Global Nexus Initiative

Where Climate, Nuclear, and Security Meet

The Role and Responsibility of Nuclear Power in a Carbon Constrained World

Policy Memo and Recommendations

December 2015

This report is based on discussions of the Global Nexus Initiative (GNI) Working Group at its September 2015 workshop held in Washington, D.C.

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POLICY MEMO AND RECOMMENDATIONS

Overview

Concentrations of greenhouse gases in the earth's atmosphere are at their highest level in recorded history. According to the Intergovernmental Panel on Climate Change, "the continued emission of greenhouse gases will cause…long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts on people and ecosystems."[1]

The international community has responded to this challenge by establishing a goal of limiting future global temperature increases to 2 degrees Celsius or below.[2] It is generally accepted that this objective will require that atmospheric concentrations of carbon dioxide equivalent (CO_2e) be limited to 450 parts per million volume (ppmv) or lower.[3] The world has already passed the 400 ppmv level, and it is adding approximately 2 ppmv per year. In addition, some greenhouse gas emissions can linger in the atmosphere for a century or longer.[4]

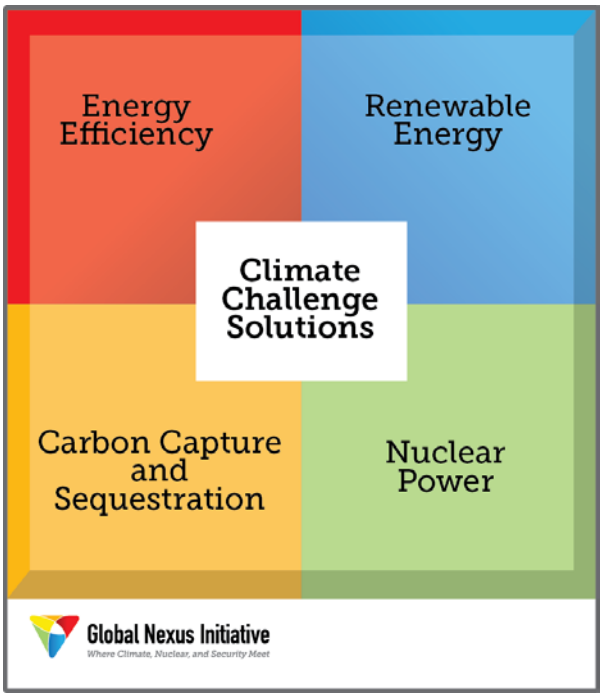
Achieving this CO_2e ceiling will require that emissions be reduced from current levels by 40% to 80% by 2050 and be near zero or negative by 2100.[5] This will require a significant transformation in the way that society produces and consumes energy and the evolution of the global energy sector away from today's reliance on fossil fuels to the large scale deployment of low and non-emitting sources. To meet the CO_2e ceiling, the worldwide amount of low-emitting energy will need to increase by approximately 145% in 2030 and 310% in 2050.[6]

This is a significant challenge that is further complicated by: 1.3 billion people who currently lack access to electricity; an expected increase in the global population from 7.3 billion to 9.7 billion by 2050; and a projected 50% increase in global energy demand by 2040.[7]

At present there are four approaches to decarbonize the global energy system:

- energy efficiency
- renewable energy
- nuclear power
- carbon capture and sequestration (CCS)

The Global Nexus Initiative (GNI) supports the continued development and deployment of all these technologies as contributions to achieving global climate objectives. However, if these technologies are going to achieve the massive reductions in greenhouse gases that are required, significant technical and policy advancement will be necessary and their impacts will need to be thoroughly assessed. Therefore, the GNI is examining both the role that nuclear power can play in reducing greenhouse gases while providing reliable and affordable supplies of electricity and the global security implications of expanded nuclear energy use.



Findings and Recommendations

Based on its initial September 2015 workshop on *The Role of Nuclear Power in a Carbon Constrained World*, the GNI has developed the following initial findings and recommendations:

- Governments, organizations, and individuals concerned with rising concentrations of greenhouse gases agree that a portfolio of technologies will be required to decarbonize the energy system. No single approach will be adequate to achieve the emission reductions necessary to limit future temperature increases. Nuclear power currently is making a significant contribution to meeting global energy and climate objectives, providing 33 percent of emission-free electricity generation worldwide which avoids 2.5 billion metric tons of carbon dioxide emissions per year.[8] Most energy and climate models indicate that this contribution could grow, and under some scenarios, its expansion is necessary. However, nuclear power is not an important element in most of the commitments that nations have submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in advance of the Conference of the Parties (COP-21) meeting in Paris.[9]

    - The participants and supporters of the UNFCCC process should acknowledge the existing and potential contribution of nuclear power as part of a suite of technologies that can address increasing levels of greenhouse gas concentrations in the atmosphere. Also, public policies should be developed that recognize the unique value of nuclear power and that will discourage the premature retirement of existing nuclear facilities and replacement with higher emitting alternatives.

