THE NUCLEAR OPTION: WHY NUCLEAR ENERGY SHOULD BE USED TO SAVE OUR FARMLAND

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ABSTRACT

The Earth is not gaining more land, but it is gaining more people. With growing populations comes the need for more houses, more food, and more power. The need for more power and more food conflicts with one another as carbon-free sources require valuable land that could be used to farm. This Note analyzes the potential for nuclear energy to save the remaining farmland and maximize the power output for a growing nation. First, it explains the history of nuclear energy, from its founding to its use in Iowa. Then, it analyzes the regulations that surround nuclear energy. Next, it details the efficiency of nuclear energy when compared to other energy sources. Then, it discusses the safety of nuclear energy and the misconceptions that surround this energy source. Finally, this Note highlights future uses of nuclear energy that can preserve farmland valuably needed to continue feeding a growing world.

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I. INTRODUCTION

The United States is a country comprised of 3,532,316 square miles of land[1] and 341,186,198 people, as of January 2025.[2] The United States uses large amounts of electricity every year running homes, businesses, cars, daily life objects, and likely the very device you are reading this Note on. To power all of these objects and continue running the country, the United States uses a variety of both "dirty" and "clean" fuel sources. Dirty fuel sources include carbon dioxide (CO2) emitting sources such as oil, natural gas, and coal.[3] Clean fuel sources are those that do not emit large amounts of CO2, including wind energy, hydropower, solar power, and the black sheep of the family, nuclear energy.[4] The term nuclear energy creates worry in the hearts of Americans as they have seen the nuclear energy disasters in places such as Chernobyl, Fukushima, and an accident that occurred in our very own backyard, Three Mile Island.[5]

In 2020, only 43% of United States adults supported the idea of nuclear power as a way to generate more electricity.[6] By 2023, the number rose 14% to a total of 57% of United States adults supporting nuclear power plants to generate more electricity.[7] With a growing shift of opinion in favor of nuclear energy, it may be time for the United States to capitalize on the wave.[8] We should do so not only for the health of our planet and our country, but also for the individual farmers

1. *United States*, U.S. CENSUS BUREAU (Feb. 13, 2025, 8:18 PM), https://data.census.gov/profile/United_States?g=010XX00US [https://perma.cc/SBE2-KFQ3].

2. *See U.S. and World Population Clock*, U.S. CENSUS BUREAU (Jan. 12, 2025, 10:42 AM), https://www.census.gov/popclock/ [https://perma.cc/5YSV-HAR7].

3. *See* Doug Moss, *Earth Talk: What Are Dirty Fuels?*, BLUE RIDGE OUTDOORS (Feb. 25, 2014), https://www.blueridgeoutdoors.com/go-outside/earth-talk-dirty-fuels/ [https://perma.cc/WHN6-D6BC].

4. *Clean Energy*, U.S. DEP'T OF ENERGY (Jan. 22, 2025, 1:39 PM), https://www.energy.gov/clean-energy [https://perma.cc/WEZ2-TCN4]; *Nuclear*, U.S. DEP'T OF ENERGY (Feb. 13, 2025, 8:32 PM), https://www.energy.gov/nuclear [https://perma.cc/2X8N-HVEZ].

5. *See* Michael Shellenberger, *It Sounds Crazy, but Fukushima, Chernobyl, and Three Mile Island Show Why Nuclear Is Inherently Safe*, FORBES (May 6, 2019, 8:41 PM), https://www.forbes.com/sites/michaelshellenberger/2019/03/11/it-sounds-crazy-but-fukushima-chernobyl-and-three-mile-island-show-why-nuclear-is-inherently-safe/?sh=fbd247116881.

6. Rebecca Leppert & Brian Kennedy, *Majority of Americans Support More Nuclear Power in the Country*, PEW RSCH. CTR. (Aug. 5, 2024), https://www.pewresearch.org/short-reads/2024/08/05/majority-of-americans-support-more-nuclear-power-in-the-country/ [https://perma.cc/9XVT-8FNF].

7. *Id.*

8. *See id.*

and the farmland they depend on to produce food and other resources. Society can always build more houses and buildings, but we cannot build more land.

With suburban sprawl on the fast track, the United States has lost over 11 million acres of farmland over the last two decades.[9] Due to a growing population and further advancement of cities, that number will continue to increase in the coming years. The United States should invest in an energy source that will adequately produce the power needed to run the country, while minimizing land use to ensure space remains for farming and other necessary purposes. This Note begins by delving into the history of nuclear energy. It then discusses the efficiency of nuclear compared to other energy sources and concludes with recommendations of how Iowa can harness this power for the future success of its people.

II. THE HISTORY OF NUCLEAR ENERGY

A. General Background

How exactly does a nuclear reaction occur and how does a nuclear reactor use that energy to create electricity? A nuclear reaction occurs when a common fuel source such as uranium-235, an isotope of uranium, is inserted into the reactor in fuel rods.[10] The uranium is packaged in small pellets and stacked on one another in the rods.[11] Around 200 rods are bundled together to create the fuel assembly.[12] Inside the fuel rods the subatomic particles called neutrons, which have no electric charge, collide with atoms, forcing them to split apart.[13] When atoms split apart it is called fission.[14] Alternatively, fusion occurs when atoms clump together and get bigger and bigger.[15] When the neutrons make contact with the atoms they split apart more and more, creating a nuclear chain reaction.[16] The nuclear chain

9. Adam Wernick, *US Lost 11 Million Acres of Farmland to Development in Past 2 Decades*, THE WORLD (July 31, 2020), https://theworld.org/stories/2020/07/31/farmland-losing-development [https://perma.cc/WMZ8-RUCF].

10. Christina Nunez, *What Is Nuclear Energy and Is It a Viable Resource?*, NAT'L GEOGRAPHIC (Mar. 26, 2019), https://www.nationalgeographic.com/environment/article/nuclear-energy [https://perma.cc/D6AW-PLW3]; OFF. OF NUCLEAR ENERGY, U.S. DEP'T OF ENERGY, THE ULTIMATE FAST FACTS GUIDE TO NUCLEAR ENERGY 4 (2019) [hereinafter ULTIMATE FAST FACTS GUIDE], https://www.energy.gov/sites/prod/files/2019/01/f58/Ultimate%20Fast%20Facts%20Guide-PRINT.pdf [https://perma.cc/7SKV-96ES].

11. ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 4.

