Transmission Line Overloading Analysis using Probabilistic Dynamic Line Rating

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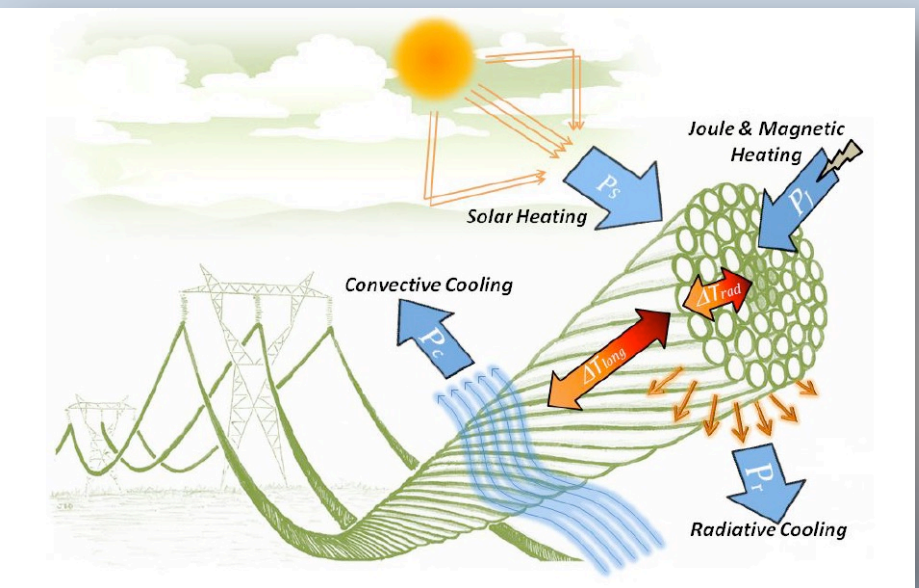
Steady-State Thermal Rating

for given weather parameters and maximum conductor temperature

$$I_{rating} = \sqrt{\frac{q_c(T_{max}, T_a, V_m, \varphi) + q_r(T_{max}, T_a) - q_s}{R(T_{max})}}$$



Ref. *''Guide For Thermal Rating Calculations Of Overhead Lines''*, CIGRE

Rating compared to base case :
490 (A) at 40 ° C, 0 wind, and sunny midday

	Increase	Rating
20 °C	14.5 %	**718 (A)**
0 °C	18%	**896 (A)**
Mid night	13%	**654 (A)**
1 m/s wind		
45 °	16%	**770 (A)**
90 °	17%	**834 (A)**

Operational Risk
Overload Protection & DLR

- ***Dependability:***

The probability of not having a failure in protection operation under given conditions, in this case overloading

