

## Project 1: BESS Design for Capacity Upgrade Deferral

**Due Date:** 9/21/2018

**Objective:** The goal of this homework is to calculate the required size of a Battery Energy Storage System (BESS) in MW and MWh for the purpose of equipment upgrade deferral on a sample distribution circuit.

**Instructions:** Use Microsoft Excel to calculate the requested information:

- 1) Use the sample 8760 load profile as the base year load profile (2018). Calculate the load profile in 2019, 2020, 2021, and 2022 using **2%** load growth factor.
- 2) Assume that the loading limit of the circuit is **7.5 MW**.
  - a. For each year, using the 8760 load profile and loading limit identify the hours in which the circuit load exceeds the loading limit. Draw a graph and identify the load profile, loading limit, and violating hours on the graph.
  - b. For each year, calculate the total number of hours for which the circuit load exceeds the loading limit.
  - c. For each year, calculate the total amount of annual energy (in kWh) for the hours that circuit load is above the circuit loading limit.

$$\sum_{h=1}^{8760} (Load(h) - Loading\ Limit) \quad \text{if } Load(h) > Loading\ Limit$$

- d. For each year, identify the maximum amount of circuit load above the circuit limit (in kW) (Maximum Load – Loading Limit).
- e. For each year, identify the maximum amount of cumulative violating energy (in kWh).

*Cumulative violating energy*

$$\begin{aligned} &= SUM((Load(h) - Limit) + (Load(h - 1) - Limit) + \dots \\ &+ (Load(h - N) - Limit) \quad \text{if } (Load(h + 1) < Limit) \text{ and } (Load(h - N - 1) \\ &< Limit) \quad \text{for } h = 1, \dots, 8760 \end{aligned}$$

- 3) Based on the results of Step 2, calculate the required size of battery to defer equipment upgrade for 5 years. Assume that battery roundtrip efficiency is 95% and the minimum allowable SOC is 30%.