EURATOM Supply Agency

ANNUAL REPORT 2008
(pre-published version)

Cover photo: GKN Nuclear Power Plant, near Neckarwestheim, Germany.
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Euratom

Supply Agency

Annual Report 2008

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Executive summary

In 2008 tangible measures were taken in the European Union (EU) to contribute to its security of energy supply and climate change policy. These measures, in particular the European Commission's Second Strategic Energy Review and the positive reactions by the European Parliament, reinforce the role of the Euratom Supply Agency (ESA) as a uniquely placed, specialist entity capable of dealing with the series of challenges lying ahead for the future of nuclear energy.

ESA is indeed a suitable Community body holding a key position: its prerogatives (the right to conclude contracts to supply nuclear materials and the right of option over nuclear materials produced in the EU) add transparency to the nuclear materials market in the EU. ESA focuses on maintaining the long-term efficiency of the EU's nuclear fuel market. This is achieved principally by implementing a diversification policy to the benefit of nuclear power plant operators in the EU. In addition, ESA maintains an industry-wide, professional network via its Advisory Committee and provides the EU view on various projects of the global nuclear organisations (such as the IAEA or the OECD's Nuclear Energy Agency, OECD/NEA). In 2008, these forms of cooperation resulted in, for example, a new indicative price index for long-term contracts for nuclear materials and the co-authoring of the NEA's publication on competition in the nuclear sector.

Furthermore, legislative developments in 2008 paved the way for ESA to go beyond the boundaries within which it has been operating up until now. Specifically, the new Statutes of ESA added 'market monitoring' to ESA's objectives. ESA's 2009 work programme turns its remit into more precise tasks and aims to produce a final proposal on the text of ESA's new rules on contract processing.

Looking at the broader political environment in 2008, EU institutions put forward a number of policy initiatives in various fields related to nuclear energy, in particular with the recent proposal by the Commission for a revised mandate for negotiating a bilateral agreement between the EU and Russia on nuclear cooperation. ESA's 2009 work programme reflects the responsibilities imposed by the above-mentioned initiatives, namely to build stronger international relations and ensure more active participation in international initiatives (i.e. those related to international fuel banks).

This Annual Report also gives an overview of developments on the EU nuclear market in 2008. Altogether, 145 commercial nuclear power reactors were operating in the EU with a total capacity of 132 GWe, supplying approximately one third of all electricity generated. Nuclear energy plays a key role today and could play an even larger one in the EU energy mix in the foreseeable future.

Nuclear materials for EU reactors come from diverse sources. Canada, Australia, Russia and Niger remained the largest suppliers to the EU. A 15.25 % increase was observed during 2008 in the prices paid under existing multiannual contracts. Spot contracts remained of minor importance for supplying EU utilities.

The new category of average prices — the ESA 'Natural Uranium Multiannual Contracts Price' or 'MAC-3' — refers to prices for natural uranium delivered under long-term contracts concluded during the last three years. ESA believes that the new index will increase transparency on the market and widen the awareness about the latest average prices paid by EU utilities.

Every year ESA monitors the difference between the quantities of nuclear materials delivered and the quantities consumed by EU utilities (loaded into reactors). In both 2006 and 2007, the balance was positive: the quantities delivered exceeded the quantities loaded. ESA welcomed this as a sign that stocks at EU utilities were stabilising or even accumulating, thereby contributing to security of supply. In 2008, the quantities loaded surpassed very slightly the quantities delivered.

If electricity producers are nevertheless currently well covered; by 2015, the supply/demand fundamentals could be leaning clearly towards the demand side as countries might be turning to nuclear energy out of energy security and climate change reasons. Secondary supply which covers today more than 30 % of world demand could drop by then to around 15 % and then be replaced on the market by materials and services offered to US utilities as a consequence of the new agreements concluded between Russia and the US. On the longer term, uncertainties on financing and on schedules of projects developments drive some analysts to forecast that the price level of natural uranium needed to support new projects would increase to a level around 60 $/lb.

Chapter 1

ESA activities in 2008

Mandate and values

The Treaty creating the European Atomic Energy Community (Euratom Treaty) established the nuclear common market in the European Union. ESA is a key player on this market, implementing the EU's supply policy for nuclear materials based on the principle of equal access to sources of supply.

In this context, ESA focuses on enhancing the security of supply of users (nuclear power plants) located in the European Union and shares responsibility for the viability of the EU nuclear industry. In particular, it recommends that EU utilities operating nuclear power plants:

- maintain stocks of nuclear materials;
- cover their requirements by entering into long-term contracts; and
- diversify their sources of supply.

ESA's mandate is, therefore, to exercise its powers and, as required by its Statutes, to monitor the market to make sure that the market activities of individual users reflect the values set out above.

Developments in EU nuclear energy policy in 2008

Strengthening the overall security of energy supplies in Europe by reducing dependence on fossil fuels, improving energy efficiency and at the same time fighting climate change remained the focus of attention during 2008. An increasing number of Member States feel that nuclear energy has a key role to play in the shift to a low-carbon economy and in securing economic competitiveness and security of supply. In this context public authorities need to further develop the framework for nuclear safety, disposal of radioactive waste and nuclear non-proliferation.

Second Strategic Energy Review

On 13 November 2008, the European Commission adopted its Second Strategic Energy Review[1], a wide-ranging policy analysis covering all sources of energy. The Commission argued that by maintaining the share of nuclear energy and increasing the share of renewable sources, nearly two thirds of EU electricity could be generated mainly carbon-free by 2020. The Commission also noted that 'EU uranium supplies are diversified within stable regions' and 'the cost of uranium has a limited impact on the electricity price.'

By a convincing majority, with 406 votes in favour, 168 against and 187 abstentions, the European Parliament adopted the Laperrouze Report[2] on the Second Strategic Energy Review. The report stressed the significance of nuclear energy which is being produced in 15 of the 27 Member States and is being used by an even greater number. The European Parliament confirmed the competitiveness of nuclear energy and emphasised its resilience to fuel price fluctuations owing to the small proportion of the generating costs accounted for by nuclear fuel and uranium. With six

1 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 'Second Strategic Energy Review, an EU energy security and solidarity action plan', COM(2008) 781.
2 European Parliament Report on the Second Strategic Energy Review, Rapporteur: Anne Laperrouze, 26.1.2009, A6-0013/2009.

new reactors currently under construction or in project phase in four Member States and, in particular, harnessing the most up-to-date enrichment technology, the report described the European nuclear industry as the world leader in all nuclear cycle technologies.

The Nuclear Safety Directive

In 2008 the Commission adopted a revised proposal for a Nuclear Safety Directive[3]. When preparing this proposal, the Commission consulted the European Nuclear Regulators' Group (ENSREG, formerly called the High-Level Group). It also took into account views expressed by the Western European Nuclear Regulators' Association (WENRA) and the European Nuclear Energy Forum (ENEF). The Council started discussions on the proposed Directive in December 2008. Following approval of the Commission's proposal by the European Parliament on 22 April 2009 by a very large majority (by 511 votes to 116, with 36 abstentions), the Council unanimously adopted the Nuclear Safety Directive on 25 June 2009.

The adoption by the Council of the Nuclear Safety Directive is a major step for achieving a common legal framework and a strong safety culture in Europe. The EU has thus become the first major regional nuclear actor to provide binding legal force to the main international nuclear safety standards, namely the Safety Fundamentals established by the International Atomic Energy Agency (IAEA) and the obligations resulting from the Convention on Nuclear Safety. The Directive also reinforces the independence and resources of the national competent regulatory authorities: it requires Member States in particular to set up and continuously improve national nuclear safety frameworks. The Directive enhances the role and independence of national regulatory authorities, confirming license holders the prime responsibility for nuclear safety.

This Nuclear Safety Directive brings legal certainty by clarifying responsibilities and provides increased guarantees to the public as required by EU citizens. It sets binding principles for enhancing nuclear safety to protect workers and the general public, as well as the environment. The European Parliament and the European Economic and Social Committee have overwhelmingly endorsed this approach.

Communication on nuclear non-proliferation

The Commission also adopted in April 2009 a Communication to the European Parliament and the Council on nuclear non-proliferation[4].

Bilateral nuclear cooperation agreements

Australia, Canada and the USA

Implementation of the nuclear cooperation agreements between the European Atomic Energy Community ('Euratom') and Australia, Canada and the USA continued throughout 2008 to the satisfaction of all involved. Regular consultation meetings were held.

Discussions continued on consolidating the text of the bilateral agreement with Canada, signed in the 1960s. In October 2008, the Commission adopted its proposal for negotiating directives with a view to revising the existing Euratom-Canada agreement. The Council has started discussions on the Commission's proposal.

Kazakhstan, Uzbekistan and Ukraine

An agreement between Euratom and Kazakhstan on cooperation on peaceful use of nuclear energy, signed in December 2006, entered into force on 1 September 2008[5]. A similar agreement between

[3] COM(2008) 790 final, 26.11.2008.
[4] COM(2009) 143 final, 26.3.2009.
[5] OJ L 10, 15.1.2009, p. 15.

Euratom and Ukraine has been in force since September 2006. The agreement with Uzbekistan has been in force since 2004.

Mandate for negotiating a new Euratom-Russia nuclear agreement

Technical discussions on a bilateral agreement between Euratom and the Russian Federation on peaceful uses of nuclear energy were held in 2008. Recently, the Commission submitted to the Council its proposal for a renewed mandate to enter into negotiations with the Russian Federation with a view to establishing the terms of a new bilateral agreement on nuclear cooperation.

Main developments in the EU Member States

In 2008, a total of 145 commercial nuclear power reactors were operating in the EU with a total capacity of 132 GWe, forming the largest geographical concentration of nuclear power plants in the world and equivalent to about one third of all electricity generated in the EU. Today there is growing recognition that nuclear power can produce competitively priced base-load electricity, essentially free of greenhouse gas emissions, and it contributes positively to energy security. Some Member States that had previously decided to phase out existing nuclear power plants or imposed moratoriums on building new nuclear plants (Italy, Sweden and the Netherlands) have made statements which are more favourable towards nuclear power. During 2008, others announced plans to enhance existing capacity and made clear commitments to maintaining nuclear power as a significant component of their energy mix. Some countries (the Czech Republic, Finland, France, Hungary, Romania, the United Kingdom, Poland, Slovakia, Lithuania and Slovenia) are considering building new nuclear reactors.

Belgium has uprated existing nuclear plants to increase its total generating capacity by 5.8 % and a debate is ongoing whether to reconsider its nuclear phase-out policy.

Bulgaria is strongly committed to nuclear energy and the Belene plant is expected to come on stream in the coming years. The date depends largely on how and when the government will secure funding for the plant.

As some old coal-fired power stations are considered that might be phased out, the Czech Republic could face a threat of electricity shortages sometime in the future, despite its current excess base-load capacity. To alleviate this, the State Energy Policy therefore envisages nuclear plant life extensions and power up-rates, and keeps the nuclear option open.

In Finland, the government approved a new climate and energy strategy that gives priority to building electricity generating capacity with low carbon emissions. The EPR at Olkiluoto is under construction and is planned to be completed by 2012. Meanwhile, by the end of 2008, environmental impact assessment reports had been submitted on plans for three new reactor projects.

In France, the first concrete was poured on schedule, in December 2007, for the 1 600 MWe Flamanville-3 EPR, which is expected to take 54 months to build. France announced Penly as the site of a second EPR, with construction starting in 2012.

Hungary has shown strong support for nuclear energy for some time. After a vote in favour of extending the life of existing reactors, successive uprates increased capacity by 12 %. Recently the government called on the plant operator to submit a feasibility study on construction of a second plant at the Paks site.

In Italy, the newly elected government announced an energy plan that includes a return to nuclear energy and introduced legislation to overturn the existing moratorium. Électricité de France and Enel have announced that they plan to build at least four EPRs in Italy.

Poland has announced plans to build two nuclear power plants in addition to a stake in a new power plant to be built in Lithuania.

The Romanian nuclear plant operator and its joint venture partners signed a partnership agreement to build two more units at Cernavoda. Successful completion of this agreement would prepare the ground for commissioning unit 3 in 2015 and unit 4 in 2016, providing additional capacity of 1 440 MWe.

In Slovakia, the Bohunice 2 reactor was shut down on 31 December 2008 as foreseen in the EU Accession Treaty. However, work has resumed for completing the units 3 and 4 of the NPP Mochovce.