- ***Security:***

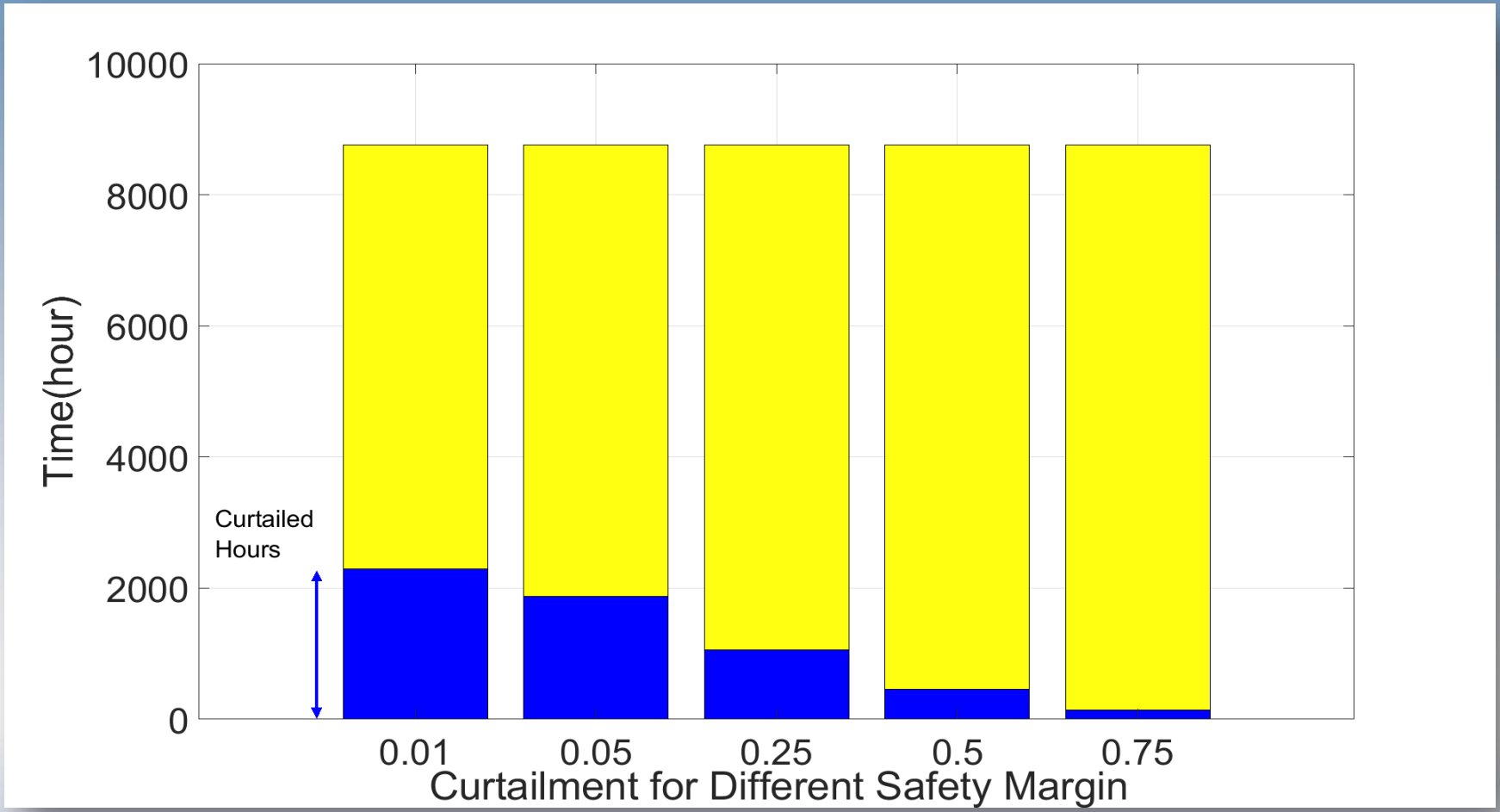
The probability of not having an unwanted operation like operation without overloading

