Utility and Residential Solar Resource Assessment and Modeling for Alaska's Railbelt Transmission System

Alexis Francisco, Michelle Wilber, Christopher Pike, and Phylicia Cicilio
afrancisco2, mmwilber, cpike6, pcicilio@alaska.edu

I. BACKGROUND

The Alaska Railbelt Electric Grid

- Electrical grid extending from Fairbanks to Homer, AK
- Consumes >75% of the state's electricity

Railbelt Decarbonization Study

- Explore Railbelt decarbonization pathways while delivering affordable and reliable electricity
- Goal of 100% carbon-free energy by 2050
- Solar PV technology- explore the potential implementation of solar PV systems as a decarbonization technology

Solar Energy

- Provides affordable, clean, and renewable energy while reducing greenhouse gas (GHG) emissions
- Classified as a variable renewable energy (VRE)
  - Production periodically fluctuates and dependent on meteorological conditions

Solar PV Value in Alaska

- Increased solar reflection (albedo) off snow during melting season
- Extended hours of sunlight in the summer
  - ~20 hours of daylight in the southcentral region
- Net Energy Metering (NEM) program
  - "sell" excess energy produced from residential PV systems back to grid for full or partial prices

II. METHODS

- Behind-the-meter (BTM PV) net energy metering (NEM) forecast for the Railbelt until 2050 developed for residential solar
- Power system modeling in PSS/e for utility and residential PV
- Hourly energy production for the year 2050 generated for residential and utility-scale solar PV using the System Advisor Model (SAM).

SAM Model Settings

- Performance Model: Photovoltaic PV Watts
- No Financial Model
- System Design - defaults except for the following
  - Fixed open rack
  - Tilt: 45 degrees
  - Azimuth: 180 degrees
  - Ground coverage ratio: 0.3
  - Module is bifacial
  - Albedo: 0.5

Acknowledgements

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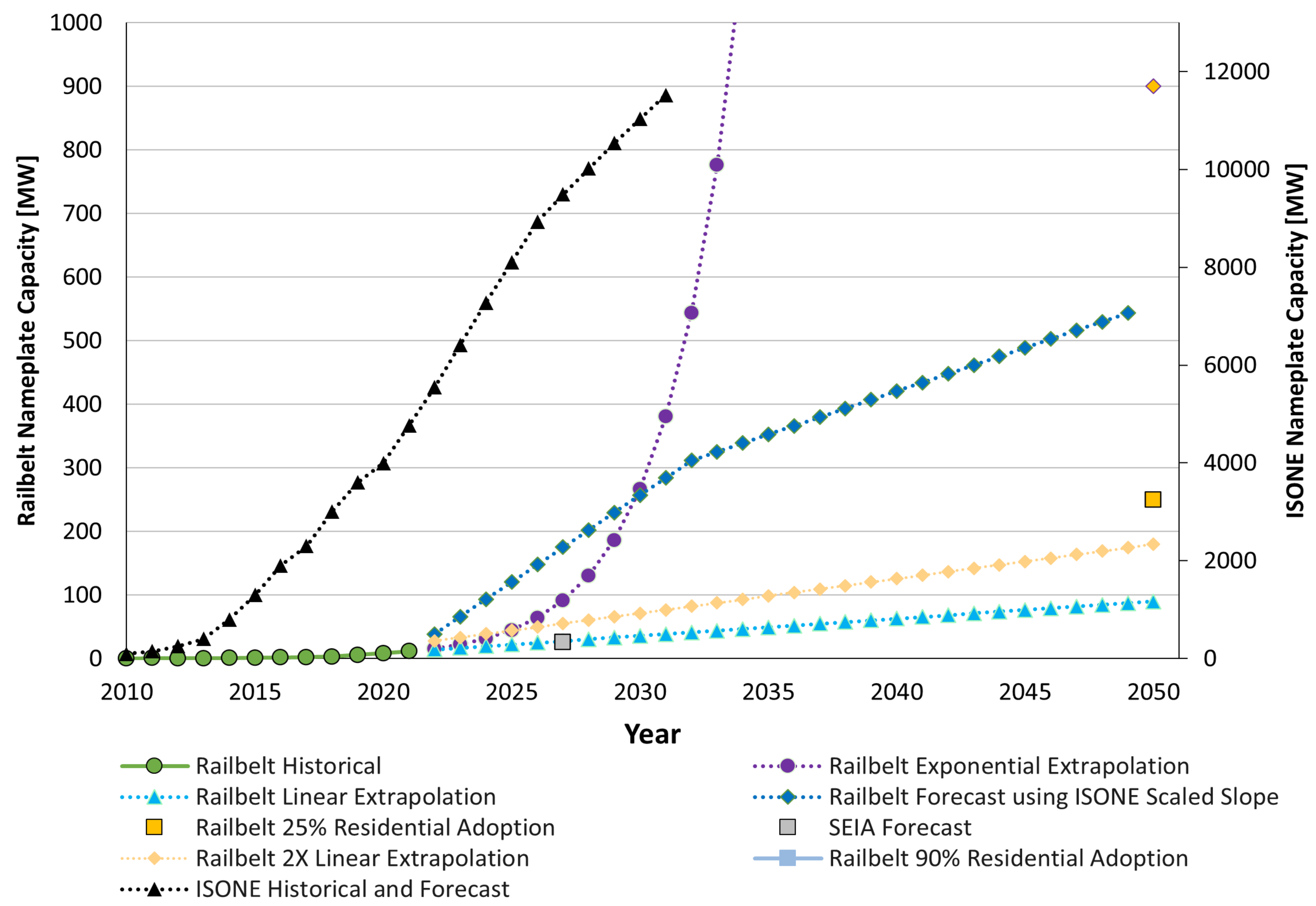
IIIA. RESIDENTIAL SOLAR PV