In early 2009, the Swedish government decided to overturn the previous phase-out policy and the ban on building new reactors. The existing ten reactors could be replaced by new reactors when they reach the end of their operating lifetime.

The United Kingdom government has expressed its commitment to nuclear energy in order to meet its objectives on climate change and energy security. A target of reducing UK greenhouse gas emissions by 80% of 1990 levels by 2050 was announced by the government in October 2008, along with the observation that nuclear power would be essential for achieving this. Therefore, the government expresses support for the construction of new reactors by private industry. In early 2009, Électricité de France completed its acquisition of British Energy, and intends to build four new nuclear reactors in the United Kingdom, with the first one operational by the end of 2017. German utilities E.On and RWE are also planning to construct 6 000 MWe of nuclear capacity in the UK.

In the immediate neighbourhood of the EU, in Switzerland plans have been submitted to the government to build a new nuclear power plant near the existing Goesgen station. Also, applications will soon be submitted to build a new reactor at each of the existing sites at Beznau and Muhleberg. In Turkey, the government is evaluating the sole bid, from Atomstroyexport (Russia), to build the country's first nuclear power plant with a total capacity of about 4 000 MWe, scheduled to come on stream by 2015.

Economic context of ESA's activities

Expectations concerning future use of nuclear energy continued to attract sustained interest from decision-makers during 2008. There are currently over 40 reactors under construction worldwide, mainly in Asia. The potential drivers that influence national positions on nuclear energy are the growing global energy demand, security of supply concerns, environmental constraints, volatile prices of fossil fuels, the improved relative economic competitiveness of nuclear power and nuclear power's good performance.

The OECD/NEA 'Nuclear Energy Outlook 2008' projects that global nuclear capacity is set to increase by a factor of between 1.5 and 3.8 by 2050. In a high scenario, the nuclear share of global electricity production would rise from 16 % today to 22 % in 2050. The number of countries currently without nuclear power having plans to join the nuclear energy community, are likely to add around 5 % to global installed nuclear capacity by 2020.

Uranium production and demand

Worldwide, the nuclear industry's demand for uranium in 2008 (approximately 67 300 tonnes) remained stable in comparison with previous years. This demand is currently matched by uranium production (mining) combined with secondary supplies (downblending of highly enriched uranium from nuclear warheads, stocks held by governments or utilities and recycled materials) which provide some 44 300 and 23 000 tonnes of uranium respectively.

The total demand from EU-27 utilities in 2008 amounted to 19 146 tonnes of uranium, which is roughly 30 % of world demand. The primary uranium supplier to the EU is Canada which met 25 % of EU demand in 2008, followed by Russia (17 %) and Australia (16 %).

The world market share of secondary supplies (more than 30%) clearly demonstrates that these sources are important for the current balance along the supply chain. Even though the EU is less dependent on secondary sources, it is particularly important to bear in mind that these supplies might become more scarce from 2013 on, when the Russian HEU downblending programme is expected to halt and, on the other hand, that these secondary supplies are replaced by new Russian enriched material which should be put on the market at market conditions, mainly bought by US utilities. On the longer term, the present situation does not weaken the necessity of investing in new projects to gradually replace secondary supplies.

Financial crisis

Uranium spot prices which peaked at around 140 $/lb in mid 2007 (compared to around 20 $/lb in 2004) have been steadily decreasing since then to reach 50 $/lb by December 2008.

The worldwide financial crisis has exerted downward pressure on uranium prices since hedge funds and investors who had been very active since 2004 were forced to sell as a result of cash requirements. Nevertheless, ESA observed a year-on-year increase in the prices paid by EU utilities for uranium. This was due to the long-term contracts binding most EU operators, where the pricing does not necessarily reflect sudden market fluctuations. Accordingly, in response to an ESA questionnaire, most EU utilities replied that the crisis had not forced them to change their supply policies. This suggests that, so far, the turbulence on financial markets has had a neutral effect on nuclear installations in the EU and world wide mining production - unless the mines that faced technical problems. On the longer term, producers responded to the lower prices by adapting their investments in new mining projects to the forecasted situation.

Situation of the new Member States

Significant differences in supply policy patterns still persist between utilities in the EU. This is because most Western European utilities obtain products (natural uranium) and services (conversion, enrichment and fabrication) under separate contracts, whereas most Eastern European utilities normally purchase fabricated fuel assemblies (products and services together) under a bundled contract. There are also State-level agreements between the new Member States and Russia which set the framework for deliveries of nuclear fuel, often spanning the entire lifetime of the Russian-design reactors.

Supply contracts signed before new Member States joined the EU have been ‘grandfathered’ under Article 105 of the Euratom Treaty. In practice, grandfathered contracts sometimes keep certain EU utilities entirely dependent on a single external supplier.

Legal assessment of enrichment in the EU and the USA

The question of whether uranium enrichment should be understood as manufacturing a product or merely providing a service generated lengthy discussions both in the EU and in the USA. First instance and appeal courts in the USA held that enrichment counts as a service, contrary to the opinion of the US Department of Commerce (DoC). In its judgment in cases C-123/04 and C-124/04, the European Court of Justice (ECJ) also classified enrichment essentially as a service.

However, the Supreme Court in the USA recently ruled that, without issuing any judgment on whether imported LEU is a product or the result of a transformation service, due to the acknowledged ambiguity of the texts, the US Department of Commerce was well founded to interpret the US regulation. Consequently, the DoC was allowed to maintain the duty on enriched uranium imported into the USA.

ESA operations

ESA's general mandate under the Euratom Treaty[6] allows it to balance the emphasis of its operations against the actual or potential outcomes on the market and policy developments. In parallel, ESA pursues a central regulatory practice.

Core activities: conclusion and acknowledgement of contracts

The Euratom Treaty delegated to ESA the task of ensuring a regular and equitable supply of nuclear fuels to EU users. To perform this task, ESA applies the principle of equal access to sources of supply. The Euratom Treaty requires ESA to be a party to supply contracts of EU nuclear power plants and research reactors. In the process, ESA implements the EU supply policy for nuclear materials by exercising its exclusive right to conclude contracts for trade in such materials (imports into or exports from the EU, plus intra-Community transfers). ESA also has a right of option to purchase, with a right of first refusal over nuclear materials produced in the Member States.

In addition, ESA monitors transactions involving services in the nuclear fuel cycle. Operators are required to submit notifications giving details of their commitments. ESA verifies whether these transactions are indeed limited to provision of services (enrichment, conversion and fuel fabrication), i.e. do not involve supply of nuclear materials. If so, ESA acknowledges the transaction; otherwise, it arranges for co-signature of the corresponding contract.

In 2008, ESA concluded 112 new supply contracts and 14 amendments to existing supply contracts. It also dealt with 193 notifications of new service contracts and 21 revisions of notifications. See Chapter 3 of this Report for a detailed analysis of ESA's contractual activities.

New Statutes

On 12 February 2008, the Council adopted ESA's new Statutes. The text was extensively updated in comparison with the previous version and the remit of ESA was expanded. Support to extend ESA's remit also came from the European Parliament in its Maldeikis Report[7], i.e. by suggesting the creation of a 'nuclear observatory'. In addition, the profile of ESA was enhanced as the new Statutes of ESA added 'market monitoring' to ESA's objectives.

Rules on contract processing and market monitoring

ESA carried out industry-wide consultations with a view to revising the rules for implementing its exclusive right to conclude supply contracts and its market monitoring activities.

The Advisory Committee of ESA established a Working Group in order to cooperate closely with ESA in its preparatory work. After several meetings with ESA representatives, the Working Group presented its opinion at the meeting of the Advisory Committee on 5 November 2008.

[6] Article 2(d) of the Euratom Treaty: to 'ensure that all users in the Community receive a regular and equitable supply of ores and nuclear fuels'.

[7] European Parliament, Report on Assessing Euratom — 50 years of European nuclear energy policy (2006/2230 (INI)), 4.4.2007.

Activities of the Advisory Committee

The Advisory Committee acts as a link between ESA and both producers and users in the nuclear industry and gives assistance with preparing reports and analyses. The Advisory Committee held three meetings in 2008 — on 11 March, on 17 June and on 5 November. The main items on its agenda were:

- discussion of ESA's 2007 Enrichment Survey;
- review of ESA's 2007 Annual Report, audited balance sheets and accounts;
- opinion on the 2008 Work Programme and budget situation of ESA;
- monitoring the progress made by its Working Group on the new rules relating to contract processing and market monitoring;
- election of a new chairperson and vice-chairpersons after the new Statutes of ESA entered into force;
- establishment of two new Working Groups, one on prices, the other on security of supply scenarios.

The first Working Group has a mandate to define an agreed method for calculating a long-term uranium price index to be regularly published by ESA.

The task of the second Working Group is to conduct analyses and surveys for ESA on the security of energy supply situation in the EU, from the point of view of nuclear fuel. It will examine the traditional segments of the nuclear fuel market: natural uranium, conversion, enrichment and fabrication services. The Advisory Committee plans to draw up nuclear energy development scenarios within each of these segments.

Joint market regulation

Since the nuclear fuel cycle brings together a combination of interconnected markets, competition-related questions inevitably arise. In 2008, ESA advised the Commission on two major cases: one concerned a proposed takeover on the uranium production market, the other alleged abuse of a dominant position.

International cooperation

ESA is actively monitoring the work on multilateral approaches, in particular on establishing international fuel banks and uranium enrichment centres[8].

ESA continued its cooperation with the two major global international organisations in the nuclear field: the IAEA and OECD/NEA. It was involved in preparing several OECD/NEA publications, for example on market competition, security of supply and uranium mining.

Market observation

The reliability of market analyses depends largely on the accuracy of the data collected. This is ensured by requiring European users and producers to provide information on their estimated future

[8] The Council in its conclusions on 8 December 2008 took the decision in principle to support the establishment of a nuclear fuel bank under the control of the IAEA, to which the European Union could contribute up to 25 million EUR, once the conditions and modalities for the bank have been defined and approved by the Board of Governors of the IAEA.

requirements, contracted purchases and the quantities of nuclear materials actually delivered (ex-ante, current and ex-post market data) and by screening open source information.

Since the enrichment market is particularly sensitive from a European perspective, ESA launched its first enrichment survey in 2007 and issued a Communication on the subject in 2008. With the support of the Advisory Committee, this survey will be repeated regularly.

Besides its Annual Report, ESA has also launched a new publication based on its market observation activity: the Quarterly Uranium Market Report. In 2008, circulation of this report was limited to within the Commission.

In addition to the historical prices of nuclear materials mentioned in Annex 5 to this Annual Report, ESA announced publication of a new Natural Uranium Multiannual Contracts Price Index (MAC-3) prepared in coordination with the Advisory Committee. This new index will reflect sudden price fluctuations better and, hence, track current market trends more closely.

Management and internal control systems

Implementation of the budget

Following the European Parliament vote on the EU budget, ESA did not receive its yearly subsidy from the Commission, an essential part of its budget, for the 2008 financial year. As a result, the Commission's budget covered ESA's administrative expenditure. The same approach has been taken for 2009.

Irrespective of the source of ESA's funds, its expenditure will remain under strict control: the accountant reports directly to the Director-General and financial commitments will require two signatures both at the checking and payment levels. The 2008 balance-sheet is available on ESA's website (http://ec.europa.eu/euratom/index_en.html).

Quality assurance

In mid-2008, ESA introduced a programme to tighten up its internal control and quality management systems. As a result, a first quality management project has been initiated and the first draft of the 'Euratom Supply Agency Quality Manual' has been prepared.

Quality management tasks at ESA include:

- monitoring implementation of rules, regulations and procedures established within ESA;
- advising management and sectors on the validity of procedures and on their compliance with the rules and regulations in force; and
- controlling the effectiveness and efficiency of procedures within ESA.

Evaluation by the Court of Auditors

The Court of Auditors audits ESA's operations on an annual basis. No irregularity was found in 2008 and ESA has taken due account of the opinions expressed by the Court.

Chapter 2

World market for nuclear fuels

This chapter presents a short overview of the main recent developments affecting the global supply and demand balance and security of supply at different stages of the fuel cycle. An established and effective market for the different front-end services exists. Most of the activities are performed under long-term contracts. Spot-market activities play a far more limited role.

