Visualization tool for comparing low-carbon energy options

PI: Mark Deinert, The Colorado School of Mines

Collaborators: Andrew Osborne and Tim Kaiser, The Colorado School of Mines

Program: FC-5.1a

ABSTRACT

Nuclear power is well established as the gold-standard for baseload power production and also as the technology with the lowest overall carbon intensity of any commercial form of electricity generation. However, the sustainability of nuclear power rests on its market competiveness, and relative climatological and environmental impacts. Any proposed fuel cycle must be evaluated as part of a large-scale energy generation environment that reflects the fluctuating nature of electricity demand as well as uncertainties surrounding the transmission of electricity. Alternatives must also be evaluated under the same constraints, with renewables such as solar and wind having additional uncertainties associated with resource availability.

While a variety of studies comparing generation technologies have been conducted in the past, no capability currently exists for non-expert audiences to make meaningful comparisons between generation technologies. We will will develop a web based visualization tool for comparing current and future nuclear fuel cycle options to low-carbon and conventional energy technologies in the United States. Users will be able to select different generation technologies for comparison as well as combine nuclear options with specific back-end fuel cycle options such as on-site storage, geological disposal or reprocessing. The visualization tool will provide users with typical pre-filled price, financing and physical system data. It will display the levelized cost of electricity, the cost of electricity at the point of sale, carbon intensity, land and water use, capacity factor and reliability as a function of location. Non-nuclear generation technologies will include solar and wind (with and without energy storage), natural gas, coal and biomass fired systems, with and without carbon capture and storage. Users will be able to couple each technology to the grid-scale storage options available at that location including above and below ground compressed air energy storage and grid-scale batteries to see how costs vary. All options will be presented to the user in a context-sensitive manner to ensure the tool is intuitive. An application programming interface (API) will also be developed to enable third party developers to build customized tools for educational, nonprofit or policy analysis using the visualization tool. The API will be based on well-known standards allowing users to build applications in any programming language. Developers will be able to implement functions that request data including wind and solar resources, variability as well as capital, O&M, and fuel costs for each technology type.

This project will have two main goals, which will be conducted in parallel:

- Develop an intuitive web-based tool for non-technical audiences to compare energy generation options;
- Develop an Application Programming Interface (API) to enable others to develop additional tools to with which to expand the presentation and analysis capabilities.