Increasing penetrations of wind will displace conventional plant

Pattern of wind capacity allocation and reactive power control scheme of wind farms may influence the voltage stability of the system

Control of reactive power generation in wind farms may improve voltage stability of the system\(^1\)

Loadability margin (LM), distance of the normal operating point to voltage collapse point, is a criteria used to assess the voltage stability of the system

**Objective:**
- Investigate the effect of the pattern of wind capacity allocation and reactive power control scheme on steady state small disturbance long term voltage stability

**METHODOLOGY**

- Loadability margin added to AC optimal power flow using the enhanced two sets of variables approach
- \(10 \times 8 = 80\) scenarios (wind capacity factor) (demand level)
- Unit commitment
- Least loadability margin = 31%
- Two objective functions:
  1. \(\text{Max } P_{\text{wind,capacity}}\): Max wind capacity
  2. \(\text{Max } LM_{HV}^{\text{Min}}\): Max voltage stability at HV buses

**TEST CASE**

- Modified IEEE 14 bus network
- 8 candidate buses for wind capacity allocation
- Automatic Voltage Regulation (AVR), \(V_{SP} = 1\ p.u.\)
- Conventional generators
- Wind farms in HV buses (buses 3 and 4)

**RESULTS**

- Almost equal total wind capacity with both objective functions
- Different pattern of wind capacity allocation:
  - \(\text{Max Wind}\): Mostly in LV side of the system
  - \(\text{Max Stability}\): Mostly in HV side of the system
- Significant difference in terms of stability:
  - \(\text{Max Wind}: LM_{HV}^{\text{Min}} = 32.45\%\)
  - \(\text{Max Stability}: LM_{HV}^{\text{Min}} = 58.19\%\)

**CONCLUSIONS**

- Application of voltage control to wind farms in LV side:
  - No significant change in the wind capacity allocation pattern
  - Improved stability \(LM_{HV}^{\text{Min}} = 50.53\%\) in \(\text{Max Wind}\) case

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