

# Taxpayer Subsidies for Small Modular Reactors



The Department of Energy (DOE) is asking Congress to provide hundreds of millions in subsidies to commercialize small modular reactors (SMR). First proposed in the 2011 budget, the Administration has committed to providing more than \$500 million dollars for licensing support and research and development for these downsized nuclear reactors. A fraction of the size of conventional-scale reactors, SMRs would be manufactured by assembly line and transported by truck, ship, or rail to their destinations. With designs ranging in size from one-third the size of a large-scale plant down to the size of a hot tub,<sup>1</sup> SMRs will also produce significantly less power: 300 megawatts electrical (MWe) or less compared to 1,000 MWe for a typical commercial-scale reactor.

SMRs will likely never be a good investment, but in the current fiscal climate taxpayers must be especially concerned with any dollars DOE doles out. High-risk, high-cost, and highly questionable, small modular reactors don't just look like bad investment they are a ridiculous waste. For a range of reasons, subsidies for SMRs equal nothing more than another handout for the nuclear industry.



## SMRs: High-risk, Unknown Costs

To date, there are no reliable cost estimates for SMRs. Nuclear vendors are notorious for underestimating costs, and there is no actual experience manufacturing or building SMRs. Since the 1950s, the nuclear industry worldwide has consistently pushed for larger reactors on the theory the economics would improve if the high fixed costs of building nuclear plants could be spread over more kilowatt hours. SMRs represent a reversal of this reasoning and call into question the extensive federal support now being offered to promote a “nuclear renaissance” based on standardizing and sticking to a few large reactor designs. While commercial scale reactors of 1,000 MWe or greater could cost at least \$8 billion, DOE officials have projected the first SMRs will cost approximately \$1 billion per 100-150 MWe.<sup>2</sup> When asked about operation and maintenance costs compared to commercial scale reactors, the federally-owned Tennessee Valley Authority (TVA) said it expects it to be higher.<sup>3</sup> The Department of Energy has already provided nearly \$100 million for these so-called mini reactors while their commercial viability remains in question. DOE has committed up to **\$452 million** over the next five years in an attempt to fund up to two separate demonstration projects.

## Federal Subsidies for Small Modular Reactors

Federal support for SMRs is provided through a subsidy program for commercial nuclear power that can be traced back to the 1950s when federal subsidies for nuclear power reached astronomical levels. Not only did the government develop reactor and enrichment technology for the private sector, it also

assumed legal responsibility for nuclear waste disposal, something never done for any other industry. In addition, the government issued multimillion-dollar development grants for many reactor technologies (most since abandoned) and distributed research reactors around the world.

At the same time, the U.S. Navy started developing smaller nuclear reactors for naval ships and the Army’s Nuclear Power Program constructed eight experimental mini-reactors for use in rural operations.<sup>4</sup> Since then, interest in using SMRs within the military and for domestic energy applications has grown. From 1999 to 2004, DOE’s Nuclear Energy Research Initiative awarded research and development grants to public, private, and non-profit entities in support of SMR development.<sup>5</sup>

Two federal initiatives currently provide support for the commercialization of SMRs: the recently created DOE Small Modular Reactor Program and the private-public partnership program at DOE’s Savannah River site in South Carolina. To date, nearly \$100 million in federal funds have been provided for SMRs through the Small Modular Reactor Program. Congress approved more than \$95 million for DOE’s SMR program in FY2012 (See Table 1). The President’s FY2013 budget proposal of \$770 million for the Office of Nuclear Energy included \$83 million for SMRs.

Below are brief descriptions of the DOE SMR Program and the Private-Public partnership program at DOE’s Savannah River site.

*DOE’s Small Modular Reactor Program*

In March 2012, the Department of Energy announced a public-private cost-share funding opportunity aimed at commercializing SMR technology.<sup>6</sup> Within the announcement, DOE stated it would select up to two SMR proposals to receive up to \$452 million in cost-share funding for design certification and licensing support, dependent on Congressional appropriations. The funds would help the SMR designs reach a commercial operation date before 2022. DOE’s funding opportunity extended from 2012 and 2016 and required taxpayers to provide up to 50% of project costs.<sup>7</sup>

Taxpayers would also fund continued SMR research and development. The SMR Program is funded through two separate annual budget lines including “Licensing Technical Support” and “Advanced Concepts Research and Development.” The Licensing Technical Support sub-program would “provide support for design, certification, standards, and licensing.”<sup>8</sup> Moreover, the Advanced Concepts R&D sub-program provides taxpayer-backed support to the nuclear industry through reactor design and concepts development.

