
The role of U.S. nuclear power in the 21st century

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ABSTRACT

In the 20th century, the U.S. established itself as the global leader in nuclear science, engineering and technology, in large part because of policy principles established in the 1940s and 1950s. However, with 20% of its current nuclear fleet at risk of premature closure, limited nuclear construction projects on the horizon and increased competition from state-owned nuclear programs in China and Russia, America’s 20th century legacy of leadership may not be sustained in the 21st century.

1. Introduction

U.S. nuclear power policy has its conceptual roots in the early days of scientists, engineers, U.S. statesmen and heads of state. Individuals such as President Franklin Roosevelt, President Harry Truman, President Dwight Eisenhower, U.S. Secretary of War Henry Stimson, and Secretary of State Dean Acheson worked closely with Robert Oppenheimer, James Conant, Vannevar Bush, and numerous other scientists and engineers in the development of nuclear energy for military purposes and the eventual crafting of U.S. policy on the use of nuclear energy for civilian purposes. From these early deliberations emerged what are arguably some of the most important policy decisions in U.S. history as pertains to America’s national security and to the stability of the liberal world order the U.S. and its allies established following World War II.

The deliberations that led to these decisions serve as original principles of U.S. nuclear policy that should be brought to bear on nuclear policy decisions today. Yet, 72 years after the original Atomic Energy Act of 1946 and 64 years after it was amended as the Atomic Energy Act of 1954, the U.S. nuclear power sector finds itself largely dormant, with no significant new nuclear construction in over 30 years and facing strong competition in global nuclear influence from countries such as Russia and China (Ogawa, 2018; Takeuchi and Lutkin, 2018).

The objectives of this paper are to present two key policy issues that confronted early U.S. nuclear policy decision-makers, provide an overview of the current status of U.S. nuclear power compared with countries that are competing for global nuclear influence, and underscore the implications of a declining U.S. nuclear enterprise at the global scale. We conclude with brief recommendations centered on the imperative for a strategic U.S. nuclear power policy.

2. Original U.S. nuclear policy issues

Throughout the efforts of the Manhattan Project to unlock the energy of the atomic nucleus, and before the atomic bomb was fully developed, James Conant, a chemist, and Vannevar Bush, an engineer, realized the impact this discovery would likely have on the world at that time—specifically, the threat of an international nuclear arms race (Hewlett and Anderson, 1962). Working with Secretary of War Henry Stimson, Bush and Conant deliberated over a post-war strategy focused on establishing international control of atomic energy where all nuclear science, engineering and technology would be placed under the auspices of a controlling authority. It was debated as to whether this control should be centralized, with the dissemination of all nuclear technology and fuels controlled by one authority, or decentralized, with each country developing its own nuclear enterprise while being held responsible for ensuring that international safeguards were implemented wherever that country’s technology was deployed—be it domestically or in foreign facilities.

Several key reports were developed, one being the Acheson-Lilienthal Report, which was the basis for the first U.S. proposal to the newly formed United Nations Atomic Energy Commission, UNAEC, (Lilienthal, 1946). This proposal, commonly referred to as The Baruch Plan, so-named for Bernard Baruch, the U.S. representative who presented it to the UNAEC, intended to chart a path toward global disarmament of nuclear weapons, prevent the proliferation of nuclear weapons among nations and channel nuclear science, engineering and technology toward peaceful purposes (U.S. Dept. of State, 1946; Gerber, 1982). The plan was rejected by the Soviet Union. Years later, in April 1952, Secretary of State Dean Acheson appointed the Panel of Consultants on Disarmament, chaired by Robert Oppenheimer, and charged...
it with providing an assessment in preparation of resuming talks within the newly organized UN Commission on Disarmament. In February 1953, that report was handed to recently sworn in President Dwight Eisenhower (U.S. Dept. of State, 1953a).

