

Analysis of Energy Transition from Fossil Fuels to Renewable Energy for the Central U.S. Region

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Where should solar PV and energy storage installation be built in order to minimize the total capacity and cost of the installations for a cleaner grid within the Central U.S. Region (ERCO and SWPP balancing authorities).

Background:

In 2019 alone, the balancing authority that serves most of Texas (ERCO) produced over 250 gigawatt-hours of electricity through natural gas and coal. This is a similar story throughout the Central U.S. Region, releasing over 250 billion pounds of CO₂. The amount of fossil fuels used has held or increased up until the present and must be addressed.

Method:

- Find and clean hourly load data from the U.S. Energy Information Administration to size solar PV production
- Separate generation sources to focus on coal and natural gas energy production
- Define locations for solar PV installations within balancing authorities to minimize the energy storage capacity
- Collect global horizontal irradiance data (GHI) from the National Solar Radiation Database for certain locations within the balancing authorities to find solar PV efficiency
- Use a MATLAB code to find the amount of land needed to dedicate to solar PV, and amount of energy storage needed to cut out coal and natural gas entirely

Preliminary Results:

- These results focus on Texas and its balancing authority, ERCO, in 2019
- 5 locations were chosen by geographic spread, analysis was run on all 5, locations included:
 - #1 - San Antonio, #2 - Lamesa, #3 - Fort Worth, #4 - Waco, #5 - Fort Stockton
- Of these 5 locations, the most feasible location was #5 - Fort Stockton
 - The least amount of land needed of all 5 locations - 1.74×10^9 m² or roughly 430,000 acres of land
- Multiple energy storage needs were also calculated for Fort Stockton
 - Daily minimum storage - amount of storage needed to power the shortest charge discharge cycle
 - Seasonal peak storage - amount of storage needed for the largest 24-hour charge discharge cycle
 - Multi-day storage - amount of storage needed for the largest storage need, completely cutting out fossil fuels

