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Nuclear Energy in the U.S. and Germany: Weighing the Risks

BY JESSICA RIESTER AND KIRSTEN VERCLAS

How do public perceptions of risk shape policies on nuclear energy in the U.S. and Germany?

Why have the two countries responded differently to the nuclear disaster in Japan?

Introduction

Energy and climate policy in the U.S. and in Germany seem to be miles apart. In 2011, Germany decided to phase-out nuclear, whereas in early 2012 the U.S. Nuclear Regulatory Commission granted the first license to build and operate an extension of a nuclear power plant for the first time since 1978. Americans view the German "energy transformation" (*Energiewende*) with skepticism; conservative policymakers argue that Germany is endangering its economic welfare, whereas U.S. environmentalists fear that Germany will be unable to meet its CO_2 emissions targets it has agreed to in the European emissions trading framework. When discussing risk assessment in Germany and the United States, analysts often argue that while Germans are risk-adverse, Americans embrace risk more easily. If nuclear energy is considered risky, then the recent decisions in the U.S. and in Germany on nuclear energy seem to bolster this claim. However, one could conversely argue that not embracing nuclear energy is more risky as the consequences are far-reaching and have to include the complete transformation of the energy grid; including nuclear energy in the energy mix might thus be a more conservative approach to the energy policy challenges of the future. To understand the different approaches, this Issue Brief outlines the history of nuclear energy in the U.S. and Germany and analyzes how both countries arrived at a very different assessment of the risk and benefits of nuclear energy.

Nuclear Energy in the U.S.: Between Security and Politics

History and Current Assessment of Nuclear Energy in the U.S.

Nuclear power made its powerful and horrific entrance on the international scene when the U.S. dropped the first atomic bombs on Hiroshima and Nagasaki, Japan, in 1945. After the Soviet Union conducted its first test of an atomic bomb in 1949, the threat of nuclear weapons became a staple of the U.S. and Soviet military and of the Cold War. When Congress enacted the Atomic Energy Act in 1946, "the significance of the atomic bomb for military purposes [was] evident."[1] Yet, the question how nuclear energy could be harnessed for peaceful means was not yet resolved; technological know-how to make this a viable energy source was still in its infancy. While the Act also established the Atomic Energy Commission (AEC), it was not until the end of 1951 that the first Experimental Breeder Reactor (EBR-1) started operating in the U.S.[2] Under President Dwight D. Eisenhower the "Atoms for Peace" program increased funding and resources to continue to expand research into the use of nuclear power as an energy source. The military was the first to use nuclear energy as fuel and launched the first nuclear-powered submarine in 1954. The first commercial nuclear power plant was opened in 1958 in Pennsylvania and the use of nuclear energy continued to grow in the U.S. throughout the 1960s and 1970s. While small accidents and limited public opposition dogged the nuclear industry, its future seemed to be one of growth and prosperity.

However, the 1970s saw a rise in environmentalism and consequently a more critical view of nuclear power. The accident at the Three Mile Island (TMI) nuclear plant near Harrisburg, Pennsylvania, underlined this dramatically. On 28 March 1979, the power plant suffered a partial core meltdown and a small amount of radiation was released. Following the worst nuclear accident in U.S. history, already planned nuclear power plants were cancelled and no plans for new nuclear power plants were developed. Even though the 1986 nuclear accident in Chernobyl did not affect the U.S. directly, it did not improve the image of nuclear energy, either. Throughout the 1990s, the U.S shut down eight reactors permanently and, in fact, until 2012 no new permits for power plants had been granted. Yet, "because of better operation and capacity expansion at existing reactors, annual U.S. nuclear generation has risen 28%" since the startup of the most recent U.S. nuclear plant, which was licensed before the TMI accident and started operating in 1996.[3]