- Nuclear power expansion in the developed world faces significant economic and policy barriers including reactor cost, siting, waste disposal, governance, and public opinion. These challenges have historical and policy origins that, in the face of a global climate challenge, need to be reconsidered. These issues, in part, can be addressed through policy changes, aggressive leadership, confidence building measures, and new partnerships.

    - A review of nuclear policy issues is needed in light of climate goals and the growing demand for electricity. It should result in changes that enhance public support, safety, and security and achieve a significant reduction in greenhouse gas emissions. The nuclear industry and its related organizations should partner with civil society to develop common objectives and cooperation that can forthrightly address the value and concerns associated with nuclear power.[10] Additional policy and partnership opportunities could include multi-national cooperation to support the development, demonstration, and coordinated licensing of advanced reactors, which offer benefits beyond the existing generation of power plants.

- Nuclear power is significantly growing in the developing world, particularly in Asia and to a lesser degree in the Middle East. Some African nations also have expressed interest in it. Some of these nations have little or no experience with nuclear regulation and operation, raising safety, security, and nonproliferation concerns. This regional shift is placing increasing demands and pressures on the current nuclear governance system.

    - The nuclear governance system must adapt to evolving circumstances and challenges by enhancing the capacity of the newcomer countries to fulfill their responsibilities for safety, security, and safeguards. The nuclear safety capacity building must start early.[11] It also is necessary to address the weak links in the nuclear security regime, which lags the nuclear safety and safeguards systems in its effectiveness. These advancements should be augmented with improvements in nuclear education, training, and assistance.[12] Together these enhancements will strengthen international confidence in the nuclear programs of all states.

The Intersection of Carbon Constraints and Nuclear Power

The global concentration of CO_2e in the earth's atmosphere reached 400 ppmv for the first time in 2013. In order to limit the average global temperature increase to 2 degree Celsius, the atmospheric concentration of CO_2e will need to be capped at approximately 450 ppm by the end of the 21st century.[13] It is unlikely that only one technology will be capable of addressing this enormous challenge. It will require a mix of renewable energy, CCS, nuclear power, and energy efficiency.

The role of nuclear power in the carbon mitigation debate is mixed at the moment. Operational nuclear power plants produce close to zero carbon output and are recognized as an important component of the climate change strategy of some high carbon emitting nations.[14] In 2012, 10.9% of global electricity production was generated by nuclear power.[15] In some countries, including in Europe, Asia, and the United States, nuclear power produces a significantly higher portion of national electricity.[16]

However, the retirement of reactors that have reached the end of their operating life in the developed world will pose a significant challenge to continuing nuclear power's contribution to the low carbon energy mix in coming decades. Fifty-one percent of the current global reactor fleet is over 30 years old, and by 2050, those plants will be over 60 years old. In the United States alone, approximately 59 new reactors would need to be built by 2040 to maintain the 20% share of energy they currently contribute, if the operating reactors retire after 60 years of operation. Currently, five new reactors are under construction, and several existing reactors have been and are being prematurely retired. The reasons for premature retirements in the United States include downward pressure on plant economics in certain markets caused by low natural gas prices and subsidies for other generation types and, in two instances, atypical issues arising from large component replacements.

Electricity generation models that limit the global carbon concentration at 450ppmv CO_2e underscore the importance of maintaining and expanding nuclear power even with substantial contributions from renewable energy sources and CCS. Scenarios without CSS rely even more heavily on continued and expanded nuclear power production.[17]

While the operational costs are low for nuclear power and operating lives of the plants are long (40 to 80 years), construction times are long (approximately 4-10 years) and upfront capital costs high (approximately $7-9 billion for large, conventional reactor designs) when compared to other energy technologies. As a result, nuclear power is facing formidable competition from cheaper energy sources, including natural gas, which produces more CO_2e than nuclear power. Also, the declining cost of renewable energy is making it more attractive, although renewables face continuing technology challenges including storage, transmission, and backup capacity issues.

The future of nuclear power now appears to be in the developing world, particularly in Asia, the Middle East, and potentially in Africa. Today there are 67 reactors under construction – a third are in China and four are in the United Arab Emirates. More than two dozen countries that currently do not operate nuclear power plants are planning or have expressed interest in developing nuclear power programs. However, even countries that are pursuing nuclear energy are planning for their programs to contribute only 20-30% of their energy by 2050 – a level unlikely to be sufficient to meet the CO_2e goal.