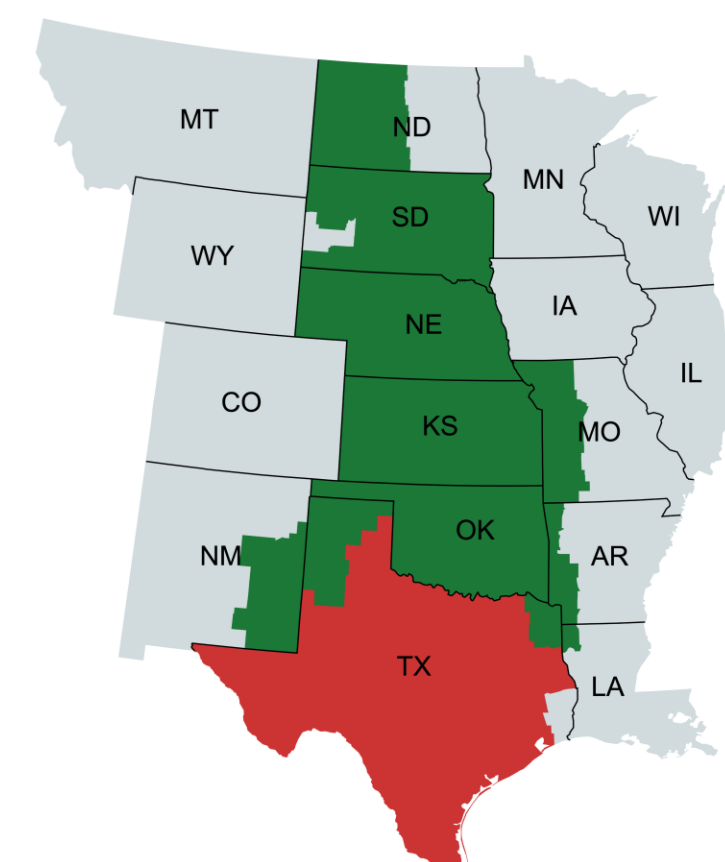


Figure 1: Map of SWPP and ERCO balancing authorities

Balancing Authorities
 ERCO
 SWPP

Coal Natural Gas Hydropower Wind Solar Nuclear Other Sources

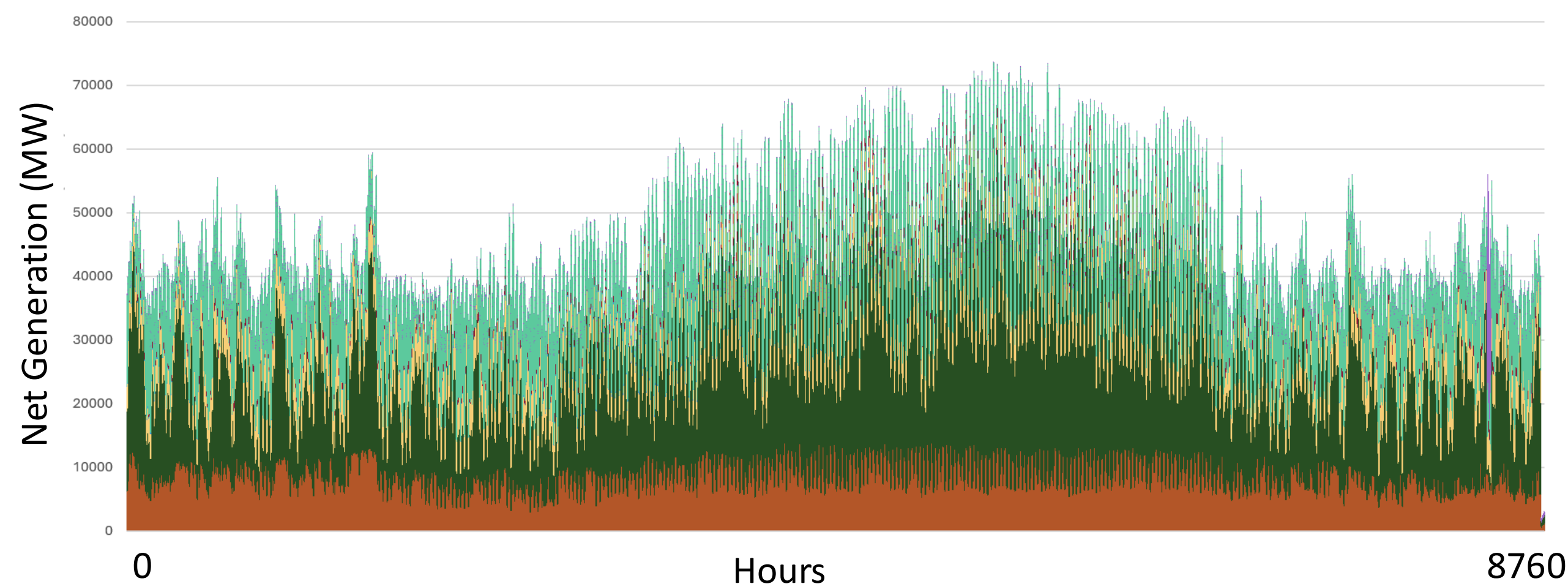