12. *Id.*

13. Nunez, *supra* note 10.

14. *Id.*

15. *Id.*

16. *Id.*

reaction can only occur if there is enough uranium for it to produce a self-sustaining reaction, known as the critical mass.[17] Below is a diagram of how a nuclear reactor operates.

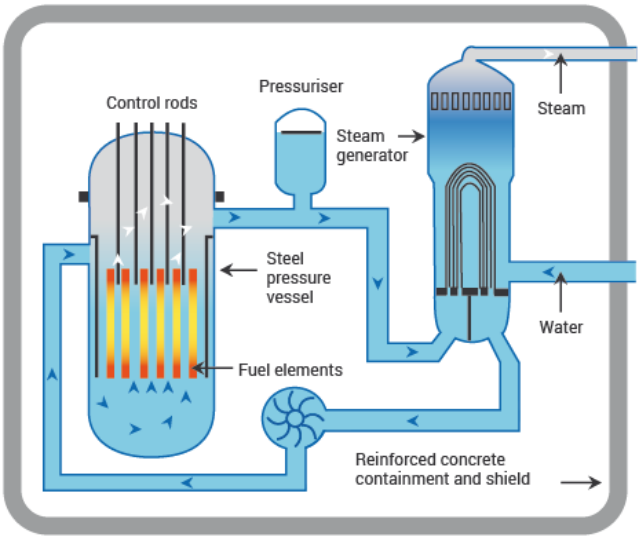

Figure 1 – Source: World Nuclear Association[18]

Inside of the reactor there is water that surrounds the fuel rods and acts as a coolant and moderator.[19] The water works to slow down the fission in the reactor and keep it from getting out of control.[20] When the control rods are inserted it reduces the reaction and when they are removed it increases the reaction.[21] The heat from the fission turns the water into steam, which rotates a turbine and ultimately produces electricity that is sent out to the public.[22]

17. *Outline History of Nuclear Energy*, WORLD NUCLEAR ASS'N (Aug. 29, 2024), https://world-nuclear.org/information-library/current-and-future-generation/outline-history-of-nuclear-energy.aspx [https://perma.cc/2G8V-ZKXN].

18. *A Pressurized Water Reactor (PWR)* (illustration), *in Nuclear Power Reactors*, WORLD NUCLEAR ASS'N (Jan. 6, 2025), https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/nuclear-power-reactors.aspx [https://perma.cc/3DQ7-3L7N].

19. ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 4.

20. *Id.*

21. *Id.*

22. *Id.*

The only type of nuclear reactor operating commercially in America is the light-water reactor.[23] There are two types of light-water reactors: the boiling water reactor and the pressurized-water nuclear reactor.[24] The boiling water reactor makes up around 33% of reactors in the United States.[25] The reactor heats up water and produces steam.[26] The water is then pumped "through the reactor core and heated by fission."[27] The pipes push the steam straight to the turbine to create electricity and the unused steam gets condensed back into the water supply for the process to begin again.[28] Below is a diagram of how the boiling water reactor produces electricity.

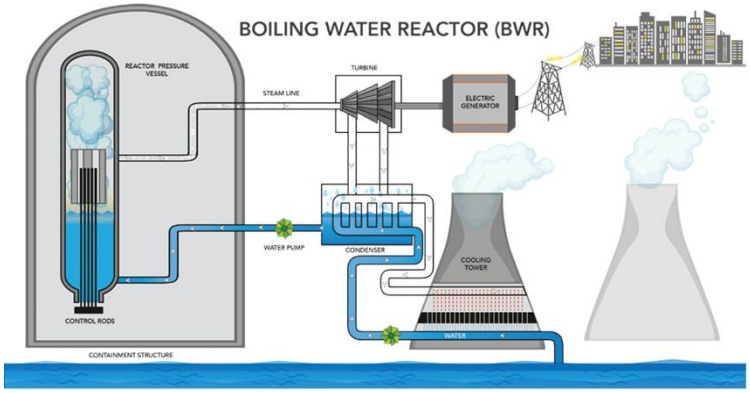

Figure 2 – Source: Office of Nuclear Energy[29]

The pressurized water nuclear reactor makes up around 65% of the commercial reactors in the United States.[30] Pressurized water reactors are different from boiling water reactors because the steam is not in the reactor itself.[31] Pressure reactors use pressure to force the water through the reactor where the fission reaction heats the water.[32] The heated water is pushed into another water source

23. *Id.*
24. *Id.* at 4–5.
25. *Id.* at 5.
26. *Id.*
27. *Id.*
28. *Id.*
29. *Boiling Water Reactor (BWR)* (illustration), *in* ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 5.
30. ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 4.
31. *Id.*
32. *Id.*

that creates the steam to power the turbine.[33] Below is a diagram of the pressure reactor.

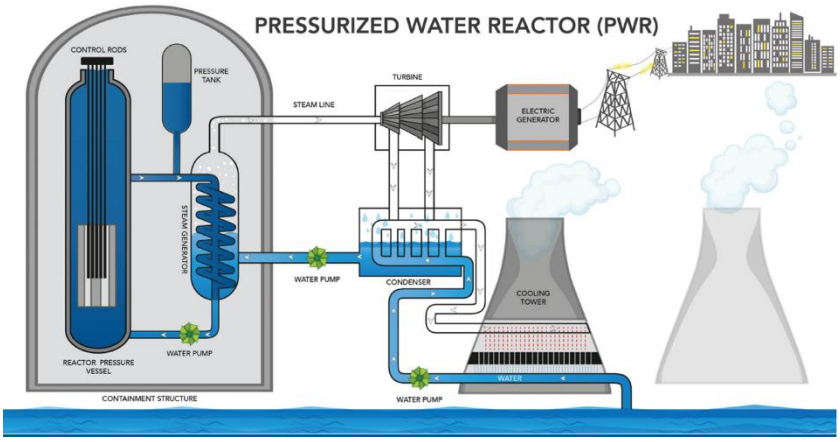

Figure 3 – Source: Office of Nuclear Energy[34]

The concept of nuclear power originated in the 1930s with physicist Enrico Fermi in Rome, Italy.[35] He experimented by bombarding uranium with neutrons, which resulted in a reaction he did not expect.[36] As the uranium was bombarded, instead of getting heavier, it got lighter.[37] He continued his experiments with uranium, and after the bombardments lighter elements such as barium were produced, meaning that fission had occurred from the experiment.[38] On a squash court under the University of Chicago's stadium, Fermi built the world's first nuclear reactor on December 2, 1942.[39] It successfully maintained the world's first self-sustaining nuclear reaction.[40]

With the positive uses of nuclear reaction came the negative. During World War II, nations were looking to harness the power of nuclear energy for

33. *Id.* at 5.