Supply of nuclear fuels

Natural uranium production

According to the IAEA, uranium is mined in 18 countries, seven of which account for 90 % of world capacity (Australia, Canada, Kazakhstan, Namibia, Niger, the Russian Federation and Uzbekistan). More than a third of the demand for uranium is still covered by secondary supplies (stored uranium, ex-military HEU or recycled materials). Identified uranium resources in the ground (around 10 million tU) will suffice to meet the present demand for about 100 years. As a strong uranium market is sustained, undiscovered conventional resources (another 10.5 million tU) are likely to be identified, which could extend uranium supplies to more than 100 years for a stock of nuclear power plants numbering up to three times the total today.

Table 1: Major identified natural uranium resources*

Country	Uranium resources (as % of world total resources)
Australia	22.5
Kazakhstan	13.7
Canada	8.4
Russia	8.4
South Africa	8.2
Niger	5.8
Namibia	5.1
Ukraine	3.8
Uzbekistan	2.1

** ESA estimates.*

During 2008, uranium production was lower than expected from many of the major producers but, despite some delayed or postponed uranium mining projects, could still be some 3 000 tonnes of natural uranium higher than in the previous year. According to the latest data issued by the industry, world natural uranium production totalled 44 248 tU, an increase of more than 7 % compared with 2007 (from 41 264 tU).

Despite a 4.9 % decrease in its overall production to 9 000 tU, Canada remained the world's largest uranium producer, accounting for more than 20 % of world production in 2008. The biggest increase was in Kazakhstan, which produced 8 512 tU compared with 6 654 tU in 2007, an increase of almost 30 %, making it the second largest uranium producer. Production in Australia decreased slightly to

8 430 tU in 2008, consolidating its position as the third largest uranium producer. The second largest increase was in Africa, up to 7 926 tU from 6 577 tU, an increase of 20 %.

Table 2: Natural uranium production

	Production in 2008 (tonnes)	Share in 2008 (%)	Production in 2007 (tonnes)	Change over 2007 (%)
Canada	**9 000**	**20.3**	**9 462**	**-4.9**
Kazakhstan	**8 512**	**19.2**	**6 654**	**27.9**
Australia	**8 430**	**19.1**	**8 577**	**-1.7**
Namibia + South Africa	**4 897**	**11.1**	**3 423**	**43.1**
Russia	**3 822**	**8.6**	**3 385**	**12.9**
Niger	**3 029**	**6.8**	**3 154**	**-4.0**
Uzbekistan	**2 338**	**5.3**	**2 308**	**1.3**
USA	**1 509**	**3.4**	**1 748**	**-13.7**
Ukraine	**800**	**1.8**	**846**	**-5.4**
China	**749**	**1.7**	**636**	**17.8**
Czech Republic	**275**	**0.6**	**262**	**5.0**
Others (estimated)	**887**	**2.0**	**794**	**11.7**
Total	**44 248**	**100.0**	**41 264**	**7.2**

Source: nuclear industry.

Canada, Russia, Australia and Niger remain the largest suppliers of nuclear materials to the EU, supplying more than two thirds of the EU's total needs. No major changes were observed in the pattern of nuclear fuel supplies to EU users during 2008. European uranium mining supplied under 3 % of the EU's needs, with a total of 515 tU mined in the Czech Republic and Romania.

Exploration and production plans

Renewed investment in uranium exploration can be expected to result in the discovery of new resources of economic interest at a reasonable cost. The analysis of exploration expenditure data in the OECD/NEA Red Book Retrospective shows that the historical cost of discovery was less than US$ 2/kgU. Higher prices for uranium could have a positive impact on investment in uranium exploration and mine development. The number of junior companies actively involved in uranium exploration has increased from a handful in 2003 to more than 400 in 2008. Several plans for new uranium production capacity around the world and for increasing output from existing facilities are still being developed. Additional discoveries can be expected, if favourable market conditions stimulate exploration. Promising early results already suggest additional discoveries in several countries, such as Kazakhstan, Canada, Namibia, Niger and Australia.

However, the financial crisis in the second half of 2008 steadily occupied the financial markets worldwide as it continued to affect markets and spread across the world economy. The scarcity of financial resources and strategic decisions have led to decisions to reduce, postpone or even stop production. Moreover, because of the squeeze on sources of finance, some companies (or countries) might even abandon new mining projects: Areva and its joint venture partners announced that they had decided to postpone the Midwest project in Northern Saskatchewan (Canada) for economic reasons, specifically due to the declining uranium market. The Australian uranium mining company BHP Billiton has withdrawn its takeover bid for Rio Tinto.

Global expenditure on exploration and mine development is not expected to decline, compared with previous years, remaining at over €476 million. Most producing countries reported significant increases in capital expenditure, perhaps best exemplified by Australia, where domestic exploration and mine development investment totalled a little over € 2 million in 2002, then increased to € 42 million in 2006 and reached an estimated € 129 million in 2008.

Uranium companies are becoming more global and vertically integrated, which, in the current circumstances of high volatility, is the best strategy to lessen the risks and achieve overall security in the nuclear industry. For example, Kazatomprom is becoming more and more vertically integrated and is seen as one of the most ambitious uranium producers in the world.

At the same time, the nuclear market is and remains largely shaped by political conditions. During 2008, the market was affected by different kinds of decisions. Several political developments contributed to liberalisation of the market: the new government in the State of Western Australia announced that it would open up the uranium mining market and the Nuclear Suppliers Group agreed by consensus to allow trade in nuclear materials, fuel and technology with India.

Conversion

Conversion is still an important link in the nuclear fuel chain. Last year, ample supplies of inventories put downward price pressure on the spot market and softened the impact of the disruption of supply from Port Hope (Canada). However long-term market indicators for conversion do not reflect decreasing supply and future growing needs.

In 2008, total world conversion capacity was estimated at 72 000 tU as UF_6, unchanged compared with 2007. Conversion capacity available in Europe makes up 27 % of the total world capacity, as the previously reported geographical imbalance in capacity between Europe and North America persists. Additional conversion capacity will be needed in Europe from 2009 onwards in the light of the new enrichment capacity being installed. For the upcoming years, these needs are expected to be supplied by North American and Russian capacities.

Table 3: Major uranium conversion companies

Company	Nominal capacity in 2008 (tU as UF_6)	Share of global capacity (%)
Atomenergoprom (RUS)	25 000	34.7
Cameco (CAN+UK)	18 000	25.0
Areva (FR)	14 000	19.4
ConverDyn (USA)	15 000	20.8
World total	72 000	100.0

Source: estimates based on data published by institutions and the industry.

Large conversion plants are operating in Canada, France, Russia, the United Kingdom and the USA. Kazatomprom has now been confirmed as a new entrant to the conversion segment after it signed an agreement with Cameco to build a new plant in Kazakhstan using Cameco technology with a potential UF_6 conversion facility with a capacity of 12 000 tonnes.

During 2008, Areva announced plans to invest another €610 million in modernising and increasing its conversion capacity with the aid of the Comurhex II plant which is scheduled to reach a capacity of 15 000 tonnes of UF_6 per year in 2013, with the possibility of expanding it further to 21 000 tonnes. At the end of 2008 Cameco Corporation announced problems with UF_6 production at the company's Port Hope plant which suspended production until the second half of 2009.

Enrichment

According to the IAEA, 13 commercial-scale uranium enrichment facilities are currently in operation worldwide, located in China, France, Germany, Japan, the Netherlands, Pakistan, the Russian Federation, the United Kingdom and the USA. Proliferation concerns could limit expansion of enrichment capability if international controls are imposed.

Current enrichment capacity (see Table 4) is considered stable, with a slight increase on the part of Urenco. Some future projects were further developed successfully in 2008: Louisiana Energy Services, owned by Urenco, announced plans to almost double its planned annual capacity from 3 000 tSWU[9] to 5 900 tSWU. In December 2008 Areva in turn established a new enrichment company named Areva Enrichment Services, which is both owner and operator of the Eagle Rock Enrichment Facility in the USA. Cameco signed an agreement with GE-Hitachi Nuclear Energy to acquire a 24 % stake in Global Laser Enrichment which applies laser enrichment technology[10]. This laser enrichment plant would be located in North Carolina and would start in 2012 with an annual capacity of between 3 500 and 6 000 tSWU. Another plant which must be mentioned is the National Enrichment Facility in the USA which remains on track to start production in 2009, thereby providing a domestic source of competition against USEC.

Table 4: Major enrichment companies with approximate 2008 capacity

Company	Capacity (thousand SWU)	Share of global capacity (%)
Atomenergoprom	22 500	36.9
USEC	15 500	25.4
AREVA	10 800	17.7
Urenco	10 200	16.7
JNFL	1 000	1.6
CNNC	1 000	1.6
World total	**61 000**	**100.0**

Source: estimates based on data published by institutions and the industry.

Furthermore, several important milestones have been reached on the Georges Besse II project, the new enrichment plant currently under construction in France since September 2006: AREVA handed the Centrifuge Assembly Building to ETC in February 2008 and launched also the construction works of the second enrichment unit. The full capacity of 7.5 million SWU is planned to be reached in 2016.

The current enrichment capacity is estimated to be sufficient to cover demand for the next decade. Forecasts suggest significant changes in world capacity, which is predicted to grow to some 69 000 tSWU by 2015 when diffusion technology will be phased out.

In 2008, the European Union announced that it will contribute up to €25 million (US$ 32 million) to the establishment of an international nuclear fuel bank controlled by the IAEA, once the conditions and modalities for the bank have been defined and approved by the Board of Governors of the IAEA. The purpose of building such a stockpile of low-enriched uranium would be to support nations that make the sovereign choice not to build indigenous nuclear fuel cycle capability by putting in place a mechanism that guarantees a sure international supply of nuclear fuel on a non-discriminatory, non-

[9] SWU stands for 'Separative Work Unit', which is the standard indicator of enrichment services. It measures the effort made in order to separate the fissile, and hence valuable, U-235 isotopes from the non-fissile U-238 isotopes, both of which are present in natural uranium.

[10] Separation of the uranium isotopes by laser excitation is an enrichment process based on photo-dissociation of UF_6 into solid UF_5, using tuned laser radiation and breaking the molecular bond holding the sixth fluorine atom. This then makes it possible to separate the UF_5 from the unaffected UF_6 molecules containing U-238 atoms, hence achieving separation of isotopes. The main molecular laser separation process is global laser enrichment (formerly SILEX), using uranium in the form of UF_6.

political basis to countries meeting their non-proliferation obligations. However the stockpile cannot be regarded as an alternative to the regular supplies but would be used as a last resort only.

Legal developments on enrichment

In 2008 and at the beginning of 2009, important decisions were taken by the US legislative and justice authorities which could potentially influence LEU trade patterns globally, as they impose limitations on entry of LEU into the US market.

The first decision was the amendment to the Russian Suspension Agreement signed by the two parties in February 2008. This agreement allows Russian LEU to be sold directly on the commercial uranium market in the USA. The amendment set the baseline quota for LEU at 20 % with an end date of 2020.

In addition, the 'Domenici Amendment to the Suspension Agreement' was signed by the US President in September 2008. This introduced a flexibility arrangement to increase the annual LEU quota to 25 %, if additional HEU is downblended. However, so far the Russian side has not explicitly expressed any intention to use this new flexibility arrangement and declared this possibility of no interest for their commercial relationship with US utilities. The amendment is regarded as one of the independent legal bases for the US Department of Commerce to limit LEU imports from Russia.

The second legal basis is the January 2009 judgment by the US Supreme Court ruling that, without issuing any judgment on whether imported LEU is a product or the result of a transformation service, due to the acknowledged ambiguity of the texts, the US Department of Commerce was well founded to interpret the US regulation and, as a consequence enrichment contracts remain subject to US anti-dumping legislation.

Fabrication

Information supplied to the IAEA identified 40 commercial-scale fuel fabrication facilities in operation in Argentina, Belgium, Brazil, Canada, China, France, Germany, India, Japan, Kazakhstan, Korea, Pakistan, Romania, the Russian Federation, Spain, Sweden, the United Kingdom and the USA.

Fuel assemblies from different suppliers are not easily interchangeable, although many utilities do periodically change suppliers to maintain competition. The main fuel manufacturers are also the main suppliers of nuclear power plants or closely connected to them. The largest fuel manufacturing capacities can be found in France, Germany, the Russian Federation and the USA, but fuel is also manufactured in at least seven other countries, often under licence from one of the main suppliers.

European fabrication facilities continued to cover the utilities' needs adequately. The bulk of the needs for fabricated fuel are covered by EU producers. On the market for VVER fuel, the Russian supplier TVEL maintained its dominant position, holding a market share of nearly 100 %. Entering the fabrication market is especially challenging because the fuel assembly itself is a highly engineered, technologically specific product with significant intellectual property behind it. In addition, the fuel assembly is a component affecting the overall safety of the plant and requires extensive licence approval.

