

# Transmission Efficiency Initiative: Host Demonstration Project Transmission Line Rating Optimization Through Weather and Rating Analysis



*Temperature Backscatter Installation*

The project proposed will help develop and assess instrumentation, software, and methodologies for optimizing (thermally) the power flow capacity of operating transmission lines. The power capacity (that is, the rating) of most overhead transmission lines is prescribed by the so-called “static rating,” which is based on conductor configuration and environmental conditions. Typically, quite conservative, worst-case assumptions about environmental conditions are used when developing these static ratings. Due to this conservative approach, significant extra power capacity exists beyond the design margin on most lines most of the time.

As part of its ongoing research in this area, EPRI has developed monitors, rating calculation methodologies, the Dynamic Thermal Circuit Rating (DTCR) software, and other products to help the power industry gain access to this extra capacity.

It is possible to rate transmission lines in real time by measuring field variables in real time and using the EPRI DTCR software to compute the ratings. Numerous approaches can be used to measure a surrogate for input into dynamic rating software. All approaches have their benefits and limitations. Weather variables can be provided by weather stations. The stations are relatively inexpensive, and they can be installed without disrupting line operation. Although a weather station is a point measurement, multiple weather stations would provide a distributed set of measurements.

- Evaluate application of advanced, dynamic rating tools.
- Monitor before and after energy losses and utilization and document the results.
- Benefits include increased system utilization and reduced carbon footprint.

Other devices, such as those that measure sag or tension, can provide an “equivalent perpendicular wind speed” for entire line sections based on a measurement of average conductor temperature along the line segment. These devices require that an extensive calibration procedure be performed in order to determine the mathematical relationship between the conductor sag or tension and the average conductor temperature, and they are costly. Another instrumentation system is being developed by EPRI. It involves mounting small sensors along a conductor. These sensors can measure the conductor temperature (and load and sag) in real time.

## **Project Objective and Scope**

The objective of this project is to explore the viability of performing real-time ratings of overhead transmission lines in the Southwest Power Pool (SPP) region by measuring weather variables in real time, which will be used as input to EPRI’s DTCR software to compute conductor temperatures and ratings in real time.

The project scope includes the following:

- Assess the efficacy of performing real-time rating of overhead transmission lines over an SPP region by measuring weather variables in real-time from a weather station, or from multiple weather stations, placed inside the rights of way.

- Assess the efficacy of performing real-time rating of overhead transmission lines over an SPP region by acquiring weather variables in real time from existing weather stations that are somewhat remote from the rights of way, such as National Weather Service or airport data. A correlation correction factor might have to be applied.
- Assess the use of a video sagometer system and a newly developed EPRI sensor system for determining conductor temperatures and ratings.
- Provide SPP with experience on using real-time field data along with EPRI's DTCR software for performing real-time ratings of transmission lines
- Assess the impact of dynamic rating technology on transmission system utilization and efficiency.

### Expected Benefits

One or more of the following benefits might be realized through the application of this technology:

- Reduce transmission system losses by increasing the capacity of lower-voltage lines and increasing the power transfer on the lower-loss, higher-voltage lines before contingency violation.
- Increase utilization of the SPP transmission system.
- Reduce overall carbon footprint by reducing congestion and facilitating greater integration of wind energy.

### Approach for Measurement and Verification

A key objective of EPRI's Transmission Efficiency Initiative is to verify and validate the "actual" benefits realized by the application of the technology using a consistent measurement and verification (M&V) methodology that will be developed as part of EPRI's transmission efficiency research portfolio.

The detailed methodology of M&V will be developed during the course of the project using the following general approach:

- Demand, energy, and CO<sub>2</sub> savings will be determined based on transmission load flow cases for the studied system before and after the installation of the dynamic rating system.
- Line load and losses will be measured and compared over a one-year period and compared to the calculations. This will lead to an industry-accepted methodology for projecting savings from advanced dynamic rating systems.

- A life cycle carbon footprint methodology will be developed for the advanced dynamic rating system.

### Implementation Considerations

The project will carefully select three lines for the study and install three high-quality weather stations on each of the lines—one station near each end of the line and one near the midpoint. The weather stations will be equipped with ultrasonic anemometers, which have the advantages of being very accurate and having no moving parts and no stall speed. For comparison, an existing weather station near each of the three lines will be identified (weather stations belonging to the National Weather Service, airports, and so on), and the weather data from these weather stations will be compared to the weather data measured on the three rights of way of this project. Using EPRI's DTCR software and the load supplied by SPP, the conductor temperatures and line ratings will be computed for each of the three lines based on weather data from four weather stations. Comparisons will be made of the weather variables (wind speed and direction, ambient temperature, and solar intensity), computed conductor temperatures, and computed ratings. Correlations between these data will be identified. In addition, one video sagometer and an EPRI sensor system (composed of six individual sensors) will be installed at one site, along with one of the above weather stations. Conductor temperature, equivalent perpendicular wind speed, and line ratings will be computed for these measurements and compared with the weather station data.

### Project Schedule

1. Identify lines and sites for study.
2. Conduct detailed design of instrumentation installations, power, and communications.
3. Specify data to be collected and details of the analysis procedure.
4. Purchase and install field instrumentation
5. Set up, verify, and execute DTCR. The total period for installation and commissioning is expected to be 21 months.
6. Analyze weather and rating data.
7. Monitor power flows and transmission-related losses for 12 months after DTCR commissioning.
8. Calculate changes in system performance utilization and efficiency using EPRI demonstration protocol and document results.
9. Deliver final project report.

April 2010

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