34. *Pressurized Water Reactor (PWR)* (illustration), *in* ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 4.

35. OFF. OF NUCLEAR ENERGY, SCI., & TECH., U.S. DEP'T OF ENERGY, THE HISTORY OF NUCLEAR ENERGY 4 (2025), https://www.energy.gov/ne/articles/history-nuclear-energy [https://perma.cc/7LBU-BNWQ].

36. *Id.*

37. *Id.*

38. *Id.* at 5; *Outline History of Nuclear Energy*, *supra* note 17.

39. THE HISTORY OF NUCLEAR ENERGY, *supra* note 35, at 7.

40. *Id.*

weaponry.[41] In June of 1942, the United States Army took over development, design, procurement of materials, and site selection from independent scientists such as Fermi.[42] In Los Alamos, New Mexico, the Manhattan Project was born, led by Robert Oppenheimer, the father of the nuclear bomb.[43] On July 16, 1945, the first atomic bomb was successfully tested in Alamogordo, New Mexico.[44] The next two atomic bombs would be dropped on Japan in August of 1945, bringing a swift end to World War II.[45] The world would continue using nuclear as weapons, but a light was on the horizon to use this power for good.[46]

B. Nuclear Power in Iowa

Long before the state of Iowa had its first nuclear reactor, it was involved with the nuclear industry. The discovery of nuclear fission in 1939 influenced the United States government to create a national consolidated effort to expand research into nuclear energy for the Manhattan Project.[47] This led Iowa State College (now Iowa State University) chemistry Professor Frank H. Spedding to create the Ames Project in 1942, designed to assist the Manhattan Project.[48] To create a nuclear reaction, scientists need pure uranium metal, which was not commercially in abundance.[49] The head of the Ames Project, chemist Harley A. Wilhelm, developed a system to produce pure uranium and safely produced large ingots of uranium, reducing costs twenty-fold.[50] The Ames Project was able to produce one-third of the uranium metal used in the first self-sustaining chain reaction at the University of Chicago in 1942.[51] Once the reaction was proven successful, the demand for uranium increased, and the Ames Project responded by producing over two million pounds of uranium for the Manhattan Project.[52] Their advancements in producing uranium metals were vital to the war efforts and earned them the honor of the Army/Navy E Flag for Excellence in Production in October

41. *Outline History of Nuclear Energy*, *supra* note 17.
42. *Id.*
43. *Id.*
44. *Id.*
45. *Id.*
46. *Id.*
47. *Manhattan Project Roots*, AMES NAT'L LAB'Y (Jan. 12, 2025, 11:07 AM), https://www.ameslab.gov/about-ames-laboratory/manhattan-project-roots [https://perma.cc/3T6V-ZL3R].
48. *Id.*
49. *Id.*
50. *Id.*
51. *Id.*
52. *Id.*

of 1945.[53] This was a unique honor for Iowa State University, as most recipients of this honor were industry players, not educational institutions.[54] Subsequently in 1947, the Atomic Energy Commission (AEC) established the Ames Laboratory at Iowa State University.[55]

Iowa's only nuclear power plant was the Duane Arnold Energy Center (DAEC).[56] The namesake of the nuclear power plant was former CEO and chairman of the Iowa Electric Light and Power Company, Duane Arnold.[57] In the 1960's the Iowa Electric and Power Company, Central Iowa Power Cooperative, and Corn Belt Power Cooperative applied for a nuclear plant license together.[58] The plant was scheduled to be built in Palo, Iowa, nine miles northwest of Cedar Rapids.[59] Construction took place on a 500-acre site on the western bank of the Cedar River.[60] The construction permit was granted in June of 1970, and by February of 1974, the power plant was granted its full power operating license.[61] Commercial operations began in February of 1975, with the power plant supplying the Cedar Rapids area and greater northeast Iowa with energy created by nuclear power.[62] The DAEC sat on a 500-acre plot of land, but the power plant did not actually take up the entire plot.[63] Instead, while most individuals may think the area surrounding the plant was a "no man's land," it was actually bordered by cornfields.[64]

53. *Id.*

54. *Id.*

55. *Id.*

56. Lee Hermiston, *Duane Arnold Nuclear Plant's New Beginning as a Solar Farm*, THE GAZETTE (Sept. 14, 2021), https://www.thegazette.com/iowa-ideas/duane-arnold-nuclear-plants-new-beginning-as-a-solar-farm/ [https://perma.cc/54VF-9NG4].

57. *Id.*

58. *Id.*

59. *Id.*

60. *Iowa Nuclear Profile 2010*, U.S. ENERGY INFO. ADMIN. (Apr. 26, 2012), https://www.eia.gov/nuclear/state/archive/2010/iowa/ [https://perma.cc/FYH4-B3FM].

61. Hermiston, *supra* note 56.

62. *Id.*

63. Samantha Kollasch, *Duane Arnold Energy Center Shuts Down for Fueling*, CORRIDOR BUS. J. (Oct. 29, 2012), https://corridorbusiness.com/duane-arnold-energy-center-shuts-down-for-fueling/ [https://perma.cc/K9KY-54MM].

64. *Id.*; NEXTERA ENERGY RES., DUANE ARNOLD ENERGY CENTER (2025), https://www.nexteraenergyresources.com/content/dam/neer/us/en/pdf/duanearnoldfactsheet.pdf [https://perma.cc/A6LS-8VER].

The DAEC operated a General Electric Type 4 boiling water reactor with a Mark I containment.[65] This containment has found itself under scrutiny as it is the same type of containment that was used at the Fukushima Daiichi Nuclear Plant.[66] The Mark I does not offer the same protections from a nuclear meltdown and radiation release as new containment vessels made from steel and concrete.[67] On site, the reactor ran using two cooling towers of 12 cells each that funneled water from the Cedar River to the reactor.[68] The Cedar River played an important role in running the reactor, which is part of the reason the location in Palo was selected.[69] The DAEC used 6,000 gallons of water a minute to cool the steam after it was used to power the turbines to generate electricity.[70] The plant itself generated 615 megawatts of electricity, which is enough to power 600,000 homes.[71] DAEC employed around 500 employees during normal operations and stimulated $255 million in economic activity in Iowa, all while paying around $3 million in property taxes.[72] Unfortunately, even with all of the power and economic benefits the plant brought, the owners announced that Duane Arnold would cease its operations in 2020, 14 years before its license was set to expire on February 21, 2034.[73] The plant was originally scheduled to decommission on October 30, 2020, but due to high winds that struck in August, the plant permanently shut down on August 10, 2020, after extensive damage to the cooling towers.[74] The plant's owners, NextEra Energy Resources (NextEra), stated that by 2023 it "plans to

65. *Duane Arnold Energy Center*, U.S. NUCLEAR REGUL. COMM'N (Oct. 29, 2024), https://www.nrc.gov/info-finder/reactors/duan.html [https://perma.cc/KZ9S-C4P4].

