

French Nuclear Power: A Model for the World?

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In today's scramble to secure renewable sources of energy that will both reduce greenhouse gas (GHG) emissions and sustain energy needs throughout the 21st century and beyond, developed and developing countries alike are pursuing a wide array of options. In this paper, I analyze the costs and benefits of nuclear energy by examining France's putatively successful nuclear industry, which many leaders in the U.S. have recently cited as an energy model to follow. Yet can the French model be realistically followed in other parts of the world, namely in the U.S.? In an effort to challenge the myth of nuclear energy as an energy panacea for the U.S.—which can be seen as a proxy for other countries considering nuclear energy—in the 21st century, I examine the unique cultural and political climate that fostered nuclear energy in France. An illustration of France's distinct political institutions, cultural inclinations, and minimal access to natural resources facilitates this process. These findings lead to the conclusion that the positive economic benefits accrued from the French government's unilateral adoption of nuclear power have overshadowed its negative aspects—specifically, the problem of waste disposal and the industry's vulnerability to water supply stability—and thus distorted its potential to help or hinder France and the world.

INTRODUCTION

In today's scramble to secure renewable sources of energy that will both reduce greenhouse gas (GHG) emissions and sustain energy needs throughout the 21st century and beyond, developed and developing countries alike are pursuing a wide array of options. France seems to have found its energy prescription in the form of nuclear power. Compared to coal, oil, or natural gas, nuclear energy production accomplishes the desired goal of reducing GHGs, producing virtually zero emissions. The U.S. Department of Energy's latest Performance Plan describes nuclear energy as "clean, non-carbon electricity...providing reliable and affordable baseload electricity without air pollution or emissions of greenhouse gases" (2010, 2). Furthermore, and in contrast to nonrenewable sources of energy, nuclear power appears to provide a stable source of energy for the foreseeable future. As a result of its transition to nuclear, France has been able to join a small group of energy-independent,¹ low GHG-emitting countries. Currently, it draws nearly 80% of its electricity from nuclear sources and gains over 3 billion euros per year as the world's largest net exporter of electricity (WNA, 2010).

These positive economic considerations, combined with the fact that lowering GHGs is currently a top priority for nations worldwide, make it clear that the nuclear industry has a prominent and established role in the welfare of France and the international community. In fact, nuclear energy has been so successful in France that some leaders in the U.S., which has not constructed a nuclear plant in nearly three

decades, have recently looked to it as a global model for the 21st century. Sen. John McCain, for example, stated in his last campaign for presidency: "The French are able to generate 80 percent of their electricity with nuclear power. There's no reason why America shouldn't" (Carey, 2008). Toward the end of his presidency, George W. Bush, too, praised the energy portfolio of France.² The most recent nuclear development from this side of the Atlantic came from President Obama's 2010 State of the Union address, in which he talked of a "new generation of safe, clean nuclear power plants in [the U.S.]," backing up these claims with more than \$50 billion in loan guarantees for construction of nuclear plants.³ Yet this sudden volte-face in American views regarding

¹France is energy independent in the sense that it is able to meet its citizens' demands of electricity independent of foreign sources of energy. It should be noted, however, that "if the term 'independence' is understood to be synonymous to domestic production of fuels only, then the official claim does not hold up, since France imports all of its uranium supply" (Makhijani, 2006, 34-35). Moreover, France still imports a considerable amount of petrol (gasoline) for automobiles.

²In his February 18, 2006, radio address, President Bush noted: "Nuclear power now produces only about 20% of America's electricity. It has the potential to play an even greater role. For example, over the past three decades, France has built 58 nuclear power plants and now gets more than 78% of its electricity from nuclear power. Yet here in America, we have not ordered a new nuclear power plant since the 1970s. So last summer, I signed energy legislation that offered incentives to encourage the building of new nuclear plants in America. Our goal is to start the construction of new nuclear power plants by the end of this decade" (Bush, 2006).

nuclear energy is misleading. It does not take into account all of the costs and benefits of adopting nuclear power as a significant source of energy production. A closer look at the history of France's acquisition of nuclear power and the negative byproducts that it produces reveals a more nuanced picture.

