

The internationalization of the nuclear fuel cycle: an Arab perspective

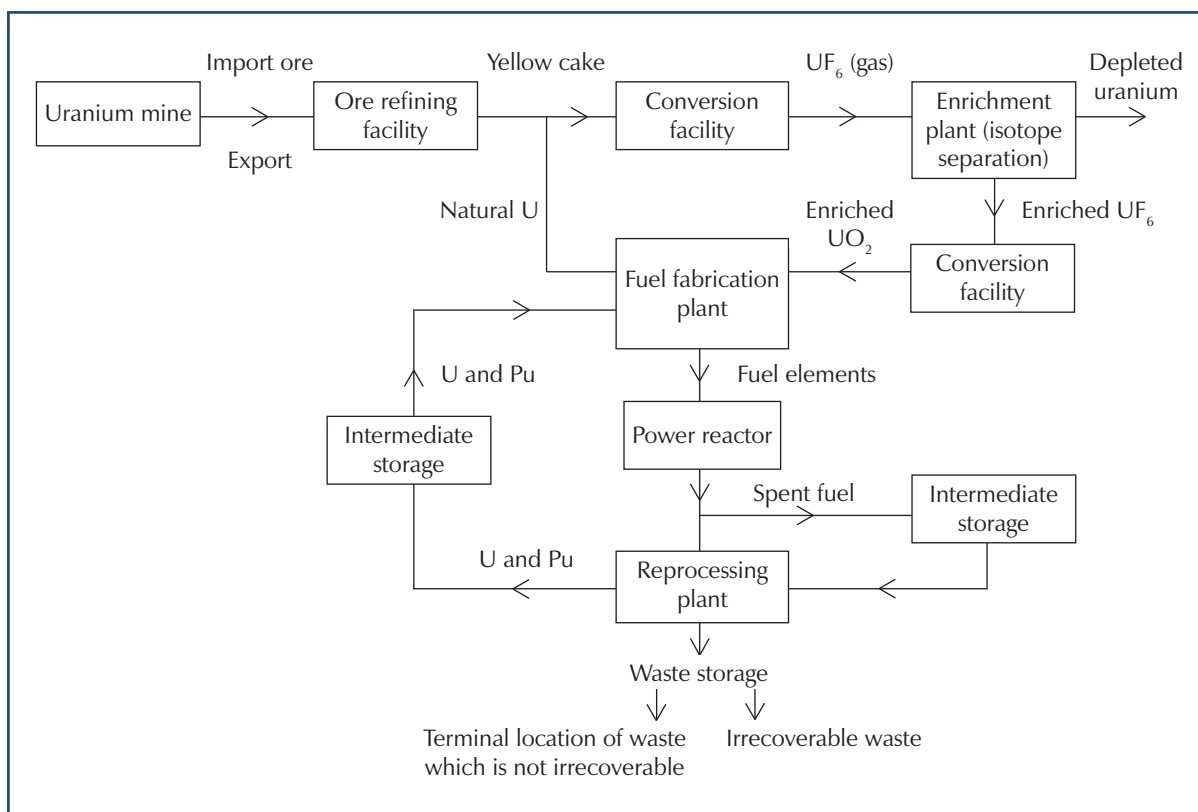
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As a result of economic development needs, particularly the need for energy in the developing world and concerns over the use of fossil fuels and climate change, there is a resurgent interest in civil nuclear energy. In addition, renewed interest in nuclear weapons in some regions highlights global concerns about managing the nuclear fuel cycle in a more robust manner to stem potential proliferation. Increased use of nuclear fuel, new nuclear energy generators and nascent industries in countries not hitherto producers of nuclear energy will change the way in which nuclear fuel cycles will need to be managed. Energy production and safe, secure, proliferation-resistant fuel cycle management will be fundamental to sustainable economic development in the near future. Multilateral approaches to the fuel cycle could be seen as a way to support the nuclear non-proliferation regime, combining greater international or regional oversight with economies of scale to meet increasing energy demands.

