# Market Efficiency Planning Process
# Modeling Dynamic Line Ratings

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Market Simulation

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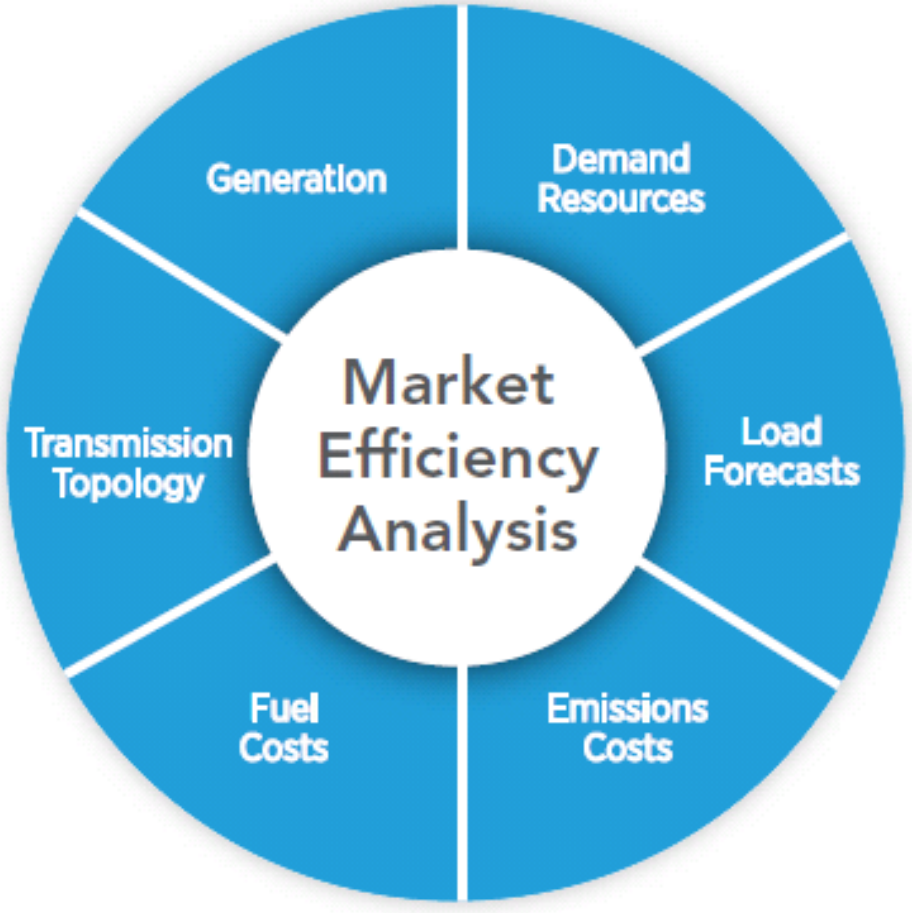
# Market Efficiency Process Overview

# Market Efficiency Analysis Overview

- Market efficiency proposals analyzed consistent with manuals 14B and 14F
  - Performance based on congestion reductions and net load payment savings
  - Benefits calculated as decreases in 15-years NPV Annual Net Load Payments for benefiting zones
- Costs based on assumed Annual Revenue Requirements
- Must pass the bright line economic efficiency tests:
  - B/C Ratio Threshold of 1.25
  - Significant decrease of the target congestion driver
- Additional analyses
  - Reliability Analysis
  - Independent Cost/Constructability  Review

# Market Efficiency Inputs



# DLR Implementation in Market Efficiency

# DLR Technology Overview

DLR technology does not modify the physical characteristics of a line, but rather provides a means for determining real-time line ratings more precisely by using specialized sensors that provide a more precise indication of the current environmental conditions.

# DLR Modeling – Market Efficiency

- **Market efficiency base case** uses planning seasonal ratings
  - Summer Normal & Emergency, Winter Normal & Emergency

- **Accounting for DLR in market efficiency base case:**
  - Ratings for lines equipped with DLR devices will be modeled using a *DLR Hourly Ratings Modifier* juxtaposed on top of the Planning seasonal ratings
  - The DLR *Hourly Ratings Modifier* will be calculated as the hourly difference between forecasted DLR ratings and forecasted ambient adjusted ratings for the DLR line

