global public policy institute

7th Transatlantic Energy Governance Dialogue

Towards a Nuclear Power Renaissance? Challenges for Global Energy Governance

Conference Report

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www.gppi.net

1. Introduction

Climate change has put nuclear power back on policy agendas on both sides of the Atlantic. The urgent need to reduce carbon emissions has led researchers and policymakers to increasingly focus their attention on the potential role of nuclear energy in achieving a low-carbon world while at the same time ensuring security of supply. In 2009, Sweden decided to go nuclear. The same year, the UK Government has initiated a major policy shift by announcing that nuclear power is supposed to be a major component of the country's energy mix in the future. Finland has launched work on multiple new reactors that are supposed to go online within the next decade. Similarly, the US is also further investing in nuclear power. Beyond the transatlantic alliance, China and India have made very significant commitments to the expansion of nuclear power. China has currently 11 reactors in operation but is starting work on as many as 10 additional reactors each year. Yet, while some see this "renaissance" of nuclear power as the key to tackling climate change, others are warning that this resurgence of nuclear power raises a number of potent challenges that need to be resolved.

The debate on the merits and perils of nuclear energy is as long-standing as it is heated with proponents and opponents in irreconcilable disagreement. This Transatlantic Energy Governance Dialogue did not venture to solve the dispute, but dared to attempt to give room to all sides of the argument, thereby creating the basis for an informed discussion on a range of exceedingly difficult issues. Developing a more comprehensive picture of a potential nuclear renaissance required an open exchange of opinions on three basic questions:

1. What is the extent of tangible benefits that can be expected from a resurgence of nuclear power?
2. What is the level of risk that corresponds with this potential nuclear "renaissance"?
3. What are the implications of an expansion of nuclear power for global energy governance?

Regarding the first question, the rise of climate change to the top of the global political agenda has certainly provided the proponents of nuclear energy with a powerful new argument. However, some pundits argue that the image of nuclear power as a climate-friendly technology is wrong. As a result of the extensive construction requirements both for the plants and waste storage sites as well as the energy intensive process of uranium mining, the climate record of nuclear power plants is seen by some at least as bad or worse than traditional fossil fuel plants. Also, access to uranium resources raises doubts about the mid-term viability of nuclear power as a main component of the global energy mix. In addition, critics also argue that due to the risks associated with nuclear power, reactors cannot possibly be built or operated in an economically and financially sustainable manner. In particular, they point to the massive subsidies required to

construct new plants, as well as the granting of government guarantees in the absence of viable insurance schemes.

Concerning the second question, opponents of nuclear power highlight the technology risks associated with nuclear reactors, and raise the specter of a new "Chernobyl" with disastrous consequences. Proponents of nuclear power argue instead that advances in technology make such accidents all but a theoretical possibility. In addition, critics argue that the issue of long-term nuclear waste storage remains unresolved in most countries. In the US, plans to develop Yucca Mountain into a storage site were cancelled early in 2009 after significant opposition from key lawmakers from the State of Arizona. Within the EU, similar "Not-In-My-Backyard" attitudes prevail.

Finally, the resurgence of nuclear power is also viewed with some scepticism by security analysts. The rapid spread of nuclear technology around the world also raises the possibility of illicit proliferation of nuclear material (including enriched uranium), and also enables countries to attain the technological expertise necessary to move from the civilian use of nuclear power to the construction of a nuclear bomb.

As highlighted above, this Transatlantic Energy Governance Dialogue did not attempt to find conclusive answers to the many open questions that are associated with the apparent renaissance of nuclear power. It certainly also did not try to build consensus around issues that for decades have been characterized by emotional and often highly divisive debates. Yet, it was the intention of this conference to provide an opportunity for constructive debate.

This TEGD brought together professionals from all sectors (governments, NGOs, business, the media, think tank and universities) in order to promote constructive debate on these issues. The dialogue sessions are also designed to complement our research program on global energy governance and serve as an important forum for both presenting our ideas and receiving feedback. More information on this research program can be found at *www.globalenergygovernance.net*.

2. The Opportunities of Nuclear Power

Global energy needs have changed. As traditional energy supplies increasingly fail to meet rising global demands and climate change policies require a shift towards low-carbon or no-carbon power sources, some argue that the role of nuclear energy needs to be revaluated in this context. From this perspective, nuclear power is a necessary ingredient of an energy mix that ensures security of supply, reduces carbon emissions and reduces dependence on foreign sources of energy. Indeed, some countries (including Finland, the UK, China and others) have recently made significant new investments in nuclear power.

At present, current nuclear production capacity consists of 370 Gigawatts of electric energy (GWe) in 30 countries plus Taiwan. In order to get an idea of how this will develop over the coming decades, different scenarios have been presented which illustrate the potential growth of global nuclear power. The Energy Information Administration at the US Department of Energy put forth a scenario which projects an increase of 140 GWe by 2030. Another scenario put forth by the Massachusetts Institute of Technology (MIT) takes into account climate change mitigation targets. With this methodology, the MIT scenario shows a higher uptake with a 1300 GWe increase by 2050. Other scenarios project increases somewhere in between. Whichever way you look at it, most scenarios project an increase in the production of nuclear power over the coming decades.

However, looking at the true merits and hidden pitfalls of nuclear energy as a clean and reliable power source reveals conflicting evidence, often times centered on carbon intensity, reliability and the market-based viability of nuclear power. There remains significant controversy surrounding nuclear energy and nuclear technology including safety issues, waste, cost risks and the potential for proliferation. Last but not least, nuclear power critics stress that it is technologically the most challenging and expensive way to produce electricity.

