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Contents

Abbreviations

CIS	Commonwealth of Independent States
ESA	Euratom Supply Agency
Euratom	European Atomic Energy Community
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
NEA	Nuclear Energy Agency
WNA	World Nuclear Association
(US) DoE	United States Department of Energy
(US) NRC	United States Nuclear Regulatory Commission
USEC	United States Enrichment Corporation
ERU	enriched reprocessed uranium
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
RepU	reprocessed uranium
SWU	separative work unit (see glossary for detailed definition)
tSW	1 000 SWU
tU	(metric) tonne of uranium (1 000 kg)
ABWR	advanced boiling water reactor
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
MW	megawatt
MWe	megawatt (electrical output)
GWe	gigawatt (electrical output)
MWh	megawatt-hour (1 000 kWh)
GWh	gigawatt-hour (1 million kWh)
TWh	terawatt-hour (1 billion kWh)

Foreword

Dear reader,

I am pleased to present the annual report of the Euratom Supply Agency (ESA) for 2012.

The report follows the same structure as in previous years. Chapter 1, including a contribution from the Nuclear Safety and Fuel Cycle Directorate of the European Commission's Directorate-General for Energy, is a concise summary of the situation in the nuclear field in the EU. It also records ESA's activities in 2012. Chapter 2 gives an overview of the world market for nuclear fuels, while Chapter 3 contains ESA's specific evaluations of the fuel market in the EU. Last, but not least, Chapter 4 sets out the Agency's work programme for 2013.

The year covered by this report was a landmark in the Agency's development. For the first time for years, following demands from the European Parliament and the European Court of Auditors, ESA was again given its own budget, partially covering its needs. This was the right step towards bringing the Agency's role back into line with the Euratom Treaty provisions.

In 2012, uncertainty persisted over future perspectives for the development of nuclear energy. In close cooperation with its Advisory Committee, representing the EU Member States' nuclear authorities and/or industry, the Agency continued to promote transparency and predictability in the market. Beyond its standard activities in contract management and market observation, it also strove to deal with new challenges arising in the current complex circumstances.

In the Agency, we have focused, in particular, on the supply of metal LEU for fuelling research reactors and producing medical radioisotopes, for which the EU is dependent on a couple of external suppliers. We have facilitated the activity of a dedicated working group, established by decision of the Advisory Committee, and expect it soon to come up with a useful proposal on this matter.

We have actively participated in the development of the European Observatory on the Supply of Medical Radioisotopes, thus promoting and helping to implement a policy adopted at Council of the European Union level.

In the light of developments in the nuclear fuel market, but also in the global trade, we have been reflecting deeply on the future deployment of our policy of diversifying sources of nuclear fuel supply for the EU. On this issue, too, we count on the contributions and support of all our stakeholders.

Having now headed the Agency for over a year, I trust that we have laid solid foundations for the present excellent cooperation with all interested parties to continue and I look forward to it bearing fruit in the future.

Stamatios Tsalas

Director-General of the Euratom Supply Agency

1. Nuclear energy developments in the EU and ESA activities

EU nuclear energy policy in 2012

EU nuclear policy in 2012 was still dominated by the aftermath of the Fukushima-Daiichi accident, with differing reactions in EU Member States as regards the use of nuclear energy. Comprehensive risk and safety assessments were completed for all nuclear power plants operating in the EU and associated neighbouring countries and follow-up measures were determined.

The focus of the EU institutions was on reviewing the legal framework for nuclear safety in Europe, and maintaining efforts to improve nuclear safety at international level.

Stress tests

The process of EU-wide comprehensive risk and safety assessments of nuclear power plants ('stress tests') continued and was finalised in 2012 with the cooperation of power plant operators, national safety regulators and the European Commission, based on the mandate from the European Council in 2011.

Following the presentation of the Commission's interim report in 2011 and finalisation of national reports at the end of the year, an extensive EU-wide peer review process was carried out from January to April 2012. This resulted in an overview report by the European Nuclear Safety Regulators Group (Ensreg) Peer Review Board, endorsed by Ensreg, and 17 individual national reports with detailed recommendations. In July, Ensreg agreed on an action plan to follow up the implementation of the peer review recommendations. The Commission's final report to the Council on the stress tests was adopted on 4 October 2012.

The EU nuclear stress tests were an unprecedented exercise in terms of extent, collaboration and the commitment of all parties involved. They have been used internationally as a basis or a benchmark for the safety assessment of nuclear power plants. The tests confirmed the high level of nuclear safety in Europe, while showing a need for technical improvements at all nuclear power plants and also for further improvements in the regulatory and legislative frameworks governing nuclear safety. National actions plans for implementing the stress test recommendations were received from all participating countries at the end of 2012 and will be reviewed in early 2013.

Nuclear safety directive

The main objective of the nuclear safety directive ([1]), adopted in 2009, is to establish a Community framework to maintain and promote continuous improvements in nuclear safety. Implementation of the directive progressed and at the end of 2012 only one Member State had yet to transpose it completely. The Commission has started an in-depth analysis of the quality of the Member States' transposing measures.

Preparatory work for the revision of the Euratom nuclear safety legislation continued in 2012, taking into account the results of the public consultation launched at the end of 2011, the findings of the stress tests and lessons from the Fukushima accident. A legislative proposal is planned for 2013; areas where the Commission is considering revisions include the following.

(a) Safety procedures and frameworks. The scope of the existing nuclear safety directive is limited to overall principles mainly regarding the distribution of competencies among nuclear operators, national regulators and other national bodies; as a result, the directive cannot address the technical safety issues identified in the Fukushima nuclear accident and the stress tests.

([1]) Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations, OJ L 172, 2.7.2009, p. 18.

(b) Role and means of nuclear regulatory authorities. The current provisions on regulatory separation and the effectiveness of nuclear regulatory authorities need to be strengthened to ensure the effective independence of these authorities and guarantee that they have the appropriate means of action.

(c) Openness and transparency. Arrangements ensuring the transparency of regulatory decisions and the regular provision of public information by nuclear operators should be extended and made more specific, for example by specifying the type of information that should be made public, as a minimum, by the competent regulatory authority or placing obligations on licence holders.

(d) Monitoring and verification. The provisions on monitoring and verification, e.g. through the extended use of peer reviews, should go beyond the review of the national regulatory framework.

Safe management of radioactive waste and spent fuel

Following the adoption in 2011 of the radioactive waste directive (2), Member States were provided with extensive support in 2012 to implement it. The general objective of the directive is to establish a Community framework for the responsible management of spent fuel and radioactive waste. It requires Member States to draw up national programmes and submit them to the Commission by August 2015 at the latest. The programmes have to include plans with a specific timetable for the construction of disposal facilities, a description of the activities involved in implementing disposal solutions, cost assessments and a description of the financing schemes.

Community system for the registration of carriers of radioactive materials

The revised draft proposal for a Council regulation establishing a Community system for the registration of carriers of radioactive materials (3) was adopted by the Commission on 28 September 2012, after the European Economic and Social Committee had given its opinion. Under the new regulation, the existing national reporting and authorisation procedures would be replaced by a single registration valid throughout the EU, while the safety levels reached would be maintained. Discussions in the Council are ongoing, with a view to adopting the regulation in 2013.

New basic safety standards (BSS) in radiation protection

Significant progress was made towards the adoption of the Commission's proposal for a Council directive on new basic safety standards (BSS) in radiation protection (4). The Economic and Social Committee delivered a favourable opinion in 2012 and discussions are progressing in the Council, with adoption expected during the Irish Presidency in the first half of 2013.

Supply of medical radioisotopes

Further efforts were made to ensure a sustainable supply of medical radioisotopes for nuclear medicine, which led to the establishment, in July 2012, of a European Observatory on the Supply of Medical Radioisotopes, involving all industrial stakeholders and relevant Commission services. In December 2012, the Council adopted additional conclusions, inter alia calling on the Commission to propose a financial instrument supporting the conversion of reactors from high-enriched to low-enriched uranium (HEU to LEU), in order to avoid an adverse effect on the production of medical radioisotopes in research reactors. ESA actively participates in the work of the Observatory by chairing the working group on the management of the conversion of targets from HEU to LEU for medical isotope production.

Bilateral nuclear cooperation agreements

Australia, Canada and the United States

Implementation of the nuclear cooperation agreements between Euratom and Australia, Canada and the United States continued throughout 2012 to the satisfaction of all involved. Regular consultation meetings were held.

Bilateral cooperation with some of these partners has been further developed through the negotiation of revised Euratom agreements aimed at ensuring the security of nuclear fuel supply. A renewed agreement with Australia, with a wider scope of application, entered into force on 1 January 2012.

The agreement with Canada is still being renegotiated. The initial agreement, signed in 1959 and amended five times since, needs to be revised and consolidated in order to facilitate its implementation.

(2) Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, OJ L 199, 2.8.2011, p. 48.

(3) COM(2011) 518 final of 30 August 2011.

(4) COM(2011) 593 final of 29 September 2011..

Russian Federation

Under the EU–Russia Energy Dialogue, a new thematic group on nuclear energy was created and met for the first time. It has a broad mandate to discuss various topics relating to nuclear energy, safety and fuel supplies.

Discussions on a possible Euratom–Russia cooperation agreement continued in 2012.