<b>Table 1: DOE Small Modular Reactor Program Funding (millions)</b>			
<b>Sub-Program:</b>	<b>FY2011*</b>	<b>FY2012 (ACTUAL)</b>	<b>FY2013**</b>
Licensing Support	-	67	65
Advanced R&D	38.88	28.001	18.479
<b>TOTAL SMR Program</b>	<b>\$38.88</b>	<b>\$95.001</b>	<b>\$83.479</b>
<i>Source: Consolidated Appropriations Act, 2012 (P.L. 112-74) &amp; Congressional Budget Requests</i>			
<i>*Requested</i>			
<i>**September 2012 Continuing Appropriations Resolution allowed FY2012 funding levels to continue through March 27, 2013.</i>			

The DOE SMR program is behind schedule. According to the FY2013 budget justification, DOE planned to select up to two designs by September 2012<sup>9</sup> but announced a month later it had missed the deadline. In response to the funding opportunity announcement, four companies applied: Westinghouse Electric Company, Generation mPower LLC, SMR LLC, and NuScale Power LLC (See Table 2 or Appendix One for more information on individual applicants).

As of February 2013, DOE has only selected one applicant. In November 2012, DOE announced the first SMR design to be awarded cost-share funding. Babcock & Wilcox (B&W) could receive any portion of the \$452 million to commercialize its 180 MWe reactor. The amount B&W will receive has yet to be determined. While DOE only announced one of potentially two selections, it also stated it intends to provide additional funding opportunities in the future.<sup>10</sup>

Earlier this month, B&W announced it had signed a contract with TVA to start preparing an NRC construction permit application for its proposed reactors at TVA's Clinch River site.<sup>11</sup> Yet according to the United States Nuclear Regulatory Commission (NRC), TVA initially intended to submit its application in late 2012.<sup>12</sup> A B&W-TVA press release says the companies plan to submit an application in 2015—three years behind schedule.

#### *Savannah River Nuclear Development Site*

In March 2012, DOE's Savannah River site and Savannah River National Laboratory (SRS) signed three Memorandums of Agreement (MOA) for public-private partnerships with small modular reactor companies to commercialize SMR technologies.<sup>13</sup> Located in South Carolina, DOE's SRS provides support ranging from technology demonstration to design certification and licensing assistance.<sup>14</sup> This support is in addition to the SMR program.

In one Memorandum of Agreement, SRS plans to invite the National Nuclear Security Administration (NNSA) to discuss incorporating mixed oxide fuels (MOX) into SMR LLC's design. When soliciting proposals for public-private partnerships, SRS said it intends to develop SMR designs that are capable of using fuel based from surplus plutonium and spent reactor fuel as a potential alternative to storing spent nuclear fuel at Yucca mountain.

Created in 1950, the federally-owned, privately-managed Savannah River complex was established to manufacture materials needed for nuclear weapons development during the Cold War. Since then, the 310-square mile complex has ceased producing weapons materials and housed much of DOE's experimental nuclear research and development including mixed oxide fuels, environmental management, and waste storage technologies to the benefit of private industry. Savannah River has an annual budget of approximately \$2.5 billion.<sup>15</sup>

#### **Current Applicants Seeking Federal Subsidies**

Five small modular reactor projects have applied for support from DOE to date, but none of the five different reactor designs have been licensed by the NRC. NRC and DOE aim to award the first design certification license by 2018 and final construction/operating license by the early 2020s. Currently, all five projects are in the pre-application phase with NRC working towards initial design certification.

All but one SMR project would develop an integral pressurized light water reactor (iPWR) while the other would develop a fast neutron reactor (FNR).

