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Imprudence and Intergenerational Injustice: The Ongoing Vices of Opting for Nuclear Fueled Electricity

Jame Schaefer
Marquette University, jame.schaefer@marquette.edu

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Imprudence and Intergenerational Injustice: The Ongoing Vices of Opting for Nuclear Fueled Electricity

Jame Schaefer*
Department of Theology, Marquette University
Milwaukee, WI

Abstract: Despite the U.S. government's failure to isolate from the biosphere the highly radioactive spent fuel that has been accumulating at nuclear power plants for sixty years, some governmental officials, scientists, nuclear industrialists, and environmentalists are urging increased reliance on nuclear-generated electricity as part of the strategy to mitigate global warming. An ethical analysis of their proposal is warranted, and one promising approach is the theologically grounded process of making prudent decisions like those that Thomas Aquinas outlined and explained in the thirteenth century. Following his detailed method of discovering the facts, identifying a justifiable course of action, and commanding its implementation, it can be concluded that adding more nuclear capacity to our nation's energy mix is imprudent and will produce intergenerational injustice until the isolation of the spent fuel at existing plants is underway and space is assured for the spent fuel removed from new nuclear reactors. The primary motivation for converting

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

from the ongoing national vices of imprudence and intergenerational injustice to a nation characterized by the virtues of prudence and justice is love for others when expressed and demonstrated inclusively.

Introduction

In the aftermath of Hiroshima and Nagasaki, the United States government promoted and facilitated converting the war atom into "atoms for peace" by generating electricity that would be "too cheap to meter."[1] However, from the moment the first nuclear power plant began operating in 1958, it also began yielding highly radioactive spent fuel for which disposition was promised in the future. Among the anticipated solutions was reprocessing the spent fuel to recover the unused uranium and plutonium for recycling in more advanced nuclear reactors and solidifying the reprocessed waste stream for eventual burial in geological formations or deep ocean beds.[2] Plans deferred reprocessing "indefinitely" with the hope of stalling the proliferation of nuclear weapons.[3] Focus was placed subsequently on identifying a place for isolating the highly radioactive spent fuel from the biosphere. All attempts have failed.

Thus, the spent fuel remains in increasing quantities in storage pools of nuclear power plants around the country.[4] Many pools have been reconfigured to place the spent fuel assemblies more closely together so they can be offloaded from nuclear reactors when new fuel is needed, and insufficient space in those storage pools has prompted the utilities to put older assemblies in silos on concrete slabs outside where cooling and radioactive decay can continue. The federal government's failure to remove the spent fuel from the reactor sites contributed to the electric utilities' lack of interest in constructing more nuclear power plants for three decades.[5] However, the major reason for their lack of interest was economic—escalating costs of building, operating, and decommissioning the plants. They never reached the "too cheap to meter" status.[6] Also contributing at least indirectly to the utilities' lack of interest was the public reaction to the accident at the Three Mile Island nuclear plant in Middleton, Pennsylvania in 1979.

After a hiatus of thirty years, the desire for energy self-sufficiency and the reality of human-forced climate change have

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

rekindled interest in nuclear generated electricity. President Obama announced in February 2010 that nuclear should be part of the U.S. energy mix and taxpayers would guarantee the utilities' loans for constructing two nuclear reactors in the State of Georgia. Of course, this decision also guarantees that additional highly radioactive spent fuel will be added to the inventory that has been accumulating at nuclear plants for approximately sixty years. Though the radioactivity that was released accidentally from the Fukushima Dai-ichi nuclear plant in 2011 emanated from its spent fuel storage pools, causing havoc in Japan and prompting reactions in other countries that rely upon nuclear-fueled electricity, political interest in building more nuclear plants in the U.S. persists; some utilities have sought government aid, and the nuclear industry is proffering nuclear as the primary option for replacing fossil-fueled electricity. The two nuclear reactors for which President Obama guaranteed loans were licensed for construction by the U.S. Nuclear Regulatory Commission (NRC) in February 2012—the first new reactors to receive approval since 1978. Several more have been proposed.

As President Obama and other officials promote additional U.S. reliance on and financial support for nuclear fueled electricity as part of the national strategy for minimizing emissions from burning fossil fuels, environmental ethicists should also consider the ethical implications of constructing more nuclear plants while highly radioactive spent fuel continues to accumulate at existing facilities. Kristin Shrader-Frechette has been a pioneer in underscoring the injustice of exposing children, Native Americans, and other vulnerable minorities to health risks at various stages of the nuclear fuel cycle.[7] In another impressive monograph, this eminent biologist, philosopher, and ethicist focused on the injustice to future generations if highly radioactive spent fuel is deposited in any geological formation despite inevitable uncertainties about containing their radioactivity for the requisite hundreds of thousands of years.[8] Shrader-Frechette subsequently countered interest in nuclear-generated electricity as a means for mitigating the climate crisis by pointing convincingly to the release of fossil fuel emissions at every stage of the nuclear fuel cycle and the high costs of nuclear energy and by arguing for energy efficiency strategies and renewable energy sources as the least expensive, most effective, and ethically justifiable approach to meeting

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

the future energy needs of the U.S.[9] The aftermath of the Fukushima accident, threats of terrorist attacks at nuclear facilities,[10] and the new strategy announced by the U.S. Department of Energy (DOE) for addressing the disposition for radioactive spent fuel further warrant our ethical consideration about adding more nuclear generated electricity to the U.S. energy mix.

Thus, I hope to stimulate conversation among environmental ethicists by sharing an approach to addressing this conundrum—the theologically grounded process of making prudent decisions that Thomas Aquinas outlined and explained in the thirteenth century.[11] This step-by-step discernment process concludes to proscribing the radioactive spent fuel from the biosphere is operating so future generations are spared the risks of exposure to a release of radioactivity from the spent fuel accumulating at existing plants and the burden of resolving a problem they did not create, nor from which they receive any benefits. Though this conclusion is supported by other ongoing safety, environmental, human health, and economic issues, including the disposition of uranium-mine tailings and retired nuclear reactors, I focus on the spent nuclear fuel removed from the reactors and requiring permanent disposition.

I begin with a brief overview of Aquinas's understanding of the chief (cardinal) moral virtues and proceed to explore and apply his explanation of the virtue of prudence to the issue of constructing more nuclear power plants in the U.S. at this time. Because foresight is one of the primary components of prudence, this sequential approach opens to the virtue of justice, which has implications for how the virtue of temperance can help and why the virtue of fortitude is essential. Though I emphasize the usefulness of this process for individuals, I move beyond Aquinas and others who think about virtues as characteristics of individuals to thinking about virtuous individuals who collaborate with one another to form communities that value, nurture, and demonstrate virtuous behavior as a group. Among the actions of a virtuous community is advocating a national conversion from imprudence and intergenerational injustice to a virtuous nation that requires an operating means for isolating the existing spent fuel before any more nuclear power plants are approved for construction.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

The Moral Virtue Of Prudence

In his *Summa Theologiae* (ST) and *Summa contra Gentiles* (SCG), Aquinas taught that a human person should be guided by the moral virtues when acting to achieve good ends in this life.[12] Whereas the intellectual virtues perfect the power of reason in the human mind and the theological virtues unite the person to God,[13] the moral virtues incline persons to follow the dictates of reason to achieve their temporal good and the common good in this life while aiming for eternal happiness with God. Aquinas cautioned that the moral virtues are only innate to the individual potentially.[14] They are like seeds that are naturally present in human reason and must be cultivated.[15] Once perfected by and characteristic of the individual, the moral virtues confer an aptness—a prompt will—to act correctly when making decisions.[16]

Prudence, justice, temperance, and fortitude are the chief virtues that incline humans to act morally to achieve good and avoid evil in temporal life. The virtue of prudence inclines the person to act rationally to achieve good,[17] while justice, temperance, and fortitude incline the human to act according to what prudence dictates. These four interconnecting virtues have significance for deciding whether or not to add more nuclear capacity to the U.S. energy mix at the present time in order to mitigate human-forced climate change.

According to Aquinas, prudence is both an intellectual virtue[18] and the chief moral virtue.[19] The intellectual virtue of prudence exists in the ability to reason, through which we can distinguish between good and evil (speculative reasoning). As the chief moral virtue, prudence inclines the person to choose the best action that achieves good and avoids evil (practical reasoning).[20] Thinking and acting prudently are essential for living in the world, Aquinas insisted, and their combined functioning as God intends yields a person who acts on the basis of careful deliberations about the rightness and wrongness of possible courses of action. Concluding to a course of action and acting on it requires a three-step process: (1) seeking counsel by discovering the facts and evidence about the decision to be made; (2) forming a good judgment on the best action that achieves good and avoids evil;

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

and (3) commanding that action correctly.[21] He characterizes this process as the habit of discretion.[22]

Seeking Counsel—Discovering the Facts

In this first step of prudent decision making, the individual or community strives to discover appropriate actions that will achieve good.[23] Both the private good of the individual and the common good of groups to which the individual belongs are to be considered. As Aquinas explained, the good of the individual is impossible unless the common good of others is assured; thus, the prudent individual considers what is good for one's self by being prudent about what is good for many.[24] Knowing the facts pertinent to the decision to be made is, of course, key to this task. The requisite information includes data pertaining to the nature of the spent fuel removed from nuclear reactors, its ongoing storage at the reactor sites throughout the U.S., and current efforts underway. Also looming large in this step of seeking counsel is the memory of the sixty-year history of scientific, technical, and political failures by the federal government to provide a means for isolating the spent fuel from the biosphere.

