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## A RATIONAL APPROACH TO U.S. CIVIL NUCLEAR POWER

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### INTRODUCTION

**T**HE U.S. COMMERCIAL nuclear sector is in trouble. Absent significant policy changes, the near-term closure of a number of reactors appears increasingly inevitable. Much has been written about the impact of cheap shale gas on the economics of nuclear power, but poorly structured, deregulated markets and market distortions – mainly in the form of subsidies and mandates for other kinds of power generation – severely undermine the competitiveness of the existing U.S. nuclear fleet, particularly smaller reactor units.<sup>1</sup> At the same time, foreign competitors, which are mostly state-run enterprises, are capturing a greater share of the export market for nuclear technology and services. The problems that U.S. nuclear vendors face are compounded by a burdensome export regulatory regime and

1. See Sen. Lisa Murkowski's white paper, "Powering the Future: Ensuring that Federal Policy Fully Supports Electric Reliability," at [http://www.energy.senate.gov/public/index.cfm/files/serve?File\\_id=3c485574-7d19-4ee9-ae0e-c7e8f986032e](http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=3c485574-7d19-4ee9-ae0e-c7e8f986032e) and Sen. Lamar Alexander's recent remarks at the National Association of Regulatory Utility Commissioners at [http://www.alexander.senate.gov/public/index.cfm?p=PressReleases&ContentRecord\\_id=ee010fa6-d7da-4e75-b561-7d98b33c8986&ContentType\\_id=778be7e0-0d5a-42b2-9352-09ed63cc4d66&Group\\_id=80d87631-7c25-4340-a97a-72cccd8a658](http://www.alexander.senate.gov/public/index.cfm?p=PressReleases&ContentRecord_id=ee010fa6-d7da-4e75-b561-7d98b33c8986&ContentType_id=778be7e0-0d5a-42b2-9352-09ed63cc4d66&Group_id=80d87631-7c25-4340-a97a-72cccd8a658).

### CONTENTS

Introduction	1
State of the U.S. commercial nuclear sector.	2
Nuclear Operators	2
Nuclear Vendors	3
Subsidies, mandates and carbon policies don't help nuclear	3
Impact of EPA Regulations	4
Rational approaches to nuclear policymaking	4
Protecting existing reactors	4
Increasing U.S. nuclear exports	7
Conclusion	9
About the author	9

a nonproliferation policy<sup>2</sup> that both fail to take into full consideration the current political realities and dynamics in the global market. Moreover, the United States no longer enriches uranium with its own technology, which increases U.S. dependence on nuclear fuel imports and foreign technology.

But the longer-term outlook for a true nuclear renaissance in the United States remains positive, provided that is determined largely by the likelihood of increased regulation of greenhouse gases, traditional pollutants and hydraulic fracturing. This regulatory scenario will play out slowly and it may take decades before the economic case for new nuclear builds can be justified in many parts of the country. Unfortunately, in the meantime, the United States is at risk of losing much of its domestic manufacturing capacity for a technology that is indispensable to promoting U.S. national and energy security interests.

Many energy analysts compare nuclear power to other forms of generation, using the cost of producing electricity as a deciding standard. But nuclear power's inherent link to national security concerns, including defense needs and the nation's ability to help shape global safety and nonproliferation standards, render straight comparisons to natural gas, coal or renewables inadequate. For example, the U.S. Navy relies heavily on the domestic commercial sector for its nuclear needs, not only for supply chain reasons but also to aid in recruitment, which would be hurt by reduced employment opportunities in the private sector. Thus, in addition to diversity of electricity production and climate change mitigation, there are a number of other significant public policy interests that policymakers should consider when determining whether and how to protect the existing fleet of nuclear reactors and to promote U.S. nuclear manufacturing.

The window for making a positive, meaningful impact to reverse or slow the decline of the U.S. nuclear sector is narrowing. Legislators, policymakers and thought leaders must act now. This paper examines a suite of near-term policies and measures that promote a more rational approach to electricity, trade and non-proliferation issues in the nuclear

2. Specifically, some nonproliferation policymaking by Congress, in contrast to the more rational approach historically taken by executive branch agencies.

sector. Taken together, effective implementation of these measures would bolster the U.S. civil nuclear sector until the economics for new builds improves substantially. For nuclear power to succeed, it does not need subsidies or mandates, but it does need its contribution to grid reliability and security to be recognized by government and the markets.

## STATE OF THE U.S. COMMERCIAL NUCLEAR SECTOR

### Nuclear Operators

DESPITE MOVING FORWARD with the construction of five new reactors in regulated markets<sup>3</sup> in the South,<sup>4</sup> last year's announced shutdown of five other reactors reflected the nuclear industry's actual state: one of contraction. For a number of reasons – including competition from cheap shale gas and subsidized renewables, and a poor market structure that does not fully value base-load power<sup>5</sup> – operators decided to retire the small Kewaunee and Vermont Yankee reactors prematurely. Given that these market factors are unlikely to change in the near term, we should expect a greater number of premature shutdowns and decisions by operators not to pursue relicensing.<sup>6</sup> In some cases, the decommissioning funds for reactors could provide an incentive to reduce costs in the short run, given rising operating and maintenance (O&M) costs.<sup>7</sup>

