

Market Efficiency Update

Transmission Expansion Advisory Committee

April 11, 2019

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2018/19 Market Efficiency Window



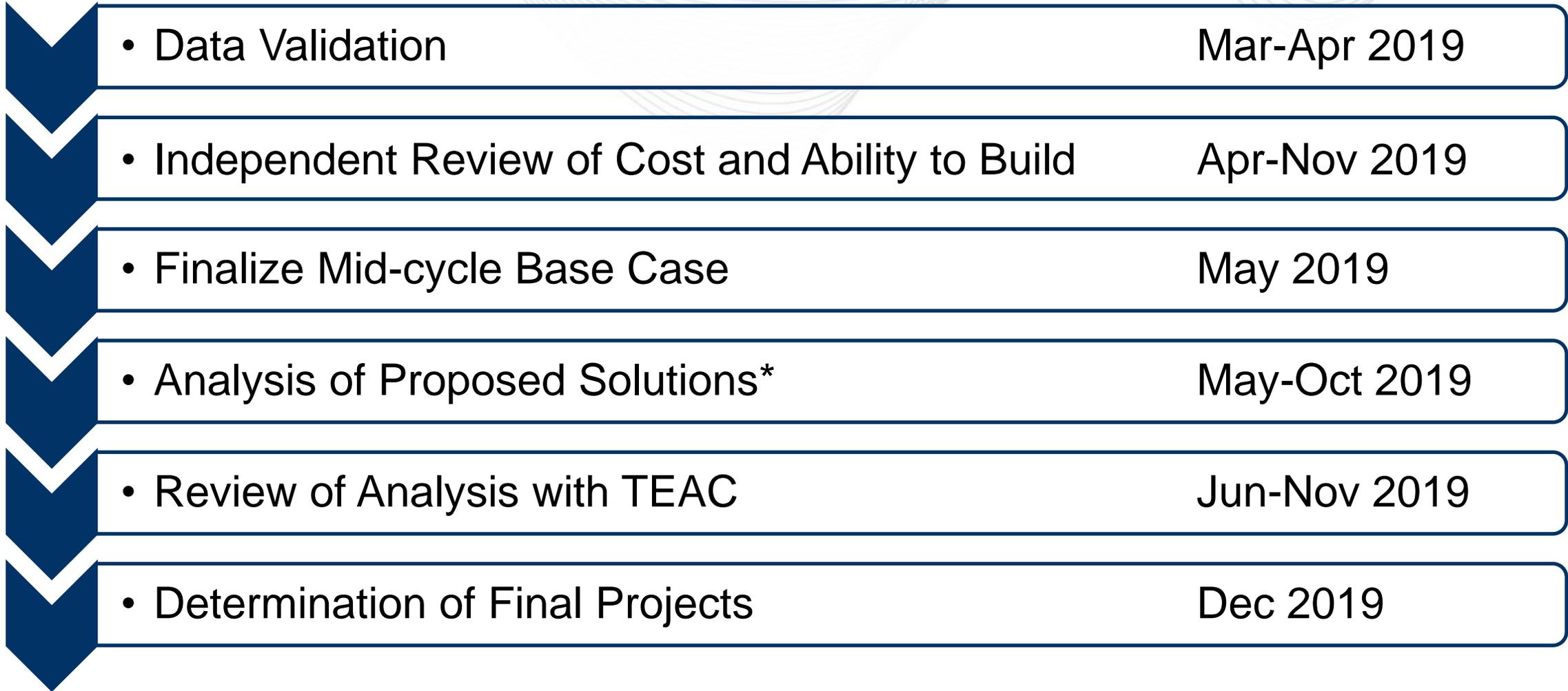
2018/19 RTEP Window Posted Congestion Drivers

