Robust Security-Constraint Unit Commitment with Dynamic Rating

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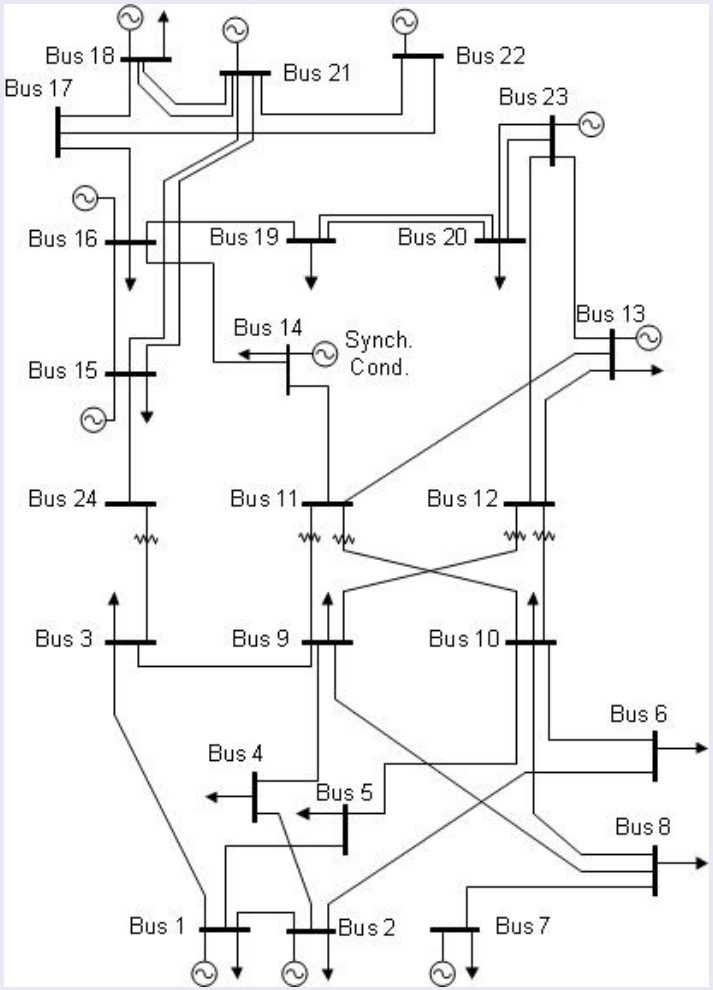
Unit Commitment Problem

- 1^{st} stage decisions:
  - On/off status
- 2^{nd} stage decisions:
  - Generation level
  - Spinning reserve level
  - Transmission utilization
- Uncertainty set:
  - Ambient air temperature
  - Electricity demand

Remark

- *The most important operation problem in the power industry*
- *NP-hard problem*



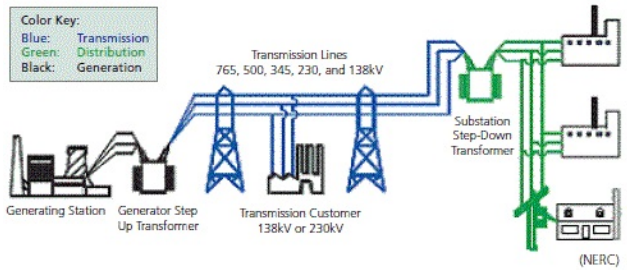
Dynamic Asset Rating

Necessity

- Impact of weather condition on the capacity of power equipment
  - Wind
  - Radiation
  - Temperature
- Static vs. Dynamic Rating
  - Static: planning based on the constant weather condition
  - Dynamic: updating the utilization based on real-time data

Advantages

- Determine the actual real-time capacity
- Improve system reliability
- Optimize grid utilization

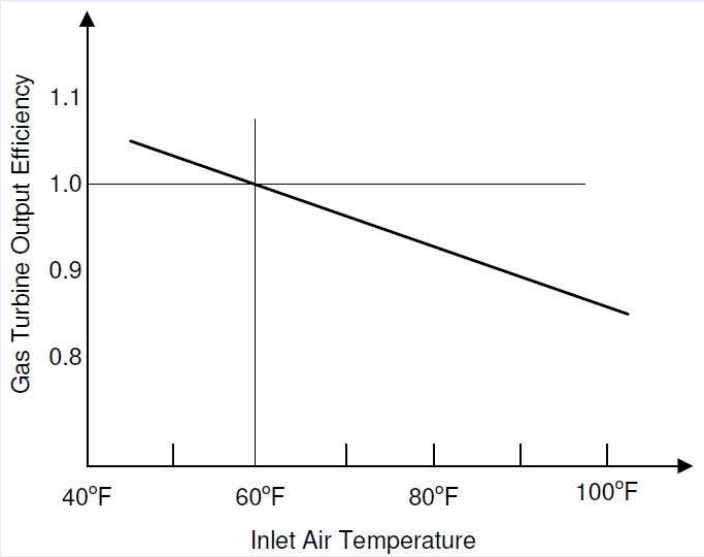


Quantification

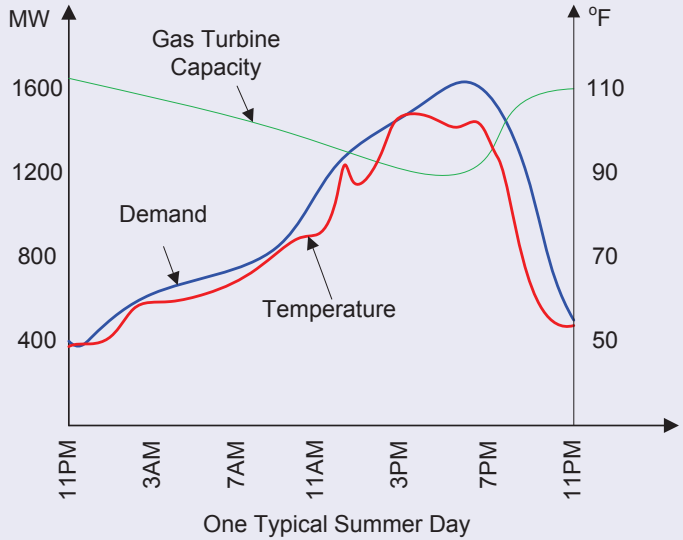
Dynamic Line Rating

Approximately 10°C increase in the temperature $\rightarrow -11\%$ capacity

Dynamic Generator Rating



(a) $x_t \rightsquigarrow x_t(1 - \frac{A_t}{300})$



(b) $D_t \rightsquigarrow D_t(A_t)$

Two Stage Robust Optimization Model

$$\min_{\mathbb{Y}} \{\textit{(Start-up cost \& No-load cost)} + \max_{\mathbb{A}} \min_{\mathbb{X}} \textit{(Fuel cost \& Load shedding penalty)}\}$$

$$\mathbb{Y} = \{\textit{on/off generator status: (Start up),(Min up \& down)}\}$$

$$\mathbb{X} = \{\textit{dispatch decision: (Ramping), (Demand satisfaction), (Spinning reserve), (transmission)}\}$$

$$\mathbb{A} = \{\textit{Temperature \& Demand Uncertainty}\}$$