South Africa

The negotiations for a new agreement between Euratom and South Africa were concluded, and the text approved by both sides, but at the end of 2012 the agreement had still to be signed and enter into force.

European Nuclear Safety Regulators Group (Ensreg)

Ensreg is made up of senior officials from all 27 EU Member States' national regulatory authorities responsible for nuclear safety, radioactive waste safety or radiation protection, plus representatives of the Commission. Its objective is to further a common approach to the safety of nuclear installations and the safe management of spent fuel and radioactive waste.

Ensreg held six meetings in 2012 and played a key role in organising and supervising the nuclear stress tests together with the Commission. Other activities included advising the Commission on the Community legislation on the transposition and implementation of the nuclear safety directive and radioactive waste directive, and the possible revision of the nuclear safety directive.

European Nuclear Energy Forum (ENEF)

ENEF was established in November 2007 as a platform for broad discussion among stakeholders on the opportunities, risks and transparency of nuclear energy. Between its annual plenary sessions, ENEF works through three working groups focusing on opportunities, risks and transparency.

The activities under ENEF were pursued actively in 2012. The plenary meeting in Bratislava was attended by over 300 participants. The 'opportunities' working group contributed to the new 'EU energy 2050' reference scenarios. The 'risks' working group contributed to the revision of the nuclear safety directive and the implementation of the radioactive waste directive. In December, a working-level meeting in Luxembourg was devoted to discussion of the past and future of ENEF and streamlining its role in the wider context of European energy policy.

Main developments in the EU Member States

One year after the Fukushima-Daiichi nuclear incident, the EU's nuclear energy map continued to be shaped in varying ways in 2012, depending on individual Member States' nuclear strategies, though with a common goal in mind: ensuring higher nuclear safety and security standards.

Although the Commission granted its prior endorsement, there is still a question mark over the project for nuclear revival in Lithuania, following the negative outcome of a non-binding referendum in October. Following the 2012 elections, France expressed its intention to reduce the share of nuclear in its future energy mix.

On the other hand, Bulgaria, the Czech Republic, Romania, Slovakia, Finland and the United Kingdom continued their ongoing projects to expand nuclear capacity, despite delays due to doubts surrounding future nuclear investments. A strategy plan for new build has been approved in Poland and political support for future new construction was confirmed in the UK.

Although uranium extraction at the Sotkamo mine (Talvivaara project) in Finland has not yet kicked off, due to unexpected public opposition and subsequent mining permit delays, production in the EU could increase in the medium term, as the Czech government approved a plan to extend the life of the Rozna uranium mine and identify other locations for uranium mining.

As shown in Table 1, at the end of 2012, a total of 131 nuclear power reactors were in operation in the EU, with four more under construction. As compared with 2011, three reactors fewer are in operation as the Magnox-type reactors Oldbury 1 and Wylfa 2 were taken off the grid in the UK and Spain's Garoña NPP ceased electricity production in December.

Major developments in 2012

Belgium: The Belgian government confirmed that the Doel 1 and 2 nuclear reactors, two of the country's oldest, would close in 2015 after 40 years of operation, while the lifetime of the Tihange 1 reactor would be extended to 2025. Due to several defect indications detected in their pressure vessel during outage, two reactors were temporarily shut down in 2012 (Doel 3 in June and Tihange 2 in August). Both were able to resume operation safely with the approval of the Belgian safety authorities after a technical investigation by Electrabel.

Bulgaria: Progress has been made on the addition of a third reactor at the 2 000 MW Kozloduy nuclear plant site, for which a feasibility study report by Westinghouse Electric Company is expected to be presented in early 2013. A Bulgarian government decision to stop the construction of a 2 000 MWe Russian-designed NPP at Belene was confirmed by the parliament. Negotiations are ongoing between NEK EAD and AtomStroyExport to settle the payments due to the producer. AtomStroyExport's claim for USD 1.3 billion in compensation has been brought before the International Court of Arbitration in Paris.

Table 1 Nuclear power reactors in the EU in 2012

Country	Reactors in operation (under construction)	Nuclear electricity as % of total electricity generated
Belgium	7	51.0
Bulgaria	2	31.6
Czech Republic	6	35.3
Germany	9	16.1
Spain*	7	20.5
France	58 (1)	74.8
Hungary	4	45.9
Netherlands	1	4.4
Romania	2	19.4
Slovenia	1	35.9
Slovakia	4 (2)	53.8
Finland	4 (1)	32.6
Sweden	10	38.1
United Kingdom	16	18.1
Total	131 (4)	

* Garoña NPP has not been included in the table, as it stopped operating in December 2012; however, its operating licence is valid until July 2013.
Sources: IAEA and WNA

Czech Republic: According to recently released official updates on the country's future energy strategy, nuclear would need to account for around 30 % to 35 % of the domestic energy mix by 2040 (up from today's 16 %), in order for the Czech Republic to meet growing demand. Several bids have been received for the two new units planned at the Temelin NPP, and the generation III+ technology supplier is expected to be chosen by the end of 2013. In order to keep on contributing to the security of nuclear fuel supply for the country's growing reactor fleet, the government is looking into a project for the continuation of domestic uranium mining.

Spain: The government has implemented a new law for the electricity sector. As regards nuclear energy, new taxes on electricity production and spent nuclear fuel were established. In order to avoid bankruptcy, Nuclenor ceased production at Santa María de Garoña and proceeded to defuel the reactor before entry into force of the new law. It has said that it could review its decision if conditions for the application of the new taxes were to change.

France: In the aftermath of the Fukushima accident, the French nuclear safety authority (ASN) published a list of measures to be implemented by the country's nuclear facility operators by 2018 which will require huge investments on the part of EDF, the nuclear fuel-cycle facility operator AREVA, and the research and development agency CEA. In 2012, the Head of State decided to establish an energy transition policy, based on energy conservation on the one hand and the diversification of energy sources on the other. With regard to nuclear policy, during the Nuclear Policy Council on 28 September 2012, the Head of State confirmed the commitment to reduce the share of nuclear power in national power production from 75 % to 50 % by 2025. To this end, he announced the definitive closure of Fessenheim NPP's two reactors by 31 December 2016 at the latest. He also confirmed that Flamanville EPR would be the only NPP to be put into operation during his 5-year term and that the closed fuel-cycle strategy would apply to the management of spent nuclear fuel. The government expressed its support for the nuclear sector, which remains a pillar of France's energy mix. France has launched a national debate on energy transition, following which the most economical, ecological and socially just approach to the transition will be determined. The projected timetable of the 2006 Act with regard to a geological repository for long-lived mid-level and highly radioactive wastes has been confirmed and the public debate will be held in 2013. The costs of the Flamanville 3 NPP project have turned out to be higher than initially estimated. The marketing of the first KWh is still on schedule for 2016. Eurodif's Georges Besse uranium enrichment plant at Tricastin in the Drôme department was permanently shut down on 7 June after 33 years of uninterrupted service. Operated by AREVA, GB has been replaced by the new Georges Besse II site, in production since April 2011, which uses the more efficient centrifugation enrichment technology.

Lithuania: After concluding that the country's project to build a new 1 350 MW ABWR NPP at Visaginas met the Euratom Treaty objectives, the Commission granted its approval subject to the EU's post-Fukushima reactor stress test criteria being taken into account in the licensing process. The newly elected government is expected to take a decision soon, against the background of a rejection of the project in a non-binding national referendum in October.

Hungary: In December 2012, Hungary's national radioactive waste agency inaugurated underground disposal of waste drums at a near-surface repository for low- and intermediate-level radioactive waste in south-west Hungary. Already accommodating 3 000 waste drums from the 2 GWe Paks NPP at a temporary surface unit, the facility has been equipped with an underground vault which can contain 4 600 waste drums. It is expected that work to build two additional vaults will start in 2013.

Netherlands: The Borssele NPP applied for its nuclear licence to be amended to allow the use of MOX and extend its lifetime to the end of 2033. This amendment is expected to be granted in 2013. Capacity at Urenco's enrichment plant in Almelo increased 10 % to 5 500 tSW/year.

Poland: PGE, the Polish state-owned company, recently adopted an energy strategy plan for 2012–35 aimed at increasing its generating capacity and diversifying its sources of generating technology. As part of the engineering, procurement and construction process for two NPPs, each with a capacity of approximately 3 000 MWe, PGE has signed major agreements with the utilities Enea and Tauron and the mining giant KGHM. A thorough analysis of the financial aspects of the project is ongoing and the final decision on the sites should be taken by 2013.

Romania: With a view to attracting additional investors in the project for the construction of Units 3 and 4 at the Cernavoda NPP, the Romanian government has approved a 6-month extension of, and possible amendments to, the current investment agreement, initially due to expire at the end of 2012. Currently, ENEL and ArcelorMittal are the only remaining shareholders in the EnergoNuclear project apart from the Romanian nuclear power company Nuclearelectrica.

Slovakia: The Slovak utility Slovenske Elektrarne, part of the ENEL group, announced in March that Units 3 and 4 at the Mochovce NPP will not begin commercial operation until late 2013 and 2014 respectively. According to Fulvio Conti, CEO of the Enel Group, the delay is due to several factors, including the obligation to carry out the post-Fukushima EU-imposed stress tests.