Figure 2: Net Generation by Source, ERCO 2019

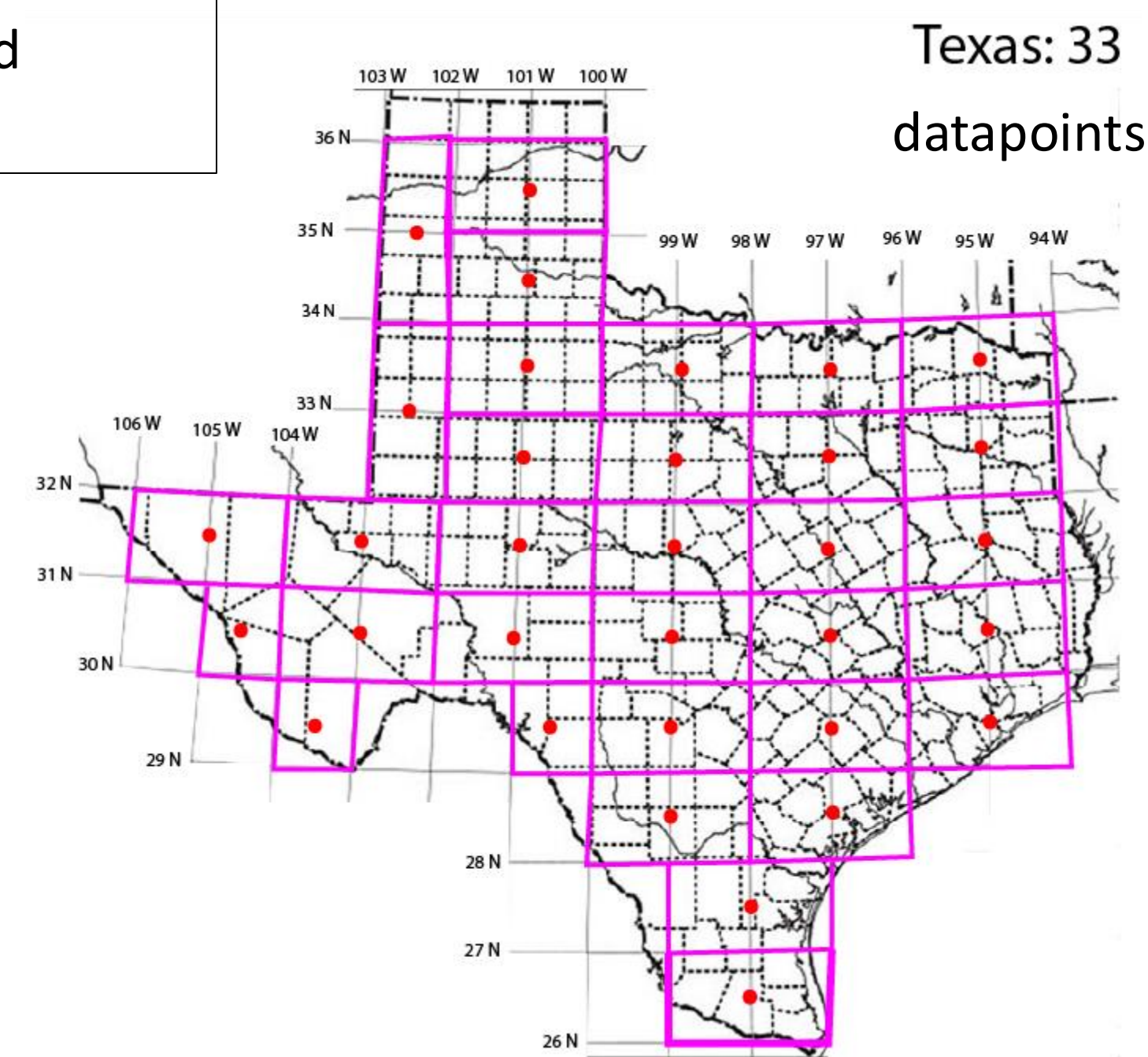


Figure 3: Map of Texas with GHI location grid overlay

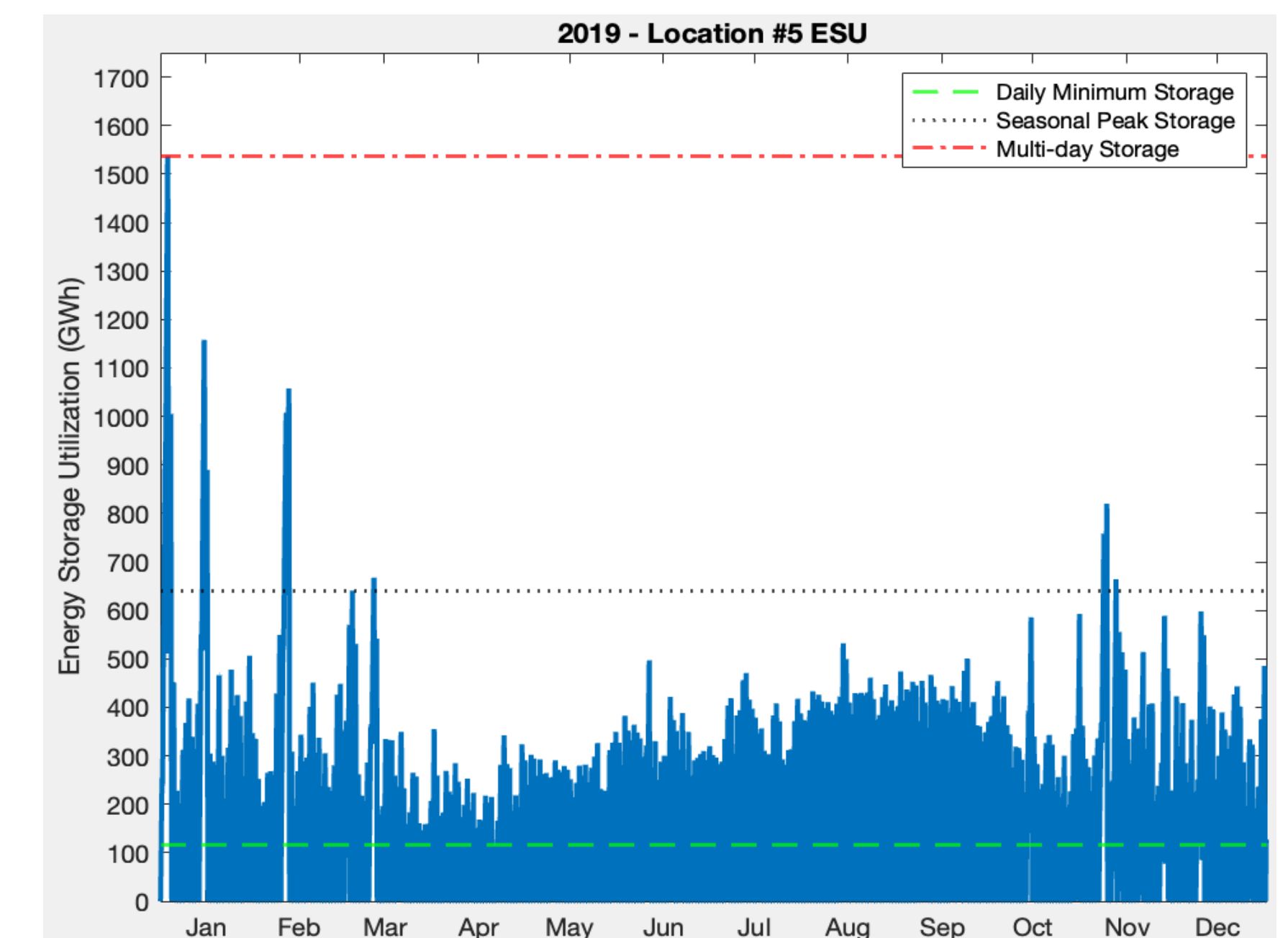


Figure 4: ESU of Fort Stockton in 2019 assuming 1.74×10^9 m² of solar PV land area