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As concern in the U.S. about energy dependence and worldwide worries about greenhouse gas emissions and climate change began to rise, nuclear energy once again became touted as a technological solution and energy source that would guarantee energy independence and low CO_2 emissions. In his State of the Union speech in 2011, President Barack Obama outlined his goal that "[b]y 2035, 80 percent of America's electricity will come from clean energy sources." He explicitly mentioned that this will also include nuclear energy.[4] Even though the nuclear accident in Fukushima, Japan, has quelled the renewed enthusiasm about nuclear energy to a certain extent, in February 2012 the Nuclear Regulatory Commission approved the construction and operating license for additional reactors at a nuclear power plant in Georgia, the first such approval since 1978. Today, the United States has 104 nuclear power plants connected to the grid. They generate 803.0 terawatt hours (net TWh), which represents about 20.3 percent of the country's electricity supply (figures from 2010).[5]

Public Opinion and Political Action

In order to understand U.S. policies toward nuclear energy it is important to consider public opinion as well as political action. In 1994 sociologists Eugene A. Rosa and Riley E. Dunlap published an overview of public opinion on nuclear power from the 1970s to the 1990s.[6] They found that Americans were in general opposed to nuclear power, yet believed it would be part of the nation's electricity mix in the future and thus favored keeping open the option of nuclear energy. Polls showed that "nuclear power was generally seen to be better for the environment than coal or oil, more economical than oil, and the energy-to-electricity source the nation is least likely to run out of. These positive perceptions of nuclear power, however, were more than counterbalanced by the vast majorities who saw it as the least safe electricity source, least acceptable for widespread use, and potentially most dangerous to human health."[7] Interestingly, Rosa and Dunlap also found that when questions varied the assurance of safety connected to nuclear energy, the opposition or support of nuclear power shifted by up to 40 percent. Additionally, when asked if they support nuclear energy should it be able to reduce greenhouse gas emissions and hypothetically decrease dependency from foreign energy imports, a majority of Americans favored its use.

The nuclear accident in Fukushima prompted more recent

public opinion polls. A Gallup poll conducted in March 2011, shortly after the Fukushima accident, found that 58 percent of Americans believe that nuclear energy is safe and 36 percent believe it is not. However, in the same poll Americans were split on the issue of building more nuclear power plants in the U.S. to help solve the country's current energy problem: 46 percent said nuclear power is necessary, 48 percent think that the dangers of nuclear energy are too great. A similar question had been asked in a Gallup poll in May 2001 and the numbers were almost identical (49 percent said that nuclear power is necessary, 46 percent thought that the dangers of nuclear energy were too great).[8] The American public is not of one mind when it comes to nuclear power and public opinion is swayed in polls by questions that suppose a greater security of nuclear power or additional benefits (the reduction of greenhouse gases and the hypothetical independence from foreign energy imports). It is therefore difficult to assess under what circumstances a majority of the American public would support nuclear energy and thus how Americans value the trade-off between risk and safety.

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The main government agency regulating nuclear energy in the U.S. is the U.S. Nuclear Regulatory Commission. The U.S. Nuclear Regulatory Commission is a self-funded agency, which means that its revenue is derived solely from the licensing fees it collects. Other federal departments and agencies, among them the U.S. Department of Energy, the U.S. Department of Defense, and the Environmental Protection Agency, as well as state and local bodies governing land use planning and economic development, also play different roles concerning the development and regulation of nuclear energy plants.[9] The development of nuclear energy in the U.S. would have been impossible without substantial involvement of the military as well as political support and this has ramifications for the use and management of nuclear energy even today: "the technology's potential military applications, the Cold War environment, and the burgeoning growth of what was to become a vast nuclear weapons program resulted in the extremely heavy and active involvement of the federal government, and from early on also created unusually close ties between the industry and its regulatory agency."[10] High costs associated with developing nuclear weapons were an additional reason why the U.S. federal government became involved in pushing for civilian nuclear energy. Nuclear energy has profited from political support in terms of subsidies, loan guarantees, and insurance regulation. The Price-Anderson Act, which became law in 1957, aims at encouraging private investment in nuclear power plants by establishing a limit of liability for nuclear power plant operators in case of nuclear accidents. The Price-Anderson Act was extended to 2025 by the Energy Policy Act of 2005.[11] The close connection between nuclear energy and the military at the beginning of nuclear power and the heavy involvement of the federal government have distorted public opinion in the U.S. to a certain extent.

