Assignment 1: Evaluating Evidence to Inform Policy

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Nuclear Energy Expansion as a Solution to Climate Change

The first step in any policy analysis is to define the problem in need of solving (Bardach & Patashnik, 2019). When it comes to energy policy, there is no more pressing problem than climate change. The earth is growing *too* warm. There is widespread scientific consensus that the planet's average temperature will rise to 1.5 degrees Celsius above pre-industrial levels (Ellicott, 2022). This increasing temperature is largely attributed to the CO_2 released when burning fossil fuels, energy sources that generated 60% of all electricity and powered over 1.5 billion vehicles globally in 2023 (Fischer, 2024). Without significant reductions in CO_2 emissions, experts predict that Earth will experience 2-3 degree warming above pre-industrial levels by the end of the 21st century. This would be a catastrophic scenario that destroys whole ecosystems, renders large portions of the planet unsuitable for human habitation, and significantly worsens the severity of natural disasters (Ellicott, 2022). These threats have motivated leaders across the globe to begin investing in and incentivizing low-emissions energy generation. Government intervention is justified here because of the nature of the policy problem: the costs of emitting CO_2 are paid for by society, not the individuals doing the polluting (Bardach & Patashnik, 2019).

The next step in conducting a policy analysis is to construct the alternatives for dealing with the problem, which is where experts begin to disagree on this issue (Bardach & Patashnik, 2019). Environmental scientists and nuclear engineers tend to promote rapid expansions in nuclear energy generation as the best way – maybe even the only way – to significantly reduce CO_2 emissions and avoid the worst impacts of climate change (Grossi, 2024; Siqueira et al., 2018). Their argument is based on the technical superiority of nuclear energy over other low-emission energy sources like renewables. For example, nuclear reactors are much more powerful. An average-sized reactor generates as much energy as 800 wind farms or 8.5 million solar panels (MIT Climate Portal Writing Team & Parsons, 2024). They therefore require far fewer resources to construct, operate, and maintain. Take land, for example. A wind farm requires 360 times more land area to produce the same amount of energy as one nuclear reactor, and a solar farm requires 75 times more land area (Fischer, 2024). And because it requires fewer resources, nuclear energy generation is cheaper and produces far fewer carbon emissions over its life cycle than any other energy source (Grossi, 2024). Finally, reactors can run at all hours – unlike solar and wind farms – eliminating the need for fossil fuels to meet non-peak energy demand (Parsons et al., 2019).

However, energy researchers tend to argue that a strategy prioritizing nuclear energy expansion would delay emissions reduction efforts and doom the world to a 2-3 degree warming scenario (Muellner et al., 2021). This argument emphasizes the challenges of expanding nuclear energy generation quickly enough to address climate change. For example, political leaders and the public still view nuclear energy warily after high-profile disasters at reactors in Chernobyl, Fukushima, and Three Mile Island (Abdulla, 2019; Fischer, 2024). Getting a new reactor project approved is therefore a difficult and time-consuming endeavor. Nuclear energy can also be difficult to promote internationally, as new technologies are increasing the national security risks of nuclear weapons proliferation (Kemp et al., 2024). Other challenges are economic in nature. There has not been a single reactor built in the U.S. during the 21st century that did not go significantly over budget, which kills many projects in their infancy and scares away investors (Fischer, 2024). Finally, some challenges are themselves environmental. The U.S. still does not have a long-term plan for safely storing the radioactive waste produced by nuclear reactors (Prăvălie & Bandoc, 2018). These experts argue that the challenges are collectively insurmountable, making prioritizing nuclear energy a poor strategy for reducing emissions.

Yet, it is fair to wonder whether these alternatives are as mutually exclusive as the experts make them seem (Bardach & Patashnik, 2019). Wouldn't the best path to reducing CO_2 emissions be to encourage energy generation from all low-emissions sources, including expanding nuclear energy generation (Parsons et al., 2019)? The problem with this perspective is that it does not consider the short time horizon for solving the policy problem. It takes CO_2 hundreds of years to leave the atmosphere, meaning that humanity must stop releasing it altogether before the worst effects of global warming become inevitable (Inman, 2008). Scientists predict that this will require achieving carbon neutrality by 2050, giving policymakers a 25-year window with which to address climate change (International Energy Agency, 2021). Solutions need to be put into place now. Yet, there is only so much political will and available capital to go around in the present. Empirical research confirms this relationship, with additional investment in nuclear energy generation correlated with decreases in a country's level of renewable energy investment, and vice versa (Sovacool et al., 2020). Prioritizing the wrong strategy may permanently close humanity's window for effectively mitigating climate change.

The third step in the policy analysis process is to specify evaluation criteria by which the outcomes of the alternatives will be judged (Bardach & Patashnik, 2019). The most important criterion relates to whether the policy problem is solved. In this case, achieving global carbon neutrality by 2050 and halting earth's temperature rise at 1.5 degrees above pre-industrial levels. However, the proponents for and against prioritizing nuclear energy expansion often appeal to many secondary criteria as well. Both sides point to environmental criteria beyond mere sustainability, such as ecological and health impacts (Fischer, 2024; Kraft, 1999). Efficiency is also a necessary criterion to include since displacing fossil fuels as the world's dominant energy source will have tremendous impacts on nations' economic growth (Ellicott, 2022). Finally, achieving carbon neutrality will require significant policy changes to be made across hundreds of countries. This makes political feasibility another important criterion to include in the analysis.