66. Tom Zeller Jr., *Experts Had Long Criticized Potential Weakness in Design of Stricken Reactor*, N.Y. TIMES (Mar. 15, 2011), https://www.nytimes.com/2011/03/16/world/asia/16contain.html.

67. *Id.*

68. NEXTERA ENERGY RES., *supra* note 64.

69. Dave DeWitte, *Palo Nuclear Plant Operator Eyeing Cedar River Levels Cautiously*, THE GAZETTE (Aug. 9, 2012, 8:04 AM), https://www.thegazette.com/business/palo-nuclear-plant-operator-eyeing-cedar-river-levels-cautiously/ [https://perma.cc/ZDZ8-2FWS].

70. *Id.*

71. Hermiston, *supra* note 56.

72. NEXTERA ENERGY RES., *supra* note 64.

73. Aaron Larson, *Duane Arnold Nuclear Plant Will Close in 2020*, POWER MAG. (July 29, 2018), https://www.powermag.com/duane-arnold-nuclear-plant-will-close-in-2020/ [https://perma.cc/CS5S-V6KW].

74. Hermiston, *supra* note 56; Aaron Larson, *Derecho Damage Results in Early Retirement of Duane Arnold Nuclear Power Plant*, POWER MAG. (Aug. 26, 2020), https://www.powermag.com/derecho-damage-results-in-early-retirement-of-duane-arnold-nuclear-power-plant/ [https://perma.cc/T79W-3594].

move all spent nuclear fuel to dry cask storage."[75] Full decommissioning activities of Duane Arnold are set to begin in 2075.[76]

The namesake Duane Arnold was quoted after the Three Mile Island accident in 1979 stating, "In my opinion, nuclear power is the most beneficial method of anything we could possibly do to provide energy to our customers in the future."[77] While many may agree with his comment, NextEra says that the new deal to close Duane Arnold will save each customer in Iowa $42 annually in energy costs starting in 2021.[78] However, after making that statement, NextEra requested the Iowa Utilities Board (now the Iowa Utilities Commission) keep its savings calculations confidential.[79] In reality, closing Duane Arnold could raise electric prices for Iowans and add the CO2 equivalent of between 700,000 and 1,000,000 cars on the road as coal or natural gas pick up the slack where nuclear left off.[80]

NextEra now plans to build a 3,500-acre solar farm where the decommissioned power plant sits.[81] The solar farm was originally expected to generate 690 megawatts of electricity by the end of 2023, which is only 90 more megawatts than Duane Arnold produced on seven times more acres than the nuclear plant.[82] Efforts to complete the project were still ongoing into late 2024.[83]

75. *Duane Arnold*, THE NUCLEAR DECOMMISSIONING COLLABORATIVE (Jan. 12, 2025, 11:10 AM), https://decommissioningcollaborative.org/duane-arnold/ [https://perma.cc/VHV6-5NG7].

76. *Id.*

77. *So Who Was Duane Arnold?*, DES MOINES LOC. HIST. (Mar. 29, 2011), https://dmlocalhistory.wordpress.com/2011/03/29/so-who-was-duane-arnold/ [https://perma.cc/Q4HN-QN58].

78. Michael Shellenberger, *Nuclear Plant Closures Show Why, When It Comes to Energy, Small Is Expensive*, FORBES (Aug. 1, 2018, 12:27 PM), https://www.forbes.com/sites/michaelshellenberger/2018/08/01/nuclear-plant-closures-show-why-when-it-comes-to-energy-small-is-expensive/?sh=2d67a57271a2.

79. *Id.*

80. *Id.*

81. Trevor Oates, *NextEra Energy Looking to Turn Decommissioned Duane Arnold Nuclear Plant into Solar Farm*, KWWL NEWS (Mar. 18, 2021), https://www.kwwl.com/news/cedar-rapids/nextera-energy-looking-to-turn-decommissioned-duane-arnold-nuclear-plant-into-solar-farm/article_d15cb161-fd37-565f-8615-ba538d6bfb9d.html [https://perma.cc/TP83-3NLE].

82. *Id.*; *Duane Arnold*, *supra* note 75.

83. Richard Pratt, *NextEra Energy Outlines Plans for Duane Arnold Solar IV Project in Linn County*, CORRIDOR BUS. J. (July 25, 2024), https://corridorbusiness.com/nextera-energy-outlines-plans-for-duane-arnold-solar-iv-project-in-linn-county/ [https://perma.cc/BR8W-WEEA].

It is disappointing to see Iowa prematurely decommission this power plant that could have been used for years to come.

C. Nuclear Power in Illinois

Iowa's neighbors to the east, on the other hand, may have it figured out. Illinois leads the way in nuclear energy within the United States as it has six power plants operating 11 total reactors.[84] These reactors include a mixture of both boiling water reactors and pressurized water reactors.[85] The Land of Lincoln currently accounts for one-eighth of the nation's nuclear power.[86] Further, nuclear power currently makes up 54.4% of all electricity generated in Illinois.[87] This nuclear energy helps support the nation's third largest city, Chicago, the nation's fifth busiest airport, and the second-largest rail network.[88] Illinois's nuclear power plants provide energy to 11.3 million homes while employing 4,100 of its states citizens.[89] With a combination of nuclear and wind power, Illinois is currently producing 79.2% of its total electricity carbon-free, avoiding 66.6 million tons of carbon emissions.[90]

Illinois, unlike Iowa, realized the importance of its nuclear power plants and in 2016 approved financial incentives to keep several of the plants active that were close to retirement.[91] In 2021, two more facilities were set to be retired until Illinois passed a new state law requiring 50% clean energy by 2040, 100% by 2050, and giving those two facilities a $700 million bailout to keep them active.[92] With the use of nuclear energy, Illinois was able to cut its electricity produced by coal from

84. *Most U.S. Nuclear Power Plants Were Built Between 1970 and 1990*, U.S. ENERGY INFO. ADMIN. (Apr. 27, 2017), https://www.eia.gov/todayinenergy/detail.php?id=30972 [https://perma.cc/5639-GR7A].

