

Homework 3

The solutions will be released on Monday, October 9, 2017

Quiz Date: Thursday, October 12, 2017 during class

The quiz is based on the following material: Lecture 7, Lecture 8, and the problems in Homework 3.

Problem 1: Which of the following is not one of the beneficial impacts of wind?

- a. No air pollution
- b. No CO₂ emissions
- c. Large water requirements
- d. Net decrease in pollution due to displacement of energy from fossil-fired sources

Problem 2: Assume that you are the grid operator of a system with a deep wind penetration. **State** the key conditions that you need to ensure with regards to the generation, load, and frequency of the grid. **Consider** the graphs on slides 22, 27, and 28 of Lecture 7. **State** your approach that you need to pursue as the grid operator, in order to ensure a reliable operation of a grid with deep wind penetration.

Solution:

This is an open-ended question, yet in order to get full credits, your response must include the following points:

- A key need in power system operations is to ensure that power system generation exactly matches the total load plus losses at all times. Moreover, the operators must ensure that the frequency in the system is maintained at its nominal value.
- In order to ensure the effective utilization of wind, the time correlation between wind and loads is essential. The operator must consider how good is the timing of high-wind speeds vis-à-vis the loads that must be supplied.
- Generation shortfalls can suddenly occur because of the loss of a generator and operators must maintain sufficient reserves – generation that is on-line but not fully loaded – to account for the loss of the largest single generator in a region and other possible contingencies.
- The operator must ensure that they can meet the large up-ramp requirements that arise due to the sudden loss of generation from wind. This is because, a wind turbine output varies with the cube of the wind speed, and even a modest drop in the wind speed can result in a major loss of generation.
- Due to the limited controllability of wind resources, the operator has no choice but depend more extensively on conventional resources to supply adequate reserves and frequency regulation

Problem 3: What is the cumulative US wind capacity by the end of 2016?

- a. 8.21 GW
- b. 82.1 GW
- c. 821 GW

Problem 4: Which of the following states has the highest cumulative wind capacity by the end of 2016?

- a. Illinois
- b. California
- c. Texas
- d. Massachusetts

Problem 5: What is the global cumulative wind capacity by the end of 2016?

- a. 4.87 GW
- b. 48.7 GW
- c. 487 GW

Problem 6: Which of the following countries has the highest wind capacity additions in 2016?

- a. US
- b. China
- c. Turkey