(1) "Spent" Nuclear Fuel

The fuel for most nuclear reactors functioning in the U.S. today consists of pellets of ceramic uranium dioxide that are sealed in hundreds of metal rods, bundled together to form a fuel assembly, and placed in a reactor vessel where the uranium atoms fission and produce heat that powers the turbines to generate electricity. When the nuclear fuel in the reactors is no longer effectively sustaining a chain reaction, the spent fuel is removed and fresh fuel is inserted. The spent fuel that is removed is highly radioactive, thermally hot, and potentially harmful to all forms of life. Technicians remove the assemblies by remote control behind shields and place them in concrete stainless steel-lined storage pools filled with water treated with a boron compound that circulates throughout the pool to remove the heat from the spent fuel. If borated water is not continuously circulating in storage pools that are filled with spent nuclear fuel, the rods could overheat and a Fukushima-type event could occur.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

According to the U.S. General Accountability Office (GAO) whose staff conducts research requested by members of the House of Representatives and Senate:

> Spent nuclear fuel is considered one of the most hazardous substances on earth. Without protective shielding, its intense radioactivity can kill a person exposed directly to it within minutes or cause cancer in those who receive smaller doses. Although some elements of spent nuclear fuel cool and decay quickly, becoming less radiologically dangerous, others remain dangerous to human health and the environment for tens of thousands of years.[25]

Because the spent fuel is highly hazardous, the NRC insists that it "must be stored and finally disposed of in a way that provides adequate protection of the public for a very long time."[26] How long is "a very long time"? According to the U.S. Environmental Protection Agency (EPA), spent fuel must be isolated from humans for one million years.[27] That is a long, long time to assure containment in any manner anywhere with any technology.

The most abundant radioactive material in spent fuel is uranium 238 which has a half-life[28] of approximately 4.5 billion years. During that time, U-238 decays through a series of steps beginning with the emission of alpha particles accompanied by weak gamma rays and ending in a stable form of lead. Ingestion of U-238 can lead to increased cancer risk, liver damage, or both, and long-term chronic intakes of uranium isotopes in food, water, or air can lead to internal irradiation and/or chemical toxicity.[29]

Among the most hazardous radioactive isotopes in spent nuclear fuel are strontium 90, cesium 137, and iodine 129 and 131.[30] Sr-90 moves easily through the environment and the food chain during its half-life of 29.10 years, emitting beta particles from moderate to strong while decaying to other isotopes that concentrate in the bones and the bone marrow. Internal exposure to Sr-90 is linked to bone cancer, cancer of the soft tissue near the bone, and leukemia. Cs-137 also moves easily through the environment during its half-life of 30.17 years, emitting beta particles and relatively strong gamma rays and decaying eventually to a non-radioactive form of barium. People can be exposed externally to the gamma rays of Cs-137 by walking on

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

contaminated soil and coming in contact with waste materials at contaminated sites, exposed internally by breathing dust contaminated with the isotope, drinking contaminated water, and/or eating contaminated food which would expose bodily tissue to gamma and beta radiation. If Cs-137 enters the body, it is distributed fairly uniformly throughout the body's soft tissues, resulting in exposure of those tissues. Slightly higher concentrations are found in muscles, while slightly lower concentrations are found in bone and fatty tissues. Like all radionuclides, exposure to radiation from Cs-137 results in increased risk of cancer. I-129 and I-131 have half-lives of 15.70 million years and eight days respectively. They can be inhaled as a gas or ingested in water into which they dissolve, in food when the isotope has settled on leafy vegetables, in milk produced by cows that eat grass on which the isotope has deposited, and in fish. The iodines concentrate in the thyroid glands of humans where they can cause health problems, including thyroid cancer.[31]

Plutonium 239 is another highly carcinogenic radionuclide that is produced in nuclear reactors and, due to its 24,100-year half-life, is one of the reasons why the EPA requires spent fuel isolation for at least a million years. Pu-239 is also dangerous because it is "most useful in making nuclear weapons"[32] when it is extracted from the spent nuclear fuel. President Carter was most likely aware of this nuclear proliferation threat when halting the reprocessing of spent fuel in 1979.

When nuclear-fueled electricity plants were originally proposed, constructed, and licensed for operation, the spent fuel was slated for reprocessing to recover some of the uranium that could be used to make new fuel while the wastes from reprocessing were slated for disposition through a means to be determined in the future. Reprocessing the spent fuel was proscribed primarily to minimize the proliferation of nuclear weapons. As spent fuel storage pools filled to capacity, they were re-racked to store more spent fuel assemblies closer together in the pools. This dense storage eventually proved inadequate to hold the spent fuel that had to be removed from the reactors, so owners of the nuclear power plants began placing the least hot and radioactive assemblies outside in dry casks on concrete

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

slabs where the radioactivity continues to decay and the heat further dissipates in the ambient air.

(2) Spent Fuel Storage Today

According to the latest figures released by the Congressional Research Service, more than 67,000 metric tons of spent nuclear fuel constituting approximately 174,000 assemblies were stored at seventy-three sites where one hundred and four nuclear reactors are operating in thirty-five states.[33] Assuming that operating reactors receive license extensions and no new reactors are built, this volume is expected to more than double by 2055.[34]

Not surprisingly, approximately eighty percent of the spent nuclear fuel from commercial nuclear power plants is stored east of the Mississippi River at the sites of the reactors from which it was generated. About seventy-three percent of this spent fuel is stored in wet pools, while the remaining twenty-seven percent is stored outside or in vaults.[35] As the plants' storage pools fill up, dry casks are used increasingly.

This accumulation of spent fuel concerns Robert Alvarez, Senior Scholar at the Institute for Policy Studies and former Senior Policy Advisor to the U.S. Secretary of Energy on environmental issues during the Clinton administration:

> One thing, however, is clear, whether we like it or not: the largest concentrations of radioactivity on the planet will remain in storage at U.S. reactor sites for the indefinite future. In protecting America from nuclear catastrophe, safely securing the spent fuel by eliminating highly radioactive, crowded pools should be a public safety priority of the highest degree.[36]

The Congressional Research Service anticipates storage of the spent fuel at the reactor sites for a "potentially foreseeable future" that spans three hundred years.[37]

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

(3) Efforts Underway to Address Spent Fuel Disposition

The most recent effort to address the nagging question of spent nuclear fuel isolation occurred when U.S. Secretary of Energy Steven Chu established in 2010 a Blue Ribbon Commission on America's Nuclear Future. Former U.S. Congressman Lee Hamilton (Indiana) and U.S. Army General Brent Scowcroft were appointed to chair the commission and tasked to "provide advice, evaluate alternatives, and make recommendations for 'a new plan' to manage the back end of the nuclear fuel cycle in the United States."[38] Subcommittees proceeded to research the available data, consult with experts, and listen to comments at public hearings. Halfway through their deliberations, the loss of coolant water in the reactors and spent fuel pools at the Fukushima nuclear facility in Japan in March 2011 spurred the commission's efforts. According to members of the disposal subcommittee, "the events at Fukushima underscore how important it is to ensure that safe and secure interim storage for spent fuel and high-level wastes is part of an integrated approach to nuclear waste management."[39] The subcommittee members underscored in their report to the commission the "ethical responsibility" for disposing of spent nuclear fuel:

> Throughout, our inquiry and our deliberations have reflected an underlying conviction that this generation has an ethical responsibility to begin implementing a durable, integrated management strategy and practical solutions that will enable disposal of spent nuclear fuel and high-level radioactive wastes. If we do not—if more years and decades elapse while we do nothing—we will have made a decision of another kind: a decision to accept the continued accumulation of spent fuel at many dozens of sites around the nation.[40]

In its final report to the Secretary of Energy, the Blue Ribbon Commission emphasized the "urgent" need for "a new strategy . . . because this generation has a fundamental ethical obligation to avoid burdening future generations with the entire task of finding a safe permanent solution for managing hazardous nuclear materials they had no part in creating."[41]

Clearly, the "decision of another kind . . . to accept the continued accumulation of spent fuel" has been made repeatedly in the

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

United States for sixty years. It has become a *habit*—the bad habit of moving ahead with more nuclear power plants when permanent disposal of the spent fuel is unavailable. A bad habit is nothing less than a *vice*, a negative characteristic of the individual and, I think, of a nation that fails to make prudent decisions and acts unjustly. Obviously, the United States is guilty of two persistent vices—the *vice of imprudence* and the *vice of intergenerational injustice*.

At least implicitly, the Blue Ribbon Commission recommended a way out of continuing these vices pertaining to spent fuel disposition. The members recommended a strategy with eight key elements which include "prompt" concurrent efforts to develop one or more geologic disposal facilities, one or more consolidated storage facilities to which the spent fuel accumulating at the nuclear power plants would be shipped, and a plan for the large-scale transport of the spent fuel to consolidated storage and disposal facilities "when they become available."[42] Two other recommendations by the commission that have significance for this discussion are (1) establishing an approach to siting future nuclear waste management facilities that would require the consent of key parties affected and (2) giving authority to an agency whose sole role is developing and implementing a nuclear waste management plan.