85. ILL. EMERGENCY MGMT. AGENCY, NUCLEAR GENERATING FACILITIES IN ILLINOIS (2015), https://iemaohs.illinois.gov/content/dam/soi/en/web/iemaohs/nrs/documents/bnfs-powerplantbrochure.pdf [https://perma.cc/YJS4-SHJ2].

86. *Illinois: Profile Analysis*, U.S. ENERGY INFO. ADMIN. (Sept. 19, 2024), https://www.eia.gov/state/analysis.php?sid=IL [https://perma.cc/JXY6-94JE].

87. *Illinois*, NUCLEAR MATTERS (Feb. 14, 2025, 10:46 AM), https://www.nuclearmatters.com/your_state?state=IL [https://perma.cc/XK2S-B6KL].

88. *Illinois: Profile Analysis*, *supra* note 86.

89. NUCLEAR ENERGY INST., ILLINOIS NUCLEAR ENERGY FACT SHEET 2024 (2024), https://www.nei.org/CorporateSite/media/filefolder/resources/fact-sheets/state-fact-sheets/Illinois-State-Fact-Sheet.pdf [https://perma.cc/A24F-6F9F].

90. *Id.*

91. *Illinois: Profile Analysis*, *supra* note 86.

92. *Id.*; John O'Connor, *Illinois Senate Approves Plan to Allow New Nuclear Reactors*, AP NEWS (Nov. 8, 2023, 4:43 PM), https://apnews.com/article/illinois-nuclear-small-modular-reactors-moratorium-a56a90a09185e864cdd7f5d6d24b9d48 [https://perma.cc/2PCZ-XHUU].

46% in 2009 to 15% in 2023.[93] Illinois is planning for its future as well. In 2023, the Senate passed legislation allowing the development of new small modular reactors in their borders.[94]

Illinois, like Iowa, is an agricultural state, generating $51.1 billion annually from the industry.[95] Illinois is made up of 27 million acres of farmland, which is around 75% of the states total land area.[96] Iowa is made up of 30.5 million acres of farmland.[97] However, since 1950, Illinois has lost 3.6 million acres of farmland, averaging 77,000 acres each year.[98] Iowa has lost 587,713 acres of farmland in the five-year period from 2017 to 2022, averaging around 118,000 acres a year.[99] This land loss illustrates the need for nuclear energy within Iowa's rural communities. With Iowa already losing hundreds of thousands of acres of farmland, it is important for the state to be efficient with the land it has. Giving up hundreds more acres for wind and solar farms is eliminating precious land for farming. Iowa instead should focus its efforts on nuclear energy, which produces more energy with less land.

III. HISTORY OF NUCLEAR REGULATION

Following World War II, the American people were in disbelief that the government had created such a devastating weapon without their knowledge.[100] In 1946, the United States Congress created the AEC to "manage the development,

93. *Illinois: Profile Analysis*, *supra* note 86.

94. O'Connor, *supra* note 92.

95. *Facts About Illinois Agriculture*, ILL. DEP'T OF AGRIC. (Jan. 12, 2025, 11:36 AM), https://agr.illinois.gov/about/facts-about-illinois-agriculture.html [https://perma.cc/4W9Y-H9HU].

96. *Id.*

97. NAT'L AGRIC. STAT. SERV., U.S. DEP'T OF AGRIC., IOWA AG NEWS—FARMS AND LAND IN FARMS (2023), https://www.nass.usda.gov/Statistics_by_State/Iowa/Publications/Other_Surveys/2023/IA-Farms-02-23.pdf [https://perma.cc/3B4G-FFFY].

98. *Farmland Protection*, ILL. DEP'T OF AGRIC. (Jan. 12, 2025, 11:38 AM), https://agr.illinois.gov/resources/farmlandprotection.html [https://perma.cc/7B5S-Z3DM].

99. Teodora Mitov, *Iowa Lost Over Half a Million Acres of Farmland from 2017 to 2022*, SIOUXLAND PROUD (Mar. 1, 2024, 10:46 PM), https://www.siouxlandproud.com/news/iowa-news/iowa-lost-over-half-a-million-acres-of-farmland-from-2017-to-2022 [https://perma.cc/MP9J-ERGB].

100. *A Brief History of the Department of Energy*, U.S. DEP'T OF ENERGY (Jan. 12, 2025, 11:40 AM), https://www.energy.gov/lm/brief-history-department-energy [https://perma.cc/2WUM-527N].

use, and control of [nuclear] energy for military and civilian applications."[101] The AEC during the early years of the Cold War mainly focused on producing nuclear weapons and developing reactors to drive naval ships.[102] In 1954, Congress passed the Atomic Energy Act, which ended the government's exclusive hold over nuclear energy, and a new industry of commercial nuclear power was born.[103] It allowed the AEC to regulate the use of nuclear materials in the commercial realm by enforcing rules and providing licensing to those who wanted to use nuclear energy.[104] Congress hoped that the Act would enhance "the development, use, and control of atomic energy . . . to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise."[105]

However, in the 1960s, there became a growing discontent with the AEC's authority to properly regulate the nuclear world due to its insufficient regulations in "radiation protection standards, reactor safety, plant siting, and environmental protection."[106] In response, Congress passed the Energy Reorganization Act of 1974 creating the Nuclear Regulatory Commission (NRC), which is the governing body of nuclear energy in the United States today.[107] The 1974 Act split the AEC into two agencies: the NRC and the Energy Research and Development Administration, the latter of which came under the Department of Energy (DOE) in 1977.[108] Because the AEC struggled to regulate commercial and military nuclear applications, the NRC now controls commercial activities, and the DOE controls military functions, among other things.[109]

101. *Atomic Energy Commission*, U.S. NUCLEAR REGUL. COMM'N (Mar. 9, 2021), https://www.nrc.gov/reading-rm/basic-ref/glossary/atomic-energy-commission.html [https://perma.cc/ZEP7-B692].

102. *A Brief History of the Department of Energy*, *supra* note 100.

103. *Id.*; *see History*, U.S. NUCLEAR REGUL. COMM'N (Sept. 10, 2021), https://www.nrc.gov/about-nrc/history.html [https://perma.cc/7DKY-QN3T].

