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Effect of Wind Gusts on Local Run-of-River Hydro Plants

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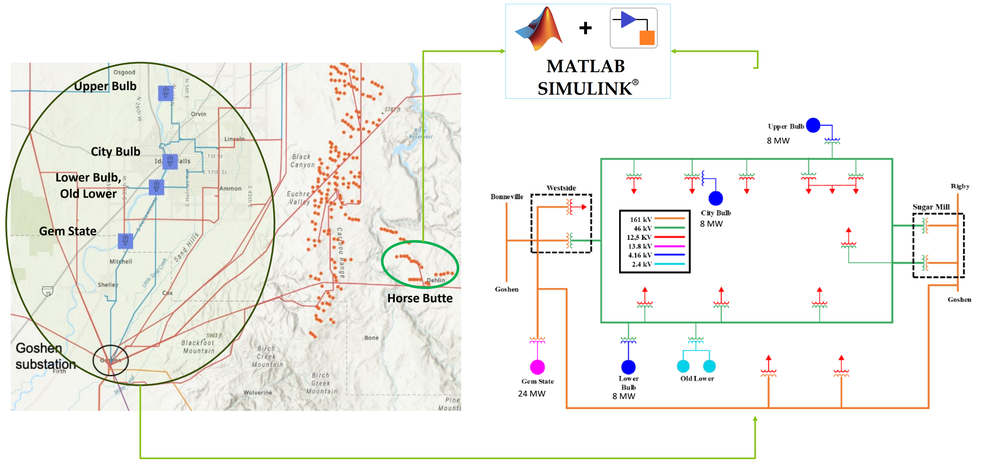
Abstract

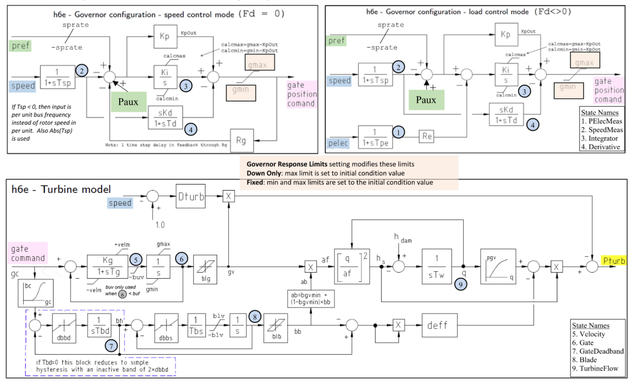
In this work, we focus on the integration of wind farms in a hydro dominated power system, and analyze the challenges and solutions associated with this integration. Due to sudden increase in wind power, the system frequency can increase, causing excessive reduction in the run-of-river (ROR) system's power. This can result in damage to the physical structure due to water level violations and cause issues for downstream customers. To prevent excessive and prolonged ROR power deviations, and to prevent tie-line deviations, we are proposing a wind-hydro centralized coordination scheme, which is not existing currently. The controller showed promising results by reducing the system frequency extrema by 0.8Hz.

Models and controls

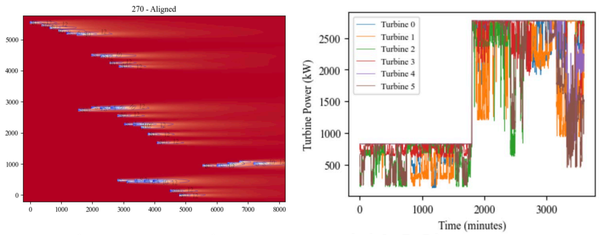
Idaho Falls Power (IFP) and wind farm modeled in a Simulink discrete simulation environment with Simscape -Simpower systems blocks.



H6e Governor and Bulb turbine model - H6e governors are working in the load following mode



ROR plants in IFP are diversion dam-based ROR plants with horizontal shaft bulb turbines. We are modeling the wind farm using FLORIS (for the power profile with the wake effect) and a current source model for the wind farm for network integration.



Centralized coordination strategy – Automatic generation control (AGC):

$$\Delta P_{pu} = \frac{\gamma}{\sum_i \overline{P_i}} \int (\gamma_t (P_{sch} - P_{tie}) + \gamma_f (60 - f)) dt$$

Results and Conclusion

System Frequency

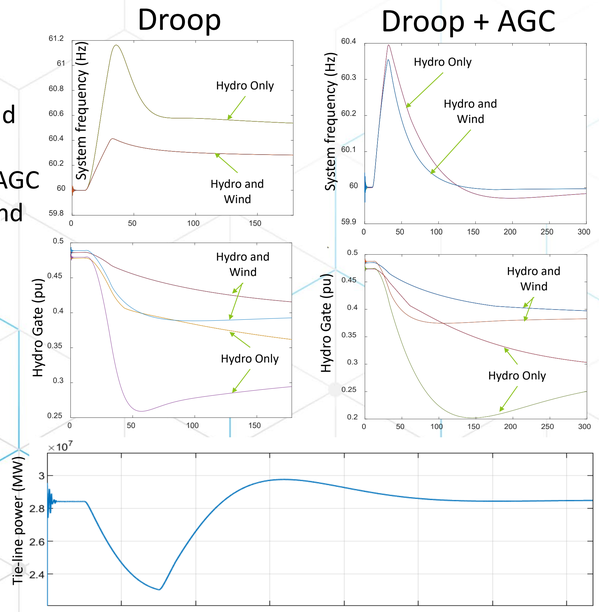
- Excessive transient frequency deviation and steady-state error are reduced with droop + AGC with or without the wind

Hydropower Response

- ROR power deviation is reduced due to participation of wind

Tie-line Power

- Tie-line power deviation is reduced



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