Following the recommendations of the Blue Ribbon Commission, the DOE announced the Obama administration's plan to initiate the selection of one or two geologic repository sites by 2026, the design and licensing of at least one by 2042, and the repository constructed and operating by 2048. The president's plan also called for the concurrent siting and development of facilities for receiving and storing the spent fuel from the nuclear plants until a repository is available and preparing for the eventual large-scale transport of the spent fuel to consolidated storage and geological disposal facilities when they become available.[43] A bipartisan effort has been underway in the U.S. Senate and the House of Representatives to establish a consolidated spent fuel storage facility and to site a geologic repository concurrently.[44] However, action was not taken on the Nuclear Waste Administration Act of 2013 by the 113th Congress nor has the 114th Congress acted on the Nuclear Waste Administration Act of 2015.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

The likelihood that consolidated spent fuel storage and a geological repository would be established was questioned by the GAO in its most recent review of the DOE's plans to manage and isolate the spent fuel from the biosphere. In April 2013, the GAO cautioned members of a subcommittee of the House of Representatives that "successfully resolving the issue of what to do with spent commercial nuclear fuel will likely be a decades-long, costly, and complex endeavor, which can be disrupted by changing views and unpredictable funding." Well aware of the history of the federal government's failure to isolate the spent fuel from the biosphere, the GAO encouraged Congress to consider creating an independent organization that might be "more effective" than the DOE for locating and developing a permanent repository for the nation's nuclear waste.[45]

Even if a repository is constructed and operating by 2048, more delays in consolidating and storing the spent fuel are anticipated. The GAO reports that "transportation planning could be a complex endeavor, potentially taking ten years to reach agreement on transportation routes and safety and security procedures."[46] The Congressional Research Service expects that the rate of spent fuel shipment would require "decades."[47] Among other causes of delay are finding a state that is willing to cooperate and obstacles that a state may erect to granting permissions essential for transporting the spent fuel, locating a preferred site for consolidated storage, and providing access to water and other services required to operate a storage facility. Delays caused by local governments and opposition groups may also be anticipated based on the past history of attempting to site a geological repository.[48]

Planning to resolve a problem in thirty-five years that has not been resolved for nearly sixty shifts to at least the next generation the responsibility for assuring the safe management of the spent fuel at nuclear power plants and attempting to isolate it from human contact for hundreds of thousands of years. This intergenerational justice issue may be lessened somewhat if some of the uncertainties about isolating the radioactivity to which Shrader-Frecette refers are minimized. However, the history of proposals for isolating these highly radioactive materials from the biosphere, the identification of a favored way of placing them in a geologic formation after considering other

possibilities,[49] and the many failed attempts to site a repository for scientific, technical, and political reasons should temper anyone's confidence in the availability of a repository at any time in the near future.[50]

Financial liabilities also loom among the risks and responsibilities thrust upon the next generation or beyond to resolve impediments to permanent spent fuel disposition. The federal government's failure to accept custody of the spent fuel accumulating at nuclear power plants has cost taxpayers billions of dollars. As the GAO indicates, the total liability remains uncertain until a final path toward disposition is determined and the spent fuel is physically accepted by the DOE.[51]

(4) Remembering Past Failures

Integral to prudent decision making is remembering past events that are pertinent to decisions to be made in the present. For Aquinas, we are supposed to learn from the past.[52] Having already gathered evidence about the ongoing accumulation of highly radioactive spent fuel at nuclear power plants, we look to the past to help discern the level of confidence we can have in the federal government to provide in forty years a process for isolating spent fuel that would be generated by additional nuclear plants.

Despite the fact that the federal government recognized the need to isolate high-level radioactive waste from the environment for many thousands of years before the first commercial nuclear power plant began operating in the United States, all efforts by agencies entrusted with this task have failed. Furthermore, this responsibility received relatively little attention from policymakers in the 1950s and 1960s, and the early regulators and developers of nuclear power viewed disposal primarily as a technical problem that could be solved when necessary by applying existing technology.[53]

The earliest responsibility for addressing radioactive waste disposition was placed in the Atomic Energy Commission which had asked the National Research Council of the National Academy of Sciences in 1955 to identify geological formations in the United States that might be suitable for high-level waste disposal. An advisory

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

committee of the council reported that naturally occurring salt formations were possibly the best geological formations for that purpose. The commission began emplacing spent fuel in an abandoned salt mine near Lyons, Kansas in 1965 to examine the effects of radiation and heat on salt. After determining that salt was a suitable storage medium, the experiment was ended, the spent fuel was retrieved, and the commission announced that it would build a high-level nuclear waste repository at the Lyons mine if further geologic studies confirmed the site's suitability. However, investigations over the next two years concluded that there was a possibility of water entry into the mine from numerous old oil and gas exploration holes and from salt mining operations near the site that might result in leakage of the radioactivity. Before these issues could be resolved from a scientific and technical perspective, however, adverse public and political reaction lead to the cancellation of the project in 1972.[54]

Subsequently, salt domes in Louisiana and the salt caverns near Carlsbad, New Mexico were considered. The domes were eventually ruled out due to their proximity to the U.S. petroleum reserves. Emplacing highly radioactive waste near a valuable energy source was considered too risky for several reasons, including the possibility that the repository would be breached and radioactive nuclides released when future generations search for oil.[55] Public and state opposition halted the continuation of federal interest in using the salt caverns for spent fuel disposal.[56]

When the Atomic Energy Commission was split into the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC) in 1974, the ERDA studied a wide array of options for disposing of highly radioactive wastes and developing temporary storage for spent fuel in a central location to await the availability of a permanent solution for isolating it from the environment. Interest in consolidated interim storage of spent fuel continued when the ERDA was replaced by the DOE in 1977. Desiring to increase the nation's reliance on nuclear generated electricity and to attend seriously to the U.S. government's responsibility for isolating the spent fuel from the environment, federal policymakers enacted legislation in 1982 that required the DOE (1) to site, license, construct, and operate repositories for the disposal of high-level radioactive

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

waste by 1998, (2) to provide a limited amount of federal interim storage capability, and (3) to study the need for and feasibility of monitored retrievable storage.[57] From 1983–1986, the DOE identified five sites for a first repository in bedded salt (Davis Canyon, Utah and Deaf Smith County, Texas), domed salt (Richton Dome, Mississippi), tuff (Yucca Mountain, Nevada), and basalt (Hanford, Washington) for constructing a repository, began to search for a crystalline rock formation to site and prepare activities essential for a second repository (initially identified thirty-six a proposal for a monitored retrievable storage facility to receive, consolidate, package, and temporarily store spent fuel prior to shipment to a repository. The DOE was required by the 1982 legislation to work closely with officials of the states and Native Americans and to involve the public in its deliberations. The main source of revenue for the DOE's program was obtained from the nuclear utilities which were charged one mill per kilowatt hour of electricity generated since 7 April 1983.[58]

Opposition to a geologic repository in all states and on all tribal lands swelled, and elected officials also responded negatively in increasing numbers. Bolstered by scientific, technical, cultural, and procedural arguments against locating a repository in their states, elected officials brought their messages to the chambers of the House of Representatives and Senate.[59] Four years after the 1982 Nuclear Waste Policy Act was enacted, it was amended to site a repository in one state that had the fewest members in the House of Representatives—Nevada. Yucca Mountain was designated as the place in which to construct a repository, and efforts to site one in crystalline rock were halted. From 1986 to 2009, the DOE spent millions of dollars preparing the Yucca Mountain site for approval by EPA and NRC. However, true to his pledge when running for a first term as President of the U.S., President Obama refused to include funding for continuing work at Yucca in the 2010 budget. The primary reason was rooted in the ongoing seismic activity in the area, though technical concerns about the safe transportation of the spent fuel to Yucca Mountain as well as political and public opposition to locating a repository there may have influenced his decision.[60]

Plans for a monitored retrievable spent fuel storage facility met a similar fate. In a report to Congress in 1989, the Secretary of Energy

announced an initiative to use a "nuclear waste negotiator" who would seek a community to identify a site for monitored retrievable storage (MRS), the facility would be developed, and a license would be sought from the NRC to begin accepting a limited amount of commercial spent fuel in 1998 for temporary storage. A retrievable storage facility would prepare and stage shipments of the spent fuel to a geologic repository developed and operated by the DOE.[61]

After several unsuccessful attempts by the nuclear waste negotiator to find a voluntary host community, the position was eliminated in 1995. Among these attempts was an invitation in 1991 to 573 tribal leaders to apply for grants to determine the feasibility of siting a MRS on their sovereign lands. Only nineteen applications were submitted, sixteen tribes withdrew their applications, and three moved through the three phases of the feasibility study. One of the three was an application by the Mescalero Apache Tribal Council that viewed the possibility of a storage site as a business opportunity through which to lift their people from poverty.[62] In the middle of the second phase of the feasibility study, a group of thirty-nine nuclear utilities organized around Northern States Power began to work with the tribal council to establish a private storage facility. However, members of the tribe disagreed about the desirability of siting a spent fuel storage facility on tribal grounds. The tribe needed the money that a storage facility would offer, but activists within the tribe expressed deep concern about errors that might occur when transporting and storing nuclear waste on their lands. After extensive educational efforts among members of the tribe and a series of three ballots within a period of four months in 1995, the Mescalero Apache and the consortium of utilities dropped their efforts to establish a spent fuel storage facility on tribal lands.[63]

Some federal legislators attempted during the 1990s to craft a bill that would facilitate the establishment of a temporary consolidated storage site for commercial spent fuel near the Yucca Mountain site, but legislation was not passed.[64] When interest surfaced in using the DOE's Waste Isolation Pilot Plant near Carlsbad, New Mexico[65] for storing commercial spent fuel, the State of New Mexico stationed four employees at the plant to assure that no spent fuel enters the facility.[66]

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

Do failed promises to isolate highly radioactive spent fuel for the past sixty years suggest *any* confidence in the federal government to succeed with a proposal in the next fifty years? Sixty? One hundred? Three hundred?[67] While the past is not definitively predictive of the outcome of the DOE's stated intention to provide by 2058 a geologic repository for permanently containing the spent fuel, can lessons be learned from the past that can be built into planning to site and prepare a repository for accepting the spent fuel? The GAO suggested two lessons to be learned from the failure to site a repository in Nevada's tuff: (1) overcome social and political opposition by "transparency, economic incentives, and education" and (2) establish "consistent policy, funding, and leadership" that might better be achieved by "an independent organization" instead of the DOE.[68]

Can learning from these two lessons reverse the vices of imprudence and intergenerational injustice that have prevailed for nearly sixty years? Based on studies following failures to site a geologic repository for isolating the spent fuel, especially the suspensions of the search for a second repository in crystalline rock and the development of the Yucca Mountain site for a first repository,[69] transparency is vital for prudent decision making. So also is collaboration of all interested parties (e.g., states, local governments, Native Americans, public interest organizations, electric utilities, and designated representatives of future generations). Their cooperation is essential for designing and carrying out a process for identifying and implementing a solution for spent fuel isolation, for assuring that the requisite data are collected and considered, for developing an education program[70] through which the process and data are understandable to a wide array of people and communities, and for establishing long-term monitoring of a disposal facility.

