

# **Past and Present Probabilistic Planning Efforts in WECC**

**GRID TRANSFORMATION Workshop,  
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# OUTLINE

- 1. Background & Current Probabilistic Efforts**
- 2. Early Beginning & RPEWG History**
- 3. WECC System Performance Criterion**
- 4. WECC TRD & Past Historical Reliability Assessments**
- 5. Discussion Items**

# 1. Present Probabilistic Efforts

- CIGRE Working Group C4.601 “Review of the Current Status of Tools and Techniques for Risk-Based and Probabilistic Planning in Power Systems”, October 2010
- IEEE PSACE Committee Activities in Probabilistic Arena: CAMS Cascading Failures Task Force, RRPA PACME Task Force and LOLE WG Activities
- NERC Probabilistic Assessments
- NERC State Of Reliability (SOR) Reports
- WECC State Of The Interconnection (SOTI) Reports
- Annual WECC Transmission Reliability Data Reports

# 1. Present Available Tools

- TRELSS/TransCare (com.)(A)
- TRANSRELL (trans.+com.)(A)
- OSCAR (com.) (A,MC)
- PROCOSE (com.) (A)
- TPLAN (trans.) (A)
- CREAM (com.) (MC)
- MECORE (com.) (A,MC)
- **MARS (gen.) (MC)**
- NARP (gen.) (MC)
- CORAL (com.) (MC)
- \* SERVIM (gen.) (MC)
- \* NH2 (com.) (A,MC)
- \* PROMOD (gen.) (MC)
- \* DIGSELNET (gen.+com) (A)
- \* UPLAN (gen.) (MC)
- \* ASSESS (gen.+com.) (MC)
- \* REMARK (gen.+com.)
- \* **GRIDVIEW (gen.) (MC)**
- \* **TIGER (gen.) (MC)**
- \* **PROMAXLT (gen.) (MC)**
- \* GENYSIS (gen.) (MC)

