

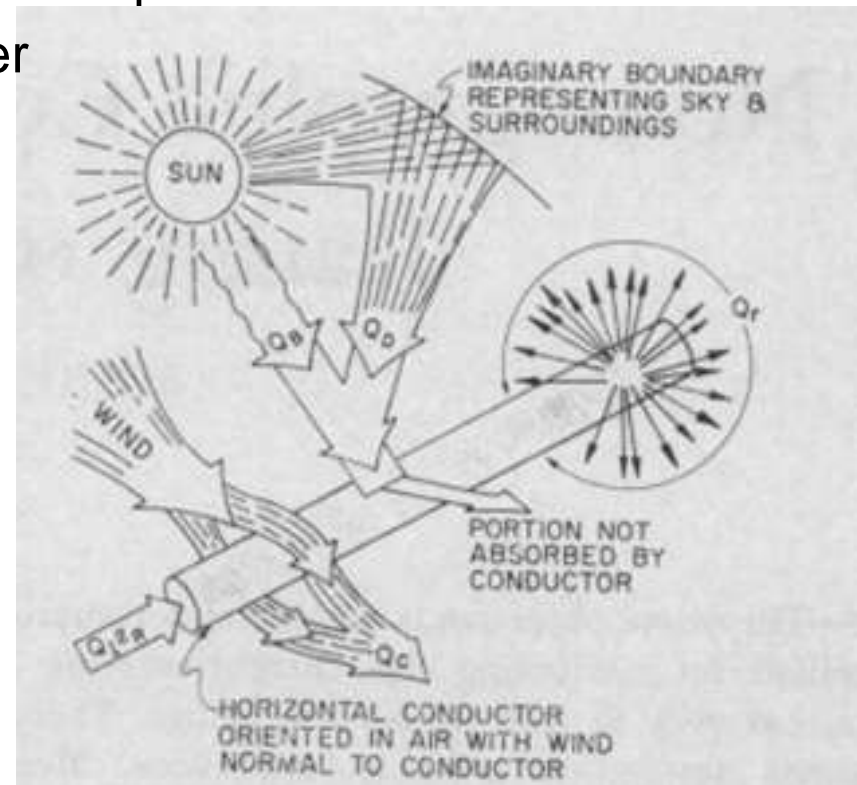
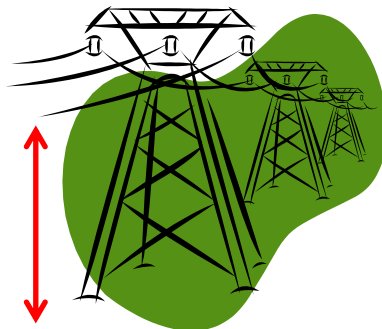
# Temperature and wind influence on power transmission capability of power lines in the vicinity of cold climate wind farms

Winterwind 2013

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## What are we talking about?

- Power lines elongate and contract according to conductor temperature
- Ambient temperature + wind (perpendicular to conductor) + solar radiation + current flowing on the conductor → conductor temperature
- The more warming conditions & higher power transmission on the line → increased conductor temperature → elongating power line → the lower the line is sagging towards the ground
- The clearance to the ground is the transmission line limiting feature!

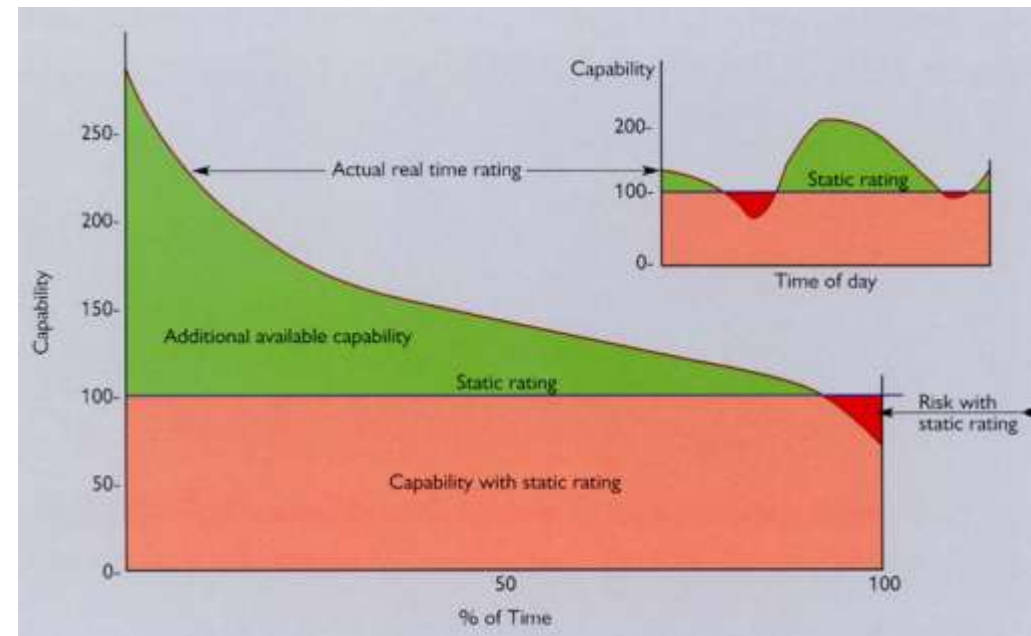
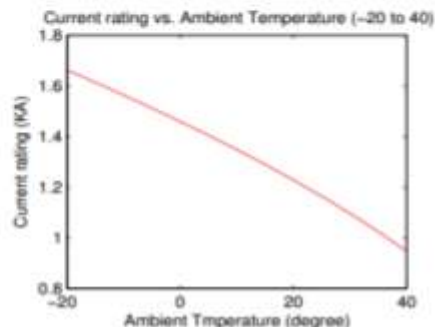
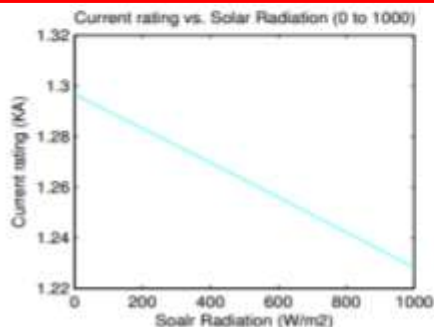
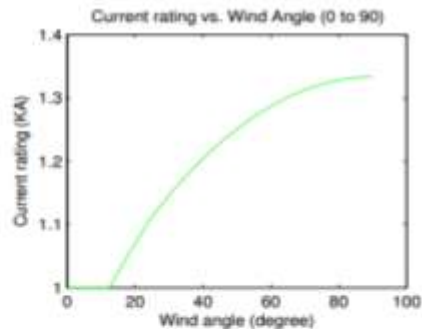
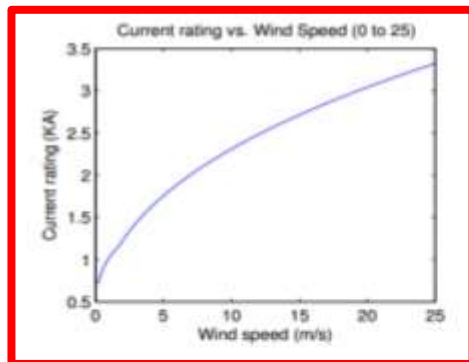