# DLR Ratings Calculation - Input Data

- Weather Data:
  - Hourly Wind Speed
  - Wind Direction
  - Ambient Temperature

- Line Ambient Adjusted Ratings

| Line Ambient Adjusted Ratings | | | | |
|---|---|---|---|---|
| Temp | Day | | Night | |
| Deg (F°) | Norm | Long | Norm | Long |
| 95 | 674 | 803 | 701 | 825 |
| 86 | 685 | 815 | 712 | 837 |
| 77 | 697 | 826 | 723 | 848 |
| 68 | 708 | 838 | 734 | 859 |
| 59 | 719 | 849 | 744 | 870 |
| 50 | 730 | 860 | 755 | 881 |
| 41 | 740 | 870 | 765 | 891 |
| 32 | 751 | 881 | 775 | 901 |

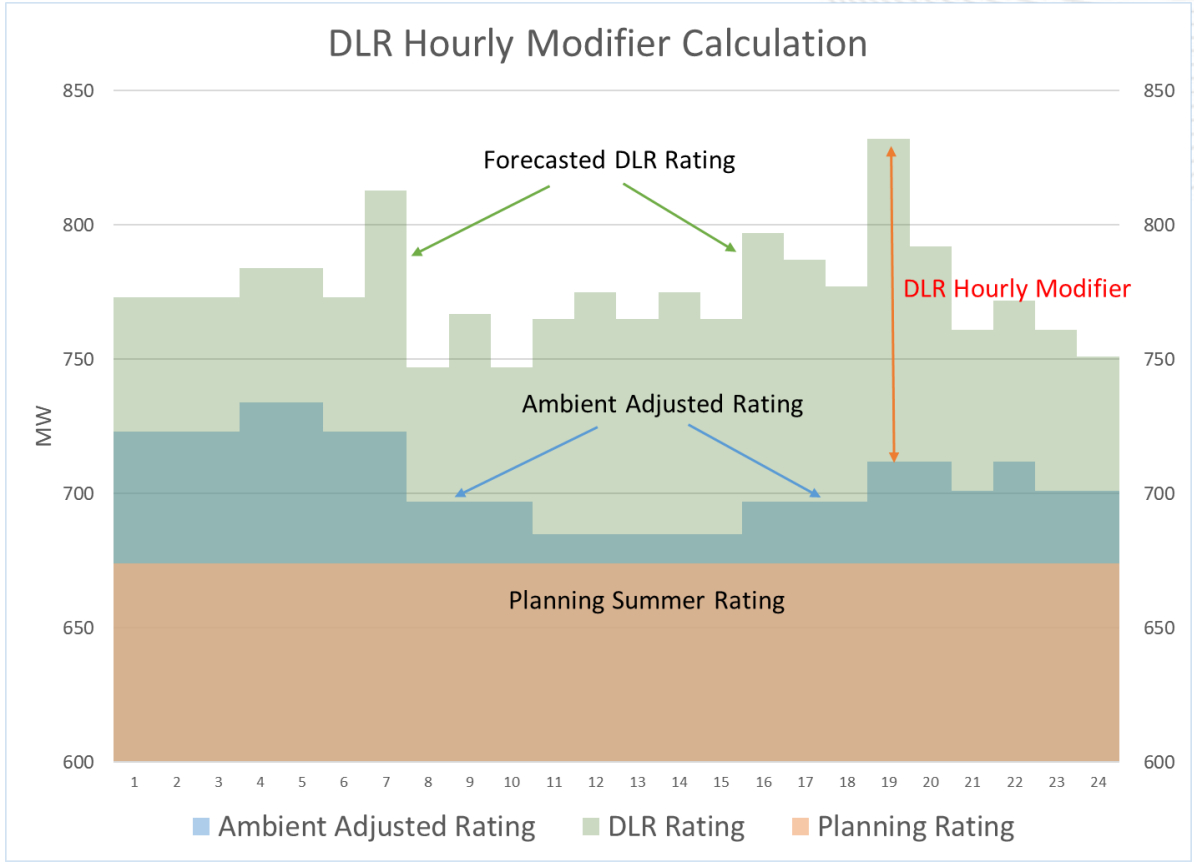
Note: Whereas ambient ratings are determined mainly based on the ambient temperature, the DLR devices implicitly report the change in line ampacity due not only to ambient temperature, but also to solar irradiance, and perpendicular wind.

