60 | $49.51 | $0.05 | $0.04 |
| 2010 | $45.92 | $45.81 | $0.06 | $0.05 |
| 2011 | $46.35 | $46.30 | $0.03 | $0.03 |
| 2012 | $31.21 | $31.18 | $0.02 | $0.00 |
| 2013 | $37.41 | $37.37 | $0.02 | $0.02 |
| 2014 | $92.98 | $93.08 | ($0.13) | $0.03 |

5 Calculated values shown in Section 11, "Congestion and Marginal Losses," are based on unrounded, underlying data and may differ from calculations based on the rounded values in the tables.

Table 11-2 shows the PJM day-ahead, load-weighted average LMP components for the first three months of 2009 through 2014. The load-weighted average day-ahead LMP increased $57.71 or 154.9 percent from $37.26 in the first three months of 2013 to $94.97 in the first three months of 2014. The load-weighted average congestion component increased $0.36 or 549.0 percent from $0.07 in the first three months of 2013 to $0.43 in the first three months of 2014. The load-weighted average loss component decreased $0.01 or 67.2 percent from $0.01 in the first three months of 2013 to $0.00 in the first three months of 2014. The load-weighted average energy component increased $57.34 or 154.2 percent from $37.19 in the first three months of 2013 to $94.52 in the first three months of 2014.

### Table 11-2 PJM day-ahead, load-weighted average LMP components (Dollars per MWh): January through March of 2009 through 2014

| (Jan-Mar) | Day-Ahead LMP | Energy Component | Congestion Component | Loss Component |
|---|---|---|---|---|
| 2009 | $49.44 | $49.75 | ($0.18) | ($0.13) |
| 2010 | $47.77 | $47.74 | $0.01 | $0.02 |
| 2011 | $47.14 | $47.36 | ($0.11) | ($0.11) |
| 2012 | $31.51 | $31.45 | $0.08 | ($0.03) |
| 2013 | $37.26 | $37.19 | $0.07 | $0.01 |
| 2014 | $94.97 | $94.52 | $0.43 | $0.00 |

## Zonal Components

The real-time components of LMP for each control zone are presented in Table 11-3 for the first three months of 2013 and the first three months of 2014.

### Table 11-3 Zonal and PJM real-time, load-weighted average LMP components (Dollars per MWh): January through March of 2013 and 2014

| | 2013 (Jan-Mar) | | | | 2014 (Jan-Mar) | | | |
|---|---|---|---|---|---|---|---|---|
| | Real-Time LMP | Energy Component | Congestion Component | Loss Component | Real-Time LMP | Energy Component | Congestion Component | Loss Component |
| AECO | $38.44 | $37.27 | ($0.43) | $1.60 | $108.65 | $91.45 | $12.48 | $4.71 |
| AEP | $35.34 | $37.35 | ($1.09) | ($0.92) | $74.34 | $93.18 | ($15.80) | ($3.04) |
| AP | $36.97 | $37.43 | ($0.41) | ($0.04) | $90.46 | $93.85 | ($4.12) | $0.73 |
| ATSI | $35.70 | $37.21 | ($1.73) | $0.22 | $75.47 | $90.21 | ($15.29) | $0.55 |
| BGE | $42.02 | $37.59 | $2.52 | $1.91 | $128.07 | $95.95 | $27.14 | $4.99 |
| ComEd | $31.60 | $37.04 | ($3.36) | ($2.08) | $60.88 | $89.49 | ($22.49) | ($6.12) |
| DAY | $35.14 | $37.38 | ($2.13) | ($0.11) | $71.49 | $92.91 | ($20.25) | ($1.16) |
| DEOK | $33.20 | $37.35 | ($2.23) | ($1.92) | $68.06 | $93.47 | ($19.38) | ($6.02) |
| DLCO | $33.77 | $37.19 | ($2.12) | ($1.30) | $65.29 | $90.36 | ($21.91) | ($3.16) |
| Dominion | $40.68 | $37.69 | $2.54 | $0.45 | $121.48 | $97.23 | $23.49 | $0.76 |
| DPL | $39.53 | $37.63 | ($0.39) | $2.28 | $122.76 | $96.58 | $18.74 | $7.44 |
| EKPC | NA | NA | NA | NA | $74.73 | $99.98 | ($19.75) | ($5.50) |
| JCPL | $40.33 | $37.43 | $1.10 | $1.80 | $109.43 | $91.21 | $12.75 | $5.47 |
| Met-Ed | $38.12 | $37.46 | ($0.06) | $0.72 | $108.44 | $92.68 | $12.40 | $3.35 |
| PECO | $37.23 | $37.35 | ($1.20) | $1.08 | $108.92 | $92.45 | $12.48 | $3.99 |
| PENELEC | $38.10 | $37.29 | $0.30 | $0.52 | $87.94 | $91.06 | ($4.57) | $1.44 |
| Pepco | $42.05 | $37.62 | $3.05 | $1.39 | $128.56 | $95.53 | $29.46 | $3.58 |
| PPL | $37.61 | $37.46 | ($0.51) | $0.66 | $109.25 | $93.24 | $13.10 | $2.92 |
| PSEG | $47.59 | $37.21 | $8.88 | $1.50 | $115.99 | $90.43 | $20.17 | $5.39 |
| RECO | $53.46 | $37.33 | $14.74 | $1.39 | $114.01 | $90.54 | $18.25 | $5.23 |
| PJM | $37.41 | $37.37 | $0.02 | $0.02 | $92.98 | $93.08 | ($0.13) | $0.03 |

The day-ahead components of LMP for each control zone are presented in Table 11-4 for the first three months of 2013 and the first three months of 2014.

**Table 11-4 Zonal and PJM day-ahead, load-weighted average LMP components (Dollars per MWh): January through March of 2013 and 2014**

| | 2013 (Jan-Mar) | | | | 2014 (Jan-Mar) | | | |
|---|---|---|---|---|---|---|---|---|
| | Day-Ahead LMP | Energy Component | Congestion Component | Loss Component | Day-Ahead LMP | Energy Component | Congestion Component | Loss Component |
| AECO | $38.64 | $37.26 | ($0.30) | $1.68 | $116.60 | $92.85 | $19.45 | $4.30 |
| AEP | $34.99 | $37.19 | ($1.27) | ($0.92) | $78.00 | $96.48 | ($15.59) | ($2.89) |
| AP | $36.49 | $37.24 | ($0.75) | $0.01 | $88.22 | $94.17 | ($6.04) | $0.09 |
| ATSI | $35.53 | $37.14 | ($1.66) | $0.05 | $79.66 | $92.23 | ($13.21) | $0.64 |
| BGE | $41.70 | $37.33 | $2.52 | $1.85 | $128.50 | $97.10 | $27.32 | $4.08 |
| ComEd | $31.83 | $37.00 | ($2.82) | ($2.36) | $66.20 | $92.49 | ($21.90) | ($4.39) |
| DAY | $35.36 | $37.28 | ($1.74) | ($0.18) | $77.53 | $96.00 | ($17.64) | ($0.83) |
| DEOK | $33.41 | $37.09 | ($1.91) | ($1.77) | $72.57 | $93.99 | ($16.32) | ($5.10) |
| DLCO | $33.48 | $37.11 | ($2.34) | ($1.28) | $68.77 | $91.88 | ($19.62) | ($3.49) |
| Dominion | $40.25 | $37.48 | $2.32 | $0.45 | $110.58 | $98.10 | $12.74 | ($0.26) |
| DPL | $39.53 | $37.28 | ($0.12) | $2.37 | $128.99 | $96.70 | $25.90 | $6.39 |
| EKPC | NA | NA | NA | NA | $77.42 | $100.93 | ($18.00) | ($5.51) |
| JCPL | $40.62 | $37.28 | $1.32 | $2.02 | $121.82 | $93.97 | $22.11 | $5.74 |
| Met-Ed | $38.03 | $37.06 | $0.25 | $0.72 | $114.57 | $93.22 | $18.45 | $2.90 |
| PECO | $37.56 | $37.10 | ($0.68) | $1.14 | $116.42 | $93.68 | $18.90 | $3.84 |
| PENELEC | $38.25 | $37.13 | $0.30 | $0.82 | $92.74 | $92.89 | ($1.99) | $1.85 |
| Pepco | $41.64 | $37.22 | $3.02 | $1.39 | $124.74 | $95.99 | $25.80 | $2.95 |
| PPL | $37.66 | $37.15 | ($0.09) | $0.60 | $116.23 | $94.03 | $19.82 | $2.39 |
| PSEG | $46.55 | $37.20 | $7.51 | $1.85 | $128.85 | $93.02 | $30.13 | $5.70 |
| RECO | $50.35 | $37.27 | $11.50 | $1.58 | $124.00 | $91.14 | $27.45 | $5.41 |
| PJM | $37.26 | $37.19 | $0.07 | $0.01 | $94.97 | $94.52 | $0.43 | $0.00 |

## Hub Components

The real-time components of LMP for each hub are presented in Table 11-5 for the first three months of 2013 and the first three months of 2014.

### Table 11-5 Hub real-time, load-weighted average LMP components (Dollars per MWh): January through March of 2013 and 2014

| | 2013 (Jan-Mar) | | | | 2014 (Jan-Mar) | | | |
|---|---|---|---|---|---|---|---|---|
| | Real-Time LMP | Energy Component | Congestion Component | Loss Component | Real-Time LMP | Energy Component | Congestion Component | Loss Component |
| AEP Gen Hub | $33.03 | $37.34 | ($2.20) | ($2.11) | $61.39 | $88.23 | ($20.16) | ($6.68) |
| AEP-DAY Hub | $34.91 | $37.34 | ($1.40) | ($1.03) | $67.48 | $90.18 | ($19.17) | ($3.53) |
| ATSI Gen Hub | $34.56 | $36.37 | ($1.53) | ($0.28) | $75.12 | $92.55 | ($16.45) | ($0.97) |
| Chicago Gen Hub | $30.64 | $36.74 | ($3.55) | ($2.55) | $57.58 | $88.88 | ($23.90) | ($7.40) |
| Chicago Hub | $31.83 | $37.18 | ($3.33) | ($2.02) | $61.27 | $89.85 | ($22.58) | ($5.99) |
| Dominion Hub | $41.02 | $38.37 | $2.60 | $0.04 | $122.57 | $100.24 | $22.86 | ($0.53) |
| Eastern Hub | $38.67 | $37.04 | ($0.57) | $2.20 | $113.36 | $90.98 | $15.72 | $6.66 |
| N Illinois Hub | $31.17 | $36.82 | ($3.41) | ($2.24) | $59.07 | $87.81 | ($22.28) | ($6.45) |
| New Jersey Hub | $44.24 | $37.28 | $5.38 | $1.58 | $112.36 | $90.65 | $16.44 | $5.27 |
| Ohio Hub | $34.55 | $37.23 | ($1.71) | ($0.98) | $68.20 | $91.31 | ($19.68) | ($3.43) |
| West Interface Hub | $36.23 | $37.13 | ($0.34) | ($0.56) | $86.49 | $90.55 | ($2.28) | ($1.78) |
| Western Hub | $38.99 | $37.97 | $0.81 | $0.21 | $100.56 | $93.78 | $6.21 | $0.57 |

The day-ahead components of LMP for each hub are presented in Table 11-6 for the first three months of 2013 and the first three months of 2014.

### Table 11-6 Hub day-ahead, load-weighted average LMP components (Dollars per MWh): January through March of 2013 and 2014

| | 2013 (Jan-Mar) | | | | 2014 (Jan-Mar) | | | |
|---|---|---|---|---|---|---|---|---|
| | Day-Ahead LMP | Energy Component | Congestion Component | Loss Component | Day-Ahead LMP | Energy Component | Congestion Component | Loss Component |
| AEP Gen Hub | $32.68 | $36.54 | ($1.90) | ($1.97) | $62.52 | $81.82 | ($13.85) | ($5.45) |
| AEP-DAY Hub | $34.40 | $36.84 | ($1.39) | ($1.05) | $71.69 | $90.45 | ($16.06) | ($2.71) |
| ATSI Gen Hub | $35.54 | $37.41 | ($1.57) | ($0.30) | $68.00 | $74.22 | ($6.31) | $0.08 |
| Chicago Gen Hub | $31.14 | $36.94 | ($3.01) | ($2.80) | $60.91 | $88.74 | ($22.34) | ($5.49) |
| Chicago Hub | $32.06 | $36.93 | ($2.64) | ($2.22) | $60.21 | $83.17 | ($19.26) | ($3.70) |
| Dominion Hub | $39.95 | $37.54 | $2.30 | $0.11 | $107.82 | $97.74 | $11.65 | ($1.57) |
| Eastern Hub | $39.43 | $37.28 | ($0.28) | $2.42 | $118.16 | $90.69 | $21.26 | $6.21 |
| N Illinois Hub | $31.66 | $36.98 | ($2.87) | ($2.45) | $61.92 | $87.88 | ($21.31) | ($4.65) |
| New Jersey Hub | $43.63 | $37.12 | $4.66 | $1.85 | $117.00 | $88.83 | $23.04 | $5.12 |
| Ohio Hub | $34.36 | $36.77 | ($1.37) | ($1.05) | $72.58 | $91.84 | ($16.86) | ($2.40) |
| West Interface Hub | $38.63 | $39.47 | ($0.40) | ($0.44) | $73.56 | $76.84 | ($2.00) | ($1.29) |
| Western Hub | $38.24 | $37.07 | $0.78 | $0.39 | $96.27 | $90.46 | $5.22 | $0.58 |

## Component Costs

Table 11-7 shows the total energy, loss and congestion component costs and the total PJM billing for the first three months of 2009 through 2014. These totals are actually net energy, loss and congestion costs.

