

Science Policy Outreach Task Force at Northwestern University

Nuclear Energy



SPOTlight: To meet its zero-carbon goal by 2050, Illinois must undertake a swift transition to renewable energy accompanied by a firm low carbon source such as nuclear power. The long term economic and operational considerations of using nuclear energy as a potential source of carbon free electricity means a decision on the moratorium of nuclear power is urgent.

What is nuclear energy and its current state?

- Nuclear power harnesses the energy produced by nuclear fission of uranium fuel in pressurized water reactors (PWRs). The produced heat boils steam which runs through a turbine to produce electricity.
- Improved technologies such as molten salt and small modular reactors [1] (SMRs) have been demonstrated at a small scale but have not been scaled and deployed [2], [3]. Nuclear fusion is in the research phase but has been observed in two different small reactor designs but not demonstrated in a scaled reactor [4].
- Nuclear power produces ~50% of the state's electricity [5]. Upgrades can extend reactor lifespan 35-54 years. The average age of reactors in Illinois is 41 years meaning all reactors will be offline by 2047 [6], [7].

Why (consider) nuclear energy?

- Nuclear is a candidate for firm low carbon power as it produces large amounts of carbon free electricity. Other firm low carbon sources include biomass, hydropower, geothermal and natural gas sequestration.
- To meet the net zero carbon goal by 2050, a major transition to renewables will be required. To offset the variational load of renewable energy sources, firm low carbon power sources will be required to provide a base load and keep costs low [8]–[10].
- A study for California's 2050 carbon free goal found using firm power in conjunction with renewables saw a 40% decrease in energy prices, ~40% decrease in land use, and ~66% decrease in transmission line installation [9], [10].
- The aging electrical grid in Illinois adds extra complications, increasing the cost of a renewable only path.
- Illinois has a thriving nuclear energy industry and abundant freshwater resources to meet this need.

What are the economic impacts of nuclear energy?

- The nuclear energy sector employs 500-800 people per nuclear reactor site and up to 7000 at the peak of construction with nationally 100,000 to 475,000 people for primary and secondary jobs respectively.
- After the 1998 Zion Nuclear Power Station shutdown, Illinois lost \$18 million in income annually and property tax rates surged by 143% [11]. In response to closures, 50 communities in Illinois were awarded energy transition community grants of an aggregate of \$40 million annually [12].
- High initial capital costs and construction timelines make returns on nuclear power plants a 30-year process. A recent plant in Georgia with 4 reactors had a total cost of \$30 billion and was delayed by seven years [13]–[15].
- The federal Inflation Reduction Act gives tax incentives, financing options, and grant money to produce certain nuclear fuels and power plants to mitigate these issues.

What are the health, safety, and environmental considerations of nuclear energy?

- Radioactive waste must be stored on-site due to the lack of a permanent waste repository. Spent nuclear fuel (SNF) is the most hazardous radioactive waste product with 88,000 metric tons stored on US plant sites [16]. SNF can be recycled with fast spectrum reactors [17]; Japan recycles most of their SNF waste [18].
- Over the history of nuclear power use, there have been three prominent accidents (Chernobyl, Three Mile Island, Fukushima). Design/equipment failures, human error, and natural disasters remain primary safety concerns [19].
- Nuclear is one of the safest sources of energy. The death rate from accidents and air pollution for nuclear energy is comparable to that of wind and solar and is 93 times lower than natural gas, 613 times lower than oil, and 820 times lower than coal. [20].

What is the current regulatory landscape for nuclear energy/what now?

- A mixture of firm low carbon energy sources could enable Illinois to effectively carry out its clean energy transition.
 - Because nuclear projects occur on a timeline representing decades of planning, a decision on the future of nuclear energy in Illinois is urgent.
 - Current nuclear regulatory law can be modernized to account for newer reactors and technologies.
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