# Identifying, Modeling and Utilizing the Hidden Capacity in the Transmission Network

Richard Tabors (TCR)
Adam Rousselle (URMC)
Aleksandr Rudkevich (NEG / TCR)
Michael Seelhof (TCR)

Utility Risk Management Corp

Tabors Caramanis Rudkevich

# Outline & Background to the problem

- Underlying fact: there is more transmission capacity than is being reported and therefore being scheduled
- Three issues
  1. Evidence of unused transmission capacity
  2. Impact of the NERC process of standardization
  3. The opportunity for improved utilization through
     - The use of near real-time rating knowledge
     - A market for “surplus” transmission capacity

U | R | M | C

# Technology: Background

- Transmission Circuit Ratings are too conservative:
  - Typically rated below their maximum operating capacity to ensure safe clearance to vegetation
  - Rated based on IEEE Standard 738 (heat balance requiring engineering judgment … applied conservatively)
  - Rated based on manufacturers specifications
  - Rated either as an annual or as summer and winter ratings
  - Only in isolated circumstances are lines dynamically rated in close to real-time and seldom rerated based on evolving conditions even though the technology exists through multiple 3rd independent party providers

U | R | M | C

T C R

# The impact of the Conservatism

- Additional transfer capability is available but not being utilized even thought it meets IEEE standards
- Congestion is occurring at times when and where there is capacity to transfer additional energy
- Consumers who are the only payees are paying more than is required (FTR costs could be decreased)
- ARRs in PJM (and their equivalents in other markets) would, generally, be fully feasible and there would be less underfunding in the case of PJM