With roughly 50 percent of the nuclear fleet located in merchant markets that also have renewable portfolio standards (and in many cases, energy efficiency/demand destruction mandates), of particular concern is the impact that policies like subsidies for non-nuclear generation<sup>8</sup> have on the continued profitability of merchant market single units with

much higher per-unit costs.<sup>9</sup> Three of the five announced retirements last year were single reactors: Kewaunee (556 megawatts), Vermont Yankee (620 megawatts) and Crystal River 3 (860 megawatts).<sup>10</sup>

Given current government policy and market structure, the future of a number of single units in merchant markets is in doubt<sup>11</sup> – putting at risk roughly an additional 7,500 megawatts for early retirement. Even some larger merchant dual units are threatened – particularly those located in the western PJM that are also close to the Mid-Continent Independent System Operator,<sup>12</sup> which has a large amount of subsidized, intermittent wind power.<sup>13</sup> Combined with other potential losses to the nation's nuclear fleet, U.S. nuclear-generating capacity could fall to about 80 gigawatts of electric energy by 2030 – down from roughly 100 gigawatts of electric energy at the beginning of 2013.<sup>14</sup>

Most of that contraction would probably occur in merchant markets located in the Northeast and parts of the Midwest. Such a decline in zero-emissions base-load capacity<sup>15</sup> would complicate greatly greenhouse gas reduction goals in those parts of the country,<sup>16</sup> as well as challenge grid reliability, particularly during periods of high demand. In 2012, U.S. nuclear plants avoided 570 million metric tons of CO<sub>2</sub>.<sup>17</sup>

3. In merchant or deregulated markets, generators respond to market demand and sell their electricity at the going market price. In contrast, generators in regulated markets receive a price that is determined by state regulatory authorities, which allows them to recover the cost of their investment, plus an authorized return. Accordingly, rate-payers in regulated markets shoulder the financial risks, while deregulated power generators and their investors bear the risks in those markets.

4. Southern Company and SCANA are building new reactors in Georgia and South Carolina, respectively, both of which are regulated markets. The federally owned Tennessee Valley Authority (TVA) is completing work on a reactor at Watts Bar, which was 80 percent completed when construction stopped in 1988.

5. Base-load power is the average amount of power used at any given time. Base-load plants – such as coal and nuclear – can run continuously, in contrast to “peaking” plants, which usually operate during periods of high demand, such as hot summer days during the week.

6. Julie Wernau, “Exelon May Shut Down Nuclear Plants in Profit Struggle,” *Chicago Tribune*, Feb. 6, 2014. [http://articles.chicagotribune.com/2014-02-06/business/ch-exelon-earnings-20140206\\_1\\_nuclear-plants-coal-fired-power-plants-power-prices](http://articles.chicagotribune.com/2014-02-06/business/ch-exelon-earnings-20140206_1_nuclear-plants-coal-fired-power-plants-power-prices).

7. Operating and Maintenance (O&M) costs for nuclear power were 69 percent of electric power production costs in 2011, compared to 12 percent for natural gas and 22 percent for coal.

8. Some states that participate PJM Interconnection LLC – originally the Pennsylvania-New Jersey-Maryland Interconnection, a regional transmission organization that stretched from Illinois to Delaware – also subsidize more than 4,500 megawatt-hours of new combine cycle gas plants with guaranteed revenue streams. This also has the impact of depressing capacity clearing and energy prices.

9. Larger dual-unit nuclear sites have much lower cost per megawatt-hour – by as much as 50 percent.

10. Unlike Kewaunee and Vermont Yankee, Crystal River's shutdown had nothing to do with its cost structure or market design. It was caused by uncertainty over the estimate to repair the containment.

11. Because of their power purchase agreements, Duane Arnold (601 megawatts) and Palisades (703 megawatts) are notable exceptions.

12. The Mid-Continent Independent System Operator, or MISO, is an independent system operator (ISO) and regional transmission organization (RTO) located across the Midwest and Manitoba, Canada.

13. See “Nuclear Energy & Renewables: Systems Effects in Low-Carbon Electricity Systems,” Nuclear Energy Agency, OECD, December 2012 at <http://www.oecd-nea.org/ndd/reports/2012/system-effects-exec-sum.pdf>. With a 10 percent penetration of wind power, nuclear operators suffer a 4 percent loss in load and a 24 percent loss in profitability; those numbers worsen considerably when 30 percent of electricity is generated by wind—a 20 percent loss in load and 55 percent loss in profitability.

14. Michael Wallace and George David Banks, “Restoring U.S. Leadership in Nuclear Energy: A National Security Imperative,” Center for Strategic & International Studies, June 2013, pg. xvi at [http://csis.org/files/publication/130614\\_RestoringUSLeadershipNuclearEnergy\\_WEB.pdf](http://csis.org/files/publication/130614_RestoringUSLeadershipNuclearEnergy_WEB.pdf). This is in stark contrast to the much more optimistic forecast by the Energy Information Administration (EIA), which does not include an analysis of the impact of market externalities, distortions or structure on the nuclear reactor fleet.

15. See <http://www.epa.gov/cleanenergy/energy-and-you/affect/nuclear.html>. It is interesting to note that EPA makes the point that carbon emissions are associated with uranium mining and transporting the fuel to nuclear plants. However, all generation sources have related carbon emissions, including solar panels and wind turbines (e.g. the mining of rare earth minerals) – a point that EPA avoids at <http://www.epa.gov/cleanenergy/energy-and-you/affect/non-hydro.html>.