**Table 11-7 Total PJM costs by component (Dollars (Millions)): January through March of 2009 through 2014[6 7]**

| | Component Costs (Millions) | | | | | |
|---|---|---|---|---|---|---|
| (Jan-Mar) | Energy Costs | Loss Costs | Congestion Costs | Total Costs | Total PJM Billing | Total Costs Percent of PJM Billing |
| 2009 | ($218) | $454 | $307 | $543 | $7,515 | 7.2% |
| 2010 | ($208) | $417 | $345 | $554 | $8,415 | 6.6% |
| 2011 | ($210) | $410 | $360 | $560 | $9,584 | 5.8% |
| 2012 | ($136) | $234 | $122 | $220 | $6,938 | 3.2% |
| 2013 | ($178) | $278 | $186 | $286 | $7,762 | 3.7% |
| 2014 | ($515) | $776 | $1,236 | $1,497 | $21,070 | 7.1% |

# Congestion

## Congestion Accounting

Congestion occurs in the Day-Ahead and Real-Time Energy Markets.[8] Total congestion costs are equal to the net implicit congestion bill plus net explicit congestion costs plus net inadvertent congestion charges, incurred in both the Day-Ahead Energy Market and the Balancing Energy Market.

In the analysis of total congestion costs, load congestion payments are netted against generation congestion credits on an hourly basis, by billing organization, and then summed for the given period.[9]

Load congestion payments and generation congestion credits are calculated for both the Day-Ahead and Balancing Energy Markets.

Total congestion costs in PJM in the first three months of 2014 were $1,236.1 million, which was comprised of load congestion payments of $406.7 million, generation credits of -$985.0 million and explicit congestion of -$155.6 million (Table 11-9).

## Total Congestion

Table 11-8 shows total congestion for the first three months of 2008 through 2014.

**Table 11-8 Total PJM congestion (Dollars (Millions)): January through March of 2008 through 2014**

| | Congestion Costs (Millions) | | | |
|---|---|---|---|---|
| (Jan - Mar) | Congestion Cost | Percent Change | Total PJM Billing | Percent of PJM Billing |
| 2008 | $485.6 | NA | $7,718 | 6.3% |
| 2009 | $306.9 | (36.8%) | $7,515 | 4.1% |
| 2010 | $344.9 | 12.4% | $8,415 | 4.1% |
| 2011 | $359.9 | 4.3% | $9,584 | 3.8% |
| 2012 | $122.4 | (66.0%) | $6,938 | 1.8% |
| 2013 | $185.9 | 51.9% | $7,762 | 2.4% |
| 2014 | $1,236.1 | 564.8% | $21,070 | 5.9% |

Total congestion costs in Table 11-8 include congestion costs associated with PJM facilities and those associated with reciprocal, coordinated flowgates in the MISO and in the NYISO.[10 11]

Table 11-9 shows the congestion costs by accounting category for the first three months of 2014. In the first three months of 2014 PJM total congestion costs were comprised of $406.7 million in load congestion payments, -$985.0 million in generation congestion credits, and -$155.6 million in explicit congestion costs.

6 The energy costs, loss costs and congestion costs include net inadvertent charges.
7 Total PJM billing is provided by PJM, and the MMU is not able to reproduce and verify the calculation.
8 When the term *congestion charges* is used in documents by PJM's Market Settlement Operations, it has the same meaning as the term congestion costs as used here.
9 This analysis does not treat affiliated billing organizations as a single organization. Thus, the generation congestion credits from one organization will not offset the load payments of its affiliate.

10 See "Joint Operating Agreement Between the Midwest Independent Transmission System Operator, Inc. and PJM Interconnection, L.L.C.," (December 11, 2008) Section 6.1 <http://pjm.com/documents/agreements/~/media/documents/agreements/joa-complete.ashx> (Accessed April 17, 2013).
11 See "Joint Operating Agreement Among and Between the New York Independent System Operator Inc. and PJM Interconnection, L.L.C.," (January 17, 2013) Section 35.2.1 <http://www.pjm.com/~/media/documents/agreements/nyiso-pjm.ashx> (Accessed April 17, 2013).

### Table 11-9 Total PJM congestion costs by accounting category (Dollars (Millions)): January through March of 2008 through 2014

| | Congestion Costs (Millions) | | | | |
|---|---|---|---|---|---|
| (Jan - Mar) | Load Payments | GenerationCredits | Explicit Costs | Inadvertent Charges | Total |
| 2008 | $286.4 | ($190.5) | $8.7 | $0.0 | $485.6 |
| 2009 | $106.0 | ($227.3) | ($26.5) | ($0.0) | $306.9 |
| 2010 | $80.1 | ($281.0) | ($16.2) | ($0.0) | $344.9 |
| 2011 | $198.1 | ($199.0) | ($37.2) | $0.0 | $359.9 |
| 2012 | $16.8 | ($120.1) | ($14.5) | $0.0 | $122.4 |
| 2013 | $78.4 | ($125.8) | ($18.2) | $0.0 | $185.9 |
| 2014 | $406.7 | ($985.0) | ($155.6) | $0.0 | $1,236.1 |

### Table 11-10 Total PJM congestion costs by accounting category by market (Dollars (Millions)): January through March of 2008 through 2014

| | Congestion Costs (Millions) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Day Ahead | | | | Balancing | | | | | |
| (Jan - Mar) | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Inadvertent Charges | Grand Total |
| 2008 | $332.4 | ($220.0) | $39.9 | $592.3 | ($46.0) | $29.5 | ($31.2) | ($106.7) | $0.0 | $485.6 |
| 2009 | $120.2 | ($221.3) | $47.9 | $389.5 | ($14.2) | ($6.0) | ($74.4) | ($82.6) | ($0.0) | $306.9 |
| 2010 | $85.9 | ($293.1) | $12.9 | $391.9 | ($5.7) | $12.1 | ($29.1) | ($47.0) | ($0.0) | $344.9 |
| 2011 | $176.5 | ($226.7) | $4.1 | $407.3 | $21.6 | $27.8 | ($41.2) | ($47.4) | $0.0 | $359.9 |
| 2012 | $21.9 | ($131.4) | $27.5 | $180.9 | ($5.1) | $11.3 | ($42.0) | ($58.4) | $0.0 | $122.4 |
| 2013 | $85.0 | ($199.1) | $47.8 | $331.9 | ($6.6) | $73.3 | ($66.0) | ($145.9) | $0.0 | $185.9 |
| 2014 | $333.7 | ($1,193.9) | ($94.3) | $1,433.3 | $73.0 | $208.9 | ($61.3) | ($197.2) | $0.0 | $1,236.1 |

## Monthly Congestion

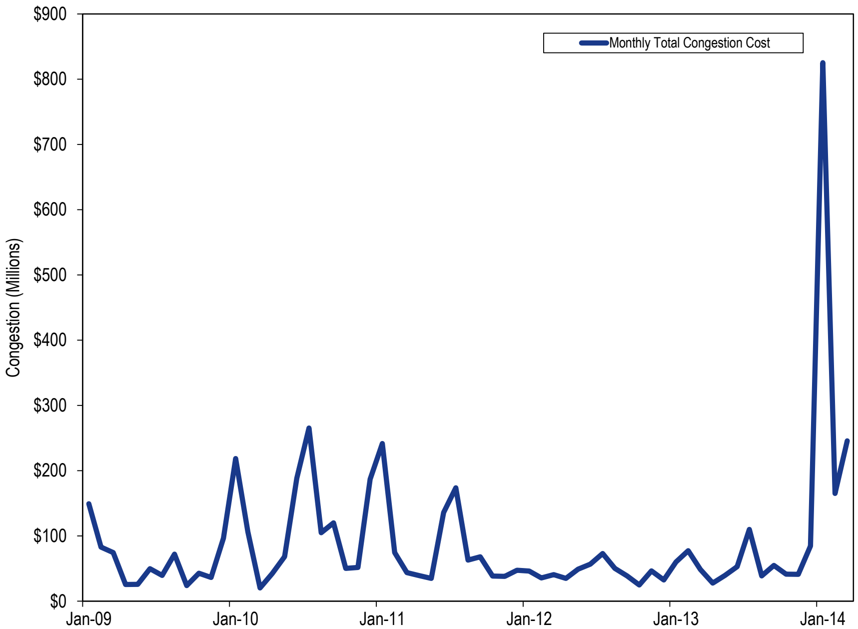
Table 11-11 shows that monthly total congestion costs ranged from $165.2 million to $825.2 million in 2014. Table 11-11 shows that monthly congestion costs in each of the first three months of 2014 were substantially higher than in the corresponding months of 2013.

### Table 11-11 Monthly PJM congestion costs by market (Dollars (Millions)): January through March of 2013 and 2014

| | Congestion Costs (Millions) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2013 (Jan-Mar) | | | | 2014 (Jan-Mar) | | | |
| | Day-Ahead Total | Balancing Total | Inadvertent Charges | Grand Total | Day-Ahead Total | Balancing Total | Inadvertent Charges | Grand Total |
| Jan | $136.8 | ($76.8) | $0.0 | $60.0 | $922.5 | ($97.3) | $0.0 | $825.2 |
| Feb | $125.1 | ($47.7) | $0.0 | $77.4 | $203.5 | ($38.3) | $0.0 | $165.2 |
| Mar | $69.9 | ($21.4) | ($0.0) | $48.5 | $307.3 | ($61.6) | $0.0 | $245.8 |
| Total | $331.9 | ($145.9) | $0.0 | $185.9 | $1,433.3 | ($197.2) | $0.0 | $1,236.1 |

Figure 11-1 shows PJM monthly total congestion cost for 2009 through the first three months of 2014.

**Figure 11-1 PJM monthly total congestion cost (Dollars (Millions)): 2009 through March of 2014**




# Congested Facilities

A congestion event exists when a unit or units must be dispatched out of merit order to control for the potential impact of a contingency on a monitored facility or to control an actual overload. A congestion-event hour exists when a specific facility is constrained for one or more five-minute intervals within an hour. A congestion-event hour differs from a constrained hour, which is any hour during which one or more facilities are congested. Thus, if two facilities are constrained during an hour, the result is two congestion-event hours and one constrained hour. Constraints are often simultaneous, so the number of congestion-event hours usually exceeds the number of constrained hours and the number of congestion-event hours usually exceeds the number of hours in a year.

In order to have a consistent metric for real-time and day-ahead congestion frequency, real-time congestion frequency is measured using the convention that an hour is constrained if any of its component five-minute intervals is constrained. This is consistent with the way in which PJM reports real-time congestion. In the first three months of 2014, there were 113,666 day-ahead, congestion-event hours compared to 81,378 day-ahead, congestion-event hours in the first three months of 2013. In the first three months of 2014, there were 10,144 real-time, congestion-event hours compared to 5,924 real-time, congestion-event hours in the first three months of 2013.

During the first three months of 2014, for only 3.6 percent of day-ahead energy market facility constrained hours were the same facilities also constrained in the Real-Time Energy Market. During the first three months of 2014, for 44.2 percent of real-time energy market facility constrained hours, the same facilities were also constrained in the Day-Ahead Energy Market.

The AP South Interface was the largest contributor to congestion costs in the first three months of 2014. With $436.9 million in total congestion costs, it accounted for 35.3 percent of the total PJM congestion costs in the first three months of 2014. The top five constraints in terms of congestion costs together contributed $762.2 million, or 61.7 percent, of the total PJM congestion costs in the first three months of 2014. The top five constraints were the AP South Interface, the West Interface, the Breed – Wheatland flowgate, and the Cloverdale transformer, and the Bedington - Black Oak Interface.

## Congestion by Facility Type and Voltage

In the first three months of 2014, compared to the first three months of 2013, day-ahead, congestion-event hours increased on all types of facilities. Real-time, congestion-event hours increased on all types of facilities.

Day-ahead congestion costs increased on all types of facilities in the first three months of 2014 compared to the first three months of 2013. Balancing congestion costs decreased on flowgates, interfaces and transformers and increased on transmission lines in the first three months of 2014 compared to the first three months of 2013.

