

Internationalisation of the Nuclear Fuel Cycle*

Mohamed I. Shaker

*Attached is a simplified diagram showing the different stages
of the Nuclear Fuel Cycle

The International Atomic Energy Agency (IAEA) paid attention to the internationalisation of the nuclear fuel cycle in the mid 70s. The emphasis was on the back end of the cycle, specifically reprocessing and plutonium containment. Recent interest has focused as well on the front end of the cycle, more specifically, uranium enrichment. A recent study on multilateral approaches to the nuclear fuel cycle by an expert group at the IAEA focused on a number of aspects of the nuclear cycle, namely uranium enrichment, reprocessing of nuclear spent fuel, spent fuel disposal and storage and a combined option: fuel-leasing/fuel take-back.¹

Before going any further, it would be important to underline what is meant by internationalisation. The aforementioned expert group was of the view that a distinction should be made between the words “multilateral” (the broadest and most flexible term, referring simply to the participation of more than two actors), “multinational” (implying several actors from different states), “regional” (several actors from neighbouring states) and “international” (actors from different states and/or international organisations, such as the IAEA). The expert group explored all the multilateral options, whether the multinational, regional or international.² In this paper, we opted for the use of the term international or internationalisation because, as will be indicated later, it is believed that the term could engulf any group of states and/or organisations of any or all parts of the nuclear fuel cycle. Such an endeavour, if possible, would have to be built gradually in terms of the number of actors involved and elements of the nuclear fuel cycle covered. Internationalisation does not certainly mean universalisation.

Before dealing with the elements of an international nuclear fuel cycle, we shall briefly trace the history of previous multilateral nuclear approaches to the nuclear fuel cycle to present-day ideas. The first feasibility study in this respect was the Regional Nuclear Fuel Cycle Centre (RFCC study of 1975-1977). The study put emphasis on the back-end of the cycle, specifically, reprocessing and plutonium containment. It was followed by the International Nuclear Fuel Cycle Evaluation (INFCE study of 1977-1980), which among other things, touched upon the possibility of regional fuel-cycle facilities and prospects for multilateral co-operation on plutonium storage. However, due, in large part, to diminishing concerns over the likelihood of a “plutonium economy”, the disinclination of some countries to give up national control over reprocessing, and the general lack of political will, both studies did not result in any further pursuit of multilateral approaches.

The following initiative was the IAEA Expert Group on International Plutonium Storage (IPS). The initiative moved away from the discussion of regional fuel-cycle centres to examine instead the prospects for IAEA-supervised management, storage and disposition of spent nuclear fuel. Once again, no consensus was reached as States were unwilling to denounce sovereign control over nuclear technology and fuel³.

The same fate met the studies undertaken by the IAEA Committee on Assurance of Supply (CAS) in the 1980s, which went into abeyance in 1987. CAS was unable to reach a consensus on both the “Principles for international nuclear energy co-operation and nuclear non-proliferation” and on “Emergency and back-up mechanisms”. A key stumbling block was the inability to reach agreement on

¹IAEA Doc. INFCIRC/640, 22 February 2005, hereinafter cited as Multilateral Approaches.

²Ibid., pp. 19-20.

³ See the Group’s report IPS/EG/140 (Rev. 2) (1982).

principles of international co-operation and the rejection of any piecemeal agreement by many parties without nuclear power programmes. In 1987, the UN Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy (UNPICPUNE), which I presided over, also failed to reach agreement on such a set of principles because of the reluctance of the major supplier States to concede any benefits and assurances to the recipient States. As president of the Conference, I tried hard to achieve a consensus on such principles, to no avail.

Although CAS and UNPICPUNE failed, their experience was not all that negative, because focus on “assurances of non-proliferation” and “assurances of supply and services” never waned. It took, however, a long time to regain prominence in present efforts amid recent serious challenges to the nuclear non-proliferation regime, with the nuclear non-proliferation treaty (NPT) at its core. For instance, Iran started a uranium enrichment programme, while Abdul Qadeer Khan, “father of Pakistan’s nuclear weapons programme”, admitted to having organised a clandestine network to supply Iran, Libya and North Korea with uranium enrichment technology.

