SAND2020-22770

SYSTEMS INTEGRATION TRACK (System Planning Models and Simulation Topic)

PROJECT NAME: Enabling Extended-Term Simulation of Power Systems with High PV Penetration

Last 5 digits of project number: **36461**
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BACKGROUND / INDUSTRY IMPACT

- Project will advance the understanding of the impact of high PV penetration on the grid
- Current tools only consider fast dynamics for brief periods
- Project will develop methods to enable simulation of both slow and fast dynamics for extended time periods

PROJECT OVERVIEW / OBJECTIVES

- Develop 3 simulation test cases (models plus data) using the baseline solver (RK-2 method)
- Implement 3 variable time-step methods in Matlab/PST to show a reduction in simulation time steps by up to 40% compared to RK-2
- Demonstrate the new integration methods in PowerWorld using variable irradiance PV data

METHODS

- We will develop time step control, simultaneous-implicit (SI) and/or multi-rate algorithms within existing power system simulation platforms
- Power systems with high PV penetration simulated over extended time frames are the target test cases
- We will conduct stakeholder engagement activities to help demonstrate market readiness

KEY OUTCOMES / MILESTONES

- Develop 3 simulation test cases (models plus datasets)
- Demonstrate 3 variable time-step methods in PST
- Present performance results of variable time step methods to power systems simulation community
- Determine algorithms for PowerWorld demonstration
- Demonstration of new integration methods in PowerWorld using high irradiance PV data
- Publish final report and present webinars to conduct stakeholder engagement activities

CONCLUSION / REMAINING RISK

- Expected project output is development of variable time-step algorithms for extended-term dynamic simulations of power grids with high PV penetration
- This will consist of a computational framework for supporting high fidelity dynamic models
- Output will be brought closer to market through demonstration in commercial simulation platforms
- Primary beneficiary will be the wider power systems community that needs to understand the impact of high PV penetration in power grids

Project goal is to develop **variable time-step** integration algorithms capable of solving both **slow and fast dynamics** for simulations spanning time frames (~15 mins) **much longer** than existing tools. This is critical to understanding the **impact of high PV penetration** in power grids.

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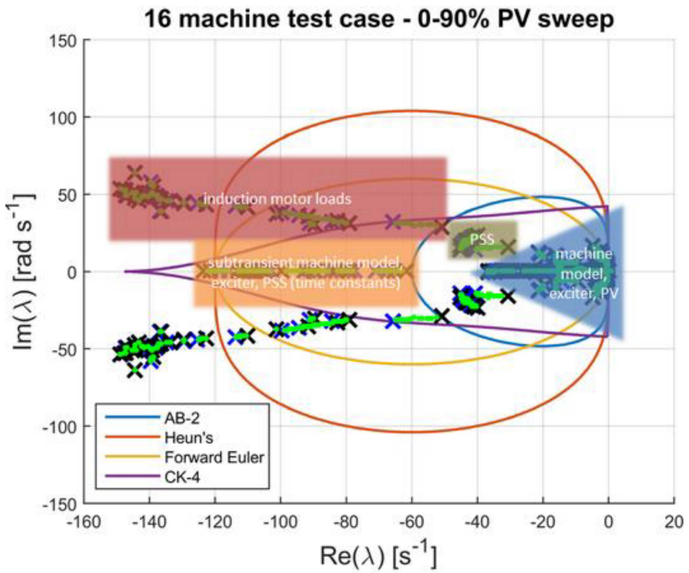
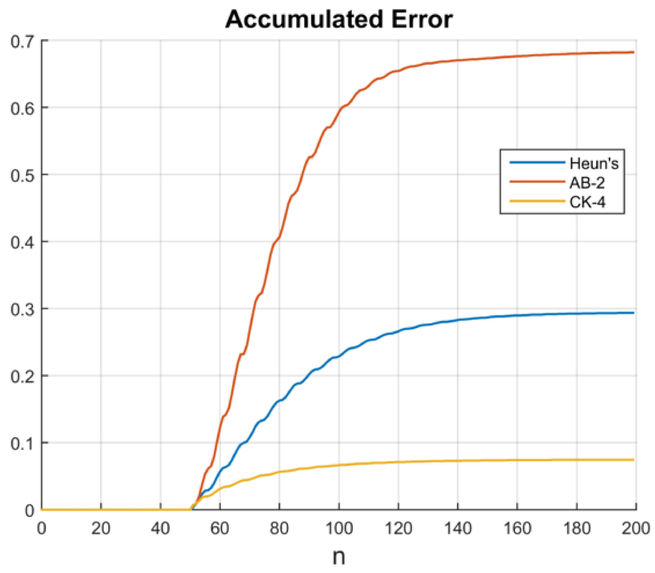
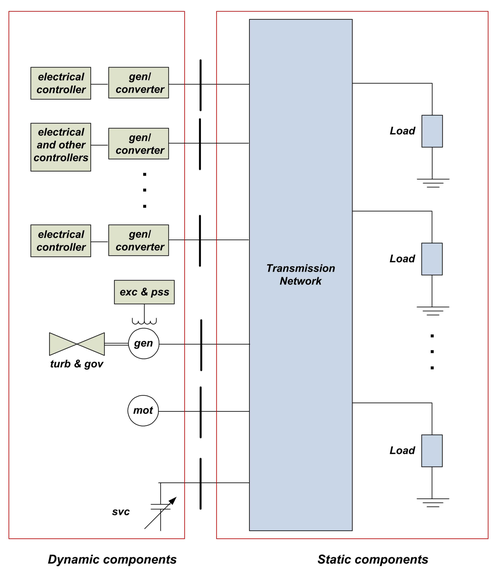


Regions of stability for four candidate integrators for a given step size. The poles of a representative power system are shown for reference.



Accumulation of integration error during simulation of a 2nd order ODE with a complex conjugate pole pair.



Topology of typical power systems.

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