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Additional concerns over U.S. dependence on foreign energy sources and Americans' desire for cheap energy have further muddied the waters about risk and security issues surrounding nuclear energy. While "[a]t the end of the day, what matters most to Americans is how much they are paying to heat their homes and fuel their lifestyles,"[12] a serious nuclear accident or terrorist attack on a nuclear power plant in the U.S. could change that.

Risk Assessment of Nuclear Energy

Risk assessment, especially in terms of nuclear energy, is often focused on security assessment. How safe is nuclear energy? Yet, aside from the very real security risk, other questions also have to be answered: What is the cost of nuclear energy? And does the risk outweigh the costs? Will the energy grid become inflexible if one energy source is favored over another? Policymakers in the U.S. view nuclear energy as a solution to reduce American energy imports (i.e., the risk of dependence on other nations) and to reduce emissions of greenhouse gases. An industry that was viewed as one of the most environmentally harmful just decades ago is now touted as a green alternative to coal and natural gas plants. While nuclear energy emits almost no CO_2 when plants are running, lifecycle assessments of nuclear power plants take into account the building of plants, the procurement of uranium, and the transportation and storage of waste and thus paint a different emissions picture. A study done by the National University of Singapore and published in Energy Policy in 2008, estimated that nuclear energy emits approximately 66 gCO_2e/kWh once its lifecycle CO_2 emissions are considered.[13] This "is well below scrubbed coal-fired plants, which emit 960 gCO_2e/kWh, and natural gas-fired plants, at 443 gCO_2e/kWh. However, nuclear emits twice as much carbon as solar photovoltaic, at 32 gCO_2e/kWh, and six times as much as onshore wind farms, at 10 gCO_2e/kWh."[14] Additionally, the uncertain availability of uranium as a necessary resource and the unsolved question of where to store nuclear waste make the case for nuclear energy problematic. Like in the 1950s, nuclear energy is still unable to be produced without government backing.

After the terrorist attacks of September 11, 2001, concerns that terrorist groups might target nuclear plants in the U.S. grew and the nuclear accident in Fukushima last year has caused increased concern about the impact of natural disasters on nuclear power plants. The NRC required nuclear power plant operators to increase safety and security measures after both incidents, and without the Price-Anderson Act nuclear power plants would be virtually uninsurable. Energy prices in the U.S. are very low compared to Europe, and proponents of nuclear energy argue these costs will be kept low only through nuclear power. Yet, a comparison by the Union of Concerned Scientists of the levelized costs for the proposed Levy nuclear power plant in Florida with alternative energy sources shows that nuclear energy is not necessarily the cheapest option: "the mid-range levelized cost estimate for the Levy reactors, $164 per megawatt-hour (MWh), was higher than that of most other energy solutions, including improved energy efficiency to reduce electricity use, natural gas, biomass, land-based wind, solar photovoltaic, and even coal."[15] Nuclear energy has high up-front and decommissioning costs. Government guarantees and tax payer subsidies tend to skew the business case in favor of nuclear energy. An honest risk assessment of nuclear energy also includes taking nuclear proliferation, the question of transparency on nuclear accidents and waste storage, the use of water as a resource, and the question of energy production without nuclear energy into account. In order to answer the questions raised above, it is necessary for the United States to develop a comprehensive energy strategy, which entails a cost-benefit and risk analysis of available energy resources and energy efficiency measures. The current natural gas boom in the U.S., however, might cause the U.S. to neglect building a robust, multi-faceted energy sector. Yet, a government strategy focused on establishing the right societal risk assessment should not take a backseat to current issues of the day.