Finland: As mentioned above, natural uranium production has not yet started at the Sotkamo nickel mine. The civil construction work of Teollisuuden Voima Oy's (TVO) Olkiluoto 3 NPP (EPR) is mostly complete. The major components of the reactor plant have been installed. TVO announced in June 2012 that the plant unit will not be ready for regular electricity production in 2014. It started the bidding process for the Olkiluoto 4 nuclear power plant project and bids have been received from AREVA and Toshiba for the construction of Fennovoima's new NPP, with a decision on the reactor supplier expected in 2013. Posiva Oy, a joint venture between TVO and Fortum, submitted a construction licence application in December 2012 for a spent-fuel repository in Eurajoki (this is the second application of its kind in Europe, the first having been submitted by Sweden in 2011). Designed as a tunnel network, with an interconnected above-ground encapsulation plant, the facility would accommodate 9 000 tonnes of spent fuel from TVO's and Fortum's existing and planned reactors.

United Kingdom: Oldbury 1, the world's oldest operating Magnox-type power reactor, in service since 1967, ceased operations on 29 February. In April, Unit 2 at the Wylfa nuclear plant in Wales was permanently shut down, after almost 41 years of service. Some of the used fuel has been transferred to Unit 1, the only remaining operational Magnox-type reactor in the UK, which has had its operational lifetime extended to 2014. Hitachi Ltd has purchased E.ON and RWE's joint venture, Horizon Nuclear Power, which holds grid connection agreements in the UK, at the Wylfa and Oldbury NPP sites. Horizon plans to build 1 300 MWe ABWRs at these two locations, where one to three reactors could be added to the grid, with at least one unit completed within 10 years. In August, the Commission officially endorsed EDF Energy's plan to build two power reactors at the Hinkley Point C site, concluding that the investment fulfils the objectives of the Euratom Treaty and contributes to developing a sustainable national energy mix. NNB Generation Company, EDF Energy's subsidiary in charge of the project, was granted a site preparation licence by the UK's Office for Nuclear Regulation (ONR). The first of its kind granted in the last 25 years, the licence ensures ONR's regulatory control over the project's activities. In order to move ahead with the project from a regulatory standpoint, EDF Energy needs further approvals, such as a construction licence from the ONR, permits from the Environment Agency and planning consent from the Secretary of State.

ESA operations

Mandate and core activities

A common nuclear market in the EU was created by the Euratom Treaty. Article 2(d) and Article 52 of the treaty established the ESA, with a mandate to ensure a regular and equitable supply of nuclear fuels to EU users. ESA therefore applies a supply policy based on the principle of equitable access to sources of supply. In this context, it focuses on enhancing the security of supply to users located in the European Union and shares responsibility for the viability of the EU nuclear industry. In particular, it recommends that European Atomic Energy Community 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 activities of individual users reflect the values set out above.

The Euratom Treaty requires ESA to be a party to supply contracts for nuclear material whenever one of the contracting parties is an EU utility, an operator of a research reactor in the EU or a producer/intermediary selling nuclear material (EU imports or exports, plus intra-EU transfers). When exercising its rights of co-signature, ESA implements the EU supply policy for nuclear materials. ESA also has a right of option on nuclear materials produced in the Member States.

Under the Euratom Treaty, ESA also monitors transactions involving services in the nuclear fuel cycle (conversion, enrichment and fuel fabrication). Operators are required to submit notifications giving details of their commitments. ESA verifies and acknowledges these notifications.

Since 2011, ESA has been scrutinising the potential risks to the security of supply of HEU and LEU which are required to produce medical radioisotopes (Mo-99). Since neither HEU nor such LEU is currently produced in the EU, our research reactors are 100 % dependent on a couple of external suppliers. In order to ensure that requirements at EU level are gauged more accurately and a common approach is taken on materials of such strategic importance and limited availability, ESA has been assessing the content of draft contracts at the initial stages of commercial negotiations and addressing, as appropriate and on time, any incompatibility with the applicable legal provisions.

ESA processed some 270 transactions, including contracts, amendments and notifications of the front-end activities, in 2012. In this way, the Agency ensured the security of supply of nuclear materials.

ESA's 2011 annual report was published in July 2012. As every year, ESA presented its annual calculation of different types of average natural uranium prices: MAC-3, multiannual and spot prices.

In 2012, in line with its statutory obligations, ESA's Nuclear Fuel Market Observatory continued to release the bimonthly nuclear news digest, quarterly uranium market reports, price trends and the weekly nuclear news brief (for readers in the Commission). Greater transparency in the EU natural uranium market reduces uncertainty and strengthens security of supply.

In 2012, ESA issued three quarterly uranium market reports (the first being a first/second quarter joint edition) and six nuclear news digests. The quarterly uranium market report reflects global and specific European Atomic Energy Community developments on the nuclear market. This includes general data about natural uranium supply contracts signed by EU utilities and descriptions of activity on the natural uranium market in the EU. In 2012, ESA quarterly uranium market reports also incorporated the quarterly spot-price index for natural uranium whenever three or more ordinary spot contracts had been concluded.

ESA's website was further developed in 2012, providing direct access to the list of members of ESA's Advisory Committee. The members of the Advisory Committee's various interest groups and working groups are now able to communicate with each other through a connection to the new CIRCA(BC) system. Data from the Agency's various publications have been added, with the aim of making the EU market more transparent and providing fuller insights into developments on the market.

Activities of the Advisory Committee

In line with ESA's statutes, the Advisory Committee assists the Agency in carrying out its tasks by giving opinions and providing analyses and information. The Advisory Committee also acts as a link between ESA and producers and users in the nuclear industry, as well as Member States' governments.

In 2012, the Advisory Committee met twice. At the first meeting (10 May), the main topics on the agenda were the Committee's opinion on ESA's 2011 annual report, assessment of ESA's accounts and 2011 budgetary situation, the budget for 2013, a presentation of the latest developments regarding the bilateral Euratom agreements with non-EU countries and the state of play and preliminary results of the EU stress tests. The committee also discussed providing its members, via ESA's website, with a web-based communication tool, the new CIRCA(BC) (Communication and Information Resource Centre for Administrations, Businesses and Citizens) EU system, and the related technical aspects. Also addressed were the perspectives of the Advisory Committee's working groups.

The second meeting took place on 8 November. The Committee discussed issues relating to its working groups (the Working Group on Prices and Security of Supply and the Working Group on Fuel Supply and Research Reactors). Discussions focused mainly on challenges to the future performance of these groups, especially the adjustment of price monitoring tools to changing market conditions and the feasibility of a LEU (for medical radioisotopes) production facility in the EU. Also, updates were given on the work of the European Observatory on the Supply of Medical Radioisotopes and negotiations on the bilateral Euratom agreements.

International cooperation

ESA has long-standing and well-established relationships with two major international organisations in the field of nuclear energy: the IAEA and the NEA. In 2012, ESA continued its cooperation with both these organisations by participating in two working groups — the Joint NEA/IAEA Uranium Group and the NEA High-Level Group on the Security of Supply of Medical Radioisotopes. Additionally, it continued to participate, on an ad hoc basis, in working groups and the nuclear fuel plenary sessions of the WNA. At the WNA plenary session in September 2012, and in the joint NEA/IAEA Uranium Group, ESA presented its latest analysis of the EU nuclear market.

ESA administrative issues

Implementation of the budget

In its vote on the 2012 budget, the Parliament decided to restore the heading 32.01.06 'Euratom contribution for operation of the Supply Agency' after a 4-year absence.

As a result, the Agency's revenue for 2012 consisted mainly of the abovementioned subsidy from the Commission and of bank interest and income from its capital and bank investments. The final budget amounted to EUR 104 500.

In line with the provisions of Article 4 of ESA's statutes, salaries were paid by the Commission and not charged to the Agency's budget. The Commission's budget also covered some other administrative expenses. Total expenditure for the year was EUR 102 500, or 98 % of the funds provided for in the budget.

The final annual accounts are available on ESA's website (http://ec.europa.eu/euratom/index_en.html).

Evaluation by the Court of Auditors

The Court of Auditors audits ESA's operations on an annual basis. ESA has taken due account of the opinions expressed by the Court.

Preserving ESA's administrative efficiency

In view of the anticipated departures of staff, in particular from the Contract Management Sector, which will result in a significant loss of experience, the Agency will face the challenge of keeping itself fully operational, without any interruption or major delay in file processing. To that end, it will have to publish the vacant posts in good time and attract, select, recruit and integrate new staff, as appropriate.

At the end of 2012, ESA had 17 permanent posts and one seconded national expert post.

2. World market for nuclear fuels

This chapter presents a short overview of the main developments in 2012 affecting the global supply and demand balance and security of supply at different stages of the fuel cycle. The information has been gathered from various specialised publications.

Last year, world reactor requirements for natural uranium were estimated at around 68 000 tU, approximately 8 % higher than in 2011. As predicted after the Fukushima accident, the nuclear fuel industry proceeded with caution, seeking assurances of market stability. Nonetheless, world civil nuclear power generation capacity increased, albeit at a slower than previously anticipated pace after the post-Fukushima drop in 2011, totalling about 374 GWe (back to its 2010 level).