| 2018/19 RTEP Market Efficiency Window Eligible Congestion Drivers* | | | | Simulated Annual Congestion (\$M) | | Hours Binding | | | | |
|--|---------------------------------|-----------|---------|-----------------------------------|---------------------|---------------------|---------------------|----------------------------|-------------------|--|
| FG# | Constraint | From Area | To Area | 2023 Simulated Year | 2026 Simulated Year | 2023 Simulated Year | 2026 Simulated Year | Line is conductor limited? | Comment | Potential Upgrades |
| ME-1 | Hunterstown to Lincoln 115 kV | METED | METED | \$20.77 | \$29.62 | 1720 | 1832 | Yes | Internal Flowgate | |
| ME-2 | Monroe to Wayne 345 kV | MISOE | MISOE | \$1.44 | \$0.61 | 45 | 30 | MISO | M2M | |
| ME-6 | Marblehead 161/138 kV | MISOC | MISOC | \$1.41 | \$1.18 | 195 | 138 | MISO | M2M | A PJM/MISO TMEP has been approved for this facility. |
| ME-7 | Bosserman to Trail Creek 138 kV | AEP | MISOE | \$1.47 | \$1.69 | 66 | 89 | Yes | M2M | |

* Market Efficiency Base Case without FSA/Susp ISA units

Note: In February 2019, Eligible Congestion Drivers were updated due to FERC Order, issued on February 12, 2019, accepting PJM’s filed revisions to exclude from its Market Efficiency assumptions, with exceptions, generation with an executed Facilities Study Agreement (FSA) or an executed Interconnection Service Agreement (ISA) under suspension.

- 22 proposals addressing Hunterstown - Lincoln 115 kV
 - 19 greenfield projects
 - \$5 M - \$291 M
 - 3 upgrade projects
 - \$7 M - \$137 M
- 9 proposals on interregional congestion drivers
 - 5 greenfield projects
 - \$19 M - \$266 M
 - 4 upgrade projects
 - \$0.5 M - \$36 M
- 2 proposals not addressing PJM-identified congestion drivers
- 10 proposing entities (including 1 joint proposal)
- 6 battery proposals and 1 Smart Wire proposal



* Due to the need to coordinate with MISO, interregional proposals will be analyzed first.

- Kick-off conference calls held with all proposing entities
 - High-level preview of the proposals
 - Verified consistency of modelling data with the project description: idv, con/mon files
 - Follow-up subsequent calls will be set as needed
- Preliminary review of received costs
 - Checked component costs against project total cost
 - Checked completeness of cost structure
- If deficiency found, contacted the proposer

- Mid-cycle update of major assumptions Apr – May 2019
 - Demand Forecast (completed)
 - Generation Expansion (completed)
 - Fuel/Emission Prices
 - Topology Updates
 - Con/Mon Updates
- Only updating the most significant changes, not a full update
- Base Case including mid-cycle update will be posted by May 2019

2018/19 Window Proposals Received



Proposal Statistics by Target Congestion Driver

| Congestion Driver | Transmission Zone | Greenfield Proposals Count | Upgrade Proposals Count | Total Proposals Count | Cost Range |
|--------------------------------|-------------------|----------------------------|-------------------------|-----------------------|------------------|
| Hunterstown - Lincoln 115 kV | METED | 19 | 3 | 22 | \$5 M - \$291 M |
| Bosserman - Trail Creek 138 kV | AEP-MISOE | 4 | 2 | 6 | \$14 M - \$266 M |
| Marblehead XFMR | MISOC | 1 | 1 | 2 | \$36 M |
| Monroe 1&2 - Wayne 345 kV | MISOE | - | 1 | 1 | \$0.5 M |
| No PJM Driver | - | 1 | 1 | 2 | \$2 M - \$14 M |
| Total | - | 25 | 8 | 33 | - |