## Why is this topic related to cold climate wind power?

- May be related to new wind farm applications
- Typically cold climate WF sites are in **distant locations** → there are possibly **weak grid connections** → in WF grid connection application
  - identified a need for **grid reinforcements** or
  - WF **capacity is limited** from applied amount or
  - conditional grid connection with **curtailment** option?
- The evaluation of available transmission capacity and acceptable WF capacity/production is probably assessed using **conservative transmission line ratings**
  - Grid companies use widely static line ratings (2-3 seasonal ratings, or even just a single one)
  - Dynamic line ratings, considering the real-time transmission ratings are not widely used, yet

## Conservative static line ratings vs. real-time ratings

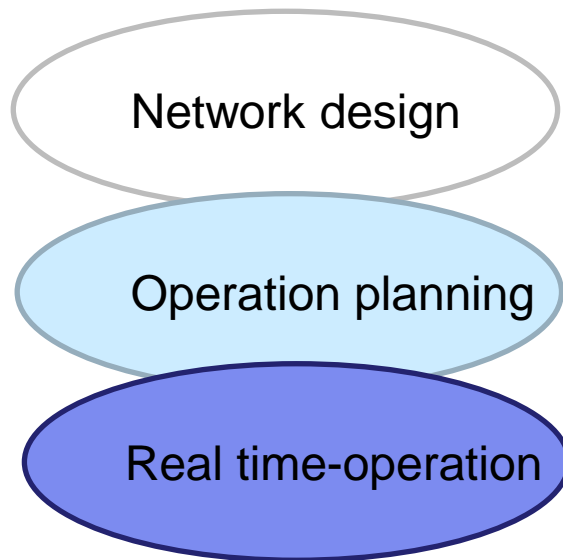
- The static ratings are based on worst case circumstances
  - High ambient temperature (e.g. 30°C at summer)
  - Low wind speed (e.g. 0.6 m/s)
- With high reliability level (but not necessarily 100%) → practically the rating is always safe (but you don't know for sure...)



## Dynamic / real-time line rating, i.e. ampacity & wind power production

- DLR (dynamic line rating), RTTR (real time thermal rating), ampacity...
- The low wind speeds ( $\sim 0 \dots 2$  m/s) are the most “critical” and difficult to predict/measure
- BUT related to wind power production, it is very likely that when there is wind power production, there is at least some wind on the power lines in the vicinity of the wind farm
- Using DLR requires monitoring the DLR (this is grid operators responsibility)
- Using DLR easily allows 10-15 % increase in line capacity
- DLR is used e.g. in North-East of England (Skegness-Boston) related to wind power, DLR implemented by weather stations, and backup relay to reduce/trip wind power

## DLR from grid operator point of view



### Network design:

- probabilistic design based on statistics (average temperatures, wind power production estimation etc)

### Operation planning:

- DLR-forecast days/hours ahead (weather forecast, i.e. temperature & wind)

### Real-time operation:

- deterministic, reliability above all!
- active network management (ANM), wind power curtailment if needed

## DLR from the wind power producer point of view

- DLR could be a possibility in case identified
  - A need for **grid reinforcements** or
  - WF **capacity is limited** from applied amount or
  - conditional grid connection with **curtailment** option
  
- DLR could
  - require e.g. automatic wind farm control option given to the grid operator (for possible curtailment) and
  - result some curtailment,
  - but enable larger capacity be connected, and/or avoid more expensive grid reinforcements, and/or avoid even larger wind power curtailment.



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