Moreover, the civilian nuclear industry appears to be poised for world-wide expansion. As noted by the IAEA expert group, rapidly growing global demand for electricity, the uncertainty of supply and price of national gas, soaring prices for oil, concerns about air pollution and the immense challenge of lowering greenhouse gas emissions, are all forcing a fresh look at nuclear power. The group goes on to say that as the technical and organisational foundation of nuclear safety improve there is increasing confidence in the safety of nuclear power plants. In light of existing, new and reawakened interest in many regions of the world, the prospects of new nuclear power stations on a large scale is therefore real. Some speak of a nuclear power renaissance. A greater number of States would consider developing their own nuclear facilities and nuclear know-how, and will seek assurances of supply in materials, services and technologies.⁴

IAEA Director General, Mohamed Al Baradei, in an article for *The Economist*, on 16 October 2003, revived the interest on issues of supply and non-proliferation when he identified three areas of vital importance: the first being how to guarantee the supply of fuel for nuclear generated electricity; the second, how to set up one or more international repositories for spent nuclear fuel; and the third, how to bring about multilateral oversight over sensitive parts of the front end of the nuclear fuel cycle. As a consequence of this new drive, the aforementioned expert group on Multilateral Nuclear Approaches was formed and met several times in 2004 and issued their report in 2005. This expert group, apart from the areas of interest indicated above (enrichment, reprocessing, storage and fuel leasing/fuel take-back), was of the view that the multilateral option for non-proliferation and assurances of supply can follow three patterns:

Type I: Assurances of services not involving ownership of facilities:

- Suppliers provide additional assurances of supply
- International consortia of governments broaden the assurances
- IAEA-related arrangements provide even broader assurances

Type II: Conversion of existing national facilities into multinational facilities

Type III: Construction of new joint facilities

In the course of our study we will come back to these patterns and their feasibility in different types of nuclear fuel cycle activities. But let us now raise a number of

⁴Multilateral approaches, *op. cit.*, p. 4.

questions concerning the internationalisation of the nuclear fuel cycle. These questions relate to the parts of the nuclear cycle to be internationalised, why an assurance of supply mechanism is needed, what is to be assured, what are the modalities of assurance mechanisms, what objective criteria could be required, possible role(s) of the IAEA, possible role(s) of the nuclear industry, and other related matters.⁵

Gradual build-up of a nuclear fuel cycle:

As we have mentioned before, the tendency by the IAEA and the aforementioned group of experts on multilateral approaches is to focus on the so-called sensitive parts of the nuclear fuel cycle, namely uranium enrichment, reprocessing of spent fuel and spent fuel disposal and storage. These are definitely important stages in the nuclear fuel cycle from the point of view of non-proliferation and supply, but other stages could be of great interest to a number of countries such as uranium ore supply, fuel fabrication and even supply of spare parts to nuclear power plants. Other stages could also be included in a multilateral arrangement.

The internationalisation of the nuclear fuel cycle can only proceed in phases. If the success of the first phases is assured, this can be an incentive to involve other stages and more actors, not necessarily from the same region or continent.

The need for a supply mechanism:

The mechanism is needed to address:

- The possible consequences of interruptions of supply of nuclear fuel due to political considerations that might dissuade countries from initiating or expanding nuclear power programmes.
- The vulnerabilities that create incentives for building new national enrichment and reprocessing capabilities.

The assurance of supply mechanism would be envisaged solely as a back up measure to the operation of the commercial market for those States that want to make use of it in order to assure supply in instances of interruption for political reasons. It would neither be a substitute for the existing commercial market in nuclear fuels nor would it deal with disruption of supply due to commercial, technical or other non-political reasons.

The material to be assured:

The existing proposals dealt with assurance of supply in different but complementary ways. Some of the proposals focused on assuring supply of natural uranium and low enriched uranium stocks, and still others focused on assurances of the supply of the nuclear fuel itself.⁶ It was asserted that there was also a complementary need for greater transparency in uranium markets, and that assured access to a broader range of nuclear reactor technology would be important to operators and countries seeking to reduce the risk of interruptions on political grounds.