In an effort to challenge the myth of nuclear energy as an energy panacea for the 21st century, I will first examine the unique cultural and political climate that fostered nuclear energy in France. Then I will argue that the positive economic benefits accrued from the French government's unilateral adoption of nuclear power have overshadowed negative aspects of this technology and thus distorted its potential to help or hinder France and the world. A PBS Frontline article on French attitudes toward nuclear energy by John Palfreman, professor of broadcast journalism at the University of Oregon, will be the primary point of reference in my analysis. Interdisciplinary scholarly work and literature from the nuclear industry undergird the remainder of my findings.

THE UNIQUE POLITICAL AND CULTURAL CLIMATE THAT HAS CONTINUED TO FOSTER NUCLEAR POWER

France's decision to "go nuclear" dates back to the early 1960s when it began to explore options to wean itself from dependence on outside energy sources. The process was accelerated in 1973 when OPEC countries quadrupled oil prices and shocked France's oil-dependent energy infrastructure. As Palfreman's report on the French nuclear industry recounts, France "had and still has very few natural energy resources. It has no oil, no gas and her coal resources are very poor and virtually exhausted" (Palfreman, 2008).

The exigent circumstances facing France in the 1970s were largely overcome due to a unique combination of cultural and political factors. Politically speaking, France's autonomous, insulated institutional structure allowed the executive branch to efficiently spearhead the project without being seriously slowed down by objections from outside interest groups. As Delmas and Heiman note, "In France, despite substantial anti-nuclear interest groups,⁴ the impermeability of the institutional setup—no division of power, weak judiciary, and reliance on bureaucratic expertise⁵—effectively prevents activists from influencing policy outcome" (2001, 433). In terms of culture, France held not only a large pool of scientists and engineers capable of implementing such a techno-

logical feat, but a citizenry which was largely willing to cede decision-making to them.

Given this combination—an independent executive branch,⁶ a large number of trusted scientists and engineers, and a generally passive electorate—which discouraged a transparent debate from all stakeholders involved, the question arises as to whether France's nuclear industry is as superior as some contemporary U.S. politicians think. Palfreman's article provides insights to both sides of this question. On the one hand, it echoes the positive sentiment of many accounts concerning French nuclear power: it creates jobs, state revenue, energy independence, etc. On the other hand, it calls attention to an important, and often obscured, aspect of the enigmatic technology—what to do with its waste. In these ways, his article provides an appropriate starting point to the discussion. Similar to the commendations by Sen. John McCain and President George W. Bush, Palfreman's opening paragraph states:

In France, unlike in America, nuclear energy is accepted, even popular. Everybody I spoke to in Civaux loves the fact their region was chosen. The nuclear plant has brought jobs and prosperity to the area. Nobody I spoke to, nobody, expressed any fear. From the village school teacher, Rene Barc, to the patron of the Cafe de Sport bar, Valerie Turbeau, any traces of doubt they might have had have faded as they have come to know plant workers, visited the reactor site and thought about the benefits of being part of France's nuclear energy effort (2008).

⁵This institutional setup is in direct contrast to that of the United States. France's parliamentary system precludes the division of power inherent in the United States' constitutional system, the latter of which provides multiple stages of inquiry and input prior to the implementation of such a large-scale and potentially dangerous project. Delmas and Heiman summarize the situation as follows: "In France, reliance on bureaucratic expertise in technical issues [such as] nuclear power is substantial. In the United States, input from multiple politically motivated sources is considered before technical decisions are made" (Ibid, 435).

⁶Delmas and Heiman further elaborate the autonomous nature of the executive authority: "The President gives general directions, such as 'promote nuclear power aggressively,' and the Ministry sets and implements specific policy (the President and ministries are taken as a unitary actor owing to their same-party affiliations and the homogeneous backgrounds of members of both institutions). Parliament cooperatively passes legislation (often retroactive of policy implementation) that falls within the limits set by the Ministry; party discipline plays a key role in determining legislative behavior in France. Electoral rules in France are such that the high costs of getting elected or reelected are generally born by the party. Party discipline is usually strong across government branches and the Prime Minister may be considered as *de facto* working for the President. Strong party discipline in conjunction with the same parties in power in the executive and parliamentary branches suggests that conflict between the two branches is rare...If members disregard warning signals and persist in passing policy outside the acceptable set for the Ministry/President, then the party can punish members for defection by withholding political rents (e.g., appointments, funding). Since members know this and wish to avoid party-imposed costs, they almost always cooperate with the Ministry/President" (Ibid, 439).