Reprocessing

Reprocessing continues to be regarded, worldwide, as an economically attractive solution. It not only reduces natural uranium requirements but also can considerably decrease the quantities of radioactive waste which have to be safely stored. Closing the fuel cycle can also lead to a decrease in the radiotoxicity of the waste. For the time being, much reprocessed material is kept in storage.

Worldwide, around 15 % of all spent fuel is reprocessed to recover and recycle uranium and plutonium. Today there are reprocessing plants in France, Japan, the Russian Federation and the

United Kingdom, but only about 50 % of their capacity is used due to uncertainties about the future use of the reprocessed material. Uranium and plutonium (as MOX) are currently re-used mainly in LWRs, but in order to make maximum use of uranium resources in a closed fuel cycle, use of fast breeder reactors or other advanced systems is being actively considered in a number of countries.

Secondary sources of supply

Currently some 23 000 tU of secondary supplies are available worldwide per year, including from draw down of inventories, but this could slowly decline to some 10 000 tU by 2030. As announced in the previous years, the Russian LEU downblending program remains to be due to finish in 2013. Recent decisions by the USA (the Russian Suspension Agreement Amendment and the Domenici Agreement) will also influence the market conditions.

Security of supply

Security of supply is a cornerstone of EU energy policy and is receiving increasing attention from the public and policy-makers, following the recent gas crises. Geopolitically, uranium resources and fuel fabrication are very different from fossil fuels. One big advantage of nuclear power is the high energy density of the fuel, combined with the diverse and stable geopolitical distribution of uranium resources and fuel fabrication facilities and the ease with which strategic stockpiles of fuel can be maintained.

In the medium term, worldwide supply is still sufficient to meet the requirements at each stage of the nuclear fuel cycle. Present resources could, however, be multiplied by a factor of at least 50 with the introduction of fast neutron 'breeder' reactors with a closed fuel cycle (Generation IV).

Table 5: Lifetime of uranium resources (years of supply at 2006 requirements)

	Identified resources	Total conventional resources	Total conventional resources plus phosphates
Present reactor technology	100	300	700
Introduction of fast neutron systems	> 3 000	> 9 000	> 21 000

Source: Nuclear Energy Outlook 2008 (OECD Nuclear Energy Agency).

The natural uranium market still shows a wide gap between world consumption and production, which is bridged by secondary sources of supply. Prolonged reliance on secondary sources and on drawing down inventories clearly has its limits. In addition, even though there were no real shortages in 2008, previous incidents in the mining and conversion industry have demonstrated the precarious balance along the supply chain. Consequently, two critical issues have to be dealt with in the near future.

First, many market participants still consider conversion the weakest link in the fuel cycle. Currently, world conversion capacity still exceeds net primary uranium production, but many EU utilities have to convert their raw materials into UF_6 in North America. The situation with enrichment is considerably better from an EU standpoint, as there are two enrichers operating four plants in the Community with capacity far exceeding the requirements.

Second, the availability of secondary supplies has deterred uranium producers from developing new mines, as they have kept prices low for many years. Secondary supplies remain a very important source and, especially in the USA, there is further potential, as strategic government inventories could be used in the event of serious shortages. However, ultimately demand will have to be covered by primary supply. This seems even more crucial at a time when many countries (especially

China, Russia and India) are planning to significantly increase their nuclear power generation capacity.

Following discussions during 2008, the Advisory Committee of ESA set up two Working Groups. One of them is concentrating on security of supply. It will hold meetings and conduct a wide-ranging analysis of all aspects of security of supply in the nuclear fuel cycle. Its aim is to finalise a report on security of supply making recommendations to different stakeholders.

ESA recommendations and diversification policy

ESA notes that the quantities delivered in 2008 are lower than the quantities loaded. It therefore recommends that EU utilities maintain an adequate level of strategic inventories, tailored to their individual circumstances. Some utilities might prefer to hold U_3O_8 or UF_6, others fabricated fuel assemblies or a combination of both. While fabricated fuel is the most expensive form, it is also the least exposed to disruption. Furthermore, ESA recommends that utilities cover most of their needs under long-term contracts with diversified primary production sources at equitable prices.

The volume of enrichment services delivered to EU utilities stabilised during 2008 and the demand for SWUs for the next 10 to 20 years will be stable. Implementation of the diversification policy remains vital for the long-term security of supply of the EU nuclear industry.

Based on its contractual role and its close relations with the industry, ESA continuously monitors the market, especially supplies of natural and enriched uranium to the EU, in order to ensure that EU utilities have diversified sources of supply and do not become over-dependent on any single source. Maintaining the viability of the EU industry at every stage of the fuel cycle remains a key goal for long-term security of supply.

Chapter 3

Supply and demand for nuclear fuels in the EU[11]

Fuel loaded into reactors

During 2008, about 2 749 tU of fresh fuel were loaded into commercial reactors in EU-27 containing the equivalent of 19 146 tU as natural uranium and 13 061 tSWU. In comparison with 2007, the quantity of fresh fuel loaded decreased by 60 tonnes or raw material equivalent to 628 tonnes of natural uranium. However, the quantities of fuel in 2008 entailed slightly more separative work, equal to an increase of 10 tSWU. The overwhelming majority of utilities put their tails assays in the range of 0.20 % to 0.30 %.The new Member States added about 10 % to the requirements of the EU-15 countries.

Reactor needs/net requirements for the next 20 years

Estimates of future EU reactor needs and net requirements for uranium and separative work, based on data supplied by all EU utilities, are shown in Figure 1 (see Annex 2 for the corresponding figures). Net requirements are calculated on the basis of reactor needs minus the contributions from currently planned uranium/plutonium recycling and taking account of inventory management communicated to ESA by utilities.

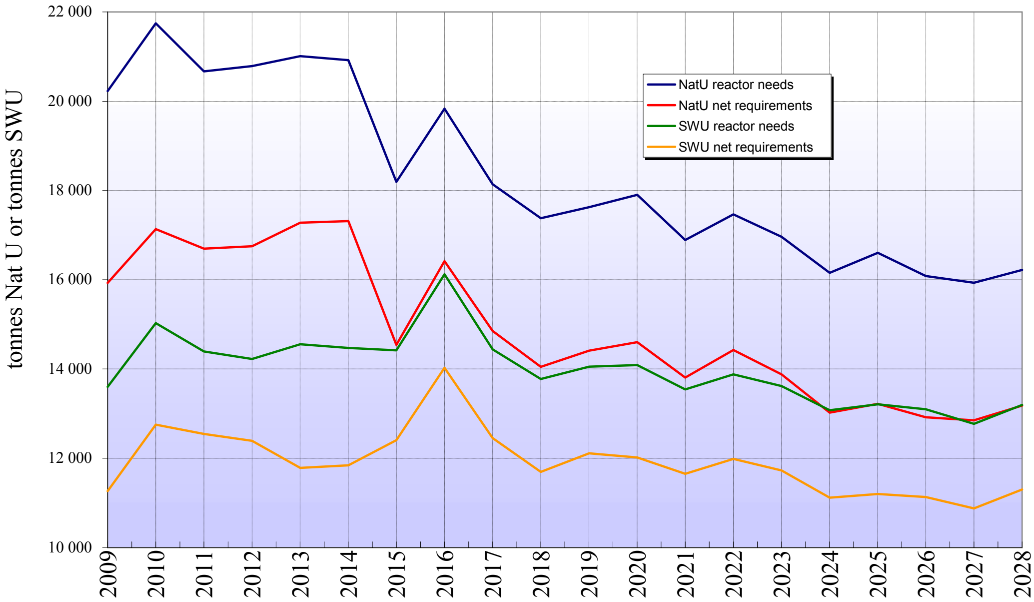
For EU-27, average reactor needs for natural uranium over the next 10 years are forecast to be 19 891 tU/year, while average net requirements will be about 16 096 tU/year, ranging from 16 785 tU/year to 13 632 tU/year for the period between 2019 and 2028.

The decline forecast over the years reflects the planned closures of reactors in some Member States, especially in Germany, and the small number of firm plans for new reactors, although several others are planned. Average reactor needs for enrichment services over the next 10 years are expected to be 14 504 tSWU/year, while average net requirements will be in the order of 12 316 tSWU/year, ranging from 13 454 tSWU/year to 11 512 tSWU/year for the period between 2019 and 2027. Compared with the forecasts made in 2007, these figures all confirm no change in the patterns for future requirements.

These averages show that both the forecast net requirements for natural uranium and the estimates for enrichment requirements have remained stable, compared with the forecasts made in 2007.

[11] This overview of supply and demand for nuclear fuels in the European Union is based on information provided by the EU utilities or their procurement organisations concerning the amounts of fuel loaded into reactors, estimates of future fuel requirements and the quantities, origins and acquisition prices of natural uranium and separative work.

Figure 1: Reactor needs and net requirements for uranium and separative work EU-27)



Supply of natural uranium

Conclusion of contracts

In 2008, ESA processed 53 contracts and amendments relating to ores and source materials (essentially natural uranium). Table 6 gives further details of the type of supply, term and parties involved. The transactions concerned totalled approximately 37 132 tU, including amendments to contracts, which was significantly lower than the 60 671 tU in 2007. Another 14 869 tU were covered by new (spot and multiannual) purchase contracts by EU utilities versus 13 869 tU in 2007. The amendments to the existing contracts led to a net increase of 11 500 tU during 2008.

Table 6: Natural uranium contracts concluded by or notified to ESA (including feed contained in EUP purchases)

Contract type	Number of contracts concluded in 2008	Number of contracts concluded in 2007
Purchase/sale by an EU utility/user	**17**	**23**
– multiannual (1)	3	16
– spot (1)	14	7
Other purchase/sale	**18**	**6**
– between intermediaries (2) (multiannual)	5	2
– between intermediaries (2) (spot)	13	4
Exchanges and loans (3)	**11**	**9**
Amendments to purchase contracts (4)	**7**	**15**
TOTAL	**53**	**53**

(1) Multiannual contracts are defined as contracts providing for deliveries extending over more than 12 months, whereas spot contracts provide for either only one delivery or for deliveries extending over a maximum of 12 months, whatever the time between conclusion of the contract and the first delivery.

(2) Purchase/sale contracts between intermediaries – neither the buyer nor the seller are EU utilities/end-users.

(3) This category includes exchanges of ownership and U_3O_8 against UF_6. Exchanges of safeguards obligation codes and international exchanges of safeguards obligations are not included.

(4) The net increase (or decrease) in material for which contracts have been concluded.

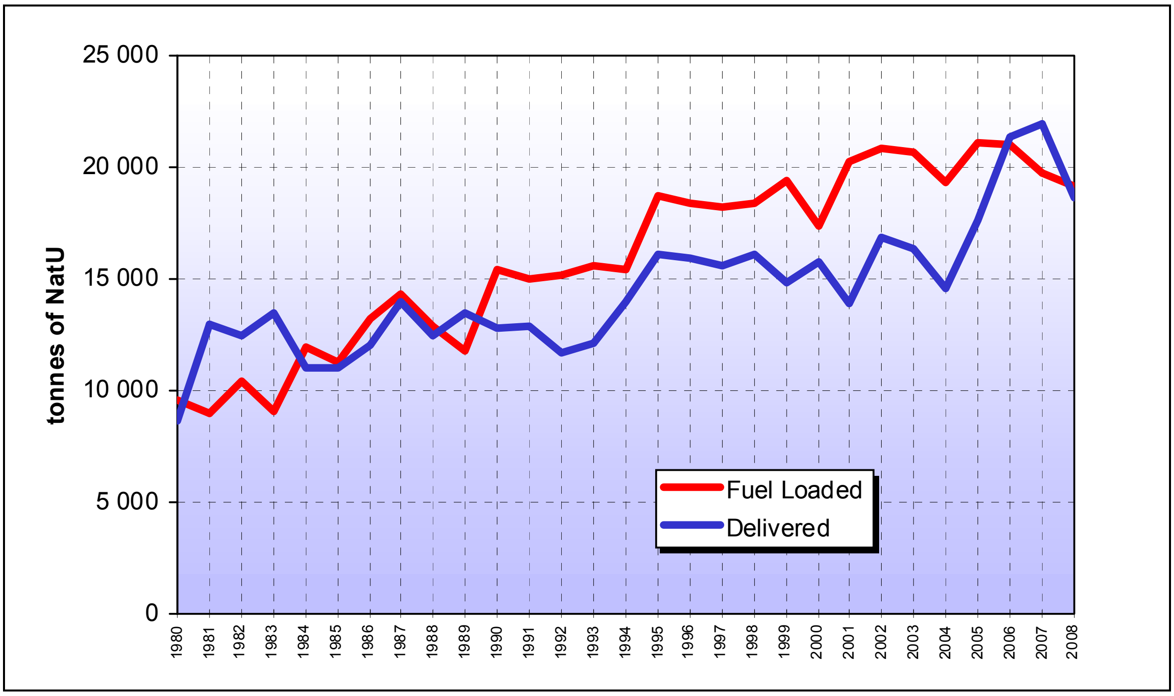
Volume of deliveries

The deliveries taken into account are those made to EU-27 utilities or their procurement organisations (excluding research reactors). They also include the natural uranium equivalent contained in enriched uranium purchases. Deliveries and fuel loaded into reactors by EU utilities since 1980 are shown in Figure 2. See Annex 3 for the corresponding table.