⁵The following is mainly based on Tariq Rauf's paper (unpublished?) "New Framework for the Utilisation of Nuclear Energy in the 21st Century: Assurances of Supply and Non-Proliferation.

⁶For a summary of these proposals see the annex to *Ibid* as well as the remarks by Richard J.K. Stratford, director, Office of Nuclear Energy, Safety and Security, US Department of State, Vienna, September 19-21, 2006 at IAEA Special Events at the General Conference 2006.

Modalities of assurance's mechanism:

The possible modalities could include a virtual reserve of natural and low enriched uranium based on binding contractual agreements for supply of such material, plus parallel binding commitments/assurances of fuel fabrication services. A virtual reserve does not involve a separate physical storage of natural or low enriched uranium, but relies on its availability from suppliers that have agreed to be part of the fuel assurance mechanism.

While an actual (physical) bank of natural or low enriched uranium could be established, it was found impractical for technical and economic reasons to have an actual bank of nuclear fuel assemblies, given the different types of reactor designs and many variants of nuclear fuel required for them.

Conditions governing eligibility for benefiting from assurance mechanisms:

Non-proliferation undertaking would be considered as a qualifying criterion. It should be mentioned however, that in accordance with the IAEA Statute an assurance mechanism would have to be available to all Member States in a non-discriminatory manner. For any mechanism, whether or not it involves a role for the Agency, certain release criteria would need to be defined and agreed upon, either by the IAEA Board of Governors, or a supply consortium. Another aspect requiring further assessment is how best to assure that the application of the release mechanism is demonstrably non-political, and based on objective criteria.

Possible Role(s) of the IAEA:

Existing proposals envisage different roles for the IAEA. Others can also be considered. The suggested roles range from Agency administration or ownership of natural or low enriched uranium stocks, to administration of virtual stocks and associated parallel fuel fabrication commitments. The IAEA Statute was sufficiently broad to allow the Agency to establish its own stocks of nuclear fuel purchased from, or donated by, Member States for supply to another Member State against charges determined by the IAEA Board; to facilitate the supply of the nuclear fuel from one Member State to another; and also to facilitate, *inter alia*, the provision of enrichment and fuel fabrication services by one Member State to another or to the IAEA. In this respect a number of legal arrangements would be required, especially if the IAEA were to establish an actual bank of nuclear fuel.

Recently the United Nations High Level Panel formed by the former Secretary-General of the UN, Kofi Anan, produced a report in 2004 entitled Threats, Challenges and Change – A More Secure World; Our Shared Responsibility⁷. The Panel urged “that negotiations be engaged without delay and carried forward to an early conclusion on an arrangement, based on the existing provisions of Article III and IX of the IAEA Statute which would enable IAEA to act as a guarantor for the supply of fissile material to civilian nuclear users. Such an arrangement would need to put the Agency in a position to meet, through suppliers it authorised, demands for nuclear fuel supply of low enriched uranium and for the reprocessing of spent fuel at market rates and to provide a guarantee of uninterrupted supply of these services, as long as there was no breach of safeguards or inspection procedures at the facilities in question.”

Leaning towards the IAEA as a guarantor is due to the fact that the membership of the Agency is much broader than that of a commercial consortium. Furthermore, the

⁷UN Doc. A/59/565, 2 Dec. 2004.

IAEA's track record, reputation, credibility and relevant experience justify this performance. However, one must take into consideration that the composition of the Board of Governors where the most advanced countries in nuclear energy have permanent or semi-permanent seats, and being at the same time the major supplier countries and parties to the export control regimes who might not necessarily be in favour of certain potential recipient States. In this case the solution might be to democratise the export control regimes, especially the Nuclear Supply Group (NSG), in opening them up to make them universal whereby suppliers and recipients would consult about the guidelines that would be adopted for the export of nuclear equipment and material. These guidelines at present are usually adopted without consultation with the recipient States. Such consultation may also not suffice as a remedy. A new democratic set up is badly needed.

