ACEP Railbelt Decarbonization Project Wind-Solar Scenario Addendum

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The analysis presented in this slide deck is an addendum to a larger project which was published in January 2024.

- The full report looks at different scenarios for a fully decarbonized Railbelt electric grid in 2024.
  - Railbelt Decarbonization Project Full Report: https://www.uaf.edu/acep/files/media/ACEP_Railbelt_Decarbonization_Study_Final_Report.pdf
    - Executive summary: https://www.uaf.edu/acep/files/media/ACEP_Railbelt_Decarbonization_Study_Final_Report__ExecutiveSummary.pdf
- Each scenario featured a large amount of Wind and Solar alongside an emerging carbon-free technology or project that has been proposed to meet a large share of demand (Nuclear, Tidal, and Hydroelectric).
- Our analysis looked at costs associated with building and operating these future systems alongside an estimate for costs associated with electrical stability.
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New Wind/Solar Scenario

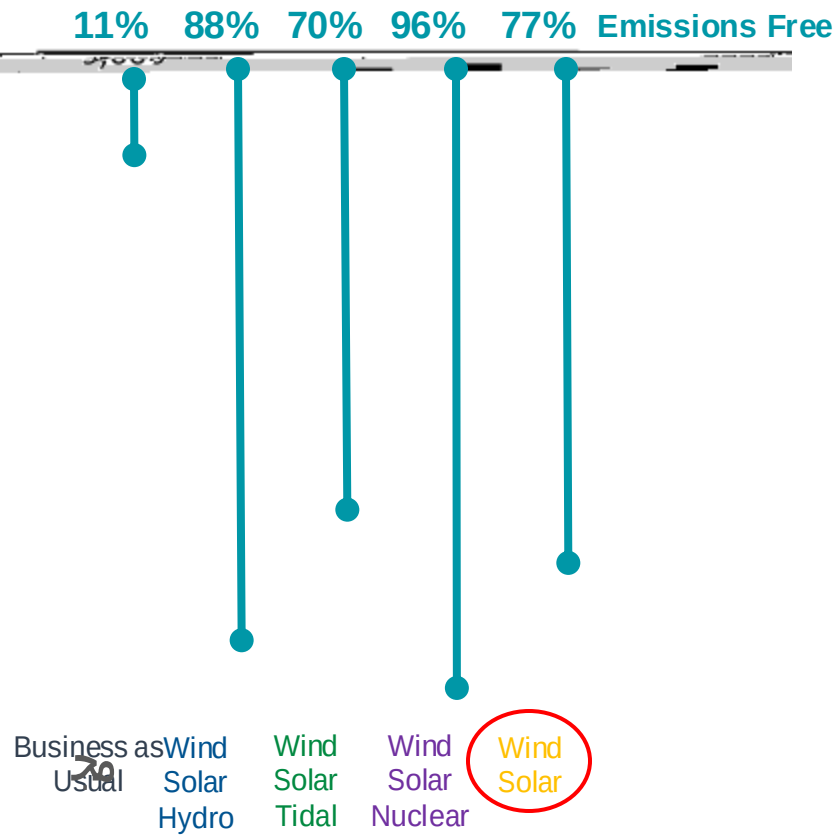
Scenario	New wind and solar	Large non-wind or non-solar power project
Business As Usual (BAU)	No	No
Wind/Solar/Hydro	Yes	Yes
Wind/Solar/Tidal	Yes	Yes
Wind/Solar/Nuclear	Yes	Yes
Wind/Solar	Yes	No

Low carbon scenarios

This scenario used the same input assumptions as the other low carbon scenarios, except no new non-wind or non-solar source of power.

