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Nuclear Power

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ABSTRACT. Nuclear power has never been free from the stifling involvement of government. Heavy regulation has reduced the ability of entrepreneurs to develop and provide new means for the generation of energy using nuclear fuel. The strict parameters dictated by government officials are based upon outdated technology, an improper regulatory philosophy, and preclude innovation in nuclear power generation. Anti-market environmentalists misunderstand the implications of a free market in nuclear power and argue against it based on problems that are actually caused by government involvement. Our position is neither for nor against nuclear power. We advocate a hands-off policy where the nuclear industry is left to its own devices, free from governmental regulations and subsidies: free to succeed or fail on its own. Thus, our position is neither right-wing conservative (removing regulations), nor left-wing liberal (removing subsidies). Very much to the contrary of both positions, we propose a free-market in nuclear power.

KEY WORDS: nuclear, energy, Price Anderson, subsidies, government interference, NIMBY

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Introduction

Nuclear energy has been heavily subsidized, and regulated, from its inception. The unintended consequence of these policies, however, was a distortion in the price of nuclear power, masking true costs of the investment, and result in gross inefficiencies. We propose a free market solution for this market. Subsidies, via the Price–Anderson Act, and regulations via the Nuclear Regulatory Commission (NRC), should be removed. In fact, we advocate the removal of all governmental distortions in the energy market.

First, we will discuss the history of the Price–Anderson Act, and how it distorts market signals. Then we turn our attention to the NRC's regulations – how these stifle innovation, and increase investment uncertainty. We find that the NRC's regulatory philosophy is inherently flawed and argue instead for free-market ''regulation'' via insurance companies. Finally, we discuss how a capitalist system would address the problems of regulation, nuclear waste disposal, and the NIMBY problem.

Should there even be a nuclear industry? Our position is neither for nor against. We advocate a hands-off policy where this initiative is left to its own devices, free from governmental regulations and subsidies: free to succeed or fail on its own.

The Price–Anderson Act

The United States government initially became involved in the development of nuclear power plants so as not to be outstripped by the Communist Bloc in the kilowatt race (Morone and Woodhouse, 1989, p. 51). That is to say, the U.S. government undertook to beat eastern planning with western planning. The problem was that semi-private enterprise[1] was not developing and producing viable forms of nuclear power fast enough, at least by the standards of elected officials. One issue involved the liability insurance regarding catastrophic atomic accidents. Because private insurers would only provide coverage up to $50 million and it was believed that the actual cost of such an event would be much more, Congress passed the Price–Anderson Act in 1957. By enacting this law, the government limited the amount of damages to be paid in the event of a nuclear catastrophe to exactly the amount it felt comfortable paying were such a tragedy to occur, $500 million. Having left the market to develop nuclear

energy for four years, the government became involved again, supposedly for the greater social good.

The amendments to the Atomic Energy Act in 1959 sought to stimulate nuclear power development ''by a combination of three devices: a requirement of 'financial protection'; government indemnity; and an over-all limitation on liability'' (Murphy, 1961, p. 16). Instead of allowing innovation in the market to develop safer applications of nuclear technology, as illustrated by appropriate insurance coverage, the government built on the philosophy undergirding the Price–Anderson Act and forced energy companies to purchase whatever insurance coverage was available and then provided the additional liability coverage up to a limit of $500 million. In addition, the government instituted the Power Reactor Demonstration Program to ''subsidize the cost of fuel, conduct pertinent research and development work for free at the national labs, and help pay for some of the research and development conducted by private industry'' (Morone and Woodhouse, 1989, p. 53).

By muscling into the development of nuclear technology, the government has altered the course of innovation in nuclear power production. When the Price–Anderson Act was passed, the size of the reactor was assumed to be quite large of necessity. This high risk (and price) associated with a nuclear reactor without government intervention would provide an incentive for individuals to develop and market new ways of containing and controlling nuclear power.

The Price–Anderson Act, argue Morone and Woodhouse (1989), preempted any such innovation and passed into law the ensured coverage of up to $500 million in the event of a nuclear catastrophe. Innovative applications of nuclear reactors may have resulted, for example, in the use of many small, dispersed reactors to generate power where the cost associated with an accident at any one reactor would be greatly reduced. Here, the federal government has subsidized high-risk large reactors and not allowed the market to develop methods of nuclear energy with acceptable levels of risk, as illustrated by adequate levels of privately provided insurance.

The Energy Policy Act of 2005 extended the Price–Anderson Act to 2025. In this current incarnation, power companies are required to purchase up to $300 million per plant in *private* insurance. If there is a claim against any one of the country's 103 nuclear plants, every last one of them must contribute up to $95.8 million toward restitution for the damages caused by the oender. The power companies are thus required to insure each other, up to damages of approximately $9.5 billion. But power companies are insulated from any further damages they might cause. Previous experience tells us that if a catastrophe were to occur, with more money being needed, Congress would raise the money. But the important feature here is that the offending power company would not be liable for the additional damages. This is an invitation to what economists call ''moral hazard.'' This refers to the phenomenon where an insured individual will undertake more risky behavior, simply because he is insured (for example, you drive faster if you wear seatbelts). So the Price–Anderson Act encourages excessively risky behavior because the offending companies would not have to pay the costs of the damages they cause.