Following shutdown of its entire operating commercial reactor fleet in May 2012 for safety inspections, Japan reactivated two power units in July. In September 2012, it released the 'Innovative strategy for energy and the environment', which includes the goal of reducing reliance on nuclear energy. After a slower first half of the year, China's growth resumed towards the end of 2012, accompanied by the development of new nuclear safety standards. The supply and demand picture is evolving as more countries, particularly in the developing world, prepare the ground (e.g. adopting legislation, regulations) for increasing nuclear generating capacity or developing it for the first time. Significant expansions of nuclear power projects have been planned in India, South Korea and Russia. The long-term role of nuclear energy in electricity supply has been given new impetus with Vietnam and Bangladesh putting forward advanced plans to build their first power reactors and the United Arab Emirates recently becoming the first Gulf state to start construction works on a commercial NPP.

According to the new policies scenario in the IEA World energy outlook 2012, world nuclear capacity is estimated to reach 580 GW in 2035 — about 50 GW lower than last year's projection. Correspondingly, the expected share of nuclear in total generation falls from 13 % to 12 %.

As regards uranium demand, future projections indicate a 22 % increase by 2020 and a 52 % increase by 2030.

Natural uranium production

In 2012, global uranium production increased by 9 % as compared with the 2011 figure, totalling approximately 58 500 tonnes of uranium (exceeding the WNA forecast of 52 000 tU). As in 2011, the top three uranium-producing countries were Kazakhstan, Canada and Australia.

According to Kazatomprom's preliminary year-end results, Kazakhstan remained the world's largest uranium producer in 2012, accounting for around 36 % of total uranium production worldwide. Kazakh uranium production reached 20 900 tU in 2012, a 7 % increase over the 2011 results (19 450 tU). Of total production in 2012, 11 900 tU went to Kazatomprom, whose exports amounted to 9 260 tU in 2012.

Preliminary year-end results published by WNA put Australia's production in 2012 at around 7 000 tU, a 19 % increase over the 2011 figure. Higher-grade ore was still extracted at the bottom of the Ranger mine in the second half of 2012, following which open-pit mining ceased, after 14 years of exploration (1997–2011) and around 67 000 tonnes of uranium oxide produced for export worldwide. Work on backfilling the pit has already begun.

Canada's production level remained almost the same in 2012.

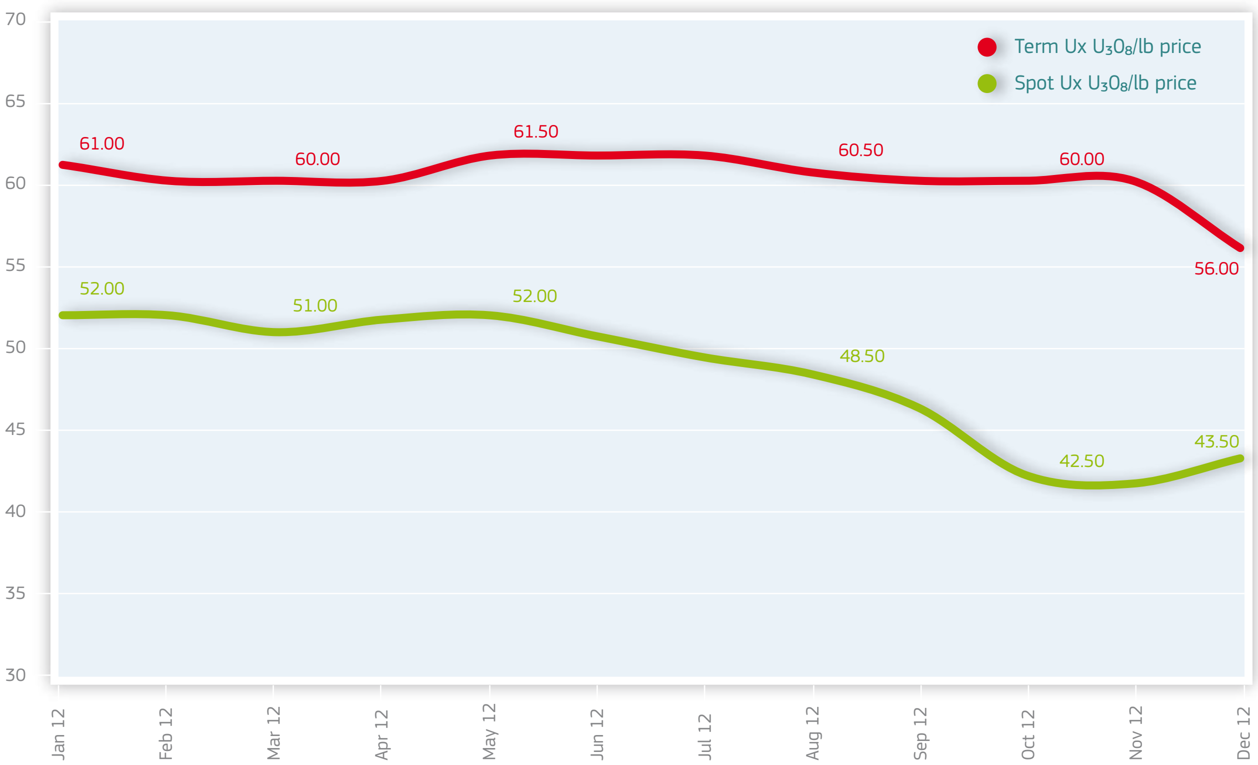
Price volatility decreased significantly in 2012. For much of the first half of the year, the U_3O_8 spot price published by the Ux Consulting Company remained close to the USD 52.00 level. The spot price started the year at USD 52.00 per pound, and increased slightly in January to USD 52.50, which was the peak for 2012. By June, the spot price had slipped and it hit USD 49.50 by the end of July. It continued its downward trend in August and September and into October, helping to spark an increase in discretionary buying and increasing spot volumes for those months. It flattened in November as some sellers became buyers, and hit its 2012 low of USD 40.75. It picked up again in December and finally ended the year at USD 43.50. The Ux U_3O_8 long-term price remained stable for most of the year at between USD 60.00 and USD 61.50, but dropped to USD 56.00 at the end of December 2012.

Table 2 Natural uranium preliminary production in 2012 (compared with 2011, in tonnes of uranium)

Region/country	Production 2012	Production 2011	Share in 2012 (%)	Share in 2011 (%)	Change 2012/11 (%)
Kazakhstan	20 900	19 451	36	36	7
Canada	9 000	9 145	15	17	– 2
Australia	7 116	5 983	12	11	19
Namibia	4 504	3 258	8	6	38
Niger	4 654	4 351	8	8	7
Russia	2 885	2 993	5	6	– 4
Uzbekistan	2 423	2 500	4	5	– 3
United States	1 595	1 537	3	3	4
Ukraine	962	890	2	2	8
China	1 520	885	3	2	72
Malawi	1 101	846	2	2	30
South Africa	462	582	1	1	– 21
Others	1 344	1 073	2	2	25
Total	**58 466**	**53 494**	**100**	**100**	**9**

Source: Nuclear data from industry and WNA (totals may not add up due to rounding).

Figure 1 Monthly spot and term U_3O_8/lb prices (USD)



Source: The Ux Consulting Company

Secondary sources of supply

In 2012, some of the uranium supplied to the market continued to come from secondary sources, including stockpiles of natural and enriched uranium, the down-blending of weapons-grade uranium, the reprocessing of spent nuclear fuel, re-enrichment of uranium tails and savings of uranium through underfeeding.

Over recent years, secondary supplies have shown a downward trend, which will continue due to the decline in the quantity of LEU derived from Russian down-blended HEU brought about by the end of the US–Russia megatons to megawatts programme in 2013. It is estimated that 463.5 tonnes of bomb-grade HEU have already been recycled into 13 345 tonnes of LEU, which is equivalent to eliminating 18 539 nuclear warheads and converting them into commercial NPP fuel.

It is expected that the recycling of reprocessed uranium (ERU) and plutonium (MOX) will still play a role in meeting the demand for nuclear fuel. Given the limited information available on secondary supplies, it is difficult to say how long this will continue to be the case in the future.

Uranium exploration and mine development projects

In light of the anticipated long-term growth in uranium demand and decline in the availability of secondary sources, it is essential that new projects be developed in good time. In 2012, due to falling uranium prices and a temporary drop in demand following the Fukushima accident, we witnessed delays to ongoing uranium exploration and mine development projects, and a dropping-off of plans to expand production.

In Australia, BHP Billiton was granted government approval to continue its delayed expansion project at Olympic Dam for four more years. BHP plans to channel most of the available funds (AUD 650 million) into studies on new processing technology which would enable it to develop an open pit mine, a cheaper alternative to the initially planned underground mining.

The French company AREVA has yet to resume its mining projects at the Trekkopje mine in Namibia and the Bakouma mine in the Central African Republic. The Imoraren project in Niger was further delayed.

The production delays at Cigar Lake in Canada increased the industry's awareness of the need to diversify its exploration efforts. Nevertheless, development of the mine continued and the owners expect to have the first ore commissioning in mid 2013, with the first pre-packaged pounds anticipated for the fourth quarter of 2013.

As for future projects, in Australia, Queensland will soon resume uranium mining and export for peaceful uses, following the lifting of its 30-year old uranium mining ban. Energy Resources of Australia (ERA) plans to start exploration drilling at Ranger 3 Deeps underground mine in northern Australia in 2013, after having secured all the necessary regulatory approvals.