In order to provide a context for discussions, the conference began by examining two reasons for which some foresee a "renaissance" of nuclear power approaching: concerns regarding climate change as well as decreasing access to domestically produced energy ("energy independence").

Can nuclear power mitigate climate change?

Nuclear energy is widely regarded as a clean source of electricity and thus provides an attractive alternative to the burning of coal. In fact, conference participants pointed out that, in order to take advantage of the public's increasing concerns regarding global warming, the nuclear power industry has re-branded itself as the environmentally friendly alternative to fossil fuels. Presenting nuclear power as a low-carbon energy source and a potential key instrument for fighting climate change has become one of the most prominent arguments for the proponents of nuclear power.

However, conference participants stressed that this argument is not without controversy. While the actual production of nuclear electricity provides substantial greenhouse gas reductions and benefits from displacing fossil-fuel derived electricity, a survey of recent literature shows a high sensitivity to system assumptions leading to overall uncertainty regarding the degree to which this is true. While the greenhouse gas benefits of nuclear power *generation* relative to fossil fuels are undeniable, the installation of nuclear power infrastructure in generation and waste storage, as well as the operation of nuclear plants, including the mining and transport of uranium, feature a range of carbon-intense activities which cast doubt over the overall eco-friendliness of nuclear energy.

In the end, estimates regarding the overall lifecycle greenhouse gas emissions of a nuclear power plant vary widely among studies, creating a significant amount of uncertainty and thus controversy regarding the overall benefit of nuclear power for achieving climate change goals. In fact, if there was one area of consensus among conference participants, it is that due diligence regarding the real carbon footprint of nuclear energy is needed.

Moreover, in addition to the uncertainty on the overall carbon footprint of nuclear power, conference participants highlighted numerous other environmental issues which arise with nuclear power, including: Mining and enrichment of uranium is not without environmental burdens and add to the CO2 footprint; spent fuel storage is needed; and nuclear reactors require massive supplies of water to cool reactor cores and spent nuclear fuel rods (thus creating a serious trade-off in times of drought).

Lastly, nuclear power needs to be measured against the alternatives, e.g. renewables. Participants pointed out that due to the long lead times, nuclear power plants are simply too expensive and too slow to get the job done and the opportunity costs of diverting such huge sums of money away from renewables and efficiency measures is not worth it. However, some participants also argued that constraints in power grids constitute a big advantage of nuclear power over renewables.

Can nuclear power provide energy security?

The issue of energy security - the stability of reasonably priced energy supplies - and dependence play an important role regarding the assessments of the merits of nuclear power. The prospect of reducing dependency on foreign oil and gas is a tempting argument for the expansion of nuclear energy. Moreover, as discussed above, nuclear advocates argue that in the absence of alternative forms of emissions-free power production on a large scale, nuclear energy is the only way to go in the short- to medium-term.

Nuclear power is used in 30 countries and Taiwan, with three quarters of the nuclear electricity in the world produced in France, Germany, Japan, Russia and the United States. The contribution of nuclear power to the global energy mix, according to the IEA in 2006, was 16% of electricity generation, 6.3% for final energy production and 2.6% for final energy consumption. In addition, 60 countries worldwide are looking to establish their first nuclear power plant due to an increase in demand for energy, desire for

domestic energy production, economic and population growth, or to achieve an increased sense of prestige, power and pride to the regimes pursuing it.

Many pro-nuclear advocates stress that the added-value of nuclear energy is that it increases energy independence and acts as a "hedge" against fossil fuel prices. Moreover, advocates point to the fact that renewable energy sources are not the silver bullet. For example, they stress that geothermal is a regional niche, hydro power is not environmentally or socially compatible, and wind and solar power are dependent on weather conditions and "real-time" demand.

However, conference participants quickly shot down the notion that nuclear power can lead to energy independence. Most countries do not benefit from domestic supply of uranium resources, thus necessitating imports from often unstable countries. In this regard, energy independence for most countries currently producing nuclear power is technically unachievable. Rather, participants argued that the focus should rather be on "energy interdependence" and how we can cooperate to achieve our energy security goals.

Moreover, some participants stressed the minimal role of nuclear in providing energy security due to the fact that "cars don't run on nuclear (or renewable) power" and thus we will remain dependent on fossil fuels. The counter argument was that as new technologies such as fuel cells are developed, this will change.

Lastly, whether or not nuclear power can play a role in achieving domestic energy security is complicated by economic and social issues. Due to huge up-front costs, nuclear power has an inclusive "boom and bust" cycle which responds to consumer demand for electricity. Since the construction of modular nuclear power stations is not (yet) being undertaken, the construction of new nuclear capacity always translates to extremely large up-front investments which require massive state subsidies (with significant opportunity costs) in order to get off the ground – an issue which will be discussed in more detail in the next session. In addition, the need to place stations close to centers of demand (i.e. urban areas) is complicated by the "not in my backyard" (NIMBY) attitude of consumers.

Ultimately, while *existing* nuclear power capacity contributes to the overall electricity mix, it is in the best interest to determine how *new* nuclear power production can contribute to the overall diversified energy mix which includes renewables and cleaner burning natural gas – a topic which is receiving renewed interest due to the "game changing" increase in non-conventional (shale) gas supply in the United States - and to make a strategic judgment on whether the opportunity costs, including massive investments and potential environmental concerns, are justifiable.

Conclusion

Most conference participants agreed that a nuclear "renaissance" is not at hand, citing the fact that construction never stopped in, for example, China and Japan and that the number of decommissioned older plants will outnumber the construction of new ones.