³The White House Office of the Press Secretary announced on February 16, 2010 "that the Department of Energy has offered conditional commitments for a total of \$8.33 billion in loan guarantees for the construction and operation of two new [light-water] nuclear reactors at a plant in Burke, Georgia" (2010).

⁴The most prominent anti-nuclear protest in France was against construction of the FBR Super-Phenix at Creys-Malville in June of 1977. "In France, support for nuclear power fell from 74 percent in 1974 to 47 percent in 1978 (Carmoy, 1982). [Yet] despite protests at least as vehement as those in the United States and the existence of well-organized national interest groups, France continued to experience growth in its use of nuclear power" (Delmas and Heiman, 2001, 440).

These positive accounts of French attitudes toward nuclear power are quite peculiar when compared to American reactions to the issue.⁷ Yet the attitudes make sense when the economic benefits of nuclear power in the small country (relative to the U.S.) are put into context.

A brief synopsis of Civaux 1 and 2 (France's 57th and 58th nuclear reactors) in particular, and the French nuclear industry in general, gives an idea of the prominent roles they play in local, national, and international economic welfare, and thus why many Frenchmen support the industry. The Civaux plants were constructed from 1993 to 1999, at which time they were both connected to the electric grid and entered full production. In 2008, the plants produced 21.2 billion kWh, which constitutes nearly twice as much production as the average U.S. reactor in the same year (EIA, 2010). In terms of employment, France's electricity utility, Electricité de France (EdF), reports that "a nuclear power plant with 2 reactors directly employs between 600 and 700 persons whereas those with 4 reactors have around 1200 employees...[a] plant with 6 reactors has around 1500 employees" (EdF, 2010). In total, there are 58 reactors spread across 19 different sites (see Figure 1)⁸ which "currently provide several tens of thousands of jobs in France. For example, plant maintenance activities alone deploy 10,000 EDF employees and 20,000 contractor staff" (Ibid).

With this considerable amount of employment in mind (taking into account that France is about twice the size of Colorado), it is easier to see why many in France argued for, and still defend, nuclear energy. Yet several questions remain. In Palfreman's words, "How was France able to get its people to accept nuclear power? What is it about French culture and politics that allowed them to succeed where most other countries have failed?" (Palfreman, 2008). The answers to his questions lie in several unique aspects of French social and political norms, combined with the reality of France's sparse natural resource endowments.

In an interview with Palfreman, Claude Mandil, General Director for Energy and Raw Materials at the Ministry of Industry in France, cited two reasons for nuclear's supposed warm reception in his country. First, the available options at the time of quadrupling oil prices did not allow for room to maneuver. He stated, simply, "no oil, no gas, no coal, no choice" (Palfreman, 2008). Second, Mandil cited cultural

influences, namely that the French have become accustomed to leaving large, centrally-planned projects to revered technocrats in Paris.

Figure 1



Part of the phenomenon of leaving such large decisions to bureaucrats, according to Palfreman, stems from the fact that scientists and engineers in France are given much more respect than in the U.S. "Many high ranking civil servants

⁸It is important to note that each plant is located, out of necessity, next to a water supply. Whether oceans or rivers or lakes, a consistent source of water is required to cool the plants. In February of 1990, the American Nuclear Society's monthly periodical, *Nuclear News*, recounted the effects of adverse weather on France's nuclear industry in the preceding year: "A severe drought throughout the summer and fall — with precipitation at only 25% of normal — increased energy demand for irrigation, but reduced hydro production by 55%, and also hit several nuclear units that had to reduce power or shut down altogether due to lack of river cooling water. The overall effects of the drought are estimated to have cost the utility 2.3 billion FF (\$340 million)" (ANS). In 2003, as the United Nations Environment Programme notes, a heat wave created difficulties for France's nuclear reactors: "In some regions, river water levels dropped so low that cooling process became impossible and plants had to shut down, while elsewhere the water temperatures after the cooling process exceeded environmental safety levels. An exceptional exemption from the legal requirements, which puts a cap on the water temperature a plant can bring into its cooling system and a cap on the water temperature flowing back out into the source of water, was granted to six nuclear reactors and a number of conventional power stations: The nuclear power plants of Saint-Alban (Isère), Golfech (Tarn-et-Garonne), Cruas (Ardèche), Nogent-sur-Seine (Aube), Tricastin (Drôme) et Bugey (Ain) continued functioning, although the upper legal limits were exceeded. Moreover, demand for electricity soared as the population turned up air conditioning and refrigerators, but nuclear power stations, which generate around 75% of France's electricity, operated at a much reduced capacity. In order to conserve energy for the nation, France (Europe's main electricity exporter) cut its power exports by more than half" (UNEP, 2004, 3). These examples illustrate the vulnerabilities of nuclear power in regions susceptible to droughts and heatwaves. Proposed construction of a nuclear power plant along the Green River in Utah has met criticism for these reasons, in addition to the fact that it would divert an estimated range of 30,000 (Estep 2010, 1) to 50,000 acre-feet of water (Smart, 2010)—about 8 to 16 billion gallons per year, respectively—in a region of the U.S. that struggles with water on an annual basis. In a desert climate nuclear energy is impractical.