Economic incentives *may* help if the process is collaborative and transparent. In addition to covering costs of involving governments and non-government organizations, economic incentives may attract the cooperation of state and local governments, tribes, and other affected people for shouldering risks associated with developing a geologic repository including transporting, packaging, emplacing, and monitoring the site for release of radioactivity and interference with its integrity. Adequate funding must also be put aside for future

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

generations to continue to monitor the facility and minimize risks associated with spent fuel disposition. These components should help halt or minimize the current persistence of intergenerational injustice.

Should an independent agency be created to lead the search for and implementation of a means of isolating the spent fuel from the biosphere? Because the DOE and its predecessors have encountered significant opposition to its scientific, technical, and methodologically flawed efforts to site a repository in a geological formation,[71] giving the lead to an independent agency should be carefully considered. An agency tainted by repeated failures, inadequacies in its collection and assessment of data, and major mistakes when dealing with state, local, and tribal governments and with the public will carry a stigma that may invite resistance before the task has been initiated.[72] Collaboration at the outset with a state or local government or a Native American nation may help.

Of course, any effort to resolve the ongoing spent fuel disposition dilemma may fail as have others in the past, but a dedicated effort should be made nationally before new nuclear plants are approved for construction and operation. Perhaps lessons learned from past efforts will facilitate a successful national effort that demonstrates this generation's responsibility to future generations. Following Aquinas, all are our neighbors, all deserve justice, and all should be considered when making decisions. Individuals, groups advocating a national plan, and national decision makers should strive courageously to advocate making prudent decisions that reflect intergenerational justice at all levels of governance.

Making A Judgment And Committing To Intergenerational Justice

Having reviewed the facts of the past and the present, the next step in the process of prudent decision making requires choosing from among the possibilities a course of action that achieves good and avoids evil.[73] Consider the following three options:

- Proceed to approve additional nuclear power plants before a system for isolating the spent fuel from the biosphere is

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

approved, developed, and accepting spent fuel from existing nuclear power plants and has the capacity to accept spent fuel from new nuclear power plants;
- Approve more nuclear power plants after the NRC has granted an operating license to isolate the spent fuel that has been accumulating at existing nuclear power plants but does not guarantee space for isolating the spent fuel from new plants; and
- Approve more nuclear power plants after the physical acceptance of the spent fuel from existing plants is underway and room for isolating the spent fuel resulting from new plants is assured.

Which of these three options achieves good and avoids evil?

Option One?

This first option would continue the sixty-year practice of licensing more nuclear power plants that will generate highly radioactive spent fuel without assurance that it will be isolated from the biosphere—the zone of life. Choosing this option means shifting to the next generation (or more) the burden of monitoring and disposing of the spent fuel resulting from the electricity that is generated. Of course, this option continues the vice of intergenerational injustice that elected and administrative U.S. governmental officials have been demonstrating and perpetuating for sixty years. Thus, this vice will persist in the future.

Option Two?

This option risks perpetuating the vice of intergenerational injustice by failing to assure that the spent fuel offloaded from the reactors of new plants will be isolated. This option also risks the possibility that the spent fuel that has been accumulating at existing plants for over sixty years will not be shipped to a place for isolation, accepted, securely placed, and adequately monitored. Until a process for isolating the spent nuclear fuel is fully operational and capable of isolating the totality of spent nuclear fuel from existing and anticipated plants, intergenerational justice cannot be demonstrated.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

Option Three?

New nuclear power plants could be approved when the licensed process for accepting and isolating the spent fuel from existing nuclear power plants is operating and space is assured for the spent fuel from new plants. This option would break the sixty-year vices of imprudence and intergenerational injustice—building nuclear power plants without an operating means for isolating the spent fuel from the biosphere.

Nevertheless, managing the uploading of spent fuel into the repository, sealing the repository, and monitoring it would remain the obligation of future generations. Why? To assure that a breach will not occur through human intervention either intentionally (e.g., to obtain the radioactive isotopes to recycle for commercial or military purposes, to satisfy inquisitive future generation about the nature of what is there), unintentionally (e.g., breach of the site from another direction that is not marked), or naturally through a seismic event or other phenomenon. This burden may be mitigated to some extent by the fact that the next generation will be benefiting from the electricity produced at the new nuclear power plants, though subsequent generations may not benefit in any way.

With option three, significant good can be accomplished—assurance of a readily available means of isolating from the biosphere the spent fuel from existing and new nuclear power plants. So also can some evil be avoided—the sixty-year vice of pushing off to the next the burden of managing, transporting, and uploading into a repository the spent fuel that is generated by new nuclear power plants without any benefit to the generation that is forced to manage and dispose of the spent fuel. Thus, good is accomplished and the *culpable* evil of imprudence and intergenerational injustice is avoided through this option.

Nevertheless, potential evil lingers if the radioactivity is somehow released from isolation during the hundreds of thousands of years of decay. Minimizing this potential is essential to any isolation plan. Minimizing this potential will require assuring that the safety of future generations remains at the forefront of deliberations and is

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

represented by present generations at each stage of planning and execution.

Commanding A Decision

Aquinas explained that command is the chief act in prudent decision making, and commanding correctly requires three considerations—foresight, circumspection, and caution.[74] All have significance for the decision that is made and implemented. All three lead to proscribing the addition of more nuclear-generated electricity until a system is licensed and available for accepting all the spent fuel produced by the new facilities. That foresight and circumspection come after having made the judgment may seem strange. However, the decision to achieve good and avoid evil has been made in the first and second steps of making prudent decision according to Aquinas. Implementing the judgment begins with command, and its implementation involves double-checking to assure the judgment made today is fitting for the future when considering possible contingencies that may arise. Exercising circumspection aims to assure that the judgment achieves good in light of a combination of circumstances that may arise. Caution aims to assure that evil is avoided through a firm understanding of the good to be achieved.

(1) Foresight

The practice of this virtue would aim to assure what is to be commanded in the present is fitting in the future[75] if accidents occur, whether caused by humans, natural events, or a combination of human error and natural events as happened in the Fukushima Prefecture. We could speculate on a plethora of possibilities that might occur in the future when choosing option (1) and option (2), including the possibility that a means will not be available for isolating the spent fuel either from existing nuclear plants where it has been accumulating for sixty years or at new nuclear plants that are approved precipitously for construction and operation. Whereas the nuclear industry and regulatory agencies have been operating on this wishful thinking, it does not equate with prudent decision making when viewed from Aquinas' perspective of the virtue. Decisions to build and operate nuclear power plants have been made on the basis of wishful thinking.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

Wishful thinking epitomizes the vices of imprudence and intergenerational injustice that has occurred in the U.S. for sixty years.

Of course, we could speculate on a plethora of problematic possibilities if the method chosen for isolating spent fuel from the biosphere proves inadequate despite efforts to assure its isolation for the requisite hundreds of thousands of years that the radioactivity is decaying. Among these problems are accidents through which radioactivity is released while the spent fuel is transported to the isolation site, handling the spent fuel at the site where it will be packaged for isolation, placing it in the isolation area, finding space adequate for all of the spent fuel that needs isolation, closing and sealing the site, and monitoring it for leakage, buildup of radioactivity within the site, and forced entry into it. The overall design of the site and methods used to emplace the spent fuel, seal the repository, and monitor it should minimize the possibility that the health and well-being of the next generation and beyond will be jeopardized.

Accepting responsibility now for proceeding to site and develop a repository for the current inventory of spent fuel at nuclear power plants while precluding the generation of more at new facilities is the only option that complies with the foresight dimension of prudent decision making. Choosing option three is warranted.

(2) Circumspection

Assuring that the decision made is suitable in light of a combination of circumstances that may arise constitutes this next step in implementing the decision.[76] What combination of circumstances may arise that needs to be considered before implementing the decision? For Aquinas, circumstances are neither infinite nor are they speculative; they are real. The availability of a source for generating electricity is a major circumstance to consider when commanding the implementation of a decision to proscribe the building of more nuclear plants until an operating solution for isolating the highly radioactive spent fuel from the biosphere is available.

How will the electricity be replaced? If more efficient means of using electricity had been implemented in all sectors of the U.S.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

economy as it should have been (following the virtue of temperance) and if renewable sources for generating electricity had been developed to replace even half of this capacity (following the virtues of prudence and justice), the combination of energy efficiency and renewable sources might have been able to meet U.S. electricity needs as Shrader-Frechette and others have proffered.[77] Reports of energy use in the United States have shown that electricity is both wasted and used inappropriately in all sectors of the economy,[78] and much more has to be accomplished in homes, businesses, industries, cultural institutions, and social settings. More efficient and appropriate use of energy could play a significant role in reducing the demand for building electricity generating facilities—both fossil and nuclear fueled. Renewable energy must play a significant role in the future of the U.S., and a dedicated commitment to making a transition to renewables is long overdue. Geothermal, biomass, radiant, hydro, wind, solar, wave, and tidal powers must all be explored creatively and expeditiously.[79]

However, according to researchers at Stanford University and the University of California, Irvine, the electric utilities' opting for natural gas is thwarting the move to renewable energy sources.[80] Furthermore, leaks from natural gas at various stages of its fuel cycle add the potent greenhouse gas methane to others that are forcing changes in the global climate.[81] A national plan is needed to specify natural gas as a "bridge" toward a renewable and efficient energy future, require the efficient use of this non-renewable resource, and establish safeguards that minimize leaks from extraction to burning for electricity generation.

