

An Analysis of the Multinational Approach in Nuclear Fuel Cycle for East Asia

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1. Introduction

To balance the need to develop nuclear power for peaceful purposes and to prevent the risks of nuclear proliferation, multinational approach (MNA) of nuclear fuel cycle has been developed on the basis that nuclear technology is managed not by individual countries, but by a community of state-level technology users, so that countries can have access to the benefits of peaceful applications of nuclear technology while any proliferation intention will be collectively eliminated by the community. Since its first inception in the 1940s, numerous MNAs have been proposed with focus on non-proliferation and assurance of nuclear fuel, of which several have been successfully implemented such as the nuclear weapon free zone (NWFZ) treaties in South America or Southeast Asia; the European Atomic Energy Community (EURATOM); or the multinational consortium URENCO and EURODIF in uranium enrichment. Although being considered the hot spot of nuclear power development as well as a troublesome region in term of nuclear non-proliferation, East Asia¹ has not possessed any successful MNA in the nuclear field despite many proposals in the past two decades.

In order to understand the benefits and challenges of MNA in East Asia, as well as to provide suggestions to enhance the MNA feasibility, this paper begins with a discussion on the experiences of the international community with MNA, as well as the unsuccessful efforts to introduce MNA to East Asia alongside with their reasons of failure. The second part of the paper focuses on why MNA is still necessary for this region in the non-proliferation and nuclear power development context of East Asia. Following the analysis on the need for MNA, the possible challenges and necessary considerations for new proposal of MNA in East Asia are provided. The paper is concluded with a summarization on the necessity and challenges of MNA as well as further direction for research.

2. The past MNA proposals for East Asia

2.1. Overview of the MNAs in the nuclear field

The history of multilateral approach was dated back to the early era of atomic energy right after the World War II, when the Baruch Plan (1946) was proposed by the United States (USA) with the purpose of establishing an international regime to control the applications of atomic

energy. In the following decades, MNAs were proposed at the international and regional levels with focus on non-proliferation. Such efforts have led to the establishment of NWFZ in Latin America (Tlatelolco Treaty), Africa (Pelindaba Treaty), Central Asia (Semei Treaty), Southeast Asia (Bangkok Treaty), and Oceania (Rarotonga Treaty). Regarding the supply side of the nuclear fuel cycle, the success of MNA mainly limits to the European community, including the safeguards-fuel supply assurance regime EURATOM, the multinational cooperation URENCO and EURODIF in uranium enrichment, or EUROCHEMIC in spent fuel reprocessing.

Recently, there has been a new wave of MNA proposals in the nuclear field with the main purpose of assuring the nuclear fuel supply while eliminating the risks of nuclear proliferation from sensitive technologies like enrichment or nuclear reprocessing (ENR). Among the recent proposals, the proposal by the Russian Federation on International Uranium Enrichment Centre (IUEC) in Angarsk, Russia has made significant progress. In December 2010, a 120-ton guaranteed reserve of low-enriched uranium reserve was official established at the IUEC and subsequently IUEC stocks were purchased by Kazakhstan and Ukraine in late 2011.

2.2. Past MNA proposals for East Asia

In mid-1990s, a significant interest in multilateral approaches was observed in East Asia with a dozen of MNA proposals. Most of these proposals were initiated by experts in the nuclear field with strong emphasis on non-proliferation and export control (ASIATOM, PACIFIATOM, PACATOM); fuel supply assurance (Nuclear Fuel Cycle Centre); spent fuel and waste management (EACIS); and nuclear safety (Asian Nuclear Safety Centre). At the governmental level, Asia Nuclear Safety Consultation Organization (ANSCO), which was proposed by the Republic of Korea (ROK) in 1997, is a rare proposal made by a governmental organization and focuses solely on nuclear safety and emergency preparedness and response [1]. Although none of these proposals gained serious attention from interested parties, further researches and suggestions have been continued regarding this subject, including the recent call by the President of Korea Park Geun-hye on the creation of a nuclear safety consultative group in Northeast Asia [2].

¹ According to the definition by the United Nations, East Asia (or Eastern Asia) is consisted of China, Japan, North Korea (DPRK), South Korea (ROK), and Mongolia. Taiwan is also geographically located in East Asia although the country is not a UN or IAEA Member due to its

political status. However, the "East Asia region" in this paper is defined to also encompass the Southeast Asian countries (ASEAN Member States), which is consisted of, among others, potential future nuclear power countries like Vietnam, Malaysia, Thailand, and Indonesia.

