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Derates

GADS Wind Training Module 10

March 2019 – Final

RELIABILITY | ACCOUNTABILITY

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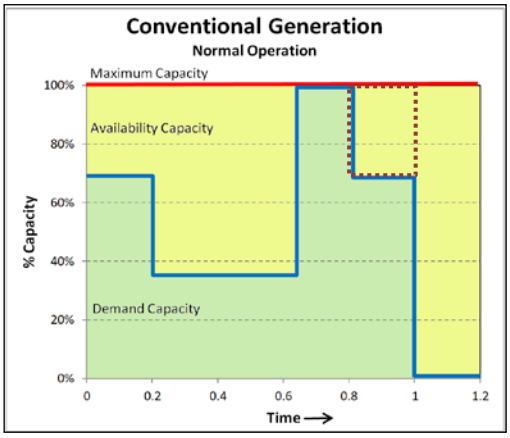
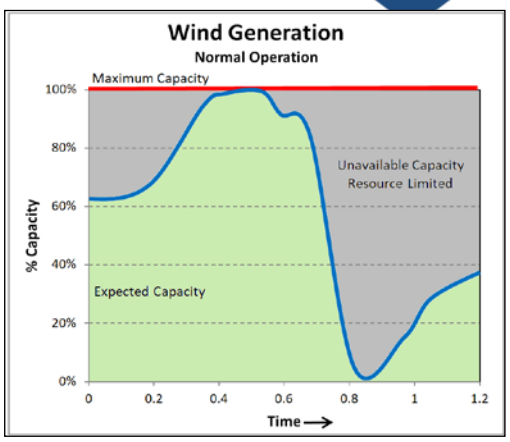
Content

- This module will review:
  - What is Expected Generation?
  - Identifying Derates
  - Types of Derates
  - What is an Equivalent Hour?
  - Why would a turbine be derated?
  - How is it calculated?
  - How are derates used equations?

  - **Remember: reporting of derates is optional.**

What is Expected Generation?



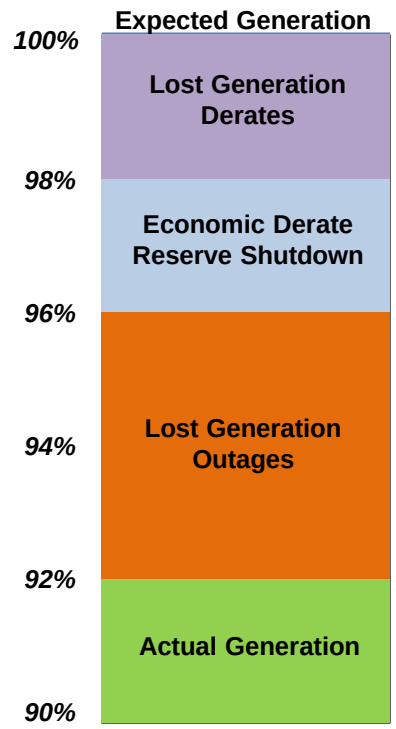


- Conventional Generation:
  - Red Line – Maximum, Dependable or Expected Capacity
  - Nice square chunks of data
  - Demand + Available = Red line
  - Derate lost generation easy to calculate
- Wind Generation:
  - Red Line – Maximum Capacity
  - Lot of motion, always changing
  - The demand is always for the highest generation possible
  - Derate lost generation very technical to calculate

Expected Generation = Highest generation possible with the available energy resources Equipment issues are not taken into account.

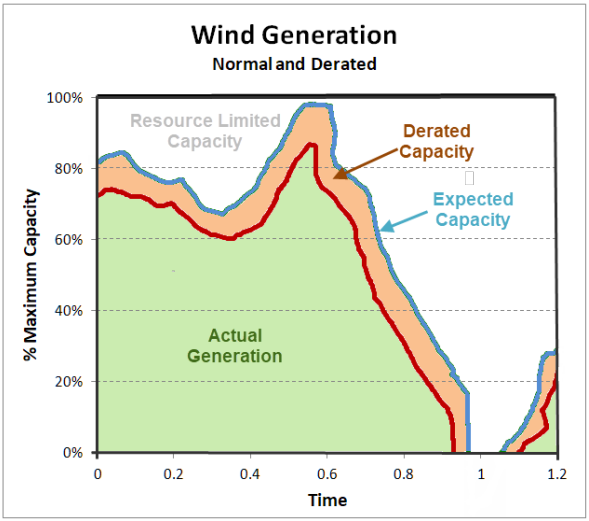
Expected Generation – An Opportunity for Improvement