The Director General of the International Atomic Energy Agency (IAEA), Dr Mohamed ElBaradei, first revived interest in the idea of an international nuclear fuel cycle in 2003, in an article he wrote for *The Economist*.¹ ElBaradei identified three areas of vital importance: how to guarantee the supply of fuel for nuclear-generated electricity; how to set up one or more international repositories for spent nuclear fuel; and how to bring about multilateral oversight over those parts of the front end of the nuclear fuel cycle that are of proliferation concern. (See Figure 1 for an overview of the nuclear fuel cycle.)

The internationalization of the fuel cycle is not a new idea. The first feasibility study on a regional nuclear fuel cycle was the Regional Nuclear Fuel Cycle Centres Study of 1975–1977, which emphasized the back end of the cycle, specifically, reprocessing and plutonium containment. The second was the International Nuclear Fuel Cycle Evaluation study of 1977–1980, which touched upon the possibility of regional fuel cycle facilities and prospects for multilateral cooperation on plutonium storage.² Diminishing concerns over the likelihood of a "plutonium economy", the disinclination of some countries to give up national control over reprocessing, and a general lack of political will, however, meant that neither study resulted in further pursuit of multilateral approaches.

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Figure 1. The nuclear fuel cycle

Source: Based upon Figure 6, p. 17 of IAEA, 1981, *IAEA Safeguards: An Introduction*, Vienna, document IAEA/SG/INF/3.

In 1982, the IAEA Expert Group on International Plutonium Storage examined the prospects for IAEA-supervised management, storage and disposition of spent nuclear fuel, but again no consensus was reached as states were unwilling to renounce sovereign control over nuclear technology and fuel. The same fate met studies undertaken by the IAEA Committee on Assurances of Supply in the 1980s, which went into abeyance in 1987. The UN Conference for the Promotion of International Cooperation in the Peaceful Uses of Nuclear Energy in 1987 also failed to reach an agreement on a set of principles of international cooperation because of the reluctance of the major supplier states to concede benefits and assurances to user states.

Recent serious challenges to the nuclear non-proliferation regime, and the civilian nuclear industry's apparent preparation for worldwide expansion, have led the questions of assurances of non-proliferation and of supply and services to regain prominence. Perhaps this time the topic may gain more momentum.

The 2005 study undertaken by an IAEA Expert Group on Multilateral Approaches to the Nuclear Fuel Cycle focused on a number of so-called sensitive aspects of the nuclear fuel cycle, i.e. uranium enrichment and spent fuel storage, reprocessing and disposal. As noted by the Expert Group, the "rapidly growing global demand for electricity, the uncertainty of supply and price of natural 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".³ Moreover, confidence in the safety of nuclear power plants is increasing as the technical and organizational basis of nuclear safety improves. The prospect of new nuclear power stations on a large scale is very real. An increasing number of states are considering developing their own nuclear facilities and nuclear know-how and seeking

assurances of supply in materials, services and technologies. There are 29 reactors being constructed in 12 developing and developed countries in addition to 4 units being planned in China alone. Some go so far as to say that there is a nuclear power renaissance.

The Arab world, and particularly the Middle East, is a region looking to nuclear energy to meet its growing energy and desalination needs. Arab interest has also partly been triggered by the major breakthrough in the nuclear field achieved by Iran. However, as the region's security and arms control discussions are stalled, many are concerned about nuclear proliferation risks such as diversion, clandestine parallel programmes, break-out and the spread of nuclear technology throughout the region. Arab states do not want to be left trying to catch up in this drive toward new sources of energy and therefore should carefully consider the potential benefits of proliferation-resistant, multilateral approaches to the fuel cycle.