16. States that participate in the Regional Greenhouse Gas Initiative (RGGI) include Maryland, Delaware, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine.

17. See <http://www.nei.org/Knowledge-Center/Nuclear-Statistics/Environment-Emissions-Prevented>.

## Nuclear Vendors

WITH FEW opportunities to build nuclear reactors at home, U.S. vendors increasingly are dependent on foreign markets to preserve or expand their capacity. Access to overseas nuclear markets also is crucial to the maintenance of the U.S. private sector's research and development programs. Despite contraction of the civil nuclear fleet in Japan, Germany and the United States, on a global basis, the sector is expanding rapidly. The World Nuclear Association reports that China plans to have nuclear capacity for 58 gigawatts of electric energy by the end of this decade, compared to less than three gigawatts of electric energy in 2000.<sup>18</sup> In total, 70 reactors currently are under construction, with about 170 on order or planned. More than 60 percent of these are located in China, India and Russia.

According to the U.S. Department of Commerce, the global market for nuclear goods and services has an estimated value of \$500 to \$740 billion over the next ten years. At first glance, U.S. companies should benefit substantially from this expansion. American firms' reputation for operational excellence, combined with the "gold standard" stamp of approval from the U.S. Nuclear Regulatory Commission (NRC), provides major competitive advantages. Moreover, U.S. industry remains a leader in advanced and innovative nuclear technologies and designs, including small modular reactors and passive safety features.

However, available data for exports indicates these advantages are not the deciding factor for many potential foreign buyers. According to a 2010 report published by the U.S. Government Accountability Office (GAO),<sup>19</sup> American vendors are losing global market share on a number of fronts, despite the increase in the value of related U.S. exports from 1994 through 2008.

- The U.S. share of global exports of sensitive nuclear material (e.g. enriched uranium) decreased significantly from 29 percent to 10 percent.<sup>20</sup>
- Despite the value of exported nuclear reactors, major components and equipment and minor reactor parts nearly doubling, the market share of U.S. firms declined from roughly 11 percent to 7 percent.

18. See <http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China-Nuclear-Power/>.

19. U.S. Government Accountability Office, "Nuclear Commerce: Government Wide Strategy Could Help Increase Commercial Benefits from U.S. Nuclear Cooperation Agreements with Other Countries," Report to the Committee on Foreign Affairs, House of Representatives, November 2010. <http://www.gao.gov/assets/320/311924.pdf>. Interestingly, GAO found that no "single federal agency systematically tracks and reports the data necessary to determine the amount and value of U.S. nuclear exports facilitated by U.S. nuclear cooperation agreements."

20. Over the past several years, this number has certainly fallen further, given U.S. dependence on Japan as an export market for sensitive nuclear material. Before the Fukushima disaster, Japan bought roughly 63 percent of those exports.

- The GAO found U.S. firms were not involved in most new foreign reactor construction projects, having participated in only eight builds during a period when more than 60 reactors came on line.

While the report's data is somewhat dated, anecdotal evidence suggests the trend has continued with a troublesome trajectory. American firms clearly face intense competition from state-owned or state-aligned enterprises, who enjoy significant political and financial support, including favorable financing, subsidies, turnkey services and fuel take-back options. Moreover, state-owned competitors are located in many of the largest markets for nuclear goods and services, creating an additional obstacle to U.S. exports. In 2009, the United Arab Emirates awarded a \$20 billion contract to a South Korean-led consortium, in what was probably the best example of the changing dynamic in the global nuclear marketplace.

## SUBSIDIES, MANDATES AND CARBON POLICIES DON'T HELP NUCLEAR

MANY PROponents FOR U.S. nuclear power argue for subsidies and mandates or for market mechanisms for reducing greenhouse gases – such as carbon trading or a carbon tax – that would incent investment in the sector. This menu of policy options, however, is unlikely to help ease the challenges faced by the existing fleet for several important reasons:

- Even with subsidies, new nuclear capacity is unlikely to be built in the near term in deregulated markets because of cheap shale gas, slow economic growth and excess capacity. Industry is faced with the more pressing problem of maintaining *existing* reactors, which are threatened by market conditions and distortions, including government subsidies for other forms of power generation.
- Redefining renewable energy mandates to include new nuclear as a compliance option would face substantial opposition from the renewable industry, which depends on existing government policy to preserve its market share. The competitiveness of existing reactors would benefit from participating in renewable or "clean energy" mandates as long as such standards are on the books. However, the renewable sector and others who already have moved to comply with existing requirements would oppose such efforts, severely complicating any effort in state legislatures to change those laws.<sup>21</sup>
- At least in the near term, carbon trading and

21. Thirty states and the District of Columbia have a renewable portfolio standard or mandated renewable capacity policies. See <http://www.eia.gov/todayinenergy/detail.cfm?id=4850>.

carbon taxes – more efficient and less costly than Environmental Protection Agency regulation – lack a critical mass of political support from conservatives. Securing such support would require preempting the EPA on a number of fronts, including the Clean Air Act, Clean Water Act and other existing environmental laws and regulations. Most Democrats and their environmental allies would balk at such a transformation of policy when current conventional thinking holds that implementation of existing environmental law is more certain to achieve climate change goals.

