II. Instructor Notes

Disciplines/courses suitable for this project: This project is an appropriate supplement to any course in economics, environmental science, business management or administration, or any other course that deals with entry-level cost-benefit analysis.

Degree of difficulty: M (moderately difficult)

Resources/background needed:

In addition to the links provided to the students, the following resources can be useful:

https://www.synapse-energy.com/sites/default/files/SynapsePaper.2008-07.0.Nuclear-Plant-Construction-Costs.A0022_0.pdf

https://www.statista.com/statistics/184754/cost-of-nuclear-electricity-production-in-the-us-since-2000/

https://www.eia.gov/electricity/annual/html/epa_08_04.html

If students do not have a background in Excel or with a financial calculator, a brief introduction will be a necessary part of the pre-project discussions. For information on getting started in Excel:

https://support.microsoft.com/en-us/office/overview-of-formulas-in-excel-ecfdc708-9162-49e8-b993-c311f47ca173

https://www.ablebits.com/office-addins-blog/2017/06/21/how-to-do-calculations-excel/

About running individual or group project: Groups of 2-3 should work together in this project. Results will be submitted according to instructor directives. Each group member should be prepared to answer discussion questions.

Discussion on duration of the project: This project should take approximately 2-3 50-minute periods of a typical course.

Open ended questions:

Why do you think countries like Russia and China are greatly investing in nuclear power while countries like Germany are moving away from it?

Does the exceptional reliability of nuclear power make it more desirable than other low-carbon energy sources that are less reliable? Explain.

How low would the probability of nuclear meltdown have to be in order for you to ignore the possibility? How high before you switch to hydro?

Should the US build more reactors as part of the push to drastically reduce carbon emissions in the near future? Explain.

What additional costs could be added to complicate the decision process?

Special instructions and assumptions:

Students will likely need to be taught or reminded about the Net Present Value function and the Expectation operator. Depending on their preparation, this could take a full lecture.

The formula for the NPV is $NPV = \sum_{t=0}^{T} \frac{CF_t}{(1+r)^t}$, where there are T time periods, a discount rate r, t denotes the time period, and CF_t is the cash flow in time period t.

The expected outcome E_x of a variable x with a discrete probability distribution is calculated as: $E_x = \sum_{i=1}^{n} x_i f(x_i)$, where n is the number of possible outcomes, x_i is the i^{th} outcome for the variable x, and $f(x_i)$ is the probability of the i^{th} outcome.

These discussions will have to be part of pre-project lectures.

Revision and Continuation: This project can be continued in the future in at least two meaningful ways. One would be to find information on the smaller modular nuclear reactors that are currently in development. These are smaller and can largely be produced in a factory setting, thereby reducing construction costs and times. The process is currently in development and more information will likely be available in the future. Another option would be to find similar cost information for other power sources, and build NPV questions for Wind, Solar, Coal, etc. A less rigorous expansion would be to update the dollar amounts for inflation and update cost numbers as years go by.

Further guidelines on evaluation: Instructors can have students submit answers through their Learning Management System (LMS), Google Forms, email, or however the instructor prefers.

The survey questions are listed in the student version. These surveys can be collected through the LMS, Google Forms, etc. in the form of a quiz that asks for team member names and asks those questions for each teammate.

Other information for faculty not covered above:

Be sure to provide step-by-step instructions for building arrays and running calculations in Excel or whatever program is used to make the calculations. Students will need to know how to multiply and add values, use exponents, and use if-else statements. If students are not prepared to do these calculations, extra time should be taken for an Excel tutorial.

There is an instructor Excel sheet answer key. It lists the information from the student paragraphs, lists answers, and demonstrates calculations and explanations for each answer. This includes a large table for calculating NPV. Answers are highlighted in yellow, and explanations and calculations are listed in blue. Instructors whose students are weaker in Excel or who would like to make the project easier could adapt the instructor Excel sheet to create a template to give to their students.