Table 11-12 provides congestion-event hour subtotals and congestion cost subtotals comparing the first three months of 2014 results by facility type: line, transformer, interface, flowgate and unclassified facilities.[12 13] For comparison, this information is presented in Table 11-13 for the first three months of 2013.[14]

### Table 11-12 Congestion summary (By facility type): January through March of 2014

| | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Day Ahead | | | | Balancing | | | | | Event Hours | |
| Type | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| Flowgate | ($53.5) | ($253.7) | ($15.4) | $184.8 | $1.1 | $12.2 | ($30.8) | ($41.9) | $143.0 | 10,847 | 3,037 |
| Interface | $300.6 | ($579.4) | ($100.6) | $779.4 | $61.3 | $142.6 | $24.1 | ($57.1) | $722.3 | 7,042 | 1,850 |
| Line | $26.1 | ($290.6) | $0.8 | $317.5 | ($2.3) | $40.2 | ($21.8) | ($64.2) | $253.3 | 58,732 | 4,420 |
| Other | ($0.1) | ($0.5) | $0.3 | $0.7 | $0.0 | $0.0 | $0.0 | $0.0 | $0.7 | 1,622 | 0 |
| Transformer | $60.0 | ($61.8) | $10.9 | $132.7 | $8.2 | $13.0 | ($41.8) | ($46.6) | $86.1 | 35,423 | 837 |
| Unclassified | $0.6 | ($8.0) | $9.7 | $18.3 | $4.6 | $1.0 | $9.0 | $12.6 | $30.9 | NA | NA |
| Total | $333.7 | ($1,193.9) | ($94.3) | $1,433.3 | $73.0 | $208.9 | ($61.3) | ($197.2) | $1,236.1 | 113,666 | 10,144 |

### Table 11-13 Congestion summary (By facility type): January through March of 2013

| | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Day Ahead | | | | Balancing | | | | | Event Hours | |
| Type | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| Flowgate | ($5.8) | ($39.1) | $6.6 | $39.9 | $1.3 | $7.1 | ($18.2) | ($23.9) | $16.0 | 5,414 | 2,333 |
| Interface | $69.4 | ($44.2) | ($1.0) | $112.5 | $6.9 | $14.8 | $1.8 | ($6.0) | $106.5 | 3,571 | 609 |
| Line | $11.7 | ($93.8) | $24.4 | $130.0 | ($12.1) | $44.5 | ($38.6) | ($95.2) | $34.8 | 47,137 | 2,482 |
| Other | $2.8 | ($1.8) | $5.1 | $9.7 | ($0.0) | $0.0 | $0.0 | ($0.0) | $9.7 | 4,443 | 5 |
| Transformer | $6.9 | ($14.9) | $7.7 | $29.5 | ($2.2) | $6.3 | ($10.3) | ($18.8) | $10.7 | 20,813 | 494 |
| Unclassified | $0.1 | ($5.2) | $5.0 | $10.3 | ($0.6) | $0.6 | ($0.8) | ($2.0) | $8.2 | NA | NA |
| Total | $85.0 | ($199.1) | $47.8 | $331.9 | ($6.6) | $73.3 | ($66.0) | ($145.9) | $185.9 | 81,378 | 5,923 |

12 Unclassified are congestion costs related to non-transmission facility constraints in the Day-Ahead Market and any unaccounted for difference between PJM billed congestion charges and calculated congestion costs including rounding errors. Non-transmission facility constraints include Day-Ahead Market only constraints such as constraints on virtual transactions and constraints associated with phase-angle regulators.

13 The term flowgate refers to MISO flowgates and NYISO flowgates in this section.

14 For 2008 and 2009, the load congestion payments and generation congestion credits represent the net load congestion payments and net generation congestion credits for an organization, as this shows the extent to which each organization's load or generation was exposed to congestion costs.

Table 11-14 and Table 11-15 compare day-ahead and real-time congestion event hours. Among the hours for which a facility is constrained in the Day-Ahead Energy Market, the number of hours during which the facility is also constrained in the Real-Time Energy Market are presented in Table 11-14. In the first three months of 2014, there were 113,666 congestion event hours in the Day-Ahead Energy Market. Among those day-ahead congestion event hours, only 4,115 (3.6 percent) were also constrained in the Real-Time Energy Market. In the first three months of 2013, among the 8,378 day-ahead congestion event hours, only 2,519 (3.1 percent) were binding in the Real-Time Energy Market.[15]

Among the hours for which a facility is constrained in the Real-Time Energy Market, the number of hours during which the facility is also constrained in the Day-Ahead Energy Market are presented in Table 11-15. In the first three months of 2014, there were 10,144 congestion event hours in the Real-Time Energy Market. Among these real-time congestion event hours, 4,484 (44.2 percent) were also constrained in the Day-Ahead Energy Market. In the first three months of 2013, among the 5,923 real-time congestion event hours, only 2,669 (45.1 percent) were also in the Day-Ahead Energy Market.

### Table 11-14 Congestion event hours (Day-Ahead against Real-Time): January through March of 2013 and 2014

| | Congestion Event Hours | | | | | |
|---|---|---|---|---|---|---|
| | 2013 (Jan - Mar) | | | 2014 (Jan - Mar) | | |
| Type | Day Ahead Constrained | Corresponding Real Time Constrained | Percent | Day Ahead Constrained | Corresponding Real Time Constrained | Percent |
| Flowgate | 5,414 | 907 | 16.8% | 10,847 | 1,542 | 14.2% |
| Interface | 3,571 | 509 | 14.3% | 7,042 | 1,086 | 15.4% |
| Line | 47,137 | 895 | 1.9% | 58,732 | 1,298 | 2.2% |
| Other | 4,443 | 5 | 0.1% | 1,622 | 0 | 0.0% |
| Transformer | 20,813 | 203 | 1.0% | 35,423 | 189 | 0.5% |
| Total | 81,378 | 2,519 | 3.1% | 113,666 | 4,115 | 3.6% |

### Table 11-15 Congestion event hours (Real-Time against Day-Ahead): January through March of 2013 and 2014

| | Congestion Event Hours | | | | | |
|---|---|---|---|---|---|---|
| | 2013 (Jan - Mar) | | | 2014 (Jan - Mar) | | |
| Type | Real Time Constrained | Corresponding Day Ahead Constrained | Percent | Real Time Constrained | Corresponding Day Ahead Constrained | Percent |
| Flowgate | 2,333 | 1,041 | 44.6% | 3,037 | 1,635 | 53.8% |
| Interface | 609 | 525 | 86.2% | 1,850 | 1,388 | 75.0% |
| Line | 2,482 | 896 | 36.1% | 4,420 | 1,293 | 29.3% |
| Other | 5 | 5 | 100.0% | 0 | 0 | 0.0% |
| Transformer | 494 | 202 | 40.9% | 837 | 168 | 20.1% |
| Total | 5,923 | 2,669 | 45.1% | 10,144 | 4,484 | 44.2% |

15 Constraints are mapped to transmission facilities. In the Day-Ahead Energy Market, within a given hour, a single facility may be associated with multiple constraints. In such situations, the same facility accounts for more than one constraint-hour for a given hour in the Day-Ahead Energy Market. Similarly in the Real-Time Market a facility may account for more than one constraint-hour within a given hour.

Table 11-16 shows congestion costs by facility voltage class for the first three months of 2014. In comparison to the first three months of 2013 (shown in Table 11-17), congestion costs decreased for facilities rated at 138 kV and 115 kV 2013.

## Table 11-16 Congestion summary (By facility voltage): January through March of 2014

| | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Day Ahead | | | | Balancing | | | | | Event Hours | |
| Voltage (kV) | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| 765 | $21.8 | ($28.8) | $0.9 | $51.5 | $0.1 | $0.2 | ($0.0) | ($0.1) | $51.4 | 3,315 | 5 |
| 500 | $310.3 | ($573.5) | ($101.3) | $782.4 | $69.7 | $158.9 | $9.0 | ($80.2) | $702.2 | 9,108 | 2,007 |
| 345 | ($53.6) | ($243.5) | ($9.9) | $180.0 | $2.8 | $14.0 | ($21.9) | ($33.1) | $146.9 | 22,632 | 1,604 |
| 230 | $5.1 | ($184.1) | ($17.4) | $171.9 | $1.3 | ($3.1) | $8.8 | $13.2 | $185.0 | 18,933 | 1,495 |
| 161 | ($4.7) | ($10.8) | $0.5 | $6.6 | ($1.5) | ($0.5) | ($0.8) | ($1.9) | $4.7 | 1,459 | 289 |
| 138 | $31.6 | ($147.8) | $20.9 | $200.3 | ($0.3) | $36.8 | ($64.6) | ($101.8) | $98.5 | 47,639 | 4,346 |
| 115 | $0.3 | ($2.7) | $1.4 | $4.4 | ($1.3) | $0.6 | ($0.3) | ($2.3) | $2.1 | 4,532 | 214 |
| 69 | $22.3 | $5.2 | $0.9 | $18.0 | ($2.3) | $1.0 | ($0.3) | ($3.6) | $14.4 | 4,581 | 184 |
| 34 | $0.0 | ($0.0) | $0.1 | $0.1 | $0.0 | $0.0 | $0.0 | $0.0 | $0.1 | 1,467 | 0 |
| -99 | $0.6 | ($8.0) | $9.7 | $18.3 | $4.6 | $1.0 | $9.0 | $12.6 | $30.9 | NA | NA |
| Total | $333.7 | ($1,193.9) | ($94.3) | $1,433.3 | $73.0 | $208.9 | ($61.3) | ($197.2) | $1,236.1 | 113,666 | 10,144 |

## Table 11-17 Congestion summary (By facility voltage): January through March of 2013

| | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Day Ahead | | | | Balancing | | | | | Event Hours | |
| Voltage (kV) | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| 765 | $5.2 | ($2.9) | $3.7 | $11.8 | $0.0 | $0.0 | $0.0 | $0.0 | $11.8 | 2,027 | 0 |
| 500 | $72.5 | ($49.3) | ($0.5) | $121.3 | $8.7 | $15.1 | ($1.6) | ($8.1) | $113.2 | 4,454 | 724 |
| 345 | ($4.1) | ($27.8) | $6.7 | $30.4 | ($1.3) | $8.9 | ($15.3) | ($25.5) | $5.0 | 12,864 | 1,559 |
| 230 | $11.9 | ($74.4) | $22.0 | $108.2 | ($11.0) | $43.1 | ($30.9) | ($85.0) | $23.2 | 15,851 | 1,330 |
| 161 | ($1.7) | ($3.1) | ($0.6) | $0.8 | ($0.4) | $0.2 | ($0.1) | ($0.7) | $0.1 | 654 | 407 |
| 138 | $0.6 | ($33.2) | $10.2 | $44.1 | ($0.5) | $4.4 | ($16.4) | ($21.4) | $22.7 | 34,864 | 1,668 |
| 115 | ($0.0) | ($2.8) | $0.6 | $3.3 | ($0.3) | $0.2 | ($0.1) | ($0.6) | $2.7 | 3,366 | 176 |
| 69 | $0.5 | ($0.3) | $0.7 | $1.6 | ($1.2) | $0.7 | ($0.7) | ($2.6) | ($1.0) | 4,394 | 59 |
| 34 | ($0.0) | ($0.0) | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | 2,893 | 0 |
| 12 | $0.0 | $0.0 | ($0.0) | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | 11 | 0 |
| Unclassified | $0.1 | ($5.2) | $5.0 | $10.3 | ($0.6) | $0.6 | ($0.8) | ($2.0) | $8.2 | NA | NA |
| Total | $85.0 | ($199.1) | $47.8 | $331.9 | ($6.6) | $73.3 | ($66.0) | ($145.9) | $185.9 | 81,378 | 5,923 |

## Constraint Duration

Table 11-18 lists the constraints in the first three months of 2013 and the first three months of 2014 that were most frequently in effect and Table 11-19 shows the constraints which experienced the largest change in congestion-event hours from the first three months of 2013 to the first three months of 2014.