This step of circumspection also requires critiquing nuclear generation of electricity as the "clean air energy" option that will offset the perils of fossil fuels.[82] Proffering nuclear over coal and other fossil fuels obfuscates the unique perils that result from their different fuel cycles. Both pose threats to present and future generations, and both threats must be addressed. The EPA's Clean Power Plan addresses the major threat of fossil fuel emissions that are forcing changes on the global climate, and a national policy is essential to address the spent nuclear fuel that continues to accumulate at power plants throughout the U.S. as a prerequisite for increased reliance on nuclear generated electricity.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

Whereas nuclear advocates have made their position clear, public sentiment toward more nuclear in place of fossil-fueled plants is less clear. For example, surveys of the public conducted at the Massachusetts Institute of Technology (MIT) in 2002, 2007, and 2009 found "little evidence" that public concern about human-forced climate change translates into higher levels of support for nuclear power. When people were asked directly in the 2009 survey to trade off the risks of nuclear and global warming, the MIT authors of *The Future of the Nuclear Fuel Cycle* concluded from survey findings:

> [T]he likelihood of supporting nuclear power is approximately the same among those who said that global warming presented a high risk and those who did not. If public understanding of these two issues remains the same, then increasing concern about global warming will not lead directly to increased support for nuclear power. . . . However, over the past seven years we have seen little evidence that those who are more concerned about global climate emissions are more likely to support nuclear power.[83]

The authors continued optimistically that a "connection might be established with increased public understanding of the comparative carbon emissions of fossil fuels and of nuclear power."[84] However, as the MIT study was nearing completion, the Fukushima accident occurred in a spent fuel pool, leading the authors to underscore the need for a national spent fuel policy "rather than the ad-hoc policies" that had been ongoing since commercial nuclear power plants began operating.[85]

Whether or not the release of high levels of radioactivity from the Fukushima spent fuel pools may increase public resistance to adding more nuclear power plants has yet to be ascertained. The fact that the radioactivity was released primarily from the spent fuel pools and a vast area to the north, west, and south of the storage facility is no longer habitable should shake the U.S. into realizing the importance of assuring that the spent fuel in nuclear plants throughout the U.S. is secure, a means for isolating it from the biosphere is determined, and efforts are underway to isolate the spent fuel.[86] To stall any longer would be imprudent, especially if nuclear generated electricity is deemed an important component of the U.S. energy mix. However confident nuclear scientists are about the spent fuel pools of nuclear

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

power plants in the U.S., accidents can happen as Fukushima attests. Close regulation of nuclear plants and their waste management facilities in the U.S. should minimize the possibility of major accidents. At the present time, the thirty-one nuclear reactors operating in the United States that are similar to Fukushima's are undergoing safety checks and improvements by order of the NRC.[87]

Assuming that siting a repository for spent nuclear fuel will proceed without state, local government, and public resistance would demonstrate abject ignorance of the recent past. The past sixty years are replete with resistance by states, local governments, the public, and, of course, officials elected from areas under consideration for repository siting—Louisiana salt domes, crystalline rock in seventeen states, and tuff in Nevada.[88] Can and will two repositories be sited promptly as urged by the Blue Ribbon Task Force? Can and will at least one be designed and licensed by 2042 and operating by 2048 as stipulated by the Obama administration?[89] If the Yucca Mountain site is licensed and operating by 2048 and capable of accepting all the spent fuel accumulating at nuclear plants today, will a second repository be available to receive the spent fuel that will accumulate tomorrow and beyond at existing plants?[90] Will the federal government learn from lessons of past attempts to site a repository to accept spent fuel?[91] Will the job of citing a repository be passed to a quasi-government agency as encouraged by the Blue Ribbon Task Force because the DOE and prior agencies repeatedly failed?[92] Will evaluation of the Fukushima spent fuel pool accident lead to a federal decision to move the spent fuel currently stored at nuclear plants to a consolidated facility as the MIT Study Group speculated?[93] Will a repository or an alternate means of isolating the spent fuel from the biosphere ever be made available?

Speculation could continue indefinitely. However, focusing on the facts as Aquinas urged is warranted at this stage of the command process. The facts are: (1) highly radioactive spent fuel continues to accumulate at nuclear power plants; (2) a solution for isolating it from the biosphere is not available after several failed attempts to implement the preferred isolation methods; and (3) the spent fuel remains in storage pools that have been reconfigured for more dense storage than originally anticipated and placed outside on concrete slabs. Knowing these facts, adding to the stockpiles by approving more

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

nuclear power plants would be highly imprudent. Waiting for the implementation of a spent fuel management program that includes acceptance of these by-products of electricity generation would be prudent and just, thus halting the vices of imprudence and injustice that have been ongoing for sixty years. In the meantime, better management strategies of the spent fuel stored in pools and on concrete slabs at existing nuclear plants must be determined and implemented.[94]

(3) Caution

For Aquinas, caution is essential at this stage of implementing a decision. He insisted that caution is required to avoid evil through a firm understanding of the good.[95] The decision to proscribe adding more nuclear power plants until permanent disposition of spent fuel from existing facilities is underway aims to avoid the evil of shifting to the next or future generations the burden and the risks of managing, transporting, and isolating it from the biosphere. Because the vices of imprudence and intergenerational injustice have been so entrenched in spent fuel decision making up to this point, considerable caution must be exerted to assure that this structural evil does not persist.

Thus, prudent individuals who are committed to justice and groups of individuals who collaborate in making prudent decisions and advocating intergenerational justice will:

- Pressure elected officials to pass legislation that will tend seriously and conclusively to the long-overdue task of isolating the spent nuclear fuel and to require at least annual updates on progress made toward disposition.[96] In the meantime, prudent and just people will refuse to accept stall tactics and make approving any new nuclear plants contingent upon the acceptance of the spent fuel that is accumulating at current operating plants for permanent isolation at a disposal facility.
- Require regulators and utilities to identify and implement lessons learned at Fukushima to assure that the spent fuel accumulating at existing nuclear power plants is safely handled and stored. Though Aquinas did not equate the command component of prudence with fear,[97] fear that present and future humans, species, and ecological systems may be harmed by a release of radioactivity from the spent fuel pools due to

mechanical or human error is warranted and that should keep technicians, managers, elected officials, and the public alert to the need for safe storage. Lessons learned from Fukushima should be implemented as should human errors at Three Mile Island, Chernobyl, Windscale in England, Fermi 1 in Detroit, and SL-1 in Idaho Falls.[98]

- Participate in opportunities to learn about, review, and comment on efforts to isolate spent fuel from the biosphere so harm to humans, other species, and ecological systems is avoided. Openness to learn and participate should counter any tendencies toward narrow mindedness, docility,[99] and negligence which adversely affect one's ability to reason–the distinguishing characteristic of humans among other creatures.[100]
- Be alert to proposals for investigating geological repository sites, become informed about these proposals, and participate in proceedings with a dedication to assure people in the present and in the future are not adversely affected, including people on advisory panels who are most vulnerable and people who can represent future generations of humans and other species.
- Avoid being lured by government officials, the nuclear industry, and the electric utilities into the structural evil of imprudence and intergenerational injustice by warnings that more nuclear power plants need to be approved for construction and operation in the U.S. now so that our country can avoid dependency on foreign oil for national security reasons. Efforts have barely begun to use oil, natural gas, and other fossil fuels efficiently, to develop and support the use of renewable sources of energy, and to implement the wide array of energy efficiency strategies in all sectors of the economy.[101]
- Rebuke the hyperbole that more electricity generated by nuclear fission must be accepted to offset the carbon output that is forcing changes on the global climate, demonstrate a commitment to minimize carbon output wherever one has authority individually and collectively, demand incentives to implement more efficient technologies, and push for a tax on carbon that will serve as a disincentive of overuse and/or inefficient or inappropriate use.
- Demand that subsidies to nuclear not exceed subsidies to the development and implementation of energy efficiency strategies in all sectors of the U.S. economy and renewable sources of energy.

The fact that the nuclear industry wants even more subsidies should caution decision makers to the economic pitfalls of having

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

opted for nuclear generated electricity that was "sold" to become "too cheap to meter." Instead, nuclear fission has become too expensive to generate electricity without hefty subsidies from governments.[102] Nuclear never has been viable without hefty subsidies and remains non-viable without them, as President Obama has demonstrated.

Sustaining prudent and just decisions can be highly challenging when the time frame for achieving the heretofore goal of establishing and operating a means for isolating spent nuclear fuel from the biosphere. Following Aquinas, prudent individuals and communities must be steadfastly cautious and alert to impediments that might deter implementing the decision.

Remaining Steadfastly Cautious—The Virtue Of Fortitude

Developing the habit of remaining steadfast is essential if the intended good is to be achieved and evil avoided. Through the habit of remaining steadfast, prudent individuals and groups will be inclined to persevere despite impediments that may weaken their resolve—especially as decades pass, memories shorten, and other pressing issues emerge.[103]

Though Aquinas considered the habit/virtue of fortitude to incline humans to be steadfast despite fear and other passions that may impede their acting according to the dictates of prudence,[104] this virtue can be understood as fortifying the human resolve to take actions for fear of failing to be virtuous in this life,[105] for failing to be prudent about approving more nuclear plants before a means of isolating the spent fuel is operable, for failing to be just toward future humans by thrusting the burden for spent fuel management and disposition on them, and for failing to be moderate in using electricity.[106]

Should individuals fear failing to become virtuous persons by continuing this imprudence and intergenerational injustice and leaving the aftermath to be resolved by the next generation and beyond? Should a group of prudent individuals who are committed to justice fear failing? Should U.S. government decision makers fear failing its

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

responsibility to the next generation by leaving a legacy of highly radioactive spent fuel?

Fear of failing to halt the ongoing imprudence and intergenerational injustice should weigh heavily on the consciences of individuals, in the collective consciousness of groups, and on the consciousness of national decision makers who are ultimately responsible for assuring the isolation of the spent fuel before approving the construction of new nuclear power plants. The fear of failing to bring an end to approving more nuclear plants before a spent fuel isolation system is operating marks forever this generation's legacy to future generations. They will remember and scoff at ours for leaving an oppressive problem for them to resolve at their risks and repercussions.

