Modeling and Validating System Dynamics in Saudi Synthetic Electric Grids

CURENT

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MOTIVATION

- ❖ The need for a comprehensive and realistic synthetic accurate model of the Saudi power grid.
- ❖ Creating an open-source accurate model that represent the dynamic behavior of the Saudi synthetic electric grid for the academic, and research communities' scientific participation.

CONTRIBUTION

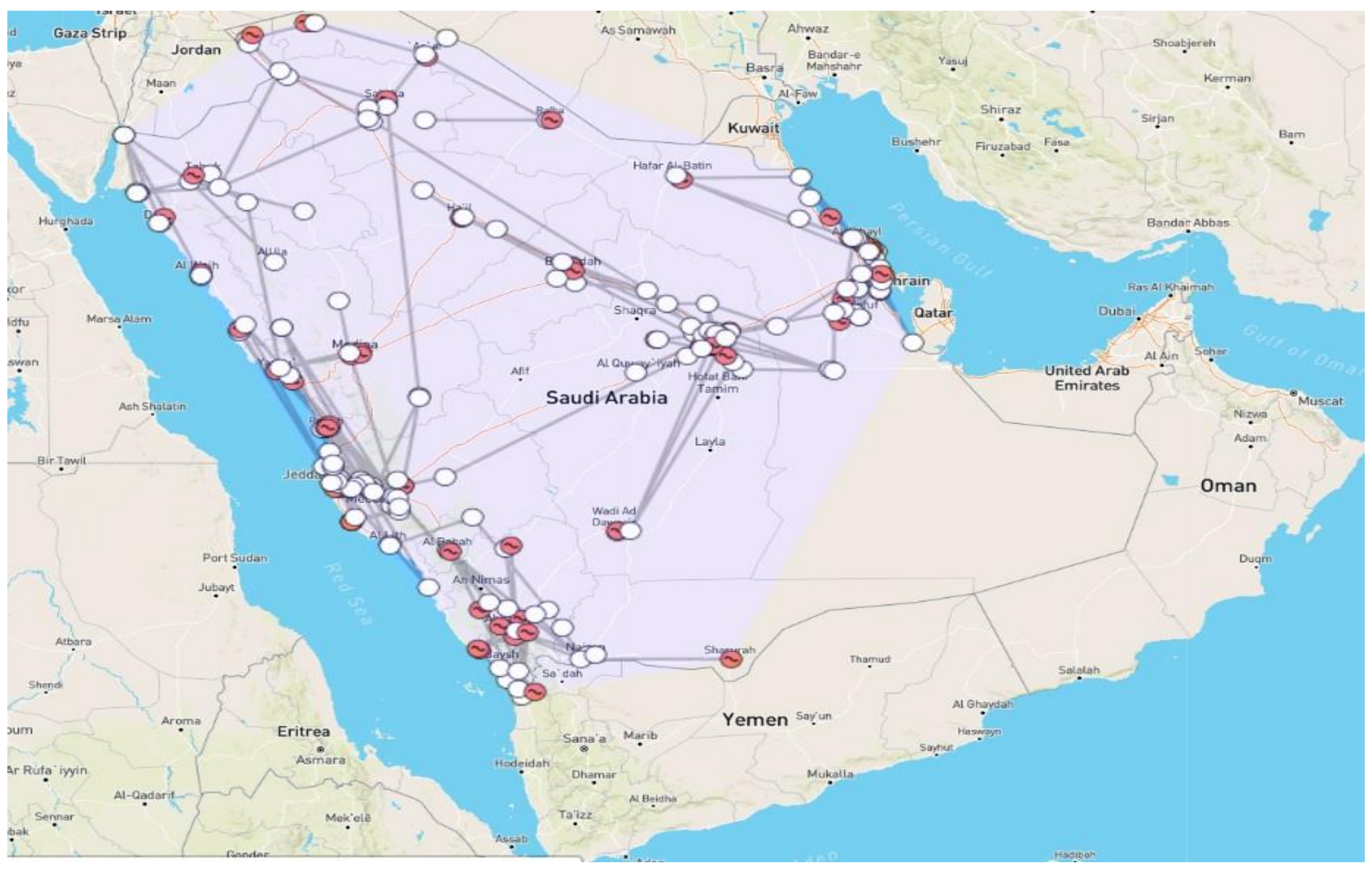
- ❖ Conduct scenario analyses to understand the impact of different factors on the performance of a synthetic grid.
- ❖ Validate models by comparing simulation results with real-data from existing or pilot projects.

FUTURE WORK

- ❖ In future research, there is potential to extend this model to create test cases for various domains within power systems research and for educational purposes.