Proposals Received PJM Internal Congestion Drivers



Hunterstown - Lincoln 115 kV (Met-Ed)

| PJM ID | Proposal Description | Greenfield/ Upgrade | Project Cost (In-Service \$M) | In-Service Date |
|--------|--|---------------------|-------------------------------|-----------------|
| 616 | Build a new Wentz-Carroll 230 kV line and a new Peach Bottom-Graceton 230 kV line. Increase ratings of Carroll-Mt. Airy 230 kV line. | Greenfield | \$290.95 | 2024 |
| 593 | Build a new Littlestown-Germantown 115 kV line and a new Peach Bottom-Graceton 230 kV line. | Greenfield | \$183.69 | 2024 |
| 387 | Build a new Wentz-Carroll 230 kV line. Increase ratings of Carroll-Mt. Airy 230 kV line. | Greenfield | \$152.18 | 2024 |
| 389 | Rebuild Hunterstown-Lincoln 115 kV line. Build a new Peach Bottom-Graceton 230 kV line. | Greenfield | \$147.64 | 2024 |
| 034 | Rebuild the Hunterstown-Lincoln-Germantown 115 kV and Germantown-Carroll 138 kV corridors as a new Hunterstown-Carroll 230 kV circuit. | Upgrade | \$136.64 | 2023 |
| 868 | Build a new Delta Tap-Conastone 500 kV line. Build a new 115 kV ring bus at the Lincoln tap connecting Orrtanna, Hunterstown and Lincoln 115 kV buses. Replace Face Rock 115/69 kV transformers. | Greenfield | \$122.08 | 2023 |



Hunterstown - Lincoln 115 kV (Met-Ed)

| PJM ID | Proposal Description | Greenfield /Upgrade | Project Cost (In-Service \$M) | In-Service Date |
|--------|--|---------------------|-------------------------------|-----------------|
| 511 | Build a new 115 kV ring bus at the Lincoln tap connecting Orrtanna, Hunterstown and Lincoln 115 kV buses. Build a new Otter Creek 500/230 kV substation connecting to the existing Otter Creek 230 kV switchyard. Upgrade the existing Otter Creek-Conastone 230 kV line. Replace Face Rock 115/69 kV transformers. Reconductor Manor-Graceton 230 kV. | Greenfield | \$95.47 | 2023 |
| 357 | Build a new Robinson Run-Graceton 230 kV line. Rebuild Cooper-Graceton 230 kV line. Build a new Hunterstown-Green Valley 230 kV line. | Greenfield | \$91.35 | 2023 |
| 847 | Build a new Robinson Run-Graceton 230 kV line. Rebuild of Cooper-Graceton 230 kV line. Reconductor Hunterstown-Lincoln 115 kV line. | Greenfield | \$56.00 | 2023 |
| 647 | Build a new 115 kV ring bus at the Lincoln tap connecting Orrtanna, Hunterstown and Lincoln 115 kV buses. Build a new Otter Creek 500/230 kV substation connecting to the existing Otter Creek 230 kV switchyard. Replace Face Rock 115/69 kV transformers. Reconductor Manor-Graceton 230 kV line. | Greenfield | \$55.12 | 2023 |



Hunterstown - Lincoln 115 kV (Met-Ed)

| PJM ID | Proposal Description | Greenfield/ Upgrade | Project Cost (In-Service \$M) | In-Service Date |
|--------|---|---------------------|-------------------------------|-----------------|
| 021 | Rebuild Hunterstown-Lincoln 115 kV. Build a new Peach Bottom-Graceton 230 kV circuit. Upgrade Face Rock 115/69 kV transformers. | Upgrade | \$56.69 | 2023 |
| 830 | Build a new Littlestown-Germantown 115 kV line. | Greenfield | \$44.92 | 2024 |
| 892 | Install a 50 MW 2-hour battery at Lincoln 115 kV substation. | Greenfield | \$28.98 | 2021 |
| 453 | Install a 25 MW 4-hour battery at Lincoln 115 kV substation. | Greenfield | \$26.69 | 2021 |
| 402 | Build a new Hunterstown-Lincoln 115 kV line. Install a 25 MW 2-hour battery at Lincoln 115 kV substation. | Greenfield | \$25.81 | 2021 |
| 413 | Build a new Hunterstown-Lincoln 115 kV line. Install a 10 MW 2-hour battery at Lincoln 115 kV substation. | Greenfield | \$19.22 | 2021 |



