Analysis of Variability of Solar Panels in The Distribution System

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Motivation

Substation

Distribution System

Residences

Solar Panels

Static VAR Compensator (SVC)
Background

• SVC (Static VAR Compensator)

• Current Power Flow

\[ S = P + jQ = \bar{V} \times I \]
• Mathematical Modelling

- The transients of the inductances of the distribution lines were neglected as they were assumed to be too fast
- Solar panels were modeled as power injections
- Dynamic model for SVC was considered
Cases

- 4 bus system
• 20 bus system
Results

Analysis of bus voltage with and without SVC for the 4 bus system with 3 different solar irradiations

Ppv = 1  0 < t < 5
Ppv = 1.1  5 < t < 7
Ppv = 0.8  7 < t < 10

Ppv = 1  0 < t < 5
Ppv = 1.1  5 < t < 7
Ppv = 1  7 < t < 10

Ppv = 1  0 < t < 5
Ppv = 1.1  5 < t < 7
Ppv = 1.5  7 < t < 10
Results

Analysis of bus voltage with and without SVC for the 20 bus system with various solar irradiations

- $P_{pv0}$ = 0.0001 \quad 0 < t < 5
- $P_{pv1}$ = 0.0001 \quad 5 < t < 7
- $P_{pv2}$ = 0.005 \quad 7 < t < 10
- $P_{pv3}$ = 0.0001 \quad 10 < t < 12
- $P_{pv4}$ = 0.0001 \quad 12 < t < 13
- $P_{pv5}$ = 0.0001 \quad 13 < t < 16
- $P_{pv6}$ = 0.0001 \quad 16 < t < 16.5
- $P_{pv7}$ = 0.0001 \quad 16.5 < t < 20
Ppv0 = 0.0001  \hspace{1cm} 0 < t < 5
Ppv1 = 0.0001  \hspace{1cm} 5 < t < 7
Ppv2  \hspace{1cm} 7 < t < 10
  \hspace{1cm} PV 1 = 0.003
  \hspace{1cm} PV 2 = 0.005
  \hspace{1cm} PV 3 = 0.003
Ppv3 = 0.0001  \hspace{1cm} 10 < t < 12

Ppv4 = 0.0001  \hspace{1cm} 12 < t < 13
Ppv5  \hspace{1cm} 13 < t < 16
  \hspace{1cm} PV 1 = 0.009
  \hspace{1cm} PV 2 = 0.005
  \hspace{1cm} PV 3 = 0.009
Ppv6 = 0.0001  \hspace{1cm} 16 < t < 16.5
Ppv7 = 0.0001  \hspace{1cm} 16.5 < t < 20
Ppv0 = 0.01  0 < t < 5
Ppv1 = 0.0001  5 < t < 7
Ppv2  7 < t < 10
PV 1 = 0.003
PV 2 = 0.005
PV 3 = 0.003
Ppv3 = 0.0001  10 < t < 12
PV 1 = 0.002
PV 2 = 0.007
PV 3 = 0.002

Ppv4 = 0.0001  12 < t < 13
Ppv5  13 < t < 16
PV 1 = 0.009
PV 2 = 0.005
PV 3 = 0.009
Ppv6 = 0.0001  16 < t < 16.5
Ppv7 = 0.0001  16.5 < t < 20
Conclusion

With the implementation of SVCs it is possible to maintain the bus voltage within an acceptable band compared with the cases without SVCs when there are variations in the solar panel output.
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Questions and Answers