Cameco Corp. reached an agreement with BHP Billiton to acquire the Yeelirrie uranium project, one of Australia's largest undeveloped uranium deposits amenable to open-pit mining techniques. In 2012, together with JCU (Canada) Exploration Co., Cameco also concluded the acquisition of the Millennium project, a proposed underground uranium mine about 600 kilometres north of Saskatoon, Canada.

China Guangdong Nuclear Power Co. acquired a majority stake (64 %) in Australian Extract Resources Ltd, the company developing the Husab uranium project in Namibia. China National Nuclear Corporation (CNNC) announced plans to step up the pace of its uranium mining exploration activities overseas, expecting to meet its growing demand from domestic resources and enhanced exploration, mainly in Australia, Africa and central Asia.

New technology developments were announced by Uranium Equities Ltd, which successfully completed tests on its PhosEnergy demonstration plant in the United States, where uranium is extracted from phosphate fertiliser manufacturing streams. The company said the process delivered consistently high (over 90 %) uranium recovery. The production cost for the uranium concentrate was estimated at USD 20–25 per pound, with other costs dependent on the size of the plant.

The 2012 edition of the 'red book on uranium' [5] reported that the production capacity of existing and committed production centres is expected to reach over 95 000 tU/year in 2020, declining thereafter to about 65 000 tU in 2035. Total potential production capacity (including planned and prospective production centres) could climb rapidly to over 130 000 tU/year by 2020, followed by a slow decline to around 110 000 tU/year in 2035. However, these projections are based on currently known uranium resources that will in all likelihood be supplemented by new discoveries in the future, with appropriate market signals. Several countries, including Australia, Brazil, Canada, Kazakhstan, Namibia, Niger and Russia, have unveiled plans for significant additions to planned future production capacity. In addition, production has already begun in Malawi, while countries such as Botswana, Jordan, Mongolia, Tanzania and Zambia are working towards production in the near future. Meeting future demand through uranium production might prove challenging, however, given the difficulty of financing new mining projects in the current complex economic and environmental climate. In the long term, the rapidly growing Asian markets could create some uncertainty as to whether anticipated world production can meet the steadily growing demand.

(5) *Uranium 2011: resources, production and demand*, a joint report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, Paris 2012.

Falling uranium prices slowed down many exploration and mine development projects in the short term, particularly in the junior uranium mining sector. However, many major uranium companies made concerted efforts, boosting their exploration and development expenditure, to secure uranium deposits suitable for projected future supply requirements. A notable increase in exploration in Africa and South America occurred during this period, primarily due to a change in focus to other deposit models (unconformity-type, high-grade deposits v lower-grade, higher-tonnage deposits).

Conversion

Four major commercial primary conversion companies, operating in Canada, France, Russia, the United Kingdom and the United States, meet most of the worldwide demand for UF_6 conversion services. In 2012, world nameplate conversion capacity was estimated at around 76 000 tU, which was well above the global demand for conversion services, estimated to be around 56 000 tU.

According to market analysts, the market has an adequate supply base up to 2030, with slightly higher concerns over the period beyond 2026 and demand for conversion continuing to grow up to 83 000 tU by 2020. Hence, conversion remains a critical step in the nuclear fuel cycle. There appears to be broad acknowledgment that, in the long run, investment in new conversion capacity is needed, either through expansions at existing facilities, e.g. in Canada, China, Russia and the United States (Metropolis), or through new build, e.g. in France (Comurhex II) or Kazakhstan.

In the aftermath of the Fukushima accident, major converters shifted their supply strategies to adapt to lower fuel demand and price levels.

ConverDyn began upgrades to bring the Metropolis Conversion Facility into line with the stricter safety standards imposed by the US NRC. Metropolis is officially expected to reopen in June 2013 and recent developments indicate that it will regain full capacity in 2014.

Cameco's Port Hope conversion plant has been granted a 5-year licence renewal, valid through February 2017, though this does not meet the converter's additional requests for flexibility as to the release of liquid-treated effluent.

The only new conversion facility, Comurhex II is expected to reach a capacity of 15 000 tonnes/year. With some of its workshops already completed, the plant's gradual start-up is on schedule.

European and North American Ux spot conversion prices increased in 2012, by 46 % and 61 % respectively. The European and North American price indices ended the year at USD 11/kgU and USD 10.50/kgU respectively. Long-term conversion prices were stable for the whole year, maintaining the previous year's level of USD 17.25/kgU in Europe and USD 16.75/kgU in North America.

Enrichment

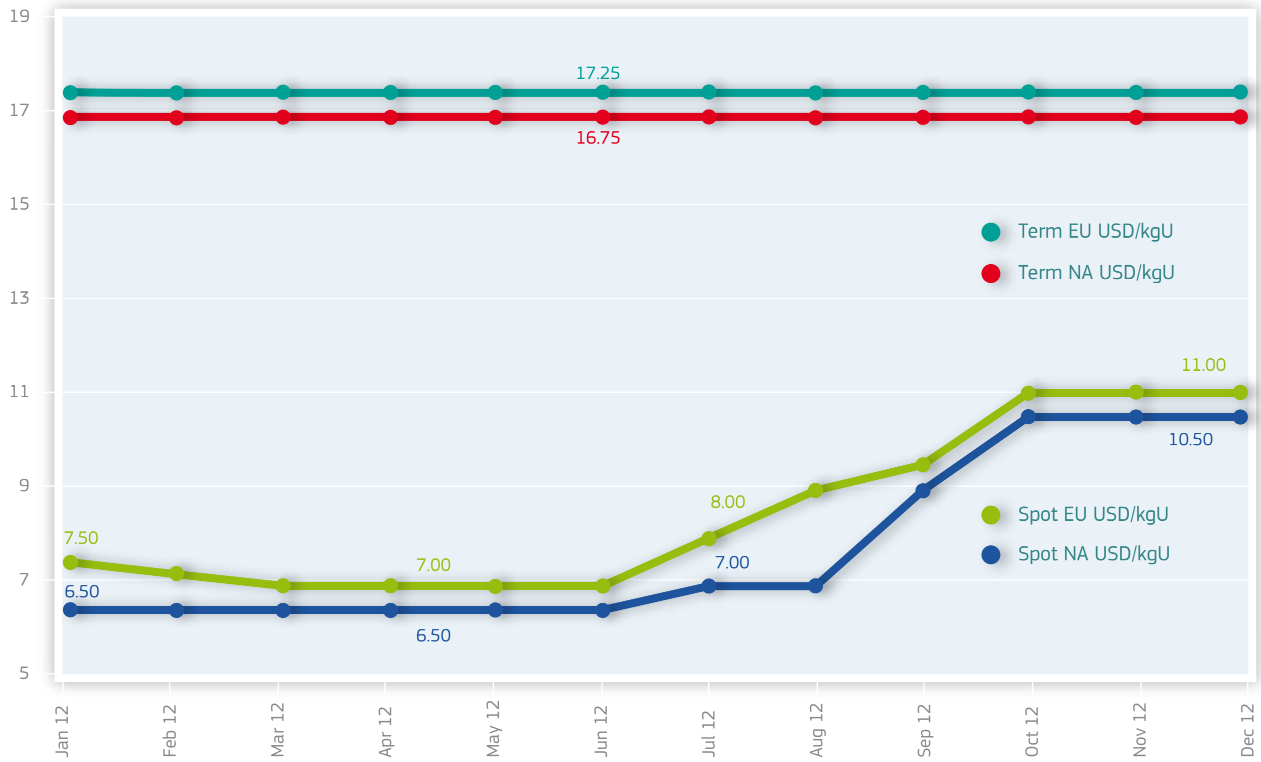
Despite lower demand since the March 2011 Fukushima accident, the enrichment market remained robust in 2012 with increased capacity and new project plans. The current commercial enrichment nameplate capacity of around 65 000 tSW indicates excess supply and is estimated to be sufficient to cover demand until 2020. In 2012, the industry put demand for enrichment services at below 50 000 tSW.

Table 3 Commercial UF_6 conversion facilities (tonnes of uranium/year)

Company	Nameplate capacity in 2011 (tU as UF_6)	Share of global capacity (%)
Atomenergoprom (Rosatom) (Russia)	25 000	33
Cameco-Springfields (Canada, UK)	17 500	23
ConverDyn (USA)	15 000	20
Comurhex (AREVA) (France)	14 000	19
CNNC (China)	3 000	4
Ipen (Brazil)	90	0
Total nameplate capacity	74 590	100

Source: The global nuclear fuel market — Supply and demand 2011–2030, WNA

Figure 2 Uranium conversion price trends (USD)



Source: The Ux Consulting Company

Table 4 Operating commercial uranium enrichment facilities with approximate 2012 capacity

Company	Nameplate capacity (tSW)	Share of global capacity (%)
Atomenergoprom (Russia)	28 600	44
Urenco (UK/Germany/Netherlands/USA)	16 900	26
USEC (USA)	11 300	17
AREVA-GBII (France)	7 500	11
CNNC (China)	1 300	2
JNFL	0	0
World total	65 600	100

Source: Nuclear data from industry

According to the latest forecasts of growth in nuclear power production, the SWU oversupply situation will not be resolved before 2020. Some of the overcapacity will be used to balance underfeeding, which in turn will have an impact on uranium markets.