If the expected cost of a nuclear accident is less than $300 million, it pays the company to reduce its exposure, balancing the marginal benefit in insurance savings with the additional marginal cost of instituting the safety measures. The firm's marginal cost versus marginal benefit decision shifts toward risky behavior once expected losses rise to between $300 and $395.8 million. If the benefits of engaging in more risk (in terms of cost savings) are borne by the firm, but the costs of increased liability are split 103 ways, then there is a tendency toward augmented risk. Further, once a firm expects to inflict damages in excess of $395.8 million, it incurs no additional insurance savings, only the costs of instituting the safety measures. It will clearly, then, not be in the firm's interest to reduce its exposure to risk, once it contemplates expected losses in excess of $395.8 million.

If we experienced the type of severe nuclear accident that Greenpeace (Riccio, 2001) believes we could, damages would be in the range of $560 billion in 2000 dollars. This may be an overly pessimistic estimate, but let us use it for illustrative purposes. If damages were $560 billion, the firm's liability would be $395.8 million. If damages were reduced to $400 million, the firm's liability remains unchanged. Why, then, would a rational company spend any money to reduce its liability to anything over $395.8 million. Such an investment would be pure loss for the firm.[2]

All insurance induces some moral hazard.[3] But because the Price–Anderson Act has completely limited the legal liability of a nuclear firm, that is, because it is subsidized insurance – it creates more moral hazard than would have arisen through the market. Instead of repealing the risk-inducing Price–Anderson Act, the government turned to a labyrinth of safety regulations.

We join Greenpeace USA (Riccio, 2001), the Cato Institute (Brownstein, 1984), The Brookings Institution (Nivola, 2004), and Taxpayers for Common Sense (Lancelot) in opposing the Price–Anderson Act.

NRC regulation

Morone and Woodhouse (1989, p.120) ask the question, ''What about the possibility that the technology was effectively out of society's control because decisions were made by a nonrepresentative group of elites?'' This is indeed what happened when the ''group of elites'' is understood to be government bureaucrats. They further describes the result of this involvement

> ''There followed two decades of regulatory changes in reactor design and operation, but virtually all such modifications were variations within an unchanging basic approach. The momentum effectively precluded serious exploration of alternative technologies and significantly different approaches to safety'' (1989, p. 125).

Their point concerns the multitude of possible types of nuclear reactors. As government regulation and licensing of private reactors increased, the specifics contained in those regulations had more and more to do with a single type of reactor, necessarily precluding any possibility of innovation down alternative avenues.

Currently, Section 50, Title 10 of the Code of Federal Regulations governs the licensing of nuclear reactors. In this 200-page exposition, specifics regarding a plant's ''managerial and administrative controls to be used to assure safe operation'' (§50.34.b.6.ii), ''plans for preoperational testing and initial operations'' (§50.34.b.6.iii), ''plans for conduct of normal operations'' (§50.34.b.6.iv), ''plans for coping with emergencies'' (§50.34.b.6.v), and ''proposed technical specifications prepared in accordance with the requirements of §50.36'' (§50.34.b.6.vi) are all subject to the approval process. Basically, this code specifies the way a nuclear power plant must be run, down to the most minute technical specifications of the amount and placement of automatic isolation valves (§50 Appendix A Criterion 56.4). It is unfortunate that regulators and legislators cannot see into the future, or account for as-yet undreamed of alternative future technologies that might arise. Alas, we are all human. Current regulations are based on the amount and type of technology possessed today. If, for example, a new reactor was developed that did not require automatic safety valves, the reactor would not be approved for licensing without adding the extraneous valves.

Michael Porter and Claas van der Linde (1995) disagree with the claim that too much government direction stifles technological advancement, and instead argue that it can stimulate innovation. However, their idea that ''regulation signals companies about likely resource inefficiencies and potential technological improvements'' (1995, p. 98) is completely untenable. Buried in this statement is the assumption that the government somehow has knowledge of a ''more efficient'' resource allocation and benevolently informs entrepreneurs of their oversight via regulations that guide private industry down the socially beneficial road.[4] For example, Porter and van der Linde might imagine the NRC discovering that the benefits of a particular valve (in terms of increased energy production, decreased risk of accident, or whatever) are greater than the costs of that valve. Porter and van der Linde would then have the NRC mandate that nuclear plants use that valve. But how did the NRC discover this, while this was somehow kept hidden from the practitioners of nuclear energy production?[5] If we have learned anything from the fall of communism in 1989, it is that the owners of property have the most expertise in the application and preservation of their property, not a coalition of ''experts'' commissioned by the government. Further, if the benefits of the valve were indeed greater than its costs, would not any profit-maximizing firm voluntarily choose to use the valve? If this mechanism really is cost-efficient, then firms will voluntarily choose to use it. If it is not, but the NRC mistakenly believes it to be, then the NRC has introduced greater inefficiency. In reality, an individual who sees an unexploited opportunity to profit

from some resource allocation and chooses to act on this knowledge is an entrepreneur (Kirzner, 1973). The possible profits direct resource owners to apply their resources in the most efficient manner given the level of technology available.