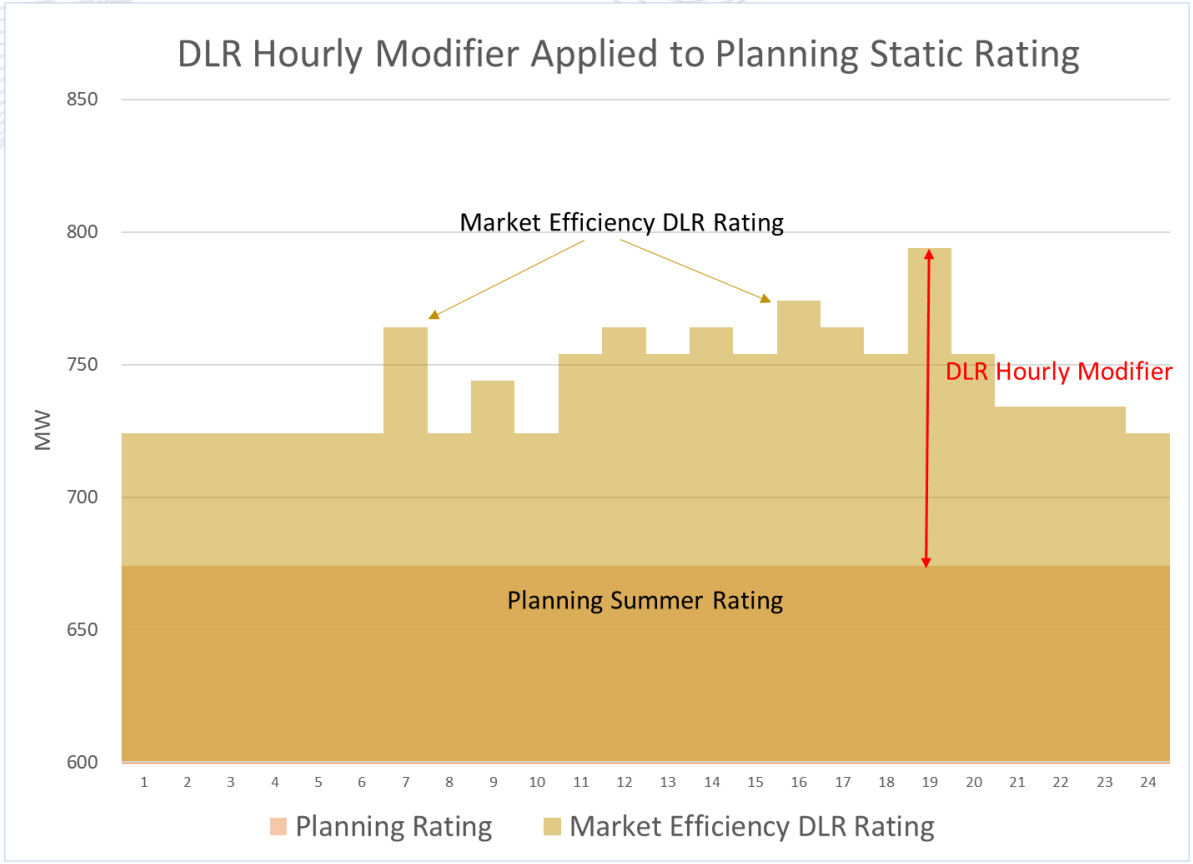
# DLR Ratings Calculation - Steps

1. • Calculate Forecasted Hourly Ambient Adjusted Ratings: $R_{AAR}$
   • (Based on forecasted hourly temperature)
2. • Calculate Forecasted Hourly DLR Ratings: $R_{DLR}$
   • (Based on forecasted hourly temperature, wind speed, and wind direction)
3. • Develop Hourly Ratings Modifier Profile: $R_{diff} = R_{DLR} - R_{AAR}$
   • (Hourly difference between forecasted DLR ratings and ambient ratings for the same hour)
4. • Determine Planning Winter/Summer Static Ratings for the DLR line: Ratings $R_{W/S}$
5. • Apply Hourly Rating Differentials to the Planning Winter/Summer Ratings
6. • Market Efficiency Hourly DLR Ratings* for the DLR line: $R_{modeled} = R_{W/S} + R_{diff}$

*Note: Reliability analyses required as part of the Market Efficiency process will continue to use the planning static seasonal ratings.*

# DLR Rating Calculation - Example




Note: This approach avoids overestimating the additional transmission capacity realized by Dynamic Line Ratings, by isolating the technology's added value (measuring real-time convective cooling).

# Glossary

| Item | Description |
|---|---|
| $R_{\mathbf{ARR}}$ | Ambient Adjusted Rating calculated using forecasted ambient temperature, solar irradiance (time of day to determine day vs night temp sets), and the line's ambient temperature rating set. |
| $R_{DLR}$ | Dynamic Line Rating calculated using the same inputs as used above, plus forecasted wind direction/speed data. |
| $R_{W/S}$ | Planning Winter/Summer peak rating currently used in the PJM Planning processes. |

# Contact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