Business

- Low-Carbon vs. BAU:
  - Much lower fossil generation
- Wind/Solar vs. Other Low-Carbon Scenarios
  - More fossil generation than W/S/Hydro and W/S/Nuclear

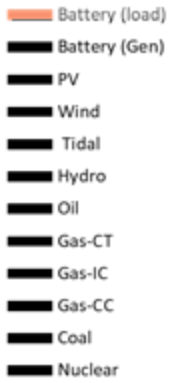


On a normal day, there is

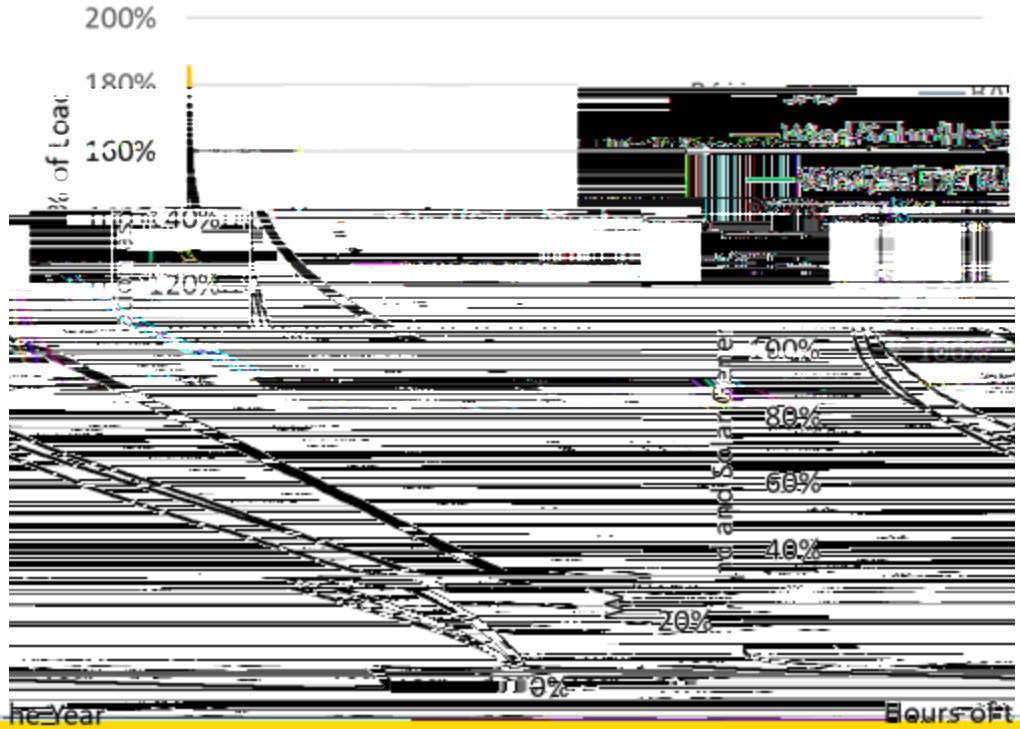
There are extended periods with significantly less synchronous generation, up to 100% inverter

Wind/Solar/Hydro

Wind/Solar/Nuclear



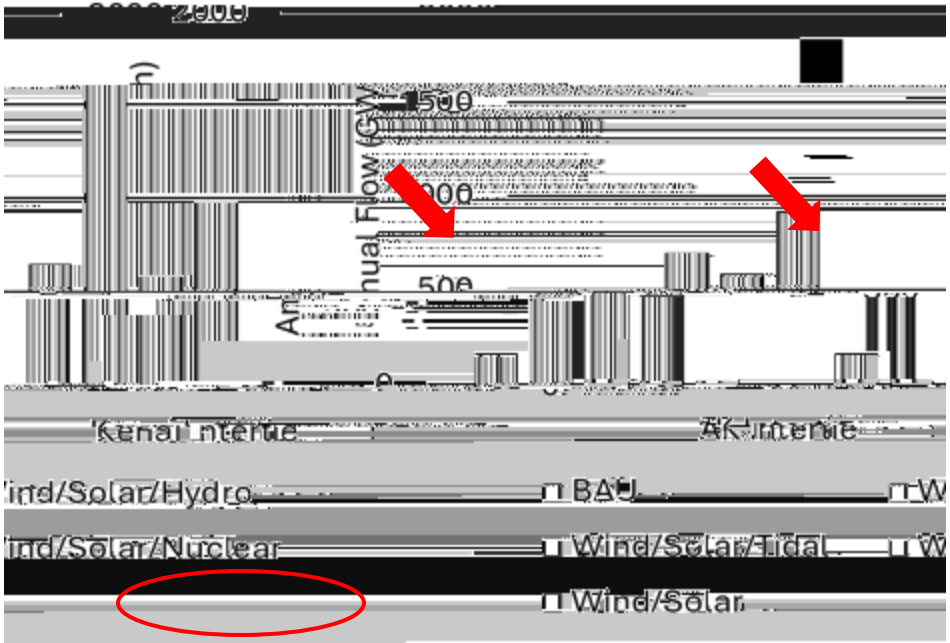
Annual Wind and Solar Generation Share Distribution