Potentially, nuclear power can expand its contribution to climate goals and energy needs through advanced technologies that promise smaller, cheaper, safer, and proliferation resistant reactors. However, these next generation nuclear technologies currently are in development with potentially long lead times before they will be ready for deployment. They also will need to demonstrate safety and nonproliferation advances, decreased construction costs, and regulatory and public acceptance.

Strengthening Nuclear Governance

If nuclear power is going to continue to make a significant contribution to limiting CO_2e emissions, it must be safe, secure, protected from misuse, and supported by the public.

Nuclear power presents special challenges including requirements for safe reactor operation, facility and material security, and the prevention of the diversion of materials for use in nuclear weapons. Strong governance, independent oversight, and a commitment to continuous improvement are important characteristics for ensuring safe and secure operations in every country.

The nuclear safeguards system that monitors civil nuclear programs to ensure that there is no diversion of materials or misuse of peaceful facilities to nuclear weapons programs has a strong success record, although it faces persistent challenges. The Convention on Nuclear Safety (CNS) provides the international legal basis for nuclear safety and includes mandatory requirements for reporting on safety activities and then subjects these reports to review by other nations. These procedures offer assurances to all nations about the effective nuclear operations in any country that is a party to the agreement.

The international nuclear security system is quite different than that of nuclear safety or safeguards. In 2010, the International Atomic Energy Agency's (IAEA) International Nuclear Safety Group concluded that, "Nuclear power plants benefit from a sophisticated and comprehensive safety regime that has been established over the years…the security regime for nuclear power plants is far less developed than the safety regime."[18]

Unlike the CNS, the nuclear security regime's key international conventions – the Convention on the Physical Protection of Nuclear Material and its proposed 2005 amendment and the

International Convention for the Suppression of Acts of Nuclear Terrorism – do not include provisions for mandatory assessment, information sharing, or peer review. The nuclear security peer review process is conducted by the IAEA, and while important and useful, it also is intermittent, voluntary, and confidential.

This difference between the nuclear safety and security regimes is driven by the sensitivity of some of the security information which can provide insights on vulnerabilities that can be exploited. However, significant work has been done over the last several years on how truly sensitive information can be separated from that which could be shared to build international confidence in secure nuclear operations.[19]

The challenges facing the nuclear governance system are being amplified by countries pursuing new and expanded nuclear power programs. As new countries pursue nuclear power and others seek to expand it, they must ensure that strong institutional, regulatory, managerial, and educational systems are in place. These are particularly significant tasks for newcomer nuclear states as these issues already have proved to be challenges in nations with a well-developed nuclear infrastructure.

Nuclear industry organizations like the World Nuclear Association, the World Association of Nuclear Operators, and the Institute of Nuclear Power Operations have much to offer to nuclear states, particularly in training, education, convening, and operational assessment. In addition, the new international network of more than a dozen Centers of Excellence that were established during the Nuclear Security Summit process could be useful partners in a range of activities that can strengthen nuclear governance.

A strengthened nuclear governance system requires additional support from the commercial nuclear sector. The nuclear industry is diverse and includes many different types of companies, including fuel cycle, vendors, operators, and waste disposal. In addition, the suppliers of nuclear technology are changing with China, Russia, and South Korea playing a leading role alongside traditional suppliers such as the United States, France, and Japan.

In each of its sub-sectors, the nuclear industry can demonstrate leadership beyond its legal obligations to safety, security, and nonproliferation by developing guiding principles for its companies. The vendors' efforts in connection with the development of Principles of Conduct are noteworthy in this regard.[20] Further, demonstrating social responsibility through "shared values" is becoming an important part of business. The development of common objectives and cooperation between the nuclear industry and civil society in the context of meeting global greenhouse gas goals, like the GNI project, can have benefits for both communities. It can provide a forum for forthrightly addressing issues, driving positive policy changes, and demonstrating to the global community the importance that both stakeholders ascribe to achieving carbon constraints.

WORKING GROUP MEMBERS

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[1] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland; "Headline statements from the Summary for Policymakers," Climate Change 2014

Synthesis Report, IPCC, November 5, 2014, https://www.ipcc.ch/news_and_events/docs/ar5/ar5_syr_headlines_en.pdf.

[2] Two degrees Celsius is equivalent to 3.6 degrees Fahrenheit.

[3] A 450 ppmv Co_2e concentration level provides a two-thirds probability of holding temperature increases below 2 degrees Celsius from the pre-industrial period.