A-Analytical MC-Monte Carlo

Com-Composite, trans-Transmission & gen-Generation

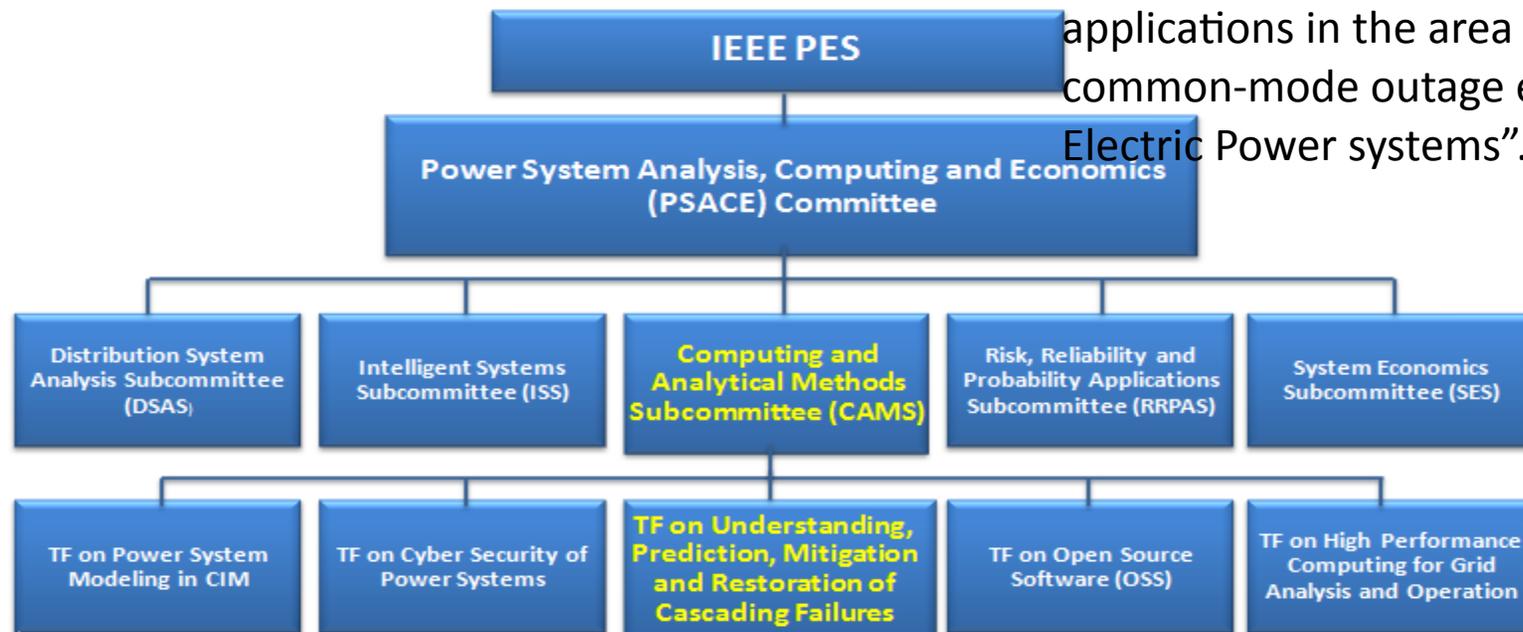
# 1. IEEE PES CAMS & RRPA Activities

- **Cascading Failure Task Force - Initiated during 2007 IEEE PES GM:**

- *“To investigate new methods, technologies and tools in order to better understand, predict, mitigate and restore cascading failures. Sponsor technical sessions, tutorial courses, workshops, conferences