2.3. Failure reasons of the past proposals

As many MNA proposals in nuclear fuel cycle have been made for East Asia without any significant progress, the principal reasons of such failures are identified and discussed in the following section.

i) Lack of consistent support from supplier countries

Although numerous technology and fuel supplying countries have expressed their support for the idea of MNA, such support has not been pushed far enough to realization. In several cases, the support proved to be inconsistent due to the policy incoherence in supplier countries. For example, during his presidency US President George W. Bush proposed a very progressive concept of GNEP, which aimed to create a consortium of states with advanced fuel cycle to provide the full services for other customer countries. However, the GNEP initiative was abandoned under the new administration of Barrack Obama in favour of the more traditional approach "forum for cooperation" (IFNEC).

Among the principal players of the international nuclear power industry, the level of support for MNA also varies greatly. While Russia, United Kingdom, or Japan have actively involved in the creation of multilateral mechanism, the support from USA, as described above, has fluctuated, while France and China have maintained quite obscure attitude towards MNA. Even the support from the International Atomic Energy Agency (IAEA) for MNA has been also fluctuated from strong leadership for MNA initiative under the directorship of Dr. Mohamed ElBaradei to a less active engagement under his successor Mr. Yukiya Amano [3].

ii) Dispute on the right to ENR

As most of the MNAs have been developed by countries that already possess these two technologies, they often include the renouncement of any domestic endeavour to develop such technological capabilities by other states (like the strict requirements of the GNEP proposal). Such requirements often meet with strong disapproval from many non-supplier states or reluctance from others on the basis of the NPT Article IV. This is the reason why the recent proposals, like the Russian LEU reserve or the IAEA LEU bank do not include such clause. Nevertheless, this dispute will remain an issue for any upcoming proposal, which has been exemplified by the lengthy discussion between USA and ROK on the pyroprocessing issue, or the concern expressed by China and ROK over the plutonium reserves obtained from reprocessing by Japan, which is among a few non-nuclear-weapon states possessing ENR technologies.

iii) Lack of clarity and coordination

As a production of supplier state, the development of multilateral approach proposals are often lack of consultation with non-supplier countries, and thus could not achieve a sufficient level of clarity, especially in term of benefits (for participating countries) and incentives (for host countries of joint facilities).

Another principal reason that often halts the MNA effort is the lack of continuous coordination, between state-level partners and between the successive administrations of the initiator of the proposal. For

example, in the early 1990s, Japanese experts and officials proposed a number of scenarios for MNA but nothing was implemented due to the limited participation of other regional countries or the disruptive change of policy by the responsible organizations in Japan [4]. As historical and territorial disputes have been a prominent feature of the East Asia political climate in recent years, this lack of clarity and coordination will probably remain in the near future.

iv) Economic, technological and social issues

Based on the technical scope of the MNA scenario, an approach can cover fuel supply guarantee (LEU reserve, LEU bank); front-end services (enrichment, fuel fabrication); bank-end services (spent fuel management; reprocessing; interim storage; final disposal). In term of uranium supply, there is a popular perception that the current uranium market has been operated successfully without disruption since the beginning of the civil nuclear industry, thus the nuclear power countries have not paid much attention to the MNA proposals related to natural uranium supply. Although such perception has stayed valid in the short-term context of strategy by governments for fuel guarantee, the lack of MNA option may cause negative effects in the long run, since the current market is not prepared for major disruption.

Regarding the fuel cycle services, up to now, MNA has focused mostly on front-end services with successful cases like the European joint-projects URENCO and EURODIF. Paradoxically, MNA is a more attractive solution for East Asia countries like ROK, Japan, and Taiwan in term of back-end services, especially radioactive waste management. However, MNA for back-end services still contains numerous challenges in term of technology, political and social acceptance. For example, one of the key issues for back-end management is final/geological disposal, which has not yet been solved, technologically and politically, while the technology-feasible interim storage service has not been able to find a country that accepts to host a large scale, multilateral interim storage facility. Even if the technology is feasible, back-end technology deployment still has a similar issue to front-end services, which is the proliferation resistance of technology, which allows the sharing between supplier and host country without compromising the spread of sensitive technology to non-supplier countries.

Finally, any MNA of nuclear fuel cycle will have to face the same economic and social issues like a nuclear power project, such as costly delay of construction and operation; economic scale of the facility; anti-nuclear movement; and lack of public perception.