### Table 11-18 Top 25 constraints with frequent occurrence: January through March of 2013 and 2014

| | | | Event Hours | | | | | | Percent of Annual Hours | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day Ahead | | | Real Time | | | Day Ahead | | | Real Time | | |
| No. | Constraint | Type | 2013 | 2014 | Change | 2013 | 2014 | Change | 2013 | 2014 | Change | 2013 | 2014 | Change |
| 1 | AP South | Interface | 2,012 | 2,347 | 335 | 505 | 864 | 359 | 23% | 27% | 4% | 6% | 10% | 4% |
| 2 | Tanners Creek | Transformer | 1,458 | 3,110 | 1,652 | 0 | 0 | 0 | 17% | 35% | 19% | 0% | 0% | 0% |
| 3 | Miami Fort | Transformer | 835 | 2,494 | 1,659 | 0 | 21 | 21 | 10% | 28% | 19% | 0% | 0% | 0% |
| 4 | Monticello - East Winamac | Flowgate | 998 | 1,489 | 491 | 387 | 1,004 | 617 | 11% | 17% | 6% | 4% | 11% | 7% |
| 5 | Braidwood | Transformer | 1,168 | 2,288 | 1,120 | 0 | 0 | 0 | 13% | 26% | 13% | 0% | 0% | 0% |
| 6 | Breed - Wheatland | Flowgate | 724 | 1,853 | 1,129 | 148 | 433 | 285 | 8% | 21% | 13% | 2% | 5% | 3% |
| 7 | Nelson - Cordova | Line | 1,112 | 2,034 | 922 | 3 | 139 | 136 | 13% | 23% | 10% | 0% | 2% | 2% |
| 8 | Sunbury | Transformer | 748 | 2,053 | 1,305 | 0 | 0 | 0 | 9% | 23% | 15% | 0% | 0% | 0% |
| 9 | Kendall Co. Energy Ctr. | Transformer | 0 | 1,984 | 1,984 | 0 | 0 | 0 | 0% | 23% | 23% | 0% | 0% | 0% |
| 10 | Keeney | Transformer | 151 | 1,742 | 1,591 | 0 | 50 | 50 | 2% | 20% | 18% | 0% | 1% | 1% |
| 11 | Oak Grove - Galesburg | Flowgate | 654 | 1,459 | 805 | 362 | 215 | (147) | 7% | 17% | 9% | 4% | 2% | (2%) |
| 12 | East Bend | Transformer | 0 | 1,601 | 1,601 | 0 | 0 | 0 | 0% | 18% | 18% | 0% | 0% | 0% |
| 13 | Clinch River | Transformer | 0 | 1,562 | 1,562 | 0 | 0 | 0 | 0% | 18% | 18% | 0% | 0% | 0% |
| 14 | Mardela - Vienna | Line | 9 | 1,501 | 1,492 | 22 | 2 | (20) | 0% | 17% | 17% | 0% | 0% | (0%) |
| 15 | Gould Street - Westport | Line | 2,893 | 1,467 | (1,426) | 0 | 0 | 0 | 33% | 17% | (16%) | 0% | 0% | 0% |
| 16 | Sporn | Transformer | 3,174 | 1,427 | (1,747) | 0 | 0 | 0 | 36% | 16% | (20%) | 0% | 0% | 0% |
| 17 | Wolf Creek | Transformer | 0 | 1,290 | 1,290 | 0 | 80 | 80 | 0% | 15% | 15% | 0% | 1% | 1% |
| 18 | West | Interface | 341 | 1,022 | 681 | 1 | 345 | 344 | 4% | 12% | 8% | 0% | 4% | 4% |
| 19 | Readington - Roseland | Line | 1,925 | 1,169 | (756) | 609 | 189 | (420) | 22% | 13% | (9%) | 7% | 2% | (5%) |
| 20 | Chicago Heights - Bloom | Line | 0 | 1,315 | 1,315 | 0 | 0 | 0 | 0% | 15% | 15% | 0% | 0% | 0% |
| 21 | Beckjord | Transformer | 783 | 1,297 | 514 | 0 | 0 | 0 | 9% | 15% | 6% | 0% | 0% | 0% |
| 22 | Loretto - Cayuga | Line | 132 | 1,295 | 1,163 | 0 | 0 | 0 | 2% | 15% | 13% | 0% | 0% | 0% |
| 23 | Argenta - Greenup | Line | 0 | 1,281 | 1,281 | 0 | 0 | 0 | 0% | 15% | 15% | 0% | 0% | 0% |
| 24 | East | Interface | 55 | 1,217 | 1,162 | 4 | 17 | 13 | 1% | 14% | 13% | 0% | 0% | 0% |
| 25 | Benton Harbor - Palisades | Flowgate | 0 | 1,096 | 1,096 | 4 | 97 | 93 | 0% | 12% | 12% | 0% | 1% | 1% |

## Table 11-19 Top 25 constraints with largest year-to-year change in occurrence: January through March of 2013 and 2014

| | | | Event Hours | | | | | | Percent of Annual Hours | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day Ahead | | | Real Time | | | Day Ahead | | | Real Time | | |
| No. | Constraint | Type | 2013 | 2014 | Change | 2013 | 2014 | Change | 2013 | 2014 | Change | 2013 | 2014 | Change |
| 1 | Kendall Co. Energy Ctr. | Transformer | 0 | 1,984 | 1,984 | 0 | 0 | 0 | 0% | 23% | 23% | 0% | 0% | 0% |
| 2 | Sporn | Transformer | 3,174 | 1,427 | (1,747) | 0 | 0 | 0 | 36% | 16% | (20%) | 0% | 0% | 0% |
| 3 | Miami Fort | Transformer | 835 | 2,494 | 1,659 | 0 | 21 | 21 | 10% | 28% | 19% | 0% | 0% | 0% |
| 4 | Tanners Creek | Transformer | 1,458 | 3,110 | 1,652 | 0 | 0 | 0 | 17% | 35% | 19% | 0% | 0% | 0% |
| 5 | Keeney | Transformer | 151 | 1,742 | 1,591 | 0 | 50 | 50 | 2% | 20% | 18% | 0% | 1% | 1% |
| 6 | Devon - Skokie | Line | 1,697 | 68 | (1,629) | 0 | 0 | 0 | 19% | 1% | (19%) | 0% | 0% | 0% |
| 7 | East Bend | Transformer | 0 | 1,601 | 1,601 | 0 | 0 | 0 | 0% | 18% | 18% | 0% | 0% | 0% |
| 8 | Prairie State - W Mt. Vernon | Flowgate | 897 | 0 | (897) | 692 | 0 | (692) | 10% | 0% | (10%) | 8% | 0% | (8%) |
| 9 | Clinch River | Transformer | 0 | 1,562 | 1,562 | 0 | 0 | 0 | 0% | 18% | 18% | 0% | 0% | 0% |
| 10 | Mardela - Vienna | Line | 9 | 1,501 | 1,492 | 22 | 2 | (20) | 0% | 17% | 17% | 0% | 0% | (0%) |
| 11 | Gould Street - Westport | Line | 2,893 | 1,467 | (1,426) | 0 | 0 | 0 | 33% | 17% | (16%) | 0% | 0% | 0% |
| 12 | Breed - Wheatland | Flowgate | 724 | 1,853 | 1,129 | 148 | 433 | 285 | 8% | 21% | 13% | 2% | 5% | 3% |
| 13 | Wolf Creek | Transformer | 0 | 1,290 | 1,290 | 0 | 80 | 80 | 0% | 15% | 15% | 0% | 1% | 1% |
| 14 | Chicago Heights - Bloom | Line | 0 | 1,315 | 1,315 | 0 | 0 | 0 | 0% | 15% | 15% | 0% | 0% | 0% |
| 15 | Waldwick - Waldwick | Other | 1,315 | 0 | (1,315) | 0 | 0 | 0 | 15% | 0% | (15%) | 0% | 0% | 0% |
| 16 | Sunbury | Transformer | 748 | 2,053 | 1,305 | 0 | 0 | 0 | 9% | 23% | 15% | 0% | 0% | 0% |
| 17 | Argenta - Greenup | Line | 0 | 1,281 | 1,281 | 0 | 0 | 0 | 0% | 15% | 15% | 0% | 0% | 0% |
| 18 | Haurd - Steward | Line | 1,533 | 300 | (1,233) | 0 | 0 | 0 | 18% | 3% | (14%) | 0% | 0% | 0% |
| 19 | Benton Harbor - Palisades | Flowgate | 0 | 1,096 | 1,096 | 4 | 97 | 93 | 0% | 12% | 12% | 0% | 1% | 1% |
| 20 | Burlington - Croydon | Line | 0 | 1,180 | 1,180 | 0 | 0 | 0 | 0% | 13% | 13% | 0% | 0% | 0% |
| 21 | Readington - Roseland | Line | 1,925 | 1,169 | (756) | 609 | 189 | (420) | 22% | 13% | (9%) | 7% | 2% | (5%) |
| 22 | East | Interface | 55 | 1,217 | 1,162 | 4 | 17 | 13 | 1% | 14% | 13% | 0% | 0% | 0% |
| 23 | Loretto - Cayuga | Line | 132 | 1,295 | 1,163 | 0 | 0 | 0 | 2% | 15% | 13% | 0% | 0% | 0% |
| 24 | Braidwood | Transformer | 1,168 | 2,288 | 1,120 | 0 | 0 | 0 | 13% | 26% | 13% | 0% | 0% | 0% |
| 25 | Monticello - East Winamac | Flowgate | 998 | 1,489 | 491 | 387 | 1,004 | 617 | 11% | 17% | 6% | 4% | 11% | 7% |

## Constraint Costs

Table 11-20 and Table 11-21 present the top constraints affecting congestion costs by facility for the periods the first three months of 2014 and the first three months of 2013.