Quantitative analysis shows that 18 622 tU were delivered to EU-27 utilities during 2008, down from 21 932 tU in 2007 (without reprocessed uranium) and below the 19 145 tU loaded into reactors. After the dramatic decrease in 2007, the amount of uranium delivered under spot contracts increased slightly during 2008 to some 2.9 % of total natural uranium deliveries, up from 2.4 %.

These figures show that after two consecutive years when the quantities loaded into reactors were lower than deliveries the pattern of the 1990s is back again, i.e. the quantities delivered and loaded are no longer in balance. The excess quantity of fuel loaded compared with the quantity delivered in 2008 can be explained by the slight drawdown of inventories held by utilities, a possible consequence of the 'wait-and-see' policy during the worldwide financial crisis.

Figure 2: Natural uranium feed contained in fuel loaded into EU reactors and natural uranium delivered to utilities under purchasing contracts (tU)



Average prices of deliveries

In order to provide price information comparable with previous years, only deliveries made to EU utilities or their procurement organisations under purchasing contracts are taken into account in the calculations of the average prices. In order to ensure statistical reliability (sufficient amounts) and the confidentiality of commercial data (no individual contracts revealed), ESA price indexes are calculated only if there are at least five relevant contracts.

To calculate the average price, the original contract prices are converted, using the average annual exchange rates published by the European Central Bank, into euro per kilogram of uranium in the chemical form of U_3O_8 and then weighted by the quantities covered by each contract. To establish a price excluding the conversion cost, if it was not specified, in 2008 ESA applied a rigorously calculated average conversion price of €6.86/kgU (US$10.09/kgU), down from €7.10/kgU (US$9.74/kgU) for the previous year.

Natural uranium prices are watched very closely by all involved in the fuel cycle since the price level has a direct impact on production levels, future investment and any nuclear revival. Any price increase stimulates uranium exploration and expansion of mining capacity. The predominant feature of the uranium market is still that it is less efficient, less liquid and less transparent than the market in other commodities. With the arrival of new participants (hedge funds, speculative stockpiles, juniors and other investors) and of new price indicators (Blended Financial Value, U Futures and Tullett-Prebon), this market is really becoming more sophisticated, bringing uranium trading closer to the trading in other energy commodities and metals.

A new instrument: the Mac-3 price index

Players on the uranium market are not fully satisfied with the current price references and are seeking greater price transparency. Uranium mostly is sold under long-term contracts and the terms are not made public. However, some national and international authorities (such as Australia, the USA and ESA) make price indicators available to illustrate uranium price trends, some of which refer to deliveries made under long-term contracts. Relatively, the spot-market price is the most transparent. However, the quantity of uranium traded on the spot market in a given year is usually equivalent to under 15 % of the total quantity of uranium traded. For example, in 2008 only 2.9 % of all uranium deliveries to EU utilities were purchased under spot contracts. It should also be taken into account that the European market makes up around 30 % of the global market.

Until recently, ESA had been publishing two categories of prices on an annual basis: the ESA Natural Uranium Multiannual Price and the ESA Natural Uranium Spot Price which are both historical price indexes calculated over many years. 'Multiannual' contracts are defined as contracts providing for multiple deliveries extending over 12 months. 'Spot' contracts provide for either only one delivery or deliveries extending over a maximum of 12 months, irrespective of the period between conclusion of the contract and the first delivery. The ESA Natural Uranium Spot Price index is the weighted average price paid by EU utilities for U_3O_8 under spot contracts in a given year. Although these indexes show the average price paid for natural uranium by European utilities, they do not necessarily reflect the reality of forward markets, but mainly historical prices. Occasionally these indexes are used by European utilities in their price formulae for future natural uranium purchases. These price indexes are made available for information purposes only and ESA can bear no legal responsibility for the use made of them.

In order to increase price transparency, in 2008 ESA introduced a new category of average prices, the ESA 'Natural Uranium Multiannual Contract' or 'MAC-3' price index, which refers only to the prices of the natural uranium delivered under long-term contracts concluded during the last three years. ESA believes that the new index will increase transparency on the market and widen the knowledge about the latest prices paid by European utilities. While protecting the confidentiality of individual transactions, the method used by ESA gives a better indication of the current trends in uranium prices.

The ESA Natural Uranium 'MAC-3' price index is based on a three-year moving average which gives a smoothed indicator of the prices per kg of natural uranium as U_3O_8. The 'MAC-3' price index is calculated using natural uranium deliveries under new multiannual contracts in the reporting year. By definition, 'new multiannual contracts' are contracts concluded during the last three years, including the reporting year. For example, if the reporting year is 2008, 'new multiannual contracts' would mean contracts concluded between 1 January 2006 and 31 December 2008, with deliveries made during 2008.

Average prices for 2008

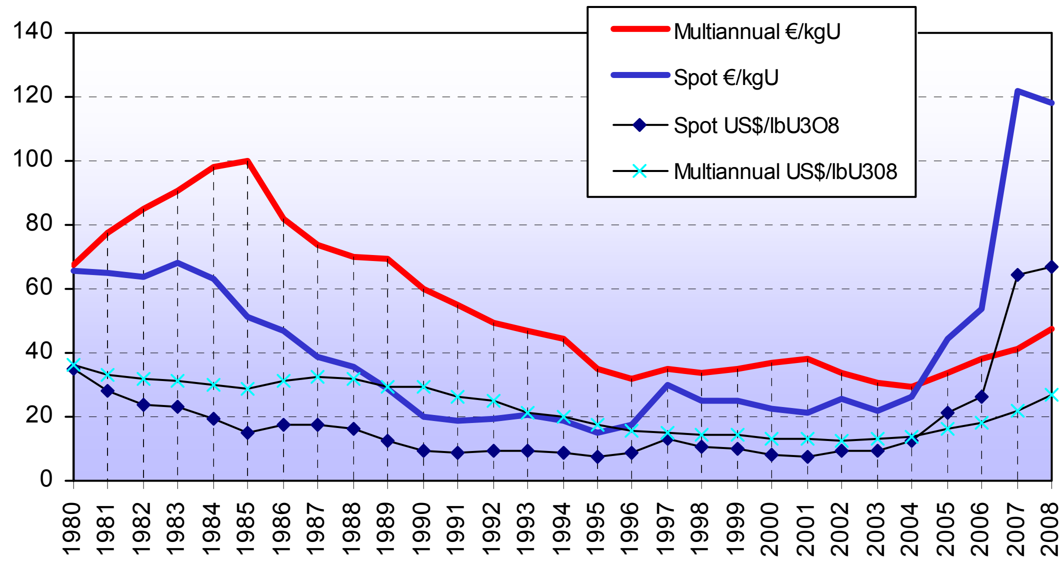
The average price of deliveries under multiannual contracts in 2008 was €47.23/kgU contained in U_3O_8, 15.25 % up from the €40.98/kgU in 2007 (or US$26.72/lb U_3O_8 v. US$21.60/lb U_3O_8 in 2007). The percentage of natural uranium delivered under long-term contracts decreased slightly during 2008 from 97.6 % to some 97.1 % of the total natural uranium deliveries. For the second year in a row, CIS prices not only did not approach non-CIS prices but also, in the case of long-term contracts, were even higher.

The average price of material delivered in 2008 under spot contracts was € 118.19/kgU contained in U_3O_8, therefore 2.96% down from the € 121.80/kgU in 2007 (or US$ 66.86/lb U_3O_8 v US$ 64.21/lb U_3O_8 in 2007). The amount of uranium delivered under spot contracts increased slightly to 2.9 % of total natural uranium deliveries in 2008. This means that utilities were not eagerly involved in spot transactions; however, the market conditions were favourable at the end of the year.

During 2008, deliveries under 'new' multiannual contracts (MAC-3) made up 5.84 % of the total natural uranium deliveries for which prices were indicated, i.e. 5.06 % of the total natural uranium deliveries. The MAC-3 average price in 2008 was €84.75/kgU contained in U_3O_8 or US$47.94/lb U_3O_8. See Annex 4 for detailed price information, including historical values, and Annex 5 for the price calculation method.

Figure 3 shows the ESA average prices for natural uranium since 1980. The corresponding data are presented in Annex 4 (note: the euro replaced the ecu on 1 January 1999 with a conversion rate of 1:1).

Figure 3: Average prices for natural uranium delivered under spot and multiannual contracts 1980–2008 (in €/kgU and US$/lb U_3O_8)

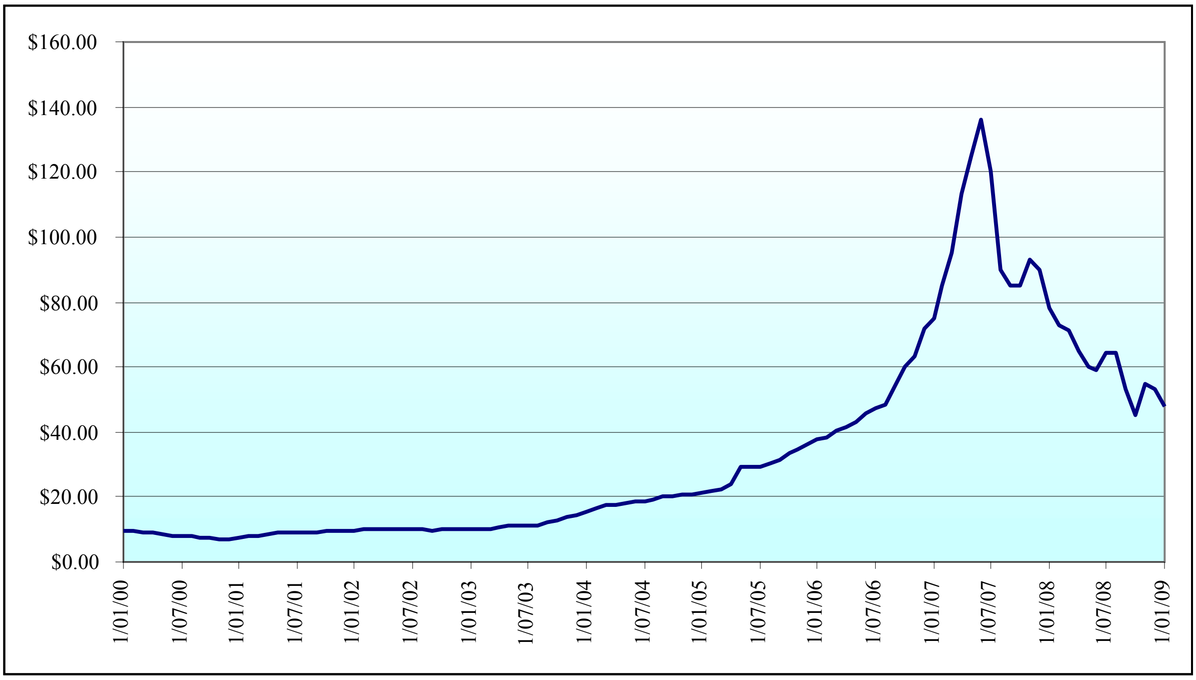


Although the calculated ESA prices use different methodologies and datasets, they are not very different from other uranium price references available on the market: the ESA average spot price for 2008 is US$ 66.84/lb U_3O_8, well between the uranium spot month-end prices estimated by Ux for January (US$ 78.00/lb U_3O_8) and December (US$ 53.00/lb U_3O_8) (see Figure 4).