3. The surging need for MNA in East Asia and the challenges for its success

3.1. Recent development of nuclear power in East Asia

Among the East Asian countries are one *de jure* nuclear weapon state (China), one *de facto* nuclear weapon state (DPRK), and four countries/sovereign with operable nuclear power plants (China, Japan, ROK, and Taiwan), two of which (China and Japan) have complete

fuel cycle. As of August 2014, there are 99 operable power reactors located in the region (22.7% worldwide), including 22 in China, 48 in Japan (all in temporary shutdown status), 23 in ROK, and 6 in Taiwan. Despite the negative effects of the Fukushima Daiichi accident in Japan (March 2011), East Asia continues to be the leading region in nuclear power development worldwide. Among the 7 new nuclear power constructions in 2012, 5 belongs to East Asia: Fuqing 4, Shidaowan 1, Tianwan 3, and Yangjiang 4 in China; Shin Ulchin 1 in ROK.

Moreover, several other countries in the region are also planning to develop nuclear power, including ASEAN Members like Vietnam, Indonesia, and Malaysia. Among these, Vietnam is the most active with two projects (with Russia and Japan) already signed and under preparation; Malaysia has established the Malaysian Nuclear Power Cooperation to prepare the feasibility study; while Indonesia has expressed the intention to develop nuclear power for a long time.

3.2. Driving forces for the renewed interest in MNA

i) Enhancement of non-proliferation regime and trust building

Given the sensitivity of nuclear weapon issue, East Asia is currently among the critical regions of the non-proliferation regime, where DPRK has showed the loophole of the Non-Proliferation Treaty, which could not prevent its member to withdraw from the Treaty and acquire proliferation technology. DPRK has also defied, for numerous times, the international efforts on denuclearization, among which the KEDO project (Korean Peninsula Energy Development Organization) was once considered a promising case for MNA for nuclear fuel cycle in the region. Besides, other countries in the region are also facing with domestic issues related to safeguards and non-proliferation that might be solved by internationalized solutions, such as the on-going discussion of ROK with USA on the revision of bilateral cooperation agreement regarding pyroprocessing issue. Although Japan has strictly committed to the IAEA safeguards, its surplus of plutonium from reprocessing has been also considered a regional concern.

As proven by the success story of EURATOM, the main driving force for MNA is to enhance the non-proliferation regime in the region. Thus, a similar cooperation regime may also facilitate a potential solution for those outstanding non-proliferation and safeguards issues in East Asia such as the DPRK problem and the ENR issue. A joint nuclear fuel cycle facility, which is joint-operated by multinational staff, will make it more difficult to divert nuclear material, as well as provide an obstacle against breakout by the host partner, since if the host state were seeking to seize the facility, there would be other partners it would have to expel [3]. Support of IAEA for such MNA on safeguards is evident since it will help the Agency to reduce their workforce and financial burden on safeguards inspection in the region.

Through the cooperation and enhancement of transparency in non-proliferation, the East Asian countries can gain another important benefit, which is the

trust building among participating countries in this region, which is now marred by political tension among neighbour countries on many issues. This kind of trust building and tension relief through multilateral approach in the nuclear field was already observed in Latin American countries.

MNA can also become a leverage tool for countries in the region when dealing with DPRK, since the current isolation of DPRK has not brought any progress to solve the proliferation issue of this country. At the same time, participation in a regional MNA is beneficial for DPRK since, once adhering to the non-proliferation principles, the country can get the help from its experienced neighbours in building a civil nuclear power programme that can ease the current energy shortage. Such development in turn will reduce the distrust between DPRK and other East Asia states, and contribute to the regional trust building process.

ii) Assurance of fuel supply and future solution for back-end services

Due to the limited domestic resources in some countries and increasing energy demand in others, East Asia is one of the few regions in the world where steady expansion of nuclear power is expected. The rapid development of nuclear power has brought in two main concerns to countries in the region, which are the assurance of fuel supply and a solution for back-end management, including interim storage and final disposal. For example, due to the lack of attention to the radioactive waste disposal issue, ROK is now facing serious problem with spent fuel management, since its in-plant spent fuel storage capacity is expected to run out in 2016 [5]. The past proposals on MNA have showed that this is a tangible solution for both front-end and back-end issues of the nuclear fuel cycle [6]. Analysis also shows that China, Russia, and Mongolia, among other countries in East Asia, have potential to host a regional radioactive waste storage facility once the political concern, safety and cost-effective issues are resolved [7]. Since these concerns have become more and more urgent, MNA should be seriously considered by the region.

iii) Enhancement of nuclear safety

Up to now, the history of nuclear power development has been marked with three major accidents, which are the Three Mile Island (TMI) Accident (USA, 1979), the Chernobyl Accident (Soviet Union, 1986), and the recent Fukushima Daiichi Accident (Japan, 2011). One of the major lessons learned after TMI and Chernobyl was the need for multilateral cooperation in order to identify the weaknesses of the technology and to improve the safety in design and operation. Yet, Fukushima has proved that international efforts were not enough to ensure nuclear safety, even in countries with high level of technology and standards like Japan. In such context, IAEA has announced its Action Plan on Nuclear Safety (2011) with 12 main actions, of which many emphasize the international cooperation.