Hunterstown - Lincoln 115 kV (Met-Ed)

| PJM ID | Proposal Description | Greenfield/ Upgrade | Project Cost (In-Service \$M) | In-Service Date |
|--------|--|---------------------|-------------------------------|-----------------|
| 201 | Install a 25 MW 2-hour battery at Lincoln 115 kV station. | Greenfield | \$17.36 | 2021 |
| 960 | Build a new Hunterstown-Lincoln 115 kV line. | Greenfield | \$10.13 | 2021 |
| 293 | Build a new Meade 115 kV substation with outgoing lines to Orrtanna, Hunterstown, and Lincoln substations. | Greenfield | \$8.95 | 2023 |
| 007 | Build a new 115 kV ring bus at the Lincoln tap connecting Orrtanna, Hunterstown and Lincoln 115 kV buses. | Greenfield | \$7.58 | 2023 |
| 622 | Rebuild the Hunterstown-Lincoln 115 kV line. | Upgrade | \$7.21 | 2023 |
| 469 | Install a Smart Wire with 5% of series reactance along the Lincoln Tap-Hunterstown 115 kV line. | Greenfield | \$4.65 | 2022 |

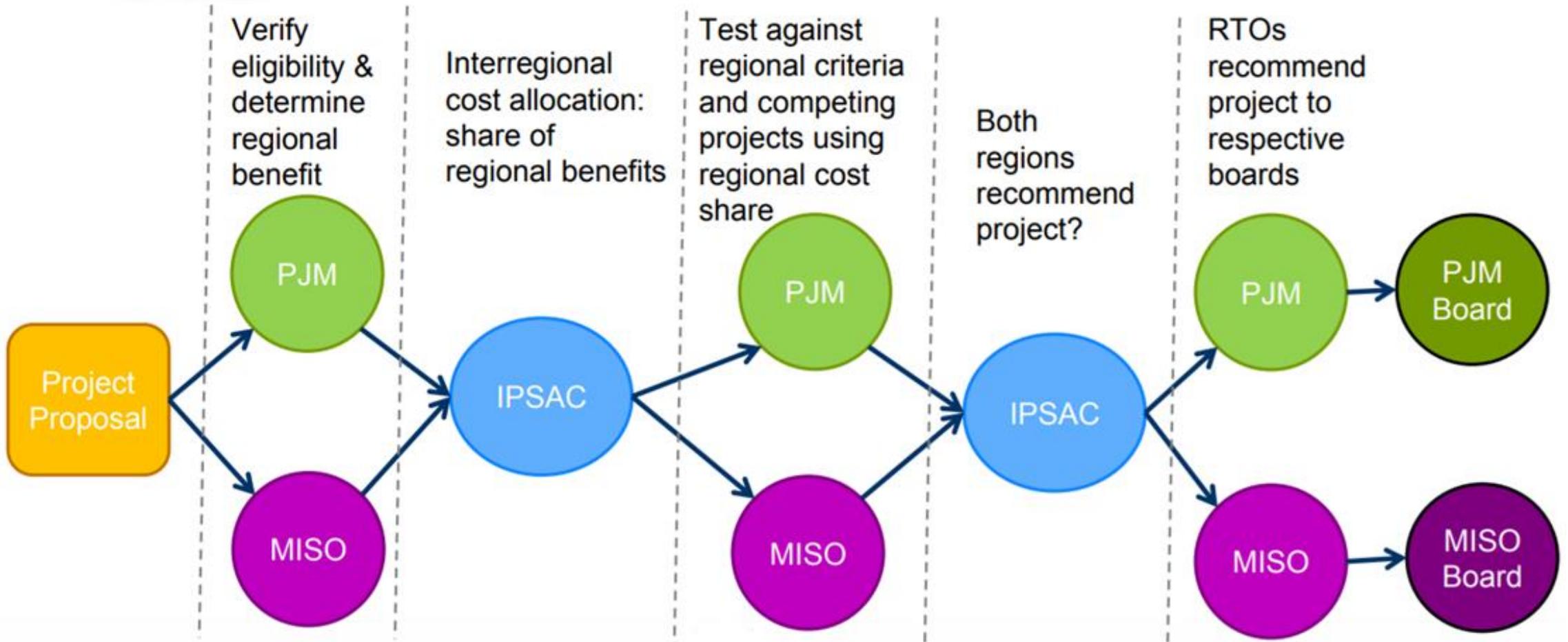


Proposal without PJM Congestion Driver

| PJM ID | Proposal Description | Greenfield/ Upgrade | Project Cost (In-Service \$M) | In-Service Date |
|--------|--|---------------------|-------------------------------|-----------------|
| 067 | Replace structures to remediate sag limitations on Dumont-Stillwell 345 kV line. | Upgrade | \$1.89 | 2021 |