Conversely, to leave the legacy of a courageous effort to resolve sixty years of imprudence and injustice, individuals who have developed the habits of making prudent decisions and acting justly toward others will persist in their commitment to demonstrate their opposition to approval and support for more nuclear power plants until a process for isolating the highly radioactive spent fuel accumulating at existing plants is isolated from the biosphere of Earth. Groups of prudent and just individuals will draw upon the virtue of fortitude to persist in advocating a national policy that precludes approving new nuclear power plants and initiates an earnest effort to isolate the spent fuel. National decision makers who are prudent and just will draw upon the virtue of fortitude to persist in pressuring their colleagues to establish a policy that precludes approving more nuclear plants and a plan that will isolate the spent nuclear fuel from contact with human and all forms of life.

At their various levels of endeavor, individuals acting solely, individuals collaborating with one another to form groups, and national decision makers are assured of God's continuous offer of help—of grace—to persist in their efforts.[107] Courage can be nurtured and bolstered within groups to remain steadfast when advocating intergenerational justice.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

Motivation For Becoming Prudent And Demonstrating Justice

According to Aquinas, the theological virtue of love—*caritate*—motivates a person to become and remain prudent and just. *Caritate* is a special kind of love infused in the human soul by God[108] which unites humans to God[109] and unites humans to one another.[110] When loving another, the person also loves the other's friends and acquaintances as well as strangers to the other and even the other's enemies.[111] The lover wishes the beloved happiness in this life and hopes for the person's ultimate good which is happiness with God forever.[112]

Aquinas's insight on loving one's neighbor with the highest kind of love is compelling when contemplating increased reliance on nuclear generated electricity as spent fuel continues to accumulate at power plants and adding more is proffered. One's neighbor would include neighbors in the next generation and beyond. One does not love one's neighbors by intentionally burdening them with managing, transporting, and attempting to isolate the spent fuel that has been offloaded from nuclear plants for sixty years and the spent fuel that will be offloaded from new plants if approved precipitously. This burden constitutes the opposite of love—lack of caring, abject selfishness, blatant irresponsibility, and callousness. Approving and facilitating more nuclear power plants when a system for isolating the highly radioactive spent fuel has not yet been established is an intentional affront to children today, to the next generation, and generations into the future.

Love for one's neighbors considered inclusively and expansively has significance for all people today. Love for one's neighbor can and should motivate individuals, advocacy groups, and national decision makers to establish a policy that demonstrates prudence and intergenerational justice pertaining to the spent fuel dilemma. Love of one's neighbor should be especially motivational for people at all levels of governance who profess faith in God, love God, and wish for eternal life in God's presence. As the late theologian Karl Rahner explained in the twentieth century, love for God is demonstrated by loving one's neighbor.[113]

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

Notes

* Marquette University–Theology, P.O. Box 1881, Milwaukee, WI 53201–1881; e-mail: schaeferj@ marquette.edu. Schaefer is an associate professor of systematic theology and ethics and director of the interdisciplinary minor in environmental ethics. An appointee for six years by successive Republican and Democrat governors to the State of Wisconsin's Radioactive Waste Review Board, she served as its first chairperson when the U.S. Department of Energy began considering the suitability of thirty-six crystalline rock formations in seventeen states for a second commercial spent fuel repository required by the Nuclear Waste Policy Act of 1982. Among her publications are *Theological Foundations for Environmental Ethics* (Washington, D.C.: Georgetown University Press, 2009), *Confronting the Climate Crisis* (Milwaukee: Marquette University Press, 2011), and the inaugural "Animals" entry in *New Catholic Encyclopedia* (Farmington Hills, Mich.: Gale Publishing, 2013).

[1]Lewis L. Strauss, Speech by the Chairman of the U.S. Atomic Energy Commission, New York City, 16 September 1954, in *New York Times,* 17 September 1954.

[2]Rob P. Rechard, Barry Goldstein, Larry H. Brush, James A. Blink, Mark Sutton, and Frank V. Perry, *Basis for Identification of Disposal Options for Research and Development for Spent Nuclear Fuel and High-Level Waste,* Sandia National Laboratories, Lawrence Livermore National Laboratory, and Los Alamos National Laboratory for DOE, FCRD-USED-2011-0000, March 2011; and Nuclear Energy Agency, "The Disposal of High-level Radioactive Waste," *NEA Issue Brief: An Analysis of Principal Nuclear Issues* 3 (January 1989), http://www.oecd-nea.org/brief/brief-03.html.

[3]President Jimmy Carter, "Policy Statement, The White House, 7 April 1977," Papers of the President, http://www.presidency.ucsb.edu/ws/index.php?pid=7315 and http://www.presidency.ucsb.edu/ ws/index.php?pid=7316.

[4]U.S. General Accountability Office, *Spent Nuclear Fuel: Accumulating Quantities at Commercial Reactors Present Storage and Other*

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

Challenges, GAO-12-797, Washington D.C., 15 August 2012, http://www.gao.gov/assets/600/593745.pdf.

[5]U.S. GAO, *Nuclear Waste: Issues Concerning DOE's Postponement of Second Repository Siting Activities*, Washington D.C., July 1986 (http://www.gao.gov/assets/90/87271.pdf).

[6]See "Special Report—Nuclear Energy: The Dream that Failed," *The Economist*, 10 March 2012, http://www.economist.com/sites/default/files/20120310_nuclear_power.pdf.

[7]Kristin Shrader-Frechette, *Environmental Justice: Creating Equality, Reclaiming Democracy* (New York: Oxford University Press, 2005); see also essays in R. D. Bullard, ed., *Unequal Protection: Environmental Justice and Communities of Color* (San Francisco: Sierra Club Books, 1994).

[8]Kristin Shrader-Frechette, *Burying Uncertainty: Risk and the Case against Geological Disposal of Nuclear Waste* (Berkeley: University of California Press, 1993).

[9]Kristin Shrader-Frechette, *What Will Work: Fighting Climate Change with Renewable Energy, Not Nuclear Power* (New York: Oxford University Press, 2011).

[10]See, e.g, Alissa J. Rubin and Milan Schreuer, "Belgium Fears Nuclear Plants are Vulnerable," *New York Times*, 25 March 2016, http://www.nytimes.com/2016/03/26/world/europe/belgium-fears-nuclear-plants-are-vulnerable.html?_r=0); Editorial Staff, "Targets for Terrorism: Nuclear Facilities," Council on Foreign Affairs, 1 January 2006 (http://www.cfr.org/homeland-security/targets-terrorism-nuclear-facilities/p10213#p0); and Union of Concerned Scientists, "Nuclear Security: Terrorists Pose a Real and Significant Threat to Nuclear Power Plants," http://www.ucsusa.org/nuclear-power/nuclear-plant-security#.VvyiODGbWIS.

[11]While approaching this problem as a systematic theologian and ethicist, I draw upon my experience as a non-governmental organization (NGO) leader who opposed the construction and licensing of additional nuclear power plants until disposition of the spent fuel is resolved, an appointee by two governors of different political parties to the State of Wisconsin's Radioactive Waste Review Board when the Nuclear Waste Policy Act of 1982 was in the process of enactment and the U.S. DOE was

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

searching for a repository site in crystalline rock, and a litigant on behalf of an NGO in the U.S. Nuclear Regulatory Commission's 1984 Waste Confidence Proceeding (U.S. Nuclear Regulatory Commission, "Waste Confidence Decision," 10 CFR Parts 50 and 51, *Federal Register*, vol. 49, no. 171, 34658-34686, 31 August 1984, http://pbadupws.nrc.gov/docs/ML1233/ML12335A680.pdf. Subsequent rule-makings by the NRC are discussed succinctly by Luther J. Carter, Lake H. Barrett, and Kenneth C. Rogers in "Nuclear Waste Disposal: Showdown at Yucca Mountain," *Issues in Science and Technology* 27 (Fall 2010): 80–84.

[12]Aquinas, *Summa contra Gentiles,*1.92.

[13]Aquinas, *Summa Theologiae,* 1|2.58.3, 62.1, 66.3, and 68.8.

[14]Ibid., 1|2.58.1, 50.3, and 63.1.

[15]Ibid., 1|2.55.1–3, and 63.1.

[16]Ibid., 1|2.56.3.

[17]Ibid., 1|2.57.4-6, and 2|2.47.7.

[18]Ibid., 1|2.58.

[19]Ibid., 1|2.61.2.

[20]Ibid., 1|2.58.5.

[21]Ibid., 1|2.65.1.

[22]Ibid., 1|2.61.4.

[23]Ibid., 1|2.57.4–6; 2|2.47.1–2, and 8.

[24]Ibid., 2|2.47.10 ad 2.

[25]U.S. General Accountability Office, *Commercial Nuclear Waste: Effects of a Termination of the Yucca Mountain Repository Program and Lessons Learned*, GAO-11-229, April 2011, p. 6 (http://www. gao.gov/assets/320/317627.pdf).

[26]U.S. Nuclear Regulatory Commission, "High-Level Waste," 2012 (http://www.nrc.gov/waste/ high-level-waste.html).

[27]U.S. Environmental Protection Agency, "Fact Sheet: Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada, Final Rule (40 CFR Part 197)," April 2016 (http:// www.epa.gov/radiation/yucca/2008factsheet.html#ts).

[28]The length of time required for half of the atoms of a radioactive isotope to decay to another.

[29]U.S. Environmental Protection Agency, "Radiation Protection: Radioactive Decay," Washington D.C., April 2016, https://www.epa.gov/radiation/radioactive-decay; see also U.S.

NRC, "Radioactive Waste," April 2015, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/radwaste.html.

[30]U.S. Environmental Protection Agency, "Radiation Protection: Glossary," Washington, D.C., December 2013, http://www.epa.gov/radiation/glossary/index.html#c.