104. *Governing Legislation*, U.S. NUCLEAR REGUL. COMM'N (Oct. 18, 2024), https://www.nrc.gov/about-nrc/governing-laws.html#atomic [https://perma.cc/NC5W-WWTS].

105. *Id.*

106. *History*, *supra* note 103.

107. *Id.*

108. *A Brief History of the Department of Energy*, *supra* note 100.

109. *Id.*; *Governing Legislation*, *supra* note 104.

IV. WHY NUCLEAR ENERGY IS MORE EFFICIENT

The United Nations projects the world population to reach 9.8 billion people by 2050 and 11.2 billion people by 2100.[110] The United States is on pace to grow by nearly 79 million people, reaching a population of around 404 million people by 2060.[111] This increase in the world's population means that our land will have to produce more food, housing, businesses, cities, and electricity. Unfortunately, we cannot produce more land. The Earth contains 57,308,738 square miles of land surface, 33% of which is desert and 24% of which is mountains.[112] This means 43% of the world is inhabitable.[113] In order to continue thriving, our leaders must prioritize efficient energy sources capable of producing the highest output of electricity while taking up the least amount of valuable space needed for other aspects of life, such as agriculture. America's agriculture sector is already shrinking, as the *Farms and Land in Farms 2022 Summary* reported that total land in farms decreased 1.9 million acres from 2021.[114]

Though nuclear energy has only supplied one-fifth of America's power since 1990, if given the chance it could be the number one producer.[115] In 2017, the United States was the world's largest producer of nuclear power, producing 805 billion kilowatt hours of electricity capable of powering 73 million homes.[116] Nuclear energy accounted for 56% of America's carbon-free electricity, with the other 44% being made up of solar, wind, hydropower, and geothermal.[117] Nuclear power's one-inch tall uranium pellet produces as much energy as one ton of coal,

110. *World Population Projected to Reach 9.8 Billion in 2050, and 11.2 Billion in 2100*, DEP'T OF ECON. & SOC. AFFS., UNITED NATIONS (Jan. 12, 2025, 11:44 AM), https://www.un.org/en/desa/world-population-projected-reach-98-billion-2050-and-112-billion-2100 [https://perma.cc/Y89U-3FJ7].

111. JONATHAN VESPA ET AL., U.S. CENSUS BUREAU, U.S. DEP'T OF COM., DEMOGRAPHIC TURNING POINTS FOR THE UNITED STATES: POPULATION PROJECTIONS FOR 2020 TO 2060, at 1 (2020), https://www.census.gov/content/dam/Census/library/publications/2020/demo/p25-1144.pdf [https://perma.cc/EG8T-5XCC].

112. Eric R. Pianka, *Land*, UNIV. OF TEX. (Sept. 12, 2014), http://www.zo.utexas.edu/courses/thoc/Land-OOOS.html [https://perma.cc/3E4F-6WPC].

113. *Id.*

114. NAT'L AGRIC. STAT. SERV., U.S. DEP'T OF AGRIC., FARMS AND LAND IN FARMS 2022 SUMMARY 4 (2023), https://downloads.usda.library.cornell.edu/usda-esmis/files/5712m6524/bk129p580/2z10z2698/fnlo0223.pdf [https://perma.cc/3L2U-N5VW].

115. *Nuclear Power Is the Most Reliable Energy Source and It's Not Even Close*, U.S. DEP'T OF ENERGY (Mar. 24, 2021), https://www.energy.gov/ne/articles/nuclear-power-most-reliable-energy-source-and-its-not-even-close [https://perma.cc/PPM7-769Y].

116. ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 2.

117. *Id.*

120 gallons of oil, or 17,000 cubic feet of natural gas.[118] It takes less than 10 pellets to power a typical household for an entire year.[119] The United States generates around 2,000 metric tons of spent nuclear fuel a year, but the fuel retains more than 90% of its potential energy, which may be recycled.[120] While 2,000 metric tons of spent fuel sounds like a lot, all of the fuel used "over the last 60 years could fit on a football field at a depth of less than 10 yards."[121]

On top of the amount of fuel needed, nuclear has the highest capacity factor of any other energy source at 92.5%.[122] A capacity factor is the percentage of time throughout the year that a plant is operating at maximum capacity.[123] Nuclear power plants can run 24 hours a day, seven days a week due to their fuel lasting one-and-a-half to two years and the plant requiring less maintenance than other sources.[124] Other power plants need more routine maintenance and/or refueling to stay operational.[125] Nuclear power is nearly two and a half times more reliable than coal (40.2%) and hydropower (41.5%).[126] It is nearly twice as reliable as natural gas (56.6%).[127] And it is three to four times more reliable than wind (35.4%) and solar (24.9%) because if the wind is not blowing and the sun is not shining, neither of those sources are worth anything.[128] There would need to be two coal plants or three renewable plants to produce the same one gigawatt of electricity a nuclear reactor creates.[129] In terms of efficiency, nuclear power plants create the most reliable energy with the least amount of fuel needed.

118. Niccolo Conte, *The Power of a Uranium Pellet*, ELEMENTS (Aug. 27, 2021), https://elements.visualcapitalist.com/the-power-of-a-uranium-pellet/ [https://perma.cc/29WH-PHCZ].

119. *Id.*

120. *Id.*

121. ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 3.

122. *Nuclear Power Is the Most Reliable Energy Source and It's Not Even Close*, *supra* note 115.

123. ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 7; Cutler Cleveland, *What Are Capacity Factors and Why Are They Important?*, BOSTON UNIV. (May 13, 2024), https://visualizingenergy.org/what-are-capacity-factors-and-why-are-they-important/ [https://perma.cc/XE73-BLHQ].

124. *Nuclear Power Is the Most Reliable Energy Source and It's Not Even Close*, *supra* note 115; ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 2.

125. *Nuclear Power Is the Most Reliable Energy Source and It's Not Even Close*, *supra* note 115.

126. *Id.*

127. *Id.*

128. *See id.*

129. *Id.*

A. Land Use

On top of being the most reliable clean energy source, nuclear also takes up the least amount of space to operate.[130] The United States is losing farmland at an "alarming rate."[131] Between 2000 and 2022, farmland in the United States declined from 954,080,000 acres to 893,400,000 acres.[132] This loss is equivalent to the state of New Jersey.[133] The United States currently uses 81 million acres to produce electricity, which is roughly the size of Iowa and Missouri.[134] A 200 megawatt wind farm could spread over 13 square miles, while a natural gas power plant with the same output could fit into a city block.[135] For our nation to be carbon free by 2050, the wind and solar farms would have to cover Arkansas, Iowa, Kansas, Missouri, Nebraska, and Oklahoma to generate enough power to sustain the United States.[136] This is just not a practical solution to the clean energy argument. A wind farm would need to cover an area of 140,000 acres, which is 170 times more land than a nuclear reactor needs, to produce 1,000 megawatts of electricity.[137] In fact, a 1,000 megawatt nuclear plant needs around one square mile to successfully operate.[138] To preserve our depleting farmland, it is important we make a switch to sustainable energy that is both green and efficient.