Proposals Received Interregional Congestion Drivers

- PJM and MISO are conducting a two-year Interregional Market Efficiency Project (IMEP) study in 2018/2019
- Issues identification and benefit determination conducted in each regional process consistent with current effective JOA
- Interregional proposals must:
 - Address at least one identified issue in each region (could be same issue if identified by both RTOs)
 - Be submitted to both regional processes



- Both PJM and MISO proposal windows have closed
 - 10 interregional proposals received by PJM
 - 1 proposal without a PJM congestion driver
 - 7 proposing entities
- RTOs reviewing proposals and preparing models



Bosserman-Trail Creek 138 kV (M2M)

| PJM ID | Proposal Description | Greenfield/ Upgrade | Project Cost (In-Service \$M) | In-Service Year |
|--------|---|---------------------|-------------------------------|-----------------|
| 398 | Build a new Meadow Lake-Pike Creek 345 kV line. | Greenfield | \$266.44 | 2023 |
| 249 | Install a 50 MW 4-hour battery at Trail Creek 138 kV station. | Greenfield | \$45.40 | 2022 |
| 129 | Build a new Kuchar station cutting into Bosserman-Liquid Carbonics 138 kV line. Build a new Kutchar-Luchtman 138 kV line. | Greenfield | \$27.62 | 2023 |
| 436 | Build a new Toto 345 kV station interconnecting Olive-Reynolds 1, Olive-Reynolds 2, and Schahfer-Burr Oak 345 kV lines. | Greenfield | \$19.31 | 2023 |
| 207 | Loop in University Park-Olive 345 kV line into Babcock 345 kV substation. Reconductor Michigan City-Trail Creek-Bosserman 138 kV and Maple-LNG 138 kV circuits. | Upgrade | \$17.50 | 2023 |
| 481 | Reconductor Michigan City-Trail Creek-Bosserman 138 kV and Maple-LNG 138 kV circuits. | Upgrade | \$14.10 | 2023 |

| PJM ID | Proposal Description | Greenfield/ Upgrade | Project Cost (In-Service \$M) | In-Service Date |
|--------|--|---------------------|-------------------------------|-----------------|
| 506 | Rebuild Palmyra-Marblehead 161 kV and Marblehead-Herleman 138 kV lines. Build a new Maywood-Palmyra 345 kV line. | Greenfield | \$36.02 | 2023 |
| 322 | Rebuild Palmyra-Marblehead 161 kV and Marblehead-Herleman 138 kV lines. Build a new 345 kV ring bus at the Palmyra substation. | Upgrade | \$35.95 | 2023 |



Monroe 1&2 - Wayne 345 kV (M2M)

| PJM ID | Proposal Description | Greenfield/ Upgrade | Project Cost (In-Service \$M) | In-Service Date |
|--------|--|---------------------|-------------------------------|-----------------|
| 782 | Upgrade Monroe-Wayne 345 kV line rating by replacing switches at the 345 kV Wayne station. | Upgrade | \$0.46 | 2023 |



M2M Proposal without PJM Congestion Driver

| PJM ID | Proposal Description | Greenfield/ Upgrade | Project Cost (In-Service \$M) | In-Service Date |
|--------|--|---------------------|-------------------------------|-----------------|
| 931 | New Second Creek 345 kV station interconnecting Tanners Creek-East Bend and Miami Fort-Terminal lines. | Greenfield | \$13.76 | 2023 |

Revision History

4/8/2019 – V1 – Original version posted to pjm.com

4/9/2019 – V2 – Formatting changes

4/16/2019 – V3 – Table formatting changes on slide 3