[31]Ibid.

[32]U.S. Department of Energy, Office of Scientific and Technical Information, *Nonproliferation and Arms Control Assessment of Weapons-usable Fissile Material Storage and Excess Plutonium Disposition Alternatives*, January 1997, p. 37 (http://www.osti.gov/scitech/servlets/purl/425259): "The most common isotope, Pu-239, is produced when the most common isotope of uranium, U-238, absorbs a neutron and then quickly decays to plutonium 239. It is this plutonium isotope that is most useful in making nuclear weapons, and it is produced in varying quantities in virtually all operating nuclear reactors."

[33]James D. Werner, "U.S. Spent Nuclear Fuel Storage," *Congressional Research Service,* 24 May 2012, http://www.fas.org/sgp/crs/misc/R42513.pdf.

[34]U.S. General Accountability Ofice, *Commercial Nuclear Waste,* p. 6.

[35]Werner, "U.S. Spent Nuclear Fuel Storage."

[36]Robert Alvarez, "Spent Nuclear Fuel Pools in the US: Reducing the Deadly Risks of Storage," *Environmental Defense Institute News on Environmental Health and Safety Issues* 22, no. 5 (2011): 2 (http://www.environmental-defense-institute.org/publications/News.11.June.Final.pdf).

[37]Werner, "U.S. Spent Nuclear Fuel Storage."

[38]Blue Ribbon Commission on America's Nuclear Future, *Report to the Secretary of Energy*, Washington, D.C., January 2012, p. 3 (http://brc.gov/sites/default/files/documents/updated_rfct_report_final. pdf).

[39]Disposal Subcommittee, "Report to the Full Commission: Updated Report," *Blue Ribbon Commission on America's Nuclear Future,* Washington, D.C., January 2012, p. ii (http://cybercemetery.unt. edu/archive/brc/20120620220845/ and http://brc.gov/sites/default/files/documents/disposal_report_updated_final.pdf).

[40]Ibid., p. 33.

[41]Blue Ribbon Commission, *Report to the Secretary of Energy*, p. vi.

[42]Ibid., p. vii.

[43]U.S. Department of Energy, *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste,* January 2013, http://energy.gov/sites/prod/files/Strategy%20for%20the%20Management%20and%20Disposal%20of%20Used%20Nuclear%20Fuel%20and%20High%20Level%20Radioactive%20Waste.pdf.

[44]U.S. Senate Committee on Natural Resources, "Senators Release Discussion Draft of Comprehensive Nuclear Waste Legislation," news release, Washington, D.C., 25 April 2013 (http://www.energy.senate.gov/public/index.cfm/2013/4/senators-release-discussion-draft-of-comprehensive-nuclear-waste-legislation).

[45]U.S. General Accountability Office, *Commercial Spent Nuclear Fuel*.

[46]Ibid., p. 11.

[47]Werner, "U.S. Spent Nuclear Fuel Storage."

[48]U.S. General Accountability Office, *Commercial Spent Nuclear Fuel*, p. 11 (http://www.gao.gov/ assets/660/653731.pdf). Many other challenges as well as benefits for the nuclear industry are discussed in this report. The challenges include uncertainties pertaining to costs that taxpayers must cover because the DOE did not take custody of the spent fuel beginning in 1998 as required by the Nuclear Waste Policy Act of 1998 when the availability of a repository was anticipated. On p. 8, the GAO estimates the taxpayer liabilities at approximately $22.3 billion and reports that DOE estimates future liabilities to cost $500 million each year after 2020.

[49]Rechard et al., *Basis for Identification of Disposal Options;* also Nuclear Energy Agency, "The Disposal of High-level Radioactive Waste."

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Cycle: An Interdisciplinary MIT Study (Cambridge Mass.: Massachusetts Institute of Technology, 2011).

[51]U.S. General Accountability Office, *Commercial Nuclear Waste.*

[52]Aquinas, *Summa Theologiae* 2|2.49.1; and also 2|2.47.8 and 1|2.57.6.

[53]U.S. General Accountability Office, *Commercial Nuclear Waste,* pp. 7–8.

[54]J. Dexter Peach, Letter to U.S. Senator Nancy Kassebaum, U.S. GAO, Washington, D.C., 23 March 1982 (http://www.gao.gov/assets/140/136974.pdf).

[55]Joonhng, Ahn, and Michael J. Apted, eds., *Geological Repository Systems for Safe Disposal of Spent Nuclear Fuels and Radioactive Wastes* (Oxford: Woodhead Publishing Limited, 2010).

[56]U.S. General Accountability Office, *Commercial Nuclear Waste*.

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[58]Congressional Budget Office, *Nuclear Waste Disposal: Achieving Adequate Financing,* Congress of the United States, Washington D.C., 1984, http://www.cbo.gov/sites/default/files/1984_08_disposal. pdf.

[59]Michael Kraft, Bruce Cleary, and Jame Schaefer, "Politics, Planning and Technological Risk: State and Citizen Participation in Nuclear Waste Management," Annual Meeting of the American Political Science Association. Chicago, 5 September 1987; Michael Kraft and Bruce Cleary, "Citizen Participation and the NIMBY Syndrome: Public Response to Radioactive Waste Disposal," *Political Research Quarterly* 44 (June 1991): 299–328; Jame Schaefer, *State Opposition to Federal Nuclear Waste Repository Siting: A Case Study of Wisconsin 1976–1988*, Center for Public Affairs, University of Wisconsin-Green Bay (1988)*; Public Reactions to Nuclear Waste: Citizens' Views of Repository Siting,* ed. Riley E. Dunlap, Michael E. Kraft, and Eugene A. Rosa (Durham: Duke University Press, 1993).

[60]Carter et al., "Nuclear Waste Disposal: Showdown at Yucca Mountain."

[61]U.S. Department of Energy, *Preliminary Site Requirements and Considerations for a Monitored Retrievable Storage Facility*, Office of Civilian Radioactive Waste Management, DOE/RW-0315P, August 1991, http://energy.gov/sites/prod/files/edg/media/MRS_Preliminary_Site_Requirements.pdf.

[62]Suzanne Westerly, "What the 'Atomic Age' Began: Grace Thorpe Honored Working for Nuclear Free Azones Across America," *News From Indian Country: The Independent Native Journal,* Los Alamos, N.M., October 1999; Tirso A. Gonzales and Melissa K. Nelson, "Contemporary Native American Responses to Environmental Threats in Indian Country," in *Indigenous Traditions and Ecology: The Interbeing of Cosmology and Community,* ed. John A. Grim (Cambridge: Harvard University Press, 2001), pp. 495–538.

[63]Shepard Krech III, *The Ecological Indian: Myth and History* (New York: W. W. Norton, 1999), p. 222. See also Minnesota Nuclear Waste Council, "Summary of the Comments on the U.S. Department of Energy Draft Area Recommendation Report for the Crystalline Repository Project," Summary of Comments on the U.S. Department of Energy Draft Area Recommendation Report for the Crystalline Repository Project, Minneapolis, March 1988; Gonzales and Nelson, "Contemporary Native American Responses to Environmental Threats in Indian Country."

[64]Werner, "U.S. Spent Nuclear Fuel Storage."

[65]Established in salt beds by the U.S. government for isolating transuranic radioactive wastes which are less hazardous than spent fuel removed from commercial nuclear power plants.

[66]Mark Holt, *Nuclear Waste Disposal: Alternatives to Yucca Mountain*, Congressional Research Service, R40202, Washington, D.C., 26 February 2009, p. 23.

[67]National Research Council, *Disposition of High-Level Waste and Spent Nuclear Fuel;* Nevada Agency for Nuclear Projects, "Nuclear Waste Policy Dilemma the First Fifty Years: A Chronology," State of Nevada, 2000 (http://www.state.nv.us/nucwaste/yucca/nwchron1.htm).

[68]U.S. General Accountability Office, *Commercial Nuclear Waste*.

[69]E.g., Kraft and Cleary, "Citizen Participation and the NIMBY Syndrome: Public Response to Radioactive Waste Disposal";

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

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[72]U.S. General Accountability Office, *Commercial Spent Nuclear Fuel*, pp. 8–12.

[73]Aquinas, *Summa Theologiae,* 2|2.47.8 and 1|2.57.6.

[74]Ibid., 2|2.47.8–9; 1|2/57.6.

75Ibid., 2|2.49.6.

[76]Ibid., 2|2.49.7.

[77]Shrader-Frechette, *What Will Work*. See also Erin Lothes Biviano, David Cloutier, Elaine Padilla, Christiana Peppard, and Jame Schaefer, "Catholic Moral Traditions and Energy Ethics for the Twenty- First Century," *Journal of Moral Theology* 5, no. 1 (2016): 18–22.

[78]E.g., Union of Concerned Scientists, "Smart Energy Solutions: Improve Energy Efficiency" (2014), http://www.ucsusa.org/clean_energy/smart-energy-solutions/improve-efficiency; U.S. GAO, "Energy Efficiency: Better Coordination among Federal Programs Needed to Allocate Testing Resources," GAO–13–135, 28 March 2013 (http://www.gao.gov/products/GAO-13-135); U.S. Senate S.761, Energy Savings and Industrial Competitiveness Act of 2013 (http://www.energy.senate.gov/public/index.cfm/legislation?ID=bd50af41-6efd-43e1-a69b-3d23ab672bcc).

[79]A few are growing rapidly and costs are decreasing dramatically; e.g., Levi Tillemann, "Revolution Now: The Future Arrives for Four Clean Energy Technologies," U.S. DOE, September 2013

(http:// energy.gov/sites/prod/files/2013/09/f2/200130917-revolution-now.pdf).