**Table 2: Active Small Modular Reactor Projects at the Department of Energy**

Company Name	Reactor Capacity (MWe)	Reactor Type	SMR Funding Applicant	SMR Funding Recipient	Savannah River Site Partnership Recipient	Location
Westinghouse Electric Company	225	iPWR	X			Ameren Power's Callaway Site, MO
Babcock & Wilcox Company*	180	iPWR	X	X		Tennessee Valley Authority's Clinch River Site, TN
Holtec International Incorporated	145	iPWR	X		X	Department of Energy Savannah River Site, SC
Fluor Power Corporation	45	iPWR	X		X	Department of Energy Savannah River Site, SC
Gen4 Energy	25	FNR			X	Department of Energy Savannah River Site, SC

\*Announced in November 2012

### NRC Not Ready For SMRs

The United States Nuclear Regulatory Commission has stated it is not fully prepared to license SMRs. In 2008, NRC estimated it would have a regulatory review process in place to license the first SMRs within *five* years.<sup>16</sup> However, in May 2012 the NRC stated “If an appreciable fraction of total SMR initiatives materialized, it would create an untenable situation for the NRC.”<sup>17</sup>

This is because the regulatory framework for licensing SMRs does not fully exist. It has yet to be determined whether many of the proposed qualities of SMRs, such as generation capacity, modularity, and security features, are covered under the current licensing process for new nuclear reactors.<sup>18</sup> Most of all, NRC hasn't decided whether it will license individual reactors or issue a combined license for a multi-reactor facility—for example GmP's 'four pack' or Holtec's 'twelve-pack.' As of December 2012, NRC projected to complete certification for B&W, NuScale, and Westinghouse's reactor designs in 2017, though a final schedule has yet to be released.<sup>19</sup>

There are questions whether NRC will uphold current regulatory standards for SMRs. The Nuclear Energy Institute (NEI) argues NRC should reduce decommissioning cost assurances (i.e. funds set aside for cleanup after the reactor is shut down); annual fees paid to NRC; the number of control room operators on site; and insurance requirements in the event of a nuclear accident.<sup>20</sup>

Under current law, SMR operators would provide the same decommissioning cost assurances as all other U.S. reactors. NEI proposes SMR operators apply for a short-term exemption and ultimately change the law in the long term.<sup>21</sup> Under the Omnibus Budget Reconciliation Act of 1990, all nuclear reactor licensees are also required to pay an annual fee that makes up the majority of NRC's budget

authority. This fee is divided equally among the nation’s 104 nuclear reactors. NEI proposes changing this requirement and linking annual fees to output levels, which would significantly reduce rates for SMR operators.<sup>22</sup>

Questions about safety and security requirements have also been raised. Since many of the SMR designs being developed include “passive safety” features, industry is in discussions with NRC about adjusting requirements. Proposals include reducing the required number of plant operators on site and decreasing the size of the emergency planning zone.<sup>23</sup> Reducing security checkpoints at SMR plants is also being considered as a cost-cutting effort.<sup>24</sup>

Although significantly smaller than traditional reactors, SMRs will still require significant insurance in the event of an accident. New nuclear reactors are currently covered by the Price-Anderson Act for accidents valued at over \$12.6 billion. Price-Anderson may fall dramatically short in the case of SMRs, however. Under the Act, reactors that produce 100 MWe or greater must hold the maximum amount of private insurance available (\$375 million) as well as a “retrospective insurance plan.” Smaller reactors producing less than 100 MWe must also hold the maximum amount of private insurance (between \$4.5 and \$75 million), but are not required to hold the additional plan. Multi-reactor facilities consisting of reactors between 100 MWe and 300 MWe that produce less than 1300 MWe are treated as a single entity for insurance purposes. The Act does not address combinations of reactors under 100 MWe, such as Gen4 or Fluor’s reactor designs.

“The current insurance and indemnity requirements ... for multiple reactor modules that collectively exceed 100 MWe may not provide adequate assurance to the public that all claims resulting from a nuclear incident at such a facility would be compensated.”

– Michael Johnson, Director of Office of Nuclear Reactors, NRC. SECY-11-0178. December 2011.

### Summary: Taxpayer Concerns

In these tight budget times, federal taxpayers cannot afford yet another giveaway to the heavily-subsidized nuclear power industry. Continued taxpayer-backed support for SMR licensing in addition to R&D giveaways amounts to just another subsidy in a suite of federal supports for the nuclear industry. More than 100 reactors operated by 30 companies exist in the United States; the nuclear industry, not federal taxpayers, must lead the way if SMRs are to reach commercial viability.

Even the nuclear industry has said they can move forward without subsidies. Senior Vice President of Holtec International Pierre Oneid said his company aims to commercialize its SMR design whether or not it receives a federal cost-share subsidy.

- James Hammond. “Holtec, NuHub to Partner on Small Reactor Grant.” *GSA Business*. April 2012.

