A Novel Control Strategy For Islanded Microgrids

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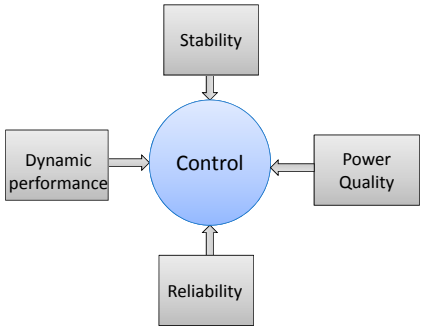
MICROGRID CONTROL

Introduction

- High penetration of renewable energy resources in the power grid
- Stability issues, frequency fluctuations, voltage control, protection system coordination
- System approach: microgrid
- Energy problems solved locally
- Grid connected operation
- Islanded operation: uninterruptable power supply



Microgrid control methods

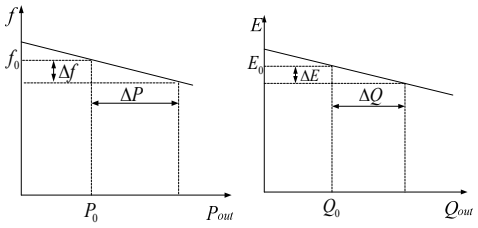
- Centralized: optimal performance, high bandwidth communication, reliability issue
- Decentralized: Droop

Basic idea of the droop control

- Use f and E as linking signals to coordinate the DGs

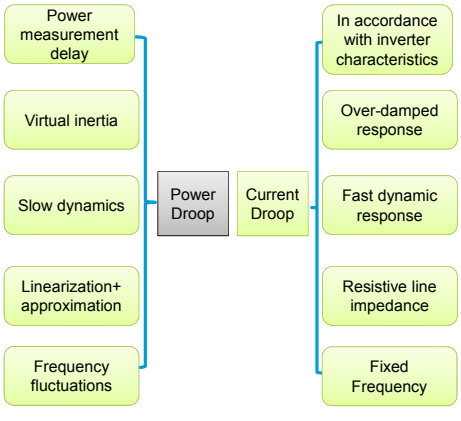
$$P = \frac{VE}{Z}\sin\delta\sin\theta + \frac{V}{Z}(E\cos\delta - V)\cos\theta$$

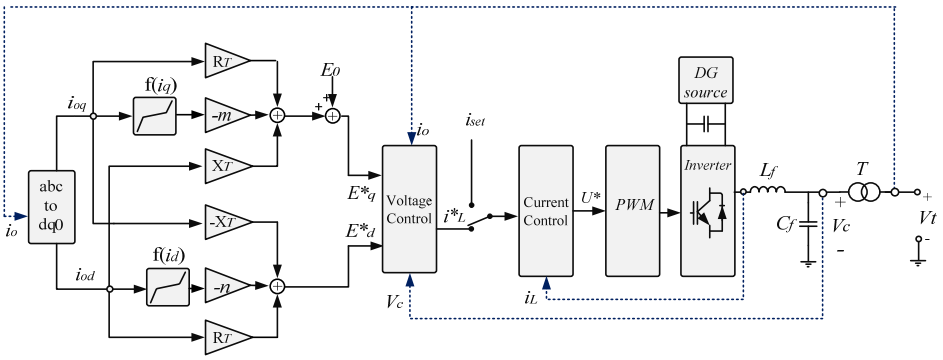
$$Q = \frac{V}{Z}(E\cos\delta - V)\sin\theta - \frac{VE}{Z}\sin\delta\cos\theta$$



Proposed solution

- Coordination of current instead of power



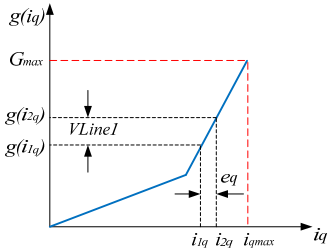


PROPOSED CONTROL METHOD

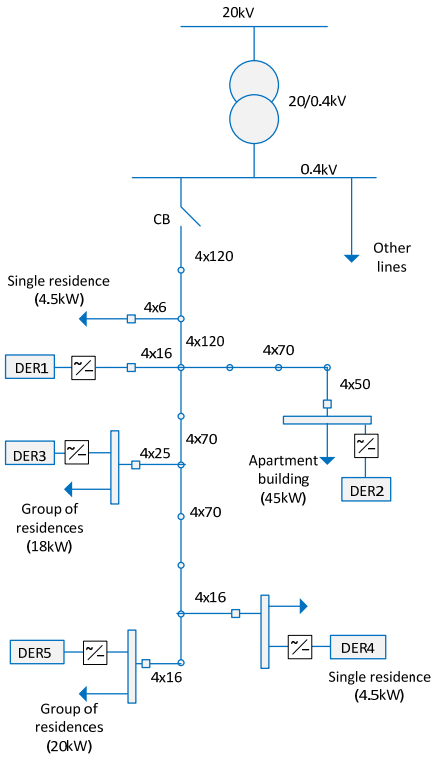
- DGs synchronized through a GPS signal
- Utilization of dq voltages as linking signals
- Coordinate dq currents instead of P and Q
- Compensate the transformer voltage drop to minimize voltage deviations
- Gain scheduled droop control law:

$$E_{qd}^{x} = \begin{bmatrix} E_0 \\ 0 \end{bmatrix} + \begin{bmatrix} R_{Tx} & X_{Tx} \\ -X_{Tx} & R_{Tx} \end{bmatrix} i_{xqd} - \begin{bmatrix} m_x g(i_{xq}) \\ n_x g(i_{xd}) \end{bmatrix}$$

- Behaves like a virtual resistor
- Increased system damping

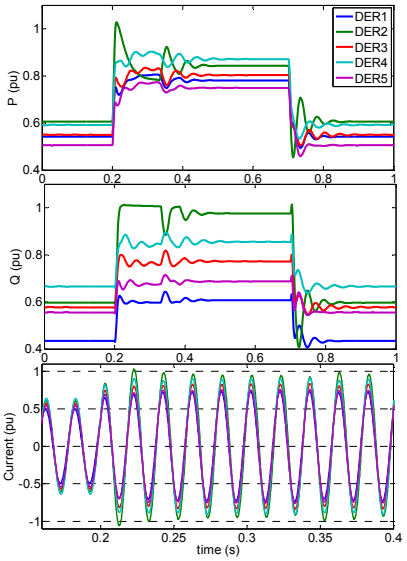


BENCHMARK MICROGRID

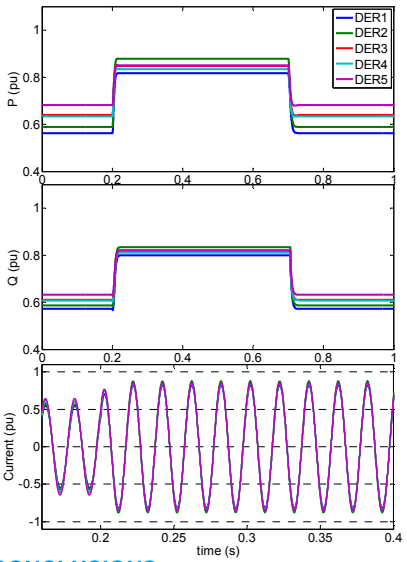


SIMULATION RESULTS

Conventional Droop Method



Proposed Method



CONCLUSIONS

- The conventional droop control relies on large inertia of synchronous machines.
- A new droop control scheme in accordance with the characteristics of inverter-based DGs (low inertia and strict current limits) is proposed.
- Simulation results show a significant improvement in the DGs dynamic response.