



Developing a Reduced 240-Bus WECC Dynamic Model for Frequency Response Study of High Renewable Integration

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Background

- Rapid adoption of **inverter-based resources (IBR)** are challenging **the operation and planning** of bulk electric system.
- **Integrated dynamic** and **scheduling** simulations are needed to study both the technical and economic characteristics of IBRs.
- Publicly available, interconnection-level models with consistent dynamic and economic data are not available.
- A 240-WECC system is created with updated resource mix and validated dynamic models based on a 2011 model.



Generation Resource Mix based on 2018 Data

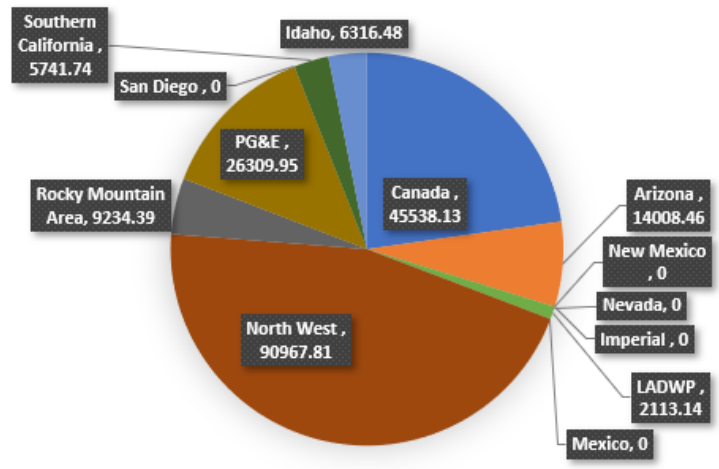
- The resource mix is updated to reflect 2018 Q3 WECC system condition using publicly available U.S. Energy Information Administration data.
- The updated system has a total capacity of 291 GW and total IBR capacity of 59 GW (20%) and can simulate over 50% instantaneous IBR penetration at low load condition.

TABLE I. GENERATION RESOURCE MIX (CAPACITY) BY STATE

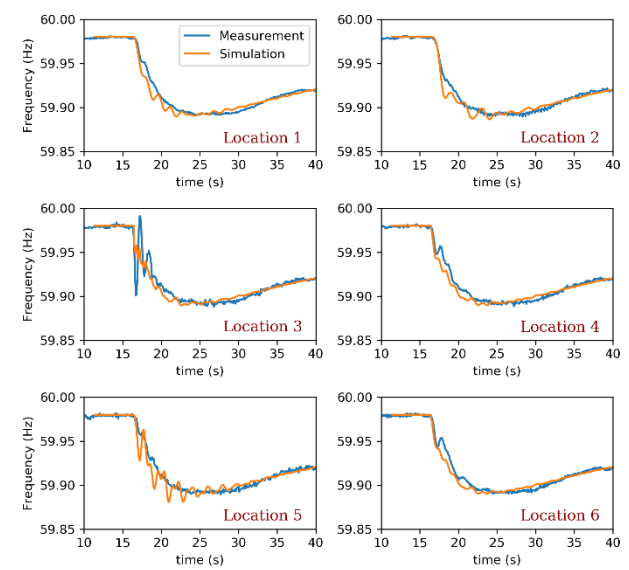
State	Biomass (MW)	Coal (MW)	Geo- thermal (MW)	Gas (MW)	Hydro (MW)	Nuclear (MW)	Pumped Storage (MW)	Utility PV (MW)	Wind (MW)	DPV (MW)	State Total (MW)
Arizona		6245		16271	3527	4210		2419		1245	33917
California	1008		2788	44039	10061	2323	3746	15452	5690	7736	92843
Colorado		4948		7829	672		509	738	3106	349	18151
Idaho	122			1272	2541			395	973		5303
Montana		2488		476	2671				720		6355
Nevada		809	751	8380	243			2423	152	284	13042
New Mexico		2817		3750				638	1682	139	9026
Oregon		642		4366	4524			427	3213		13172
Utah		4894		3239	275			1407		229	10044
Washington	711	1460		4162	25066	1200			3075		35674
Wyoming		7254		418	303				1489		9464
Alberta		13039		9636	108			4410	541		27734
B. C.				2650	10747						13397
Mexico			699	2140							2839
Grand Total	1841	44596	4238	10826	60588	7733	4255	28309	21032	9982	290961

Dynamic Model

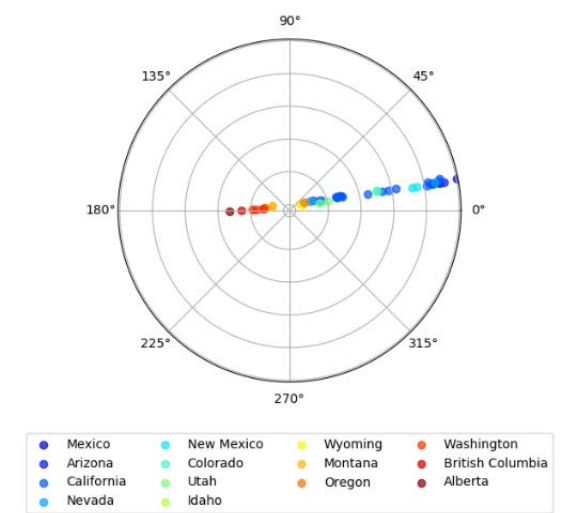
- Generic dynamic models including synchronous generator, exciter and governor and second generation generic renewable models are used.
- Kinetic energy of a planning case is mapped to the 240-bus WECC system.
- Dynamic response of the system is verified.



Kinetic energy contribution from hydropower plants.



Comparison of simulation and measurement for Event A.



Mode shape of N-S mode

Conclusions/Recommendations

- This work developed a reduced 240-bus WECC model for integrated scheduling and dynamic simulation.
- The 2018 state of WECC is reflected and therefore can simulate realistic IBR-dominated grid conditions.
- A dynamic model that preserves the system-level frequency response and the dominant N-S oscillation mode was developed, which is a first of its kind.

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