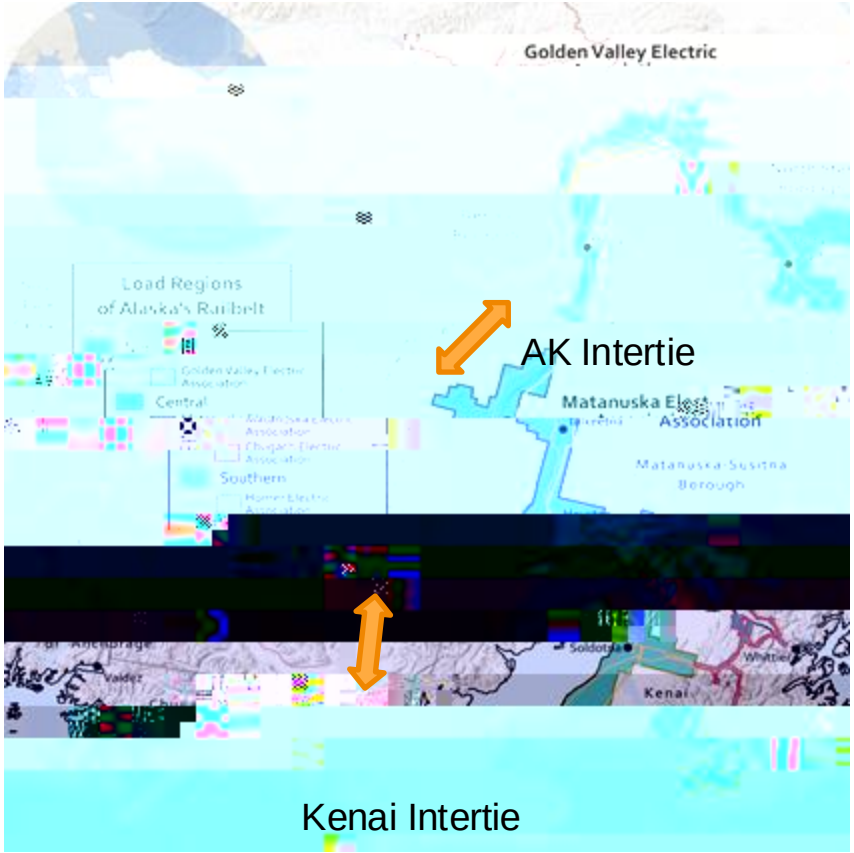


- Low-Carbon Scenarios have periods with very high and very low wind and solar generation
- Wind/Solar spends much more time at high wind and high solar

Intertie Use

- AK Intertie: increase in use
- Kenai Intertie: increase in use compared to W/S/Hydro and W/S/Nuclear