GRID SYSTEM DESCRIPTION

Visualization of the synthetic Saudi power system grid by AGVis



Region	Number of Buses	Number of Power Plants
Central	52	15
Eastern	40	14
Western	66	19
Northern	38	9
Southern	28	11

TABLE III. COMPOSITION OF SYNTHETIC SAUDI POWER SYSTEM MODEL

Parameter	Value
Voltage limits (pu)	0.953 to 1.045
Total active power generation (MW)	64,637.7
Total reactive power generation (Mvar)	19,087.8
Total active power load (MW)	64,033.3
Total reactive power load (Mvar)	14,569.1

TABLE IV. THE COMPREHENSIVE POWER FLOW RESULT

Area	CENTRAL	EASTERN	WESTERN	NORTHERN	SOUTHERN
Generation (MW)	17,761.6	22,027.2	17,805.0	3,430.4	3,613.5
Generation (Mvar)	5,936.7	6,343.7	4,812.2	947.7	1,047.6
Load (MW)	18,471.8	20,673.8	17,531.7	3,323.7	4,032.3
Load (Mvar)	4,399.6	4,769.8	3,822.4	767.4	809.9

TABLE V. COMPREHENSIVE OVERVIEW OF THE OPERATIONAL REGION'S POWER FLOW

CASE STUDY

1) Generator Trip Event :
In the Central region in the city of Riyadh, a generator at bus 352 in PPT10 power plant station is tripped. The generating capacity of the unit is 1,965 MW.

2) Load Shedding Events :
Load shedding events involve the disconnection of loads at certain buses. A load of 772 MW located at the MADINAH bus 106 inside the western operating region is reduced.

3) Line Trip Event :
The third scenario is to trip a transmission line between cities in different operating regions. A transmission line between RIYADH bus 338 in the Central region and DAMMAM bus 293 in the Eastern region is tripped.

Simulation Results of the Synthetic Model

Flat Run Simulation

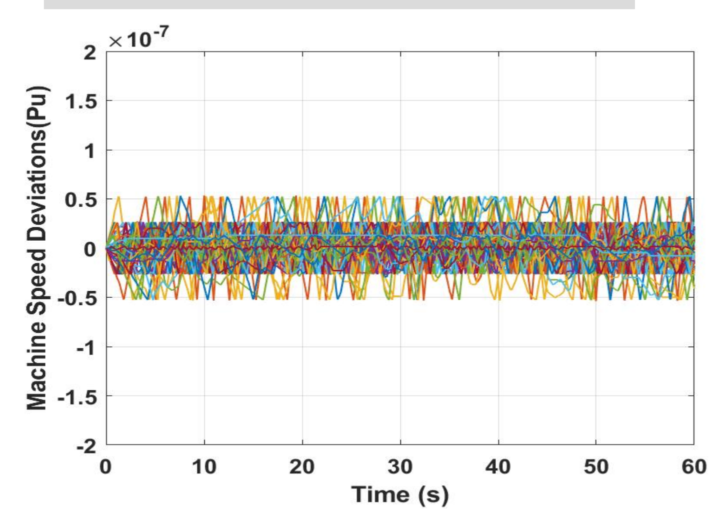


Fig 1. The machine speed deviation of all machines

Validation of the Synthetic Model

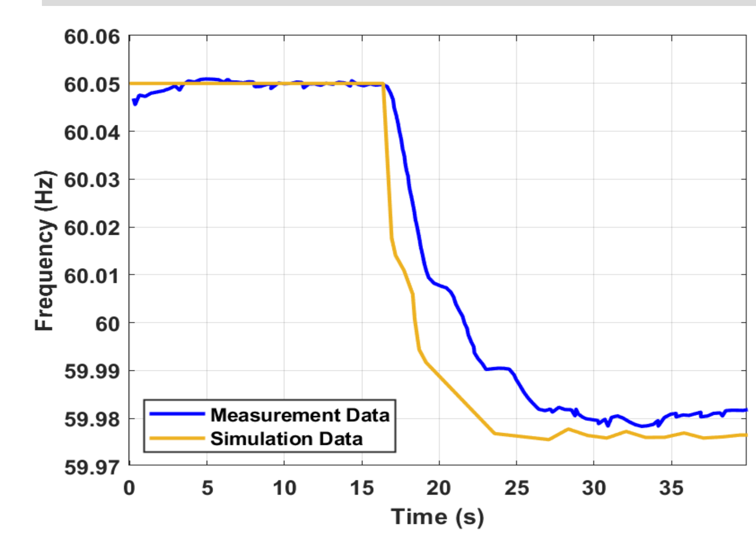


Fig 2.Simulation and measurement comparison of case.