In the Department of Energy’s materials on SMRs, the agency argues there is a “need and a market” in the United States for SMRs. In reality, no one is clamoring to buy an SMR because there is no assurance the electricity will be remotely competitive with power from other sources. New nuclear power today is uncompetitive by a very wide margin. To compete with today’s natural gas prices, SMRs would have to produce electricity at half the projected cost of conventional reactors. There is not the slightest indication they can do so.

During times of economic stress, the nuclear industry has a tradition of rushing forth to proclaim a new technology just around the corner will sweep current problems aside. Unfortunately, these visions have an equally long tradition of expensive failure, most often at taxpayers' expense. The Department of Energy's efforts to spend taxpayer dollars on Small Modular Reactors will simply continue this legacy of failure and must be rejected.

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## Appendix One: Company Profiles

### ***Babcock and Wilcox Company***

[Generation mPower, LLC](#) (GmP) is a jointly-owned subsidiary of Babcock & Wilcox Nuclear Energy Inc. (B&W) and Bechtel Power Corporation. Established in 1867, B&W is a public utility component manufacturer and government contractor based in Charlotte, NC with more than 12,000 employees. B&W made nearly [\\$170 million](#) in net profits in 2011. Bechtel is one of the largest engineering and construction companies in the United States with more than 50,000 employees. Founded in 1898, Bechtel Power Corporation is headquartered in San Francisco, CA.

GmP was founded in 2010 following two years of research and development, and intends to commercialize its 125 MWe small modular reactor by 2018.<sup>25</sup> GmP is partnering with the federally-owned Tennessee Valley Authority (TVA) which aims to construct a ‘six pack’ of SMRs at TVA’s Clinch River site in Tennessee.<sup>26</sup> In 2012, GmP altered its reactor design to increase generation capacity to 180 MWe,<sup>27</sup> downsized its plans to only four reactors at TVA’s Clinch River site, and delayed the proposed initial operating date until 2022—dependent on plant licensing from NRC.<sup>28</sup> GmP’s reactor is proposed to be 83 feet tall by 13 feet wide, have a four-year refueling lifecycle,<sup>29</sup> and construction period of three years.<sup>30</sup> As of May 2012, more than \$200 million has been spent on the development of GmP’s SMR design.<sup>31</sup> Most recently, GmP signed a contract with TVA to start preparing the NRC construction permit application for the proposed reactors at TVA’s Clinch River site.<sup>32</sup> GmP aims to submit its design certification application in 2014.<sup>33</sup>

Babcock & Wilcox has designed and built seven of the 104 current operating nuclear reactors in the United States.<sup>34</sup> TVA currently operates six commercial reactors and will advise GmP throughout the NRC licensing process.<sup>35</sup> According to a recent presentation, TVA has been working on the commercialization of SMRs since 2009.<sup>36</sup> GmP’s plans are backed by the Generation mPower Industry Consortium and advisory council—a collection of more than a dozen public utility suppliers.<sup>37</sup>

### ***Fluor Power Corporation***

[NuScale Power, LLC](#) is a majority-owned subsidiary of Fluor Power Corporation with close ties to the Idaho National Engineering and Environmental Laboratory (INEEL) and Oregon State University (OSU). Founded in 1912, Fluor is a global engineering and construction company headquartered in Irving, TX. Fluor has more than 43,000 employees worldwide and net profits of nearly [\\$600 million](#) in 2011. Overall, Fluor’s largest contribution to the project has been providing \$30 million to NuScale (simultaneously becoming a majority owner) for continued research and development in 2011.<sup>38</sup> Fluor itself has little or no experience designing nuclear reactors.

Founded in 2007, NuScale Power LLC aims to commercialize its 45 MWe reactor by 2020.<sup>39</sup> NuScale’s SMR design is a product of a more than decade long partnership between the federally-managed Idaho National Engineering and Environmental Laboratory and Oregon State University—dating back to 2000. Soon after the company was founded, NuScale was awarded exclusive rights to the SMR design which had been developed through this partnership with funding from DOE.<sup>40</sup> Soon after, NuScale signed a memorandum of understanding with Kiewit Contractors Company that Kiewit will provide construction

services once NuScale's SMR design has been approved by NRC.<sup>41</sup> As of February 2012, approximately \$130 million has been spent on the development of NuScale's SMR design.<sup>42</sup>

NuScale is one of three companies awarded a public-private partnership to commercialize its SMR design at DOE's Savannah River site in South Carolina. Once NuScale has demonstrated its 45 MWe reactor, it intends to build a '12 pack' to produce a total of 540 MWe at one facility. In one 2008 presentation, NuScale proposed combining up to 30 reactors at one facility.<sup>43</sup> NuScale's 45 MWe SMR design is proposed to be 65 feet high by 14 wide,<sup>44</sup> last up to 60 years,<sup>45</sup> and have a two-year refueling interval.<sup>46</sup>

NuScale's plans are backed by a Customer Advisory Board—a collection of more than a dozen public utility suppliers and organizations.<sup>47</sup>

\*Noteworthy: Fluor Corporation is a joint-owner of the corporation (Savannah River Nuclear Solutions, LLC) that manages and operates the Savannah River site facilities.