However, there is a positive mood towards nuclear power in some developed countries as consumer see nuclear as the only way to achieve climate change mitigation targets and energy independence, however valid the premise of these goals are. As a step forward, participants emphasized the need for more verifiable data on nuclear reactors and called for an honest economic analysis of nuclear power which includes all hidden costs (environmental, security, political, etc).

Climate change is an extraordinary global risk and most agree that countries around the world should adopt aggressive greenhouse gas targets in order to mitigate this risk. However, nuclear is still a niche technology and far from mainstream and is therefore not a worldwide answer to climate change. Participants agreed that demand-side management (efficiency) and new smart electricity grids are the most effective way to combat climate change, followed by increased uptake of renewables. These should be the long-term goals from a sustainability standpoint.

As the scale of proposed greenhouse gas reductions is profound, many argue that it is prudent policy to keep all options open, including nuclear power. Nuclear power, however, is by no means emissions free and when all quantifiable costs and benefits are included, nuclear power appears to be squarely in the middle of the energy spectrum with regard to lifecycle emissions: it is worse than renewables and energy efficiency, but better than fossil fuels. In order to eliminate or reduce uncertainty regarding the potential role of nuclear power in mitigating greenhouse gas emissions, more rigorous work on green accounting and lifecycle assessments is needed.

With respect to energy security through nuclear power, conference participants generally agreed that this notion is false and emphasized the important of energy interdependence through effective cooperative mechanisms. Moreover, there seemed to be a consensus that in order to put into perspective the future role of nuclear power in achieving energy security, more quality work is necessary to determine whether the economic, political, security and environmental costs of nuclear power justify its expansion.

Either way, in the short- to medium-term, many argue that it is necessary to extend the life of current nuclear plants to bridge the gap until renewables take over. As capital costs are already written off, they argue, the plants should continue to operate. While prudent from an economics standpoint, from a safety standpoint it is necessary to evaluate the risks of aging plants and the probability of an incident. If nuclear power is going to work, it should cost less than the alternatives and as safe. At present, this is not the case.

3. The Viability of Nuclear Power

In assessing the benefits of nuclear power, one crucial aspect is the economic reality of nuclear energy as a competitive energy source. In fact, one of the key talking points of the conference centered on the overall capital cost of building and maintaining plants and whether these costs are both reasonable from the "business case" standpoint as well as from an ethical perspective (e.g. huge subsidies might better be spent on development goals or more sustainable energy solutions).

Is there a business case for nuclear power?

The fact is, nuclear plants are extremely capital intensive, require long lead investments and are prone to huge cost overruns. Participants cited numerous examples where initial cost projections for project completion were considerably overshot, for example, the AREVA reactor in Finland which is running three years behind its scheduled completion and is 75% over budget and the Tennessee Valley Authority reactor in the United States which is running at double the cost of its construction. According to the Energy Information Administration (EIA) of the US Department of Energy, the nuclear industry's historical record of cost overruns is roughly 2 to 4 times higher than the original estimates.

Despite this evidence, some argue that through the streamlining of reactor development, the development of new parts and the updating of old reactors, costs can be considerably reduced. Moreover, advocates point out overshooting initial cost projections is not just limited to the construction of nuclear projects, but almost every other large-scale building project, from space stations to opera houses.

However, participants pointed out that free market economies eventually pick winners and losers who either receive capital from financial markets ("winners") and those who don't ("losers"). In this regard, nuclear power is a clear "loser" in that private institutions are unwilling to put up the money for investment without public backing, as evidenced by six Wall Street banks rejecting loans in 2007 for new nuclear projects as being too risky. As new nuclear power plants require enormous amounts of capital, the question of where this money will come from is a prudent one, especially now when cash-strapped governments are carefully prioritizing the usage of public funds. Moreover, the opportunity costs of this scale of investment are staggering and following through on other public priorities such as energy efficiency measures, construction and implementation of the Smart Grid, as well as a myriad of other key infrastructure, development and public needs would be extremely challenging.

Due to the long planning and construction period, the fact that costs can increase drastically while the project is underway, and that until the plant is actually up and running zero kilowatt hours are actually produced, participants emphasized the overall risk of "putting all eggs in one basket" with nuclear power. Moreover, as historically demonstrated, there is a very real risk of abandoning new projects down the road, which

would lead to enormous sunk costs. Furthermore, even if plants are completed, the cost of operating a nuclear power plant will always be dependent upon uncertain fluctuations in price of uranium. Moreover, this only includes the costs that are transparently known. Some participants also stressed that numerous hidden costs also exist which have not been adequately calculated and taken into account, for example, long-term waste costs and the myriad of costs associated with the link to nuclear weapons.

In spite of the apparent lack of a business case for nuclear power, why then do countries continue to plan and build new plants? The answer, according to participants, is a political one as opposed to an economic one. First, it is a palatable, easy to understand strategy for addressing climate change and electricity needs, whereas the promotion of a diverse mix of renewable energies and efficiency measures is complicated and may require consumer sacrifices in their established way of life. Second, while most participants at the conference disagreed with the notion that nuclear power can lead to energy security and independence, politically this is still very much a talking point and adds considerable momentum to nuclear advocates. Third, in the case of developing countries such as China and India, nuclear power can contribute to development goals by providing massive amounts of electricity to populations in need without requiring the burning of large amounts of coal. The irony, as pointed at by some conference participants, is that nuclear is not the easiest solution to achieve development goals as it is the slowest and most expensive solution for generating electricity.