These two bodies of work were highly influential in what would eventually become The Policy of the United States with Respect to Atomic Energy and the Regulation of Armaments, which was presented by President Eisenhower to the UN General Assembly on Dec. 8, 1953 in his so-named “Atoms for Peace” speech (U.S. Dept. of State, 1953b). Subsequently, the original Atomic Energy Act of 1946 was amended as the Atomic Energy Act of 1954, which firmly established America’s formal policy on atomic energy.

The position of early U.S. nuclear power policymakers was that U.S. national interests were best served if the anticipated global flow of nuclear technology, materials and services was subjected to a disciplined, rules-based order of control led by the U.S. (Burr, 2017). As such, Atoms for Peace, as envisioned in the U.S. Atomic Energy Act of 1954, was a policy of global U.S. engagement, not disengagement. The spirit of the policy was that the U.S. would be embedded in the global cycle of nuclear technology, nuclear fuels, nuclear materials and nuclear knowledge in order to minimize the unknowns of the global nuclear supply chain and maximize oversight on as many aspects as possible.

As such, at least two foundational principals were established for U.S. nuclear power policy:

1. The U.S. will lead an international system to control atomic energy and integrate itself as a nation of experts, not merely inspectors, in the global nuclear network and supply chain; and
2. The U.S. will develop a vigorous research and development enterprise that will establish the U.S. as the global leader in the nuclear field.

3. U.S. nuclear power in the global context

Nuclear construction in the U.S. has been largely dormant for over 30 years. The most recent reactor to be brought online was Watts Bar 2, yet the original construction start date was in 1973 and commercial operation didn’t begin until 2016 (IAEA Power Reactor System Information, 2018c). Construction at Watts Bar 2 was suspended in 1985 and didn’t restart until 2007. The U.S. currently has 98 operational reactors following the recent permanent shutdown of its oldest operating reactor at Oyster Creek Nuclear Generating Station (Proctor, 2018). As for new nuclear construction, only one project is currently underway at Georgia’s Plant Vogtle, where two reactors are scheduled to come online in 2021 and 2022. The only other recent nuclear construction activity in the U.S. was at V.C. Summer in South Carolina, but that project was canceled in 2017 with deliberations ongoing as to how the cancellation will impact ratepayers (Marchant, 2018). In addition, due to a lack of new construction, the scheduled retirement of 20% of the current U.S. fleet is eroding U.S. nuclear capacity. These early closings represent over 27,000 MW of nuclear capacity that will be shut down for different reasons, not the least of which can be attributed to inexpensive natural gas and markets that cannot value nuclear for its baseload, zero-carbon characteristics (Fitzpatrick, 2018; Gattie, 2017, 2018b).

The U.S. also has issues on the upstream uranium supply end and downstream spent fuel end. The World Nuclear Association projects that the U.S. has insufficient nuclear fuel production capacity to meet the needs of its existing fleet with only 10% of domestic mining providing for fuel used in its fleet. Such an overdependence on foreign imports of nuclear fuel has national security implications, particularly when 40% of those imports are from Russia, Kazakhstan, and Uzbekistan (Abraham, 2018). In addition, government policy prohibits reprocessing, and the Yucca Mountain repository for spent fuel is caught in a political stalemate (World Nuclear Association, 2018a).

In the global context, which was the context of primary concern to early U.S. nuclear power policymakers, the U.S. is losing ground in the nuclear field. Among countries with substantial civilian nuclear power programs, the U.S. has long been the global leader in annual nuclear power generation (Fig. 1). However, the global landscape is shifting, as China and Russia are developing aggressive and robust nuclear programs to meet both domestic electricity needs and geopolitical objectives, and emerging economies are turning to nuclear power for its proven reliability and zero-carbon characteristics (World Nuclear Association, 2018b; Smith, 2017). Currently, 55 reactors are under construction globally, representing 55,859 MW of new nuclear capacity (Table 1). Beyond current construction projects, the World Nuclear Association reports that about 30 countries are considering, planning, or starting nuclear power programs, with China and Russia taking the lead in offering their respective services in nuclear power technology to developing regions (World Nuclear Association, 2018b).