The role of the nuclear industry:

Consultations would be useful with the nuclear industry particularly in the framework under which the nuclear industry would provide the required goods and services in support of an assurance of supply mechanism without negative effects on the diversity and stability of the existing commercial market in nuclear fuels.

Other related issues:

These pertain to how to structure assurance mechanism in a manner that would not result in a real or perceived division between nuclear fuel/reactor technology haves and have-nots, and does not undermine existing multilateral, treaty-based nuclear non-proliferation norms or State sovereignty/rights. In this respect, it would be important to re-read Article IV of the NPT on co-operation on peaceful uses of nuclear energy, which has encouraged Parties to the Treaty to engage fully in such co-operation.

Having said this, let's go back to the three types of supply assurances that we alluded to earlier, i.e., assurances of services not involving ownership of facilities; conversion of existing national facilities to multinational facilities; and construction of new joint facilities. On the basis of these three types, we shall deal with uranium enrichment, reprocessing of nuclear spent fuel and spent fuel disposal and storage. We shall end up with a combined option, fuel-leasing/fuel take-back.

Uranium enrichment

The IAEA expert group in its report expects that suppliers could provide additional assurances of supply. Also, an international consortium of governments could step in, that is they will guarantee access to enrichment services, the suppliers being simply executive agents. The arrangement would be a kind of "inter-governmental fuel bank".

There are also IAEA related arrangements, a variation of the preceding option, with the IAEA acting as the anchor of the arrangement. The agency would function as a kind of guarantor of supply to States in good standing, as earlier referred to and dealt with. The IAEA might either hold title to the material to be supplied or more likely act as facilitator, with back-up agreements between the IAEA and supplier countries. In effect, the IAEA would be establishing a default mechanism only to be activated in instances when a normal supply contract had broken down for reasons other than commercial reasons.

As to multilateral nuclear arrangements that would take the form of a joint facility, the IAEA expert group took note of the existence of two ready-made precedents, the

Anglo-Dutch-German company Urenco and the French EURODIF. The experience of Urenco, with its commercial-industrial management on the one hand, and the governmental joint committee on the other had shown that the multinational or international concept can be made to work successfully. EURODIF on the other hand has a successful multinational record as well. By enriching uranium only in one country, France, instead of three countries, as the case is with Urenco, it provides enriched uranium to its co-financing international partners, thus restricting all proliferation risks, diversion, clandestine parallel programmes, breakout and the spread of technology. The partners of EURODIF are France, Italy, Spain and Belgium, and Iran in the past. Unlike Urenco, EURODIF is known to have never been a manufacturer of enrichment equipment.

A question to raise: is there any possibility of enlarging the two companies to accommodate more partners in the future and to make it more international than they are today in terms of financial contribution, management and decision making? In admitting Iran as a partner in EURODIF indicates that there was open-mindedness with regard to admitting countries from other continents as partners.

There are national facilities for enriching uranium in other parts of the world such as Japan and Brazil, and here too, we can foresee that such national uranium enrichment facilities could one day be converted to multinational facilities that would provide services, for example, to regional neighbours. By taking such steps, we would be further internationalising essential parts of the nuclear fuel cycle.

Reprocessing of nuclear spent fuel

The IAEA expert group noted that the present capacities to reprocess spent fuel for light water reactors and those under construction, there would be sufficient reprocessing capacity globally for all expected demands in plutonium-recycled fuel during the coming two decades. Therefore, the expert group concludes that the objectives of assurances of supply can be fulfilled to a large extent without new reprocessing facilities involving ownership. Currently all reprocessing plants are essentially state-owned. As to IAEA-broker arrangements, this could mean an IAEA participation in the supervision of an international consortium for reprocessing services.

Converting a national facility to international ownership and management would involve the creation of a new international entity that would operate as a new competitor in the reprocessing market. They have the advantages of bringing together international expertise, but at the same time, they would include a non-proliferation disadvantage related to know-how dissemination and to the return of the separated plutonium. Also, of the existing facilities, all except two Japanese facilities are in nuclear-weapon States, or in non-NPT States. In cases of conversion to international entities, appropriate safeguards would have to be introduced if they have not been applied before.