Another claim by Porter and van der Linde (1995, p. 100) is that "regulation reduces the uncertainty that investments to address [the] environment will be valuable. Greater certainty encourages investment in any area." One problem with this claim is that it assumes that more "investment in any area" is better than less. But more investment in any one area *necessarily* implies *less* in some other area. It is unclear as to why there is a case for more investment in the regulated sector of the economy at the cost of less in the unregulated sector.

Another problem is that it is by no means true that regulation leads to less uncertainty that produces, in turn, more investment. Very much to the contrary, the possibility of regulation affecting the legality of investments *increases* uncertainty and thus *reduces* the amount of investments.[6] This is *very* much the case with regard to rent control, a price regulation on rental housing. This program has been so destructive of new building and upkeep of old dwellings, that even proponents of government regulation in general have acknowledged this eect. For example, stated Lindbeck (1972): "In many cases, rent control appears to be the most efficient technique presently known to destroy a city except for bombing;" and according to Myrdal (1965): "Rent control has in certain western countries constituted, maybe, the worst example of poor planning by governments lacking courage and vision."

Regulation may increase uncertainty and decrease investment for another reason. The limited length of time conferred by nuclear power plant licenses decreases the life of the investment and the value of it. A publication of the Nuclear Regulatory Commission illustrates this uncertainty: "the original operating license for a nuclear power plant has a term of 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met" (Strasma and Mitlyng, 2004, p. 1). A nuclear power plant requires a large amount of capital. Combined with the limited profit opportunity in the energy production industry, a long-term approach to returns must be adopted.[7] The limited life of 40 years and the uncertain extension of up to 20 years more gives an individual constructing a nuclear power plant, at best, 60 years to recoup and profit from the initial investment. The time frame may be too short, or too long, but the point is that the lifespan of a nuclear reactor is arbitrarily determined by the NRC and the operations of such a plant are just as subject to public opinion (if not more so) as they are to the profitable production and distribution of energy.

Consider the example of the Shoreham Nuclear Power Station in Long Island. The owners of Shoreham were granted a license to begin construction of the plant in 1973. After years of redesigns in order to comply with changing regulations, Shoreham was issued a license in 1985 to begin testing the plant at 5% capacity. That license was effectively revoked a few months, and $5.6 billion dollars, later due to intense public opposition. Not 1 kW of commercial power was ever generated at the Shoreham plant. (State of New York Office of the State Comptroller, Division of Management Audit). One detail of this story will serve as a counterexample to Porter and van der Linde:

> "The Shoreham plant on New York's Long Island is a virtual twin to the Millstone 1 plant in Connecticut, both ordered in the mid-'60s. Millstone, completed for $101 million, has been generating electricity [to this day]... Shoreham, however, was singled out by anti-nuclear activists..." (American Nuclear Society)

Certainly, if Millstone-1 was considered safe, why wasn't Shoreham? Contrary to Porter and van der Linde, regulations seem to have increased uncertainty, as the two plants are virtually identical. What was the difference that made the difference? Shoreham was too close to New York City. We grant that proximity to a major city should be a major consideration. However, this does not invalidate our point: regulations can change and completely wipe out the value of an investment. Investment uncertainty is improperly increased.

In what amounts to an astonishing admission, in 1999, the NRC decided to switch regulatory focus to a more risk-informed basis. The Nuclear Energy Institute (NEI)[8] seemed pleased with this, since the NRC would be "devoting less regulatory attention to issues with little or no safety significance" (NEI,

2004). In testimony before a Senate subcommittee, Gary Jones of the General Accounting Office reported that the ''NRC believes that a risk-informed approach would reduce unnecessary regulatory burden and costs, without reducing safety.'' Balancing the costs and benefits, risks and rewards, is exactly what the market does best. Risk assessment is exactly what the insurance industry would insist upon. Profitable business for an insurance company is impossible without proper risk assessment. That is why they ask you if you smoke when you apply for health insurance; smokers are at a quantifiably greater risk of contracting lung cancer. Similarly, a properly priced nuclear insurance policy would require estimating the likelihood of various nuclear catastrophes.

