Using railway traction lines to combat grid congestion

Studies: BSc Electrical Engineering

The electrification of our energy demand, as a result of the energy transition, has resulted in various problems, including the present day grid congestion, which prevents companies from growing and residential areas from being built. Also the Dutch railway companies face similar challenges. Currently, we are investigating the installation of a battery energy storage system (BESS) with PV (solar panels) near the Wierden station with Nationale Spoorwegen (NS) and ProRail.

The idea here is that this system will not be connected to the main Dutch electricity grid, but instead directly to the 1.5kV catenary (the power lines above the railway track) that provides traction power to the trains. In this sense, the case for the railroads is interesting as ProRail operates its own dedicated electricity grid. However, this grid is connected to the national power grid in various locations to inject power into the railway system. This power flow is uni-directional, i.e., ProRail cannot feed-in surplus of power back into the national grid. The goal of the envisioned BESS+PV installation is twofold:

1. In some places, such as Wierden, the grid operators cannot provide a new power connection to ProRail due to the aforementioned grid congestion issues. Such conections are essential to ensure a stable supply of electricity for the trains, however.
2. The system allows for further decarbonziation of the railways to provide sustainable transport.

However, we also see potential to use the railway catenary system to reduce the power load at nearby substations (connections to the main grid) by providing power from the battery. Especially to be prepared for potential time-dependent power limitation contracts.

Assignment
For this assignment you have to model the catenary system with 2 substations (at both ends of the line) and the BESS+PV system halfway. On top of this you have to impose train power models (available) to assess investigate whether the system is adequate enough to prevent voltage sags at the Wierden station. Based on this, you also can assess the (remaining) potential for the system to provide so-called “anicallary services” to the main grid by reducing the grid load upon request on either substation.

Research Questions:

- To what extent can a BESS+PV prevent voltage sags in teh railway systems?
- To what extent can this system support load reduction in the national power grid?

Objectives:

1. Literature study of railway power models;
2. Modelling a small railroad power system with loads, battery storage and generation;
3. Create a small simulation setup with trains and a simple energy management system;
4. Analyse the results of the BESS+PV setup on the railway power quality.

Work Division

- Literature: 20%
- Modelling: 25%
- Coding: 20%
- Evaluation: 10%
- Writing: 25%

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