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RESEARCH

Large Scale Testbed

Overview

The overall objective of the Large-Scale System Testbed is to represent large grids of the future, such as that of North America, at several resolution levels for both evaluation of new technologies and to drive research efforts. The success of the testbed enables a comprehensive evaluation of the impact of the changes and new technologies on the operation of future power grids. The models include different scenarios of generation mix and operating scenarios, wide-area measurements, new actuation technologies and new control strategies.

Approach

There are several on-going efforts associated with building the Large-Scale System Testbed. The primary focus is on positive sequence dynamic models of the system. One challenge is developed reduced modeling needed for studying future scenarios. Although commercial software packages provide computationally efficient approaches to model power systems in great detail, it is neither practical nor necessary to build a detailed testbed that covers say the entire North American power grid for the purpose of many studies. This is partially because our focus is on future grids. A technically viable approach is to reduce the system complexity without losing the dynamic characteristics of the original system.

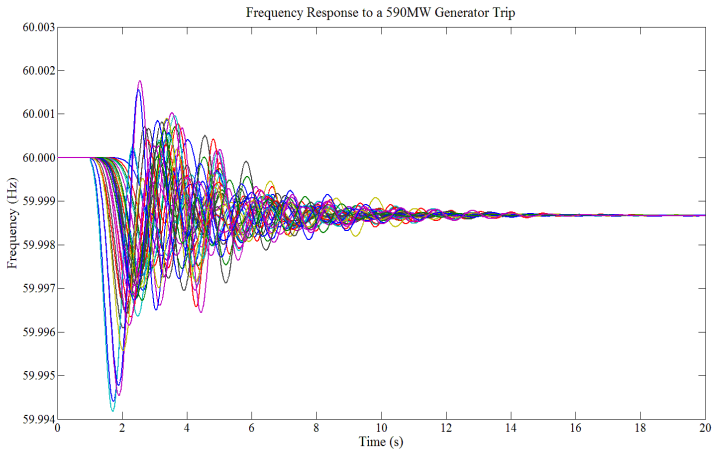

Fig. 1 2030 high wind scenario: 590 MW generator trip (detailed 70,000 bus model)

System	Bus Number	Transfer Capacity	Limiting Factor	System Capacity
Detailed Model	15,600	4800MW	VAR Limit	154.4GW
Classical Case	179	4105MW	VAR Limit	61.4GW
Light Wind Penetration (3.68 GW)	190	3813MW	Volt. Dip Limit in SCE System	61.4GW
Heavy Wind Penetration (7.37 GW)	190	3056MW	Volt. Dip Limit in SCE System	61.4GW

Fig. 2 WECC models - COI transfer limit comparisons

Another challenge remains in modeling the penetration of renewable energy sources and new transmission architectures. Renewable generation sources, such as wind and solar, have unique dynamic behavior as well as highly variable output. To evaluate the impact of the high penetration of renewable energy, it is

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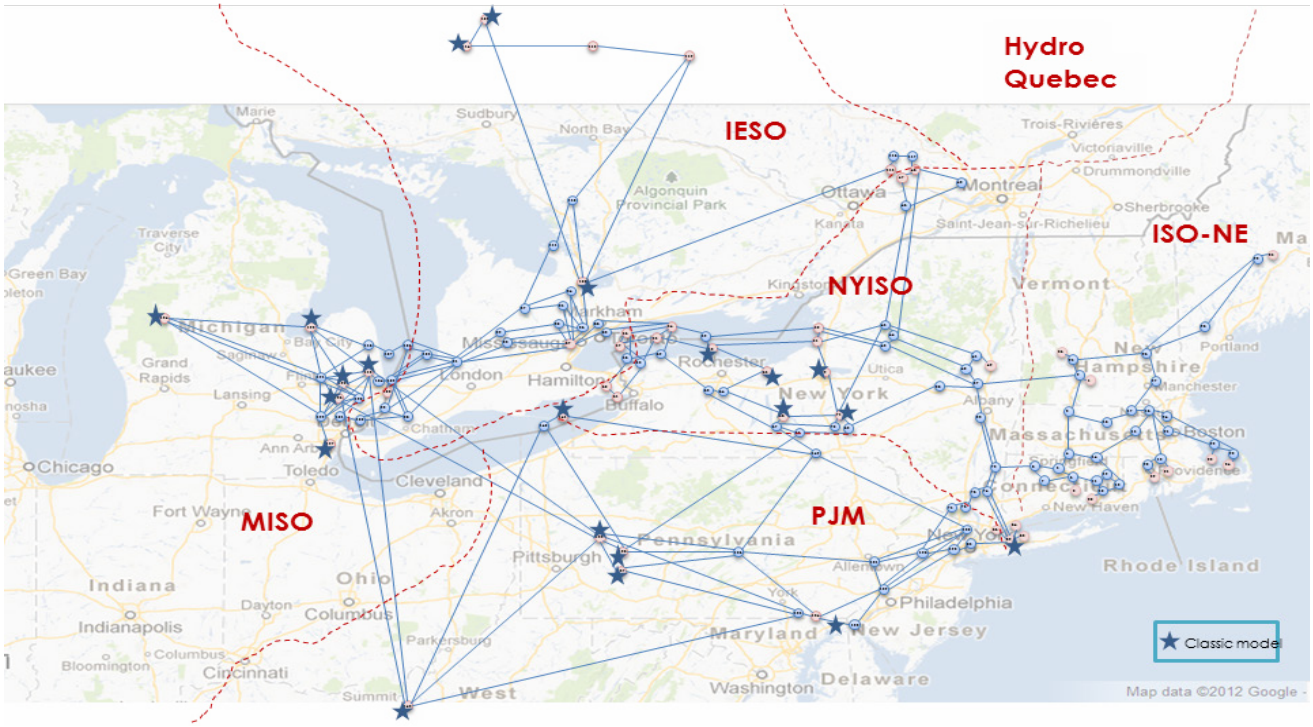

Fig. 3 One Line Diagram of NPCC System Testbed

important to represent renewable generation sources with accurate models and realistic scenarios of levels of penetration and likely locations for the units.

Finally, the testbed is crucial for development and evaluation of the proposed wide-area measurement-based control methods. The challenge here is how to integrate novel control approaches within the testbed so as to practically examine their performance.

This project is developing the following test systems:

• EI – Reduced dynamic model of the entire eastern interconnect. A dynamic model of the 2030 system and a study of the impact of coal plant retirement. Results of the application of EPRI program DYNRED for selective model reduction to maintain voltage stability concerns.

• WECC – Simplified model based on 179 bus and 240 bus systems that are available in the open literature. This model includes detailed dynamic data that can faithfully represent the system dynamics and transfer limits based on industry operating standards. The generation and load patters will be based on the yearly data available from the 240 bus system data. This system has been modified to included increased penetration of wind.

• NPCC – A model based on a 48-machine (140 buses) system of 28 GW of load. This model represents NPCC region covering whole or parts of ISO-NE, NYISO, PJM, MISO and IESO. Approximately 27 generators are modeled with detailed models and the remaining units are reduced models or dynamic equivalents. Wind units are being added based on likely regions for significant wind.

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