As to the construction of new joint facilities, the IAEA expert group believes that they will not be needed for a long time, mainly because of the sufficient reprocessing capacity globally.

Spent fuel disposal and storage

At present, there is no international market for spent fuel disposal services, as all undertakings are strictly national. The final disposal of spent fuel is thus a candidate for international approaches. The IAEA is encouraged to continue its effort in that direction.

Storage facilities for spent fuel are in operation and are being built in several countries. There is also no international market for services in this area, except for the readiness of the Russian Federation to receive Russian supplied fuel and with a possible offer to do so for other spent fuel. The storage of spent fuel is also a candidate for multilateral approaches, primarily at the regional level. Here too, the IAEA is encouraged to continue investigation in that field.

Many political and public acceptance issues will arise in connection with the import of nuclear materials to an existing repository. Public acceptance is already of crucial importance for setting up national repositories; it will even be of greater importance for multinational repository projects with nuclear waste and spent fuel coming from several countries.

Combined option: fuel-leasing/fuel take-back

In this arrangement the leasing State providing fuel would undertake to take back the spent fuel it had provided under a lease contract. The IAEA could broker the creation of international spent fuel storage facilities, where spent fuel owned by leasing States and burnt elsewhere, could be sent. The IAEA could thus become an active participant in spent fuel storage facilities.