An Arab nuclear fuel cycle

The Arab Atomic Energy Agency is an Arab scientific organization, based in Tunisia, concerned with the peaceful uses of nuclear energy, its development and technological applications. It is a subsidiary of the Arab League, but it has an independent identity. Its main role is to coordinate among Arab states, and to assist in research activities, human resources development, and technical and scientific information. It also seeks to coordinate scientific and technical activities with concerned regional and international organizations. It aims to establish unified regulations for radiological protection and the safe handling of radioactive materials; to support and protect patents in the peaceful uses of atomic energy; and to encourage and assist Arab scientists in the field of nuclear sciences and technologies to attend relevant conferences.⁴

Until now, the Agency has generally been dormant. However, decisions made at the March 2007 Arab Summit in Riyadh could prove a turning-point. One of the decisions was to undertake joint Arab cooperation activities for the development of peaceful uses of nuclear energy and related technology and to carry out a practical programme including "joint ventures for the development of nuclear technology applications in various developmental fields especially energy, water, medicine, agriculture and industry". The Secretary General of the League of Arab States was requested, with the participation of the Arab Atomic Energy Agency, to form groups of experts and specialists to consider ways and means for such cooperation to take place within an integrated Arab framework.⁵

The Summit also adopted a resolution inviting Arab countries to use or expand the use of nuclear technology for peaceful purposes for all fields of sustainable development, with due consideration to the diversity of their needs and to the strict observation of the provisions of all international treaties, conventions and regulations that they have signed.⁶ Among the executive steps to be taken, the Summit provided support to the Arab Atomic Energy Agency as the organ for joint Arab action in this field and called upon Arab countries that had not yet joined the Agency to do so without delay. The Summit requested the agency to develop an Arab strategy for the mastering of nuclear sciences and technology for peaceful purposes until 2020.⁷ The Riyadh Declaration and Decisions struck a balance between peaceful nuclear ambitions and the reaffirmation of "the importance of clearing the region from all weapons of mass destruction [WMD], away from double-standards and selectiveness and warn against launching a dangerous and devastating nuclear arms race in the area".⁸

It was also decided at the Summit to suspend the work of the Technical Committee on the preparation of a draft treaty on the establishment of a WMD-free and especially nuclear-weapon-free zone in the Middle East (a committee that was established at the initiative of Arab countries in 1994), until the Arab policies that have been followed during past decades are assessed in the light of current international conditions. The Technical Committee has drafted a treaty establishing a WMD-free zone

in the Middle East; however, the Arab League has not made the text available as it has not yet been finally approved by the League, and other relevant parties outside the framework in which the draft was negotiated have not yet been approached.

The suspension of the work of the Technical Committee reflects frustration on the part of the Arab states with the lack of implementation of the Middle East resolution of the 1995 Review and Extension Conference of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which was sponsored by the three depository governments (the Russian Federation, the United Kingdom and the United States) in conjunction with the three decisions made at the conference (including the decision on the indefinite extension of the NPT). The consensus attained with regard to the latter in particular would not have been possible without the Middle East resolution.

Nonetheless, the League decided at the Riyadh Summit to convene an extraordinary session of the Ministerial Council of the League of Arab States, to be preceded by a meeting of senior officials

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from Arab countries, to consider and assess Arab efforts to free the Middle East from nuclear and other weapons of mass destruction (although no date has been set for this meeting).⁹

The clear message of the Riyadh Summit is that the Arab states would prefer to develop peaceful nuclear activities in a

Middle East completely free of WMD and in conformity with all the relevant international instruments of which they are members. There would be no stability or security in the region in the presence of any nuclear-weapon capability.