for effective exchange of information on the state-of-the art, best practices, procedures and strategies.”*

- **Probability Applications for Common-Mode Events (PACME) Task Force - Initiated during 2010 IEEE PES GM:**

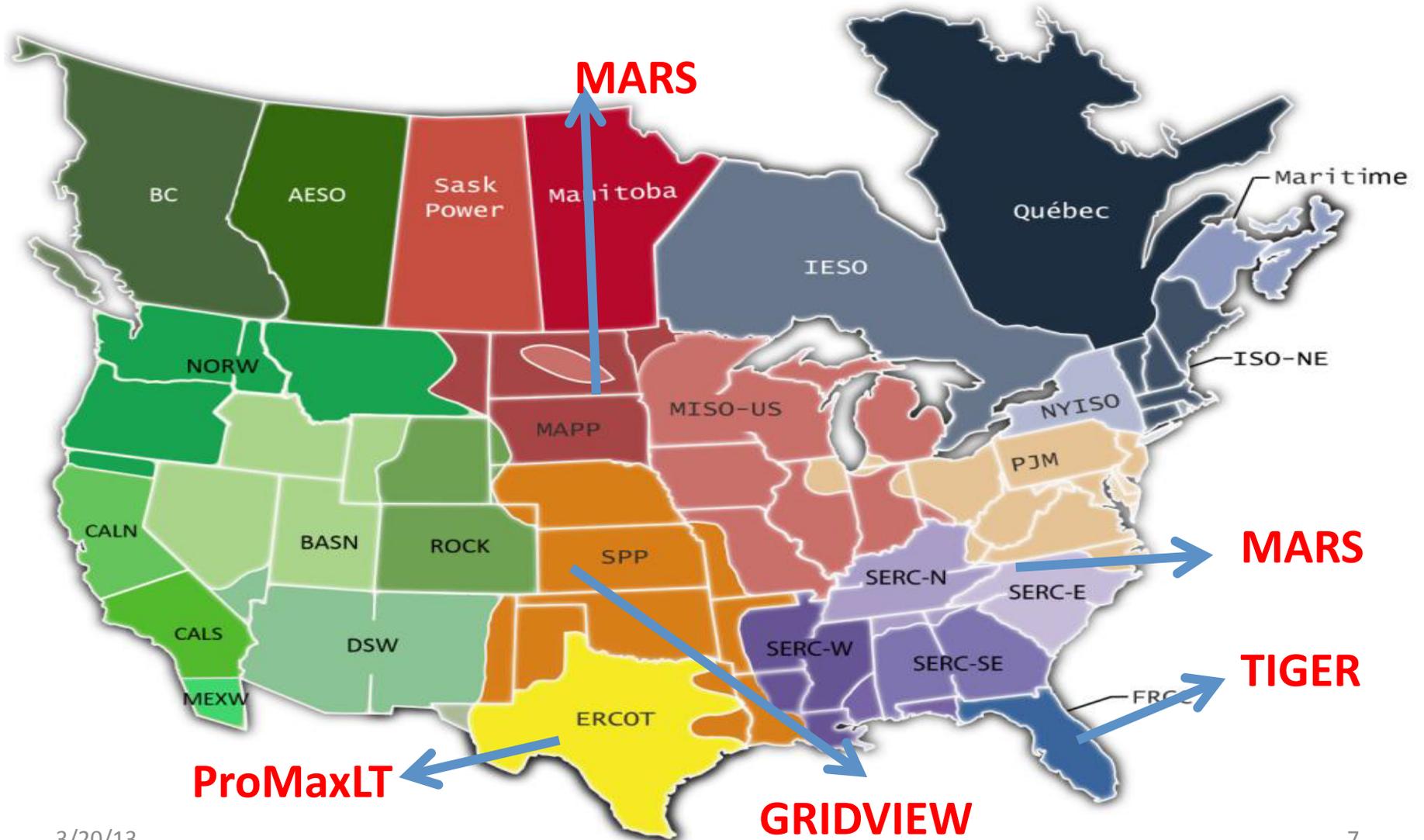
- *“To review, advance and present state-of-the-art research and practical applications in the area of common-mode outage events in Electric Power systems”.*