### Table 11-20 Top 25 constraints affecting PJM congestion costs (By facility): January through March of 2014

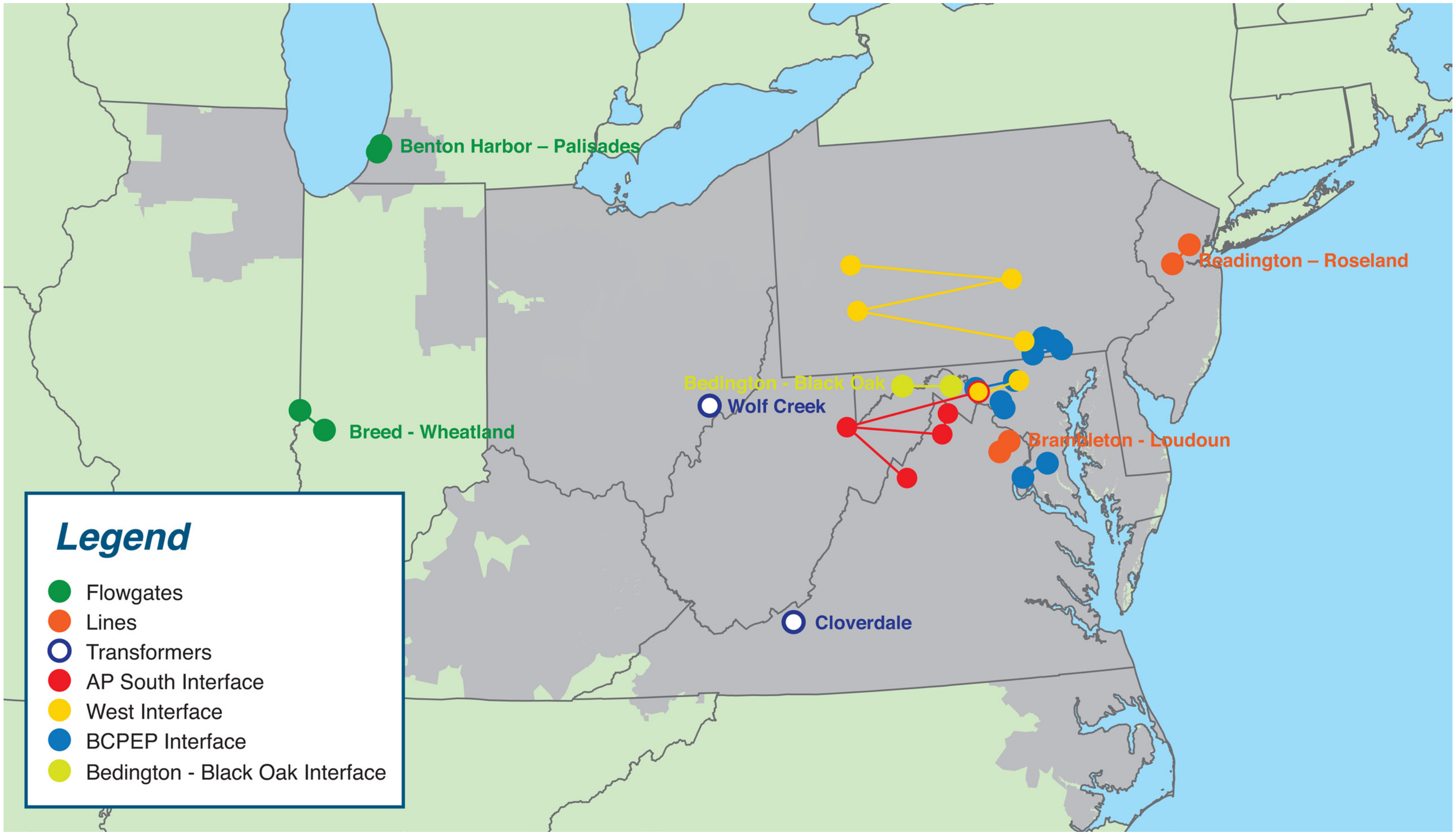
| | | | | Congestion Costs (Millions) | | | | | | | | | Percent of Total PJM Congestion Costs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Day Ahead | | | | Balancing | | | | | |
| No. | Constraint | Type | Location | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | 2014 (Jan - Mar) |
| 1 | AP South | Interface | 500 | $295.7 | ($185.8) | ($11.7) | $469.8 | $31.1 | $73.1 | $9.1 | ($32.8) | $436.9 | 35.3% |
| 2 | West | Interface | 500 | ($19.9) | ($282.4) | ($77.9) | $184.5 | $16.7 | $47.7 | $16.7 | ($14.3) | $170.2 | 13.8% |
| 3 | Breed - Wheatland | Flowgate | MISO | ($13.9) | ($78.9) | ($8.4) | $56.5 | $2.1 | $1.3 | $5.7 | $6.5 | $63.0 | 5.1% |
| 4 | Cloverdale | Transformer | AEP | $21.6 | ($25.8) | ($0.5) | $46.8 | $0.0 | $0.0 | $0.0 | $0.0 | $46.8 | 3.8% |
| 5 | Bedington - Black Oak | Interface | 500 | $20.5 | ($30.7) | ($2.3) | $48.8 | $1.4 | $3.9 | ($1.2) | ($3.6) | $45.2 | 3.7% |
| 6 | Benton Harbor - Palisades | Flowgate | MISO | ($10.9) | ($64.0) | ($7.3) | $45.8 | ($0.2) | $0.7 | ($0.7) | ($1.6) | $44.2 | 3.6% |
| 7 | BCPEP | Interface | Pepco | $8.4 | ($14.6) | ($2.1) | $21.0 | ($1.7) | ($14.1) | $1.4 | $13.8 | $34.8 | 2.8% |
| 8 | Unclassified | Unclassified | Unclassified | $0.6 | ($8.0) | $9.7 | $18.3 | $4.6 | $1.0 | $9.0 | $12.6 | $30.9 | 2.5% |
| 9 | Readington - Roseland | Line | PSEG | ($8.9) | ($46.1) | ($12.2) | $25.1 | $0.9 | $5.4 | $5.8 | $1.3 | $26.4 | 2.1% |
| 10 | Wolf Creek | Transformer | AEP | $2.2 | ($0.2) | $2.2 | $4.7 | $2.9 | $5.1 | ($27.0) | ($29.2) | ($24.5) | (2.0%) |
| 11 | Brambleton - Loudoun | Line | Dominion | ($11.2) | ($35.1) | ($1.3) | $22.6 | $0.6 | $0.0 | $0.1 | $0.6 | $23.2 | 1.9% |
| 12 | Wescosville | Transformer | PPL | $17.3 | ($0.9) | $2.7 | $20.9 | ($0.0) | $0.0 | $0.0 | ($0.0) | $20.9 | 1.7% |
| 13 | Monticello - East Winamac | Flowgate | MISO | ($3.1) | ($30.3) | $0.0 | $27.2 | $1.7 | $3.8 | ($5.6) | ($7.6) | $19.5 | 1.6% |
| 14 | Cook - Palisades | Flowgate | MISO | ($8.9) | ($42.8) | ($5.4) | $28.5 | ($1.5) | $1.6 | ($6.2) | ($9.3) | $19.2 | 1.6% |
| 15 | Cloverdale | Transformer | AEP | $17.3 | ($4.4) | ($2.7) | $18.9 | $0.0 | $0.0 | $0.0 | $0.0 | $18.9 | 1.5% |
| 16 | Bridgewater - Middlesex | Line | PSEG | ($0.2) | ($21.7) | ($3.0) | $18.6 | ($1.4) | $0.1 | $1.4 | ($0.1) | $18.4 | 1.5% |
| 17 | Atlantic - Larrabee | Line | JCPL | $2.0 | ($14.8) | ($0.7) | $16.1 | $0.0 | $1.3 | $1.2 | ($0.1) | $16.0 | 1.3% |
| 18 | East | Interface | 500 | ($6.2) | ($25.1) | ($3.0) | $15.9 | $0.3 | $0.7 | $0.5 | $0.1 | $16.0 | 1.3% |
| 19 | Rising | Flowgate | MISO | ($5.1) | ($3.8) | $1.4 | $0.2 | ($3.9) | $1.2 | ($9.3) | ($14.3) | ($14.1) | (1.1%) |
| 20 | 5004/5005 Interface | Interface | 500 | $0.4 | ($17.6) | ($2.7) | $15.3 | $7.7 | $17.5 | $7.1 | ($2.7) | $12.6 | 1.0% |
| 21 | Clover | Transformer | Dominion | $0.0 | $0.0 | $0.0 | $0.0 | $2.0 | $3.9 | ($10.6) | ($12.5) | ($12.5) | (1.0%) |
| 22 | Nelson - Cordova | Line | ComEd | ($16.7) | ($30.8) | $1.3 | $15.4 | ($0.7) | $0.8 | ($2.6) | ($4.1) | $11.3 | 0.9% |
| 23 | Bergen - New Milford | Line | PSEG | $13.4 | $6.8 | $3.9 | $10.5 | $0.0 | $0.0 | $0.0 | $0.0 | $10.5 | 0.8% |
| 24 | Wake - Carso | Flowgate | MISO | $0.0 | $0.0 | $0.0 | $0.0 | $4.2 | $2.7 | ($10.7) | ($9.3) | ($9.3) | (0.7%) |
| 25 | Huntington Junction - Huntington | Line | AP | $2.3 | ($17.6) | ($10.7) | $9.2 | $0.0 | $0.0 | $0.0 | $0.0 | $9.2 | 0.7% |

## Table 11-21 Top 25 constraints affecting PJM congestion costs (By facility): January through March of 2013

| | | | | Congestion Costs (Millions) | | | | | | | | | Percent of Total PJM Congestion Costs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Day Ahead | | | | Balancing | | | | | |
| No. | Constraint | Type | Location | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | 2013 (Jan - Mar) |
| 1 | AP South | Interface | 500 | $62.2 | ($23.0) | $0.2 | $85.4 | $5.8 | $10.8 | $1.4 | ($3.6) | $81.8 | 44.0% |
| 2 | Readington - Roseland | Line | PSEG | $1.5 | ($41.1) | $8.5 | $51.2 | ($10.7) | $37.0 | ($21.4) | ($69.1) | ($17.9) | (9.6%) |
| 3 | Clover | Transformer | Dominion | $0.0 | $0.0 | $0.0 | $0.0 | ($0.1) | $5.2 | ($6.4) | ($11.7) | ($11.7) | (6.3%) |
| 4 | Cloverdale | Transformer | AEP | $5.2 | ($2.6) | $3.1 | $10.9 | $0.0 | $0.0 | $0.0 | $0.0 | $10.9 | 5.9% |
| 5 | West | Interface | 500 | $1.9 | ($8.4) | ($0.6) | $9.8 | $0.0 | $0.0 | ($0.0) | ($0.0) | $9.7 | 5.2% |
| 6 | Bridgewater - Middlesex | Line | PSEG | $0.0 | ($13.3) | $1.0 | $14.3 | ($0.0) | $3.5 | ($1.2) | ($4.7) | $9.6 | 5.1% |
| 7 | Unclassified | Unclassified | Unclassified | $0.1 | ($5.2) | $5.0 | $10.3 | ($0.6) | $0.6 | ($0.8) | ($2.0) | $8.2 | 4.4% |
| 8 | Crete - St Johns Tap | Flowgate | MISO | ($0.4) | ($5.8) | $2.2 | $7.6 | $0.0 | $0.0 | $0.0 | $0.0 | $7.6 | 4.1% |
| 9 | New Dover - Westfield | Line | PSEG | $0.6 | ($5.6) | $0.9 | $7.0 | $0.0 | $0.0 | $0.0 | $0.0 | $7.0 | 3.8% |
| 10 | Bristers - Ox | Line | Dominion | $2.4 | ($2.5) | $0.4 | $5.4 | $0.8 | $0.3 | ($0.3) | $0.1 | $5.5 | 3.0% |
| 11 | Breed - Wheatland | Flowgate | MISO | ($0.6) | ($5.6) | $1.4 | $6.4 | $0.0 | ($0.0) | ($1.0) | ($1.0) | $5.4 | 2.9% |
| 12 | 5004/5005 Interface | Interface | 500 | $1.0 | ($6.7) | ($0.3) | $7.3 | $1.2 | $3.9 | $0.4 | ($2.3) | $5.0 | 2.7% |
| 13 | Bedington | Transformer | AP | $1.7 | ($2.9) | $0.1 | $4.7 | $0.1 | $0.1 | $0.0 | $0.0 | $4.8 | 2.6% |
| 14 | AEP - DOM | Interface | 500 | $3.0 | ($2.1) | ($0.4) | $4.7 | $0.0 | $0.0 | $0.0 | $0.0 | $4.7 | 2.5% |
| 15 | Dickerson - Pleasant View | Line | Pepco | $0.6 | ($3.1) | $1.2 | $5.0 | $0.4 | $0.9 | ($1.1) | ($1.6) | $3.4 | 1.8% |
| 16 | Amos | Transformer | AEP | $0.6 | ($2.6) | $1.1 | $4.2 | ($2.5) | $1.1 | ($3.8) | ($7.4) | ($3.2) | (1.7%) |
| 17 | Prairie State - W Mt. Vernon | Flowgate | MISO | ($1.7) | ($4.3) | ($0.2) | $2.3 | $0.0 | ($0.2) | $0.6 | $0.8 | $3.1 | 1.7% |
| 18 | Waldwick - Waldwick | Other | PSEG | $0.0 | ($1.4) | $1.5 | $3.0 | $0.0 | $0.0 | $0.0 | $0.0 | $3.0 | 1.6% |
| 19 | Maywood - Saddlebrook | Line | PSEG | $0.0 | ($0.0) | $0.1 | $0.2 | ($0.0) | $0.5 | ($2.6) | ($3.1) | ($3.0) | (1.6%) |
| 20 | Crete - St Johns | Line | ComEd | $0.0 | $0.0 | $0.0 | $0.0 | $0.1 | $0.6 | ($2.5) | ($2.9) | ($2.9) | (1.6%) |
| 21 | Monticello - East Winamac | Flowgate | MISO | ($0.8) | ($15.0) | $2.6 | $16.8 | $0.3 | $4.4 | ($9.8) | ($13.9) | $2.9 | 1.5% |
| 22 | Bagley - Graceton | Line | BGE | $1.9 | ($0.7) | ($0.0) | $2.6 | ($0.2) | ($0.0) | $0.4 | $0.3 | $2.8 | 1.5% |
| 23 | Hudson | Other | PSEG | $2.1 | $2.2 | $3.0 | $2.8 | $0.0 | $0.0 | $0.0 | $0.0 | $2.8 | 1.5% |
| 24 | Huntington Junction - Huntington | Line | AP | ($0.7) | ($4.2) | ($0.9) | $2.6 | $0.0 | $0.0 | $0.0 | $0.0 | $2.6 | 1.4% |
| 25 | Essex - Essex | Other | PSEG | $0.4 | ($1.3) | $0.5 | $2.2 | $0.0 | $0.0 | $0.0 | $0.0 | $2.2 | 1.2% |

Figure 11-2 shows the locations of the top 10 constraints affecting PJM congestion costs in the first three months of 2014.

Figure 11-2 Location of the top 10 constraints affecting PJM congestion costs: January through March of 2014[16]




16 The term flowgate refers to MISO reciprocal coordinated flowgates and NYISO M2M flowgates in this section.

## Congestion-Event Summary for MISO Flowgates

PJM and MISO have a joint operating agreement (JOA) which defines a coordinated methodology for congestion management. This agreement establishes reciprocal, coordinated flowgates in the combined footprint whose operating limits are respected by the operators of both organizations.[17] A flowgate is a facility or group of facilities that may act as constraint points on the regional system.[18] PJM models these coordinated flowgates and controls for them in its security-constrained, economic dispatch.

As of December 31, 2013, PJM had 159 flowgates eligible for M2M (Market to Market) coordination and MISO had 265 flowgates eligible for M2M coordination.

Table 11-22 and Table 11-23 show the MISO flowgates which PJM and/or MISO took dispatch action to control during the first three months of 2014 and the first three months of 2013, and which had the greatest congestion cost impact on PJM. Total congestion costs are the sum of the day-ahead and balancing congestion cost components. Total congestion costs associated with a given constraint may be positive or negative in value. The top congestion cost impacts for MISO flowgates affecting PJM and MISO dispatch are presented by constraint, in descending order of the absolute value of total congestion costs. Among MISO flowgates in the first three months of 2014, the Breed - Wheatland flowgate made the most significant contribution to positive congestion while the Rising flowgate made the most significant contribution to negative congestion.