## IMPACT OF EPA REGULATIONS

THE SLOW UNFOLDING of EPA air regulations, including those to control greenhouse gas emissions, will not salvage a number of troubled nuclear reactors in merchant markets, given the immediate problems these units face. Moreover, these rules will not fix the fundamental structural problems in those markets, nor will they level the playing field vis-à-vis subsidized and mandated renewables, which will ramp up between now and 2025. Accordingly, the federal government and the states – given their dominant role in electricity legislation and regulation – should explore and implement regulatory and market reforms that do not distort the market and recognize the contribution of nuclear power to grid reliability and security.

For the remainder of this decade, natural gas is poised to benefit more than any other power generation source from EPA regulation of mercury and air toxics,<sup>22</sup> which is helping displace from the grid 30 gigawatts of electric energy, or roughly 8 percent of the nation's coal fleet. Natural gas prices are likely to increase modestly over the next ten to 15 years, thanks to fuel switching in the electricity sector, an expansion of chemical industry and a growth in exports. Nonetheless, we do not see the economics of nuclear improving sufficiently to stop further contraction of the nuclear sector between now and 2030.

Over the next few decades, the proposed rule on carbon pollution from new power plants released last fall and the forthcoming proposal to control carbon from existing plants could force an additional 100 gigawatts of electric energy currently provided by coal from our electricity mix. If these rules survive litigation and are implemented, a slight expansion of nuclear power in regulated markets is possible, given advanced cost recovery and the value placed by state regulators on future diversity of generation in those areas of the country.

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22. Anne Smith, et al. "An Economic Analysis of EPA's Mercury and Air Toxics Standards Rule," NERA Economic Consulting, March 2012. [http://www.nera.com/nera-files/PUB\\_MATS\\_Rule\\_0312.pdf](http://www.nera.com/nera-files/PUB_MATS_Rule_0312.pdf).

Over the longer term, natural gas generation likely will face expanded regulation of air quality emissions and hydraulic fracturing. At the Copenhagen climate conference in 2009, the United States pledged a reduction in its greenhouse gas emission of 83 percent by 2050, compared to a 2005 base line, a target that requires a significant role for nuclear power.<sup>23</sup> In addition, an official announcement of a mid-term reduction target at next year's meeting in Paris is expected, building on President Barack Obama's 17 percent target for 2020.<sup>24</sup> If realized, the next phase in carbon regulation, aimed at achieving the U.S. long-term target, would change the economics for nuclear power fundamentally. When total life-cycle emissions are considered, the average intensity from nuclear is 28 metric tons of CO<sub>2</sub> equivalents per gigawatt-hour, compared to 500 metric tons of CO<sub>2</sub> equivalents per gigawatt-hour for natural gas. While stricter greenhouse gas regulation eventually would drive significant amounts of natural gas from the nation's grid, this scenario is unlikely to begin shifting the economics in nuclear power's favor until after 2030.

## RATIONAL APPROACHES TO NUCLEAR POLICY-MAKING

IT IS TYPICAL for nuclear power advocates to propose expanding the role of nuclear in the U.S. electricity mix for environmental, energy diversity and national security reasons. However, their concentration is largely on the commercialization and deployment of advanced nuclear that incorporates lessons learned from Fukushima, produces minimum or no waste and is proliferation resistant. While long-term thinking for the sector has value, it does little to address the sector's current problems. If left unaddressed, these issues certainly would have negative effects on the investment community's views of the future of nuclear in the United States, including advanced platforms that produce less or no waste.

This section looks briefly at policy recommendations that would help maintain the operation of troubled reactors and improve the competitiveness of U.S. vendors in the global market.

## PROTECTING EXISTING REACTORS

Maintaining the current fleet would help stabilize the domestic industry and improve the outlook for investment in the sector, including small modular reactors and U.S. enrichment technology.

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23. John Broder, "Obama to Go to Copenhagen with Emissions Target," New York Times, Nov. 25, 2009. [http://www.nytimes.com/2009/11/26/us/politics/26climate.html?pagewanted=all&\\_r=0](http://www.nytimes.com/2009/11/26/us/politics/26climate.html?pagewanted=all&_r=0).

24. Lisa Friedman, "Obama Administration Quietly Preparing Pledge of Deeper GHG Emissions Targets for U.N. Talks," *ClimateWire*, Feb. 11, 2014. <http://www.eenews.net/stories/1059994373>.



**A. States should reform or repeal Renewable Portfolio Standards (RPS), recognizing the impact of EPA regulations – current and projected – on utility emissions.**

The adoption of renewable energy mandates at the state level was justified mostly to reduce greenhouse gas emissions in the absence of federal climate legislation. With EPA carbon pollution regulations on new and existing power plants moving forward (albeit slowly) and carbon advocacy on the verge of a major political victory, states should begin plans to phase out renewable portfolio standards, which force consumers to spend more for less-reliable power generation. Utilities are best positioned to pick the environmental compliance pathway for their electricity mix. If deployment of renewables is a better, more efficient path to reach emissions reduction targets than building nuclear reactors or investing in nuclear uprates, utilities should make that decision – not civil servants.

If these laws are not reformed or repealed, government-mandated renewables increasingly will take a larger share of a state's electricity generation, thus shutting off that part of the market from nuclear power and contributing to the financial difficulty of some reactors. A phase-out or repeal of renewable portfolio standards would send a positive market signal that government is taking a *technology-neutral* position to achieving emissions-reduction targets.<sup>25</sup>

Reform or repeal of renewable portfolio standards certainly would face major opposition from the renewable energy sector because of that industry's dependence on mandates and subsidies for preservation of its artificial market. Further, some industry stakeholders would be concerned with changing the rules midstream after significant investments for compliance already have been made. However, the world of federal environmental regulation has changed drastically since the adoption of most (if not all) of these mandates, a fact that should weigh heavily toward justifying reform or total repeal.