⁷In the U.S., the Three Mile Island incident of 1979, in which a partial reactor meltdown at the Three Mile Island nuclear power plant in Harrisburg, Pennsylvania, released radioactive gases into the atmosphere, accelerated the decline of the American nuclear industry. Delmas and Heiman ask, "What if an incident like TMI had happened in France? The model suggests," they conclude, "that the public would never have been informed; the strong bureaucracy and unified Executive/Legislative branches may have kept the public ignorant. What then, if a Chernobyl were to happen in France? As the media would play its role, asymmetry of information between government officials and public opinion would be much lower. The model suggests that the system would collapse completely and rapidly, instead of incrementally as in the United States (2001, 452).

and government officials trained as scientists and engineers (rather than lawyers, as in the United States), and, unlike in the U.S. where federal administrators are often looked down upon, these technocrats form a special elite" (Ibid). In Mandil's words, "We like our engineers and our scientists and we are confident in them" (Ibid).

When viewed separately, Mandil's two reasons for welcoming nuclear energy may not appear very convincing, especially in light of the industry's recent past, namely the Chernobyl⁹ and Three Mile Island incidents. Yet when viewed in tandem, they seem more rational. Psychologist Paul Slovic and colleagues at Decision Research in Eugene, Oregon, found through their surveys that a number of French people have fears of nuclear power similar to those in the U.S., but the combination of unique cultural views and a lack of choice in the matter have great bearing on the outcome of their behavior toward it. Palfreman found:

While French citizens cannot control nuclear technology any more than Americans, the fact that they trust the technocrats that do control it makes them feel more secure. Then there is need. Most French people know that life would be very difficult without nuclear energy. Because they need nuclear power more than us, they fear it less (2008).

These findings suggest that the lack of choice in the matter—both in terms of an absence of alternative natural resources and the institutional arrangement that undermines the agency of French citizens—combined with a cultural tendency to trust experts with such projects (perhaps this trust was also borne out of a lack of choice in the political process) has led the French population to accept their potentially dangerous energy source.

When asked specifically about past nuclear industry disasters, a local Civaux baker reasoned, with regard to Chernobyl, that the Russians were not "up to the task. But the French scientists and engineers are" (Ibid). Another Civaux resident said "I would be much more frightened living next to a dam [France has about 12% hydroelectric power]" (Ibid). These opinions—expressing a high degree of trust in scientists and engineers, and defending nuclear at the expense of the relatively marginal hydroelectric industry—reinforce the cultural and "no choice" explanations which put the industry in a positive light. It seems that many French citizens are making the best out of the nuclear situation with which they are stuck by highlighting the positives and downplaying the negatives.

AN OVERLOOKED BYPRODUCT OF THE NUCLEAR INDUSTRY: NUCLEAR WASTE

One thing that does frighten, or anger the French is the prospect of nuclear waste. Mandil recounted the prospect of

storing waste in France from the eyes of a Frenchman. "It's not the risk of a waste site, so much as the lack of any perceived benefit," he stated. "People in France can be proud of their nuclear plants, but nobody wants to be proud of having a nuclear dustbin under its feet" (Ibid). As a result of this stumbling block, in 1990, all further nuclear energy activity was halted and the issue was given to the French parliament, which appointed a politician, Christian Bataille, to explore the matter.

After visiting the protesters, Bataille discovered that the technocrats had misinterpreted the psychology of their constituents and viewed the matter in purely technical terms.

To them, the cheapest and safest solution was to permanently bury the waste underground. But for the rural French, says Bataille, 'the idea of burying the waste awoke the most profound human myths. In France we bury the dead, we don't bury nuclear waste...there was an idea of profanation of the soil, desecration of the Earth' (Ibid).