### ***Gen4 Energy Incorporated***

Founded in 2007 and headquartered in Denver, Colorado, Gen4 Energy Inc. (formerly Hyperion Power Generation Incorporated) is a private company focused on commercializing its 25 MWe small modular reactor design. A participant in DOE's Technology Transfer Program, Gen4 SMR design is the sole product of the federal Los Alamos National Laboratory (LANL).<sup>48</sup> Exclusive rights to the 25 MWe reactor design developed by LANL were awarded to Gen4 soon after it was founded and nearly a dozen LANL employees continue to work on SMR design today.<sup>49</sup>

Gen4 is one of three companies with a public-private partnership agreement with DOE's Savannah River Site to commercialize its small modular reactor design. Gen4's design is the smallest of the federally supported SMR designs, describing its reactor as "about the size of a typical backyard hot tub."<sup>50</sup>

Unlike the other four applicants, Gen4 announced in early 2012 it would not pursue DOE's SMR cost-share funding opportunity.<sup>51</sup> "While we will not pursue the Licensing [public-private partnership], we are excited to continue our work under our Memorandum of Agreement with DOE to deploy our advanced reactor at Savannah River," stated David Carlson, Gen4 Energy's Chief Operating Officer.<sup>52</sup> Gen4's reactor design is proposed to last ten years after which the entire reactor module must be replaced.<sup>53</sup>

### ***Holtec International Incorporated***

[SMR, LLC](#) is a wholly-owned subsidiary of Holtec International Incorporated. Established in 1986 and headquartered in Jupiter, FL, Holtec is a public utility components manufacturer specializing in waste storage facilities with operations worldwide. While Holtec is a global leader in power plant waste management and has supported the construction of nuclear reactors in the past, it has little to no experience designing nuclear reactors.

Founded in 2011, SMR LLC aims to complete design certification in 2013<sup>54</sup> and commercialize its 160 MWe reactor by 2018.<sup>55</sup> In addition to the cost-share funding opportunity, SMR LLC is one of three companies awarded a public-private partnership to further develop its reactor design at DOE's Savannah



River site in South Carolina. Notably, within SMR LLC's memorandum of agreement with DOE, the company agrees to discuss incorporating MOX fuel into its design with the National Nuclear Security Administration.<sup>56</sup> SMR LLC's reactor is proposed to have a four-year refueling cycle and last up to 80 years.<sup>57</sup> Most recently, Holtec altered its reactor design to decrease generation capacity to 145 MWe and refueling intervals of three years.<sup>58</sup>

SMR LLC's plans are supported by NuHub, Exelon, Entergy, PSEG, First Energy, and SCE&G which have agreed to share operation responsibilities if and when the demonstration project is constructed.

### ***Westinghouse Electric Company***

Formed in 1886, [Westinghouse Electric Company](#) is a service provider to nearly every corner of the nuclear power industry. Westinghouse is a subsidiary of Toshiba Nuclear Energy Holdings Inc. with more than 14,000 employees and is headquartered in Monroeville, PA with operations worldwide. Westinghouse has significant experience designing and building nuclear reactors. Currently, 48 of the 104 operating nuclear reactors in the United States have been designed and built by Westinghouse<sup>59</sup> with another 14 proposed reactors under consideration.<sup>60</sup>

Westinghouse announced plans in February 2011 to commercialize its 200 MWe small modular reactor by 2021.<sup>61</sup> The design is largely based off Westinghouse's AP1000 reactor design which was approved by the Nuclear Regulatory Commission (NRC) in December 2011.<sup>62</sup> Westinghouse's SMR design is proposed to be 89 feet tall by 39 feet wide,<sup>63</sup> have a refueling period of two years, and a lifespan of 60 years.<sup>64</sup> In addition to power generation for public utilities, Westinghouse envisions its SMRs to supply on-site power for coal-to-liquid operations, as well as tar sands and oil shale development operations.<sup>65</sup> Most recently, Westinghouse altered its reactor design to increase generation capacity to 225 MWe.<sup>66</sup> Westinghouse aims to submit its design certification application in 2014.<sup>67</sup>

