

A large part of your grade is earned with a final project. If you are a graduate student in NPRE 412, the project is mandatory. If you are an undergraduate student in NPRE 412, the project is optional. If you choose not to do the project, your course grade will be based on all other assignments and will be renormalized appropriately. It is intended to tie together the lessons of the course with an independent analysis of a relevant topic in the context of nuclear power economics and fuel management (or, the nuclear fuel cycle).

Final projects will be assessed as independent research work, much like a journal article undergoes peer review. I will be looking for :

- Relevance
- Novelty
- Technical Detail
- Analytic Rigor
- Verifiability
- Clarity
- A Conclusion

This work will consist of one deliverable: a final report. To help determine if your chosen topic is of reasonable scope, you are welcome to ask for my feedback (once) before May 1. To request feedback, send a paragraph describing your topic to me via email which states the question you plan to answer and describes the approach and methods you will take to answer the question. For your guidance, a list of example topics appears at the end of this document. Feel free to choose one of these. However, choosing a creative topic of your choice is encouraged.

1. (100 points) **Final Report: Due 7pm, May 12, 2020**

Prepare a final document in the style of a journal article or conference proceedings. It should meet the following guidelines:

- Minimum 3000 words.
- Maximum 10000 words.
- Two columns.
- Reasonable margins.
- 10 pt font or larger.
- State the question you answered.
- Comprehensively report and cite the current state of the art in the literature.
- Motivate the problem, explaining its relevance.
- Describe the approach, methods, and other elements of your solution.
- Describe in detail: the analysis, software, data, conclusions produced in this work.
- Include publication quality graphs and figures.
- Cite and provide data and code generated for this work sufficient to reproduce the conclusions.
- Compare this result to previous results in the literature, reinforce the relevance of the work.
- Suggest future work.

1 Topic Examples

For your guidance, a list of example topics appears here. Feel free to choose one of these. However, choosing a creative topic of your choice is encouraged.

Levelized Cost of Electricity Choose an advanced nuclear reactor and a compatible advanced fuel cycle. Calculate the levelized cost of electricity of this mode of electricity generation to the best of your ability. Include all facilities in the fuel cycle from the mine to the final repository as well as any reprocessing.

Energy Return on Investment Choose a nuclear reactor and a compatible fuel cycle. Calculate the energy return on investment of that fuel cycle. Include all facilities in the fuel cycle from the mine to the final repository as well as any reprocessing.

Waste Comparison Choose a nuclear reactor and a compatible fuel cycle. Categorize and quantify the waste products of this fuel cycle. Include all facilities in the fuel cycle from the mine to the final repository as well as any reprocessing. How does this compare the waste products generated by solar panels, wind turbines, etc?

Impact of a Zero Emissions Tax Credit New York state recently (summer 2016) implemented a zero emissions tax credit. It was enough to save the Fitzpatrick nuclear generating station. Were the parameters of that state-level to be implemented accross the US, either federally or individually in each state, the risk of owning and building nuclear plants would decrease. Quantify the change in risk. Predict the impacts to the nuclear industry. Would it be enough to save at-risk plants? Would we likely see an increase in new builds? What other impacts might we see? How did this tax credit operate differently or similarly to the Clean Jobs Bill recently passed in Illinois?

Illinois Senate Bill 2814, the Future Energy Jobs Bill The state of Illinois similarly passed Senate Bill 2814, the Future Energy Jobs Bill. It saved the Clinton nuclear power plant from imminent shutdown. How did that bill economically incentivize Exelon to keep plants open? How long will this incentive be sufficient to keep these plants open? If this bill were passed nationwide, what would the economic impacts be?

The Likelihood and Implications of the Duck Curve The California Independent System Operators published the “duck chart.” This curve, describing the predicted mid-day overgeneration of grid-bound electricity, caused by installations of solar, primarily, makes load-following generation sources or storage methods necessary. A few questions that would make interesting projects on this topic include:

- What is the level of alarm appropriate in reaction to this chart and why?
- Can you suggest a novel strategy that would allow nuclear generation to be adapted to load follow?
- What would the impact to nuclear power be if this situation is allowed to proceed and there is no curtailment of variable generation sources?
- How could current storage technologies smooth this curve?

Liquid vs. Solid Fuelled Molten Salt Reactor Source Term and Release Pathways Reactor designs involving molten salts can have either solid fuel or fluidized fuel. In the fluid fuel case, proponents are often heard to say they can’t melt down because they operate safely at a melted state. Compare the source term and release pathways of a containment breach in a solid fuelled salt reactor vs. a fluid fuelled one.

Economics of Uranium Extraction from Seawater A great deal of research is being undertaken to lower the costs of uranium extraction from seawater. Can you replicate the results of a previous calculation of those costs? To what extent are those results sensitive to uncertain assumptions (assumptions of a political, technical, or economic nature, it matters not.)

Metrics for Proliferation in the Nuclear Fuel Cycle Suggest a metric that captures proliferation concern in a nuclear fuel cycle scenario. Defend it. Analyze

Assessment of Dose To Workers in Reprocessing Schemes Propose a model for calculating the dose impact on workers within an arbitrary fuel cycle. Include dose due to all steps of the fuel cycle, including reprocessing and disposal. Compare and contrast fuel cycle strategies with and without reprocessing.

Fuel Cycle Transition Scenario Choose one of the Evaluation Groups identified by the Fuel Cycle Options Evaluation and Screening. Use a simulator (e.g. Cyclus, CLASS, or Orion) or your own model to assess the time-to-transition from our current reactor fleet to 100% deployment of the new technology (e.g. SFRs, MSR, etc.)

Repository Cost Estimation Suggest a high level waste repository site. Suggest appropriate waste forms, waste packages, and other disposal system design features for this geology. Estimate construction rates, loading rates, transportation costs, and a closing timeline. With these estimates, defended by analysis, conduct a life cycle cost estimation of your proposed site.

Assessment of Competitiveness In the paper referenced below [1], the factors impacting competitiveness of fast reactors are assessed. Conduct a similar assessment for your favorite, different, reactor type (e.g. HTGR, MSR, FHR, etc).

[1] A. Baschwitz, G. Mathonnière, S. Gabriel, J.-G. Deveziaux de Lavergne, and Y. Pinc, “When would fast reactors become competitive with light water reactors? Methodology and key parameters,” *Progress in Nuclear Energy*, vol. 100, pp. 103–113, Sep. 2017.
this paper 10.1016/j.pnucene.2017.05.028