The NRC, on the other hand, has not taken risk factors into account when it created its regulations. In the same senate sub-committee meeting, Gary Jones reported that

> ''Since the early 1980s, NRC has *considered applying risk to the regulatory process*. [Emphasis added.] To facilitate a discussion about the enforcement program... at NRC's request, NEI and the Union of Concerned Scientists reviewed 56 enforcement actions taken by the agency during fiscal year 1998... From an overall perspective, the Union concluded that NRC's actions are neither consistent nor repeatable and that the enforcement actions did not always reflect the severity of the offense.''

That enforcement did not always reflect the severity of the offense is very troubling, for this is exactly what we would hope the regulator would do.[9] Either enforcement was too lax, and therefore too many unsecured risks were being taken, or it was too stringent, in which case costs were unnecessarily too high. Neither case is an efficient outcome. The cost savings from more targeted regulation could be substantial, given that ''In 1997, for example, 94 percent of violations had little or no safety significance'' (NEI, 2004).

At least the NRC has, as of 1999, begun to address the issue of risk in its regulatory rule-making. Has it done a good job? Arguably, no. David Lochbaum (2000), writing for the Union of Concerned Scientists, conducted a study of the NRC's risk-assessment performance. He found that ''the accident probability calculations are seriously flawed'' (2000, p. v). Though he found many flaws, we will address here only two of them.

First, the probabilities of failure are assumed to be a constant function of plant age. For statistics aficionados, this means that failure ''arrives'' according to a Poisson distribution. But experience has shown that problems are less likely to occur for medium age plants; they typically arise when the plant is either brand new and untested, or when it is very old and rickety (Lochbaum, 2000). This oversight can easily be solved. Engineers have used computers to model U-shaped failure probabilities for decades, and non-Poisson distributions are commonly taught to actuarial studies undergraduates. It would appear that this is above the capabilities of the Nuclear Regulatory Commission.

The most serious flaw is that the NRC has forgotten half the risk equation. If Green bets $100, and Brown bets $100 million, on a coin flip, the NRC would assess the risks to be equal in both cases; that is, the risk is 50–50. But clearly you are taking a bigger risk than I am. Risk, properly assessed, does not merely focus on probabilities. It focuses on expected costs. A 0.005% chance of catastrophic meltdown should be assessed a different risk factor if the plant is in Manhattan, than it is in Antarctica. This is common sense that the NRC has missed (Lochbaum, 2000). In contrast, insurance companies rely upon this consideration every time they write a new policy.

Section 50.11 of the Code of Federal Regulations deals with exceptions and exemptions from licensing requirements. It states that, the ''manufacture, productions, or acquisition by the Department of Defense'' (§50.11.a), ''performance of work for the Department at a United States government-owned or controlled site'' (§50.11.1.i.A), and ''research in, or development, manufacture, storage, testing or transportation of atomic weapons'' (§50.11.1.i.B) are all exempt from the regulations to which private industry is subject. However, Benson (2004, p. 2) points out that U.S Department of Energy nuclear weapons laboratory, production, and test facilities ''have produced more than 99 percent of all the high-level radioactive waste in America.'' According to this claim, these regulations fail to limit the actions of the worst radioactive offender, namely the government itself. It is in this area that environmental activists misdirect their zealousness.

Does not this argue for more regulation? It certainly argues for some, but the salient point is, who is doing the regulating? The problem is that there is a conflict of interest when the government is both the creator and regulator of nuclear waste. This is why the Departments of Defense or Energy do not fall under the NRC's regulatory reach. The government, in effect, has exempted itself from its own regulations, and has polluted in the process (DiLorenzo, 1990). If the government is to regulate itself, then we are right back where we started, with a conflict of interest. Under a system of private production, firms are largely regulated by the safety concerns of their insurance companies (Hoppe, 2001). Why not by the safety concerns of the government? Because regulation from this source tends to be a one-size-fits-all prescription, and changes in regulations are easily moved by political digressions and fickle public opinion. Private insurance companies competing with each other for the nuclear industry's business have an interest in responsive regulation that at the same time minimizes risk. If no insurance companies are willing to bear the risk of a nuclear catastrophe, then to the market's best judgment[10] the expected costs outweigh the benefits (i.e. the risks are simply too high). This is a market signal for either (a) withdrawal from the industry, or (b) greater research into nuclear safety technology.

Government has not allowed individual owners of resources to determine how best to allocate nuclear power in the framework of private property rights. In so doing, the government directed the development of nuclear technology by heavily regulating the industry. These regulations, due to their specifics, assume away any possibility of innovation. A given technology was understood at the time the regulations were drafted, and so forced nuclear advancement into a given paradigm based on this antique technology. Only where entrepreneurs are limited by their own imagination in the allocation of resources to relieve scarcity can innovation truly occur in the field of nuclear power and all others.

Nuclear waste and pollution

A major challenge to nuclear power is what to do with the spent fuel. Government has socialized disposal management services for the country, and atomic waste is no different. It is no surprise that the Hanford Nuclear Reservation, created as part of the Manhattan Project via government influence and involvement, ''remains the nation's most contaminated site'' (Dininny, 2004, p.1).[11] The government-run atomic programs remain the worst offenders in terms of radioactive pollution. There exists constant conflict between a government deciding where to exercise eminent domain in siting nuclear waste repositories and communities chanting, ''Not in my backyard!''