The fourth step in the policy analysis process is to project the outcomes of the alternatives, which many climate and energy researchers attempt to do through econometric modeling (Bardach & Patashnik, 2019). These models can take two approaches: examining historical data to search for empirical relationships or hypothesizing relationships between variables to predict future CO_2 emissions levels. Unfortunately, both of these methods have produced conflicting results. For example, Nathaniel et al. (2021) use AMG and CCEMG estimation to analyze seventeen years of data from six G7 countries, concluding that increases in nuclear energy generation were far more often associated with emissions reductions than were expansions of renewable energy generation. However, when Sovacool et al. (2020) used regression analysis to analyze 25 years of data from 123 countries, they came to the opposite conclusion: countries that prioritized expanding nuclear energy had not achieved emissions reductions while those that prioritized renewables had. The same is true of the forecasting models. Siqueira et al.'s (2018) model predicts that only a high nuclear investment scenario would significantly decrease future emissions; meanwhile, Osman et al.'s (2022) model predicts that renewable energy sources alone can decarbonize 90% of electricity generation by 2050.

Altogether, these studies suggest that the plausible emissions reductions benefits of prioritizing either strategy are extremely uncertain and largely overlap. In situations like this, it is useful to compare alternatives using sensitivity analysis (Bardach & Patashnik, 2019). This entails questioning the assumptions of a model's predictions in order to identify the most likely outcomes. Muellner et al. (2021) is one paper that critically analyzes the assumptions of nuclear energy expansion models well. They argue that these models make many faulty assumptions that systemically *overestimate* potential emissions reductions. For example, most models use IAEA nuclear construction projections as their base case, yet these have historically proven to be overly optimistic (Fischer, 2024; Muellner et al., 2021). Additionally, these models assume a large supply of uranium-235 will be available to power nuclear reactors, which is not supported by current supply projections (Muellner et al., 2021). Conversely, other scholars find that most models make faulty assumptions that systemically *underestimate* the emissions reduction potential of expanding renewable energy generation. Creutzig et al. (2017) argue that these models assume a steep technical learning curve in deploying solar technologies that does not reflect recent trends. Williams et al. (2017) argue that the same is true for wind technologies. Sensitivity analysis therefore suggests that the emissions reduction potential of prioritizing nuclear energy expansion likely falls towards the lower bound of its plausible outcome range, while that of prioritizing renewable energy expansion likely falls towards its upper bound.

Predicting the alternatives' outcomes on the secondary criteria is more straightforward. Both strategies will have ecological and health consequences. Experts predict that rapidly expanding nuclear energy generation will result in more reactor meltdowns, uranium mining, and nuclear waste storage problems (Prăvălie & Bandoc, 2018; Rose & Sweeting, 2016). These effects will have detrimental impacts on the health of ecosystems, workers, and nearby residents. Yet, the secondary environmental consequences of expanding renewable energy production would be even more severe. Its significant land requirements would mean tearing down millions of acres of natural habitat, leading to a significant loss of biodiversity and increasing the risks of pathogen spillovers (Plowright et al., 2021; Rehbein et al., 2020). As for efficiency, nuclear energy is already the least input-intensive technology available for producing energy. This would free up resources for other uses and drive economic growth, though recent innovations in renewable energy generation technologies suggest that they are not too far behind in this respect (Osman et al., 2022). Finally, renewable energy expansion is far more politically feasible than nuclear expansion. It does not naturally elicit dread or raise national security concerns like expanding nuclear energy does, making it easier for this alternative to gain the widespread political support necessary for policy change (Abdulla et al., 2019; Kemp et al., 2024).

The final step in the policy analysis process, then, is to confront the tradeoffs of the available alternatives and reach a recommendation (Bardach & Patashnik, 2019). In this case, the tradeoffs arise between the primary and the secondary evaluative criteria. A strategy prioritizing renewable energy expansion seems much more likely to achieve global carbon neutrality by 2050, but it would also result in ecological destruction, new disease outbreaks, and slower economic growth. Meanwhile, a strategy prioritizing nuclear energy expansion seems to have limited potential for achieving carbon neutrality by 2050. Yet, it could still make important progress towards avoiding more severe warming scenarios while at the same time minimizing ecological, health, and economic consequences. How one decides between these tradeoffs depends upon the weight they assign to the different criteria. This could be left up to the political process to decide, but I instead suggest imposing a solution (Bardach & Patashnik, 2019). Climate change is perhaps the most dire policy problem facing the world today. Emissions reductions will need to take priority over other policy goals if our leaders are to effectively address it in the timeframe available. For this reason, I recommend that U.S. policymakers deprioritize the global expansion of nuclear energy. Instead, they should approach energy policy with a strategic emphasis on rapidly expanding renewable energy generation. This can be done by creating new incentives for renewable energy investments, financing grid modernizations and energy storage research, and providing technical and financial assistance to global partners.