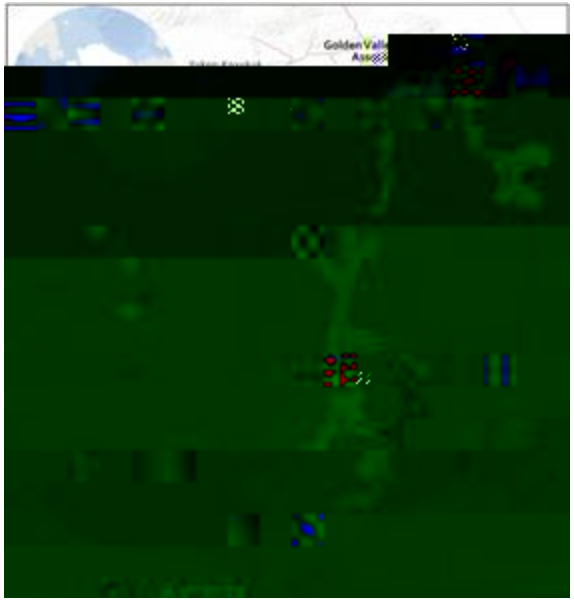


Grid Operations

- The most challenging hours for stability have changed
- The highest flows on the interties have changed, particularly the Kenai intertie flow direction

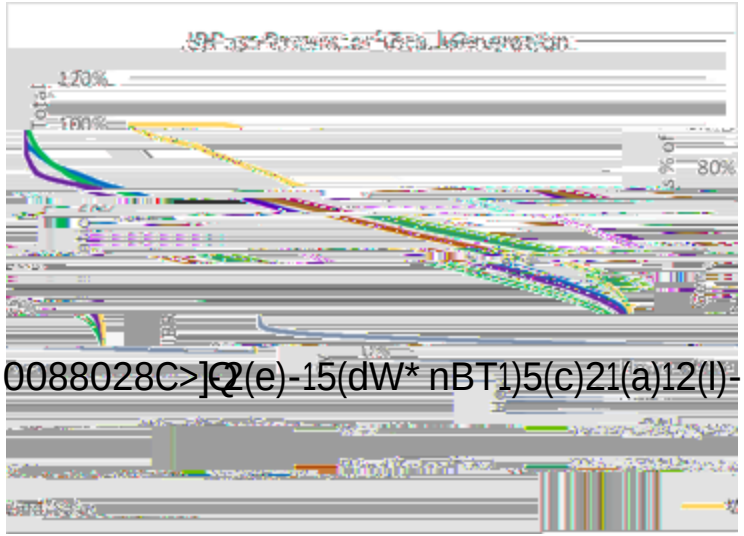
Additional Contingency

- An additional contingency was evaluated because it was more severe due to higher North → South flows on the interties
- This contingency was not analyzed for any other scenario



Inverter based resources (IBR) in the Wind & Solar Scenario

- More dominated by IBR than the previously studied scenarios
- There are thousands of hours with a 100% IBR Railbelt!



Implications

- Historically, synchronous machines have provided critical stab/EMC/0.0088028C>]Q/EMC/0.0088028C>]Q2(e)-15(dW* nBT1)5(c)21(a)12(l)-199 0