- ***Problem with classical overload protection:***

Low security leading to high probability of unnecessary tripping or curtailment

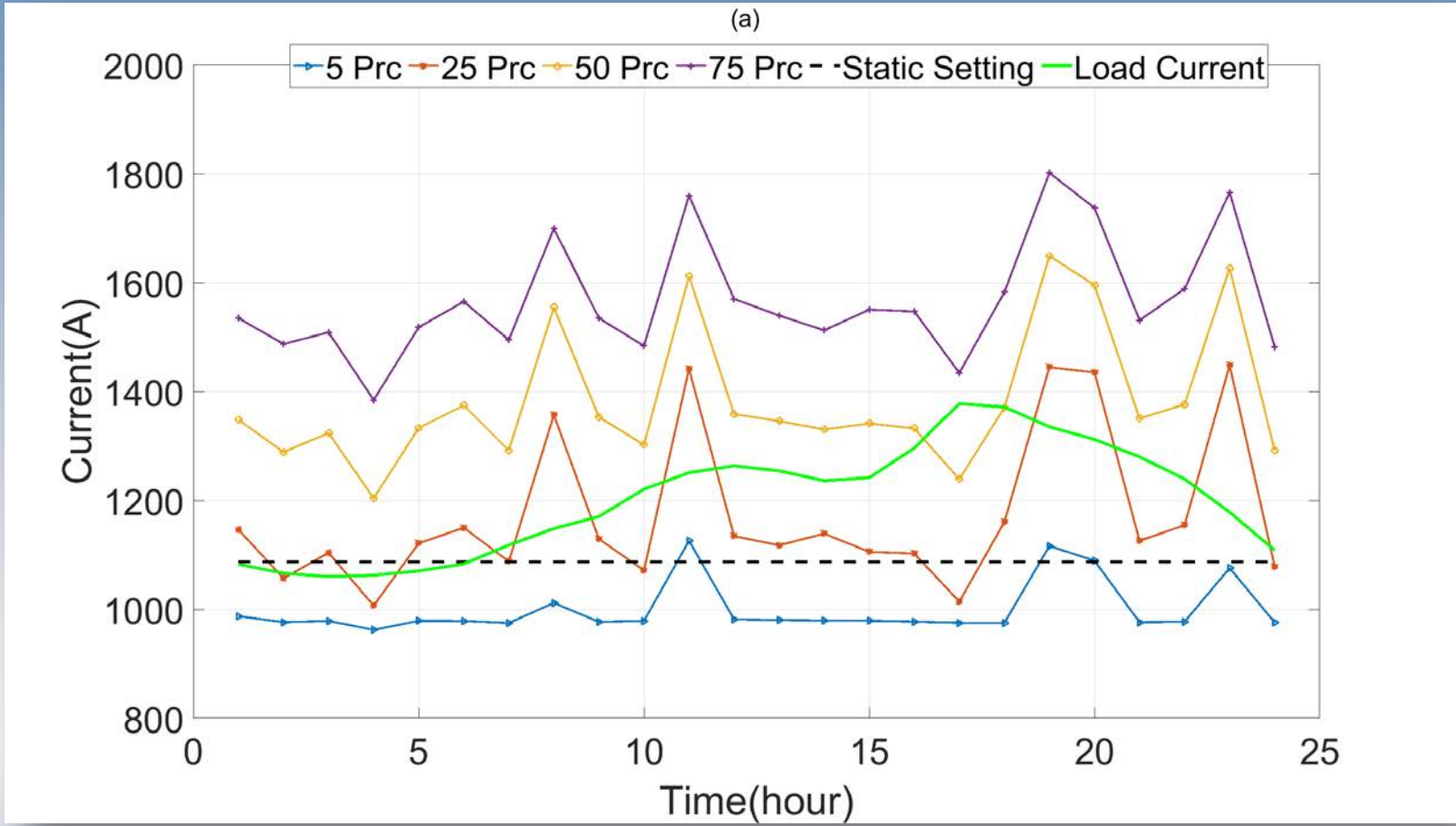
Making the addition of generation and load growth difficult