How can we best address the NIMBY problem? In the case of radioactive waste storage and disposal, the ''solution of the problem is to be found in a lack of clearly defined or enforced property rights'' (Cordato, 2004). Communities protest the possible siting of atomic waste repositories nearby because this process involves the government asserting eminent domain to acquire nearby property.[12] In addition, the state will not be held accountable for any violations of private property by subatomic particles (i.e. pollution) on the persons or property of nearby individuals because the ''rules of product liability are suspended when the end product comes into the hands of an instrumentality of the United States'' (Murphy, 1961, p. 14). The obvious solution is then to take this service away from the government and put it in the hands of responsible individuals acting in their own self-interest, and therefore the benefit of all. The NIMBY problem will no longer exist when the lands of all those who may be affected by such sites are purchased by private enterprise, and when neighbors no longer have the right to determine what is done on nearby properties, absent clear and present danger of invasions or other such trespass.

The NIMBY problem can also be solved by a restrictive covenant, which is in effect the market's version of zoning. When a property owner sells his land, he can stipulate in the contract that the buyer gives up his right to use his land in a particular way, or to sell to a specific party. In this case, it could be stipulated that the new owners do not resell to a nuclear power plant. Of course, this would entail large transactions costs if 10,000 neighbors were asked to sign such an agreement. There would be balking, fussing, holding out, etc. However, if there were an initial single owner of a large plot of land, big enough to encompass the said 10,000 housing

plots, this entrepreneur could earn greater profits by tailoring a restrictive covenant to the tastes of his customers. For example, he could sell them their holding subject to the condition that they never open a nuclear power plant on their land, nor vend to anyone else without imposing this condition on them. The land with this ''restriction'' would actually be worth more than in its absence.[13]

Granted, a restrictive covenant of these 10,000 people cannot prohibit adjacent landowners from installing this dread technology on their own property. The beauty of the market in this regard, however, is that transactions costs are a lot lower when groups composed of 10,000 homeowners each, that is, homeowners' associations of this sort, negotiate with each on matters of this sort.

If we dispose with the regulations governing nuclear waste disposal, would not the nuclear companies dump their radioactive waste anywhere, thereby irreparably polluting the environment? Again, the answer depends on the degree to which the free market is able to function. If land is held in common, as is much of the world's oceans, then a common economic problem called the tragedy of the commons arises. The tragedy is that if the benefits of polluting are borne by the individual polluter, but the costs are split evenly among the population (since the polluted land is common property) then there is a tendency to over-pollute. Where private property is concerned, people are far less likely to pollute their own land.[14] If a nuclear power company wanted to store its radioactive material on a site it owns, it is free to do so. It can do what it wants with its land. But it does not have the right to pollute other people's land. Thus, if some of the radiation seeps out onto the holdings of other people, a violation of property rights has occurred. The private owner can then take matters into his own hands, and sue the polluter; he would certainly be justified in obtaining prior restraint, or a legal injunction. Or, the company might consider paying the private owner for the right to pollute his land to a mutually agreed upon level.

Let us make a more philosophical rebuttal to at the zoning challenge. Under the libertarian legal code (Kinsella, 1996; Rothbard, 1982), the only time force is justified is to respond to, or defend against, or punish, a prior use of force or threat. A zoning law forbidding the construction of a nuclear facility without prior approval would thus be illegitimate. The only situation under which such an edifice could be properly restrained before completion would be if it constituted a threat: a clear and present danger. But, given the exemplary record of this industry, even under government control, no rational court could make any such finding.

A referee of this Journal asks ''why can't nuclear plants constitute threats?'' The essence of a threat is, well, to *threaten* someone if they do not do as you wish. For example, in robbery, extortion, the threat might be couched as follows: ''if you do not give me money, you will be shot or your children kidnapped.'' Setting up a nuclear generator, obviously, has nothing to do with anything even remotely connected to this. But there is a peripheral or extended meaning of threat (http://www.en.wikipedia.org/wiki/Threat) that does encompass acting in a negligent manner, one likely to cause an accident. For example, Jones shoots high-powered arrows at a target set up on a tree on his own property. If he misses, the arrow will land on Smith's property, and, quite possibly, do great harm there. At first glance, nuclear power might well fall under this heading. After all, if one of these installations blows up, it is an extreme understatement to say that massive destruction will ensue. So, what is the record of this industry, even under (we contend inefficient) government control? Pretty good, actually. Perhaps that famous bumper sticker says it all: ''More people died at Chappaquiddick than at Three Mile Island.''[15] Another consideration: if atomic generators are declared a ''threat'' and banned by law on that account, then so must the entire airline industry, which has killed far more non-passengers.[16] We regard this as a *reductio ad absurdum*, as no one, no one, advocates grounding all planes for this or any other such reason.