### Table 11-22 Top 20 congestion cost impacts from MISO flowgates affecting PJM dispatch (By facility): January through March of 2014

| | | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Day Ahead | | | | Balancing | | | | | Event Hours | |
| No. | Constraint | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| 1 | Breed - Wheatland | ($13.9) | ($78.9) | ($8.4) | $56.5 | $2.1 | $1.3 | $5.7 | $6.5 | $63.0 | 1,853 | 433 |
| 2 | Benton Harbor - Palisades | ($10.9) | ($64.0) | ($7.3) | $45.8 | ($0.2) | $0.7 | ($0.7) | ($1.6) | $44.2 | 1,096 | 97 |
| 3 | Monticello - East Winamac | ($3.1) | ($30.3) | $0.0 | $27.2 | $1.7 | $3.8 | ($5.6) | ($7.6) | $19.5 | 1,489 | 1,004 |
| 4 | Cook - Palisades | ($8.9) | ($42.8) | ($5.4) | $28.5 | ($1.5) | $1.6 | ($6.2) | ($9.3) | $19.2 | 569 | 291 |
| 5 | Rising | ($5.1) | ($3.8) | $1.4 | $0.2 | ($3.9) | $1.2 | ($9.3) | ($14.3) | ($14.1) | 386 | 104 |
| 6 | Wake - Carso | $0.0 | $0.0 | $0.0 | $0.0 | $4.2 | $2.7 | ($10.7) | ($9.3) | ($9.3) | 0 | 115 |
| 7 | Oak Grove - Galesburg | ($4.7) | ($10.8) | $0.5 | $6.6 | ($0.1) | ($0.5) | $0.1 | $0.6 | $7.2 | 1,459 | 215 |
| 8 | Crete - St Johns Tap | ($1.4) | ($6.4) | $1.3 | $6.3 | $0.0 | $0.0 | $0.0 | $0.0 | $6.3 | 571 | 0 |
| 9 | Cumberland - Bush | ($0.2) | ($3.0) | $0.4 | $3.2 | $0.0 | $0.0 | $0.0 | $0.0 | $3.2 | 403 | 0 |
| 10 | Todd Hunter | ($0.7) | ($3.0) | $0.7 | $2.9 | $0.0 | $0.0 | $0.0 | $0.0 | $2.9 | 864 | 0 |
| 11 | Beaver Channel - Albany | $0.0 | $0.0 | $0.0 | $0.0 | ($1.4) | $0.0 | ($1.0) | ($2.4) | ($2.4) | 0 | 69 |
| 12 | Nelson | ($2.6) | ($4.9) | ($0.4) | $1.9 | $0.0 | $0.0 | $0.0 | $0.0 | $1.9 | 81 | 0 |
| 13 | Pana North | $0.1 | ($0.1) | $0.1 | $0.3 | $0.0 | $0.2 | ($1.8) | ($1.9) | ($1.6) | 157 | 48 |
| 14 | Michigan City - Laporte | ($0.4) | ($1.7) | $0.0 | $1.4 | $0.0 | $0.0 | $0.0 | $0.0 | $1.4 | 188 | 0 |
| 15 | Tiltonsville | $0.2 | ($0.7) | $0.1 | $0.9 | $0.0 | $0.0 | $0.0 | $0.0 | $0.9 | 50 | 0 |
| 16 | Whitestown - Guion | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | ($0.1) | $0.8 | $0.9 | $0.9 | 0 | 23 |
| 17 | Paddock - Townline | ($0.0) | ($0.5) | $0.2 | $0.7 | $0.0 | $0.0 | ($0.0) | ($0.0) | $0.7 | 475 | 2 |
| 18 | Kewanee - Edwards | $0.0 | $0.0 | $0.0 | $0.0 | $0.1 | ($0.2) | ($0.8) | ($0.5) | ($0.5) | 0 | 84 |
| 19 | Powerton Jct - Lilly | ($0.3) | ($0.5) | $0.3 | $0.5 | ($0.0) | ($0.0) | ($0.0) | ($0.0) | $0.5 | 384 | 0 |
| 20 | Bunsonville - Eugene | ($1.2) | ($1.5) | $0.5 | $0.8 | ($0.1) | ($0.1) | ($1.2) | ($1.3) | ($0.5) | 282 | 8 |

17 See "Joint Operating Agreement Between the Midwest Independent Transmission System Operator, Inc. and PJM Interconnection, L.L.C.," (December 11, 2008) <http://pjm.com/documents/agreements/~/media/documents/agreements/joa-complete.ashx>.

18 See "Joint Operating Agreement Between the Midwest Independent Transmission System Operator, Inc. and PJM Interconnection, L.L.C.," (December 11, 2008), Section 2.2.24 <http://pjm.com/documents/agreements/~/media/documents/agreements/joa-complete.ashx>.

Table 11-23 Top 20 congestion cost impacts from MISO flowgates affecting PJM dispatch (By facility): January through March of 2013

| | | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Day Ahead | | | | Balancing | | | | | Event Hours | |
| No. | Constraint | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| 1 | Crete - St Johns Tap | ($0.4) | ($5.8) | $2.2 | $7.6 | $0.0 | $0.0 | $0.0 | $0.0 | $7.6 | 773 | 0 |
| 2 | Breed - Wheatland | ($0.6) | ($5.6) | $1.4 | $6.4 | $0.0 | ($0.0) | ($1.0) | ($1.0) | $5.4 | 724 | 148 |
| 3 | Prairie State - W Mt. Vernon | ($1.7) | ($4.3) | ($0.2) | $2.3 | $0.0 | ($0.2) | $0.6 | $0.8 | $3.1 | 897 | 692 |
| 4 | Monticello - East Winamac | ($0.8) | ($15.0) | $2.6 | $16.8 | $0.3 | $4.4 | ($9.8) | ($13.9) | $2.9 | 998 | 387 |
| 5 | Volunteer - Phipps Bend | $0.0 | $0.0 | $0.0 | $0.0 | $0.8 | $0.0 | ($2.9) | ($2.1) | ($2.1) | 0 | 63 |
| 6 | Oak Grove - Galesburg | ($1.7) | ($3.1) | ($0.6) | $0.8 | ($0.2) | $0.1 | $0.3 | $0.0 | $0.8 | 654 | 362 |
| 7 | Beaver Channel - Albany | $0.0 | $0.0 | $0.0 | $0.0 | ($0.2) | $0.1 | ($0.4) | ($0.7) | ($0.7) | 0 | 41 |
| 8 | Lanesville | ($0.1) | ($0.5) | $0.2 | $0.6 | $0.0 | ($0.0) | ($0.0) | $0.0 | $0.6 | 290 | 14 |
| 9 | Pana North | $0.0 | $0.0 | $0.0 | $0.0 | ($0.0) | $0.0 | ($0.5) | ($0.6) | ($0.6) | 0 | 7 |
| 10 | Rising | ($0.4) | ($1.5) | $0.6 | $1.7 | ($0.1) | $0.1 | ($1.0) | ($1.2) | $0.5 | 534 | 138 |
| 11 | Rantoul - Rantoul Jct | ($0.0) | ($0.2) | $0.2 | $0.3 | $0.0 | $0.0 | $0.0 | $0.0 | $0.3 | 53 | 0 |
| 12 | Cayuga | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | ($0.2) | ($0.3) | ($0.3) | 0 | 13 |
| 13 | Reynold-Monticello | ($0.1) | ($0.5) | $0.2 | $0.7 | $0.0 | $0.0 | ($0.5) | ($0.5) | $0.2 | 86 | 51 |
| 14 | Bushcin - Lafayette | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | ($0.1) | ($0.1) | ($0.1) | 0 | 5 |
| 15 | Edwards - Kewanee | ($0.0) | ($0.1) | $0.1 | $0.1 | ($0.0) | $0.0 | $0.0 | $0.0 | $0.1 | 140 | 2 |
| 16 | Bunsonville - Eugene | ($0.1) | ($0.2) | $0.0 | $0.2 | $0.0 | ($0.1) | ($0.3) | ($0.3) | ($0.1) | 24 | 91 |
| 17 | Pawnee | $0.0 | ($0.0) | $0.1 | $0.1 | $0.0 | $0.0 | $0.0 | $0.0 | $0.1 | 39 | 0 |
| 18 | Rantoul Jct - Sidney | $0.0 | $0.0 | $0.0 | $0.0 | ($0.0) | $0.0 | ($0.1) | ($0.1) | ($0.1) | 0 | 34 |
| 19 | Powerton Jct - Lilly | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | ($0.0) | $0.0 | $0.1 | $0.1 | 0 | 23 |
| 20 | Cumberland - Bush | ($0.1) | ($1.0) | $0.1 | $1.0 | $0.0 | $0.2 | ($0.8) | ($1.0) | $0.0 | 76 | 50 |

## Congestion-Event Summary for NYISO Flowgates

PJM and NYISO have a joint operating agreement (JOA) which defines a coordinated methodology for congestion management. This agreement establishes a structure and framework for the reliable operation of the interconnected PJM and NYISO transmission systems and efficient market operation through M2M coordination.[19] Only a subset of all transmission constraints that exist in either market are eligible for coordinated congestion management. This subset of transmission constraints is identified as M2M flowgates. Flowgates eligible for the M2M coordination process are called M2M flowgates.[20]

Table 11-24 shows the NYISO flowgates which PJM and/or NYISO took dispatch action to control during the first three months of 2014, and which had the greatest congestion cost impact on PJM.

### Table 11-24 Top two congestion cost impacts from NYISO flowgates affecting PJM dispatch (By facility): January through March of 2014

| | | | | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Day Ahead | | | | Balancing | | | | | Event Hours | |
| No. | Constraint | Type | Location | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| 1 | Central East | Flowgate | NYISO | $0.0 | $0.0 | $0.0 | $0.0 | $0.5 | $2.0 | ($0.1) | ($1.6) | ($1.6) | 0 | 107 |
| 2 | Dysinger East | Flowgate | NYISO | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | ($0.0) | ($0.0) | $0.0 | $0.0 | 0 | 4 |

### Table 11-25 Top two congestion cost impacts from NYISO flowgates affecting PJM dispatch (By facility): January through March of 2013

| | | | | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Day Ahead | | | | Balancing | | | | | Event Hours | |
| No. | Constraint | Type | Location | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| 1 | Central East | Flowgate | NYISO | $0.3 | ($1.2) | ($0.2) | $1.3 | $0.6 | $2.1 | ($1.4) | ($2.9) | ($1.6) | 48 | 159 |
| 2 | Dysinger East | Flowgate | NYISO | $0.0 | $0.0 | $0.0 | $0.0 | ($0.0) | $0.2 | $0.0 | ($0.2) | ($0.2) | 0 | 9 |

19 See "Joint Operating Agreement Among and Between the New York Independent System Operator Inc. and PJM Interconnection, L.L.C.," (January 17, 2013) Section 35.3.1 <http://www.pjm.com/~/media/documents/agreements/nyiso-pjm.ashx> (Accessed April 17, 2013).

20 See "Joint Operating Agreement Among and Between the New York Independent System Operator Inc. and PJM Interconnection, L.L.C.," (January 17, 2013) Section 35.23 <http://www.pjm.com/~/media/documents/agreements/nyiso-pjm.ashx> (Accessed April 17, 2013).

## Congestion-Event Summary for the 500 kV System

Constraints on the 500 kV system generally have a regional impact. Table 11-26 and Table 11-27 show the 500 kV constraints impacting congestion costs in PJM for the first three months of 2014 and the first three months of 2014. Total congestion costs are the sum of the day-ahead and balancing congestion cost components. Total congestion costs associated with a given constraint may be positive or negative in value. The 500 kV constraints impacting congestion costs in PJM are presented by constraint, in descending order of the absolute value of total congestion costs.