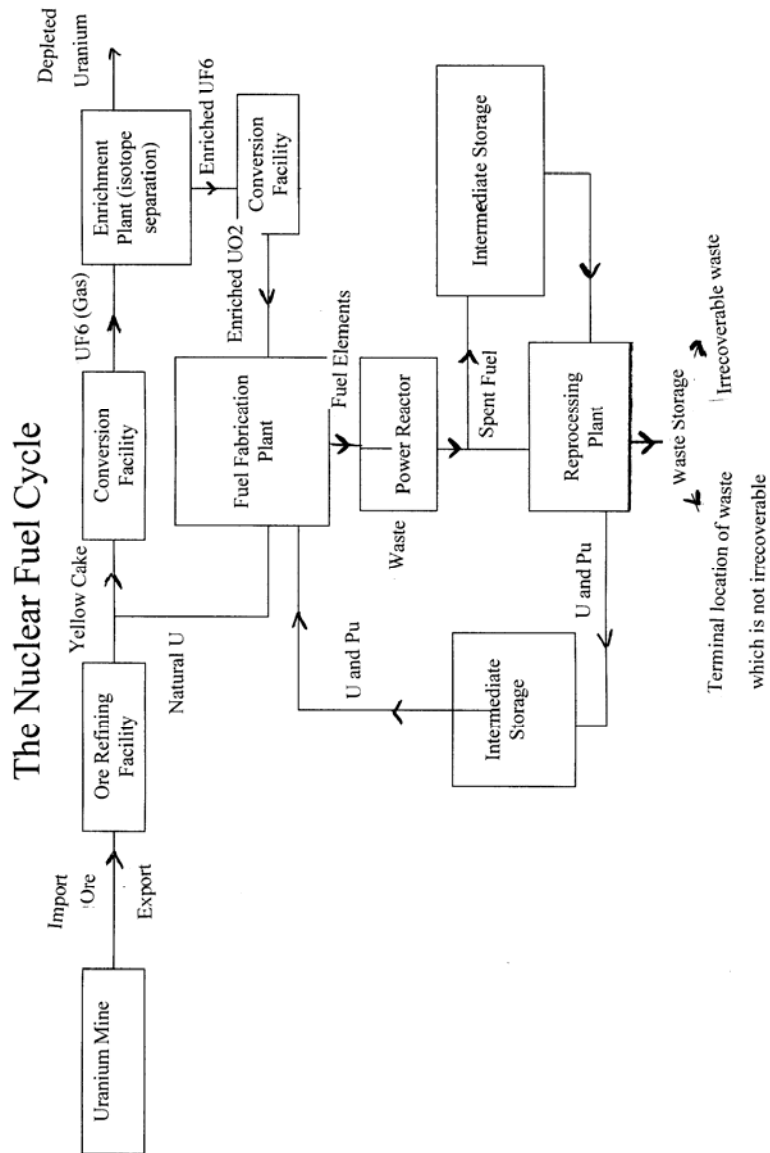
Conclusion

The internationalisation of the nuclear fuel cycle is not a myth. As this paper indicates, internationalisation can take place if political will exists, under conditions of non-proliferation and smooth co-operation. It can only be a gradual process with regard to the different stages of the nuclear fuel cycle, especially with regard to the so-called sensitive stages of the cycle, namely enrichment, reprocessing and the disposal and storage of spent fuel. The IAEA is well placed to encourage and to be involved in such an international endeavour. The only draw back is that most advanced States in the nuclear technology who are at the same time major suppliers of nuclear technology and Parties to the Nuclear Supplier Group would have the upper hand in the IAEA Board of Governors. They can block in certain cases the supply of nuclear material and equipment to potential recipient States. A first step to reduce the influence of the nuclear supplier States and their group is to open up the group for the admission of the recipient States and carry an ongoing dialogue together for the benefit of the two categories of States. This dialogue is missing now and the recipient States are often confronted with decisions made in their absence, and without taking into consideration their essential needs and concerns. This new partnership should be institutionalised in a way that would guarantee new voices in the making of decisions or formulating guidelines for the export of nuclear material and equipment.

As a second step, and apart from converting or constructing new international facilities in the nuclear fuel cycle, we should test such possibilities by pilot simulation projects to find out how such new entities would work in an atmosphere of openness, but at the same time conscious of the proliferation dimensions related to these potential activities.

The most important element in all of that is that we must reach a stage where no supplier country alone can hamper or interrupt a co-operative venture in the field of peaceful uses of nuclear energy for political reasons. Our objective should be to protect the recipient State who has lived up to its international commitments and obligations and to allow it to continue unhindered in its peaceful nuclear activities.

Every individual State participating in an international nuclear fuel cycle should feel that it has a say in one way or another in the operation or the running of such an enterprise. This participatory aspect is just as important as the guarantee of supply.



Draft Statement

Amid recent serious challenges to the nuclear non-proliferation regime with the Nuclear Non-Proliferation Treaty (NPT) at its core; and as the civilian nuclear industry appears to be poised for worldwide expansion due to the rapidly growing demand for electricity, the uncertainty of supply and price of natural gas, soaring prices of oil, concerns about air pollution and the immense challenge of lowering green house gas emissions, the L-14 is of the view that present efforts should be streamlined and accelerated to bring about multilateral oversight over sensitive parts of the nuclear fuel cycle that would also guarantee the supply of nuclear fuel for nuclear generated electricity as well as the setting up of multilateral repositories for spent nuclear fuel.

To that effect, the L-14 invites the IAEA to establish its own virtual reserves of nuclear fuel through binding and reliable contractual agreements with supplier States of long duration as a first step towards an actual multilateral nuclear fuel bank with branches established in carefully selected locations run jointly by suppliers and recipients whether States and/or industry, and under the supervision of the IAEA.

Cognisant of the many political and public acceptance issues in connection with nuclear spent fuel disposal, the L-14 believes that the IAEA is best suited to promote the establishment of a multilateral network of spent fuel repositories that would be run and supervised by the IAEA in a number of safe and secure locations. This network could be built around existing national locations, carefully selected.

Taking into consideration the expected growing role of IAEA in the multilateralisation of the nuclear fuel cycle with regard to its different stages, the L-14 strongly believes that a first step towards greater participation and involvement, the L-14 strongly recommends instituting an open-ended dialogue between the Nuclear Suppliers Group (NSG) and the recipient States before and during their periodic reviewing of their guidelines for their exports, a dialogue that would live up to the expectations of the NPT as an instrument for the prevention of nuclear-weapon proliferation and at the same time as a promoter of peaceful nuclear co-operation.