

# Nuclear Energy Renaissance Set to Move Ahead Without U.S.



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## Takeaways

- International experts have concluded that hundreds of new nuclear reactors are needed globally by 2035 to mitigate climate change.
- Significant innovation is required to reduce cost, address safety issues, and make nuclear power scalable.
- Other countries, like China, are ramping up investment in nuclear energy R&D.
- New Third Way analysis has found that in the U.S., federal funding for nuclear R&D is declining sharply just as we need it to grow.

## Experts Agree: Nuclear Energy is Key to Tackling Climate Change

In early 2014, the Intergovernmental Panel on Climate Change's (IPCC) climate assessment listed nuclear alongside renewables and carbon capture and storage as the technologies necessary to successfully mitigate climate change.<sup>1</sup> The International Energy Agency (IEA) has concluded that the world needs to add the equivalent of between 270 and 410 new, large-scale nuclear reactors to electricity grids by 2035 to mitigate climate change and meet

growing energy demand.<sup>2</sup> That means potentially nearly doubling the fleet of 435 nuclear reactors that are generating electricity today. This ambitious boost in nuclear energy would be *in addition* to the even more significant increase in renewable energies, like wind and solar, that the IEA also calls for.<sup>3</sup>

But won't most of this new nuclear power come from developing countries like China? Not entirely.

A 2012 IEA assessment by the found that the 34 countries that make up the Organization for Economic Cooperation and Development alone will have to add more than 60 large-scale reactors over the next twenty-five years.<sup>4</sup> This would exceed the 58 reactors currently operating in France, which has the second largest nuclear power fleet in the world (behind only the U.S., with 100 reactors).<sup>5</sup> Moreover, 17% of the world's currently operating 435 reactors will be sixty years or older in 2035.<sup>6</sup> The electricity they produce will also need to be replaced with new technology.

## **Growth in nuclear energy requires innovation**

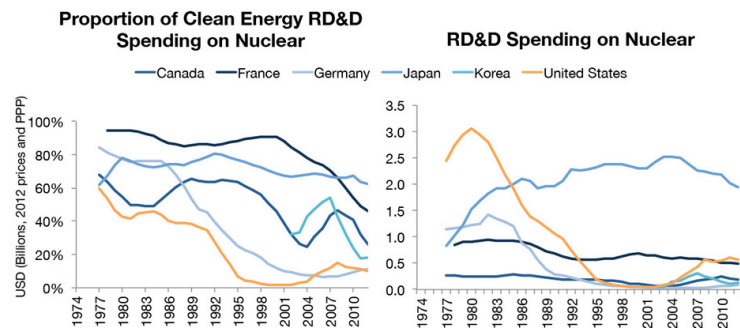
Worldwide, the addition of 400 more reactors would bring over a trillion dollars in new capital investments,<sup>7</sup> mainly in developing countries. This is an enormous economic opportunity for whichever companies (and countries) lead the market. That makes this an excellent time to invest in new innovations to make nuclear energy cheaper to construct and operate, sized to meet various market needs, and even safer than it is now. Moreover, they're already on the drawing board.

However, funding such innovation in the U.S. is tricky. The costs are high; the time horizons are very long compared to other technologies; and the regulatory environment for electricity generation is fractured and difficult to navigate. Even non-nuclear energy research and development is underfunded.<sup>8</sup> The rigorous testing and licensing phases for nuclear energy, which add huge costs and uncertainty for

investors, can further discourage already skittish private investors.

## OECD Countries and China are Investing in Nuclear R&D

Today, the moment at which the U.S. should be ramping up its funding for nuclear innovation, it is doing the opposite and falling behind our biggest competitors. This wasn't always the case. In 1980, U.S. nuclear RD&D exceeded that of Japan and France combined.<sup>9</sup> Thirty years later, American investment in civilian nuclear innovation barely exceeds France's RD&D spending and is only about a third of what Japan spends. Moreover, among all developed countries that annually spend more than \$100 million on nuclear research, development, and demonstration, since the 1990s the U.S. has consistently spent a proportionally much lower share of its clean energy research budget on nuclear technology.



Source: International Energy Agency, "RD&D Statistics," database, 2014, Accessed May 5, 2014. Available at: <http://www.iea.org/statistics/RDOnlineDatabase/>.  
; See also United Kingdom, Department of Energy & Climate Change, "A Review of the Civil Nuclear R&D Landscape in the UK," report, 26 March 2013, p. 23, Accessed May 2, 2014. Available at: <https://www.gov.uk/government/publications/civil-nuclear-research-and-development-landscape-in-the-uk-a-review>.