- Identifying the pieces:
  - Actual Generation – The largest piece
  - Outage – Lost Generation
    - Zero generation
    - Sum expected energy data points for the outage period
  - Reserve Shutdown (economic curtailment)
    - Original method was to shut turbines down
    - Current method is to decrease generation to meet a limit
  - Still a Gap – Are there other losses or is this measurement error
    - Anemometer slope and off-set
    - Turbine parameters
    - Anemometer age and variation
    - Missing or bad data
  - The Missing Piece - Derates
    - Internal turbine derates
    - External turbine derates
    - Weather derates



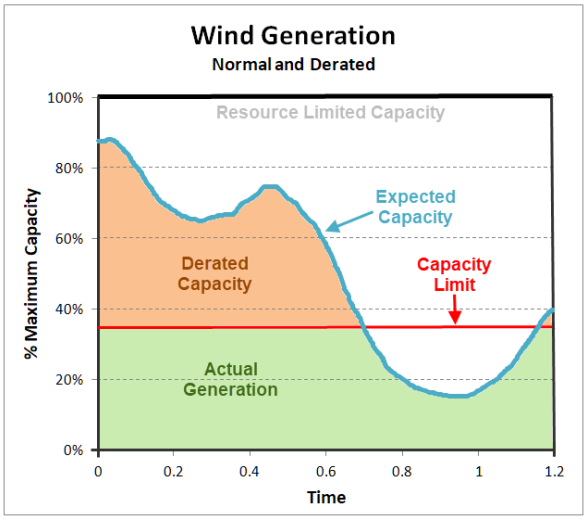
Constant Derate

- Variable unit derates can occur in many forms
- The most common form of derate is a constant derate seen throughout the operation range
- Common causes:
  - Soiling of solar panels
  - Wind vane out of calibration
  - Wind pitch mechanism failing
  - Icing on blades
  - Blade alignment
  - Controller automatic derates
  - Temperature – high and low