In 2012, expansions in enrichment capacity moved forward and new build plans, albeit revised, remained in place. In June, the George Besse uranium enrichment plant at Tricastin in France definitively ceased production after 33 years of uninterrupted operation. Operated by AREVA, GB has been replaced by the more efficient centrifugation enrichment technology-based Georges Besse II plant, in production since April 2011, which already has installed capacity of 2.8 million SWU/year.

At the end of 2012, Urenco's total annual enrichment capacity (both European- and US-based) amounted to 16.9 million SWU. Louisiana Energy Services (LES), in operation since June 2010, has applied to the US Nuclear Regulatory Commission for increased capacity licensing at the Urenco USA (UUSA) centrifuge facility, aiming to reach an annual enrichment capacity of 10 million SWU by 2020.

USEC entered into a multi-party arrangement with the US DoE, among others, to extend uranium enrichment operations at Paducah Gaseous Diffusion Plant through 31 May 2013. Under the agreement, DoE will transfer 9075 tU of its high-assay depleted uranium tails inventory to Energy Northwest, which will then contract enrichment services to USEC for the production of 482 tU of low-enriched uranium.

The US Nuclear Regulatory Commission granted Global Laser Enrichment (a subsidiary of GE-Hitachi) a licence to build and operate a full-scale laser enrichment facility, using Silex-based laser enrichment technology and able to produce 6 million SWU/year at an enrichment level of up to 8 %. This technology would be used at the Paducah site and might enhance the economics of the Silex technology, while also improving the market potential of the DoE's large stockpile of depleted uranium.

USEC and the US DoE signed new agreements in June for a 2-year, USD 350 million cooperative research, development and demonstration (RD & D) programme for the American Centrifuge technology. The programme will support the building, installing, operating and testing of commercial plant support systems and a 120 machine cascade.

TVEL, Rosatom's subsidiary, and Kazatomprom, Kazakhstan's nuclear holding company, finalised the legal basis for the creation of a joint uranium enrichment centre (UEC).

Fabrication

Nuclear fuel fabrication is a specialised service rather than a commodity transaction, and the main fuel manufacturers are also the main suppliers of nuclear power plants, or connected to them. The largest fuel manufacturing capacity can be found in the EU (Germany, Spain, France, Sweden and the UK), Russia and the United States, but fuel is also manufactured in other countries, often under licence from one of the main suppliers.

At Rokkasho-mura, Japan, it is expected that completion of the MOX fuel fabrication plant with an annual planned capacity of 130 tonnes of heavy metal (1 000 BWR MOX assemblies) will be delayed beyond the target date of March 2016.

Cameco's fuel manufacturing plant at Port Hope has been granted a 10-year operating licence renewal by the Canadian Nuclear Safety Commission.

TVEL signed a contract with Sweden's Vattenfall Nuclear Fuel AB for the supply of a pilot batch of its TVS-Kvadrat lead fuel assemblies. These fuel assemblies will be tested for qualification, which would enable TVEL to emerge as a new player in the PWR fuel fabrication market.

Reprocessing

In the past, the recovery of uranium and plutonium through the reprocessing of spent fuel was common in several countries. It is now done routinely only in France and Russia, principally because it is relatively costly, due mainly to the need for dedicated conversion, enrichment and fabrication facilities for reprocessed uranium.

In 2012, the use of reprocessed uranium and plutonium was limited. It is estimated that about 200 tonnes of ERU and MOX fuel are used annually, which represents about 2 % of new nuclear fuel and is equivalent to about 2 000 tonnes of mined uranium.

3. Supply and demand for nuclear fuels in the EU

This overview of supply and demand for nuclear fuels in the EU is based on information provided by the EU utilities or their procurement organisations in an annual survey of acquisition prices for natural uranium, the amounts of fuel loaded into reactors, estimates of future fuel requirements, quantities and origins of natural uranium and separative work, and future contracted deliveries and inventories. At the end of 2012, there were 131 commercial nuclear power reactors operating in the EU, located in 14 EU Member States and managed by 18 nuclear utilities. There were four reactors under construction in France, Slovakia and Finland. According to the latest available data published by the Commission in 2012, EU-27 gross electricity generation amounted to 916.6 TWh in 2010 and nuclear gross electricity generation accounted for 27.4 % of total EU-27 production.

Fuel loaded into reactors

In 2012, 2 271 tU of fresh fuel was loaded into commercial reactors in the EU-27. It was produced using 15 767 tU of natural uranium and 1 024 tU of reprocessed uranium as feed, enriched with 11 803 tSW. The quantity of fresh fuel loaded decreased by 12 % (i.e. 313 tU less than in 2011). In 2012, the fuel loaded into EU reactors had an average enrichment assay of 3.78 % and an average tails assay of 0.24 %.

Future reactor requirements (2013–32)

EU utilities have estimated their gross reactor requirements for natural uranium and enrichment services over the next 20 years, taking into account possible changes in national policies or regulatory systems resulting in the construction of new units, lifetime extensions, the early retirement of reactors, phasing-out or decommissioning. Net requirements are calculated on the basis of gross reactor requirements after subtracting savings resulting from planned uranium/plutonium recycling and inventory usage.

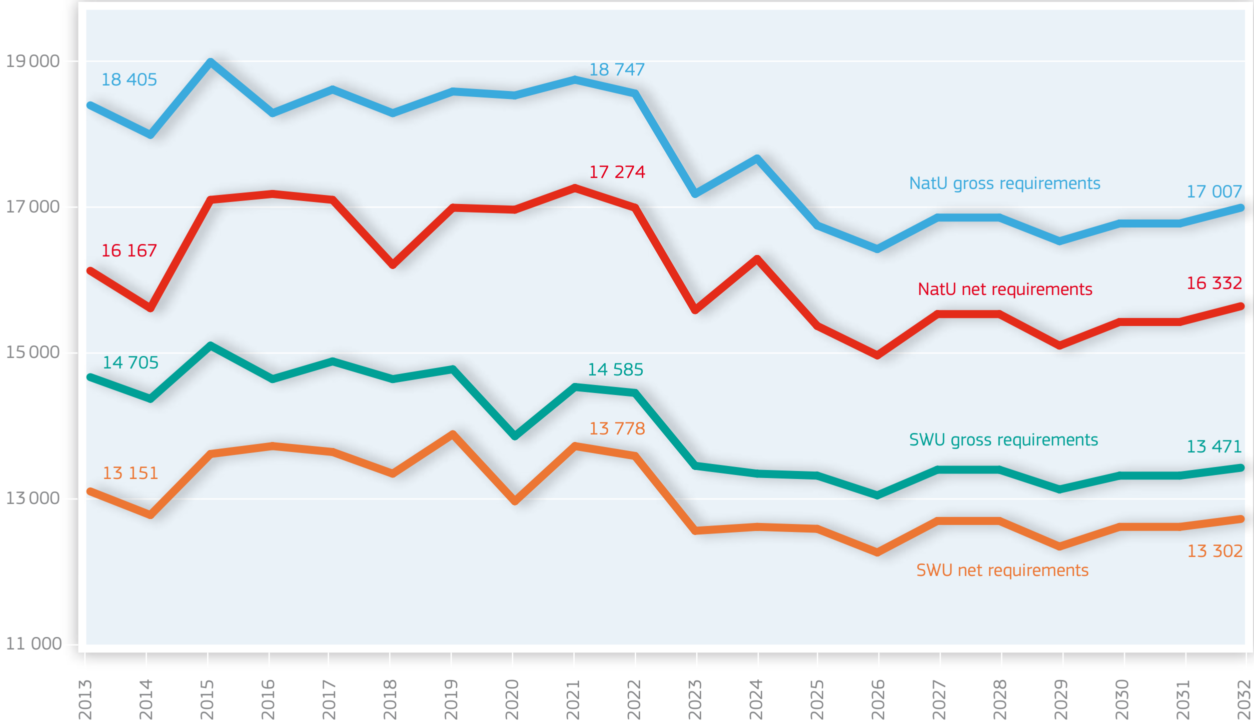
Natural uranium — average reactor requirements		
2013–22	18 508 tU/year (gross)	16 780 tU/year (net)
2023–32	16 903 tU/year (gross)	15 522 tU/year (net)

Enrichment services — average reactor requirements		
2013–22	14 635 tSW/year (gross)	13 492 tSW/year (net)
2023–32	13 365 tSW/year (gross)	12 628 tSW/year (net)

Estimates of future EU reactor requirements for uranium and separative work, based on data supplied by all EU utilities, are shown in Figure 3 (see Annex 1 for the corresponding figures).

Compared with last year's annual survey, European utilities have revised their forecasts of gross requirements for natural uranium downwards by 2 % (362 tU) and for separative work upwards by 1 % (18 tSW) for the period 2013–22 and in both cases downwards by 4 % (691 tU and 501 tSW respectively) for 2023–32. The drop in natural uranium requirements in 2012 was smaller than forecast last year, when utilities reduced their anticipated requirements in the coming two decades by 10 % and 17 % respectively, a result of the uncertainty spread by the Fukushima accident and Germany's subsequent decision to phase out nuclear power completely by 2022. The increase in separative work requirements for the coming decade is in line with the recent trend of EU utilities opting for a higher enrichment assay and a lower tails assay.