# 1. NERC Probabilistic Assessment

- In 2010, the NERC Generation and Transmission Reliability Planning Models Task Force (GTRPMTF) developed a common composite Generation and Transmission probabilistic assessment methodology to supplement NERC Long-Term Reliability Assessment.
- The GTRPMTF proposed and NERC PC approved the following three reliability Metrics:
  - Expected Unserved Energy (EUE)
  - Loss of Load Hours (LOLH)
  - Normalized EUE to count for the size of a given assessment area

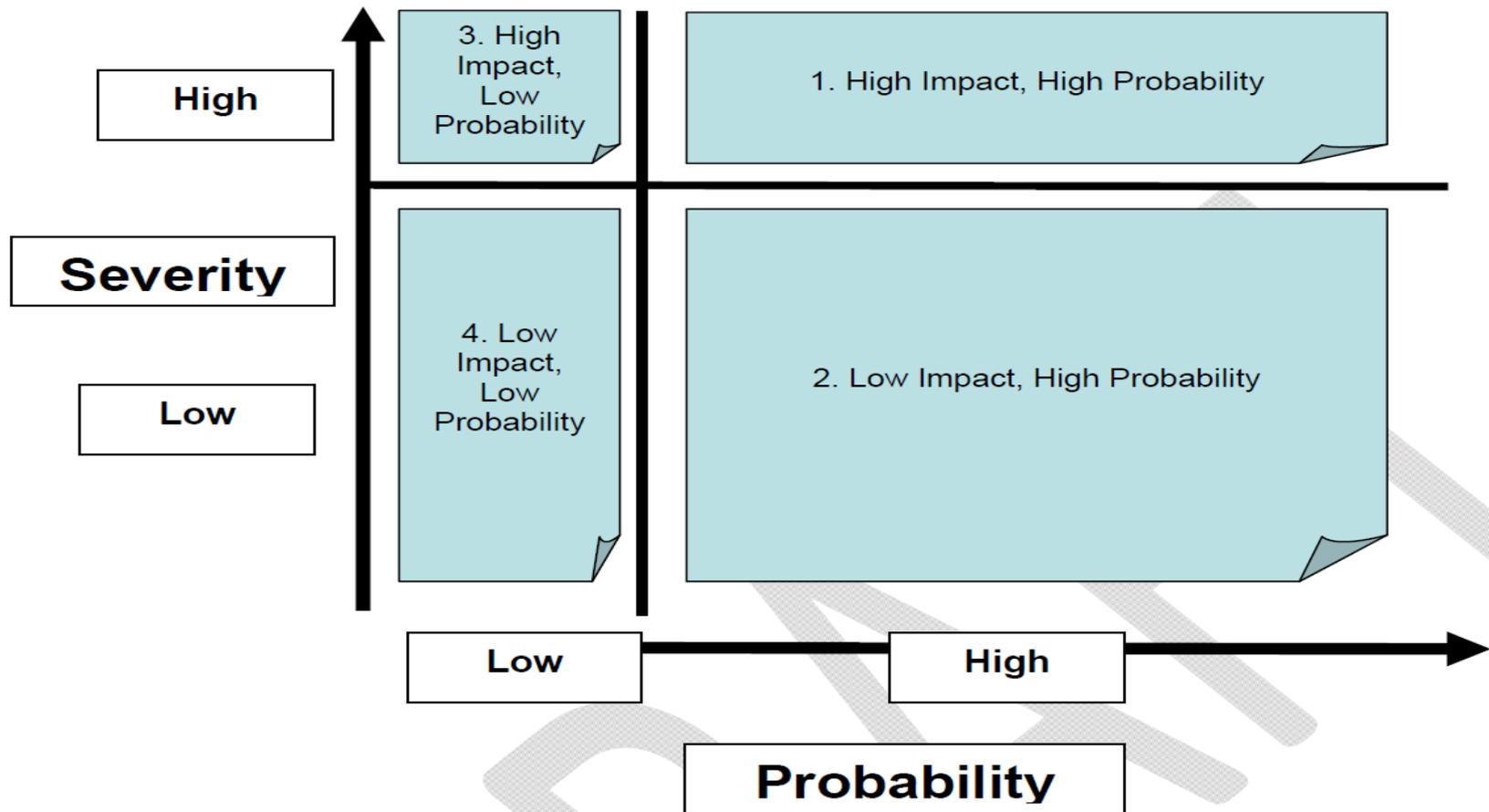
# 1. NERC Assessment Areas



# 1. Why Assess the Risk?

- Planning Horizon: Where and When to Invest?
- Operation Horizon: What operating actions to take to assure secure and safe operation of the system
- Assessing the Risk is in essence evaluation of Severity & Probability of critical states

# 1. Severity vs. Probability of an Event



## 2. Early Beginnings

- In a 1996 WSCC survey indicated that 90% of member utilities expressed interest in a development of some type of probabilistic based reliability criteria.
- In 1998 PCC approved the PBRC development framework and Phase I Implementation Plan.
- PBRC Phase I development and implementation of event probabilities into Performance Table (Table W-1) was completed.
- Ultimate goal is to produce a more economically efficient system without sacrificing transmission system reliability.

## 2. RPEWG - History

- RPEWG was initially formed as a PCC Working Group .
- PMWG was formed as a RS Working Group in June 1996.
- TRD started as a sub group of the Reliability Subcommittee in Spring 2004
- TRDTF was formed in Fall 2005
- WECC PCC, OC and Board approved the implementation of the proposed TRD in Fall of 2006
- RPEWG merged with TRDTF as a new RPEWG sometimes in the end of 2006 and presently it reports to the RS
- RPEWG Chairs: James Leigh-Kendall (SMUD), John Leland (NWE), Brian Keel (SRP) and Milorad Papic (IPC)

## 2. RPEWG – Scope of Work

- Develops processes to implement probabilistic-based reliability criteria (PBRC)
- Reviews requests for performance category adjustments
- Monitors facility outage data and recommends category adjustments
- Maintains the Performance Level Adjustment Record
- Define facility outage data reporting requirements and making recommendations to the RS on reliability performance level.

## 2. Probability Based Reliability Criteria

- Performance Level Evaluation (PLE) includes event probability assessment of a facility taking into consideration the facility's:
  - physical characteristics,
  - design considerations,
  - operational history,
  - geographic location,
  - environmental surrounding,
  - or other appropriate factors.

Phase I Probabilistic Based Reliability Criteria, February 2, 2001.