**B. Congress should not renew the federal wind production tax credit (PTC).**

The federal wind production tax credit (PTC) should not be renewed because the policy objectives to support the PTC have been achieved widely. The wind PTC of \$23 per megawatt-hour has been successful to encourage

deployment of wind power across the country and help the wind industry reach maturity. Over the past decade, wind facilities have increased tenfold to more 60 gigawatts.<sup>26</sup> Even if Congress does not renew the PTC, wind developers will benefit from the credit because it remains in effect for ten years, serving as a built-in phase-out.

A continuation of the wind PTC would add to the financial difficulties facing a number of existing nuclear reactors in areas of the country with significant amounts of subsidized wind power. Recent studies have shown the negative impact of the PTC on base-load power, particularly because of its link to negative pricing for electricity (i.e., when power providers must pay “congestion” charges to the grid to take their electricity).<sup>27</sup>

The PTC encourages wind farm operators to produce power regardless of market demand. Because the wind blows mostly during the late hours of the night and early morning, wind farms produce significant amounts of electricity when demand is at its lowest. Receiving the tax credit, however, allows wind-power generators to pay “congestion” charges to the grid and still earn a profit, as long as those charges are not greater than the credit. In some parts of the country, negative pricing accounts for up to 13 percent of all hourly prices, and this number is growing as more subsidized wind comes on line.

Nuclear facilities, which attempt to run at a set level of output for technical, safety and cost-recovery reasons, must pay the “congestion” charge without benefitting from the tax credit. Thus, base-load plants, including nuclear, face increased operation costs for no real policy justification, given that the PTC already has achieved its objectives.<sup>28</sup>

Clearly, a shutdown of a nuclear reactor because of subsidized wind would undermine the *actual intent* of the wind production tax credit – to reduce emissions by increasing deployment of clean energy generation – because wind generation requires back-up power, most likely in the form of natural gas, to produce electricity when the wind is not blowing.

Of course, the wind industry opposes an end to the PTC, because the tax credit creates an artificial market for

25. As part of these efforts, the Obama administration should adopt a technology-neutral approach in its procurement of electricity. Last December, President Obama issued an executive order to nearly triple the federal government's procurement of electricity from renewable sources by 2020. The previous renewable target, set in 2009, was 7.5 percent. See <http://www.whitehouse.gov/the-press-office/2013/12/05/presidential-memorandum-federal-leadership-energy-management>.

26. See <http://energy.gov/articles/energy-dept-reports-us-wind-energy-production-and-manufacturing-reaches-record-highs>.

27. For a discussion on the impact of the wind production tax credit on the operation of the nuclear fleet, see Frank Huntowski, Aaron Patterson and Michael Schnitzer, “Negative Electricity Prices and the Production Tax Credit,” The NorthBridge Group, Sept. 10, 2012. <http://graphics8.nytimes.com/news/business/exelon.pdf>.

28. Julie Wernau, “Exelon May Be Feeling A Bit Winded,” *Chicago Tribune*, Sept. 16, 2012. [http://articles.chicagotribune.com/2012-09-16/business/ct-biz-0916-new-exelon-20120916\\_1\\_exelon-ceo-christopher-crane-wind-power](http://articles.chicagotribune.com/2012-09-16/business/ct-biz-0916-new-exelon-20120916_1_exelon-ceo-christopher-crane-wind-power).

wind that otherwise would not exist. However, wind advocates ignore that the PTC creates a disincentive to private sector investment in storage technology, a necessary breakthrough for the transition of wind power from an intermittent source of generation to base load. As long as wind power cannot be used as base load, wind will never be as widely deployed as more reliable forms of generation.

*C. The Federal Energy Regulatory Commission (FERC) should ensure that capacity markets adequately compensate assets that provide critical services to the grid and address the impact of subsidies on energy markets.*

Currently, capacity markets do not sufficiently value base load, resulting in a trend of growing dependence on less-reliable generation in merchant markets. In fact, in some capacity markets, less-reliable resources, such as demand response and intermittent renewables, are valued as much as base load, including nuclear reactors.

In addition, energy markets in deregulated areas of the country are substantially distorted by subsidies. This is particularly true for renewables, though guaranteed revenue streams for combined cycle natural gas in the PJM pose a problem as well. These subsidies, combined with other market imperfections, suppress locational marginal pricing (LMP), which is used in the PJM to price energy purchases and sales.<sup>29</sup> As a result, non-subsidized plants – including nuclear and coal units – are disadvantaged.

We have already seen the implications of these structural problems. Last August, Entergy announced the retirement of Vermont Yankee, in part because the wholesale market did not value the reactor for its fuel diversity benefits.<sup>30</sup> Exelon Chief Executive Officer Christopher Crane echoed this point in early February, warning that a number of the company's reactors may be shut down soon because of market defects.<sup>31</sup>

Deregulated markets face a widespread problem with the lack of investment in new generating capacity. The only viable new build options in these markets are natural-gas fired plants and subsidized renewables. Given the historical unpredictability of the price of natural gas and the intermittent nature of renewables, deregulated markets are clearly rolling the dice on price volatility.