Figure 3 Reactor requirements for uranium and separative work (EU-27) (tonnes NatU or tSW)



Supply of natural uranium

Conclusion of contracts

In 2012, ESA processed a total of 63 contracts and amendments, of which 44 (70 %) were newly concluded contracts. Of the 39 new purchase/sale contracts, 46 % involved EU utilities and the remainder were signed by intermediaries. Table 5 gives further details of the type of supply, terms and parties involved.

Table 5 Natural uranium contracts concluded by or notified to ESA (including feed contained in EUP purchases)

Type of contract	Number of contracts concluded in 2011	Number of contracts concluded in 2010
Purchase/sale by an EU utility/user	**18**	**24**
— multiannual (1)	10	8
— spot (1)	8	16
Purchase/sale by intermediaries	**21**	**17**
— between intermediaries (2) (multiannual)	5	4
— between intermediaries (2) (spot)	16	13
Exchanges and loans (3)	**5**	**6**
Amendments	**19**	**28**
TOTAL (4)	63	75

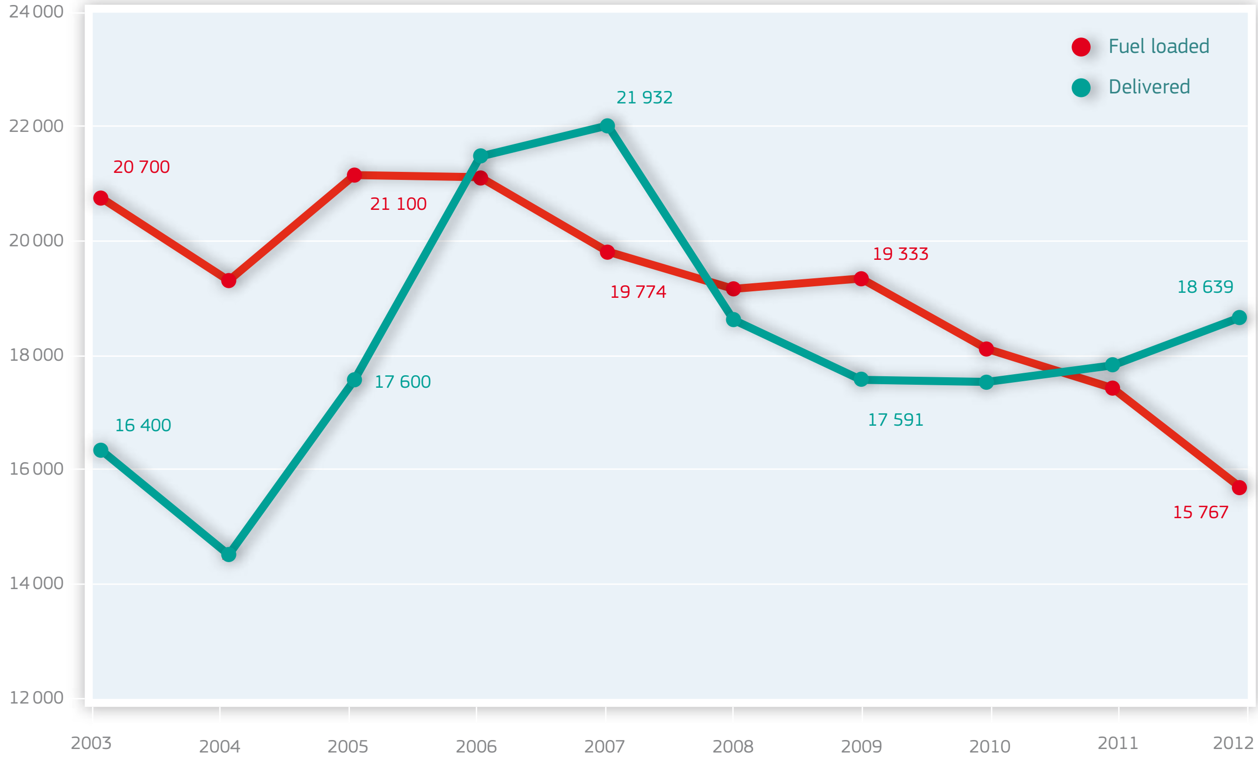
(1) Multiannual contracts are contracts providing for deliveries extending over more than 12 months, whereas spot contracts provide either for one delivery only or for deliveries over a maximum of 12 months, whatever the time between conclusion of the contract and the first delivery.

(2) Purchase/sale contracts between intermediaries — neither the buyers nor the sellers 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) In addition, there were transactions for small quantities (Article 74 of the Euratom Treaty) which are not included here.

Figure 4 Natural uranium feed contained in fuel loaded into EU reactors and natural uranium delivered to utilities under purchasing contracts (tonnes NatU)



Volume of deliveries

The deliveries taken into account are those to EU utilities or their procurement organisations in 2012, excluding research reactors. Also taken into account is the natural uranium equivalent contained in enriched uranium purchases, when stated.

In 2012, demand for natural uranium in the EU represented approximately one third of global uranium requirements. EU utilities purchased a total of 18 639 tU in 127 deliveries under long-term and spot contracts, 807 tU or 4.5 % more than in 2011. As in previous years, long-term supplies remained the main source for meeting demand in the EU. Deliveries of natural uranium to EU utilities under long-term contracts accounted for 17 929 tU (of which 17 120 tU with reported prices) or 96.2 % of the total deliveries, whereas the remaining 3.8 % (710 tU) were purchased under spot contracts. On average, the quantity of natural uranium delivered was 166 tU per delivery under long-term contracts and 37 tU per delivery under spot contracts.

Natural uranium contained in the fuel loaded into reactors in 2012 totalled 15 767 tU. The difference between natural uranium delivered and natural uranium contained in the fuel loaded was positive, as in the previous year. The surplus is a result of technical requirements for reloading campaigns, fuel fabrication lead times and inventory management by the utilities. The quantity of fuel loaded was smaller than previously expected also due to the temporary shutdown of two reactors in Belgium. Natural uranium feed contained in fuel loaded into EU reactors and natural uranium delivered to utilities under purchasing contracts are shown in Figure 4 (see Annex 2 for the corresponding table for 1980–2012).

Average prices of deliveries

In order to enhance market transparency, ESA publishes three EU natural uranium price indices on an annual basis, which are based only on deliveries made to EU utilities or their procurement organisations under natural uranium and enriched uranium purchasing contracts in which the price is stated.

The natural uranium delivery price stated in purchase contracts concluded in recent years (mainly for new multiannual contracts but also for a non-negligible percentage of the spot contracts) is generally agreed using sophisticated price formulae using uranium price and inflation indices.

ESA's price calculation method is based on the currency conversion of the original contract prices, using the average annual exchange rates published by the European Central Bank, into EUR/kg uranium (kgU) in the chemical form U_3O_8. The average prices are then calculated after weighting the prices paid according to the quantities delivered under each contract. A detailed analysis is presented in Annex 8 — Calculation method for ESA's average U_3O_8 prices.

Since uranium is priced in US dollars, the fluctuation of the EUR/USD exchange rate influences the level of the price indices calculated. The year 2012 was marked by a depreciation of the euro in nominal effective terms against the dollar. On average, the US dollar appreciated by 8 % against the euro as compared with 2011, with the annual average ECB EUR/USD rate falling to 1.28 from 1.39 in 2011, which consequently had an impact on the final dollar-denominated ESA prices.

In order to establish a natural uranium price excluding the conversion cost, whenever the latter was included, but not specified, ESA applied a rigorously calculated average conversion price, on the basis of reported conversion prices under the natural uranium long-term contracts.

1. **ESA spot U_3O_8 price:** the weighted average of U_3O_8 prices paid by EU utilities for uranium delivered under spot contracts in 2012 was calculated as:

EUR 97.80/kgU contained in U_3O_8	(9 % down from EUR 107.43/kgU in 2011)
USD 48.33/lb U_3O_8	(16 % down from USD 57.52/lb U_3O_8 in 2011)

2. **ESA long-term U_3O_8 price:** the weighted average of U_3O_8 prices paid by EU utilities for uranium delivered under multiannual contracts in 2012 was calculated as:

EUR 90.03/kgU contained in U_3O_8	(8 % up from EUR 83.45/kgU in 2011)
USD 44.49 /lb U_3O_8	(0.4 % up from USD 44.68/lb U_3O_8 in 2011)

3. **ESA 'MAC-3' new multiannual U_3O_8 price:** the weighted average of U_3O_8 prices paid by EU utilities, only for multiannual contracts which were concluded or for which the pricing method has been amended in the past 3 years and under which deliveries were made in 2012, was calculated as:

EUR 103.42/kgU contained in U_3O_8	(3 % up from EUR 100.02/kgU in 2011)
USD 51.11/lb U_3O_8	(4.5 % down from USD 53.55/lb U_3O_8in 2011)

The ESA U_3O_8 spot price reflects the latest developments on the uranium market as it is calculated from contracts providing either for one delivery only or for deliveries over a maximum of 12 months. In 2012, the ESA U_3O_8 spot price was EUR 97.80/kgU (or USD 48.33/lb U_3O_8), 9 % lower than in 2011. Price data were narrowly distributed, mostly falling within the range of EUR 90 to EUR 98/kgU (USD 44.5 to USD 48.5/lb U_3O_8). The ESA long-term U_3O_8 price was EUR 90.03/kgU U_3O_8 (USD 44.49/lb U_3O_8). Long-term prices paid varied widely, with approximately 70 % (assuming a normal distribution) falling within the range of EUR 64 to EUR 119/kgU (USD 31.5 to USD 58.5/lb U_3O_8). Normally, traded long-term prices go at a premium to spot prices as buyers are willing to pay a risk premium to lock in future prices. However, the ESA long-term U_3O_8 price is not forward looking. It is based on historical prices contracted under multiannual contracts, which are either fixed or calculated on the basis of formulae indexing mainly uranium spot prices. Spot prices are the most widely indexed prices in long-term contracts. On average, the multiannual contracts which led to deliveries in 2012 had been signed 8 years earlier.