In the long-term it is possible that nuclear power will sometimes be the most cost-effective alternative. However, uncertainties in start-up costs, operation and maintenance costs, fuel costs and decommissioning, among others, make it extremely difficult to foresee in advance the financial viability of new projects. Moreover, most cost estimates do not include the many hidden costs intrinsic in nuclear power, for example, political and security ramifications of increased global fissile materials and long-term waste management costs.

Conclusion

With trillions of dollars of energy investments now at stake, it is high time to take a look at the overall costs of nuclear power, including the "hidden" costs. While there seemed to be a consensus at the conference that there is no "business case" for nuclear power, especially when taking into account hidden costs, some argued that in the short- to medium-term, renewables are not yet at the point of being able to supply rising consumer demand for electricity. Thus, in the meantime, nuclear needs to stay.

However, in light of the enormous known and unknown costs, blind subsidies to the nuclear industry should be re-examined as there are convincing arguments against the "business case" of new nuclear power plants based on historical evidence as well as hidden costs. Moreover, using massive amounts of public funding to subsidize new nuclear projects, especially in times of economic downturn, has huge opportunity costs which also need to be accounted for, both from an ethical as well as research and development standpoint.

4. Risks of nuclear power

The special character of nuclear power and the intensity of the debate surrounding the use of nuclear energy are rooted in the enormous dangers that are connected to radioactive material. The possibility of catastrophic events, both through nuclear accidents and the intentional use of nuclear material in weapons, as well as the long-term health implications of radiation pose considerable risks that play a central role in every discussion about the merits and dangers of nuclear power.

Three key risks were presented by conference participants that need to be addressed: 1) safety of the reactor, 2) the issue of nuclear waste storage and 3) the issue of proliferation.

Safety of nuclear reactors

In light of the two severe nuclear accidents at Chernobyl and Three Mile Island (TMI), there are serious concerns about the safety of nuclear reactors and the potential implications of a failure. Some conference participants stressed that, with the glaring exception of Chernobyl and TMI, nuclear power plants have a relatively safe track record. Other participants argued, however, that as most of the nuclear plants in the developed world are approaching the end of their lifecycle, the real risks are yet to come as the plants continue to age. Second, some argued that "small" malfunctions occur quite often and that while these have thus far not led to a serious incident, it demonstrates that the risk of nuclear power can never fully be eliminated.

With regards to reactor safety, first and foremost, in addition to standards, inspectors, quality components and an independent regulator, there are five basic layers of defense associated with nuclear reactors:

1. **Fuel.** As a lot physically happens to the fuel over its roughly 18 month lifecycle, in order to be safe it is necessary to understand the physics of the fuel and the risks.
2. **Engineered systems behind the fuel**, such as the cladding and heat removal systems.
3. **Reactor containment** for enclosing the nuclear reactor.
4. **Biological containment.** A concrete, pressure resistant, air-tight, earthquake and hurricane proof dome.
5. **Emergency preparedness**, for expected and unexpected events, consisting of sheltering, evacuation, cooperation with authorities and communication with citizens

Second, conference participants added that the existence and fostering of a "safety culture" over time is exceedingly important to prevent both expected and unexpected incidents. As every reactor has a risk of something happening at some point during its

lifecycle, and only with high standards, comprehensive defense systems, the appropriate safety culture and regular inspections can you reduce the risk of incidents.

Third, participants stressed that as nuclear power becomes increasingly ubiquitous, multilateral safety frameworks to enforce proper safety measures as well as to promote a necessary safety culture is necessary. However, most participants agreed that a global, multilateral safety framework is impossible, evidencing the inability of even the European Union to adopt a regional safety framework do to the differing positions of the member states. Thus, as technology is sold to emerging economies, there are no international regulatory frameworks governing the safe use of these technologies.

Lastly, some participants emphasized that in order to promote quicker profitability of extremely capital intensive plants, often times corners are cut with regards to safety, thus leader to a higher risk for potential reactor incidents.

Waste storage

The issue of where to store nuclear waste is one of the major unsolved questions and contributes significantly to negative public perception of nuclear power. Geologic repository efforts are currently underway in a number of countries: Sweden, Finland and France have candidate sites; plans for sites in Canada, Belgium, Japan, the UK and Switzerland are underway; and Argentina, Slovakia, Slovenia and South Africa are just starting out. In the US, the Obama Administration has halted the Yucca Mountain project after considerable investment and has now established the Blue Ribbon Commission to evaluate potential solutions to the waste problem.

However, there are numerous other challenges for waste repositories. First, technical challenges exist which include the ability to adequately and safely store waste over a significant period of time (millennia) without the ability to "prove" this adequacy. Second, political and institutional challenges exist including siting issues, values and ethics of nuclear power, nuclear stigma and fears, political implications of waste storage siting, as well as the fact that decisions now may not hold up over time.

Many argue that reprocessing the fuel is an option for waste elimination. At present, six countries currently reprocess spent nuclear fuel commercially: France, India, Japan and Russia, with China just starting and the United Kingdom phasing out. Five of the six have fast reactor programs which produce considerably less waste. Spent nuclear fuel, or fuel which has been used to the degree that it is no longer useful in producing energy in a reactor, in fact still has significant potential energy which can be released through (expensive) reprocessing. Initially, the plutonium-uranium extraction (PUREX) process was developed from nuclear weapons programs and was embraced in 1960s as a solution to perceived uranium shortage problem, but only in context of fast breeder reactors. Since no breeder has been commercially viable, the spent plutonium was recycled into mixed oxide fuel (MOX) and burned once in light water reactors.