### Table 11-26 Regional constraints summary (By facility): January through March of 2014

| | | | | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Day Ahead | | | | Balancing | | | | | Event Hours | |
| No. | Constraint | Type | Location | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| 1 | AP South | Interface | 500 | $295.7 | ($185.8) | ($11.7) | $469.8 | $31.1 | $73.1 | $9.1 | ($32.8) | $436.9 | 2,347 | 864 |
| 2 | West | Interface | 500 | ($19.9) | ($282.4) | ($77.9) | $184.5 | $16.7 | $47.7 | $16.7 | ($14.3) | $170.2 | 1,022 | 345 |
| 3 | Bedington - Black Oak | Interface | 500 | $20.5 | ($30.7) | ($2.3) | $48.8 | $1.4 | $3.9 | ($1.2) | ($3.6) | $45.2 | 841 | 171 |
| 4 | East | Interface | 500 | ($6.2) | ($25.1) | ($3.0) | $15.9 | $0.3 | $0.7 | $0.5 | $0.1 | $16.0 | 1,217 | 17 |
| 5 | 5004/5005 Interface | Interface | 500 | $0.4 | ($17.6) | ($2.7) | $15.3 | $7.7 | $17.5 | $7.1 | ($2.7) | $12.6 | 299 | 313 |
| 6 | Central | Interface | 500 | ($5.0) | ($13.6) | ($3.8) | $4.8 | $0.2 | $0.5 | $0.0 | ($0.3) | $4.5 | 297 | 10 |
| 7 | AEP - DOM | Interface | 500 | $6.7 | ($9.7) | $3.0 | $19.4 | $5.5 | $13.3 | ($9.6) | ($17.3) | $2.1 | 756 | 54 |
| 8 | Branchburg - Elroy | Line | 500 | ($0.0) | ($0.0) | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | 10 | 0 |
| 9 | Juniata | Transformer | 500 | $0.0 | ($0.0) | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | 2 | 0 |
| 10 | SENECA | Interface | 500 | $0.0 | ($0.0) | ($0.0) | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | 1 | 0 |

### Table 11-27 Regional constraints summary (By facility): January through March of 2013

| | | | | Congestion Costs (Millions) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Day Ahead | | | | Balancing | | | | | Event Hours | |
| No. | Constraint | Type | Location | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Grand Total | Day Ahead | Real Time |
| 1 | AP South | Interface | 500 | $62.2 | ($23.0) | $0.2 | $85.4 | $5.8 | $10.8 | $1.4 | ($3.6) | $81.8 | 2,012 | 505 |
| 2 | West | Interface | 500 | $1.9 | ($8.4) | ($0.6) | $9.8 | $0.0 | $0.0 | ($0.0) | ($0.0) | $9.7 | 341 | 1 |
| 3 | 5004/5005 Interface | Interface | 500 | $1.0 | ($6.7) | ($0.3) | $7.3 | $1.2 | $3.9 | $0.4 | ($2.3) | $5.0 | 151 | 96 |
| 4 | AEP - DOM | Interface | 500 | $3.0 | ($2.1) | ($0.4) | $4.7 | $0.0 | $0.0 | $0.0 | $0.0 | $4.7 | 609 | 1 |
| 5 | Central | Interface | 500 | ($0.6) | ($2.7) | ($0.4) | $1.7 | $0.0 | $0.0 | $0.0 | $0.0 | $1.7 | 116 | 0 |
| 6 | Bedington - Black Oak | Interface | 500 | $0.9 | ($0.7) | $0.1 | $1.7 | $0.0 | $0.0 | ($0.0) | ($0.0) | $1.6 | 105 | 2 |
| 7 | East | Interface | 500 | ($0.1) | ($0.3) | ($0.0) | $0.3 | ($0.0) | $0.0 | ($0.0) | ($0.0) | $0.2 | 55 | 4 |
| 8 | Conemaugh - Hunterstown | Line | 500 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | ($0.0) | ($0.2) | ($0.2) | ($0.2) | 0 | 13 |
| 9 | Nagel - Phipps Bend | Line | 500 | $0.0 | ($0.0) | $0.1 | $0.1 | $0.0 | $0.0 | $0.0 | $0.0 | $0.1 | 22 | 0 |
| 10 | Cloverdale - Lexington | Line | 500 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | ($0.1) | ($0.1) | $0.0 | $0.0 | 0 | 6 |
| 11 | Juniata | Transformer | 500 | $0.0 | ($0.0) | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | 1 | 0 |

## Congestion Costs by Physical and Financial Participants

In order to evaluate the recipients and payers of congestion, the MMU categorized all participants in PJM as either physical or financial. Physical entities include utilities and customers which primarily take physical positions in PJM markets. Financial entities include banks and hedge funds which primarily take financial positions in PJM markets. International market participants that primarily take financial positions in PJM markets are generally considered to be financial entities even if they are utilities in their own countries.

In the first three months of 2014, financial companies as a group were net recipients of congestion credits, and physical companies were net payers of congestion charges. UTCs are in the explicit cost category and comprise most of that category. Explicit costs are the primary source of congestion credits to financial entities. In the first three months of 2014, financial companies received $190.8 million, an increase of $162.4 million or 571.9 percent compared to the first three months of 2013. In the first three months of 2014, physical companies paid $1,426.9 million in congestion charges, an increase of $1,212.6 million or 565.8 percent compared to the first three months of 2013.

### Table 11-28 Congestion cost by type of participant: January through March of 2014

| | Congestion Costs (Millions) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Day Ahead | | | | Balancing | | | | | |
| Participant Type | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Inadvertent Charges | Grand Total |
| Financial | $56.1 | $65.3 | ($110.5) | ($119.7) | ($14.0) | ($2.5) | ($59.6) | ($71.1) | $0.0 | ($190.8) |
| Physical | $277.6 | ($1,259.2) | $16.2 | $1,553.0 | $87.0 | $211.4 | ($1.7) | ($126.1) | $0.0 | $1,426.9 |
| Total | $333.7 | ($1,193.9) | ($94.3) | $1,433.3 | $73.0 | $208.9 | ($61.3) | ($197.2) | $0.0 | $1,236.1 |

### Table 11-29 Congestion cost by type of participant: January through March of 2013

| | Congestion Costs (Millions) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Day Ahead | | | | Balancing | | | | | |
| Participant Type | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Inadvertent Charges | Grand Total |
| Financial | $29.4 | $25.3 | $30.3 | $34.4 | ($12.3) | $1.2 | ($49.2) | ($62.7) | $0.0 | ($28.4) |
| Physical | $55.6 | ($224.4) | $17.5 | $297.5 | $5.7 | $72.1 | ($16.8) | ($83.2) | $0.0 | $214.3 |
| Total | $85.0 | ($199.1) | $47.8 | $331.9 | ($6.6) | $73.3 | ($66.0) | ($145.9) | $0.0 | $185.9 |

# Marginal Losses

## Marginal Loss Accounting

PJM calculates marginal loss costs for each PJM member. The loss cost is based on the applicable day-ahead and real-time marginal loss component of LMP (MLMP). Each PJM member is charged for the cost of losses on the transmission system.

Total marginal loss costs, analogous to total congestion costs, are equal to the net of the load loss payments minus generation loss credits, plus explicit loss costs, incurred in both the Day-Ahead Energy Market and the Balancing Energy Market. Total marginal loss costs can by more accurately thought of as net marginal loss costs.

Marginal loss costs can be both positive and negative and consequently load payments and generation credits can also be both positive and negative. The loss component of LMP is calculated with respect to the system marginal price (SMP). An increase in generation at a bus that results in an increase in losses will cause the marginal loss component of that bus to be negative. If the increase in generation at the bus results in a decrease of system losses, then the marginal loss component is positive.

The total marginal loss cost in PJM for the first three months of 2014 was $775.9 million, which was comprised of load loss payments of -$15.1 million, generation loss credits of -$813.7 million, explicit loss costs of -$22.8 million and inadvertent loss charges of $0.0 million. Monthly marginal loss costs in the first three months of 2014 ranged from $175.4 million in March to $414.6 million in January. Marginal loss credits increased in the first three months of 2014 by $158.0 million or 158.9 percent from the first three months of 2013, from $99.4 million to $257.4 million.

## Total Marginal Loss Costs

Table 11-30 shows the total marginal loss component costs for the first three months of 2009 through 2014.

### Table 11-30 Total PJM costs by loss component (Dollars (Millions)): January through March of 2009 through 2014 [21]

| (Jan-Mar) | Loss Costs | Percent Change | Total PJM Billing | Percent of PJM Billing |
|---|---|---|---|---|
| 2009 | $454 | NA | $7,515 | 6.0% |
| 2010 | $417 | (8.2%) | $8,415 | 5.0% |
| 2011 | $410 | (1.7%) | $9,584 | 4.3% |
| 2012 | $234 | (42.8%) | $6,938 | 3.4% |
| 2013 | $278 | 18.5% | $7,762 | 3.6% |
| 2014 | $776 | 179.5% | $21,070 | 3.7% |

Total marginal loss costs for the first three months of 2009 through 2014 are shown in Table 11-31 and Table 11-32. Table 11-31 shows PJM total marginal loss costs by accounting category for the first three months of 2009 through 2014. Table 11-32 shows PJM total marginal loss costs by accounting category by market for the first three months of 2009 through 2014.

### Table 11-31 Total PJM marginal loss costs by accounting category (Dollars (Millions)): January through March of 2009 through 2014

| | Marginal Loss Costs (Millions) | | | | |
|---|---|---|---|---|---|
| (Jan-Mar) | Load Payments | Generation Credits | Explicit Costs | Inadvertent Charges | Total |
| 2009 | ($21.3) | ($460.6) | $14.7 | $0.0 | $454.0 |
| 2010 | ($3.8) | ($414.1) | $6.3 | ($0.0) | $416.6 |
| 2011 | ($26.5) | ($421.2) | $14.9 | $0.0 | $409.6 |
| 2012 | ($11.2) | ($252.1) | ($6.6) | $0.0 | $234.3 |
| 2013 | $8.0 | ($277.8) | ($8.2) | ($0.0) | $277.6 |
| 2014 | ($15.1) | ($813.7) | ($22.8) | $0.0 | $775.9 |

21 The loss costs include net inadvertent charges.

Table 11-32 Total PJM marginal loss costs by accounting category by market (Dollars (Millions)): January through March of 2009 through 2014

| | Marginal Loss Costs (Millions) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Day Ahead | | | | Balancing | | | | | |
| (Jan-Mar) | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Inadvertent Charges | Grand Total |
| 2009 | ($23.3) | ($457.6) | $30.9 | $465.2 | $2.1 | ($3.0) | ($16.3) | ($11.2) | $0.0 | $454.0 |
| 2010 | ($8.5) | ($413.5) | $12.8 | $417.8 | $4.7 | ($0.6) | ($6.5) | ($1.2) | ($0.0) | $416.6 |
| 2011 | ($37.1) | ($430.1) | $26.0 | $419.1 | $10.6 | $8.9 | ($11.1) | ($9.5) | $0.0 | $409.6 |
| 2012 | ($16.7) | ($256.8) | $8.0 | $248.1 | $5.6 | $4.7 | ($14.6) | ($13.8) | $0.0 | $234.3 |
| 2013 | ($0.1) | ($288.2) | $8.1 | $296.2 | $8.1 | $10.4 | ($16.3) | ($18.6) | ($0.0) | $277.6 |
| 2014 | ($48.6) | ($847.4) | $32.3 | $831.1 | $33.5 | $33.7 | ($55.1) | ($55.3) | $0.0 | $775.9 |

## Monthly Marginal Loss Costs

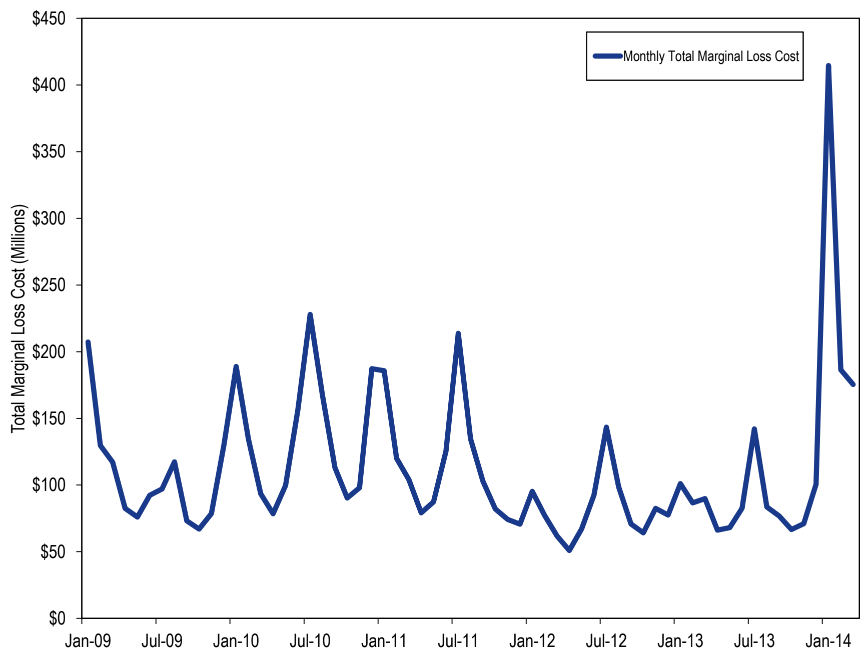
Table 11-33 shows a monthly summary of marginal loss costs by market type for the first three months of 2013 and the first three months of 2014.

Table 11-33 Monthly marginal loss costs by market (Dollars (Millions)): January through March of 2013 and 2014

| | Marginal Loss Costs (Millions) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | | | | 2014 | | | |
| | Day-Ahead Total | Balancing Total | Inadvertent Charges | Grand Total | Day-Ahead Total | Balancing Total | Inadvertent Charges | Grand Total |
| Jan | $105.8 | ($4.7) | $0.0 | $101.1 | $431.1 | ($16.5) | $0.0 | $414.6 |
| Feb | $93.2 | ($6.5) | ($0.0) | $86.7 | $202.1 | ($16.3) | $0.0 | $185.8 |
| Mar | $97.2 | ($7.4) | ($0.0) | $89.8 | $198.0 | ($22.6) | ($0.0) | $175.4 |
| Total | $296.2 | ($18.6) | $0.0 | $277.6 | $831.1 | ($55.3) | $0.0 | $775.9 |

Figure 11-3 shows PJM monthly marginal loss costs for January 2009 through March 2014.