Dynamic Performance Analysis

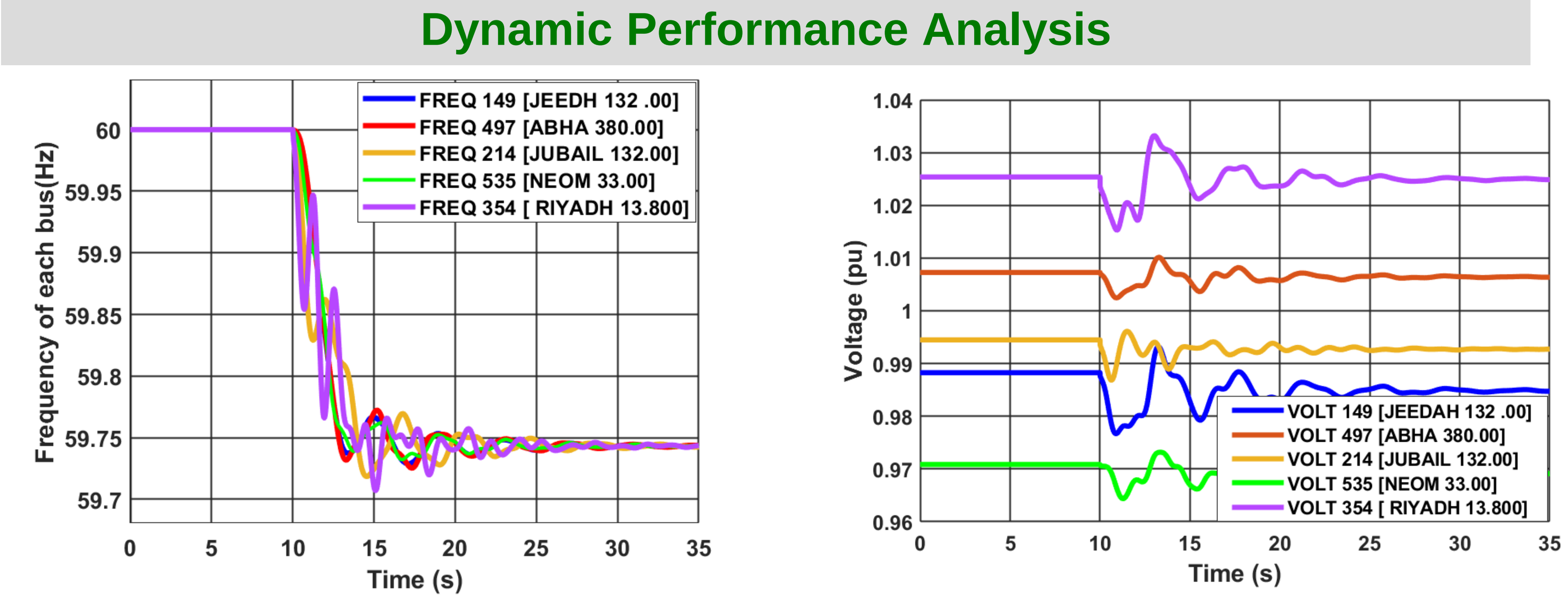


Fig. 3.System Frequency and Voltage Response After Generator Trip at Bus 352 in the Central Region