In addition to polluting their soil and tainting their myths, a rural/urban divide was awakened. "Bataille discovered that the rural populations had an idea of 'Parisians, the consumers of electricity, coming to the countryside, going to the bottom of your garden with a spade, digging a hole and burying nuclear waste, permanently'" (Ibid).

What resulted from these realizations about local perception was a different state approach to burying waste. Instead of burying the waste permanently, Bataille proposed "stocking" the waste, which implied reversibility. In other words, the waste could potentially be removed in the future. This change, of course, apparently appealed to the psychology of the French masses because "stocking waste and watching it involves a commitment to the future. It implies that the waste will not be forgotten...[moreover], says Bataille, 'Today we stock containers of waste because currently scientists don't know how to reduce or eliminate the toxicity, but maybe in 100 years perhaps scientists will'" (Ibid).

Unfortunately, there is a big problem with Bataille's creative thinking (which may have been addressed had there been a public debate before the creation of France's nuclear industry). As Leonard Solon, former Director of the New York City Department of Health's Bureau for Radiation Control, aptly noted nearly 30 years ago, "One of the most persistent and refractory problems of the nuclear fuel cycle...is the ultimate disposition of long-term radioactive waste. 'Long-term' in this case dwarfs recorded human history. The half-life of plutonium-239, a significant and inevitable by-product of all light-water nuclear reactors [which are predominant in France], is 24,000 years" (Solon, 1982, 15). Yet its exceedingly long life-span is not the only worrisome aspect of nuclear waste. An overview of its other qualities is in order.

The United States' Nuclear Regulatory Commission divides nuclear waste into three broad categories: high-level radioactive waste, mill tailings and low-level radioactive waste. According to the NRC:

⁹On April 26, 1986, the Chernobyl nuclear reactor in the Ukrainian Socialist Soviet Republic exploded. Atmospheric radioactive debris from the accident extended throughout Eastern, Northern, and Western Europe.

High-level radioactive waste consists of “irradiated” or used nuclear reactor fuel (i.e., fuel that has been used in a reactor to produce electricity). The used reactor fuel is in a solid form consisting of small fuel pellets in long metal tubes. Mill tailings wastes are the residues remaining after the processing of natural ore to extract uranium and thorium. Commercial radioactive wastes that are not high-level wastes or uranium and thorium milling wastes are classified as low-level radioactive waste.¹⁰

The low-level wastes can include radioactively contaminated protective clothing, tools, filters, rags, medical tubes, and many other items (NRC, 2002, 2-3).

Waste from nuclear reactors falls within the high-level waste category, for which neither the U.S. nor France has constructed a permanent disposal facility.¹¹ In the meantime, high-level waste (also referred to as spent fuel) goes through the following two step process: after spent fuel is removed from a reactor which has reached the end of its productive life, spent fuel is first stored in cooling pools of water for at least ten years. Then, the cooled spent fuel is transferred to dry storage in shielded concrete casks for about ten more years (Ansolabehere et al. 2003, 97).

Perhaps the most prominent element of France’s nuclear waste issue is located in La Hague, along the English Channel in northwest France. It is here that spent nuclear fuel is

“reprocessed,”¹² which is to say fuel from spent nuclear rods is salvaged in order to be used again in the future. This efficiency-enhancing step in the nuclear process is another seemingly positive attribute France’s nuclear energy industry. The reprocessing facility (See Figure 2) is especially appealing when it is taken into account that “La Hague...provide[s] about 11,000 jobs and 479 million (about \$624 million) for the local economy. Areva [owner of France’s reprocessing facility]...had revenues of 1.74 billion (about \$2.3 billion) in 2007” (Ling, 2010).

Figure 2 (Fairley, 2007)



¹⁰Currently, the largest low-level radioactive waste disposal site in the United States is located in Tooele, Utah, at EnergySolutions’ Clive facility. Here, only Class A waste (the least radioactive form in the low-level category) is authorized for disposal. A contentious debate has arisen in light of EnergySolutions’ attempts to dispose of depleted uranium (DU) (a byproduct of uranium enrichment to be used, inter alia, as fuel in light-water reactors), which starts out as Class A low-level waste but increases in toxicity (beyond Class B and C standards, which are banned in Utah) for about 1,000,000 years. EnergySolutions is also attempting to “downblend” Class B and C waste, the result of which is a waste product not suitable for Clive’s Class A disposal facilities. The debate surrounding the importation of DU and downblending of Class B and C waste is that 1) laws pertaining to these issues are interpreted differently depending on the interest group (for example, various community groups in Utah are raising public health concerns; EnergySolutions has fiduciary duty to maximize its shareholders’ returns); and 2) the Nuclear Regulatory Commission (NRC) has not yet completed studies determining the potential risks of these activities on public health.