The advantages of reprocessing as a waste management strategy are that it extends uranium and plutonium resources, it reduces the volume of long-lived actinides

(radioactive elements), and it can tailor the form of the waste to fit the repository. The disadvantages are that a repository for the final waste is needed, the process is not cost-effective, it increases the overall waste volume and the process includes risks of proliferation. If reprocessed, twenty tons of spent nuclear fuel yields 2-4 tons of high-level waste, 20-30 tons of intermediate-level waste and 70-95 tons low-level waste. The volume of waste, however, is not the limiting factor for a repository, but rather heat production and the concentration of low-solubility species.

The spent fuel implications of growth in nuclear power production globally are significant. With every 1 GW increase in energy produced, about 20 tons of spent fuel is produced per year. States just starting out with nuclear power will either store this waste or accept fuel leasing arrangements. It goes without saying that the increase in storage sites, either on-site or in repositories, requires more safety and security measures. This also includes secure transportation of spent fuel in the case of leasing agreements.

Of course, there are numerous implications for security as well. Depending on how the spent fuel pools are designed and how tight security is, the threat of terrorism directed at waste facilities, either through the sabotage of nuclear power plants or fuel storage sites is always a possibility. The potential also exists for terrorists to steal weapons-usable nuclear material from civilian facilities.

Proliferation

The possibility of the usage of nuclear technology and material for non-peaceful purposes in its various forms, from nuclear war to terrorism, has plagued humankind for decades. The prevention of the proliferation of nuclear technology and material has to be one of the most crucial concerns when considering nuclear energy. What this calls for is serious and sustained efforts to stem the tide of nuclear weapons proliferation while securing the rights of all parties under the Nuclear Non-proliferation Treaty to their guaranteed right to utilize nuclear technology for peaceful use. Cognizant of the complexities of involved with issue nuclear power, participants discussed the dangers of nuclear energy and assessed the various existing proposals for the multilateralization of the nuclear fuel cycle.

With an increasing number of countries, especially in Asia, applying for permission to construct nuclear power plants to ease demands for energy by their citizens, the idea of a nuclear renaissance has gained currency over the last decade. Fanned by the fear of global warming and the high prices for fossil fuels, nuclear energy looks increasingly favorable as a clean alternative energy source. Yet the concern that nuclear material, even the peaceful kind, could fall into the hands of terrorists or be used by rouge states for military purposes remains worrying. To address this issue, the IAEA proposed a far reaching proposal that moves towards securing peaceful use of nuclear energy for NPT member states while preventing nuclear material from falling into the wrong hands.

Former IAEA Director General Mohammed El Baradei proposed a three-stage process in developing a new multilateral nuclear fuel bank mechanism: the first step would be to establish a system for assuring supply of fuel for nuclear power reactors; the second step

would be to have all new enrichment and reprocessing activities in future put exclusively under multilateral control; and the third step would be to convert all existing enrichment and reprocessing facilities from national to multilateral operations.

The initiative for an IAEA-led fuel reserve is supported with additional proposals calling for the multilateralization of the nuclear fuel cycle and assurance for nuclear fuel. Five existing categories of proposals were identified and their specifics discussed. Amongst them was the "Far-Reaching Visions for the Global Supply Mechanisms" which included the Russian Global Nuclear Power Infrastructure, the United States' Global Nuclear Energy Partnership and Austria's Proposal on Multilateralization of the Nuclear Fuel Cycle. Bold measures, including proposals assuring the supply of nuclear energy included the World Nuclear Association (WNA) Proposal, the Six-Country Concept (France, Germany, the Netherlands, Russia, the United Kingdom, and the United States), Japan's Standby Arrangements Proposal, and the United Kingdom's Nuclear Fuel Assurance Proposal. Other propositions looking to multinationalize the sensitive parts of the nuclear fuel cycle include Russian International Uranium Enrichment Center (IUEC) in Angarsk and the German Multilateral Enrichment Sanctuary Project (MESP). Three fuel bank proposals were discussed. Amongst them was the Russian Guaranteed Reserve of LEU, the Nuclear Threat Initiative (NTI) Fuel Bank and the United States' Proposal on a nationally-controlled reserve of low-enriched uranium (LEU). Finally, the EU Proposal on Nuclear Fuel Cycle was also discussed by the participants. Taken together, these proposals provide vital measures if the international community is to enlarge the contribution of atomic energy to peace, well-being and prosperity throughout the world while limiting the proliferation of nuclear weapons and eliminating them altogether.

During the meeting several points of agreements regarding the multilateral mechanisms for nuclear energy emerged. Participants stressed that any multilateral mechanism should not deprive states from any of their rights, especially those guaranteeing them the right to peaceful use of nuclear technology; any multilateral mechanism should not disturb the international market for nuclear fuel cycle services; the establishment of multilateral fuel cycle arrangements should be implemented step by step; there would be no uniform approach that would be satisfactory for all technologies and all countries and that successful implementation of the multilateralization would depend on the flexibility of its application.

A Number of fundamental considerations were also addressed. The central problem hampering the further progress of a multilateral approach to the nuclear fuel cycle is distrust among states. The problem of building trust is a political problem that needs to be tackled using political means. Thus far many states, especially those in the G-77 camp, view multilateral mechanisms to nuclear energy as yet another means by the developed countries to cement their control over nuclear technology and to deny the rest of them. Secondly, most of the proposals to date have been put forward by supplier states and have received lukewarm support from the customer side. Many customer states tend to argue that the proposals now on the table fail to adequately address their concerns. To overcome this gap, supplier states need to take into serious consideration the concerns of

their counterparts and see to it that any response takes into account the energy, development, economic and security concerns of the countries looking towards nuclear energy to fuel their economy.