Could the Riyadh call for joint Arab action in the field of peaceful uses of nuclear energy lead to a regional or Arab nuclear fuel cycle, a cycle that would foster greater coordination and cooperation and at the same time ensure regional control that could be effectively verified internationally? It is clear that Arabs have the expertise, the scientists, uranium ore deposits, research reactors, fuel fabrication skills (on a small scale), accelerators and other nuclear-related laboratories, including hot cell laboratories, for such an initiative. However, in the present international context and given the policies of the Nuclear Suppliers Group (NSG), the Arab states would face difficulties in investing, individually or collectively, in the sensitive activities of uranium enrichment, fuel reprocessing or heavy water production. Although enrichment activities for peaceful purposes are permitted under the NPT, and despite the fact that numerous non-nuclear-weapon states parties to the NPT (including Brazil, Germany, the Netherlands and most recently Japan) are active in enrichment, international opposition to fuel cycle activities in Iran, Iraq and Libya could lead one to believe that an Arab enrichment plant would not be tolerated, regardless of its location.

Potential Arab approaches to the nuclear fuel cycle

The nuclear fuel cycle involves a number of phases and will require many sensitive issues to be addressed for any internationalization or regionalization¹⁰ to be achieved.¹¹

GRADUAL BUILD-UP OF A NUCLEAR FUEL CYCLE

The IAEA and its expert group has tended 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 concerns regarding non-proliferation and supply, but a multilateral arrangement involving other stages of the process, for example uranium ore supply, fuel fabrication and even the supply of spare parts to nuclear power plants, could also be of great interest. As internationalization of the nuclear fuel cycle can only proceed in phases, early successes could be an incentive to address more sensitive stages of the process

and to involve more actors. And early successes would be more likely if the less sensitive stages of the cycle were addressed first. These could build trust and pave the way for discussions on cooperation regarding more sensitive aspects. In the Arab region, building up a regional nuclear fuel cycle would be expected to be gradual due to the diversity of the ongoing nuclear projects in the region.

A SUPPLY ASSURANCE MECHANISM

An assured supply mechanism is needed to address the possible consequences of interruptions in the supply of nuclear fuel. These vulnerabilities create incentives for building national enrichment and reprocessing capabilities. Such a mechanism would be a back-up measure to the operation of the commercial market in order to assure supply in instances of interruption for political reasons. It would neither be a substitute for the existing commercial market nor would it deal with disruption of supply due to commercial, technical or other non-political reasons.

The existing proposals deal with assurance of supply in different but complementary ways. Some of the proposals focus on assuring the supply of natural uranium and low-enriched uranium (LEU) stocks, and others focus on assurances of the supply of the nuclear fuel itself.¹² The IAEA Expert Group is of the view that there is a complementary need for greater transparency in uranium markets, and that assured access to a broader range of nuclear reactor technologies would be important to operators and countries seeking to reduce the risk of interruptions on political grounds.

The possible modalities of assuring supply could include a virtual reserve of natural uranium and LEU based on binding contractual agreements for the supply of such material, and binding commitments to fuel fabrication services. A virtual reserve is not a separate physical store, but relies on suppliers' assurances. The alternative is for an actual, physical bank of natural uranium or LEU to be established. The Expert Group found this impractical for technical and economic reasons, given the different types of reactor designs and variants of nuclear fuel required for them.

If Arab countries were satisfied that a reliable mechanism was in place, then it would relieve them from looking for alternatives—either seeking supplies from outside the region or developing national capacities—and thus minimize proliferation risks. As a number of Arab countries (e.g. Algeria and Egypt) have developed the technology of fuel fabrication, they may be more interested in assuring the supply of enriched uranium rather than the supply of ready-made fuel. A virtual reserve of Arab-fabricated fuel could then be made available for the parties to a regional nuclear fuel cycle.

Conditions governing eligibility for assurance mechanisms

Membership of any supply assurance mechanism, whether regional or international, would require a non-proliferation undertaking—the application of measures to guard against the diversion of material for non-peaceful purposes. Any assurance mechanism would have to be available to all member states of the accepted mechanism in a non-discriminatory manner (in accordance with the IAEA's Statute). For any mechanism, whether or not it involves the IAEA, certain release criteria would need to be defined and agreed upon. Another aspect requiring further assessment is how best to ensure that the application of the release mechanism is demonstrably non-political, and based on objective criteria.

