



Engineering Studies for Interconnection of Generation Systems

There are two main parts of an engineering study relating to the interconnection of generation systems into a utility grid:

1. Does the distributed generation system cause a problem?
2. What would it cost to make a change that rectifies the problem?

The first question is relatively straightforward to determine as Nodak Electric Cooperative, Inc. (Nodak Electric) engineering staff reviews the proposed installation. The second question typically has multiple alternatives and can turn into an iterative process, which can become quite large and involved for more complex generation system installations. From an engineering perspective relative to this particular issue, there are no 'cook book' solutions which can be applied.

For some of the large generation installations and/or the more complex interconnections, Nodak Electric may suggest dividing up the engineering studies into the two parts: identifying the problem scope and attempting to identify solutions to resolve the problem(s). By dividing the engineering studies into two steps, it may allow the Applicant to see the problems identified, thereby affording the Applicant an opportunity to reconsider the project if they feel the problems are too large and possibly expensive to resolve. Or they may choose to move forward with the next step which might involve more extensive engineering studies to identify problem solutions and thus additional costs.

This document provides an overview of some of the main issues that are looked at during the engineering study process. Every interconnection has its unique issues, such as relative strength of the distribution system, ratio of the generation size to the existing area loads, etc. Thus many of the generation interconnections will require further review of one or several of the issues listed.

- **Short circuit analysis:** The distribution system is studied to make sure that the addition of the generation system will not overstress any of Nodak Electric's distribution plant or equipment, and that the equipment will be able to operate properly during a faulted condition. It is expected that the Applicant will complete their own short circuit analysis on their equipment to ensure that the addition of the generation system does not overstress the Applicant's electrical equipment.

- **Distribution System Protection Coordination:** System protection analysis studies using computerized modeling of Nodak Electric's system with and without the generation system will be performed. Areas studied in this work include:
 - Fault current studies: Distribution system fault currents are calculated with and without the generation system to determine fault current levels under different types of faulted conditions. Distributed generation systems may contribute fault current to Nodak Electric's distribution system under faulted circuit operating conditions.
 - Reclosing/Clearing issues: Once fault currents have been calculated, the engineer studies the coordination of distribution and transmission system devices along with the generation system equipment to ensure that proper coordination of all devices can be achieved. Depending on the proposed size of the generation system, various operating parameters may be established or required, such as:
 - Voltage supervision of reclosing
 - Transfer trip requirements for the generation system
 - Changing of existing set points for system protection equipment
 - Requirements for synchronous operation and the impact of out-of-sync operation
 - Requirements for reverse power flow protection
 - Potential problems caused by any voltage transformations within the generation system
 - Sensitivity of the generation system equipment to problems on Nodak Electric's distribution system

- **Grounding design and review:** Electrical grounding is one of the most fundamental safety considerations for any electrical system. In addition to the National Electric Code, which Nodak Electric presumes will be complied with in the design process, Nodak Electric will also determine if the proposed design relative to grounding complies with the National Electric Safety Code (NESC) which applies more to utility operations.

- **Power Flow and Voltage Drop/Flicker:** Load flow analysis using computerized modeling of Nodak Electric's system with and without the generation system will be performed. Areas studied in this work include:
 - Potential effects for and from islanding of the generation system
 - Effect of generation system on Nodak Electric's system loading - will the system ever be overloaded under normal, contingent, or backfeed operation?
 - Will operation of the generation system result in any voltage swings or flicker during up-loading or offloading and will additional voltage regulation be required?
 - How will the generation system interact with Nodak Electric's distribution system voltage regulation?
 - How will the generation system affect Nodak Electric's distribution system power factor and will power factor correction be required?

- **Special Operation Impact:** These considerations will determine if special operating procedures are needed with the addition of the generation system into Nodak Electric's distribution system and what, if any, limitations need to be placed on the operation of the system.