3.1. Nuclear power in Russia and China

Russia has 37 nuclear reactors in operation and six under
4. The need for a strategic U.S. nuclear power policy

The U.S. nuclear enterprise, from domestic uranium mining to new nuclear construction projects to spent fuel reprocessing to advanced reactor deployment to nuclear waste disposal, is not advancing as it did in the 20th century when the U.S. led the world in nuclear expertise and reactor development. This is in contrast with China and Russia, both of which are growing their respective nuclear programs in terms of domestic deployment and exports and leveraging nuclear expertise to enhance their respect geopolitical influence throughout Asia and the Middle East (Ichord, 2018; Freeman, 2018). Perhaps what is most concerning is that these advances by China and Russia are a matter of state policy being carried out through state-owned nuclear enterprises such as China’s CNNC (China National Nuclear Corporation) and Russia’s Rosatom (World Nuclear News, 2018b; Ren, 2018). This state-owned enterprise structure puts the U.S. nuclear industry at a significant disadvantage when competing for international nuclear partnerships with other countries.

The decline in domestic U.S. nuclear activity combined with the challenge of state-owned Chinese and Russian nuclear enterprises is sufficient to characterize this as an issue with national security implications, as U.S. influence in the nuclear supply chain is at risk of being diminished. It is also sufficient to characterize this as being in conflict with the original policy principles put forward by early nuclear power policymakers who were unambiguous in their stance that the U.S. must be engaged as global experts in the international control of the nuclear supply chain and that it must maintain a robust, world-class nuclear research and development program. On its own, this decline should serve as a clarion call to U.S. policymakers that policy action is needed. However, the issue is all the more dire when the specter of climate change, in and of itself a national security issue, and the loss of baseload coal capacity are taken into account.

The U.S. power sector is undergoing a major transition from base-load coal to natural gas (Fig. 3). This decline in coal capacity is due largely to the abundance of currently inexpensive natural gas, a market force issue, and concerns about the impacts of CO2 emissions on climate change, a social, environmental, and political issue. In the absence of economically viable carbon capture and storage technologies, and given the political likelihood of a carbon tax, coal plants face a tenuous future, at best, in the U.S. When this loss in baseload coal capacity is combined with the projected loss in baseload nuclear capacity, as previously discussed, the U.S. is facing an electric power sector future that is predominantly dependent on natural gas and intermittent renewable energy. Losing one of two baseload energy resources is one issue, but losing both is an altogether different proposition that is unprecedented for the U.S.

With the decline in its nuclear power sector, the U.S. faces domestic challenges with respect to such a loss in baseload capacity—this is an energy security issue. At the international level, this decline has national security implications if the U.S. cedes global leadership in nuclear power to China or Russia. As such, the U.S. has a major decision to make about nuclear power, and it revolves around one question:

Should the U.S. nuclear power sector be left to market forces alone to dictate the fate of nuclear energy in the U.S., or is the U.S. nuclear power sector of such vital national interest that the U.S. should develop a comprehensive and strategic nuclear policy that ensures a robust civilian nuclear power enterprise?

Our contention is that a strategic nuclear power policy is a national security imperative. We base this on the original principles of nuclear power policy makers who comprehended the reality that nuclear energy is not merely another energy commodity, such as coal, natural gas, solar and wind. Rather, these policymakers recognized that nuclear energy is a fundamentally different energy resource with implications that extend far beyond the geographic borders of the U.S. and are capable of reshaping the geopolitical contours of the world order. As such, we contend in this paper that U.S. policymakers must develop a strategic U.S. policy for nuclear science, engineering, and technology that:

• Acknowledges the U.S. civilian nuclear power sector as a vital national security interest whose future should be governed by U.S. policy and not by market forces alone;
• Leverages market forces and competition as a means for developing the most advanced and cost-efficient nuclear technologies;
• Maintains and extends (where feasible) the life span of the current nuclear research and development program. On its own, this decline should serve as a clarion call to U.S. policymakers that policy action is needed. However, the issue is all the more dire when the specter of climate change, in and of itself a national security issue, and the loss of baseload coal capacity are taken into account.