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Nuclear Energy in Germany: An Unacceptable Risk

After the tsunami and nuclear disaster in Japan, a general reassessment of the risks of nuclear energy has been underway. In Germany, Chancellor Angela Merkel's decision to shut down all German nuclear reactors by 2022 has reignited the debate over nuclear energy. Lauded by environmentalists and decried by the energy industry, her decision sheds light on German perceptions of nuclear energy and the risk the country is willing to accept. Beyond the risk of natural disasters, as in Japan, environmental and security risks play a large role in the debate; the interconnectedness of nuclear energy to these other policy domains complicates the question of Germany's energy policy. Economic considerations also factor into the question of energy supply.

German public opinion is likewise complicated. According to the latest poll in 2012, 76 percent of Germans favor the shift from nuclear to renewable energy.[16] This stands in contrast to a 2010 OECD poll, in which support for nuclear energy, with the benefits of its use vis-à-vis climate change (lower carbon emissions) explained, grew in a number of countries; in Germany, support grew by 16 percent.[17] In the end, policymakers will have to weigh the risks of ending nuclear energy against the risks of keeping it.

In 2011, nuclear energy accounted for 18 percent of Germany's energy mix, in comparison to 20 percent provided by renewables.[18] This is lower than the OECD's figure for 2010—22.8 percent—when Germany was above the OECD average (21.8 percent) for nuclear as a percentage of total electricity supply.[19] Substituting other energy sources for nuclear as well as reducing energy consumption will be key aspects of Germany's policy for the next decade and beyond. Transparency and public involvement will be essential in transforming the German energy system, where critics of all stripes are outspoken. As Federal Minister for the Environment Norbert Röttgen said in a 2011 interview: "The country cannot get around a fundamental decision: If nuclear is too dangerous, fossil fuels are too dirty and renewable energy is too complicated, where are we supposed to get our energy?"[20]

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History of Nuclear Energy in Germany

Nuclear policy in Germany fluctuated in the postwar period. Commercial nuclear power plants started to come on-line in Germany in 1969 and nuclear was seen as a reasonable alternative to foreign oil after the 1970s oil price shocks and embargo. In the 1980s, opposition to nuclear energy grew after the Chernobyl disaster in 1986 and fears of radioactive

fallout across Europe. The last new nuclear power plant in Germany was commissioned in 1989.[21] After unification in 1990, Soviet-built nuclear power plants in the former East Germany were decommissioned.

As the Green Party grew in membership in the 1990s, opposition to nuclear energy did as well. Beginning with its election in 1998, the Red-Green coalition led by Gerhard Schröder sought to phase out nuclear energy, finding that "in the long term, the use of nuclear energy for electricity generation is unacceptable due to its high risks."[22] Although the 1959 Atomic Energy Act (*Atomgesetz*) promoted nuclear energy, later amendments to it have called for the structured phase-out of nuclear. Codified in the new Atomic Energy Act, the 2001 agreement reached with energy companies granted the remaining nineteen reactors an average lifespan of thirty-two years; consequently, two were shut down within the next four years. As a concession to the energy industry, the government affirmed its commitment to allow companies to continue running existing plants and to avoid any politically-motivated interference.[23] This also gave the government time to formulate a coherent national energy policy focused on promoting renewable energy sources and reducing energy consumption, with the ultimate goal of reducing greenhouse gas emissions to 40 percent below 1990 levels by 2020.[24] According to then-environment minister Jürgen Trittin, "Renewable energies, greater energy efficiency, energy saving and the nuclear phase-out are the corner stones of a responsible and future-oriented energy policy."[25]

Angela Merkel's Conservative-Liberal coalition changed course in 2010, rescinding Schröder's phase-out and granting license extensions for nuclear plants (eight years and fourteen years for plants built prior to and after 1980, respectively) in exchange for new taxes on nuclear power that would then subsidize renewables at an estimated €2.3 billion per year.[26] The Bundestag voted to approve the amendments to the Atomic Energy Act in November 2010. However, following the nuclear disaster in Japan in March 2011, Merkel ordered all seven pre-1980 plants shut down and returned to the previous Red-Green phase-out plan, shutting down all reactors by 2022. In response, energy companies have been filing claims for lost revenue and the taxes they must continue to pay as part of the 2010 agreement.