There need not be any fear that nuclear power stations would be located under free enterprise, cheek by jowl with high population concentrations. For one thing, insurance would be far more expensive. For another, so would real estate purchases. The zoning which is part and parcel of the free enterprise system (Siegan 1970, 1972) would thus tend to ensure that such facilities would be located in virtually empty locales. The market zones itself. Consider what it would cost to purchase on the free market enough space for a private garbage

dump in Manhattan; or an automobile manufacturing plant there. These things do not occur in a free market because of the opportunity costs associated. To purchase land in Manhattan, or any such residential or business area, is far more costly than land in uninhabited, remote places.[17] By and large, factories are found in the periphery. Only after they have been established do private individuals decide whether it is in their self-interest to build homes in the neighborhood. If people wish to buy land next to Yucca Mountain, we do not oppose this.

This is not to deny, of course, the possibility that neighboring land-holders in these out of the way places might possibly suffer a loss in property values unrelated to intrusion by subatomic particles. Who, after all, wants to be located next to a nuclear power plant? However, in the libertarian legal code, one does not own the *value* of one's property, only its physical integrity (Hoppe and Block, 2002). Thus, protests on NIMBY grounds for this reason would be ruled out of court.

The possibilities of nuclear energy have been held in check indefinitely by government regulation. There is no reason to believe that nuclear power plants must be as large in scale as coal plants. Yet, this view was adopted when drafting the current regulation regarding nuclear reactors because of the technology of energy production and distribution at the time. A drawback to large nuclear plants is the tremendous liability due to the possibility of an atomic accident. Although it is difficult if not impossible to anticipate the future workings of a fully free market, in a truly privatized energy industry, a network of small reactors may minimize risk.[18] As to the radiation of the actual power plant, ''[nuclear power] produces no carbon dioxide and radioactive emissions are actually *lower* than the radioactivity caused by coal-fueled power plants'' (Lomborg, 129). The greatest problem the public may have with a nuclear power plant is the possibility of a major accident; however, ''in the last 40 years... not one single fatality has occurred as a result of the operation of a civilian nuclear power plant in the United States'' (Electricity: Benefits/Eects, 2).[19] And this is with outmoded and inefficient Atomic Energy Commission in charge of the industry's safety. Under a pure profit and loss free enterprise system, experience suggests safety will be improved.

The fate of the nuclear industry

Should there even exist a nuclear power industry? What about Chernobyl? Chernobyl was the world's worst nuclear disaster. Estimates of the death toll vary widely. Industry estimates that 31 people were killed (Gonzalez, 1996). Other estimates are ''4,000 deaths among those who took part in the hasty and poorly organized cleanup; 70,000 people disabled by the radiation'' (Greenpeace, Probability of a Nuclear Accident, p. 3).

In a study, ''Chernobyl – Ten years after'' (Gonzalez, 1996) a group of more than 800 experts from 71 countries came to a consensus view about the effects of the disaster. Their findings pointed to significant thyroid problems among children in the region. The study concluded that:

> ''The radiation levels that can still be detected in most affected areas are sufficiently low as to permit normal economic and social activity to be resumed. The health effects have not turned out to be as catastrophic as some feared and others reported. But a number of radiation effects did occur and more are expected to occur and should be dealt with. Moreover, the socioeconomic impacts are very serious.''[20]

The problem becomes, how might one weight the costs and benefits of environmental damage, versus health damage, etc.? Are these costs high, or low? Without some common denominator, such questions are impossible to answer.

Yuri Koryakin, a Soviet nuclear industry economist, estimated that ''by 2000... the Chernobyl accident would cost the country between 170 and 215 billion rubles from contaminated farm land, lost electricity production and other economic consequences.'' This is far in excess of the net economic contribution of the entire Soviet nuclear industry, estimated at between 10–50 billion rubles. In terms of costs and benefits, ''the Soviet Union may have been better off if it had never begun building nuclear reactors in the first place'' (Hudson, 1990, p. A8).

Clearly, such cost benefit analysis is necessary, but the real cost/benefit analysis can truly take place only in a free market. Such argumentation was the centerpiece of Ludwig von Mises' (1969) critique of socialism. How can anyone know how many resources to put into an industry, if there are no prices?

How can one estimate the cost from depleted fish stocks, and add them to the costs of health damage? You can only do that if these costs are denominated in the same units. Only if these costs take on dollar terms, and can they be quantified, aggregated, and thus compared. Market prices indicate relative scarcities and surpluses. They tell us if a resource would be better used elsewhere. Should steel be used to make a car factory or a nuclear power plant? We can only decide such questions if we know the price of steel, the price of constructing the two plants, and the expected revenues from auto and energy production. It is only to the extent that private property rights permeate an economy that these questions can be answered.