Amount of Curtailment versus Acceptable Probability of Overload



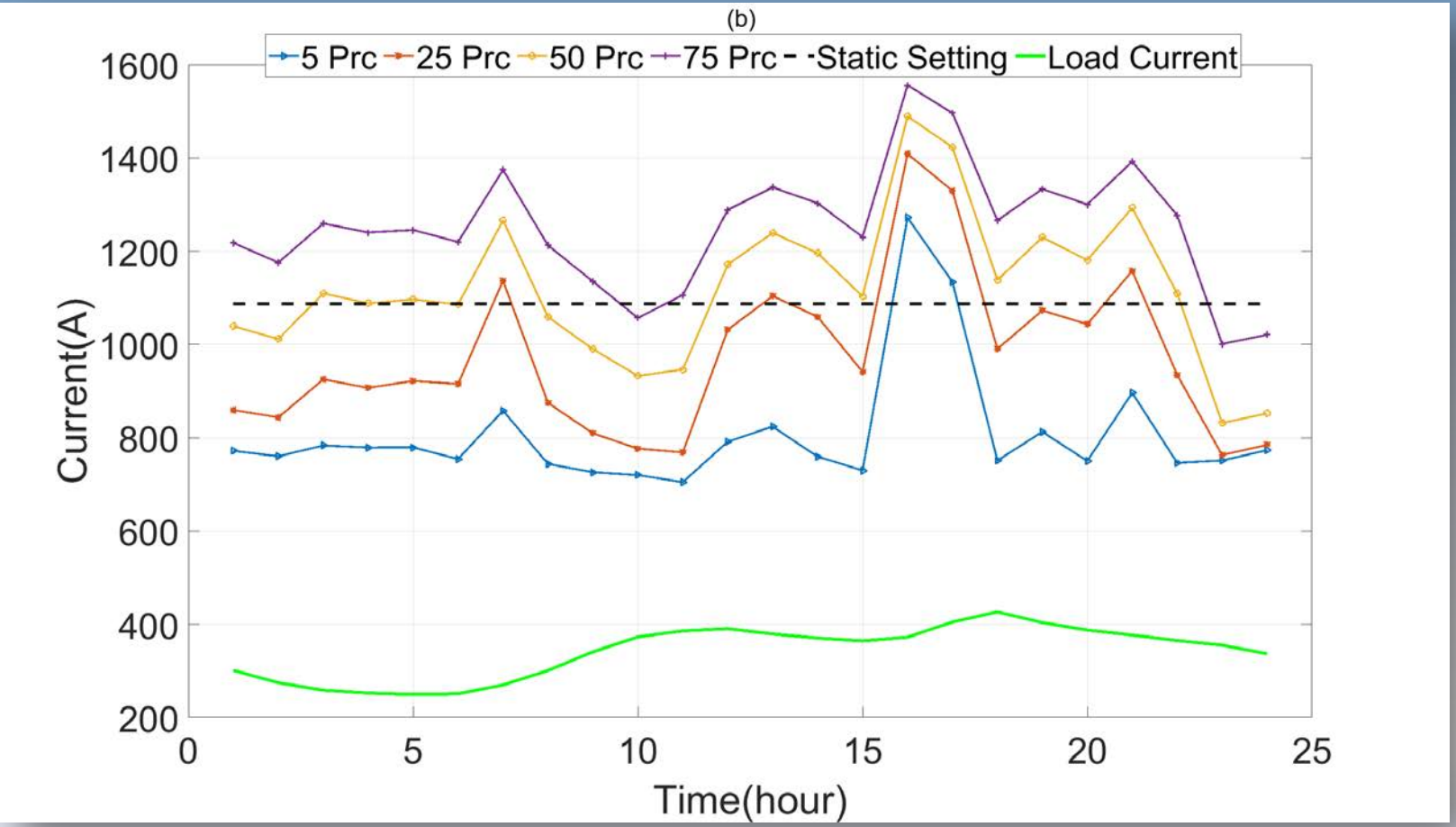
Hours with curtailment as a function of the acceptable probability of overload

Probabilistic Rating – Winter Day



Static rating (dashed line) and four different probabilistic dynamic ratings (solid curves) together with line current (green) for a **winter** day

Probabilistic Rating – Summer Day



Static rating (dashed line) and four different probabilistic dynamic ratings (solid curves) together with line current (green) for a **summer** day

Discussion

- Additional uncertainties
  - *Such as emissivity, absorbtivity of the surface and loading profile*
- Acceptable probability of overload
  - *Deterministic DLR will be associated with a high probability of overload not being removed*
  - *A stochastic approach to DLR-based overload protection is highly recommended.*

However

  - *What are the acceptable risks?*
  - *Balance between dependability and security*

Thank you