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29. LMP reflects the value of power at a specific location at the time that it is delivered. In this case, if subsidized electricity can reach all locations within the PJM, that price will determine the price throughout the market.

30. See [http://www.entergy.com/news\\_room/newsrelease.aspx?NR\\_ID=2769](http://www.entergy.com/news_room/newsrelease.aspx?NR_ID=2769)

31. Evan Brandt, Evan. "Exelon, Owner of Limerick Nuke Plant May Shut Down Unprofitable Plants," Feb. 13, 2014. <http://mainlinemedianews.com/articles/2014/02/13/region/doc52fa7cdb07e8a215407175.txt?viewmode=default>

Left unaddressed, these flaws are likely to harm future grid reliability, according to some credit market analysts.<sup>32</sup> Consequently, structural problems that affect capacity and energy markets should be addressed as soon as possible. Federal policymakers need to work with the markets, including regional transmission organizations and independent system operators, to find a way to ensure the maintenance of adequate baseload generation. Specifically, deregulated power markets should reflect the value of generation assets based on key criteria, such as providing critical reliability services (including VAR<sup>33</sup>) and fuel on site, which is not subject to hourly price spikes. They also should address subsidies that artificially drive down energy prices and negatively impact baseload generation, including nuclear power.

*D. Congress needs to conduct effective oversight of the Nuclear Regulatory Commission to ensure beneficial post-Fukushima regulation and a transparent process for determining fees charged to the private sector.*

The Nuclear Regulatory Commission (NRC) serves as a model of regulatory excellence, providing a competitive advantage to U.S. nuclear vendors abroad and bolstering domestic political support for nuclear power in the U.S. electricity mix. However, there are growing concerns among operators that post-Fukushima regulation will be pursued without adequate consideration of costs and benefits. Regulatory requirements and costs that are not accompanied by real public benefits only add to the nuclear industry's financial woes.

The NRC's budget has grown considerably over the past decade – from roughly \$585 million in 2003 to \$986 million in 2013. Full-time staff has increased over the same time period from 2,906 to 3,931.<sup>34</sup> The private sector, mostly operators of nuclear plants, cover 90 percent of the NRC's budget by law.<sup>35</sup>

With a contraction of the nuclear fleet, the private sector's contribution to the NRC budget will fall. Accordingly, the NRC will either need to reduce its staff and costs or increase fees it levies on existing operators for other services. Some industry leaders already speculate that, to help fill the funding gap, the NRC will increase its

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32. Aneesh Prabhu, "How Changes in U.S. Power Capacity Markets Might Affect Merchant Generators' Credit Quality," Standard & Poor's Rating Services, Jan. 3, 2014. <http://twitdoc.com/upload/standardpoors/ratingsdirect-commentary-1236127-01-06-2014-11-18-03.pdf>.

33. Volt-Amp-Reactive. VAR is needed to deliver power effectively across transmission lines, which base-load generation provides.

34. See <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350/v25/sr1350v25-sec-1.pdf>.

35. It is interesting to note that during the recent government shutdown, the NRC furloughed 92 percent of its staff, while the private sector continued to pay its obligated fees, though not directly to the commission. On average, other federal agencies – excluding the Defense Department – furloughed only 36 percent of their workforces.

staff hourly rates for responding to operators. Transparency in work performed and achieved by the NRC could help address these concerns.

Over the past several years, the NRC has issued rules in silos without recognizing their cumulative impact or ranking them in order of importance. The commission – with stakeholder input – needs to prioritize regulations, focusing on those that have real safety or public health benefits that can be realized more immediately. For example, some ongoing industry and regulatory activities, outside of the post-Fukushima recommendations carry more near-term benefits to the public.

Congress should ensure the NRC maintains adequate resources to help ensure safety and security for the nation’s fleet of reactors. As part of this effort, given a contracting sector, policymakers and legislators should consider at least a temporary change in the percentage of the NRC budget covered by industry. Raising fees on a smaller pool of operators would worsen the economics for operators, particularly smaller units that play an important role in grid reliability but have higher costs per megawatt-hour.

## INCREASING U.S. NUCLEAR EXPORTS

IMPROVING U.S. VENDOR access to global nuclear markets would help maintain domestic manufacturing capacity during a time of few nuclear builds in the United States. Though the U.S. government cannot reasonably address directly the significant competitive disadvantage that U.S. industry faces, vis-à-vis state-owned enterprises and entities,<sup>36</sup> Washington can pursue a more rational approach to nuclear trade policy that reflects the current state of the global market, including a recognition that formidable competitors will continue to seek greater market share to the detriment of U.S. national interests.

*A. The federal government should pursue a pragmatic approach to negotiating and approving nuclear cooperation or 123 agreements.*

U.S. nuclear trade is governed by Section 123 of the Atomic Energy Act, which generally requires the successful negotiation of a nuclear cooperation agreement before U.S. nuclear equipment or materials can be exported. So-called “123 agreements” are the principal U.S. foreign policy means to gain assurance that U.S. nuclear technology and materials will be used for peaceful purposes. Our main foreign competitors – France, Japan, Russia and South Korea – typically negotiate bilateral agreements

as well, but this practice is a matter of policy; they are not required to do so for the export of controlled items.<sup>37</sup> Currently, the United States has nuclear cooperation agreements with 21 countries,<sup>38</sup> Euratom (the 27 member states of the European Union), the International Atomic Agency and Taiwan. Seven of these agreements expire between now and 2015, including the NCA with a key U.S. military ally, South Korea. At the same time, the United States is negotiating or in the process of finalizing 123 agreements with countries that do not have existing NCAs – most notably Vietnam, which already has bilateral nuclear trade agreements with France, Japan and Russia.