Possible role of the IAEA

In addition to that of the IAEA, there have been numerous other proposals concerning the fuel cycle.¹³ Many of these envisage a role for the IAEA, ranging from IAEA administration or ownership of natural uranium or LEU stocks to its administration of virtual stocks and associated parallel fuel fabrication

commitments. The IAEA's Statute allows it 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 nuclear fuel from one member state to another; and also to facilitate the provision of enrichment and fuel fabrication services by one member state to another or to the IAEA. In this respect, a number of new legal arrangements would be required, especially if the IAEA were to establish an actual bank of nuclear fuel.

However, many of these proposals do not guarantee supply in case of its interception for political reasons. In light of this limitation, I will focus particularly on the IAEA's potential role of a guarantor and coordinator of supply as it is, in my judgement, the best fit with the energy and security needs of the Middle East region.

In 2004, the United Nations High-Level Panel on Threats, Challenges and Change urged:

that negotiations be engaged without delay and carried forward to an early conclusion on an arrangement, based on the existing provisions of articles 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 authorized, demands for nuclear fuel supplies 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 safeguard or inspection procedures at the facilities in question.¹⁴

The IAEA is favoured by many as a guarantor because of its membership, which is much broader than that of a commercial consortium. Furthermore, the IAEA's track record, reputation, credibility and relevant experience justify this role. However, the composition of the Board of Governors must also be considered; it is the most advanced countries in nuclear energy (and the major supplier countries) that have designated seats on the Board,¹⁵ and they might not necessarily be in favour of certain potential recipient states. In this case the solution might be to democratize and universalize the export control regimes, especially the NSG, so that suppliers and users can consult about the guidelines to be adopted for the export of nuclear equipment and material. These guidelines are at present usually adopted without consultation with user states.

The NSG's current practices and supplier countries' domination of the IAEA Board may invite Arab countries to ponder whether the Arab Atomic Energy Agency could play the role of a guarantor of supply of fuel in a regional context. However, as the Agency is mainly involved in encouraging research in the basic sciences, it would have to be restructured to be able to undertake this new role.

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.

Ensuring parity and non-proliferation

A supply assurance mechanism must be structured in a manner that would not result in a real or perceived division between nuclear technology haves and have-nots, and that would not undermine existing multilateral, treaty-based nuclear non-proliferation norms or state rights and sovereignty.

Article IV of the NPT (cooperation on peaceful uses of nuclear energy) is particularly pertinent to this question.

The IAEA Expert Group was of the view that multilateral options for the nuclear fuel cycle could follow three patterns:

Type I: Assurances of services not involving ownership of facilities

- Suppliers provide additional assurances of supply
- International consortium of governments broadens assurances
- IAEA-related arrangements provides even broader assurances

Type II: Conversion of existing national facilities into multinational facilities

Type III: Construction of new facilities

URANIUM ENRICHMENT

The IAEA Expert Group report expects that current suppliers could provide additional assurances of supply. An international consortium of governments could even step in to guarantee access to enrichment services, the suppliers being simply executive agents. The arrangement would be a kind of "intergovernmental fuel bank".

In a variation on this option, the IAEA would function as a kind of guarantor of supply to states in good standing. The IAEA might either hold title to the material to be supplied or, more likely, act as facilitator. In effect, the IAEA would be establishing a mechanism only to be activated in instances when a normal supply contract had broken down for political reasons.

As for the creation of a joint facility, the IAEA Expert Group took note of two precedents, the Anglo–Dutch–German company Urenco and the French EURODIF. Urenco has a governmental joint committee but is a commercial-industrial venture, and shows that the multinational or international concept can work successfully. EURODIF provides a different model as it enriches uranium in only one country, France, and provides enriched uranium to its co-financing international partners, thus restricting proliferation risks. The partners of EURODIF are France, Belgium, Italy and Spain (Iran was once a partner, but withdrew when its programme stumbled). Unlike Urenco, EURODIF is known never to have been a manufacturer of enrichment equipment.