Residential solar PV systems were modeled in PSS/e as a distributed energy resources aggregate (DER_A) model attached to load buses. To estimate the Railbelt's residential PV growth from 2022 to 2050, several forecast models were generated and compared. Linear and exponential regression models were created from the Railbelt's historical data from 2010 to 2021. ISO New England's (ISONE) historical and forecasted BTM PV capacity were also used as a reference to generate a Railbelt forecast scaling values based on the ratio of peak loads in 2021. The five-year linear nameplate capacity growth of ISONE was estimated and divided by the peak load ratio of ISONE and the Railbelt. The plot to the right illustrates the various forecast trendlines.

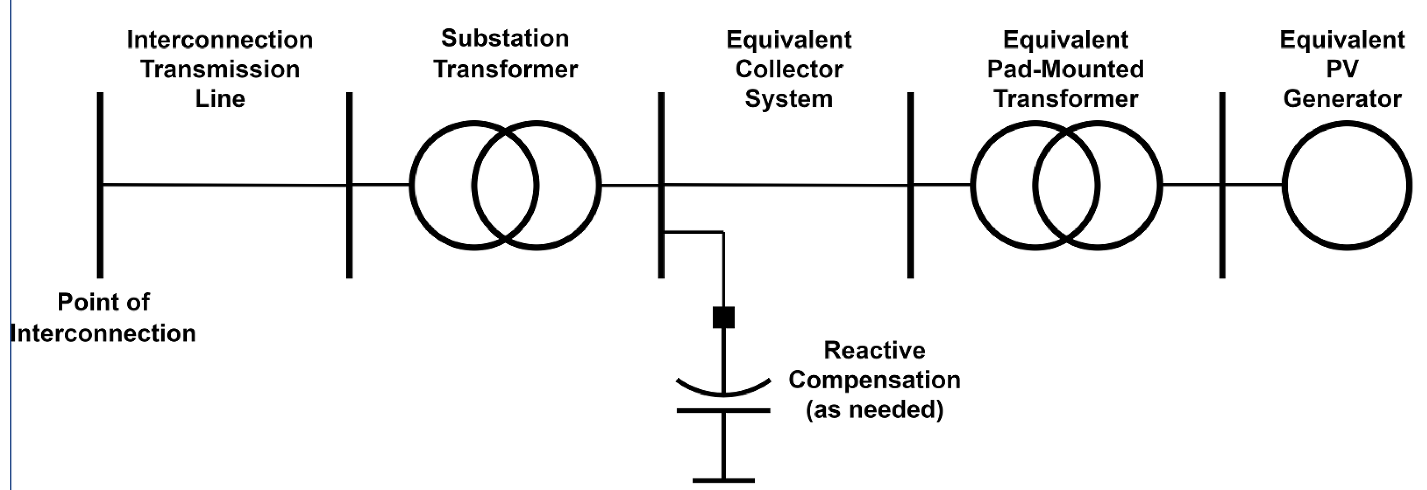


2050 Railbelt Adoption Assumptions

- Assumes 200,000 homes will install 5 kW residential PV

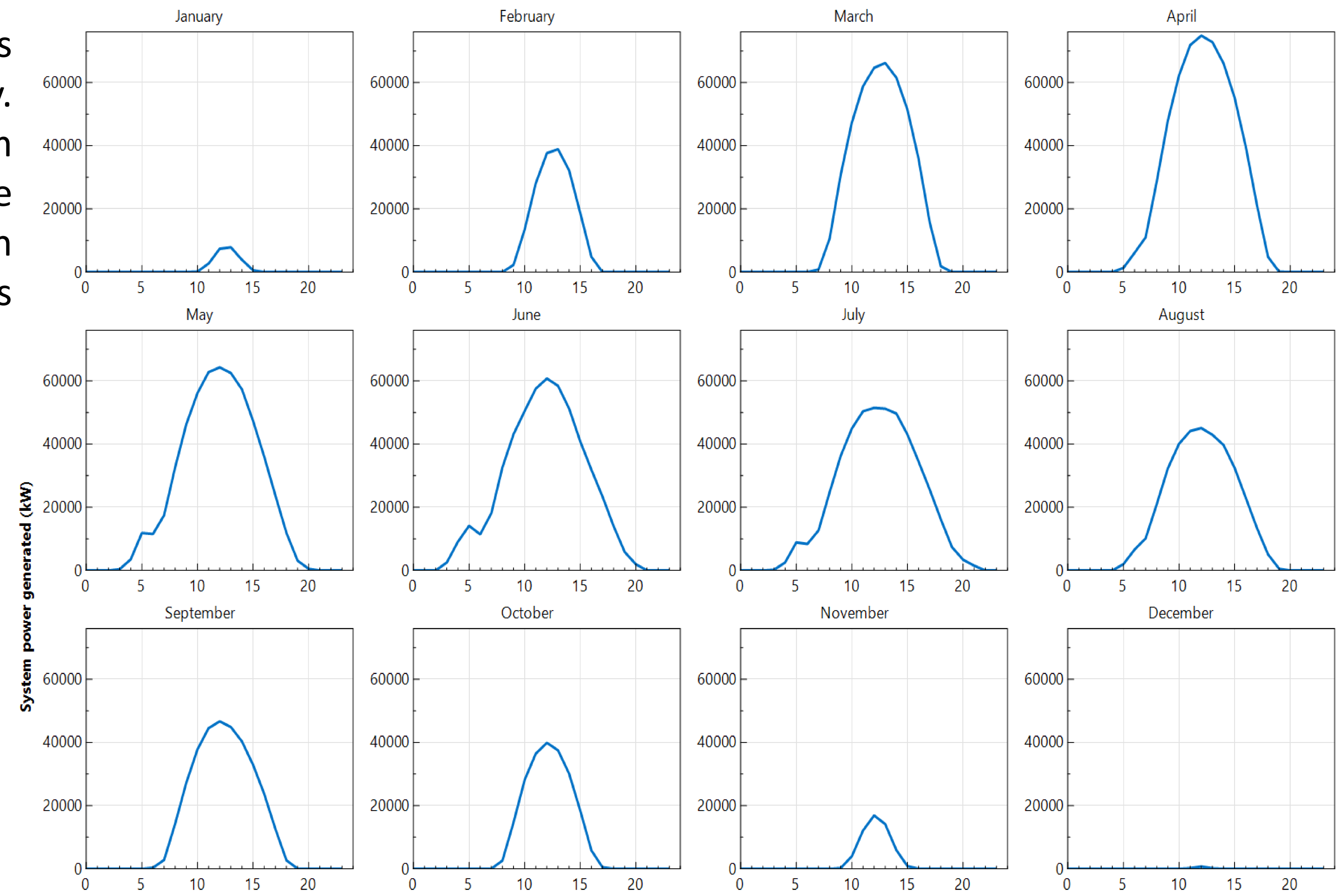
IIIB. UTILITY SCALE SOLAR PV DEVELOPMENT

Solar facility developments were selected at several locations near the Railbelt and assigned a calculated nameplate capacity. These nameplate capacities were simulated in the System Advisor Model (SAM) to determine their hourly outputs. The dynamic modeling guide recommended by the Western Electricity Coordinating Council (WECC), shown below, was implemented in PSS/e for modeling of utility-scale PV plants.



SAM PV utility-scale hourly output adjustments

- Converted to MW
- Scaled by 140% (x1.4) to account for DC-AC conversion
- Limit generation by the nameplate capacity size of location



Example of a SAM monthly profile for a 100 MW solar PV development in A Fairbanks, AK

IV. CONCLUSION

Solar PV technology is an economical and environmentally critical option for decarbonization in Alaska's Railbelt grid. Extended daylight summer hours and albedo effects in winter and spring increase the value of solar in Alaska as well as the NEM system. Power system modeling of the utility-scale and residential solar is implemented using the power flow representation by WECC and as aggregated model DER_A. In both PV systems sizes, the hourly outputs of the select locations and calculated nameplate capacities were simulated in a SAM Model.