Intertie Flows in the W/S Scenario

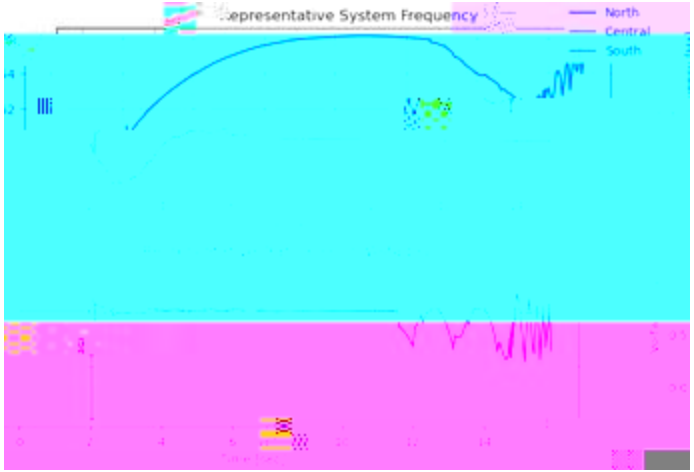
- Periods of increased southern flow

Mitigation Options: Equipment v. Operations

Contingency	Violation	Equipment Mitigation	Operational Mitigation

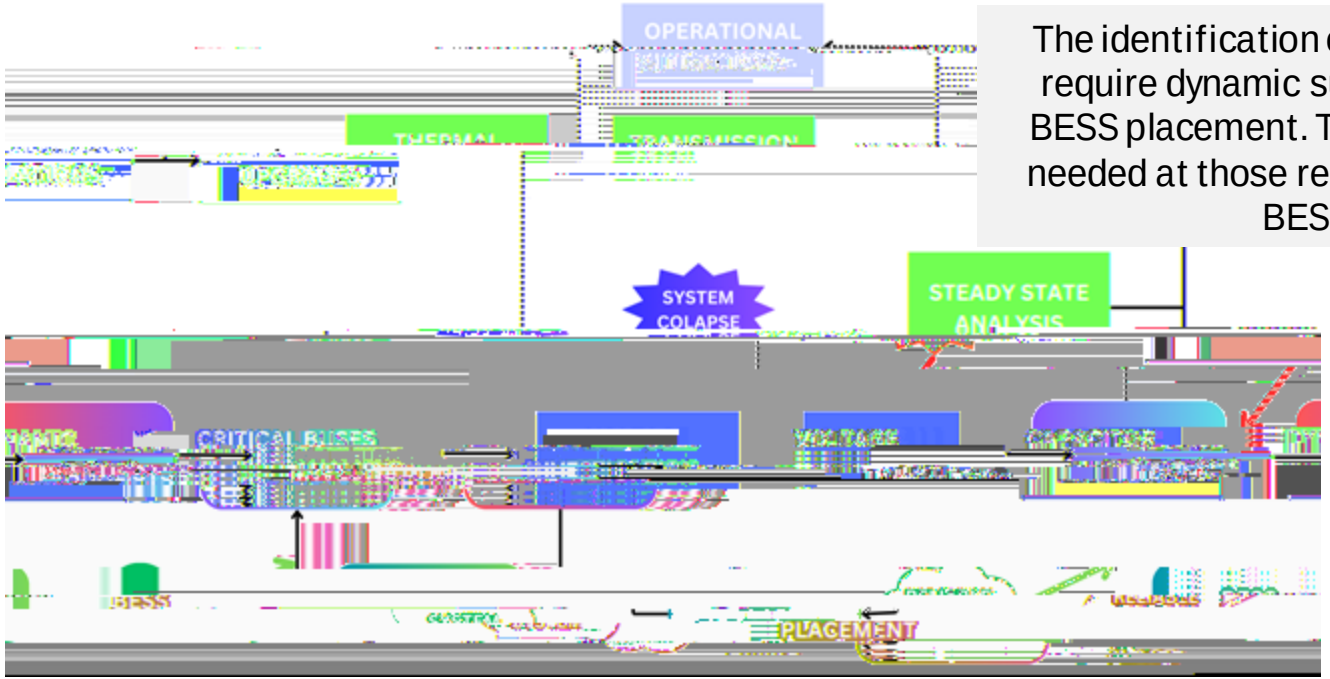
Lessons Learned From the Other Scenarios