[4] "Carbon is forever," Nature Reports Climate Change, November, 20, 2009, http://www.nature.com/climate/2008/0812/full/climate.2008.122.html.

[5] According to scenarios used in the preparation of the IPCC 5th Assessment Report, the impacts of the median scenario of countries implementing only their planned policies as of 2014 to reduce greenhouse gas emissions results in a concentration of more than 1000 ppmv Co_2e and a temperature increase of between 3.75 and 4.75 degrees Celsius in 2100, and a commitment to long-term temperature change of roughly 6 degrees Celsius.

[6] These figures are from 2010 levels. See, James Edmonds, "Getting to 2 degrees C: Global Goals and Realistic Responses, GNI Workshop, Washington, D.C., September 22, 2015, http://globalnexusinitiative.org/wp-content/uploads/2015/10/Getting_to_Two_Degrees-GNI_Wkhp1.pdf.

[7] World Population Prospects, 2015 Revision, Department of Economic and Social Affairs, United Nations, 2015, http://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf; "About Energy Access," International Energy Agency, OECD, 2015, http://www.iea.org/topics/energypoverty/; "EIA projects world energy consumption will increase 56% by 2040," U.S. Energy Information Administration, July 25, 2013, http://www.eia.gov/todayinenergy/detail.cfm?id=12251.

[8] "Environment: Emissions Prevented," Nuclear Energy Institute, http://www.nei.org/Knowledge-Center/Nuclear-Statistics/Environment-Emissions-Prevented.

[9] Conference of the Parties-21 of the United Nations Framework Convention on Climate Change. "INDCs as communicated by Parties," United Nations Framework Convention on Climate Change, October 2015, http://www4.unfccc.int/submissions/INDC/Submission%20Pages/submissions.aspx.

[10] Shared Values is a business strategy that brings business and society together to create economic value and address social concerns. See Michael Porter and Mark Kramer, "Creating Shared Value," Harvard Business Review, January-February 2011, https://hbr.org/2011/01/the-big-idea-creating-shared-value.

[11] Licensing the First Nuclear Plant, INSAG-26, International Atomic Energy Agency, 2012, http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1573_web.pdf.

[12] Assistance should be provided in a regular and sustainable manner, through regional centers, national support organizations, and by the technology providers.

[13] James Edmonds, "Getting to 2 degrees C: Global Goals and Realistic Responses," 2015.

[14] China and India recognized the role of nuclear power in their Intended Nationally Determined Contributions (INDC) that were submitted to COP-21: http://www4.unfccc.int/submissions/INDC/Submission%20Pages/submissions.aspx. Nuclear is also credited in the 2015 U.S. Clean Power Plan: http://www2.epa.gov/cleanpowerplan.

[15] "Nuclear Energy Around the World," Nuclear Energy Institute, July 2015, http://www.nei.org/Knowledge-Center/Nuclear-Statistics/World-Statistics.

[16] For example, U.S. 19.5%, France 76.9%, South Korea 30.4%. See: Everett Redmond, "Nuclear Power Trends," GNI Workshop, Washington, D.C., September 22, 2015, http://globalnexusinitiative.org/wp-content/uploads/2015/10/Nuclear_Power_Trends-GNI_Wkshp1.pdf.

[17] James Edmonds, "Getting to 2 degrees C: Global Goals and Realistic Responses," 2015.

[18] "The Interface Between Safety and Security at Nuclear Power Plants," INSAG Series 24, International Atomic Energy Agency, 2010, http://www-pub.iaea.org/books/IAEABooks/8457/The-Interface-Between-Safety-and-Security-at-Nuclear-Power-Plants.

[19] Responsibility Beyond Rules: Leadership for a Secure Nuclear Future," Nuclear Security Governance Experts Group (NSGEG), March 2013, page 25, http://www.nsgeg.org/NSGEG_Responsibilty_Beyond_Rules_2013.pdf; John Bernhard, Kenneth Brill, Anita Nilsson, and Shin Chang-Hoon, "International Convention on Nuclear Security," NSGEG, March 2015, http://www.nsgeg.org/ICNSReport315.pdf; Bart Dal, Jonathan Herbach, and Kenneth Luongo, "The Strengthening Nuclear Security Implementation Initiative: Evolution, Status and Next Steps," NSGEG, October 2015, http://www.nsgeg.org/ICNSReport315.pdf; "The Results We Need in 2016: Policy Recommendations for the Nuclear Security Summit," Fissile Materials Working Group, March 2015, http://www.fmwg.org/FMWG_Results_We_Need_in_2016.pdf.

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