Would it be possible to enlarge the two entities to accommodate more partners in the future? Admitting Iran as a partner in EURODIF indicates open-mindedness with regard to admitting countries from other continents. Could Arab countries benefit from this precedent, especially considering that in the present international context, they may be pressured to bypass enrichment in any regional arrangement (without giving up the right that is permitted under the NPT)?

National facilities for enriching uranium exist in other parts of the world (in countries such as Brazil and Japan). Such national uranium enrichment facilities could one day be converted to multinational facilities that would provide services, for example, to regional neighbours, and perhaps even beyond.

REPROCESSING SPENT NUCLEAR FUEL

The IAEA Expert Group noted that present capacities to reprocess spent fuel for light water reactors and those under construction will provide sufficient reprocessing capacity globally for all expected demand for plutonium-recycled fuel over the next two decades. Currently all reprocessing plants are

essentially state-owned; in a multilateral approach, the IAEA could participate 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 competitor in the reprocessing market. It would have the advantage of bringing together international expertise, but it would include a non-proliferation disadvantage related to the dissemination of know-how and the return of the separated plutonium; possession of plutonium would be of concern, because it can be readily used in the making of a nuclear device. Moreover, all except two of the existing facilities are in either nuclear-weapon states or non-NPT states (the two other facilities are in Japan). For these to be converted to international entities, appropriate safeguards would have to be ensured.

As for the construction of new joint facilities, the IAEA expert group believes that they will not be needed for a long time. In any case, any Arab nuclear fuel cycle is expected to bypass reprocessing (without giving up that right to it), given current international circumstances. The NSG has imposed a firm ban on the export of equipment related to reprocessing. The region would therefore have to rely on existing, foreign national facilities or internationally converted entities. The Arab countries may find Japan (a heavy oil importer) a reliable partner.

SPENT FUEL DISPOSAL AND STORAGE

There is currently no international market for spent fuel storage or disposal services, 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. These activities are therefore candidates for the development of multilateral approaches, primarily at the regional level. The IAEA is encouraged to continue its investigations.

The issue is of great sensitivity. Many domestic 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 be of even greater importance for multinational repository projects with nuclear waste and spent fuel coming from several countries. There was uproar in the Egyptian People's Assembly (parliament) for even contemplating a proposition from Austria to send the potential waste of its aborted single reactor to Egypt. In light of this experience, it is far-fetched to imagine an Arab country agreeing to host a regional repository in the framework of an Arab nuclear fuel cycle.

Conclusion

Internationalization of the nuclear fuel cycle can take place if the political will exists, under conditions of non-proliferation and smooth cooperation. It must be a gradual process with regard to the different stages of the fuel cycle. So far, most of the initiatives and proposals put forward are concerned with the supply mechanism, none has dwelt upon the merits of a multinational or regional nuclear fuel cycle as suggested by the IAEA Director General.

No supplier country alone should be able, for political reasons, to hamper or interrupt a cooperative venture in the peaceful use of nuclear energy.

The IAEA is well placed to encourage a potential regional nuclear fuel cycle in the Arab region. The only drawback is that most states advanced in nuclear technology, who are also members of the Nuclear Suppliers Group, hold designated seats on the IAEA Board of Governors and thus can block the supply of nuclear material and equipment. A first step to reduce the influence of these states would be to open up the NSG and institutionalize dialogue among all interested states. At the moment, user states are often confronted with decisions made in their absence, which do not take their needs and concerns into consideration.

No supplier country alone should be able, for political reasons, to hamper or interrupt a cooperative venture in the peaceful use of nuclear energy. Our objective should be to protect the user state that has lived up to its international arms control commitments and obligations, and to allow it to continue unhindered in its peaceful nuclear activities. Every individual state participating in an international or regional nuclear fuel cycle should feel that it has a say in the operation of such an enterprise. This participatory aspect is just as important as the guarantee of supply.

