Northern Arizona University
NAU Capstone
New Mexico State University
2.B. Distribution System Impact Analysis—Battery Rationale

1 Methodology for Battery Storage Sizing

While REopt Lite was the most appropriate software tool available to assist with battery sizing, the team's decision to implement saltwater batteries made this process slightly more complicated. REopt uses internal battery sizing algorithms that adhere to current industry standards, all of which are formed around the use of traditional electrolytic batteries. Due to the different chemo-mechanical process taking place within the battery cells, traditional sizing equations and standards do not carry over to saltwater batteries. With this limitation in mind, the team used the information generated by REopt Lite to better inform the use of the battery manufacturer's sizing tables in designing the storage sub-system.

2 Battery Use Summary

Battery storage offers various benefits to a photovoltaic system, both as a means of temporary backup during outages as well as various forms of optimization with the use of a controller. This controller is used to govern when power generated in the PV system is delivered to the load or used to charge the storage sub-system. If the current demand is lower than the amount of power being generated, it can be redirected to the battery so that that power deficit is not wasted and does not pose any risk to the distribution system down-stream. While a practical means of storing enough power to withstand long-term service drops would require a massive storage system and millions of dollars to implement, designing the sub-system for peak shaving has a much more affordable up-front cost, requires less maintenance, and helps to mitigate losses.

3 Battery System Operational Details

The battery modules the team selected for the design conveniently come pre-packaged with a controller whose functionality can be emulated in the OpenDSS system model with the use of a 'Storage Controller' object declaration. As this sub-system was designed to be used as a means of peak shaving, the controller model is configured accordingly. The team set the sub-system to charge the batteries when sunlight was most available, which was determined to be the five-hour window roughly between 9:30 and 14:30. The controller is also set to a target power factor of 0.98 in order to perform some active compensation without adding unnecessary strain to the system. Although the manufacturer claims these batteries have a 100% depth of discharge, the team decided that this figure may not hold up in practice and set the system to discharge no more than

95% of its total capacity. This should hopefully extend the batteries' lifetime and help mitigate any deterioration in performance or efficiency. All other parameters for the battery subsystem model were informed by the device specifications and data sheet.

4 Recommended Upgrades to Current System

One of the team's main goals through the course of this project had been to design the peripheral systems to have as little impact on the original system as possible in order to keep installation costs at a minimum. As such, the team did not make any changes to the current distribution system, including the base system model used within OpenDSS. However, preceding the addition of the team's sub-systems to this model, there were system losses due to transmission line impedance and phase mismatching. While line losses cannot be easily or conveniently mitigated, capacitor banks can be added to a load to non-intrusively compensate for reactive power transmission. While the selected storage controllers have some power factor correcting capabilities, it is significantly more effective to approach this issue within the base distribution system.