## 2. Uncertainties At Play

- Unusual load/generation pattern
- Rights-of-Way encroachments
- Situation Awareness incomplete
- Delay in system readjustment
- Equipment performs as intended
- Extreme Events (Category D)

## 2. PBRC Event Probability Outage Frequency Ranges

Category	Disturbance Outage Class	Outage Frequency (outages/year)	Mean-Time- Between-Failure (year)	DV <sub>1</sub> (%)	Dt (cycle)	DV <sub>2</sub> (%)	f <sub>min</sub> (Hz)	Damp. (%)
A	No Outage							
B	Single Element	0.33 ≤	≤ 3	25/30	20	5	59.6	>0
C	Two Elements	0.033 - 0.33	3 - 30	30	40	10	59.0	>0
D	More than Two Elements	< 0.033	30 <	EVALUATE FOR RISKS & CONSEQUENCES				

## 2. Seven-Step Process

- Project (Facility) Description
- Outage Database
- Mean Time Between Failure Calculation
- Robust Line Design Features
- Exposure Analysis
- Consequence of an Outage
- Comprehensive report of details in steps 1-6

## 2. Robust Line Design Features<sup>1</sup>

- A document outlining risk factors, design variables and mitigation examples used in evaluating lines for RPEWG reclassification.
- Design features consider:
  - centerline spacing, line crossings, substation configuration, locational hazards, Vegetation management, lightning mitigation, and protective relaying

1 Board of Directors approved December 5, 2003.

## 2. Computing Risk

$$Risk = I \bullet C \sum_{x \in X} P_x = I \bullet C / MTBF$$

I – Impact in MW or MWhr

C – Cost of impact in \$/MWhr

P<sub>x</sub> – Probability of event x

MTBF – Mean Time Between Failures

## 2. WECC Policy On Extreme Events

- Observe the safe limits for covered contingencies.
- Utilize safety nets for low probability and unforeseen events.
- Implement measures to locally contain the impact of disturbances.

WECC Policy Regarding Extreme Contingencies and Unplanned Events,  
Board approved 1997.

### 3. TPL-001-WECC-CRT-2

Definition:

- Adjacent Transmission Circuits are two transmission circuits with separation between their center lines **less than 250 feet** at the point of separation with no Bulk Electric System circuit between them.

### 3. TPL-001-WECC-CRT-2

- WRS1.1. NERC Category C.5 also applies to common mode contingency of two Adjacent Transmission Circuits on separate towers unless the event frequency is determined to be **less than one in thirty years**.
- Requirement WRS1.1 applies only to Adjacent Transmission Circuits where both circuits are **greater than or equal to 300 kV**.
- Requirement WRS1.1 does not apply to transmission circuits that share a common right-of-way for **three miles or less**.

### 3. TPL-001-WECC-CRT-2

- **WRS5.** For any event that has actually resulted in cascading, action must be taken so that future occurrences of the event will not result in cascading, or it must demonstrate that the Mean Time Between Failure (MTBF) is **greater than 300 years** (frequency less than 0.0033 outages/year) and approved by PCC.
- **WR5.1.** Any contingency adjusted to Category D must not result in a cascading outage unless the MTBF is greater than 300 years (**frequency less than 0.0033 outages/year**) or the initiating disturbances and corresponding impacts are confined to either a radial system or a local network.

## 4. Purpose of Transmission Reliability Data (TRD)

- Provides a common format for outage data submittal to WECC and NERC
- Provides a transmission outage database for PCUR (Performance Category Upgrade Requests)
- Provides database to monitor, evaluate and report WECC transmission lines & transformers performance
- Provides pool of reliable outage statistics to assess impact of various variables such as: environmental conditions, equipment type, voltage class, age etc).
- Enables Benchmark data with other data sources (NERC, CEA, CIGRE, SGS, Companies database, etc.)

## 4. Statistical Analysis Based on TRD Data

- Statistical Analysis of Outage Rates related to Standard FAC-501-WECC-1
- Statistical Analysis of Common-Mode and Dependent Outages using TRD Data
- Statistical Analysis Based on TRD Inventory Data
- RPEWG Annual Performance Reliability Reports

## 4. RPEWG Annual Reports

- First Annual WECC Transmission Reliability Data Report, October 15, 2007
- Second Annual WECC Transmission Reliability Data Report, October 15, 2008
- Third Annual WECC Transmission Reliability Data Report, October 15, 2009
- Fourth Annual WECC Transmission Reliability Data Report, July 8, 2010
- Fifth Annual WECC Transmission Reliability Data Report, August 17, 2011
- 1999-2008 500-kV WECC Transmission Reliability Data Report, January 19, 2010
- WECC TRD Common Corridor and Tower Data, October 26, 2010

# *Questions*