It was also suggested that proposals that respond to the "entitlement" motivation of the customer states – in terms of their participation in ownership, management, operation, decision-making, profit-sharing – perhaps would be more attractive then just backup supply mechanisms for the existing market. Furthermore, proposals that would include taking away spent nuclear fuel after it was used and providing other back-end services would create stronger incentives to rely on international mechanisms for fuel supply and would help towards building confidence in multilateral mechanisms. The existing proposals are not carved in stone. Better understanding of the underlying interests and concerns of the different stake holders, coupled with an open dialogue between supplier and non-supplier states, will go a long way toward establishing a basis of trust and confidence.

Participants also stressed that while assurances of nuclear fuel supply are a useful start, serious work must commence on complete internationalization of the fuel cycle if the international community is serious about its goal to provide secure and reliable supply of the fuel for the nuclear power generation. The internationalization of the fuel cycle would strengthen the nuclear non-proliferation regime through assurance of supply and reliance of the nuclear fuel market.

So how should the international community address the growing security and proliferation risks from the nuclear fuel cycle, while protecting the right of states to develop the peaceful use of nuclear energy? One part of the nuclear fuel cycle framework that has been under discussion is to reach agreement that all new enrichment and reprocessing activities should be placed exclusively under multilateral control and this should be followed by agreement to convert all existing nuclear facilities from national to multinational control as well. This is indeed a long term goal of such an initiative; nonetheless, there are increasing signs of support for these aims coming from both supplier and demand sides. However, an essential security questions remains: can a multilateral approach to the nuclear fuel cycle make nuclear technology and material "proliferation-proof"? Participants agreed that while it is impossible to suggest the nuclear fuel cycle will render nuclear technology absolutely proliferations-proof, the experience of the AQ Khan Network and nuclear black markets have taught vital lessons. To curb nuclear material proliferation, world leaders will need to agree to secure all vulnerable nuclear material as a step towards making nuclear technology proliferation-proof. Another step is to make the Comprehensive Safeguards Agreements and Additional Protocols of the IAEA truly universal as a measure to verify that a State is living up to its international commitments not to use nuclear material for nuclear weapons supposes.

Conclusion

The opportunities and dangers associated with the use of nuclear energy are increasingly multinational and global in nature and therefore call for mechanisms of global governance. A nuclear program in one country becomes porous to national borders and involves governments, non-governmental organizations and businesses from many countries. The opportunities and challenges of today have moved international cooperation closer, however multilateral, bilateral and regional agreements are not yet equipped for governing the risks and challenges of nuclear energy amidst these new trends.

There are enormous unsolved risks, including technical malfunction, terrorism, proliferation and waste which require attention. In addition, to ensure that systems are properly safeguarded, maintained and evaluated, you need a long-term and stable political and regulatory framework as well as an established safety culture. While high standards are enforced in some countries, these same standards do not exist in some countries which are pursuing civilian nuclear power programs.

This raises the question of whether or not it is ethical to deny others the right to nuclear power, or at the very least, deny access to the safest and most advanced technologies. For example, some argue that Generation III and IV designs will provide a substantial increase in safety, while others argue that a 100% risk free nuclear power plant is not possible, especially without proper safety cultures in place. However, without a functioning multilateral safety framework in place, or at the very least regional or bilateral agreements, this is highly unlikely. Either way, one of the big unsolved questions is who decides whether or not a power plant is safe.

Some participants argued that Europe can put forth a regional safety framework right now if the will exists. They stress that the 1957 Euratom treaty provides the legal framework for regulatory harmonization already and a few willing member states could in fact move foreword. However, participants also emphasized that questions of safety governance are beyond the scope of scientists and engineers and that it is absolutely necessary to involve other disciplines in the construction of this safety framework at the international level.

With regards to waste, some argued that Generation IV reactors claim significant benefits over previous generations, including higher energy yield and the ability to reprocess existing waste. However, with or without reprocessing, waste will still exist and the international consensus is that geologic repositories is the right approach, however, no country has yet opened a site due to siting hurdles. However, lately Sweden and Finland have seen competition among sites for waste repositories.

To mitigate the risks of waste, participants stressed the need to shape the fuel cycle to limit the amount of directly weapons-usable nuclear material, limit the geographical spread of sensitive fuel cycle facilities, enhance focus on security and better adherence to international standards such as the Convention on the Physical Prevention of Nuclear Material (CPPNM).

With regards to proliferation and safeguarding, some argued that placing the multilateral nuclear energy fuel cycle under the control of the IAEA with universal approval would go a long way in strengthening the Agency's authority as well as three pillars of the NPT: non-proliferation, disarmament and the peaceful use of nuclear energy. However, the proposals for the multilateral nuclear fuel cycle initiative are still missing substantial details and this has yet to be hammered out and to gain currency in countries that need to see these proposals as a way towards making nuclear technology and material proliferation proof. Finally, the MNA proposals remain largely Western lead initiatives and are seen by developing countries as a measure to cement the technological divide between the nuclear haves and nuclear have-nots. This is a severe challenge that will undermine this initiative and therefore deserves serious and immediate political consideration.

Annex I: Conference Program

Day 1

01:00pm **Arrival, Registration and Light Lunch**

02:00pm **Welcome and Introduction**

- *Björn Conrad, Research Associate, Global Public Policy Institute*
- *Peggy Knudson, Director of Development, Foreign Policy Studies Program, Brookings Institution*

02:30pm PANEL DISCUSSION I

True benefits or hidden costs - What can really be expected from nuclear energy and its future in the global energy mix?