The calculated ESA long-term 'MAC-3' price (US$ 47.94/lb U_3O_8) is even lower than the spot prices in 2008. The negative financial developments in 2008 had a downward impact on uranium prices and the overall market mood.

The uranium market was highly volatile during 2008, due to the uncertain economic climate and a number of uncertainties about uranium supplies, including production levels and secondary supplies. Another important consideration is that hedge funds did a lot more selling than buying in 2008.

Figure 4: Monthly natural uranium spot prices in US$/lb U_3O_8



Source: The Ux Consulting Company, LLC.

Although the uranium price was traditionally low for many years, during 2006 and 2007 it increased substantially due to technical problems in mines, dramatic increase of financial resources available for investments in 'paper uranium' anticipating speculative opportunities due to prices volatility in a context of worldwide speculation on commodities. In contrast with the previous year's drastic increase, spot uranium prices fell during 2008.

Historically, the rising uranium prices in 2006 and 2007 triggered a significant increase in investment in uranium exploration and mine development. Should favourable market conditions again stimulate exploration, further discoveries can be expected, as was the case during past periods of heightened exploration activity.

If the adverse economic conditions persist, it will be more difficult to satisfy investment needs all the way through the nuclear cycle and if economic growth slows down there is less need to expand nuclear capacity. Nevertheless investments in the nuclear sector are long term and should have less short-term economic impact.

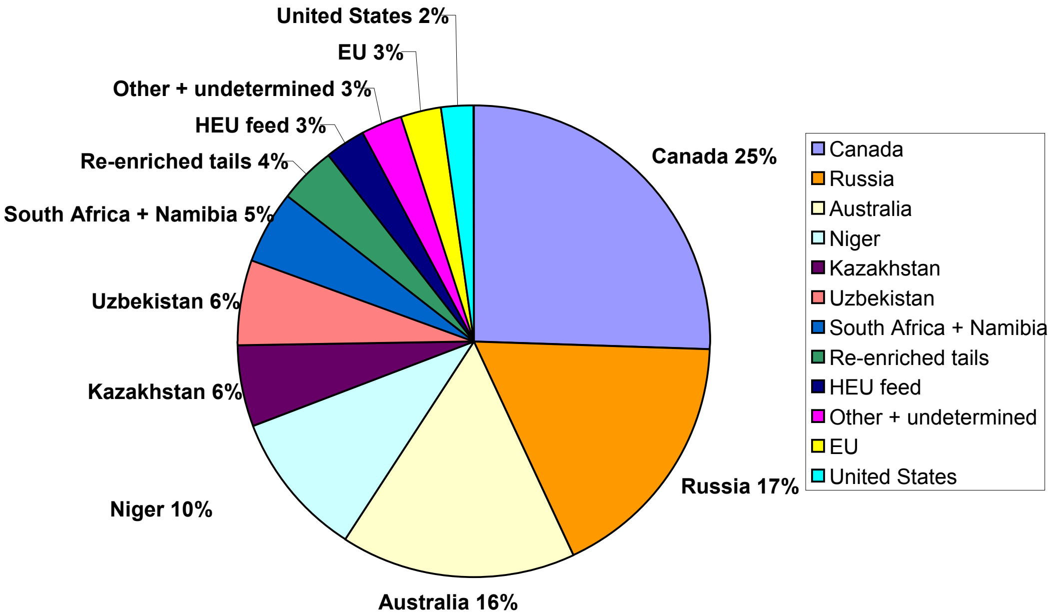
Origins

Canada's position as the leading supplier of natural uranium to EU utilities was challenged by Russia in 2007. After a 25 % increase in deliveries of Canadian uranium in 2008, Canada remained the EU's primary natural uranium source supplying 4 757 tU or one quarter of the total deliveries to the EU.

In 2008, Russia was hence the second biggest supplier of natural uranium with 3 272 tU. As explained in the previous reports, this figure is open to discussion and would need more detailed analysis, as it would be equivalent to almost the whole of Russia's production of natural uranium (3 381 tU according to the latest Red Book). Since many EU utilities receive enriched uranium or even complete fuel assemblies from Russia, it is simply impossible to determine the exact origin of the uranium contained in these products. Uranium declared as 'Russian' could therefore include uranium mined in other countries (i.e. Kazakhstan, Ukraine and Uzbekistan). Also, part of the high quantity could be explained by the low tails assays[12] used by the Russian enrichment industry, thereby 'creating' enriched uranium based on significantly lower needed quantities of fresh uranium.

Direct purchases from Kazakhstan and Uzbekistan remained relatively low on 1 072 and 1 070 tU respectively, considering the production and capacity levels, but took a considerable share of the EU supply (5.76 % and 5.75 % respectively giving a combined total of almost 12 %). Given the potential of both countries, the amount of uranium, especially from Kazakhstan, is expected to increase in the years ahead with the operation of various joint ventures.

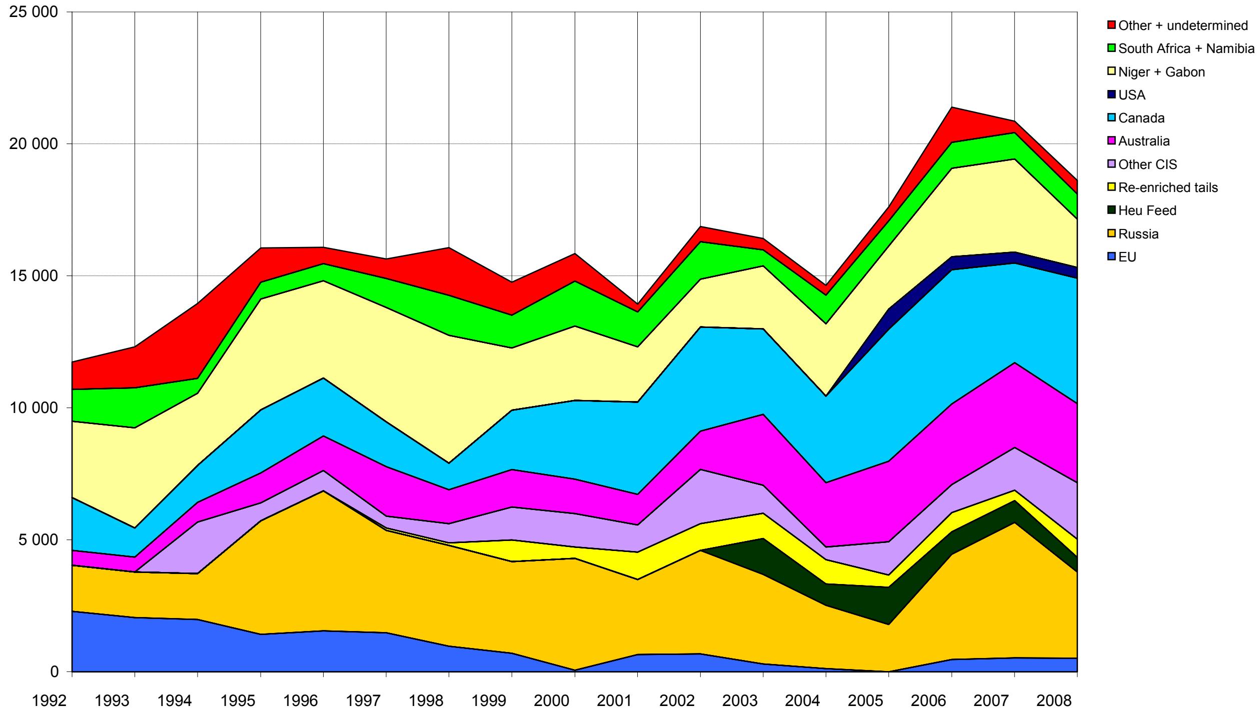
Figure 5: Sources of uranium delivered to EU utilities in 2008 (% share)



Australia maintained its previous level of deliveries with 2 992 tU and regained its position as third biggest supplier to the EU. European uranium mined in the Czech Republic and Romania supplied just below 3 % of the EU's total needs (a total of 515 tU). In 2008, the amount of re-enriched tails material totalled 688 tU and HEU feed 550 tU.

[12] By definition, the enrichment tails assay is a measure of the amount of fissile uranium (U-235) remaining in the waste stream from the uranium enrichment process. The natural uranium feed that enters the enrichment process generally contains 0.711 percent (by weight) U-235. The product stream contains enriched uranium (more than 0.711 percent U-235) whereas the waste or 'tails' stream contains depleted uranium, i.e. less than 0.711 percent U-235.

Figure 6: Purchases of natural uranium by EU utilities by origin, 1992-2008 (tU)



Special fissile materials

Conclusion of contracts

Table 7 shows the number of contracts and amendments relating to special fissile materials (enrichment, enriched uranium and plutonium) dealt with during 2008 in accordance with ESA's procedures.

Table 7: Special fissile material contracts concluded by or notified to ESA

Contract type	Number of contracts 2008	Number of contracts 2007
A. Special fissile materials	**72**	**87**
Purchase (by an EU utility/user)	10	15
Sale (by an EU utility/user)	8	3
Purchase/sale (between two EU utilities/end-users)	3	10
Purchase/sale (intermediaries)	17	17
Exchanges	16	19
Loans	2	3
Pool	9	9
Total ([1])	65	76
Contract amendments	7	11

B. Enrichment notifications ([2])	11	45
Notification amendments	8	18

(1) In addition, there were transactions for small quantities (Article 74 of the Euratom Treaty) which are not included here.

(2) Contracts with primary enrichers only.

Deliveries of low-enriched uranium

In 2008, the enrichment services (separative work) contained in the fuel supplied to EU utilities totalled approximately 13 560 tSWU, a decrease of 8.1 % compared with 2007, delivered in 2 302 tonnes of low-enriched uranium (tLEU) which contained the equivalent of some 17 688 tonnes of natural uranium feed.

As in previous years, the overwhelming majority of the separative work requested (97 %) was carried out with tails in the range of 0.20 % to 0.30 %. The remaining 3 % of separative work produced tails either between 0.16 % and 0.20 %, or between 0.31 % and 0.35 %. This confirms that the slightly downward trend in tails assays continued in 2008. The volatility of the natural uranium prices is not directly and instantly mirrored in the specifications of enrichment services, since those are laid down in long-term contracts. This result is therefore expected and normal.

The tails assay used to calculate the natural uranium feed and separative work components has a significant impact on the values of these components. An increase in the tails assay increases the amount of natural uranium and reduces the amount of separative work required to produce the same amount of enriched uranium. The optimum tails assay is dictated by the prices of natural uranium and separative work. For its calculations ESA used the contractual tails assay declared by the utilities or, when this was not available, a standard 0.30 %. It should be added that enrichers do not always use the contractual tails assay at their plants. As a result, they could become either major users or ‘producers’ of natural uranium, depending on the circumstances. The real figures for supply of and demand for natural uranium and separative work can be influenced in one direction or the other by the real tails assay.

As regards the origins of enrichment services, more than two thirds (67 %) of the EU separative work (SW) required was carried out by the two European enrichers (AREVA-Eurodif and Urenco) which means that they were able to increase their share by 5 percentage points, compared with 2007.