### Figure 11-3 PJM monthly marginal loss costs (Dollars (Millions)): January 2009 through March 2014




## Marginal Loss Costs and Loss Credits

Marginal loss credits (loss surplus) are calculated by adding the total energy costs, the total marginal loss costs and net residual market adjustments. The total energy costs are equal to the net implicit energy costs (generation energy credits less load energy payments) plus net explicit energy costs plus net inadvertent energy charges. Total marginal loss costs are equal to the net implicit marginal loss costs (generation loss credits less load loss payments) plus net explicit loss costs plus net inadvertent loss charges.

Ignoring interchange, total generation MWh must be greater than total load MWh in any hour in order to provide for losses. Since the hourly integrated energy component of LMP is the same for every bus within every hour, the net energy bill is negative (ignoring net interchange), with more generation credits than load payments in every hour. Total energy costs plus total marginal loss costs plus net residual market adjustments equal marginal loss credits which are distributed to load and exports as marginal loss credits.

Table 11-34 shows the total energy costs, the total marginal loss costs collected, the net residual market adjustments and total marginal loss credits redistributed for the first three months of 2009 through 2014. The total marginal loss credits increased $158.0 million in the first three months of 2014 from the first three months of 2013.

### Table 11-34 Marginal loss credits (Dollars (Millions)): January through March of 2009 through 2014[22]

| | Loss Credit Accounting (Millions) | | | |
|---|---|---|---|---|
| (Jan-Mar) | Total Energy Charges | Total Marginal Loss Charges | Adjustments | Loss Credits |
| 2009 | ($218.3) | $454.0 | $0.9 | $236.6 |
| 2010 | ($207.6) | $416.6 | ($0.0) | $208.9 |
| 2011 | ($209.9) | $409.6 | $0.5 | $200.1 |
| 2012 | ($136.4) | $234.3 | ($0.2) | $97.7 |
| 2013 | ($177.9) | $277.6 | ($0.3) | $99.4 |
| 2014 | ($515.1) | $775.9 | ($3.3) | $257.4 |

22 The net residual market adjustments included in the table are comprised of the known day-ahead error value minus the sum of the day-ahead loss MW congestion value, balancing loss MW congestion value and measurement error caused by missing data.

# Energy Costs

## Energy Accounting

The energy component of LMP is the system reference bus LMP, also called the system marginal price (SMP). The energy cost is based on the day-ahead and real-time energy components of LMP. Total energy costs, analogous to total congestion costs, are equal to the load energy payments minus generation energy credits, plus explicit energy costs, incurred in both the Day-Ahead Energy Market and the Balancing Energy Market, plus net inadvertent energy charges. Total energy costs can by more accurately thought of as net energy costs.

Ignoring interchange, total generation MWh must be greater than total load MWh in every hour in order to provide for losses. Since the hourly integrated energy component of LMP is the same for every bus in every hour, the net energy costs are negative (ignoring net interchange), with generation credits greater than load payments in every hour. These net energy costs plus net marginal loss costs plus net residual market adjustments, equal the marginal loss surplus which is distributed to load and exports.

The total energy cost for the first three months of 2014 was -$515.1 million, which was comprised of load energy payments of $28,506.4 million, generation energy credits of $29,014.7 million, explicit energy costs of $0.0 million and inadvertent energy charges of -$6.9 million. The monthly energy costs for the first three months of 2014 ranged from -$272.5 million in January to -$119.6 million in March.

## Total Energy Costs

Table 11-35 shows total energy component costs and total PJM billing, for the first three months of 2009 through 2014. The total energy component costs are net energy costs.

Table 11-35 Total PJM costs by energy component (Dollars (Millions)): January through March of 2009 through 2014[23]

| (Jan-Mar) | Energy Costs | Percent Change | Total PJM Billing | Percent of PJM Billing |
|---|---|---|---|---|
| 2009 | ($218) | NA | $7,515 | (2.9%) |
| 2010 | ($208) | (4.9%) | $8,415 | (2.5%) |
| 2011 | ($210) | 1.1% | $9,584 | (2.2%) |
| 2012 | ($136) | (35.0%) | $6,938 | (2.0%) |
| 2013 | ($178) | 30.4% | $7,762 | (2.3%) |
| 2014 | ($515) | 189.6% | $21,070 | (2.4%) |

Energy costs for the first three months of 2009 through 2014 are shown in Table 11-36 and Table 11-37. Table 11-36 shows PJM energy costs by accounting category for the first three months of 2009 through 2014 and Table 11-37 shows PJM energy costs by market category for the first three months of 2009 through 2014. These energy costs are the actual total energy costs rather than the net energy costs in Table 11-35.

Table 11-36 Total PJM energy costs by accounting category (Dollars (Millions)): January through March of 2009 through 2014

| | Energy Costs (Millions) | | | | |
|---|---|---|---|---|---|
| (Jan-Mar) | Load Payments | Generation Credits | Explicit | Inadvertent Charges | Total |
| 2009 | $14,058.4 | $14,277.4 | $0.0 | $0.7 | ($218.3) |
| 2010 | $13,424.4 | $13,629.0 | $0.0 | ($3.0) | ($207.6) |
| 2011 | $11,943.9 | $12,160.7 | $0.0 | $6.9 | ($209.9) |
| 2012 | $8,485.4 | $8,628.7 | $0.0 | $6.8 | ($136.4) |
| 2013 | $10,357.2 | $10,535.1 | $0.0 | ($0.0) | ($177.9) |
| 2014 | $28,506.4 | $29,014.7 | $0.0 | ($6.9) | ($515.1) |

23 The energy costs include net inadvertent charges.

Table 11-37 Total PJM energy costs by market category (Dollars (Millions)): January through March of 2009 through 2014

| | Energy Costs (Millions) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Day Ahead | | | | Balancing | | | | | |
| (Jan-Mar) | Load Payments | Generation Credits | Explicit Costs | Total | Load Payments | Generation Credits | Explicit Costs | Total | Inadvertent Charges | Grand Total |
| 2009 | $14,129.6 | $14,375.6 | $0.0 | ($246.0) | ($71.2) | ($98.2) | $0.0 | $27.0 | $0.7 | ($218.3) |
| 2010 | $13,408.9 | $13,619.2 | $0.0 | ($210.2) | $15.5 | $9.8 | $0.0 | $5.6 | ($3.0) | ($207.6) |
| 2011 | $12,055.5 | $12,259.3 | $0.0 | ($203.9) | ($111.6) | ($98.6) | $0.0 | ($12.9) | $6.9 | ($209.9) |
| 2012 | $8,534.4 | $8,649.0 | $0.0 | ($114.6) | ($49.0) | ($20.4) | $0.0 | ($28.6) | $6.8 | ($136.4) |
| 2013 | $10,387.2 | $10,580.9 | $0.0 | ($193.7) | ($29.9) | ($45.8) | $0.0 | $15.9 | ($0.0) | ($177.9) |
| 2014 | $28,412.1 | $29,082.9 | $0.0 | ($670.9) | $94.3 | ($68.3) | $0.0 | $162.6 | ($6.9) | ($515.1) |

## Monthly Energy Costs

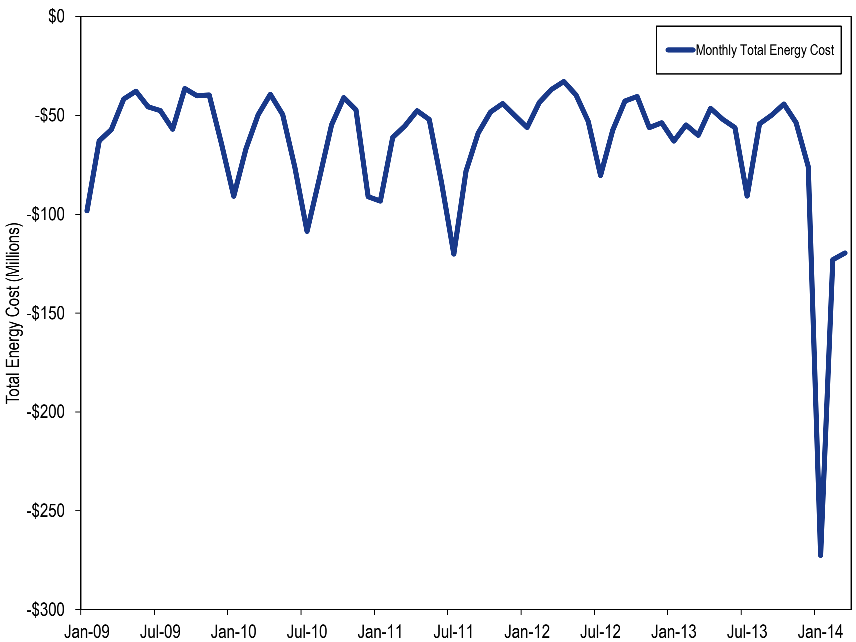
Table 11-38 shows a monthly summary of energy costs by market type for the first three months of 2013 and the first three months of 2014.

Table 11-38 Monthly energy costs by market type (Dollars (Millions)): January through March of 2013 and 2014

| | Energy Costs (Millions) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | | | | 2014 | | | |
| | Day-Ahead Total | Balancing Total | Inadvertent Charges | Grand Total | Day-Ahead Total | Balancing Total | Inadvertent Charges | Grand Total |
| Jan | ($69.2) | $5.8 | $0.5 | ($63.0) | ($339.8) | $68.3 | ($1.0) | ($272.5) |
| Feb | ($60.6) | $5.9 | ($0.1) | ($54.8) | ($163.7) | $43.5 | ($2.8) | ($123.0) |
| Mar | ($63.9) | $4.2 | ($0.3) | ($60.0) | ($167.3) | $50.8 | ($3.1) | ($119.6) |
| Total | ($193.7) | $15.9 | ($0.0) | ($177.9) | ($670.9) | $162.6 | ($6.9) | ($515.1) |

Figure 11-4 shows PJM monthly energy costs of January 2009 through March 2014.

Figure 11-4 PJM monthly energy costs (Dollars (Millions)): January 2009 through March 2014

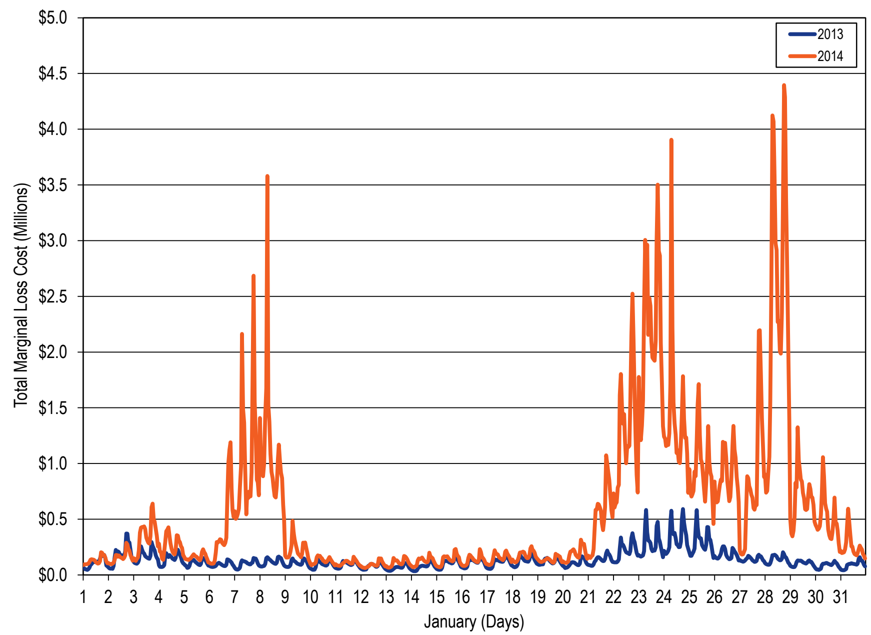



## January High Load Days

The total marginal loss cost in January 2014 was 310.3 percent higher than in January 2013. Total marginal loss costs increased because of the cold weather in January, which caused higher load and prices and an increased level of losses. The loss MW in PJM increased 16.9 percent, from 1,686 GWh in January 2013 to 1,971 GWh in January 2014.

Figure 11-5 shows PJM total marginal loss cost for January of 2013 and 2014.

Figure 11-5 PJM total marginal loss cost (Dollars (Millions)): January of 2013 and 2014




The total congestion costs in January 2014 were 1,275.3 percent higher than in January 2013. Total congestion costs increased because of the cold weather in January, which caused higher load and prices and an increased frequency of congestion.

Figure 11-6 shows PJM total congestion cost for January of 2013 and 2014.

**Figure 11-6 PJM total congestion cost (Dollars (Millions)): January of 2013 and 2014**