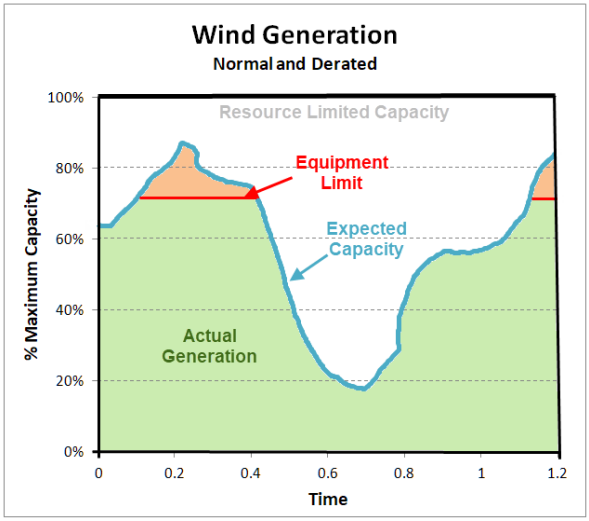
Capacity Limit

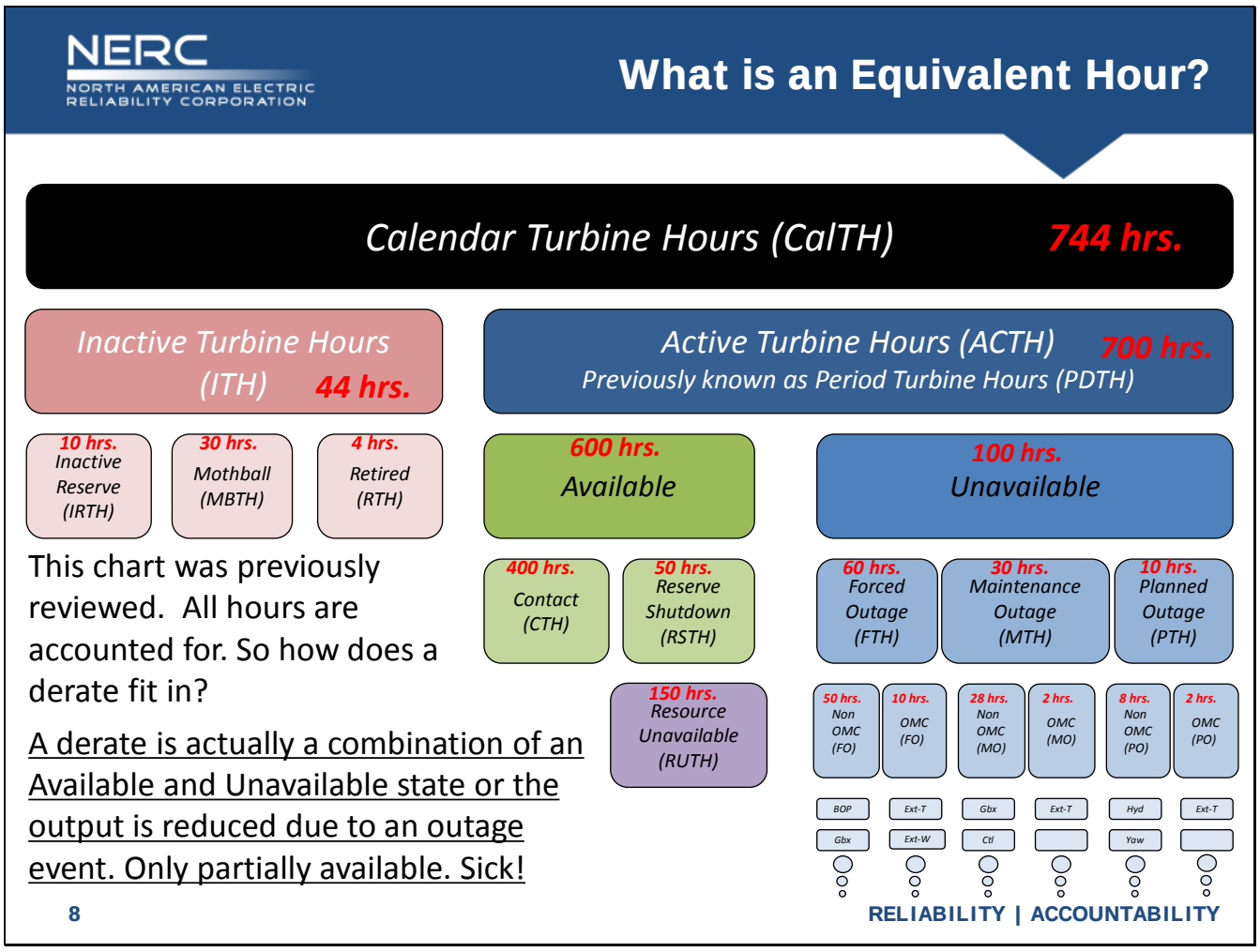
- Capacity limits or restrictions are usually orders from the System Operator
- The plant is limited to a <u>not to exceed</u> specified capacity
- Production less than the limit is OK
- When the Expected Capacity (EC) is less than the limit there is no derated capacity
- Common Causes:
  - Limit due to Reserve Shutdown. Lack of demand or negative energy pricing. This is defined as ERSDTH in the wind data reporting instructions
  - Transmission constraints



Equipment Derate

- Equipment limitations
- There is no derate when the EC is below the equipment limit
- Common causes:
  - Failing gearbox – output limited to prevent failure before replacement
  - Sensor calibration – automatic derate from controller usually identified during start-up checks





If derates are optional why bother. As systems mature, calculating derates will become easier. Derates have a definite impact on revenue and understanding them is the next step in improved performance.