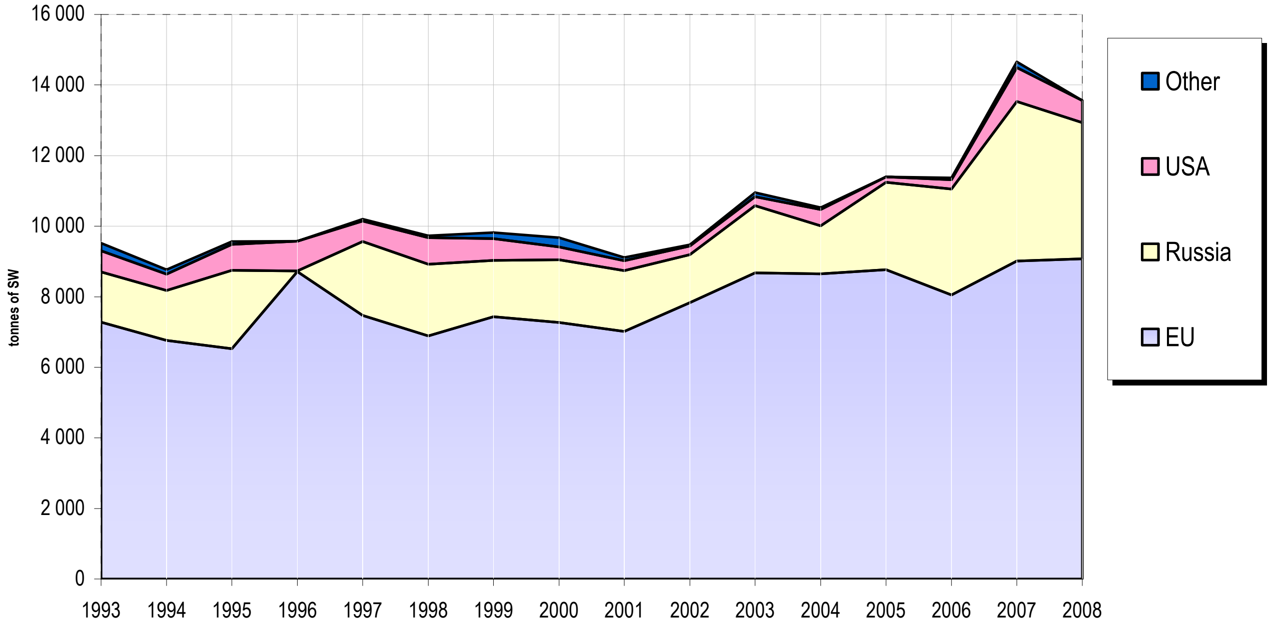
Table 8: Sources of enrichment services delivered to EU utilities

Enricher	Quantities 2008 (tSWU)	Share in 2008 (%)	Quantities 2007 (tSWU)	Share in 2007 (%)	Change over 2007 (%)
EURODIF+URENCO (EU)	9 078	66.95	9 009	61.47	0.78
TENEX (Russia)	3 856	28.43	4 528	30.89	-14.85
USEC (USA)	626	4.62	953	6.50	-34.3
Others	0	0	167	1.14	-100
TOTAL	**13 560**	**100**	**14 657**	**100**	**-7.48**

Deliveries of Russian separative work to EU utilities under purchasing contracts totalled 3 856 tSWU, a decrease of 672 tSWU compared with 2007 and equivalent to 28 % of the total enrichment services supplied to EU utilities.

Enrichment services provided from the USA totalled only 626 tSWU and accounted for about 4.6 % of the total enrichment services supplied to EU-27. Figure 7 shows the enrichment services provided to EU utilities by origin since 1993.

Figure 7: Supply of enrichment to EU utilities by origin, 1993–2008



Based on the annual declarations of contracts, where prices per SWU were disclosed by European utilities, ESA calculated a weighted average price for enrichment services for 2008. Altogether these contracts were for 4865 tSWU, i.e. 36 % of the total deliveries to EU utilities during 2008. ESA found that the weighted-average SWU price for 2008 was € 86.3/kgSWU or US$ 126.86/kgSWU, compared with € 84.64/kgSWU or US$ 124.42/kgSWU in 2007.

Plutonium and mixed-oxide fuel

One way of reusing or recycling plutonium, which is an inherent by-product of operation of nuclear reactors, is to fabricate mixed-oxide fuel (MOX) where the plutonium oxide (PuO_2) is mixed with depleted uranium oxide (UO_2) to form fresh fuel. MOX fuel typically contains 7 % to 9 % of Pu mixed with depleted uranium, equivalent to a normal enriched uranium fuel with a tails assay of about 4.5 %.

Pu stocks might exceed 250 tonnes before they start to decline after 2010 as MOX use increases, with MOX then expected to supply about 5 % of the world’s nuclear reactor fuel requirements. MOX production worldwide since 1963 accounts for consumption of over 400 tonnes of Pu. Use of MOX has been contributing to a significant reduction in requirements for natural uranium and separative work for many years.

In 2008, transactions involving plutonium again mainly related to use for MOX fuel fabrication. ESA co-signed four such contracts. Reprocessing of irradiated fuel continued at the La Hague plant in France, which was able to reprocess all the material offered for reprocessing and even has some spare capacity. Reprocessing restarted during 2008 at the THORP plant in the United Kingdom.

The quantities loaded into EU reactors and the estimated savings from use of MOX fuel are shown in Table 9 (no MOX fuel is used in the new Member States). The quantity of MOX fuel loaded totalled 16 430 kg Pu in 2008, a significant increase from the 8 624 kg Pu in 2007.

Table 9: Use of plutonium in MOX in EU-27 and estimated natural uranium (NatU) and separative work savings

Year	kg Pu	Savings	
		t NatU	tSWU
1996	4 050	490	320
1997	5 770	690	460
1998	9 210	1 110	740
1999	7 230	870	580
2000	9 130	1 100	730
2001	9 070	1 090	725
2002	9 890	1 190	790
2003	12 120	1 450	970
2004	10 730	1 290	860
2005	8 390	1 010	670
2006	10 210	1 225	815
2007	8 624	1 035	690
2008	16 430	1 972	1 314
Grand total	**120 854**	**14 521**	**9 664**

Note that the published figures on natural uranium and separative work savings could vary, depending on the calculation method. In this report ESA assumed that one tonne of plutonium saves the equivalent of 120 tonnes of natural uranium and 80 tonnes of separative work.

Prospects for MOX fuel use

Use of MOX fuel is attracting more attention as it is seen as a viable option in both economic and waste management terms. For example, the French operator EDF plans to use at least one-third MOX core fuel in its 900 MWe reactors (its new EPR will accept a full MOX core loading) and Japan plans to have one third of its reactors partly MOX-fuelled by 2015 and to introduce a new fully MOX-fuelled reactor.

The OECD/NEA expects that by 2010 MOX fuel will be used by 45 reactors in Europe, together with 16 to 18 in Japan, possibly five in Russia and another six in the USA, making a combined share of some 15 % of the world's reactors. Some Generation III power plants are specifically designed to take either fully or partly loaded MOX cores.

Chapter 4

ESA work programme for 2009

In line with the tasks conferred on it under the Euratom Treaty and its new Statutes, ESA built its 2009 work programme around three major objectives:

1) *Guaranteeing the security of nuclear fuel supply:* this remains the core objective of ESA, as it is a precondition for fulfilling the other two. ESA will continue to monitor the nuclear fuel market by making decisions on supply contracts for nuclear materials and acknowledgements of transactions covering provision of nuclear fuel-cycle services.

2) *Becoming the EU's nuclear observatory:* this new challenge stems from the new Statutes. To achieve this objective, ESA will explore new alternatives for exercising its exclusive rights in order to put greater emphasis on receiving accurate and timely information from the market rather than on enforcing formalistic rules.

3) *Intensifying international relations:* the previous two objectives require ESA to play a more direct and active role with the players in the international nuclear community (such as non-EU countries with significant uranium resources, non-EU market observers and international organisations developing multilateral approaches).

Furthermore ESA can contribute to EU's non-proliferation policy through checking that supply contracts are concluded in accordance with Euratom bilateral agreements. In terms of future guarantees, the provisions relating to stocks of nuclear materials in the Euratom Treaty might be of assistance for launching international nuclear fuel banks.

Enhancing the security of nuclear fuel supply by means of diversification

ESA exercises its exclusive rights in order to put into practice the principle of equal access to sources of nuclear materials. Enforcing this principle can enhance security of supply, which is in the public interest. One key aspect of security of supply is diversification. Users purchasing nuclear material from different geographical sources enjoy greater long-term stability than those relying on a single source of supply — a view upheld consistently by the European Court of Justice and the European Commission.

Chapter VI of the Euratom Treaty established a centralised procurement system. This was simplified in 1960, since when EU producers and users have conducted their sales and purchases themselves. ESA co-signs each supply contract (for nuclear materials) and acknowledges each transformation contract (for nuclear fuel services), allowing it to monitor them and, if necessary, intervene in order to uphold the diversification principle.

In the case of some specific contracts, however, protection of legal certainty in particular justifies exemption from the diversification principle. This is the case with numerous contracts entered into by nuclear power plants of Russian design before the State concerned had joined the EU. Article 105 of the Euratom Treaty protects the rights acquired under these contracts. However, they will gradually expire and ESA will need to ensure a satisfactory degree of diversification at EU level.

Specific objective N° 1

ESA will optimise its co-signature and acknowledgement procedures for contracts to supply or transform nuclear materials. Exercising its exclusive rights in the context of market liberalisation, it can validate further simplifications in the co-signature procedure and can cut red tape by opening up a 'fast-track' process for contracts complying with the following criteria:

1) comply with the principles set out in the Euratom Treaty and the supply policies established by the Council and the Commission;

2) comply with the provisions of the Treaty establishing the European Communities and its secondary legislation, in particular the rules on competition and foreign trade; and

3) enable ESA to extract certain pre-defined information from the contract or notification for the purposes of monitoring the market.

In order to collect the information for market monitoring, ESA will strengthen its cooperation with other Commission departments.

Acting as a nuclear fuel market observatory

The new Statutes give ESA an additional market observatory function. Market observation requires accurate and timely data on all the relevant sectors of the industry. ESA's exclusive rights, combined with cooperation with other Commission departments, enable it to collect the information needed to produce reliable market analyses.

Accordingly, the main sources of input for ESA's observation activity will be:

- the contracts to supply or transform nuclear materials;
- the yearly updates received from EU utilities on performance of these contracts; and
- information received from other Commission departments.

In addition, the Advisory Committee remains in a position to supplement preliminary conclusions drawn from the raw data. ESA may also resort to open input sources, which means the energy statistics issued by the Commission, the IAEA and the OECD/NEA.

ESA has already taken steps to upgrade its current data processing methods. The result should be a comprehensive statistical service offering unambiguous data entry, fully automated calculations and attractive display options.

ESA will use these analyses to compile comprehensive reports reflecting the overall situation on the nuclear fuel market. The Annual Report will be the flagship publication on this activity, supported by quarterly reports on the uranium market.

Specific objective N° 2

ESA will boost its market observation and market monitoring activities by:

1) following general market trends and summarising its observations, with the support of the Advisory Committee, in its Annual Report and quarterly market reports;

2) following up EU policy decisions (the Nuclear Illustrative Programme of the Commission, the Second Strategic Energy Review, etc.); and

3) starting, in the second half of 2009, to issue a publication at regular intervals on average prices and indexes.

Intensifying international relations

The Euratom Treaty limits ESA's exclusive rights to transfers of nuclear material of Community relevance. However, this is not the case with market observation, which can take a global perspective. For example, understanding the role of intermediaries and the availability of stocks calls for a worldwide analysis, including market players which consider uranium a simple commodity.

Nuclear organisations always have been interested in cooperating with ESA. This will probably apply even more so in the light of ESA's expanded missions. To this end, ESA has to communicate these improvements to its 'target group', the international nuclear community, and keep it permanently up to date with its activities. ESA would welcome *ad hoc* consultations in the form of recurring expert-level meetings both with international nuclear organisations (IAEA, NEA, etc.) and with non-EU States hosting current and potential suppliers.

Specific objective N° 3

ESA will adopt a more open strategy towards the world nuclear community by:

1) increasing the frequency of exchanges of information with international nuclear organisations;

2) intensifying contacts with non-EU countries where existing and potential suppliers operate.

Conclusion

These three specific objectives cover the approach which ESA intends to take to fine-tune and broaden its activities in line with its new Statutes and the views expressed by the European Parliament. Evidently, any extension of its activities on such a scale has to be matched by the necessary internal restructuring. Successful implementation of this approach will signify substantial reforms in the operations of ESA.

To this end, ESA will adjust its structure to its new extended remit by:

1) evaluating the rules on balancing supply and demand to simplify the co-signature procedure even further; and

2) introducing an internal quality management system to turn ESA into a centre of excellence within the nuclear energy services of the European Union.

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A limited number of paper copies of this report may be obtained, subject to availability, from the above address.

Further information

Additional information can be found on Europa, the European Union server, at http://europa.eu/index_en.htm. It provides access to the websites of all European institutions and other bodies.

The Internet address of the European Commission's Directorate-General for Energy and Transport is http://ec.europa.eu/energy/index_en.html. This website contains information on, for example, security of energy supply, energy-related research, nuclear safety and liberalisation of the electricity and gas markets.