References

Abdulla, A., Vaishnav, P., Sergi, B., & Victor, D. (2019). Limits to deployment of nuclear power for decarbonization: Insights from public opinion. *Energy Policy*, 129, 1339–1346. https://doi.org/10.1016/j.enpol.2019.03.039

Bardach, E., & Patashnik, E. M. (2019). *A Practical Guide for Policy Analysis: The Eightfold Path to More Effective Problem Solving.* http://www.gbv.de/dms/sub-hamburg/30636509X.pdf

Ellicott, V. (2022). Climate Change. *CQ Researcher*. https://doi.org/10.4135/cqr_ht_climate_change_2022

Fischer, K. (2024). Nuclear Power Resurgence. *CQ Researcher*, 34(37). https://doi.org/10.4135/cqresrre20241011

Grossi, R. M. (2024, January 17). *5 reasons we must embrace nuclear energy in the fight against climate change.* World Economic Forum. Retrieved February 12, 2025, from https://www.weforum.org/stories/2024/01/nuclear-energy-transistion-climate-change/

Inman, M. (2008). Carbon is forever. *Nature Climate Change*, 1(812), 156–158. https://doi.org/10.1038/climate.2008.122

International Energy Agency. (2021). Net Zero by 2050: A Roadmap for the Global Energy Sector. In *IEA*. Retrieved February 12, 2025, from https://www.iea.org/reports/net-zero-by-2050

Kemp, R. S., Lyman, E. S., Deinert, M. R., Garwin, R. L., & Von Hippel, F. N. (2024). The weapons potential of high-assay low-enriched uranium. *Science*, 384(6700), 1071–1073. https://doi.org/10.1126/science.ado8693

Kraft, M. (1999). Environmental Policy: New Directions for the Twenty-First Century (4th ed.). CQ Press. ISBN 978-1568023410.

MIT Climate Portal Writing Team, & Parsons, J. (2024, January 4). *How many wind turbines would it take to equal the energy output of one typical nuclear reactor?* MIT Climate Portal. Retrieved February 12, 2025, from https://climate.mit.edu/ask-mit/how-many-wind-turbines-would-it-take-equal-energy-output-one-typical-nuclear-reactor

Muellner, N., Arnold, N., Gufler, K., Kromp, W., Renneberg, W., & Liebert, W. (2021). Nuclear energy - The solution to climate change? *Energy Policy*, 155, 112363.

https://doi.org/10.1016/j.enpol.2021.112363

Nathaniel, S. P., Alam, M. S., Murshed, M., Mahmood, H., & Ahmad, P. (2021). The roles of nuclear energy, renewable energy, and economic growth in the abatement of carbon dioxide emissions in the G7 countries. *Environmental Science and Pollution Research*, 28(35), 47957–47972. https://doi.org/10.1007/s11356-021-13728-6

Osman, A. I., Chen, L., Yang, M., Msigwa, G., Farghali, M., Fawzy, S., Rooney, D. W., & Yap, P. (2022). Cost, environmental impact, and resilience of renewable energy under a changing climate: a review. *Environmental Chemistry Letters*, 21(2), 741–764. https://doi.org/10.1007/s10311-022-01532-8

Parsons, J., Buongiorno, J., Corradini, M., & Petti, D. (2019). A fresh look at nuclear energy. *Science*, 363(6423), 105. https://doi.org/10.1126/science.aaw5304

Plowright, R. K., Reaser, J. K., Locke, H., Woodley, S. J., Patz, J. A., Becker, D. J., Oppler, G., Hudson, P. J., & Tabor, G. M. (2021). Land use-induced spillover: a call to action to safeguard environmental, animal, and human health. *The Lancet Planetary Health*, 5(4), e237–e245. https://doi.org/10.1016/s2542-5196(21)00031-0

Prăvălie, R., & Bandoc, G. (2018). Nuclear energy: Between global electricity demand, worldwide decarbonisation imperativeness, and planetary environmental implications. *Journal of Environmental Management*, 209, 81–92. https://doi.org/10.1016/j.jenvman.2017.12.043

Rehbein, J. A., Watson, J. E. M., Lane, J. L., Sonter, L. J., Venter, O., Atkinson, S. C., & Allan, J. R. (2020). Renewable energy development threatens many globally important biodiversity areas. *Global Change Biology*, 26(5), 3040–3051. https://doi.org/10.1111/gcb.15067

Rose, T., & Sweeting, T. (2016). How safe is nuclear power? A statistical study suggests less than expected. *Bulletin of the Atomic Scientists*, 72(2), 112–115. https://doi.org/10.1080/00963402.2016.1145910

Siqueira, D. S., De Almeida Meystre, J., Hilário, M. Q., Rocha, D. H. D., Menon, G. J., & Da Silva, R. J. (2018). Current perspectives on nuclear energy as a global climate change mitigation option. *Mitigation and Adaptation Strategies for Global Change*, 24(5), 749–777. https://doi.org/10.1007/s11027-018-9829-5