Insurance companies estimate the potential risks in pricing their policies. These prices are factored into the cost calculations of a nuclear firm. If the sum of all these costs is greater than the expected benefits of energy production, then it will not pay any profit-seeker to build nuclear power plants. The problem for regulators is that they cannot beat the performance of the insurance companies. Experience suggests that their risk-assessment capabilities are far inferior to those of profit-seeking insurance companies. But even on the best-case scenario that the government can just as effectively quantify the risk as can the insurance companies, this still does not mean that government should be doing the regulating. Why not? For one thing, only if the insurance policy is priced by the market, can anyone know the proper level of insurance (i.e. how much insurance to buy). Just because government can equally well quantify risk does not mean that their pricing policy will not be high jacked by political and special interest considerations. For another, even if per impossible the government would replicate the market, what is the case for it doing so? Surely, on grounds of specialization and division of labor, the state should cease and desist, under these conditions.

How much nuclear power should there be? Lorna Salzman (1979, p. 112), arguing against nuclear power, unknowingly stumbled onto something when she claims that, ''*no one knows all the questions that must be asked and answered* in order to find solutions.'' This is precisely what economists mean when they say that ''competition is a discovery procedure.'' (Kirzner, 1985) We cannot know *ex ante* what the best allocation of resources will be. We do not know everyone's costs – in fact, costs are inherently subjective and as such, they are unknowable by anyone else. Similarly we must necessarily be in ignorance of the benefits of a particular economic outcome. However, the market provides a forum where everyone's costs and benefits are addressed in the form of supply and demand. For this reason, government cannot be relied on to direct private industry to the ''social good'' or to minimize ''externalities'' because it cannot know what that good is or how these externalities, if they exist in the first place, can best be internalized. It cannot learn the appropriate technology required to ideally serve the public. Innovation, almost by definition, cannot be planned[21, 22]. Anti-market environmentalists such as Salzman find themselves railing against the government whether they like it or not when they protest the storage and disposal of spent nuclear fuel, because only the government has been legally allowed to perform this service.

Thus no one can answer the burning question: should there be any nuclear power. Only the market can answer that.

Conclusion

Let us summarize. The nuclear industry was too risky for private firms to enter without subsidization. That is, the risk was too great for any company, and no insurance companies would shoulder this burden either. Government wanted nuclear energy so it limited, via the Price–Anderson Act, the liability of the nuclear industry. The Act enticed firms to enter the industry that would not have done so otherwise, causing an artificially low price for its energy. The Price–Anderson Act causes a moral hazard situation, which encourages further risky behavior, increasing the likelihood of a catastrophe, the costs of which the offending firm would not have to pay. How did we address this problem? Instead of dropping the Price–Anderson Act, the government opted instead for a regulatory system that was, from day one, fundamentally flawed, and continues to have major problems. To the extent that nuclear operators spend too many resources dealing with non-safety related paperwork, the costs of nuclear power increase. So the industry faces price distortions on both directions. Finally, why did the government renew the Price–Anderson Act? It was because of the very risky

behavior of nuclear operators which the Price–Anderson Act encouraged. This is clearly circular logic; the government's inefficiency used as a rationale for more governmental inefficiency. This is a road to serfdom (Hayek, 1944).

The present paper is neither pro nor anti-nuclear power in terms of its public policy proposals. Rather, the view espoused in this quarter is that there should be an "even playing field"[23] between *all* sources of energy: the mainstream ones, such as coal, oil and natural gas, the gaia-ist ones such as water (hydro-electric), wind and solar, and the "conservative" one under discussion, nuclear power. But the competition between them can only be "fair" if each one pays its own way; if none of them are allowed to violate the property rights of third parties (Rothbard, 1982). The Price–Anderson Act should be repealed, forthwith, along with all other legislation that gives this industry an unfair advantage. As well, subsidies to it should also be consigned to the dust-bin of economic history, so that nuclear power can succeed or fail entirely on its own merits. The same ought to be done with regard to all competing sources of energy. Then and only then will the total benefits and costs (including health and environmental costs) be allowed to determine the contours of the energy industry.

Right now, paper clips compete with staples, glue and rubber bands on a more or less even playing field. The government gives no special favor and imposes no particular fear on any of these industries devoted to keeping paper in order. Thus, there is a certain rationality involved with them. We pretty much know that the allocation of resources between paper clips, staples, glue and rubber bands is a reasonable one. Were it not, for any reason, market forces would soon enough bring matters back into conformity with consumer tastes, given relative costs. Would that a similar situation prevail in the energy field, and the political economic problem with regard to it would pretty much vanish.

Notes

[1] The government, surprisingly, failed to recognize that the monopoly it granted to energy companies at the time was the source of sluggish development. Though established in the field of energy distribution, there is no reason the production of energy from nuclear sources would follow the same industrial organization of other forms of energy production. Development by companies outside the current circle of privileged energy producers did not exist because any other firm other than current energy utilities could not benefit from the use of the new technology.