Therefore, Fukushima Daiichi, like the two previous major accidents, can be considered as another turning-

point that indicates the need for a stronger and more effective MNA in the nuclear field. This need is even more urgent for the East Asia region, which has witnessed in recent years the fastest development of nuclear power in the world, as well as the most serious nuclear accident in recent times.

iv) Continuation of existing regional nuclear cooperation frameworks

Under the technical cooperation framework of IAEA, East Asian countries have been cooperating in the nuclear field for the last few decades. Besides, there are several regional nuclear cooperation networks have been established such as the Asian Nuclear Safety Network (ANSN) and the Forum on Nuclear Cooperation in Asia (FNCA). Although the Member States, especially the ASEAN developing countries, have benefited significantly from such cooperation, these frameworks are mostly related to capacity building, knowledge management, or other technical exchanges on non-power applications of atomic energy.

By establishing a strong multilateral mechanism, the scattered resources of these existing cooperation frameworks could be re-arranged to produce more tangible and sustainable benefits for the participating countries, as well as enhance the nuclear cooperation in the region. An MNA of nuclear fuel cycle has numerous potential benefits for nuclear power infrastructure development of participating states, including the establishment of common standards and practices; sharing of available nuclear facilities among regional countries and achievement of profitable scale for such facilities; and facilitation of scientific, educational, and technical exchanges on nuclear fuel cycle. The successful example of APEC (Asian Pacific Economic Cooperation), a regional cooperation in economics, could serve as a model and momentum for the East Asian cooperation scheme in the nuclear field.

3.3. Principal challenges to MNA in East Asia

i) Positions of China and USA

In the past few decades, China has emerged as an upcoming military and economic superpower in East Asia. In the nuclear field, China is now without a doubt the locomotive for the nuclear power development worldwide, with 22 reactors in operation, 27 under construction, and an ambitious goal of increasing nuclear capacity to 58 GWe by 2020 and 150 GWe by 2030. After the Fukushima accident, China has imposed some measures to increase the safety of its nuclear fleet, but there is no sign that China will significantly rescale its nuclear development plan. Besides, as a nuclear weapon state and complete fuel cycle technology holder, China has a major role in the current non-proliferation regime as well as a potential service provider for the any MNA in nuclear fuel cycle. Therefore, any MNA in the East Asian region will make no sense without the participation of China.

However, China has maintained a “wait-and-see” attitude on MNA, which means that other countries in the region will have to create a proposal attractive enough for the involvement of China [3]. Since China already

possesses a closed nuclear fuel cycle and is an aspiring nuclear exporter, the country will be probably more interested in MNA if such cooperation can increase the assurance of natural uranium supply for China and enhance its credibility as a nuclear technology supplier.

Besides, the possible participation of Taiwan will apparently conflict with the “One China” policy of China, while the refusal of Taiwanese appearance will damage the integrity of such regional approach since Taiwan itself has a considerable nuclear fleet with six units in operation. Some suggested that this issue could be resolved by applying the model of APEC and ADB (with state-level participation of Taiwan), or WANO (industry-level participation) [8]. Finally, the frequent political tension between China and Japan, and its territorial dispute with ASEAN countries, including Vietnam, over the islands at South China Sea could also induce negative effect to any proposal.

Although not a state in the East Asia, the position of USA towards the proposal will greatly affect its viability. Firstly, for a long time USA has kept its policy of discouraging reprocessing, especially in regions of proliferation concern. Secondly, it also expresses a sceptical attitude towards internationally controlled enrichment centres and solutions for the back-end of the nuclear fuel cycle [3]. Therefore, it will not be an easy task to set up a full-scale multilateral approach to nuclear fuel cycle that could gain the active support from USA.

ii) Political tension among regional countries

Although the previous lessons learned show that the most viable feature of MNA is the enhancement of regional non-proliferation regime, the proliferation crisis of DPRK will not disappear with a single MNA solution. Rather, DRPK issue is likely an important political obstacle to the creation of any MNA in East Asia.