U | R | M | C

# Evidence of Unused Transmission Capacity

Utility Risk Management Corp

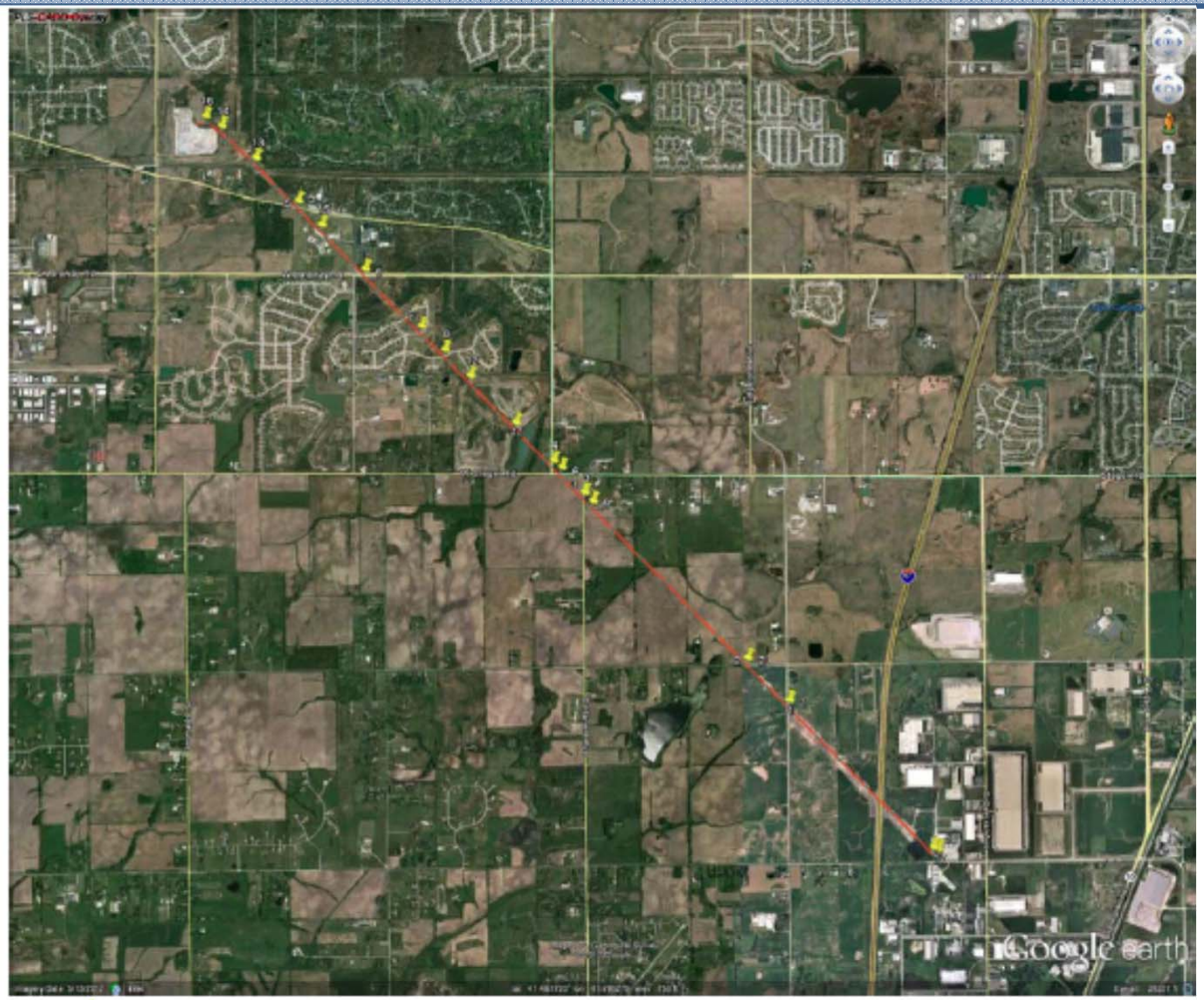
Tabors Caramanis Rudkevich

# A case Example in the ComEd Service Area

- Initial study undertaken as part of the NERC and FERC facilities rating standardization process
- Follow-on study undertaken at the request of Exelon on a specific *known to be congested* ComEd line
  - Line runs from East Frankfort to University Park North southwest of Chicago
  - 5 miles long
  - 345 KV

U | R | M | C

# ComEd Case Study




Source: Google Earth

# Evidence of Benefits of Accurate Measurements

**Maximum Conductor Temperature for Line L6608 based on ComEd Input and Thermal Direct™ Results;**

| KV | Maximum Operating Temperature of the Conductor | Calculated MVA | Conversion to AMP's |
|---|---|---|---|
| Current rating - Low | 203 Deg F | 878 | 1469 |
| Current rating - High | 203 Deg F | 1249 | 2091 |
| Thermal Direct w Sensor- Low* | 246 Deg F | 1078 | 1804 |
| Thermal Direct w Sensor- High* | 246 Deg F | 1380 | 2310 |
| Thermal Direct w Thermography - Low | 260 Deg F | 1135 | 1899 |
| Thermal Direct w Thermography - High | 260 Deg F | 1371 | 2295 |