Westinghouse intends to build its first SMR in partnership with public service utility Ameren Missouri, at Ameren's Calaway site.<sup>68</sup> Westinghouse's plans are also backed by the "NexStart SMR Alliance"—a coalition of more than a dozen public utility suppliers.<sup>69</sup>

## Appendix Two: Legislation

In the 112<sup>th</sup> Congress, six pieces of legislation were introduced in order to provide federal support for small modular reactors. Most notably, Senator Mark Udall (D-CO) introduced the Nuclear Energy Research Initiative Improvement Act of 2011 (S. 1067) that would have earmarked \$250 million to SMRs between 2012 and 2016. Furthermore, three of the six bills call for public-private cost-share agreements as the main funding mechanism for a small modular reactor program. Below are brief summaries of each piece of legislation.

- November 1, 2011 – Rep. Thomas Rooney (R-FL) – [H.R. 3302: Restore America Act of 2011](#)
  - Rep. Rooney’s bill would require the Nuclear Regulatory Commission (NRC) to provide a report to Congress with policy recommendations for streamlining licensing of SMRs and then administer those recommendations within one year. The bill had no cosponsors.
- June 16, 2011 – Sen. Kent Conrad (D-ND) – [S. 1220: Fulfilling U.S. Energy Leadership Act of 2011](#)
  - Sen. Conrad’s bill would require NRC to establish a program to streamline the licensing of a standard SMR design through public-private cost-share agreements within ten years. The bill had no cosponsors.
- June 3, 2011 – Rep. Jim Matheson (D-UT) – [H.R. 2133: FUEL Act](#)
  - Rep. Matheson’s bill would require DOE to carry out a SMR RD&D program to support the commercialization of SMRs through public-private cost-share agreements. The bill had no cosponsors.
- May 25, 2011 – Sen. Mark Udall (D-CO) – [S. 1067: Nuclear Energy Research Initiative Improvement Act of 2011](#)
  - Sen. Udall’s bill would require DOE to carry out a nuclear RD&D program including SMRs with annual appropriations of \$50 million for five years, totaling \$250 million. The bill had three cosponsors: Sens. Jeff Bingaman (D-NM), Lisa Murkowski (R-AK), and Amy Klobauchar (D-MN).
- March 8, 2011 – Sen. Jeff Bingaman (D-NM) – [S. 512: Nuclear Power 2021 Act](#)
  - Sen. Bingaman’s bill would require DOE to carry out a SMR RD&D program to support the commercialization of two SMR reactor designs through public-private cost-share agreements so industry can obtain a design certification NRC by January 1, 2018. The bill had seven cosponsors: Sens. Mary Landrieu (D-LA), Lisa Murkowski (R-AK), Mark Pryor (D-AR), Mark Udall (D-CO), Michael Crapo (D-ID), James Risch (R-ID), and Roy Blunt (R-MO).
- March 3, 2011 – Rep. Devin Nunes (R-CA) – [H.R. 909: Roadmap for America’s Energy Future](#)
  - Rep. Nunes’ bill—similar to Rep. Rooney’s bill—would require NRC to provide a report to Congress with policy recommendations for streamlining licensing of SMRs and then administer those recommendations within one year. The bill had 73 Republican cosponsors.

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<sup>1</sup> Gen4 Energy's SMR design is the smallest of all applicants and has been described as "about the size of a typical backyard hot tub," generating only 25 MWe.

<sup>2</sup> Jessica Mulholland. "Mini-Nukes Advancing in South Carolina." *Government Technology*. September 2012.

<http://www.govtech.com/transportation/Mini-Nukes-Advancing-in-South-Carolina.html>

<sup>3</sup> Dan Stout, Senior Manager of SMR Technology at the Tennessee Valley Authority. "Nuclear Energy Policy and Small Modular Reactors." *The University of Tennessee*. February 2013.

<http://160.36.161.128/UTK/Viewer/?peid=fa73ded60b7b46698e9adc0732101a76>

<sup>4</sup> Kate Anderson. "Small Modular Reactors." *National Renewable Energy Laboratory*, Department of Energy. February 2010.