B. Safety of Energy Sources

When people hear the term nuclear power, they may think of bombs, or they may think of one of the three nuclear disasters that has occurred in nuclear's 70-year history. The accidents occurred on three different continents in three different

130. ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 6.

131. Zongyuan Zoe Liu, *Going Green Pits Renewables Against Farmland. Nuclear Energy Can Help*, COUNCIL ON FOREIGN RELS. (Mar. 23, 2023, 3:55 PM), https://www.cfr.org/blog/going-green-pits-renewables-against-farmland-nuclear-energy-can-help [https://perma.cc/4SNY-JVVH].

132. *Id.*

133. *Id.*

134. *Id.*

135. Dave Merrill, *The U.S. Will Need a Lot of Land for a Zero-Carbon Economy*, BLOOMBERG (June 3, 2021), https://www.bloomberg.com/graphics/2021-energy-land-use-economy/?sref=51J26SiN#xj4y7vzkg.

136. Emma Derr, *Nuclear Needs Small Amounts of Land to Deliver Big Amounts of Electricity*, NUCLEAR ENERGY INST. (Apr. 29, 2022), https://www.nei.org/news/2022/nuclear-brings-more-electricity-with-less-land [https://perma.cc/3PK7-TEBB].

137. *Id.*

138. ULTIMATE FAST FACTS GUIDE, *supra* note 10, at 3.

decades, and led to wide distrust in nuclear energy ever since.[139] The three accidents include the 1979 Three Mile Island accident in the United States, the 1986 Chernobyl disaster in the Ukraine Republic of the Soviet Union, and the 2011 Fukushima accident in Japan.[140] Although these three accidents were disastrous, nuclear still remains one of the safest forms of energy this planet has to offer.[141]

The Three Mile Island accident occurred on March 28, 1979 in Pennsylvania due to a malfunctioning relief valve that was stuck open which prevented the removal of heat from the reactor's core.[142] The instruments incorrectly relayed to the operators that the valve was closed and the operators proceeded with their jobs.[143] Unaware that the core was overheating and losing coolant, the operators took inadequate action that caused the core to suffer a partial meltdown.[144] There were no deaths, injuries, or direct health effects caused by this accident, but about two million people in the surrounding area experienced about one millirem of extra radiation exposure.[145] The average chest x-ray is about six millirem.[146]

The Chernobyl accident was the most serious of the three and occurred April 26, 1986.[147] The Chernobyl disaster occurred due to operator error, design flaws, and the Soviet Union.[148] The operator error that resulted in the Chernobyl disaster was because a safety test, that was two years overdue, had gone wrong.[149] The test was designed to determine if the emergency diesel generators would turn on and keep the water pumping in the event of a blackout.[150] Attempts to perform the test had failed before, and on the day of the accident the test was delayed to preserve

139. Cecilia Eiroa-Lledo et al., *Critical Underlying Factors in Three Major Nuclear Accidents*, BULL. OF THE ATOMIC SCIENTISTS (Aug. 31, 2020), https://thebulletin.org/2020/08/critical-underlying-factors-in-three-major-nuclear-accidents/ [https://perma.cc/AX7D-7ERG].

140. *Id.*

141. *See What Are the Effects of Nuclear Accidents?*, WORLD NUCLEAR ASS'N (Feb. 12, 2025, 11:54 AM), https://world-nuclear.org/nuclear-essentials/what-are-the-effects-of-nuclear-accidents.aspx [https://perma.cc/6H85-9TUB].

142. *5 Facts to Know About Three Mile Island*, OFF. OF NUCLEAR ENERGY, U.S. DEP'T OF ENERGY: BLOG (May 4, 2022), https://www.energy.gov/ne/articles/5-facts-know-about-three-mile-island [https://perma.cc/N4R5-T4WN].

143. *Id.*

144. *Id.*

145. *Id.* (noting that people in the area already experienced about 100-125 millirem per year in the area).

146. *Id.*

147. *What Are the Effects of Nuclear Accidents?*, *supra* note 141.

148. *See* Eiroa-Lledo et al., *supra* note 139.

149. *Id.*

150. *Id.*

power for the rest of the region.[151] The main operator error was that the deputy chief engineer dropped the power too low to the reactor, causing xenon gas to build in the core, and dangerously lowering power levels.[152] The deputy chief engineer then ordered the withdrawal of the control rods to increase the power of the reactor.[153] Once the power had increased, the operator was ordered to press the "scram" button to insert the control rods and stop the reaction.[154] The rods, however, stuck in place due to a design flaw in selecting graphite tips for the control rods.[155] The graphite tips caused the opposite effect, leading to a greater reaction, and eventually causing the water that was supposed to cool the reactor to turn to steam.[156] At that point, the reactor was in effect a bomb that exploded with the force of 60 metric tons of 2,4,6-trinitrotoluene (TNT), sending a 2,000 metric ton concrete and steel biological shield into the air.[157]

Another design flaw of the reactor was the lack of containment structure.[158] Unlike Three Mile Island and Fukushima, the Soviets did not build concrete and steel containment structures around their reactors.[159] This is not to suggest that the structure would have stopped the shield from piercing it, but that the lack of containment allowed a greater amount of radiation to spew from the reactor.[160] Overall, two workers died directly from the explosion, 28 emergency personal and workers died from acute radiation syndrome (radiation sickness), and 15 of the 5,000 cases of thyroid cancer turned fatal.[161]

The last of the three accidents occurred on March 11, 2011 at Fukushima, Japan, similarly due to a design error in the power plant.[162] On that day, a 9.0 magnitude earthquake struck, causing severe damage to Japan and almost 19,500