Global energy needs have changed, as traditional energy supplies are increasingly failing to meet rising global demands and climate change requires a shift towards a low-carbon or no-carbon power sources. As a result, some argue that the role of nuclear energy needs to be revaluated in this context. From their perspective, nuclear power is a necessary ingredient of an energy mix that ensures security of supply and reduces carbon emissions. And indeed, some countries (including Finland, the UK, China and others) have recently made significant new investments in nuclear power.

This panel will address key questions concerning the true merits and hidden pitfalls of nuclear energy as a clean and reliable power source. It will provide an evaluation of recent developments of the nuclear energy landscape and the key trends of the so-called "nuclear renaissance" that will serve as the basis of further discussions. This stocktaking of the current state of nuclear energy will include the role of involved actors, from industry to governments. The panel will also touch on the various criticisms that put the real benefits of nuclear power in doubt, including scrutinizing the carbon intensity, reliability and market-based viability of nuclear power.

Panelists:

- *Nathan Hultman, Assistant Professor, School of Public Policy, University of Maryland*
- *Urban Rid, Director General, Climate Protection, Environment and Energy, Renewable Energies, International Cooperation, German Federal Ministry for Environment*
- *Wolfgang Dirschauer, Vattenfall Europe AG*

Commentator:

- *Benjamin K. Sovacool, Research Fellow, National University of Singapore*

Moderated by: *Björn Conrad, Research Associate, Global Public Policy Institute (GPPi), Berlin*

Q&A

04:00pm **Coffee Break**

04:30pm WORKING GROUP SESSION (I)

Assessing the opportunities of the global nuclear energy market

Following the insights presented during the panel discussion, the working groups will delve deeper into the discussion of potential benefits of nuclear power and their limits. Regarding all advantages put forward by proponents of the nuclear renaissance, the true extent of the corresponding benefits is highly disputed. The in-depth assessment and scrutinizing of the merits of nuclear power relating to climate change, energy security and economic profits is the goal of this working group session.

WORKING GROUP A

Carbon accounting – How green is nuclear energy?

Presenting nuclear power as a low-carbon energy source and a potential key instrument for fighting climate change has become one of the most prominent arguments of the proponents of nuclear power. However, some due diligence regarding the real carbon footprint of nuclear energy is certainly needed. The installation of nuclear power infra-structure, in generation as well as waste storage, and the operation of nuclear plants including the mining and transport of uranium feature a range of carbon-intense activities that cast doubt over the eco-friendliness of nuclear energy. This working group will take a close look at the question of how green nuclear power really is, how it contributes to carbon emission reductions and how it fares in comparison to other energy sources.

Introduction: *Benjamin K. Sovacool, Research Fellow, National University of Singapore*

Commentator: *Paul Meier, Director, Energy Institute at the University of Wisconsin-Madison*

WORKING GROUP B

Bottomless pit? – Assessing the "business case" for nuclear power

In assessing the benefits of nuclear power, one important aspect is the economic reality of nuclear energy as a competitive energy source. Critics point out that the immense costs of infra-structure, illustrated by the massive subsidies required to construct new plants, as well as the enormous risks associated with nuclear power that cannot be effectively account for through existing insurance schemes and therefore necessitate government guarantees, prevent nuclear power from becoming

economically and financially viable in a sustainable manner. This working group will examine the "business case" for nuclear power, approaching the question of how viable nuclear energy is and will be in market terms. The discussion will include key trends that might influence the nuclear business case in the mid-term future, for example the further development of the price of carbon emissions.

Introduction: *Craig Severance, CPA and Editor and Founder of Energy Economy Online*

WORKING GROUP C

Nuclear self-sufficiency – Can nuclear power pave the road towards energy independence?

The central issue of energy security and dependence also plays an important role regarding the assessments of the merits of nuclear power. The prospect of reducing dependency on foreign oil and gas is a tempting argument for the expansion of nuclear energy. On the one hand, this working group will be concerned with exploring the true potential of nuclear energy reduce energy dependencies, especially in the light of uranium supply challenges. On the other hand, the discussion will also take into account the new dependencies that emerge as a result of a potential nuclear renaissance, not only with regards to access to the increasingly scarce resources of uranium, but also concerning technology- and infrastructure-driven dependencies, for example in the case of enrichment facilities.

Introduction: *Antony Froggatt, Senior Research Fellow, Energy, Environment and Resource Governance, Chatham House*

Commentator: *Jessica Jewell, Doctoral Researcher, Central European University*

05:45pm **Break**

06:30pm **Dinner**

09:00pm **After Dinner Keynote**

Topic: Peaceful Use of Nuclear Energy - a Solid Pillar of the Nuclear Non-Proliferation Treaty or a Trojan Horse for Proliferation?

Speaker: *Ambassador Peter Gottwald, Commissioner of the Federal Government for Arms Control and Disarmament, German Federal Foreign Office*

Day 2

09:00am PANEL DISCUSSION II

A controllable technology? Assessing the global risks of nuclear power

The special character of nuclear power and the intensity of the debate surrounding the use of nuclear energy is rooted in the enormous dangers that are connected to radioactive material. The possibility of catastrophic events, both through nuclear accidents and the intentional use of nuclear material in weapons, as well as the long-term health implications of radiation pose considerable risks that will have to play a central role in every discussion about the merits and dangers of nuclear power. The panel discussion will focus on the overall questions of the perception, assessment and management of the risks of nuclear energy, key developments over time and outlook into the future.