¹¹On June 3, 2008, the U.S. Department of Energy (DOE) “submitted a license application to the U.S. Nuclear Regulatory Commission (NRC), seeking authorization to construct a high-level waste geologic repository at Yucca Mountain, Nevada” (NRC, 2010). Subsequently, in an interview with MIT’s Technology Review, current Department of Energy Secretary Steven Chu stated that “Yucca Mountain as a repository is off the table. What we’re going to be doing is saying, let’s step back. We realize that we know a lot more today than we did 25 or 30 years ago. The NRC is saying that the dry cask storage at current sites would be safe for many decades, so that gives us time to figure out what we should do for a long-term strategy. We will be assembling a blue-ribbon panel to look at the issue” (Bullis, 2010). A 2010 update to MIT’s 2003 study on the future of nuclear power concluded, pithily, that “the progress on high-level waste disposal has not been positive” (Deutch et al., 2010, 11).

Yet much of this revenue comes from reprocessing the waste of Japan, Germany, Switzerland, the Netherlands, Belgium and Italy. If, as Mandil noted, French citizens “cannot be proud of having a nuclear dustbin under its feet,” it seems unlikely that they would be proud of hosting the world’s nuclear waste for years at a time, before and after which requires transportation along French highways and through French ports. The likelihood of an accident only increases when countries start shipping their waste back and forth

¹²Reprocessing is a highly technical process that entails the following: “Old nuclear fuel assemblies — highly radioactive, elongated packages of metal rods that once energized some of France’s 58 nuclear power plants — are gripped by large mechanical arms. They are hoisted by cranes and placed on belts that move them along in the dim orange light. The machinery works to prepare the assemblies to be lowered into four giant pools. There they will sit, with about 13 feet of demineralized water above them, a bath to shield and cool them, for about three years. Then more machines will lift them out, chop them up and put the pieces to be dissolved in vats of nitric acid. The fissioning of the fuel in the power plant, or the splitting of uranium atoms to release energy, has created a large family of elements, called fission products. The goal of this process is to find and recycle the ones that still contain more energy — the plutonium and the uranium” (Ling, 2010).

across the globe on a regular basis. Nuclear proliferation concerns arise from the reprocessing cycle.¹³

Again, the French public seems to think that the economic benefits outweigh the health risks. A recent study by members of the Association pour le Contrôle de la Radioactivité dans l'Ouest (ACRO), an organization sent to Normandy (where La Hague is located) to monitor the environment for radioactive discharge levels and forward information to the locals found the following:

Tritium and iodine levels are cumulatively much higher than they naturally would be. ACRO said community members are concerned about the environmental and health impacts of La Hague, but they are more concerned about their jobs... 'There is doubt in their heads,' said ACRO's Pierre Barbey and André Guillemette through a translator. 'They keep this fear at bay because the economics is favorable for the area.' (Ling, 2010).

CONCLUSION

The undemocratic means by which France acquired nuclear energy—an executive-empowering institutional structure, a citizenry that has great trust in its technocrats, and a lack of alternative sources of energy—has given rise to the myth that France's energy restructuring should be a model for other countries seeking to lower GHGs while sustaining their energy demands throughout the 21st century and beyond. The reason this myth has been able to thrive is primarily due to the fact that enormous economic benefits have overshadowed the industry's negative byproducts, specifically, water-related issues and the many risks of nuclear waste. Other countries would do well to take into account not only the positives, but the negatives, in considering nuclear as a potential source of energy.

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¹³MIT's interdisciplinary panel argues against reprocessing spent fuel on safety grounds: "The current international safeguards regime is inadequate to meet the security challenges of the expanded nuclear deployment contemplated in the global growth scenario. The reprocessing system now used in Europe, Japan, and Russia that involves separation and recycling of plutonium presents unwarranted proliferation risks" (Ansolabehere et al. 2003, ix).

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