Calls to improve safety standards at German nuclear plants—rather than a full phase-out—are largely met with skepticism. In 2011, only twenty of twenty-seven safety measures from a 1991 directive had been implemented. Environment minister Röttgen is trying to change that. Insisting that nuclear plants meet modern scientific standards, plants must have four back-up power systems. Furthermore, plants must be protected against natural disasters, such as earthquakes.[27] The challenges associated with meeting these measures stem from the long dissatisfaction with nuclear energy in Germany: Lacking not only the money to enact safety measures, Germany also lacks enough qualified nuclear personnel (it is widely regarded as a dying profession).[28]

Risks of Nuclear Energy

Looking at the history of nuclear energy in Germany, it is clear that risk has always played a role, whether it was risk of energy security, risk to the environment, or risk to people. In an age of heightened security concerns due to terrorism, the risk of security vulnerability has also become a consideration. Finally, economic considerations factor into the assessment of each of these types of risks, weighing the potential for investment and profit against the risk of economic losses at a time of economic uncertainty.

ENERGY SECURITY

Nuclear energy first came to the fore when the country's reliance on foreign energy sources made it vulnerable to foreign actors. Through diversification, Germany has been able to mitigate this risk—to a certain extent. Although domestic sources, including renewables such as wind and solar, coal, and liquefied natural gas (LNG), provide a certain amount of Germany's energy mix, foreign reliance is still a concern. Middle Eastern oil and Russian gas contribute significantly to German industry and the German economy. This reliance was brought up at a July 2011 meeting between Merkel and Russian President Dmitry Medvedev. Merkel's cool response to Russian excitement about a larger German market indicates that she does not necessarily agree with critics who foresee increased dependence.[29]

Following Germany's decision to return to the phase-out plan, nuclear policy at the EU level is becoming contentious. Without producing its own nuclear energy, some argue, German reliance on foreign sources will not only increase, but its energy needs will still be met by nuclear sources provided by its neighbors. France, Poland, and the Czech Republic all continue to produce nuclear energy, and have recently reiterated both their right and intent to do so. The Czech government has announced plans to build two new reactors near the German-Austrian border, strongly opposed by non-nuclear Austria.[30] Meanwhile, nuclear provides about one-third of electricity and

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15 percent of energy consumed in the EU.[31] In France, nuclear accounts for 75 percent of electricity. Recognizing the broader risks associated with having 143 nuclear plants in twenty-seven member states, the EU planned a series of tests after the disaster in Japan. Anti-nuclear sentiment swept the EU in 2011, but weighing the risk of nuclear versus the risk of foreign energy sources or increased CO_2 emissions is an ongoing debate.

ENVIRONMENTAL RISK

Germany has long been a leader in environmentally-friendly renewable energy policies, setting ambitious goals for emissions reductions, renewables, and energy efficiency. Carbon emissions reduction is a central aspect of Germany's energy policy. On the one hand, nuclear energy has allowed Germany to reduce its carbon footprint. The fact that Germany will need to turn to fossil fuels to replace nuclear is a concern. By some estimates, Germany's policy could add 370 metric tons of greenhouse gas emissions through 2020—an annual equivalent of Slovakia's emissions.[32] Fossil fuels currently provide about 40 percent of German energy[33]; greater reliance indeed poses an environmental risk of potentially higher likelihood than nuclear risk.

On the other hand, environmental incentives to improve the use of renewables could speed the process and be appealing to innovators and small businesses trying to expand their market and technology. The costs of Germany's energy transformation will be distributed across sectors, from government to business to private citizens. Röttgen believes that everyone will benefit from this investment in the long term[34]; the potential benefits outweigh the economic risks.