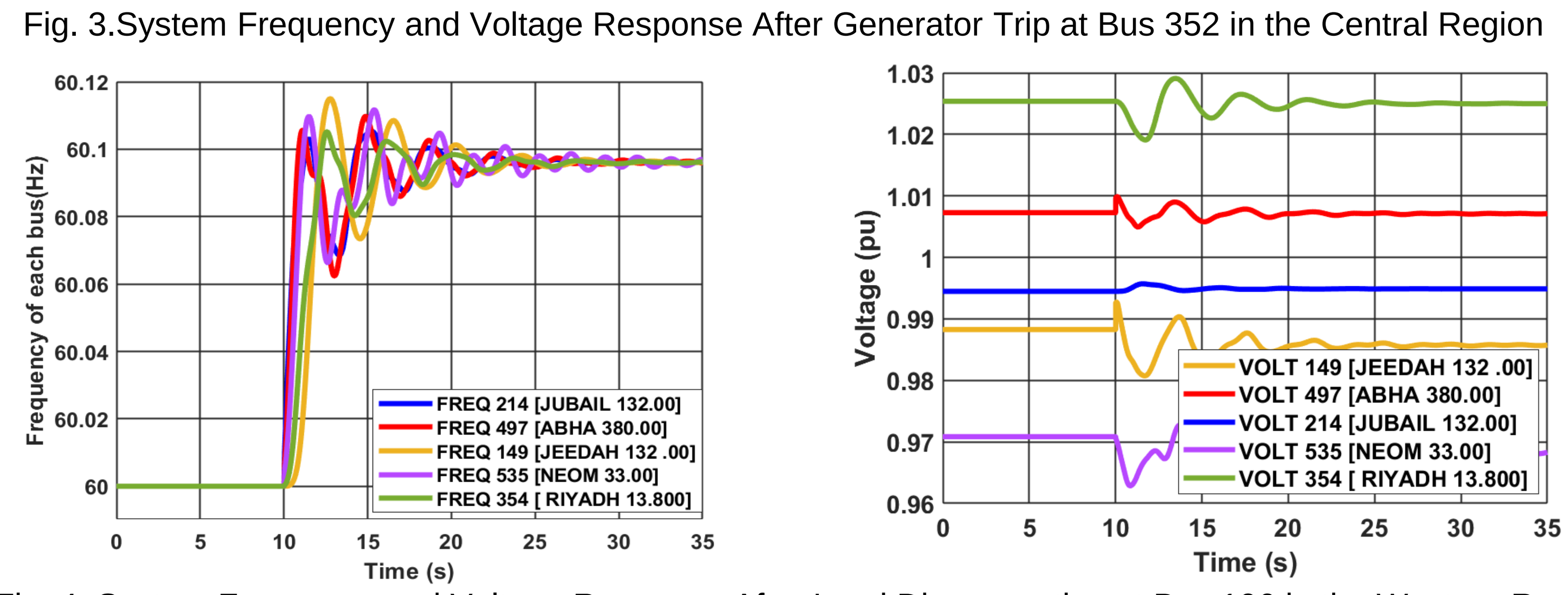


Fig. 4. System Frequency and Voltage Response After Load Disconnection at Bus 106 in the Western Region.

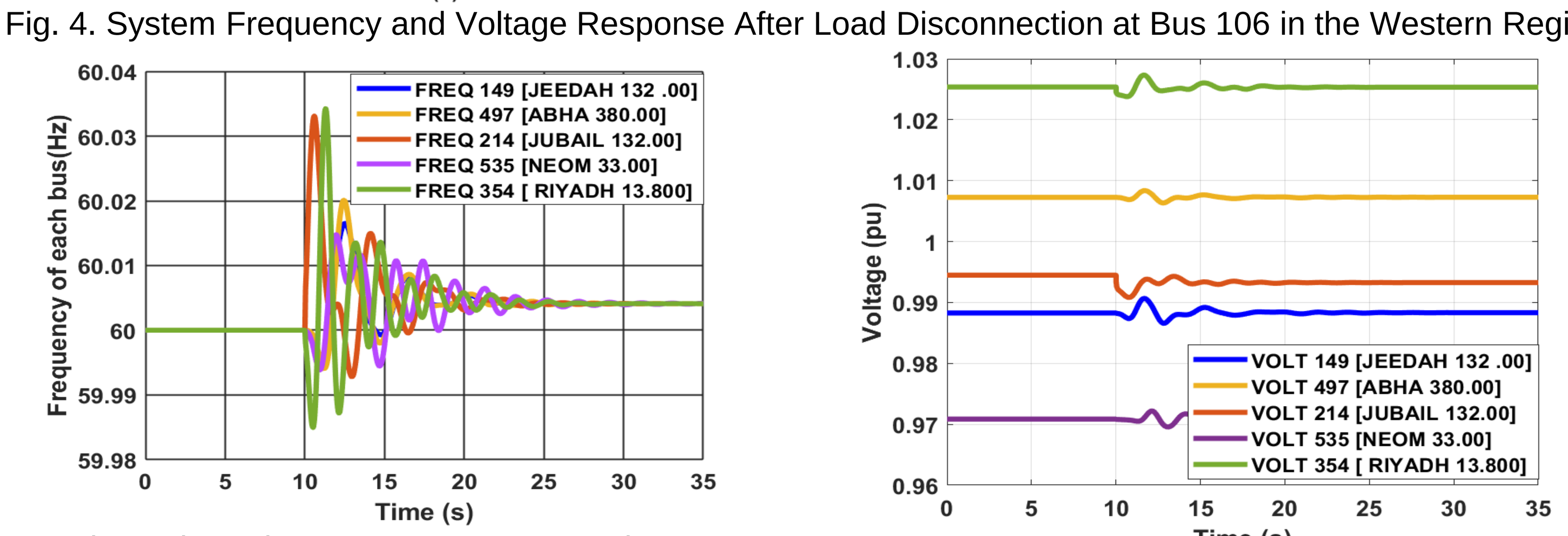


Fig. 5.Line Trip Between Bus 338 and Bus 293

CONCLUSION

This paper represents an initial step towards constructing synthetic networks for the Saudi electric grid that are geographically and statistically plausible.

- ❖ The results of simulations presented in this research provide empirical evidence validating the assertion that the system under investigation exhibits dynamic stability based on code requirements.
- ❖ The 224-bus synthetic Saudi electric grid model incorporates geographic coordinates, load and generation profiles, and successfully replicates the geographic constraints observed in similar real systems.
- ❖ The synthetic network model is built and subjected to various disturbances at various parts of the system to verify the stability of this synthetic model.

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