Loss of the AK Intertie for Hour 7763, GFL with SC Addition



Loss of the AK Intertie for Hour 7763, GFM Included

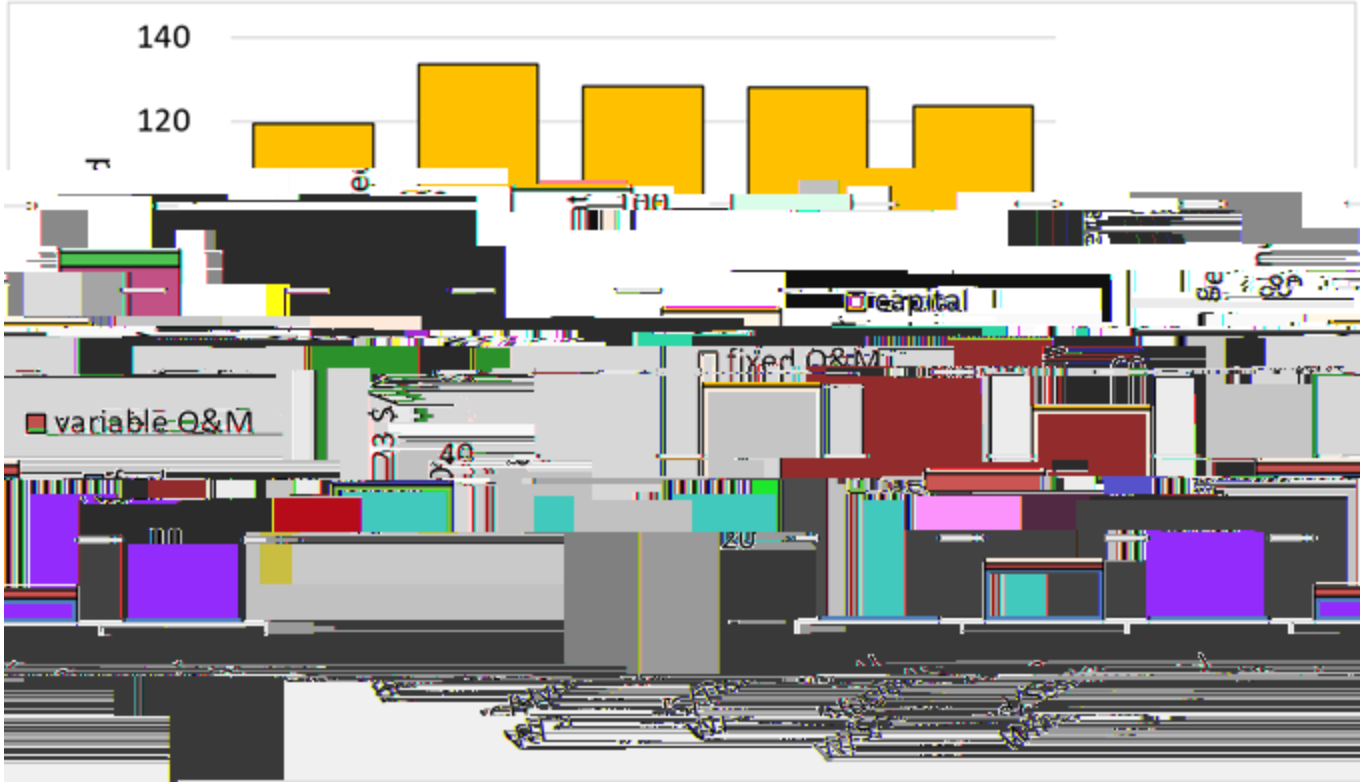
GFM Batteries: Location & Size



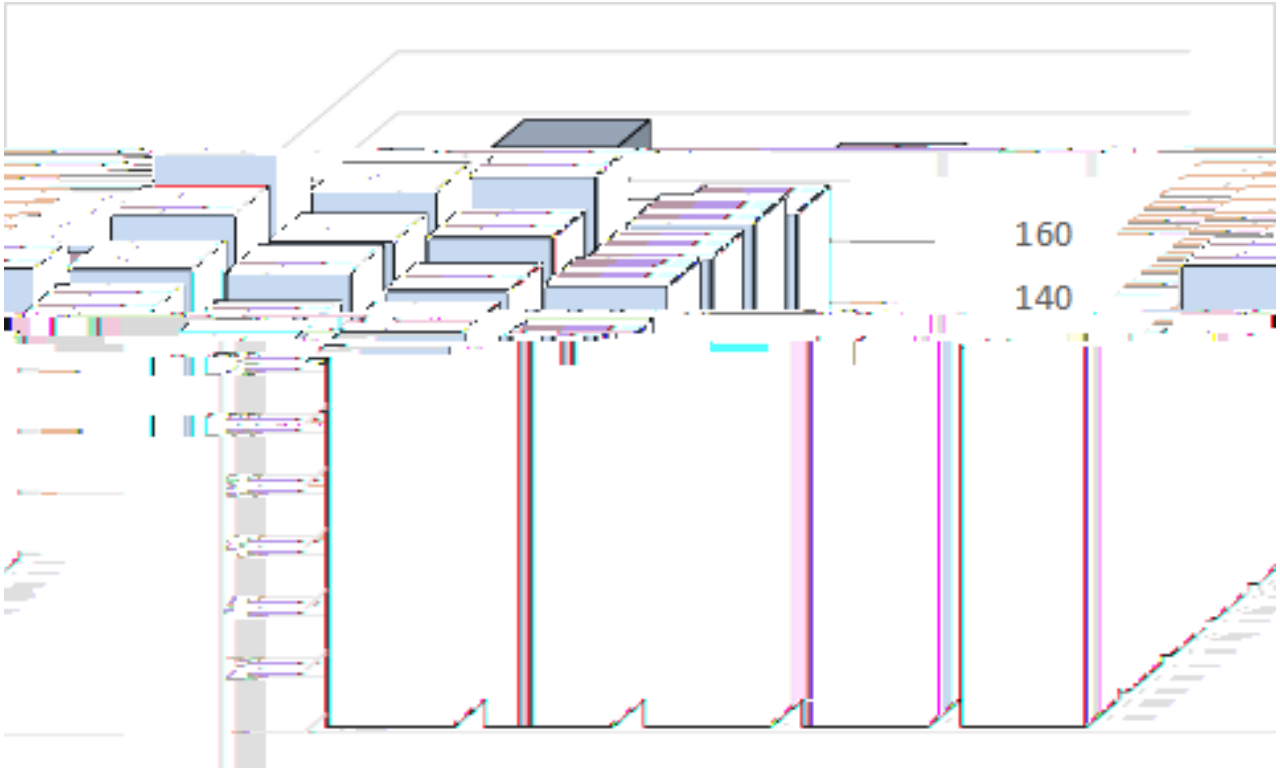
The identification of the locations which require dynamic support led to the GFM BESS placement. The amount of support needed at those regions defined the GFM BESS sizes.

Required Capital Investment

Base Case Generation & Transmission Cost of Service



Costs are all in the same ballpark range



Recap of Sensitivity Cases

S1: High Fuel
Fuel costs are 20% higher

S2: High interest
Debt interest rate is 6% (vs 5%)