Panelists:

- *Jean-Paul Glatz, Head of Nuclear Chemistry Department, Institute for Transuranium Elements, Joint Research Centre, European Commission*
- *Jean-Pol Poncelet, Senior Vice President, Sustainable Development and Continuous Improvement, AREVA*

Moderated by: *Björn Conrad, Research Associate, Global Public Policy Institute (GPPi), Berlin*

Q&A

10:30am **Coffee Break**

11:00am WORKING GROUP SESSION (II)

Playing with fire? - Assessing the risks of nuclear power in the 21st century

Building on the panel discussion, the working groups will provide a more detailed picture on specific risk dimensions of nuclear power. They will cover the issues of nuclear safety and the risk of catastrophic accidents in nuclear power plants, the problem of long-term nuclear waste storage and reprocessing as well as the dimension of nuclear proliferation and military use of nuclear material by state as well as non-state actors.

WORKING GROUP A

A disaster waiting to happen? The variables of reactor risk management

Based on an introduction of the current safety situation of nuclear reactors around the world, this working group will focus on the question of how the risk of catastrophic reactor accidents has to be judged; how the current risk governance systems on the national and international level works; and how it would need to be changed in order to be able to tackle the challenges of a potential expansion of nuclear power generation. A special

focus of this working group will be put on the case of China, where a grand-scale expansion of nuclear energy generation meets a disputed system of national risk governance.

Introduction: *Anthony Hechanova, Associate Executive Director for Sustainable and Clean Energy Programs, Harry Reid Center for Environmental Studies, University of Nevada, Las Vegas*

Commentator: *Chrisoph Pistner, Researcher, Nuclear Engineering & Facility Safety, Öko-Institut e.V.*

WORKING GROUP B

Long-term nuclear waste storage and nuclear reprocessing

The long-term dangers of radiation from nuclear waste is at the very core of assessing the risks of nuclear energy. The procedures of waste storage and waste reprocessing pose a lot of questions yet to be answered. This working group will discuss the technological as well as the political dimension of storage and reprocessing on the national as well as international level. It will also zoom in on the security implication of waste storage regarding the potential theft of fissile material and nuclear terrorism. One focus area will be the empirical record of nuclear reprocessing in Japan and France and the implications for the viability of reprocessing as an option for addressing the challenges of nuclear waste management and proliferation risks at the same time.

Introduction: *Sharon Squassoni, Center for Strategic and International Studies (CSIS)*

Commentator: *Mark Gaffigan, Director, Energy Issues, Natural Resources and Environment Team, U.S. Government Accountability Office*

WORKING GROUP C

Making civilian nuclear technology and material proliferation-proof

The possibility of the usage of nuclear technology and material for non-peaceful purposes in its various forms, from nuclear war to terrorism, has plagued humankind for decades. The prevention of the proliferation of nuclear technology and material has to be one of the most crucial concerns when considering nuclear energy. This working group will discuss the dangers of nuclear proliferation and explore ways of managing this particular risk of nuclear power. A special focus of the discussion will be various existing proposals with the objective to multilateralization of the nuclear fuel cycle. Putting sensitive nuclear fuel cycle activities under exclusive control of the International Atomic Energy Agency (IAEA) is one possible way to overcome the security dilemma regarding the peaceful use of nuclear energy.

Introduction: *Yuri Yudin, Senior Researcher and Project Manager, United Nations Institute for Disarmament Research (UNIDIR)*

Commentator: *Joel Sandhu, Research Associate, Global Public Policy Institute (GPPi)*

12.15pm **Lunch**

01:45pm PANEL DISCUSSION III

A Transatlantic Agenda for Global Nuclear Governance

The opportunities and dangers associated with the use of nuclear energy are increasingly multinational and global in nature and therefore call for mechanisms of global governance. A nuclear program in one country becomes porous to national borders and involves governments, non-governmental organizations and businesses from many countries. The opportunities and challenges of today have moved international cooperation closer, however are multilateral, bilateral and regional agreements equipped for governing the risks and challenges of nuclear energy amidst these new trends and into the future? What are the main impediments to their effectiveness and how will the governance structures need to adapt to the new global environment?

Panelists:

- *Joachim Pfeiffer, Member of German Parliament and Speaker for Political and Economic Affairs, CDU-CSU*
- *R. Andreas Kraemer, Chairman, Ecologic Institute, Washington DC*
- *Helga Flores Trejo, Nonresident Fellow, Foreign Policy, Center on the United States and Europe, the Brookings Institute*

Moderated by *Andreas Goldthau, Associate Professor, CEU and Fellow, GPPi*

Q&A

03:15pm **CONCLUDING DISCUSSION**
Moderated by *Andreas Goldthau, Associate Professor, CEU and Fellow, GPPi*

03:30pm Farewell

Annex II: List of Participants

Mr. Cameron ABADI
Germany correspondent, GlobalPost and freelance Journalist

Mr. Thorsten BENNER
Associate Director, Global Public Policy Institute (GPPi), Berlin

Ms. Ulrike BRÖDERMANN
Zweites Deutsches Fernsehen (ZDF)

Mr. Björn CONRAD
Research Associate, Global Public Policy Institute (GPPi), Berlin

Mr. Wolfgang DIRSCHAUER
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Mr. Antony FROGGATT
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Associate Professor, Applied Economics, Universidad Complutense de Madrid

Dr. Jean-Paul GLATZ
Head of Nuclear Chemistry Department, Institute for Transuranium Elements, Joint Research Centre, European Commission

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Organizer Information

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