

# Managing Transmission Line Ratings

FERC TECHNICAL CONFERENCE

PRESENTED BY  
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# Agenda

- What are Line Ratings?
- Static vs Dynamic Line Ratings
- Potential Benefits
- What is Missing?

# What are Line Ratings?

***Transfer capabilities are largely defined by two factors: the physical capacity of individual lines and network topology.\****

Physical capacity of individual overhead lines:

- Primarily defined by the maximum operating temperature to:
  - Maintain minimum electrical clearances (line sagging etc).
  - Limit annealing of conductor aluminum.
  - Limit aging of connectors/hardware.
- Increased power flow warms the line (resistive heating)
- Ambient conditions also impact line temperature.



***Dynamic Line Rating and Adoptive Line Ratings are technology options for enhanced and flexible application of the transfer capability of individual overhead lines.***

Network Topology

- Key factor defining the distribution of power flows—i.e., how much flows on individual lines.
- Technology options include PARs, FACTS devices, and Topology Control.

\* Note that the actual operating limits are more often defined by contingencies, rather than the ratings of a single line.

# Static vs Dynamic Line Ratings

## ***Today's practice is largely based on Static Line Ratings (SLR).***

Maximum operating temperature for a given line is pre-determined.

- Uses conservative assumptions, such as low wind, higher temperature, high solar irradiance etc., to accommodate most conditions.
- It is similar to setting the speed limit for highways based on a snowy road conditions.

## ***Dynamic Line Rating (DLR) adjusts this limit based on ambient conditions.***

- Thermal ratings use real time measurements at the line location (along line corridor).
  - Line temperature.
  - Line sagging.
  - Ambient conditions (temperature, humidity, solar irradiance, wind, precipitation etc.).
- Accumulation of real time data can be used for future calibration.
- High wind leads to higher cooling and allows for increased flow.
  - High degree of overlap between wind production and DLR-induced allowable flow increase has been observed.
  - European studies indicate DLR contributes to approximately 15% reduction in wind curtailments.



# Static vs Dynamic Line Ratings

## ***There are commonalities between SLR and DLR.....***

- Both use conservative assumptions.
- The maximum allowable temperature is likely the same.

## ***And there are difference between SLR and DLR.***

- DLR requires line specific data (real time measurements).
- SLR that applies uniform weather conditions to all lines is generally lower than DLR that applies line specific conditions.
  - DOE/ONCOR study indicates DLR to be 5 to 25% higher than SLR.
- DLR is variable and therefore requires a forecast for operations planning.



# Potential Benefits

## ***Various studies indicate significant benefit potentials at relatively low cost.***

Benefits are in the tens to hundreds of million dollars:

- Similar range to the operational benefits of RTO-/ISO-operated regional markets.
  - PJM estimates benefits of \$100 million a year for nodal vs TLR, and \$100 million a year reduced needs of Grid services.
- Reduces congestion.
  - DOE/ONCOR Study estimates 10% increase in ratings could eliminate most congestion.
  - Entergy confirms an average of 10+% increase in line capacity (DLR applied primarily in off-peak periods).
  - U.S.-wide annual congestion cost is estimated to be nearly \$6 billion.
- Helps with renewable integration.
  - European studies indicate DLR's contribution to reduced wind curtailment (~15%).
  - Quick implementation helps with the fast clean energy transition pace.
  - Relatively lower cost investments helps cash stranded utilities that need to invest to accommodate load growth (which could be triggered even further by electrification etc).
- Complements new investments.
  - Enhance underlying system to take full advantage of new investment potential
  - Remedy during construction (or maintenance) outages.
  - Bridge the gap until permanent solution can be achieved.
- Others (system awareness, redundancy and resiliency etc).

# What is Missing?

## ***Are the technologies by themselves understood?***

- DLR (and other operational technologies) are relatively new.
  - Enabled through recent technology breakthrough in electronics, communications, computational power, etc.

## ***Are the incentives aligned?***

- Congestion costs are passed through to end-consumers.
  - Limited benefits for transmission operators/owners to adopt these technology options.
- Industry rewards maintaining reliability more than improving operational efficiency.
  - Changing operations to improve efficiency can be seen as risk taking.
- Transmission owners who earn sufficient returns on investments may prefer larger investments.
  - These technology options are actually complementary to new investments.
- Should there be a benefit-sharing mechanism?
  - UK or Australian system may provide hints.

<https://www.brattle.com/news-and-knowledge/publications/improving-transmission-operation-with-advanced-technologies-a-review-of-deployment-experience-and-analysis-of-incentives>





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