S3: High-Cost Renewables
Hydro,Tidal, Nuclear CAPEX is
20% higher (vs 5% lower)

S4: Low-cost renewables

The Wind/Solar scenario (W/S) focuses solely on new wind and solar sources of generation and was developed in response to feedback

W/S achieves 77% fossil-free generation, less than W/S/Hydro and W/S/Nuclear

Much higher levels of inverter-based generation and North-South intertie flows result in more hours with stability challenges compared to the other low carbon

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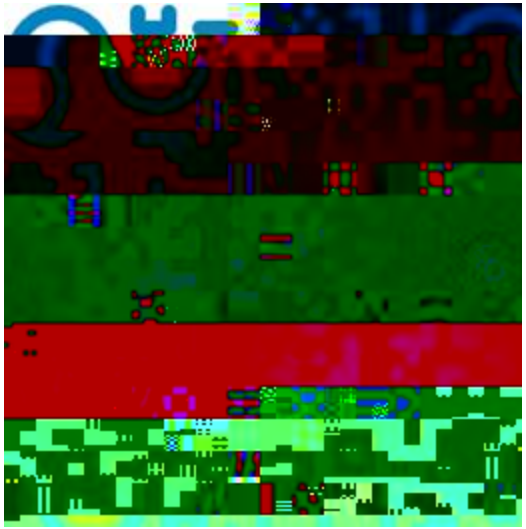
Thank you!



For more information, see our project website