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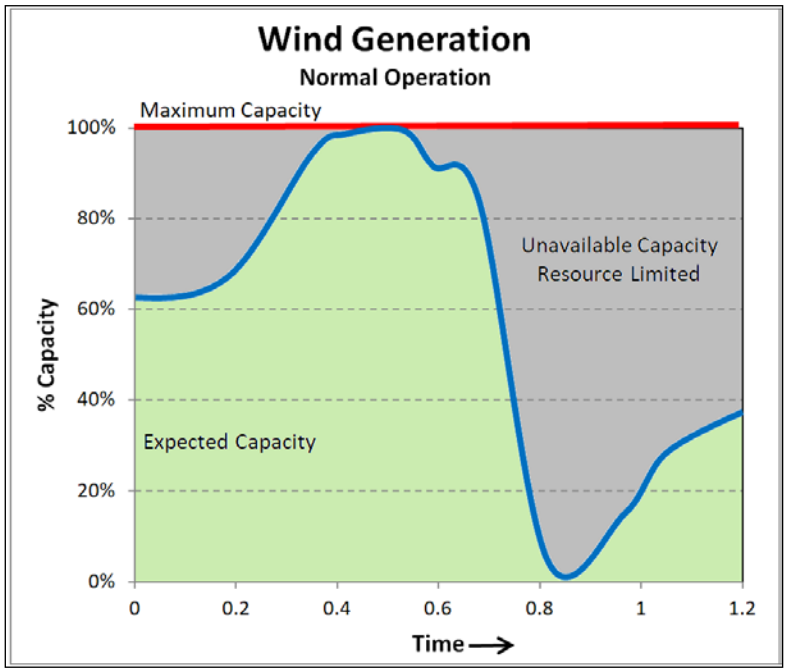
How are Derates Calculated?

- Derate calculations produce **equivalent hours**. It is not a direct measurement. Basically, a derate is a percent of capacity times the hours during which the turbine was derated.
- The most **accurate** method, but more technically challenging, is to use generation. As an example: A turbine lost 5 MWH due to a derate issue and was expected to produce 10 MWH during the same period. This is a 50% derate so 50% of the derate period hours are equivalent hours. This calculation takes into account available resources. It is **Generation or Resourced based**.
- A turbine has been derated to 70% of its maximum capacity for a 100 hour period for a blade crack issue. The 30 hours the turbine is unavailable is equivalent to a forced derate. This calculation does not take into account any change in resource. **Strictly maximum capacity based.**
- Equivalent downtime hours are **tracked separately**. They are not added to the outage hours reported. This is because the available time (CTH or RUTH) are tracked as a whole.

- Remember that the turbine is running during the derate period. The main contactor is closed and the turbine is collecting contactor (CTH) hours.
- When equivalent hours are calculated and reported separately. They are not part of the Calendar Hours for the period.
- Calculations can be either time or energy based. Energy based calculations are more accurate as they take into account losses that can be converted to dollars. When there is no wind there is no energy loss and no lost income.
- When energy losses are understood and separated into different categories, a better understanding of where our losses are occurring and how to implement countermeasures.

Maximum vs. Expected Capacity



How are Derates Used in Equations?

- Equation 1.B.12 is the calculation for equipment based EFOR and is defined below. EFDTH = Equivalent Forced Derated Turbine Hours.

1.B.12. Equipment Equivalent Forced Outage Rate (EEFOR)
Probability of forced WTG equipment downtime when needed for load.

$$EEFOR = \frac{(FTH + EFDTH)}{[(CTH - ERSDTH) + FTH + RUTH]} \times 100$$

- Given - FTH = 300 hrs., EFDTH = 30 hrs., CTH = 3,000 hrs., RUTH = 1,500 hrs., ERSDTH = 0Hrs
- Therefore:
- EEFOR = (300 + 30) / ((3,000-0) + 300 + 1,500) = 6.875%
- You should be asking the question "Why is EFDTH not in the denominator?"
- Remember on the previous page the turbine was running and our equivalent downtime hours are somewhere in CTH and RUTH. We don't know exactly, so they were not subtracted out. Adding them in would be double counting.

Derates are optional, so what happens when the formula is used? EFDTH become 0 and there is no impact to the result.

The title of equation 1.B.12 is Equipment Equivalent Forced Outage Rate (EEFOR). If there are no equivalent hours, EFDTH becomes zero and the true title is Equipment Forced Outage Rate (FOR).

The new term for 2018 is ERSDTH. Equivalent Reserve Shutdown Derated Turbine Hours. Reserve Shutdown is not part of the EEFOR equation. Often in wind, RS is implemented by derating the turbine. The equivalent RS hours should be subtracted from CTH to get a correct value for EEFOR.

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