151. *Id.*
152. *Id.*
153. *Id.*
154. *Id.*
155. *Id.*
156. *Id.*
157. *Id.*; U.S. ENV'T PROT. AGENCY, TECHNICAL FACT SHEET – 2,4,6-TRINITROTOLUENE (TNT) 1 (2014), https://19january2017snapshot.epa.gov/sites/production/files/2014-03/documents/ffrrofactsheet_contaminant_tnt_january2014_final.pdf [https://perma.cc/5QLF-WR6M].
158. Lois Beckett, *Six Ways Fukushima Is Not Chernobyl*, PROPUBLICA (Mar. 18, 2011, 12:22 PM), https://www.propublica.org/article/six-ways-fukushima-is-not-chernobyl [https://perma.cc/D3K7-9ND2].
159. *Id.*
160. *See id.*
161. *What Are the Effects of Nuclear Accidents?*, *supra* note 141.
162. *Id.*

deaths.[163] As a result of the earthquake, a tsunami formed and barreled towards the Fukushima power plant.[164] After the plant's original construction, the Japanese learned the plant's site was dangerously close to the shoreline, but did nothing to mitigate the risk.[165] The tsunami crashed over the seawall and flooded the plant, including the backup generators responsible for keeping the pumps running to cool the reactors.[166] This caused three reactor cores to explode, releasing radiation into the air.[167] Thankfully, although the cores exploded, there were no cases of radiation death or sickness of the employees or surrounding communities.[168] The only deaths that occurred from the accident were due to the poor evacuation of residents, particularly the elderly.[169]

While these three accidents are alarming, nuclear energy is still one of the safest energy sources around. Compared to energy sources such as oil, coal, gas, or hydropower, nuclear energy has a lower death rate per terawatt-hour of electricity.[170] On average, coal kills 24.6 people per terawatt, oil 18.4, gas 2.8, and hydropower 1.3, while nuclear totals 0.03 deaths per terawatt, even with three significant accidents.[171] Even wind energy results in more deaths than nuclear at 0.04 deaths per terawatt.[172] Further, air pollution from fossil fuels causes 8.7 million deaths every year, making it the deadliest of energy sources.[173]

To offer a degree of contrast, the fatalities of the three major nuclear accidents pale in comparison to the deaths caused by the collapse of a singular dam—the Banqiao Dam failure in China caused 171,000 fatalities.[174] It shows that other energy sources can cause fatalities as well, but nuclear is the source that receives the bad press. It is time to shift our perspective on nuclear energy. Instead

163. *Fukushima Daiichi Accident*, WORLD NUCLEAR ASS'N (Apr. 29, 2024), https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-daiichi-accident.aspx [https://perma.cc/3ZWP-XX38].

164. *Id.*

165. *Id.*

166. *Id.*

167. *Id.*

168. *Id.*

169. *What Are the Effects of Nuclear Accidents?*, *supra* note 141.

170. Hannah Ritchie, *What Are the Safest and Cleanest Sources of Energy?*, OUR WORLD IN DATA (Feb. 10, 2020), https://ourworldindata.org/safest-sources-of-energy [https://perma.cc/6GNM-AUZ3].

171. *Id.*

172. *Id.*

173. *Id.*; *What Are the Effects of Nuclear Accidents?*, *supra* note 141.

174. *What Are the Effects of Nuclear Accidents?*, *supra* note 141.

of viewing nuclear as a dangerous energy source, we should realize its positive attributes.

V. RECOMMENDATIONS FOR THE FUTURE

Nuclear energy has a future in the United States. President Joseph Biden launched a $6 billion dollar effort to keep power plants that were at risk of closing operational.[175] This program was funded through the $1 trillion dollar infrastructure deal passed in November of 2021.[176] Plant owners who have already announced a shutdown are given priority for funding.[177] This is the largest federal investment in nuclear energy to date.[178] Additionally, the House of Representatives on February 28, 2024 passed the Atomic Energy Advancement Act with a vote of 365 to 36.[179] The bill would redirect how NRC operators approve new reactors, increase hiring in the commission, reduce applicant fees, and encourage the development of nuclear power plants.[180] The bill also looks to reduce the cost of building new reactors, given that two new reactors in Georgia cost upwards of $35 billion.[181]

Nuclear power is the way of the future. In a state like Iowa, land is a vital asset that we must work to protect. If the state wants to run efficiently for years to come, we must increase our nuclear energy production. Hopefully, Congress can pass a version of the Atomic Energy Advancement Act in future years to help smooth the process of creating nuclear power plants.[182] It is important that Iowa pass its own legislation to entice potential investors in nuclear energy to construct in Iowa. There is no reason for people to fear nuclear energy because statistics show that nuclear power is less dangerous than other sources already operating in this state.[183]

175. The Associated Press, *Biden Launches $6B Effort to Save Distressed Nuclear Plants*, NBC NEWS (Apr. 20, 2022, 10:48 AM), https://www.nbcnews.com/science/science-news/biden-launches-6b-effort-distressed-nuclear-plants-rcna25186 [https://perma.cc/N95M-XFSR].

176. *Id.*

177. *Id.*

178. *Id.*

179. Brad Plumer, *U.S. Seeks to Boost Nuclear Power After Decades of Inertia*, N.Y. TIMES (Mar. 1, 2024), https://www.nytimes.com/2024/03/01/climate/nuclear-power-legislation-congress.html.

180. *Id.*

181. *Id.*

182. *See* H.R. 6544, 118th Cong. (2024).

183. *See* Ritchie, *supra* note 170.

Iowa has begun to take steps towards bringing nuclear energy back. The Iowa Utilities Commission has proposed companion bills for energy production.[184] Two provisions from the 2024 legislative session in House Study Bill 555 and Senate Study Bill 3075 designated nuclear power as an alternate energy production facility.[185] Hopefully, with public approval, this could mean nuclear energy is making a comeback in the state.

VI. CONCLUSION

The world's population is not shrinking, and its land surface is finite. As a nation and a global community, we must focus on a more sustainable form of energy—nuclear. With nuclear energy and the help of other sustainable energy sources, we can shrink the land needed for energy production, allowing us to devote more space to livestock and crop production to feed our growing population. If we continue to rely solely on solar and wind energy, we will continue to lose valuable land. Farmland is what makes Iowa, Iowa. If the state turns to nuclear energy, it will power the economy for generations to come, all while conserving its most important resource.

184. Wally Taylor, *Iowa Utilities Board Bill Includes a Good Idea- and a Lost Cause*, BLEEDING HEARTLAND (Jan. 25, 2024), https://www.bleedingheartland.com/2024/01/25/iowa-utilities-board-bill-includes-a-good-idea-and-a-lost-cause/ [https://perma.cc/Z23R-9FL4].

185. *Id.*