Dynamic Stochastic Optimal Power flow (DSOPF) Control for Power Systems with High Variability

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To achieve a high penetration level of intermittent renewable energy, power system stability and security need to be ensured dynamically as the system operating condition continuously changes. A DSOPF control algorithm using adaptive critic designs (ACDs) is proposed as a solution to control the smart grid in an environment with high short-term uncertainty and variability.

### Traditional Power System Control and Operation

- **Active Power Control**
- **Reactive Power Control**
- **Speed Governor**
- **Automatic Voltage Regulation (AVR)**
- **Automatic Generation Control (AGC)**
- **Regional Voltage Control (RVC)**

- **Steady-State Optimal Power Flow (OPF)**

#### Based on linear PI controllers
- **Cannot consider security**
- **Have no coordination**

#### Static and deterministic
- **Based on forecasts**
- **Cannot handle fast events**

### DSOPF-Based Smart Grid Control and Operation

- **AC Power Flow Control**
  - Generators
  - FACTS Devices
  - DSOPF Control
  - Steady-State OPF

- **Based on adaptive critic designs (nonlinear optimal control)**
- **Simultaneously consider economy, stability, and security**
- **Coordinate of AC power flow**
- **Handle fast stochastic events**

### Example: 12-bus test power system

#### Case 1: load & cap tripped at bus 5

- Frequency (Hz)
- Tie Line Flow (MW)
- Bus 4 Voltage (pu)

#### Case 2: line 2-5 outage

- Variable Constant-Power Load (MW, MVAr)

#### Case 3: large short-term varying loads at buses 4&5

- Varying Load (MW, MVAr)
- Frequency (Hz)

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