[2] This is exactly the same type of reasoning that some people have used against mandatory death penalties: a criminal on the run, who knows he will be executed if he gets caught, has every incentive to kill anyone who stands in his way.

[3] Under the pressure of marketplace competition in this industry, however, this is kept to a minimum.

[4] Hayek (1989) called this the "fatal conceit."

[5] We do not deny that sometimes, rarely, government does discover something before private enterprise. Radar is a case in point. However, there is a weeding out process in the latter case that simply does not function in the former: profit and loss. Thus, over the long haul, we can expect, and empirical evidence bears this out, that entrepreneurs are far more likely than bureaucrats to make commercially viable breakthroughs.

[6] For the more general argument against rent control on the ground that it *reduces* investment is residential rental units, see, Baird (1980), Block and Olsen (1981), Block et al. (1998), Block (2002), Grampp (1950), Hayek (1981), Johnson (1982), Lindbeck (1972), Myrdal (1965), Salins (1980), Tucker (1990).

[7] This is due to the application of anti-trust laws on energy utility companies. Companies in the energy industry must walk a thin line between predatory pricing, collusion, and price gouging.

[8] This organization is to the nuclear industry what the NRA is to guns.

[9] Were we, that is, to rely on government regulations in the first place, which we do not.

[10] To use a crass anthropomorphism.

[11] For the case that government is the worst polluter of them all, see DiLorenzo (1990).

[12] Though we consider all exercises of eminent domain to be illegitimate, this critique would take us too far from the topic at hand. For a critique of eminent domain, see Epstein and Block (2004), Block and Block (1996), Block (1979, 1998).

[13] Suppose that in 100 years nuclear power plants become no more dangerous than are Frisbees nowadays, and that people, then, want to have their own backyard installations of this technology. Will the dead hand of the past, these restrictive covenants, prohibit them from doing so? Not at all. The members of the covenant can agree beforehand, that is, now, that a certain proportion of them can always overturn any specific element of the contract.

[14] Indeed, this is a contradiction in terms. One, logically, *cannot* pollute his own property. He can of course use it as a garbage dump. But it is not *pollution* until it lands on someone else's property.

[15] See also fn. 33 on this point.

[16] We ignore that meltdown that occurred in Chernobyl; Russian technology is vastly inferior to our own (see text at fn. 34 for more on Chernobyl). We do not count the tragic deaths of 9/11; that was purposeful, not accidental. We abstract from airline passengers who died in crashes; they voluntarily took upon themselves the risk of travel in this mode. We focus solely on ''civilians,'' people on the ground who perished in air crashes.

[17] This is the same argument, in the other direction, for why the free market would provide for public goods. The positive externalities associated with waterfront public sidewalks is just the converse of the negative externalities of public nuclear plants. The detailed argument can be found in Block and Block (2005).

[18] In Rifkin (2002) the possibility of a worldwide energy web is discussed. While he applies this idea only to the production of electricity by hydrogen fuel cells, there is no reason why it cannot be applied to other forms of energy production. A network of nuclear reactors the size of submarine engines may produce the same amount of energy as one large facility, with much less liability in the case of a cataclysmic event. This is one way the private insurance problem may have been overcome had government allowed the private enterprise to determine for itself how to solve the problem of making new technology viable for the market. For more on the benefits of the insurance industry to free enterprise, see Hoppe (2001).

[19] A referee has pointed out that this statement is controversial. The consensus is that, even at Three Mile Island, no one died. However, in his 1981 book *Secret Fallout*, professor of radiation physics Dr Ernest Sternglass, who estimated that more than 430 infants died as a result of low-level radiation poisoning. Allen Lutins reports six workers have died in non-research power plants, five of which were from non-nuclear causes such as steam scalds and sabotage. Suce it to say, that even if these two gentlemen are correct, the risk of injury is extremely low in the nuclear industry. The American Nuclear Society reported that accidents which resulted in lost work time plus fatalities was 0.13 per 100,000 worker-hours for nuclear versus 1.55 for US private industry in general.

[20] We thank an anonymous referee for pointing us to this very important research.

[21] A government that initiates a set of regulations regarding an industry bases these regulations on a given technology known at the time. The possibility of innovation in this technology cannot be taken into account by the regulation, and the regulation necessarily precludes such innovation from existence in that future technologies must be subject to the regulation based on the historic or outdated technology.

[22] It cannot be denied that sometimes, in a rare while, innovations stem from governmental activity. Radar came about from World War II efforts; some people credit the U.S. military with early contributions to the internet; certainly, the moon shot was a statist operation to its core. However, we may always ask the question of whether these breakthroughs came about because of or in spite of governmental activity. That is, had the state not diverted to its own coffers gigantic amounts of treasure from the private sector, might these innovations come about sooner, or better, or more efficiently?

[23] To adopt that silly phrase from the debates over free trade.

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