Table 1 Nuclear reactors currently under construction. (Data Source: IAEA Power Reactor Information System, 2018a; Under Construction Reactors).

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of Reactors</th>
<th>Total Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>13</td>
<td>13,168</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>4</td>
<td>5,380</td>
</tr>
<tr>
<td>Korea, Republic of</td>
<td>4</td>
<td>5,360</td>
</tr>
<tr>
<td>India</td>
<td>7</td>
<td>4,824</td>
</tr>
<tr>
<td>Russia</td>
<td>6</td>
<td>4,573</td>
</tr>
<tr>
<td>Japan</td>
<td>2</td>
<td>2,653</td>
</tr>
<tr>
<td>Taiwan, China</td>
<td>2</td>
<td>2,600</td>
</tr>
<tr>
<td>U.S.</td>
<td>2</td>
<td>2,234</td>
</tr>
<tr>
<td>Belarus</td>
<td>2</td>
<td>2,220</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2</td>
<td>2,160</td>
</tr>
<tr>
<td>Ukraine</td>
<td>2</td>
<td>2,070</td>
</tr>
<tr>
<td>Pakistan</td>
<td>2</td>
<td>2,028</td>
</tr>
<tr>
<td>France</td>
<td>1</td>
<td>1,630</td>
</tr>
<tr>
<td>Finland</td>
<td>1</td>
<td>1,600</td>
</tr>
<tr>
<td>Brazil</td>
<td>1</td>
<td>1,340</td>
</tr>
<tr>
<td>Turkey</td>
<td>1</td>
<td>1,114</td>
</tr>
<tr>
<td>Slovakia</td>
<td>2</td>
<td>880</td>
</tr>
<tr>
<td>Argentina</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>55</strong></td>
<td><strong>55,859</strong></td>
</tr>
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Establishes a robust, politically resilient public-private partnership that can be sustained across election cycles in order to stand up a long-term nuclear research and development program around advanced light-water reactors, small modular reactors, fast reactors, molten salt reactors, fuel reprocessing and advanced fuels such as thorium and high-assay low-enriched uranium; and

Seeks to re-establish U.S. competitiveness in international nuclear development partnerships as a means of responding to the challenge of Chinese and Russian state-owned nuclear enterprises.

5. Conclusions

Our contention in this paper is that the U.S. nuclear power sector is of such vital national security interest that it is too strategic to be allowed to fail due to market forces alone (Gattie, 2018a). While competing nations such as China and Russia are standing up their own nuclear enterprises with strategic nuclear policies, the approach to nuclear power in the U.S. is largely transactional in nature and lacks a strategic purview. We contend that markets are not policy and cannot substitute for policy as pertains to nuclear energy. We further contend that modern-day nuclear policy must embody original nuclear policy principles established in the 1940s and 1950s—principles that stipulated the U.S. would be engaged as global experts in the international control of the nuclear supply chain and that the U.S. would maintain a robust, world-class nuclear research and development program. Moreover, U.S. policy should be comprehensive such that it broadens nuclear research and development to include molten salt reactors, fast reactors, advanced fuels and technologies for closing the nuclear fuel cycle. To accomplish this, a public-private partnership should be developed as the means to establish a vibrant nuclear research and development enterprise, to respond to the global competition of China and Russia and to balance their geopolitical aspirations in Asia and the Middle East (Gattie, 2018b).

The history and legacy of U.S. leadership in nuclear power and nuclear power policy, a legacy that was earned and established in the 20th century, continues to be of vital U.S. interest today. As such, early policy principles should be understood and integrated into U.S. deliberations today. Otherwise, the stature and influence of the U.S. in the 21st century global cycle of nuclear science, engineering and technology
won't be what it was in the 20th century.

References


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