YUKON RESEARCH CENTRE
Yukon College

Grid Impact Study for Old Crow Solar Project

Northern Energy Innovation Team at the Yukon Research Centre, Yukon College

Project background & context

Communities throughout the Yukon that are not connected to the grid have demonstrated significant interest to shift their electric generation from diesel-based to include more renewable-based generation. While electric power utilities are interested in implementing renewable generation and reducing diesel fuel consumption, they must continue to meet their prime mandate to provide safe and reliable power to their customers. Installing a high amount of renewable generation such as wind and solar, where the prime mover is highly intermittent and uncontrollable, will reduce the utility's ability to meet their prime mandate. To account for this, utilities across the country have indicated a consistent conservative blanket statement of how much can be integrated into remote electric power systems.

The objective of this project is to perform grid impact studies on remote electric power systems in order to assess the renewable generation penetration limit on each community. In essence, we are stepping away from blanket statements of renewable generation integration limits in the north by performing analyses on individual communities to provide better insight to utilities on a case-by-case basis of the technical bottlenecks. We want to ensure that communities are able to integrate the maximum amount of renewable generation on isolated communities in a responsible manner, such that neither stability nor reliability are compromised. As the project's first test site is the Old Crow electric system, this project is of high interest to both ATCO Electric Yukon (ATCO), who serves the power needs of the community, and Vuntut Gwitchin Government (VGG), as project results can directly support their Old Crow Solar Project. The Northern Energy Innovation's role in the study is to provide unbiased and transparent technical analyses of the Old Crow electric power system to both the utility and community.

Research & development

The first stage of the project identified all possible technical barriers that may be present to integrating renewable generation on an isolated diesel-based system. These barriers were identified through a literature review of industry standards, peer-reviewed journal articles, technical papers from national research laboratories; as well as interviews with equipment manufacturers and industry personnel with experience in integrating renewables to provide a collection of lessons learned. The potential barriers for any isolated system have been identified to be: energy balance (including steady-state voltage profiles), small signal stability, transient stability, protection coordination, harmonic analyses, and resonant phenomena. While many of the technical barrier analyses were implemented through a direct application of the theory, some of the standard analysis methods were derived with the assumption that the system is connected to the large interconnected grid (infinite bus) – an assumption that is not valid for isolated systems. For these technical barriers, the analyses were reformulate to remove the assumptions to ensure that they are applicable for the northern and remote context.

Design & implementation

The analyses of these barriers as well as the engineering principles that lead to the non-desirable behavior have been modelled within a software analysis framework with the intention to be modular and replicable on other Yukon communities. The approach was to make the analysis sufficiently generic so that it can be applied to other communities without having to invest significant time and resources to replicate the study methodology, while being sufficiently specific to each individual system so that the results are pertinent for that community. A strong partnership with ATCO facilitated the gathering of real data, parameters, topology, equipment, and profiles from the Old Crow system to ensure that the system was modelled accurately. Industry standard models (where real data were unavailable) were implemented to ensure technical rigour. The outcomes of the analyses are not only an identification of the renewable integration limit, but also the specific barrier(s) that prevent a higher penetration and the sensitivities around those barriers. These results indicate to all stakeholders the limiting problem(s) so that both the utility and community can work together to find viable potential solutions to the identified bottleneck.

Stakeholder engagement

In addition to the strong partnership with ATCO, a partnership was formed between the Yukon Research Centre (YRC) and VGG for this project to ensure that the analyses met the specifications of their proposed plan through its evolution and incremental improvements from our ongoing feedback. Regular meetings were held with all three stakeholders to ensure consistent communication and the objectives and suggestions were met with honest feedback and transparency. As a large proponent of the project, the Old Crow community was engaged throughout the project through several community outreach events and presentations at community meetings. The feedback was well received by the community, and comments were considered in the implementation.

Results & outcomes

The results of the project were informative to both VGG and ATCO, and the outcomes have provided a platform upon which further design modifications are met. All stakeholders are interested in reducing diesel consumption while ensuring that the lights stay on. This can lead to an enhanced quality of life for the Old Crow community in terms of sustainability, self-empowerment, a cleaner and less noisy environment, and a means of income through renewable energy sales. The deliverables included not only a report of the studies performed, but also a technology transfer to the utilities of the developed models so that they can replicate and perform further studies on the Old Crow system. The future steps of this project are to replicate the efforts and work together with Yukon Government, utilities, and communities in the Yukon who would like to integrate renewable generation in their diesel-powered community to ensure a sustainable and reliable integration.

Project team

Many northerners have been engaged throughout this project, which also helps with building local capacity of highly skilled personnel in the Yukon. The personnel from the Northern Energy Innovation team at the YRC are comprised the following engineers, students, and early-career professionals:

Michael Ross, Ph.D., P.Eng. – Principal Investigator

Jason Zrum, E.I.T. – Project lead	Tarek Bos-Jabbar	Sinan Bulut, Ph.D.
Tim Dohring	Geneviève Favreau	Adrienne Hynes
Tanvir Rahman, Ph.D.	John Ross	Spencer Sumanik, E.I.T.
Nicholas Starr	Sara Thompson	Rosamund Tutton