[80]Christine Shearer, John Bistline, Mason Inman, and Steven J. Davis, "The Effect of Natural Gas Supply on U.S. Renewable Energy and CO_2 Emissions," *Environmental Research Letters*, 24 September 2014 (http://iopscience.iop.org/article/10.1088/1748-9326/9/9/094008/pdf). Also see Charlotte Cox, Molly Christian, and Neil Powell, "Coal-to-Gas Switching," *American Oil and Gas Reporter,* 17 April 2016 (http:// www.aogr.com/web-exclusives/exclusive-story/power-generators-turning-to-natural-gas). According to the U.S. Energy Information Administration, "Electricity Explained: Electricity in the United States," 29 March 2016 (http://www.eia.gov/energyexplained/index.cfm?page=electricity_in_the_united_states), natural gas fueled approximately thirty-three percent of the electricity generated in the U.S. in 2015 while coal generated another thirty-three percent, nuclear twenty percent, and renewable thirteen percent.

[81]Steve Hamburg, "Methane: The Other Important Greenhouse Gas," Environmental Defense Fund, 13 April 2016 (https://www.edf.org/methane-other-important-greenhouse-gas). A list of studies by government and academic research institutions on methane leaks is available in Katie Brown, "Study Finds Decrease in Methane Emissions from Fracking," *Energy in Depth*, 14 July 2015 (http://energyindepth. org/national/top-methane-studies-confirm-low-and-dramatically-declining-emissions).

[82]For example, the nuclear advocacy group Clean and Safe Energy Coalition unveiled in April 2016 an interactive map that explores the potential value of nuclear energy in helping a state meet U.S. EPA's Clean Power Plan goals; see CAS Energy Coalition, "Clean Power Resource Center," 18 April 2016 (http://casenergy.org/clean-power-resource-center/). Emily Holden and Rod Kuckro anticipate the American Nuclear Society's releasing "a new set of tools to help policymakers craft options to comply with the U.S. EPA's carbon rule; see "Power Plan Hub: Nuclear Advocates Roll Out Carbon Rule Calculator," *E&E Publishing,* 18 April 2016

(http://www.eenews.net/interactive/clean_power_plan/ column_posts/1060035769). CNN Wire Staff, "Energy Secretary Defends U.S. Nuclear Industry," *CNN Politics,* 16 March 2011 (http://www.cnn.com/2011/POLITICS/03/15/chu.nuclear.power /index.html).

[83]Kazimi and Moniz, *The Future of the Nuclear Fuel Cycle.*

[84]Ibid.

[85]Ibid.

[86]Though disposition of spent nuclear fuel in deep geological repositories is preferred by countries that are generating electricity (e.g., Argentina, Austalia, Belgium, the Czech Republic, Finland, Japan, The Netherlands, the Republic of Korea, Russia, Spain, Sweden, Switzerland, and the U.S.), the International Atomic Energy Agency reported in "Managing Spent Nuclear Fuel: Global Overview," September 2015 (https://www.iaea.org/newscenter/focus/radwaste-management/managing-spent-nuclear-fuel-global-overview): "No country has a geological repository for spent fuel storage or disposal. Neither have most countries decided on a final destination for spent fuel." Sweden, Finland, and France have selected sites for a repository while Canada and the United Kingdom are in the site selection process according to the World Nuclear Association, April 2016 (http://www.world-nuclear.org/information-library/ nuclear-fuel-cycle/nuclear-wastes/appendices/radioactive-waste-management-appendix-2-storage-an. aspx).

[87]U.S. Nuclear Regulatory Commission, "Japan Lessons Learned" (http://www.nrc.gov/reactors/ operating/ops-experience/japan-dashboard.html); DOE, Office of Environmental Management, "Accident Investigation Report: Waste Isolation Pilot Project, April 2014" (http://energy.gov/sites/prod/ files/2014/04/f15/Final%20WIPP%20Rad%20Release%20Phase%201%2004%2022%202014_0.pdf).

[88]Ironically, though some states have encouraged and facilitated the building of more nuclear power plants within their borders through economic incentives, the history of attempts to site a repository in Kansas, Louisiana, seventeen states underlain with crystalline rock, and Nevada's tuff is replete with resistance by these states, local governments, and the public. Clearly, a

disconnection persists between responsibility for generating and using the electricity that is produced and for the disposition of the highly radioactive spent fuel that results. Resistance of the past suggests that few if any states will welcome a repository within their borders.

[89]U.S. Department of Energy, *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste.*

[90]According to the Blue Ribbon Task Force on America's Nuclear Future, p. xii, "regardless what happens with Yucca Mountain, the U.S. inventory of spent nuclear fuel will soon exceed the amount that can be legally emplaced at this site until a second repository is in operation. So under current law, the United States will need to find a new disposal site even if Yucca Mountain goes forward."

[91]Schaefer, *State Opposition to Federal Nuclear Waste Repository Siting*.

[92]Kraft et al., "Politics, Planning and Technological Risks."

[93]Kazimi and Moniz, *The Future of the Nuclear Fuel Cycle*, p. xv.

[94]E.g., Union of Concerned Scientists, "Draft Senate Nuclear Waste Bill Fails to Address Current Storage Safety Issues at Nuclear Power Plants," 25 April 2013 (http://www.ucsusa.org/news/press_release/draft-senate-nuclear-waste-0378.html.

[95]Aquinas, *Summa Theologiae,* 2|2.49.8; also 2|2.47.9 and 1|2.57.6.

[96]In *Summa Theologiae,* 2|2.49.3–4, Aquinas explains that docility requires slowing down to listen and remaining shrewd when moving toward a decision.

[97]In *Summa Theologiae*, 1|2.44.2, Aquinas considered fear a poor counselor.

[98]U.S. Nuclear Regulatory Commission, "Backgrounder on the Three Mile Island Accident" (http:// www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html); U.S. NCR, "Fact Sheets and Brochures" (http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/#fs); "Hyperphysics," Georgia State University (http://hyperphysics.phy-str.gsu.edu/hbase/NucEne/nucacc.html).

[99]Aquinas, *Summa Theologiae*, 2|2.49.3.

[100]Ibid., 2|2.54.1–3.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.

[101]According to the U.S. Energy Information Administration (EIA) in "International Energy Outlook 2013" (http://www.eia.gov/tools/faqs/faq.cfm?id=527&t=1), approximately ten percent of world marketed energy consumption comes from renewable energy sources (hydropower, biomass, biofuels, wind, geothermal, and solar) which is projected to increase to fourteen percent by 2035. EIA estimates that about nineteen percent of world electricity generation is from renewable energy, with a projection of nearly twenty-three percent in 2035. For energy efficient measures, see Union of Concerned Scientists, "Smart Energy Solutions: Improve Energy Efficiency," March 2012 (http://www.ucsusa.org/ clean_energy/smart-energy-solutions/improve-efficiency/); Union of Concerned Scientists, *Climate 2030: A National Blueprint for a Clean Energy Economy*, May 2009 (http://www.ucsusa.org/assets/ documents/global_warming/Climate-2030-Blueprint_executive-summary.pdf); Nuclear Energy Institute, "Public Opinion Survey Shows Overwhelming Support for Clean-Energy Loan Guarantees," NEI News Release, 17 February 2011 (http://www.nei.org/newsandevents/newsreleases/public-opinion-survey-shows-overwhelming-support-for-clean-energy-loan-guarantees/). A wide array of consumption types by state and sector was compiled by the U.S. Energy Information Administration in "Consumption and Efficiency," August 2010 (http://www.eia.gov/emeu/efficiency/energy_savings.htm), though an update would be helpful.

[102]Doug Koplow, *Nuclear Power—Still Not Viable without Subsidies,* http://www.ucsusa.org/sites/ default/files/legacy/assets/documents/nuclear_power/nuclear_subsidies_report.pdf, pp. 15–16, Subsidies include reactor loan guarantees or direct loans (domestic and foreign)—very large; recovery of construction/work-in-progress (regulated utilities only)—large; transfer of stranded asset liabilities and traditional rate regulation/return on investments even if not used or economically competitive—large; the Price-Anderson cap on accident liability on reactors—large; fuel-cycle facilities and shippers—large; plant security/low design-basis requirements

for attacks—moderate to large; and subsidies to decommissioning and waste management—large. The informative and reflective "Special Report—Nuclear Energy: The Dream that Failed" in *The Economist* (http://www.economist.com/node/21549936) reinforces Koplow's conclusions.

[103]Aquinas, *Summa Theologiae*, 2|2.123.2–3; see further ibid., 2|2.123.11, 141.3, and 1|2.61.4.

[104]Ibid., 1|2.61.2.

[105]Ibid., 2|2.142.3.

[106]Ibid., 1|2.68.4. According to the U.S. Energy Information Administration, the primary energy consumption of the U.S. in 2012 was approximately nineteen percent of the world's total primary energy consumption; "What is the United States' Share of World Energy Consumption?" 10 February 2015 (https://www.eia.gov/tools/faqs/faq.cfm?id=87&t=1).

[107]Jame Schaefer, *Theological Foundations for Environmental Ethics: Reconstructing Patristic and Medieval Concepts* (Washington, D.C.: Georgetown University Press, 2009), pp. 244–45, 258–63.

[108]Aquinas, *Summa Theologiae*, 1|2.62.1.

[109]Ibid., 2|2.161.5; *De Caritate,* 3 ad 17.

[110]Ibid., 2|2.23.1; 25.1, 2. The virtue of charity unites the human being to God by directing all the other virtues to the divine good; also see Aquinas, *Summa Theologiae*, 1|2.65.3; 2|2.23.7-8; 58.6; 184.1 and *De Caritate,* 3.

[111]Ibid., 2|2.184.2 ad 3; Aquinas, *Summa contra Gentiles,* 3.117.2.

[112]Ibid., 2|2.25.2.

[113]Karl Rahner, "Reflections on the Unity of the Love of Neighbour and the Love of God," in *Theological Investigations* (New York: Crossroads, 1982), vol. 6, pp. 231–49.

Environmental Ethics, Vol 38, No. 3 (2016): pg. 259-286. DOI.