Negotiating 123 agreements can be challenging for the United States, given the level of U.S. engagement and political capital invested in regional security matters, including defense and military agreements, and civil society and human rights around the world. Further, the role of Congress in reviewing nuclear cooperation agreements introduces into the equation the dynamic of special interest considerations, which can complicate the executive branch’s negotiating process. Consequently, negotiations can take years to wrap up.

Specifically, some members of Congress want to include legally binding commitments by partner countries not to develop uranium enrichment and reprocessing – commonly referred to as the “gold standard” for such agreements. While this request may seem reasonable to some U.S. nonproliferation advocates, most countries view such a request as infringing upon rights recognized by the Nonproliferation Treaty (NPT), which the United States has ratified.<sup>39</sup>

The administration’s current position of using a case-by-case approach to negotiating NCAs is practical, given that each potential foreign partner has different national circumstances, levels of development, political and secu-

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37. James Glasgow, Elina Teplinsky, and Stephen Markus. “Nuclear Export Controls: A Comparative Analysis of National Regimes for the Control of Nuclear Materials, Components and Technology,” Pillsbury Winthrop Shaw Pittman, LLP, October 2012. <http://www.pillsburylaw.com/siteFiles/Publications/NuclearExportControls.pdf>.

38. Argentina, Australia, Bangladesh, Brazil, Canada, China, Columbia, Egypt, India, Indonesia, Japan, Kazakhstan, Morocco, Norway, Peru, Russia, South Africa, South Korea, Switzerland, Thailand, Turkey, Ukraine and the UAE. See <http://nnsa.energy.gov/about/ourprograms/nonproliferation/treatiesagreements/123agreementsforpeacefulcooperation> for further information.

39. While the NPT does not explicitly grant countries the right to enrichment, Article IV says, “Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production, and use of nuclear energy for peaceful purposes without discrimination and in conformity with articles I and II of this Treaty.” See <http://www.state.gov/t/isn/trty/16281.htm>. Thus, as long as countries remain non-weapons states and comply with International Atomic Energy Agency safeguards, the plain reading of the NPT implies that countries have some right to enrich. See Chairman Bob Menendez’s remarks at the hearing on 123 agreements of Jan. 30, 2014, pushing back on the assertion of a witness that the NPT does not give countries the right to enrich, at minute 44:35, located at <http://www.foreign.senate.gov/hearings/section-123-civilian-nuclear-cooperation-agreements>.

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36. Some market observers also stress the need for industry (e.g. operators and vendors) to bundle services to better compete with foreign suppliers, but this task should not be led by the government.

riety concerns and economic arguments for pursuing commercial nuclear power. Further, some countries belong to multiple export control and nonproliferation regimes and others already are nuclear weapons states – factors that should be considered.

Certainly, the United States should consider current nuclear cooperation agreements between the potential U.S. partner and foreign competitors – particularly if Washington is pursuing higher standards than those that already exist in non-U.S. arrangements. While obtaining the blessing of the United States for a nuclear program remains politically important, it is not indispensable to a country’s plan to develop a commercial program – a fact that we have seen play out between Vietnam and Russia. Accordingly, a pragmatic approach to negotiating and approving nuclear cooperation agreements is needed, including potential NCAs with Saudi Arabia and Jordan. Shutting out U.S. vendors from any particular export market would not only harm domestic manufacturing capacity, but would also do little to ensure continued U.S. ability to shape a country’s nonproliferation policy.

**B.** *The federal government needs to reform its burdensome export regulations on nuclear trade, while promoting an effective global nonproliferation regime.*

The successful negotiation of pragmatic 123 agreements is by far the most important step that Washington can take to promote U.S. nuclear trade, but the U.S. export control regime remains mired in unnecessary bureaucratic red tape that hinders commerce. Compared to their U.S. counterparts, foreign suppliers have streamlined procedures for nuclear exports – aided by firmly established deadlines for review. Moreover, decision-making rests in the hands of fewer governmental entities. For example, Japan’s Ministry of Economy, Trade and Industry (METI) and the Russian Federal Service for Technical Export Control (FSTEC) are responsible for all export licensing. Such a concentration of regulatory authority eliminates inefficiencies that result from the involvement of multiple actors and produces faster application processing. In the case of Japan, South Korea and Russia, the review of an export license application can be completed within 15-90 days, with many licenses good for multiple exports.<sup>40</sup>

U.S. nuclear exports are certainly subject to strict conditions, overseen by several different agencies and departments. The departments of Energy, Commerce and State, as well as the NRC, all play significant roles, though each

enjoys different regulatory authority. The review and approval process can take about three months to more than a year, depending on the type of export and which federal agency or department has the lead.<sup>41</sup>

- The DOE’s National Nuclear Security Administration (NNSA) grants Part 810 authorizations (10 CFR Part 810), which allows technology transfers and technical assistance involving any part of the fuel cycle. For approval, a foreign government must give nonproliferation assurances that the transferred technology will not be used for non-peaceful purposes nor retransferred without U.S. consent. On average, six to 14 months is needed for a specific authorization.
- The NRC is responsible for approval of Part 110 licenses (10 CFR Part 110), which control the import and export of nuclear reactors, equipment, components and materials, a process that takes approximately one year. Granting a Part 110 license for a significant nuclear export to a specific country requires successful negotiation of a bilateral nuclear cooperation agreement (NCA or 123 Agreement) with that foreign government before it is sanctioned.
- The Department of Commerce clears the export of dual-use technology subject to Export Administration Regulations. Typically, the department’s review requires 45 to 90 days.