Besides DRPK, it should be noted that the relationships between Japan and its victim during World War II have not completely healed, which can be seen through the massive anti-Japan protests in China in recent years or the apparent rivalry between Japan and ROK in many subjects. Moreover, the regional confidence is now marred by geo-political tension on territorial dispute (China, Taiwan and ASEAN countries on Paracel and Sparty Islands; China, Taiwan and Japan on Senkaku Islands; ROK and Japan on Liancourt Rocks/Dokdo Islands) and military build-up, which can greatly affect any initiative of regional cooperation, especially on sensitive issue like MNA of nuclear fuel cycle.

iii) Feasible scope of the MNA

One of the main reasons for the failure of MNA proposals is the fact that they were not financially feasible or not economically attractive enough. Even the successful examples like EURODIF and URENCO have also changed their financial models through time to better adapt to the business nature of the nuclear industry. Therefore, any MNA proposal in East Asia will have to not only emphasize the non-proliferation aspect but also the economic aspect.

A feasible scope of the MNA is also crucial for its success. Such feasible scope is even more difficult to achieve in East Asia where countries have different fuel cycle technology levels, of which two already have complete nuclear fuel cycle (China and Japan), one is constrained to achieve such level (ROK, limited by the cooperation agreement with USA), and one is fully dependent on foreign suppliers (Taiwan). A regional approach that abandons sovereign control of reprocessing will upset countries like Japan, while an approach with reprocessing will require the prior concern from USA.

4. Proposals to enhance the feasibility of MNA

A survey on the bilateral trade values revealed that, despite the political animosity in the region, the trade among the East Asia countries, especially with China, is essential to the domestic economies of these countries [9]. There is also a significant similarity in recent voting history of regional countries at the United Nations General Assemblies (UNGA) [10]. Therefore, a MNA in nuclear fuel cycle is still feasible and desirable if it is less political-emphasized and more economic-oriented and seriously considers the role of China. The trade interdependence and voting similarity between some countries in East Asia with China in 2011 is presented in Table I.

Table I. The bilateral trade value (as percentage of total trade) and the voting similarity at the UNGA (ranges from -1 to 1) between some East Asia countries with China in 2011

	Japan	ROK	DPRK	Viet nam	Indo nesia
Trade	20.38	22.63	73.90	20.00	16.05
Vote	0.369	0.344	0.759	0.891	0.8

Another factor that can enhance the feasibility of MNA in East Asia is the role of the developing countries as neutral connectors between regional powers like China, Japan and ROK, which themselves have political and territorial disputes at different levels. For example, Mongolia, despite its isolated location and small economy, has actively provided a neutral ground to facilitate the dialogue between USA and DPRK through track 1.5 meetings. Vietnam is also a potential facilitator of MNA in East Asia, given its close relation with all the regional powers and its multi-supplier nuclear power programme. The relationship between Vietnam and the four countries operating nuclear power in the region is presented in Table II.

Table II. Relationship between Vietnam and the nuclear power countries in East Asia in term of economics, nuclear cooperation agreement (NCA) and politics

Relation	Economics (2012)	NCA	Politics
Vietnam-China	China is the 9 th investor to Vietnam	Yes (2000)	Strategic partner (2008)

Vietnam-Japan	Japan is the 1 st investor to Vietnam	Yes (2011)	Strategic partner (2006)
Vietnam-ROK	ROK is the 4 th investor to Vietnam	Yes (1996)	Strategic partner (2009)
Vietnam-Taiwan	Taiwan is the 2 nd investor to Vietnam	No	No

5. Conclusions

From the analysis in this paper, it could be concluded that the development of MNA for nuclear fuel cycle is a complex process, of which the success could only be assured by the combination of political effort, feasible technology choice, and practical approach. The complexity and political-implied nature of MNA in East Asia have resulted in the failure of every proposals in this region. Nevertheless, given the numerous issues of the regional nuclear industry, MNA has become once again a reasonable choice for the East Asia countries, which are thriving to a solution to assure fuel supply and back-end fuel cycle management while trying to eliminate the risk of nuclear proliferation in the region. The creation of such cooperation regime will have to surpass the obstacles of international relations, regional political tension and scope of approach. In this paper, a comprehensive coverage of the MNA for nuclear fuel cycle is not presented due to space limitation. Rather, this paper focuses on analysing the advantages and obstacles of MNA in East Asia, with the hope that it can serve as basis for the creation of a more practical and viable approach for the region.

For future research, a more quantitative study of MNA in the region needs to be considered, which takes into account different factors that can affect the chance of regional cooperation, from politics, economics to public acceptance. Such studies on nuclear cooperation related to non-proliferation have been carried out by Fuhrmann (2009) or Kroenig (2009) but with main focus on proliferation-related bilateral relations [11][12]. A region-specific study for East Asia with emphasis on multilateral cooperation will bring insight to the cooperation mechanism, thus help develop more feasible solution for a much-needed MNA for nuclear fuel cycle in East Asia.

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