## China is betting on advanced nuclear

With hundreds of new nuclear energy projects needed and a trillion dollars in invested capital at stake, it's not just developed economies that are investing in nuclear innovation. China has sharply scaled up its efforts over the past decade. In 2011, it announced the largest program to date on advanced thorium reactors,<sup>10</sup> and the central government recently accelerated the timeline for a fully functional thorium reactor to just ten years<sup>11</sup> — lightning-fast by U.S. standards.

# U.S. Funding for Nuclear R&D is Tiny and Getting Smaller

Third Way analyzed federal R&D expenditures for advanced nuclear energy in detail.<sup>12</sup> We found that while overall nuclear energy research funding has increased, funding for *advanced* nuclear reactor research is small, and falling.

 DOE Nuclear Energy Research, 2003-2015

## Just 8% of the nuclear energy budget goes directly to advanced nuclear R&D

Funding directly dedicated to advanced reactor research—the three darkest orange areas in the graph above—increased rapidly in 2008, only to dwindle in 2011. Funding shrunk 40% between 2010 and 2012 and has held steady around \$120 million since.

As the graph demonstrates, the rapid growth in advanced reactor research funding in 2008 is attributed to the “Next Generation Nuclear Project.” The program was intended to create a high temperature gas reactor that also produced high temperature heat as a by-product for use in industries that need it.<sup>13</sup> In 2011, DOE decided not to proceed with a demonstration high-temperature gas reactor,<sup>14</sup> and program funding has predictably withered since then. Nothing has replaced the project, in funding or breadth of vision.

Research on other innovative reactor designs has received even less money. While the most cutting edge research program (“Advanced Reactor Concepts,” which is darkest orange in graph) appears to have grown in the 2015 budget, it actually shrunk by 18% because it absorbed the remnants of the two other advanced reactor research programs.

**It will take a lot more to commercialize advanced nuclear**

If we want successful advanced nuclear technology, we need much greater investment. From 2003 to 2010, the Department of Energy spent \$670 million on the “Nuclear Power 2010” project (part of dark gray). This public-private partnership sought to help commercialize state-of-the-art large reactor technology.<sup>15</sup> Four reactors being built in South Carolina and Georgia are the result.

The “Nuclear Power 2010” project received an average of \$82 million per year in federal funding; by contrast, the most advanced reactor research program received an average of \$25 million per year from 2003-13. This is far too low to support a demonstration reactor—a program with the capacity to build advanced nuclear demonstration reactors will likely need at least \$100 million per year in federal funding for at least five years.

## Conclusion

As the IPCC and IEA conclude, nuclear power could and should be a major tool in the global strategy to address climate change. We are already seeing this happening as countries like China expand their reliance on nuclear power. But we will need a mix of existing and innovative new nuclear technologies to meet the world’s demand for emissions-free power. Emerging economies are ramping-up their investments in nuclear energy R&D, but the U.S. is headed in the opposite direction. That’s a big mistake for the American economy and for the world’s battle against climate change.

### TOPICS

ADVANCED NUCLEAR 81

INNOVATION 51

### END NOTES

- 1.** Working Group III, "Summary for Policymakers," Mitigation of Climate Change, Intergovernmental Panel on Climate Change, 2014, p. 15, Accessed May 1, 2014. Available at: <http://www.ipcc.ch/report/ar5/wg3/>.
- 2.** According to the IEA, nuclear energy must increase 3,212 TWh worldwide by 2035 to retain a 50% chance of maintaining global warming trends at 2° C or less. Assuming a 90% nuclear energy capacity factor, this represents 407 GW of new nuclear energy. As state-of-the-art large scale reactors are generally 1 to 1.5 GW, this translates to 271 – 407 new nuclear reactors. See International Energy Agency, "World Energy Outlook 2012," 2012, p. 182 & 629, print.
- 3.** The IEA assumes world renewable energy capacity should increase more than 8,000 TWh in the next 25 years to mitigate climate change according to the scenario cited above; See also Ibid.
- 4.** OECD country nuclear power supplied 2,288 TWh in 2010 and that power must increase to 2982 TWh in 2035. This translates to a minimum of nearly five dozen, new, large-scale reactors; See also Ibid.
- 5.** Harrison Jacobs, "The 17 countries generating the most nuclear energy," Business Insider, March 6, 2014, Accessed August 4, 2014. Available at: <http://www.businessinsider.com/countries-generating-the-most-nuclear-energy-2014-3?op=1>.