Recent attempts by the Obama administration to update DOE’s Part 810 rule have been encouraging, with most stakeholders expressing support. For example, the department has promised to implement a process improvement program to speed up its review. However, further steps should be taken to align the U.S. export control regime as much as possible with those of its competitors. The United States should also focus its export control reforms on markets that plan a significant commercial nuclear power program.<sup>42</sup>

While no one would advocate softening controls to the detriment of the nonproliferation regime, it is important that U.S. vendors have as much access as possible to the growing market for nuclear technology and services. Because U.S. exports are accompanied with conditions on use and transfer, an increase in U.S. market share would

40. James Glasgow, Elina Teplinsky, and Stephen Markus. “Nuclear Export Controls: A Comparative Analysis of National Regimes for the Control of Nuclear Materials, Components and Technology,” Pillsbury Winthrop Shaw Pittman, LLP, October 2012. <http://www.pillsburylaw.com/siteFiles/Publications/NuclearExportControls.pdf>.

41. For a flow chart on the export approval process see [http://ita.doc.gov/td/energy/Civil%20Nuclear%20Exporters%20Guide%20\(FINAL\).pdf](http://ita.doc.gov/td/energy/Civil%20Nuclear%20Exporters%20Guide%20(FINAL).pdf).

42. Margaret Harding, “Time for DOE to Complete its Part 810 Nuclear Export Reform,” Nuclear Townhall, Feb. 22, 2014 at <http://www.nucleartownhall.com/blog/time-for-doe-to-complete-its-part-810-nuclear-export-reform/>. Harding points out that “DOE needs to improve its authorization process to facilitate trade where there is nuclear business: China, India, Southeast Asia and the Middle East.”



correspond with an enhanced U.S. ability to help shape global nonproliferation and safety issues.

Washington should therefore seek to increase the trade controls of our competitors when pursuing that path makes sense and is plausible. On the other hand, the federal government should reduce unnecessary and redundant bureaucratic red tape that unfairly penalizes the U.S. nuclear industry without any real benefits.<sup>43</sup> Because nuclear trade is viewed broadly as a strategic asset, we should expect our competitors to pursue aggressive export strategies, which left unchecked, would result in a further erosion of U.S. market share.

## CONCLUSION

IN 2010, THE Department of Commerce's International Trade Administration warned that the U.S. nuclear sector had "atrophied." This sharp decline in our nuclear program should disturb any policymaker who understands the national security dimensions of commercial nuclear power, including the dependence of our military on the civil sector. It should also trouble environmental activists, given the importance of an expansion of nuclear power in climate mitigation strategies.

Subsidies and mandates for the nuclear industry, however, are not the answer to getting nuclear back on track. Market distortions in energy markets, caused by these types of policy measures, are increasingly problematic, threatening the future of grid reliability. Now that the climate agenda is progressing, state and federal policymakers need to reexamine measures adopted to further clean energy goals that are no longer practical or required.

Ending or reforming policies and regulations that disadvantage nuclear power would increase the odds of survival for existing reactors that must also overcome genuine market-driven forces, such as competition from shale gas. Further, pursuing nuclear trade policy in the context of current market realities – the United States no longer has a monopoly over nuclear technology and services – is more likely to produce better results for U.S. nonproliferation and trade policy. Taking a more rational approach to electricity market and nuclear trade policymaking would go a long way toward bolstering the outlook for both operators and vendors, including the nuclear fuel industry. However, the time to act is now – before we lose leadership in an indispensable technology that is vital to preserving and promoting U.S. national security interests.

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43. In an effort to streamline the parts of the U.S. export control regime under the jurisdiction of the departments of State and Commerce, the Obama administration launched an initiative in 2010 to create a single control list, single licensing agency, unified information technology system and enforcement coordination center. While this is an important step forward, nuclear exports that fall under the control of DOE and NRC – the federal entities that review the applications of most U.S. nuclear trade – are not included in the initiative. See <http://export.gov/ecr/index.asp> for further details.

## ABOUT THE AUTHOR

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During the Bush Administration, Dave was the senior adviser on international affairs and climate change at the White House Council on Environmental Quality, where he was one of the chief architects of the Major Economies Meeting on Energy Security and Climate Change. In September 2008, he was nominated by President George W. Bush to be assistant administrator of international activities at the EPA. His CEQ work on promoting the reduction of non-CO2 greenhouse gases, including methane and HCFs, was later recognized by the Obama Administration, earning him an EPA Climate Protection Award for Diplomacy.

From 2004 to 2006, he served as the State Department's point person on climate change and energy diplomacy at the U.S. Mission to the EU in Brussels, Belgium, where he received a Superior Honor Award for promoting U.S. diplomatic objectives. He was also a decorated CIA economic analyst and served as legislative fellow to Rep. Howard Berman, D-Calif.

A native southeast Missourian, Dave received his bachelor's and a master's in economics from University of Missouri at St. Louis, and also has a law degree from George Mason University.