22%

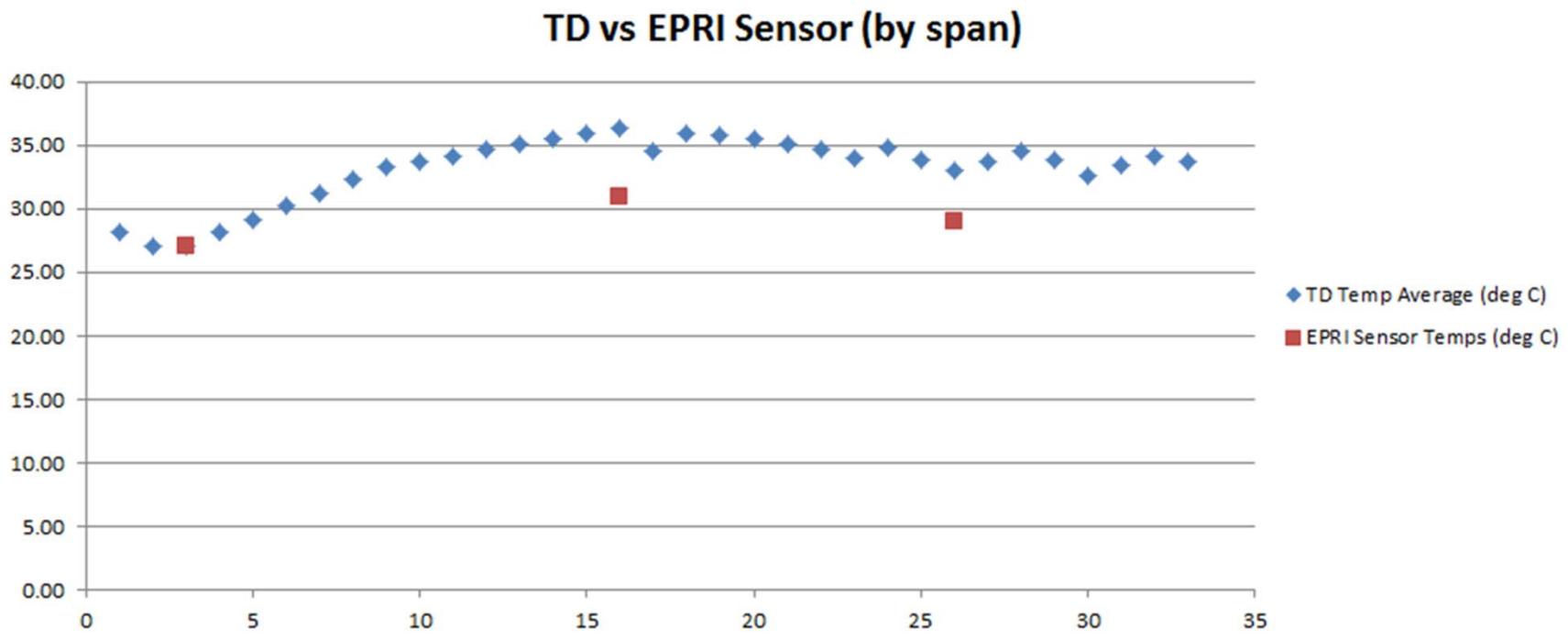
29%

- * Sensor has a +- 9 degree F error

U | R | M | C

T C R

# Temperature is the Critical Variable




U | R | M | C

T C R

# What is the technology?

- Two critical measurements
  - LiDar information (detailed 3D mapping of the transmission line to identify clearance of ground, trees and man-made objects including other power lines)
  - Temperature sensing at the time of overflight*
    - Contact through on-wire sensors
    - Non-contact through thermography
- Engineering knowledge
  - The physical characteristics of the conductors
  - The ability to follow the IEEE standards safe operating clearances.
- Application software systems
  - 3D Computer aided Design and Drafting (CADD) modeling capabilities to provide both static and real time temperature measurements*
  - RESULTS… Accurate and current (defined in multiple time domains) measures of transmission capacity using IEEE standards confirmed by EPRI test results

*(U.S. Patent 138245.00401)

U | R | M | C

T C R

# Impact of the NERC Process of Standardization

Utility Risk Management Corp

Tabors Caramanis Rudkevich

# NERC Facilities Rating Impact

- NERC / FERC requirement for standard method for rating of transmission lines
  - 2 year effort of the Performance Analysis subcommittee (formerly the Reliability Metrics Working Group) of NERC to standardize reporting
  - "Consideration of Actual Field Conditions in Determination of Facility Ratings" (revised November 30, 2010)
  - Prior ratings were inconsistent – generally high…
  - Some physical improvements were made to bring lines up to former ratings
  - Often, however, lines were down-rated to meet consistent standards of reporting rather than upgrading the lines