<sup>5</sup> (1) NuScale Power LLC. "History of the NuScale Power Design." <http://www.nuscalepower.com/an-About-Company-History.php> (2) *World Nuclear Association*. "U.S. Nuclear Power Policy." Updated January 2013. [http://www.world-nuclear.org/info/inf41\\_US\\_nuclear\\_power\\_policy.html](http://www.world-nuclear.org/info/inf41_US_nuclear_power_policy.html)

<sup>6</sup> *Department of Energy*. "Obama Administration Announces \$450 million to Design and Commercialize U.S. Small Modular Nuclear Reactors." March 2012. <http://energy.gov/articles/obama-administration-announces-450-million-design-and-commercialize-us-small-modular>

<sup>7</sup> *Department of Energy*. "Obama Administration Announces \$450 million to Design and Commercialize U.S. Small Modular Nuclear Reactors." March 2012. <http://energy.gov/articles/obama-administration-announces-450-million-design-and-commercialize-us-small-modular>

<sup>8</sup> Mark Holt. "Nuclear Energy Policy." *Congressional Research Service*. June 2012. <http://www.fas.org/sgp/crs/misc/RL33558.pdf>

<sup>9</sup> *Department of Energy*. "FY 2013 Budget Request to Congress." Volume 3. February 2012.

<http://www.cfo.doe.gov/budget/13budget/Content/Volume3.pdf>

<sup>10</sup> *Department of Energy*. "Energy Department Announces New Investment in U.S. Small Modular Reactor Design and Commercialization." November 2012. <http://energy.gov/articles/energy-department-announces-new-investment-us-small-modular-reactor-design-and>

<sup>11</sup> *The Babcock & Wilcox Company*. "B&W, TVA Sign Contract for Clinch River mPower Construction Permit." February 2013.

[http://www.babcock.com/news\\_and\\_events/2013/20130220a.html](http://www.babcock.com/news_and_events/2013/20130220a.html)

<sup>12</sup> *Nuclear Regulatory Commission*. TVA Voluntary Response to NRC Regulatory Issue Summary 2011-02, "Licensing Submittal Information and Design Development Activities for Small Modular Reactor Designs." March 2011.

<http://pbadupws.nrc.gov/docs/ML1108/ML110840713.pdf>

<sup>13</sup> *Department of Energy*. "Energy Department Announces Small Modular Reactor Technology Partnerships at Savannah River Site." March 2012. <http://energy.gov/articles/energy-department-announces-small-modular-reactor-technology-partnerships-savannah-river>

<sup>14</sup> According to DOE's Savannah River site long-term strategy documents entitled "Enterprise SRS," small modular reactors are key to the site's revitalization.

<sup>15</sup> *Savannah River Site*. "Facts: Enterprise SRS." January 2012. [http://www.srs.gov/general/news/factsheets/srs\\_esrs.pdf](http://www.srs.gov/general/news/factsheets/srs_esrs.pdf)

<sup>16</sup> *Targeted News Service*. Chairman Gregory B. Jaczko Responds to Senator Jeff Bingaman Submitting NRC's Comments Regarding S. 2052. December 2009.

<sup>17</sup> Michael Mayfield, Director of Division of Advanced Reactors and Rulemaking. "Advanced Reactor Program: Overview of Small Modular Reactor Licensing." *Nuclear Regulatory Commission*. May 2012. PowerPoint Presentation.

<sup>18</sup> R. W. Borchardt, Executive Director for Operations. "Policy Issue Information: Potential Policy, Licensing, and Key Technical Issues for Small Modular Nuclear Reactor Designs." *Nuclear Regulatory Commission*. SECY-10-0034. March 2010.

<http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2010/secy2010-0034/2010-0034scy.pdf>

<sup>19</sup> *Nuclear Regulatory Commission*. "New Reactor Licensing Applications: Schedules by Calendar Year." February 2013.

<http://www.nrc.gov/reactors/new-reactors/new-licensing-files/new-rx-licensing-app-legend.pdf>

<sup>20</sup> *Nuclear Regulatory Commission*. "Stakeholder Position Papers." Updated July 2012.

<http://www.nrc.gov/reactors/advanced/stakeholder-papers.html>

<sup>21</sup> Michael R. Johnson, Director of Office of New Reactors. "Policy Issue Information: Decommissioning Funding Assurance for Small Modular Nuclear Reactors." *Nuclear Regulatory Commission*. SECY-11-0181. December 2011.

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