List of abbreviations

CIS	Commonwealth of Independent States
ESA	Euratom Supply Agency
Euratom	European Atomic Energy Community
IAEA	International Atomic Energy Agency
(US) DoE	United States Department of Energy
(US) NRC	US Nuclear Regulatory Commission
USEC	United States Enrichment Corporation
EUP	Enriched uranium product
HEU	Highly enriched uranium
LEU	Low-enriched uranium
MOX	Mixed-oxide fuel (uranium mixed with plutonium oxide)
RET	Re-enriched tails
SWU	Separative work unit
tSWU	1 000 SWU
tU	Metric tonne of uranium (= 1 000 kg)
BWR	Boiling water reactor
EPR	Evolutionary (European) pressurised water reactor
LWR	Light water reactor
NPP	Nuclear power plant
PWR	Pressurised water reactor
RBMK	Light water graphite-moderated reactor (Russian design)
VVER/WWER	Pressurised water reactor (Russian design)
kWh	kilowatt-hour
MWh	megawatt-hour (= 10^3 kWh)
GWh	gigawatt-hour (= 10^6 kWh)
TWh	terawatt-hour (= 10^9 kWh)

Annexes

Annex 1: CIS supplies

(A) Supplies of natural uranium and feed contained in EUP from Russia to EU-27 utilities

Year	Deliveries [1]	Re-enriched tails [2]	Total [1] [2]	Total as % of supply
1992	1 800	0	2 700	23
1993	1 700	0	2 300	19
1994	1 700	0	2 200	16
1995	4 300	0	4 500	28
1996	5 100	0	5 800	36
1997	3 900	–	4 400	28
1998	3 900	–	4 500	28
1999	3 500	1 100	5 000	34
2000	4 200	1 200	5 400	34
2001	2 850	1 050	4 100	29
2002	3 900	1 000	5 500	33
2003	3 400	1 200	4 600	28
2004	2 400	900	3 300	23
2005	3 800	500	4 300	23
2006	4 850	700	5 550	26
2007	5 144	388	5 532	27
2008	3 272	688	3 960	21
Total	**59 716**	**8 726**	**73 642**	**27**

(B) Deliveries of natural uranium and feed contained in EUP from the CIS to EU-27 utilities (tU)

Year	Deliveries to EU utilities [1]			
	Quantity tU	as % of supply	incl. RET [2]	incl. RET as % of supply
1992	2 700	23		
1993	2 700	22		
1994	4 500	32		
1995	5 200	32		
1996	6 800	43		
1997	5 000	32	–	–
1998	5 600	35	–	–
1999	5 100	34	6 200	42
2000	5 800	37	7 000	44
2001	4 100	29	5 100	37
2002	6 900	41	7 900	47
2003	4 500	27	5 700	35
2004	2 900	20	3 800	26
2005	5 050	27	5 550	30
2006	5 300	25	6 000	28
2007	6 750	32	7 150	34
2008	5 965	32	6 653	36
Total	**84 865**	**31**		

(1) Deliveries to EU utilities means total deliveries under purchasing contracts during the relevant year.

(2) Deliveries of re-enriched tails (RET) to EU utilities started in 1997 but were negligible (< 1 % of total supply) during the first two years. For confidentiality reasons, they have been included under 'Quantity tU' for 1997 and 1998. The figures include RET acquired as a result of exchanges.

Annex 2: EU-27 reactor needs and net requirements (quantities in tU and tSWU)

(A) From 2008 until 2017

Year	Natural uranium		Separative work	
	Reactor needs	Net requirements	Reactor needs	Net requirements
2009	20 237	16 233	13 647	12 208
2010	21 420	19 177	14 935	13 949
2011	21 049	18 962	14 249	13 262
2012	20 330	18 623	14 183	13 458
2013	20 586	18 834	14 514	13 978
2014	19 425	17 869	14 348	13 680
2015	17 462	16 222	13 887	13 297
2016	18 894	17 500	15 084	14 351
2017	17 529	16 329	14 228	13 638
2018	17 378	14 048	13 778	11 694
Total	**198 913**	**160 962**	**145 040**	**123 165**
Average	**19 891**	**16 096**	**14 504**	**12 316**

(B) Extended forecast from 2018 until 2027

Year	Natural uranium		Separative work	
	Reactor needs	Net requirements	Reactor needs	Net requirements
2019	17 627	14 409	14 053	12 111
2020	17 903	14 604	14 087	12 019
2021	16 893	13 809	13 544	11 650
2022	17 467	14 427	13 882	11 988
2023	16 964	13 883	13 620	11 726
2024	16 156	13 022	13 078	11 116
2025	16 602	13 222	13 209	11 201
2026	16 086	12 917	13 097	11 134
2027	15 931	12 851	12 771	10 877
2028	16 221	13 181	13 195	11 301
Total	**167 852**	**136 322**	**134 538**	**115 123**
Average	**16 785**	**13 632**	**13 454**	**11 512**

Annex 3: Fuel loaded into EU-27 reactors and deliveries of fresh fuel under purchasing contracts

Year	Fuel loaded			Deliveries		
	LEU (tU)	Feed equivalent (tU)	Enrichment equivalent (tSWU)	Natural U (tU)	% spot	Enrichment (tSWU)
1980		9 600		8 600	(4)	
1981		9 000		13 000	10	
1982		10 400		12 500	<10	
1983		9 100		13 500	<10	
1984		11 900		11 000	<10	
1985		11 300		11 000	11.5	
1986		13 200		12 000	9.5	
1987		14 300		14 000	17.0	
1988		12 900		12 500	4.5	
1989		15 400		13 500	11.5	
1990		15 000		12 800	16.7	
1991		15 000	9 200	12 900	13.3	10 000
1992		15 200	9 200	11 700	13.7	10 900
1993		15 600	9 300	12 100	11.3	9 100
1994	2 520	15 400	9 100	14 000	21.0	9 800
1995	3 040	18 700	10 400	16 000	18.1	9 600
1996	2 920	18 400	11 100	15 900	4.4	11 700
1997	2 900	18 200	11 000	15 600	12.0	10 100
1998	2 830	18 400	10 400	16 100	6.0	9 200
1999	2 860	19 400	10 800	14 800	8.0	9 700
2000	2 500	17 400	9 800	15 800	12.0	9 700
2001	2 800	20 300	11 100	13 900	4.0	9 100
2002	2 900	20 900	11 600	16 900	8.0	9 500
2003	2 800	20 700	11 500	16 400	18.0	11 000
2004	2 600	19 300	10 900	14 600	4.0	10 500
2005	2 500	21 100	12 000	17 600	5.0	11 400
2006	2 700	21 000	12 700	21 400	7.8	11 400
2007	2 809	19 774	13 051	21 932	2.4	14 756
2008	**2 749**	**19 146**	**13 061**	**18 622**	**2.9**	**13 560**

Annex 4: ESA average prices for natural uranium

Year	Multiannual contracts		Spot contracts		New multiannual contracts (MAC-3) (**)		Exchange rate (year average)
	€/kgU	*US$/lb U_3O_8*	*€/kgU*	*US$/lb U_3O_8*	*€/kgU*	*USD/lb U_3O_8*	*€/US$*
1980	67.20	36.00	65.34	35.00			1.39
1981	77.45	33.25	65.22	28.00			1.12
1982	84.86	32.00	63.65	24.00			0.98
1983	90.51	31.00	67.89	23.25			0.89
1984	98.00	29.75	63.41	19.25			0.79
1985	99.77	29.00	51.09	15.00			0.76
1986	81.89	31.00	46.89	17.75			0.98
1987	73.50	32.50	39.00	17.25			1.15
1988	70.00	31.82	35.50	16.13			1.18
1989	69.25	29.35	28.75	12.19			1.10
1990	60.00	29.39	19.75	9.68			1.27
1991	54.75	26.09	19.00	9.05			1.24
1992	49.50	24.71	19.25	9.61			1.30
1993	47.00	21.17	20.50	9.23			1.17
1994	44.25	20.25	18.75	8.58			1.19
1995	34.75	17.48	15.25	7.67			1.31
1996	32.00	15.63	17.75	8.67			1.27
1997	34.75	15.16	30.00	13.09			1.13
1998	34.00	14.66	25.00	10.78			1.12
1999	34.75	14.25	24.75	10.15			1.07
2000	37.00	13.12	22.75	8.07			0.92
2001	38.25	13.18	(*) 21.00	(*) 7.23			0.90
2002	34.00	12.37	25.50	9.27			0.95
2003	30.50	13.27	21.75	9.46			1.13
2004	29.20	13.97	26.14	12.51			1.24
2005	33.56	16.06	44.27	21.19			1.24
2006	38.41	18.38	53.73	25.95			1.26
2007	40.98	21.60	121.80	64.21			1.37
2008	**47.23**	**26.72**	**118.19**	**66.86**	**84.75**	**47.94**	**1.47**

(*) The spot price for 2001 was calculated on the basis of an exceptionally low total volume of only some 330 tU under four transactions, one of which accounted for two thirds of this quantity. Some 300 tU were delivered as UF_6 without a price being specified for the conversion component. To establish a price excluding conversion costs for these deliveries, ESA applied an estimated average conversion price of €5.70/kgU (or US$5.10/kgU).

(**) This new 'MAC-3' price index is based on a three-year moving average which gives a smoothed price indicator of the natural uranium prices per kg U as U_3O_8. During 2008, this type of contract accounted for 5.84% of the total natural uranium deliveries for which prices were indicated, i.e. 5.06% of the total natural uranium deliveries.

Annex 5: Calculation methodology for ESA U_3O_8 average prices

ESA collects two categories of prices on an annual basis:

- ESA weighted average U_3O_8 price for multiannual contracts, paid by EU utilities for their deliveries in a given year;
- ESA weighted average U_3O_8 price for spot contracts, paid by EU utilities for their deliveries in a given year.

The difference between multiannual and spot contracts is that:

- 'multiannual' contracts provide for deliveries extending over more than 12 months;
- 'spot' contracts provide for either only one delivery or for deliveries extending over a maximum of 12 months, whatever the time between conclusion of the contract and the first delivery.

In 2008, ESA introduced a new category of price and calculated a Natural Uranium 'New Multiannual Contracts' Price. This index was created to increase transparency on the market and to widen the knowledge about the latest prices paid by European utilities. The ESA Natural Uranium 'New Multiannual Contracts' Price Index is based on a three-year moving average which gives a smoothed price indicator of the natural uranium prices per kg U as U_3O_8.

Methodology

Prices

Prices are collected directly from utilities or via their procurement organisations from:

- contracts submitted to ESA;
- end-of-year questionnaires backed up, if necessary, by visits to the utilities.

Data requested on natural uranium deliveries during the year

The following details are requested: ESA contract reference number, quantity (kgU), delivery date, place of delivery, mining origin, natural uranium price specifying the currency, unit of weight (kg, kgU or lb), chemical form (U_3O_8, UF_6 or UO_2), whether the price includes conversion and, if so, the price of conversion, if known.

Deliveries taken into account

The deliveries taken into account are those made under purchasing contracts to the EU electricity utilities or their procurement organisations during the relevant year. They also include the natural uranium equivalent contained in enriched uranium purchases.

Other categories of contracts, such as between intermediaries or for sales by utilities, purchases by non-utility industries or barter deals, are excluded.

Deliveries for which it is not possible reliably to establish the price of the natural uranium component are excluded from the price calculation (e.g. uranium out of specification or enriched uranium priced per kg of EUP without separation of the feed and enrichment components).

Checking

The ESA compares the deliveries and prices reported with the data collected at the time of conclusion of the contracts, taking into account any subsequent updates. It compares, in particular, the actual deliveries with the ‘scheduled deliveries’ and options. Where there are discrepancies between scheduled and actual deliveries, clarifications are sought from the organisations concerned.

Exchange rates

To calculate the average prices, the original contract prices are converted into EUR per kgU contained in U_3O_8 using the average annual exchange rates published by the European Central Bank.

Prices which include conversion

For the few prices which include conversion but where the conversion price is not specified, given the relatively minor cost of conversion, ESA converts the UF_6 price to a U_3O_8 price using an average conversion value based on its own sources and on specialised trade press publications and confirmed by discussions with the converters.

Independent verification

Two members of ESA staff independently verify spreadsheets from the database.

Despite all the care taken, errors or omissions are discovered from time to time, mostly in the form of missing data, e.g. on deliveries under options, which were not reported. As a matter of policy, ESA never publishes a corrective figure.

Data protection

Confidentiality and physical protection of commercial data are ensured by using stand-alone computers, which are neither connected to the Commission Intranet nor to the outside world (including the Internet). Contracts and back-ups are kept in a secure room, with restricted key access.

ESA Annual Report 2008

Electronic document — 48 pp.

Created: 2009-02-21 / Finalised: 2009-03-27

Ref. (2009) AR2008-ZsP/SG — ESA

Euratom Supply Agency

European Commission — Luxembourg