U | R | M | C

# NERC January 2012 Memorandum

**January 15th, 2012 High Priority Assessment Report**: *

The second assessment plan report date on the progress each registered entity made in completing its high priority assessment plans was January 15, 2012. NERC and the Regional Entities received this second of two "high priority" assessment responses from 200 NERC facility owners. Including the information from both the July 2011 and January 2012 responses, the following high priority information was observed:

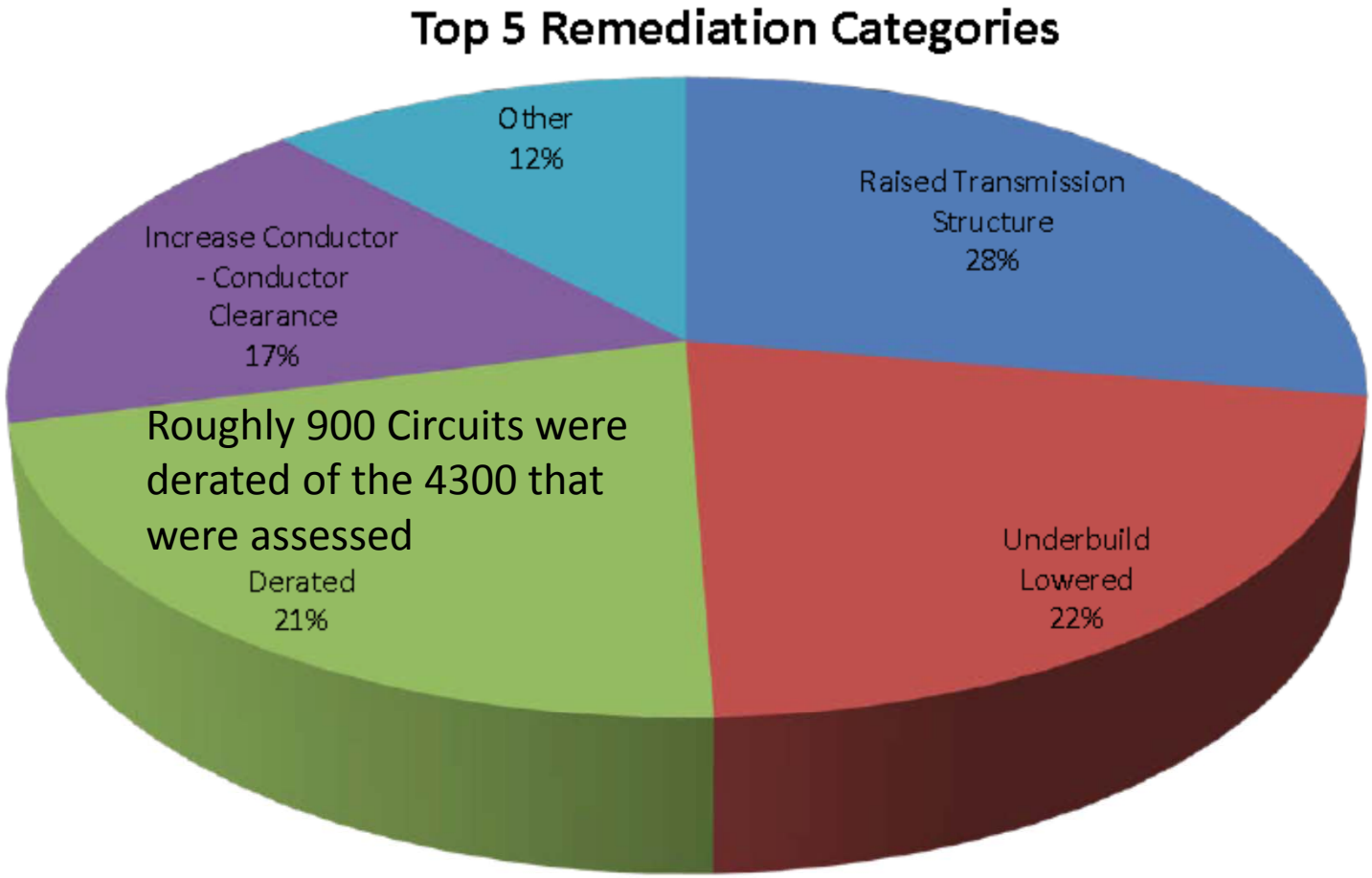
- A **97 percent response** rate by registered entities was achieved in providing summaries of their high priority assessments.
- Approximately **4,300 circuits were assessed.**
- Approximately **73,000 miles** of line were assessed.
- Approximately **5,100 discrepancies were discovered.** Of these discrepancies, approximately **42 percent have been mitigated** as of January 15, 2012.