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SECURITY RISK

Unlike the United States, Germany does not have nuclear weapons and, as such, the question of nuclear security does not rest on Germany's ability to act offensively, but defensively. Nuclear plants are vulnerable to terrorist strikes, and the potential for destruction is enormous. Following the 9/11 attacks, studies showed that all but three German reactors would release severe amounts of radioactivity if struck.[35] Although the perceived risk of a terrorist attack is lower in Germany than in the U.S., some argue that allowing these potential targets to exist is a larger risk than the country should take. However, the policies needed to disrupt an attack—physical or cyber—have not been put in place. An earlier smoke-screen proposal, in which nuclear plants would be surrounded by smoke if a nearby airplane veered off course, which would then be intercepted or shot down by the German military, has been stalled after the Federal Constitutional Court ruled the military's involvement unconstitutional. Newer plants with digital controls are vulnerable to cyber attacks, such as the Stuxnet virus.[36] The difficulties and costs associated with retrofitting a plant for increased security—in some cases impossible due to space and ventilation restrictions—has led the industry to successfully lobby against anti-terrorism upgrades proposed in the 2010 extension.[37]

Outlook for Nuclear Energy

Political pressure to continue the phase-out of nuclear energy is strong and likely to continue. The German government is enacting strategies and policies aimed at increasing the country's share of renewables and modernizing the energy grid, while continuing to meet its CO_2 emissions reduction targets, and is confident that its energy goals will be met. Integrating renewables into the existing grid will be essential if Germany is to meet its goal of 35 percent renewable energy.[38] The economic cost of these measures—in a time of economic uncertainty—could hamper the speed with which these policies are enacted; conversely, renewable energy investment could be a driver of the German economy in the twenty-first century. Public perceptions of the risk of nuclear energy will be a driving force for the eventual phase-out.

Nuclear risks remain. Unless Germany is able to rapidly expand renewable energy, it will continue to require nuclear energy—imported from its neighbors. Critics allege that, rather than accepting the risk of nuclear within its borders and regulating and investing wisely to ensure its secure supply, Germans are pushing that risk on its neighbors. In some ways, this seems a short-sighted action: Germany will undoubtedly suffer should a nuclear disaster take place next door, but it will lack the oversight controls to try and prevent such a disaster. Likewise, the original risk that spurred the development of nuclear energy—the risk of relying on imported energy—will return, albeit at a lower scale.

Conclusion

The assessment of the risk of nuclear energy differs in Germany and the U.S., at least at the political level. As public opinion polls indicate, the American public is as uneasy when it comes to the safety of nuclear power plants as its German counterpart. Yet, the strong connection between the military, the government, and the utilities operating nuclear power plants has skewed at least the official risk and cost-benefit analysis in favor of nuclear energy in the U.S. While President Obama has argued that clean energy encompasses all energy sources, it would be prudent for this administration and those that follow to assess risks and benefits of nuclear energy by taking true societal and governmental costs into account. Germany's decision to phase-out nuclear energy should be embedded in a sensible, European-wide energy strategy, so that the phase-out of nuclear energy does not become a phase-in of imported nuclear power. Assessing costs, benefits, and risks of nuclear energy and other energy sources as well as developing a robust, comprehensive, and far-sighted energy policy is thus necessary for both sides of the Atlantic. Cooperation will be essential for the success of both countries.

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AICGS' project "Germany and the U.S.: A New Generation's Transatlantic Dialogue for the Future" brought together a group of young transatlanticists to discuss different aspects of risk assessment and perception across the Atlantic. The participants analyzed risk across a variety of policy spectrums, from economics, to climate change, to international security.

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Jessica Riester is the Managing Editor/ Financial Associate at AICGS and can be reached at jriester@aicgs.org.
Kirsten Verclas is the Senior Program Manager at AICGS and can be reached at kverclas@aicgs.org.

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1755 Massachusetts Ave., NW
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