The formation of regional nuclear fuel cycles would challenge the dominance and current structure of the NSG. After Riyadh, are we going to witness the emergence of an Arab Euratom, which could be a prelude to an Arab Union, following the path that Europe has travelled since 1957? The experiences of the Tlatelolco Treaty in Latin America and the Caribbean as well as the Argentine–Brazilian Agency for Accounting and Control of Nuclear Materials (ABAAC) could also be instructive in strengthening the Arab Atomic Energy Agency for such a pivotal role. The individual Arab countries' experience in the field of peaceful uses of nuclear energy ought to be widely exchanged. The new spirit of Riyadh should encourage this to happen.

Notes

1. Mohamed ElBaradei, "Towards a Safer World", *The Economist*, 16 October 2003.
2. *Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report*, IAEA document INFCIRC/640, 22 February 2005.
3. *Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report*, op. cit., Executive Summary, paragraph 3.
4. For more information, see the Arab Atomic Energy Agency's web site, at <www.aaea.org.tn>.
5. League of Arab States, Development of a Joint Program for the Peaceful Use of Nuclear Energy, resolution S.384–OS19, 29 March 2007, unofficial translation.
6. League of Arab States, Development of Peaceful Use of Nuclear Energy in Member States, resolution S.383–OS19, 29 March 2007.
7. Ibid.
8. League of Arab States, Riyadh Declaration, 29 March 2007, unofficial translation.
9. League of Arab States, Defining a Unified Arab Position on Practical Measures to be Taken to Free the Middle East from Nuclear Weapons, resolution S.382–OS19, 29 March 2007.
10. The IAEA Expert Group was of the view that a distinction should be made between the words "multinational" (implying several actors from different states), "regional" (several actors from neighbouring states) and "international" (actors from different states and international organizations, such as the IAEA). This paper uses the term international or internationalization because it is believed that the term encompasses any group of states or organizations and any or all parts of the nuclear fuel cycle. Internationalization, however, does not mean universalization.
11. The following is mainly based on Tariq Rauf, Head, Verification and Security Policy Coordination, IAEA, (unpublished), "New Framework for the Utilization of Nuclear Energy in the 21st Century: Assurances of Supply and Non-proliferation".
12. For a summary of these proposals see the annex to Tariq Rauf, op. cit., as well as Richard J.K. Stratford, Director, Office of Nuclear Energy, Safety and Security, US Department of State, "Future Directions", remarks made at the IAEA Special Event at the General Conference 2006: New Framework for the Utilization of Nuclear Energy in the 21st Century: Assurances of Supply and Non-Proliferation, Vienna, 19–21 September 2006. See also Germany, *Multilateralizing the Nuclear Fuel Cycle: German Proposal*, discussion paper, IAEA document INFCIRC/704, 4 May 2007, a proposal for an enrichment plant under sole IAEA supervision with regard to export controls.
13. These include the 2006 proposals from Presidents Bush and Putin on cooperation in civil nuclear energy; the Reliable Access to Nuclear Fuel proposal from France, Germany, the Netherlands, Russia, the United Kingdom and the United States; the IAEA Multilateral Nuclear Approaches proposal; the World Nuclear Association's Assuring Security of Supply proposal; Japan's Standby Arrangement proposal; the UK Enrichment Bond proposal; and the Nuclear Threat Initiative's Nuclear Fuel Bank proposal.
14. *A More Secure World: Our Shared Responsibility*, Report of the Secretary-General's High-Level Panel on Threats, Challenges and Change, United Nations, 2004, UN document A/59/565, paragraph 130.
15. The Board of Governors has 35 members, of which 13 are designated by the Board itself (these are the members most advanced in nuclear technology), and 22 others are elected by the General Conference (based on geographic representation). See Statute of the IAEA, Article VI, at <www.iaea.org/About/statute_text.html>.