* NERC Third Report, *Recommendation to Industry: Consideration of Actual Field Conditions in Determination of Facility Ratings issued October 7, 2010 and revised November 30, 2010,* from Roman Carter, Manager of Bulk Power Systems Awareness, NERC to Mr Keith O'Neal, FERC, March 2, 2012.

U | R | M | C

T C R

# 21% of the Remediation was Derating




U | R | M | C

T C R

# Impact of Down Rating

- TSO/RTOs now have less *reported and operational* transmission transfer capability than was the case before standard reporting methods were introduced
- Transmission congestion has increased as has congestion cost
- Only very limited merchant upgrades have occurred even with FERC 1000

U | R | M | C

# Opportunities Exist for Improved Transmission Capacity Utilization

The use of near real-time rating knowledge

A market for “surplus” transmission capacity

# Challenge: Are We Focused on Modeling the Most Critical Need

- Real-time or near real time ratings
  - Technologically proven and approved
- Analytically requires
  - Capability to reset the transmission operating limits
    - Day ahead based on forecast of hourly temperatures
    - Hour ahead based on improved knowledge of temperature forecast

U | R | M | C

# Physical Evidence ?

- Improved temperature data even if handled statically provides 22% to 29% increase in MVA on case studied circuit
  - All circuits will be different
  - Methods are known and exist to identify those with the greatest potential of being thermally limited
- With multiple 3rd party service suppliers …
  - Why are we not using the knowledge?
  - Where are the investment incentives both positive and negative?

U | R | M | C

T C R

# Analytical Evidence ?

- ARPA E Topology Control Algorithm (TCA) project reported at these meetings
- While an admittedly different question being answered, modeling evidence from PJM indicates that incorporating TCA into the scheduling would produce savings of 100 million annually
- The expectation is that we have the modeling capability to evaluate the positive impact incorporating knowledge of near real-time thermal related transmission ratings into transmission planning and scheduling

U | R | M | C

# What Could a Transmission Capacity Market Look Like?

- Consider a given transmission line that has thermal capacity that in real time varies between a flow of fmin and fmax
- Consider also an independent 3rd party can forecast/predict the line's capacity (day ahead or hour ahead) and that it can be verified in real-time
- The 3rd party bids in the day ahead market an additional capacity over fmin, ($\Delta f$ for hour h). If the flow on the line is above fmin ($\Delta f$ is actually being used) the 3rd party is credited $\Delta f$* $\Delta$LMP at two ends of the line for that hour.
- When hour h arrives, the 3rd party is obligated to the actual line conditions are known. If the actual line flow capacity varies from the bid level $\Delta f$ then a financial reconciliation of differences will take place using the real-time price difference.
- Assuming that FTRs are traded under the assumption of the fmin for the line rating, System Operator should face no revenue adequacy issues

U | R | M | C

# Could a Transmission Capacity Market be Implemented?

- The technology for the 3rd party is known and available
- The market itself is (at 50,000 feet) not that different from the energy market of today
- Extensions from day ahead to hour ahead to real time is conceptually possible

U | R | M | C

Tabors Caramanis Rudkevich 1 Memorial Drive Suite 1410 Cambridge, MA 02142