- 6.** 435 reactors operate worldwide today. In 2035, 365 of those reactors will be 40 years or older, and 74 will be 60 years or older. International Atomic Energy Agency, “Operational Reactors by Age,” May 1, 2014, Accessed May 1, 2014. Available at: <http://www.iaea.org/PRIS/WorldStatistics/OperationalByAge.aspx>.
- 7.** The median cost of new nuclear in the U.S. is \$5.3/kW. Building 375 GW of new nuclear contributes \$2.0 trillion in overnight capital costs. While the \$5.3 figure may not hold for all countries or advanced nuclear, capital investments will surely exceed \$1 trillion if the world builds the nuclear the IEA believes it should. United States, Department of Energy, National Renewable Energy Laboratory, Open Energy Information, “Transparent Cost Database,” database, Accessed May 12, 2014. Available at: <http://en.openei.org/apps/TCDB/>.
- 8.** Joshua Freed and Sam Hodas, “Creating a Clean Energy Century,” Report, Third Way, p. 19, November 2010, Accessed May 1, 2014. Available at: <http://www.thirdway.org/publications/351>.
- 9.** Graphs present 4-year moving averages of RD&D spending on nuclear fission from OECD countries that spent at least \$100 million in 2010. See International Energy Agency, “RD&D Statistics,” database, 2014, Accessed May 5, 2014. Available at: <http://www.iea.org/statistics/RDDonlinedataservice/>; see also United Kingdom, Department of Energy & Climate Change, “A Review of the Civil Nuclear R&D Landscape in the UK,” report, 26 March 2013, p. 23, Accessed May 2, 2014. Available at: <https://www.gov.uk/government/publications/civil-nuclear-research-and-development-landscape-in-the-uk-a-review>.

- 10.** A thorium reactor uses thorium and not uranium as a fuel, and is considered a leading contender of next generation nuclear technology. Richard Martin, "China Takes Lead in Race for Clean Nuclear Power," WIRED Magazine, February 1, 2011, Accessed May 2, 2014. Available at: <http://www.wired.com/2011/02/china-thorium-power/>.
- 11.** Stephen Chen, "Chinese scientists urged to develop new thorium nuclear reactors by 2024," South China Morning Post, March 18, 2014, Accessed May 2, 2014. Available at: <http://www.scmp.com/news/china/article/1452011/chinese-scientists-urged-develop-new-thorium-nuclear-reactors-2024>.



- 12.** Graph derived from Third Way analysis on DOE 2005 through 2015 budget justifications ranging from 2005 to 2015. Additional spending figures cited in paper come from this analysis. United States, Department of Energy, “Fiscal Year 2005 Budget Justification,” Vol. 3, February 2, 2004, p. 326–487; United States, Department of Energy, “Fiscal Year 2006 Budget Justification,” Vol. 3, February 1, 2005, p. 325–489; United States, Department of Energy, “Fiscal Year 2007 Budget Justification,” Vol. 3, February 1, 2006, p. 570–705; United States, Department of Energy, “Fiscal Year 2008 Budget Justification,” Vol. 3, February 1, 2007, p. 518–641; United States, Department of Energy, “Fiscal Year 2009 Budget Justification,” Vol. 3, February 1, 2008, p. 589–750; United States, Department of Energy, “Fiscal Year 2010 Budget Justification,” Vol. 3, February 2, 2009, p. 569–684; United States, Department of Energy, “Fiscal Year 2011 Budget Justification,” Vol. 7, February 1, 2010, p. 5–154; United States, Department of Energy, “Fiscal Year 2012 Budget Justification,” Vol. 7, February 1, 2011, p. 6–135; United States, Department of Energy, “Fiscal Year 2013 Budget Justification,” Vol. 3, January 20, 2012, p. 279–404; United States, Department of Energy, “Fiscal Year 2014 Budget Justification,” Vol. 3, April 11, 2013, p. All “NE”; United States, Department of Energy, “Fiscal Year 2015 Budget Justification,” Vol. 3, April 4, 2014, p. 400–541; All Accessed April 7, 2014. Available at: <http://energy.gov/cfo/reports/budget-justification-supporting-documents>.
- 13.** United States, Department of Energy, “Fiscal Year 2013 Budget Justification,” Vol. 3, January 20, 2012, p. 309, Accessed May 1, 2014. Available at: <http://energy.gov/cfo/reports/budget-justification-supporting-documents>.

- 14.** The decision not to proceed with a demonstration reactor reflected structural program issues rather than the viability of the program itself. See United States, Government Accountability Office, “Advanced Reactor Research: DOE Supports Multiple Technologies, but Actions Needed to Ensure a Prototype Is Built,” June 23, 2014, Accessed June 27, 2014. Available at: <http://www.gao.gov/products/GAO-14-545>; See also United States, Department of Energy, “Fiscal Year 2013 Budget Justification,” Vol. 3, January 20, 2012, p. 309, Accessed May 1, 2014. Available at: <http://energy.gov/cfo/reports/budget-justification-supporting-documents>.
- 15.** For a brief background on the Nuclear Power 2010 program, see United States, Nuclear Regulatory Commission, “Nuclear Power 2010 Program Report,” March 7, 2006, presentation, Accessed August 15, 2014. Available at: <http://www.nrc.gov/public-involve/conference-symposia/ric/past/2006/slides/t2d-smith-kevern.pdf>.