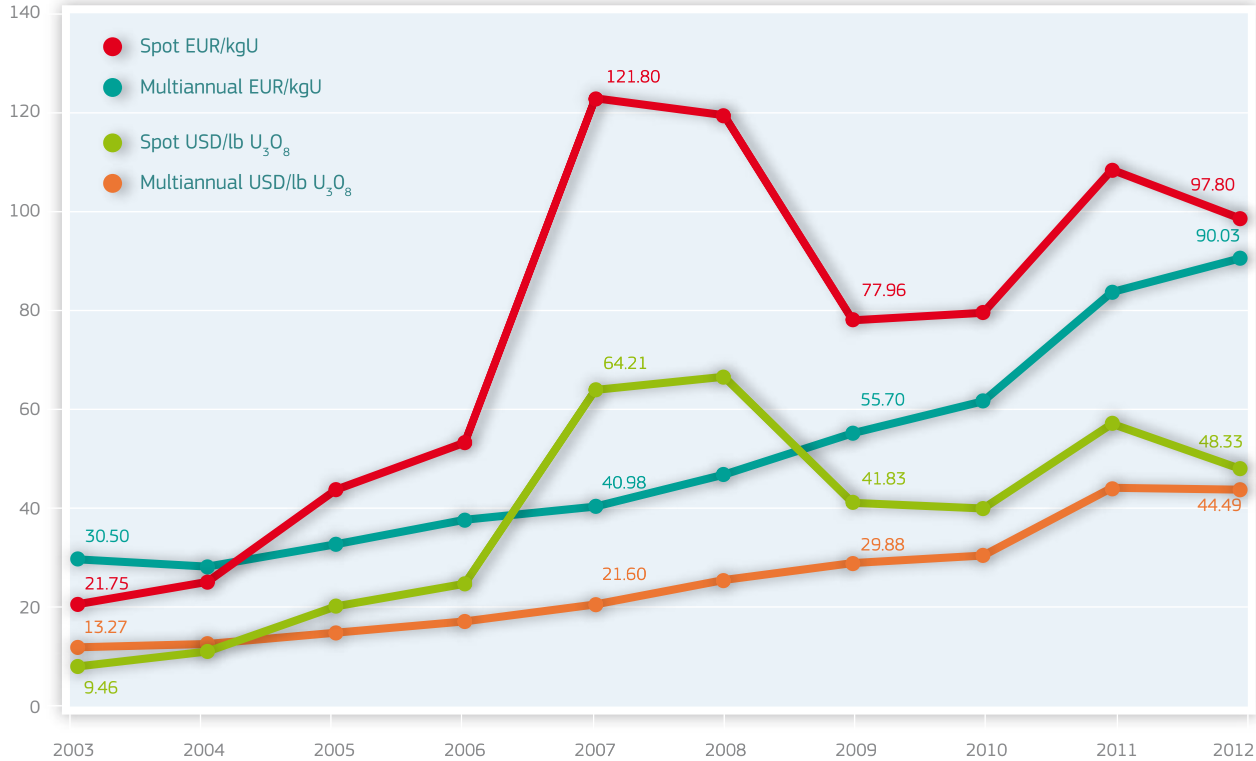
However, the ESA MAC-3 multiannual U_3O_8 price data were distributed within a narrower range, with approximately 85 % of prices reported falling between EUR 91 and EUR 122/kgU (USD 45 to USD 60/lb U_3O_8). The ESA MAC-3 index takes into account only long-term contracts signed recently (in 2010–12) or older long-term contracts for which the uranium pricing method was amended during the same period, thus incorporating current market conditions and providing insights into the future of the nuclear market.

The ESA long-term U_3O_8 price paid for uranium originating in the CIS ([6]) was 13 % higher than the prices for uranium of non-CIS origin. By contrast, the ESA MAC-3 multiannual U_3O_8 price paid for uranium originating in CIS countries was 10 % lower than the price for uranium of non-CIS origin.

Figure 5 shows the ESA average prices for natural uranium since 2003. The corresponding data are presented in Annex 3.

([6]) Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

Figure 5 Average prices for natural uranium delivered under spot and multiannual contracts, 2003–12 (EUR/kgU and USD/lb U_3O_8)



Origins

In 2012, natural uranium supplies to the EU continued to come from diverse sources. In general, the origins of natural uranium supplied to EU utilities have remained unchanged since 2011 (except for Ukraine, which made no deliveries in 2012). However, the relative shares of the four big uranium-producing regions (the CIS, North America, Africa and Australia) have shifted substantially.

Russia and Canada were the top two countries delivering natural uranium to the EU in 2012, providing 44 % of the total. Uranium originating in Russia (including purchases of natural uranium contained in EUP) represented the largest proportion, with 5 102 tU or 27 % of total deliveries, which was 13 % up on 2011. It was followed by uranium of Canadian origin, with a 17 % share or 3 212 tU, a year-on-year decline of 3 %. In third place, uranium mined in Niger amounted to 2 376 tU or 13 %, a strong 38 % increase over 2011. Australia and Kazakhstan accounted for 12 % each in 2012, an increase of 28 % and a 15 % decrease, respectively.

Natural uranium mined in the CIS (mainly Russia, Kazakhstan and Uzbekistan) accounted for 7 910 tU, or 42 % of all natural uranium delivered to EU utilities, a 13 % decrease from the year before.

Deliveries of uranium of North American origin totalled 3 454 tU (19 %), a decrease of 1 % from 2011.

Deliveries of uranium from Africa increased by 49 %, up to 4 318 tU from 2 899 tU in 2011, accounting for a considerably higher share of the European market in 2012. Uranium extracted from Niger accounted for 2 376 tU, or 13 % of the total deliveries to EU utilities, and for 55 % of all African-origin uranium. A substantial 33 % increase was reported in deliveries of uranium extracted in Namibia, which represents 7 % of the total deliveries to the EU in 2012, and there was a strong increase in uranium deliveries from South Africa, which more than doubled its deliveries to the EU as compared with 2011 figures.

Similarly, Australian-origin uranium totalled 2 280 tU (or 12 % of total deliveries), an increase of 28 % over last year (1 777 tU).

European uranium delivered to EU utilities originated in the Czech Republic and Romania and covered approximately 2 % of the EU's total requirements (a total of 421 tU), which is 7 % less than in 2011.

The amount of HEU feed used decreased to 395 tU from 732 tU in 2011, showing an annual decline of almost 50 %.

No deliveries of re-enriched tails material were reported by EU utilities.

Figure 6 Origins of uranium delivered to EU utilities in 2012 (% share)

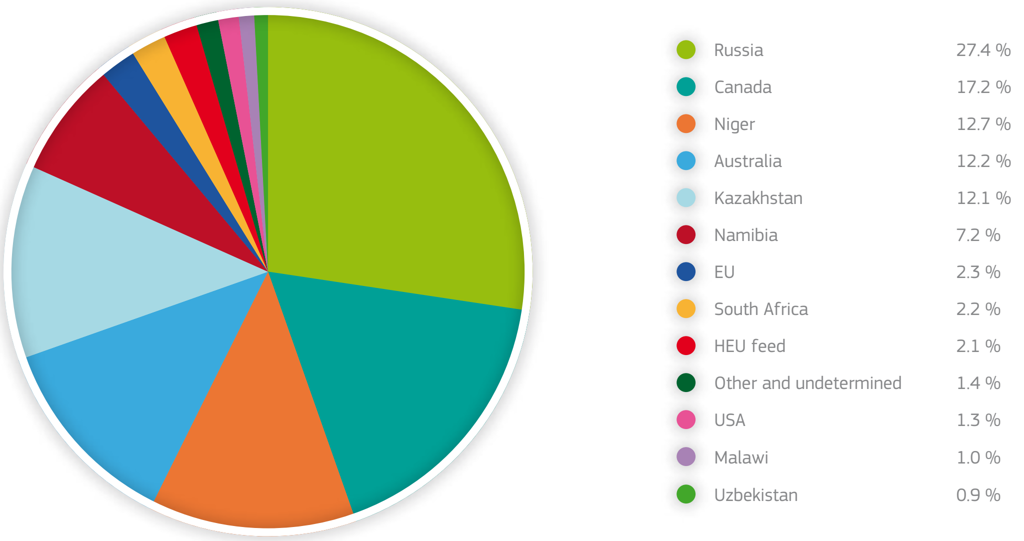
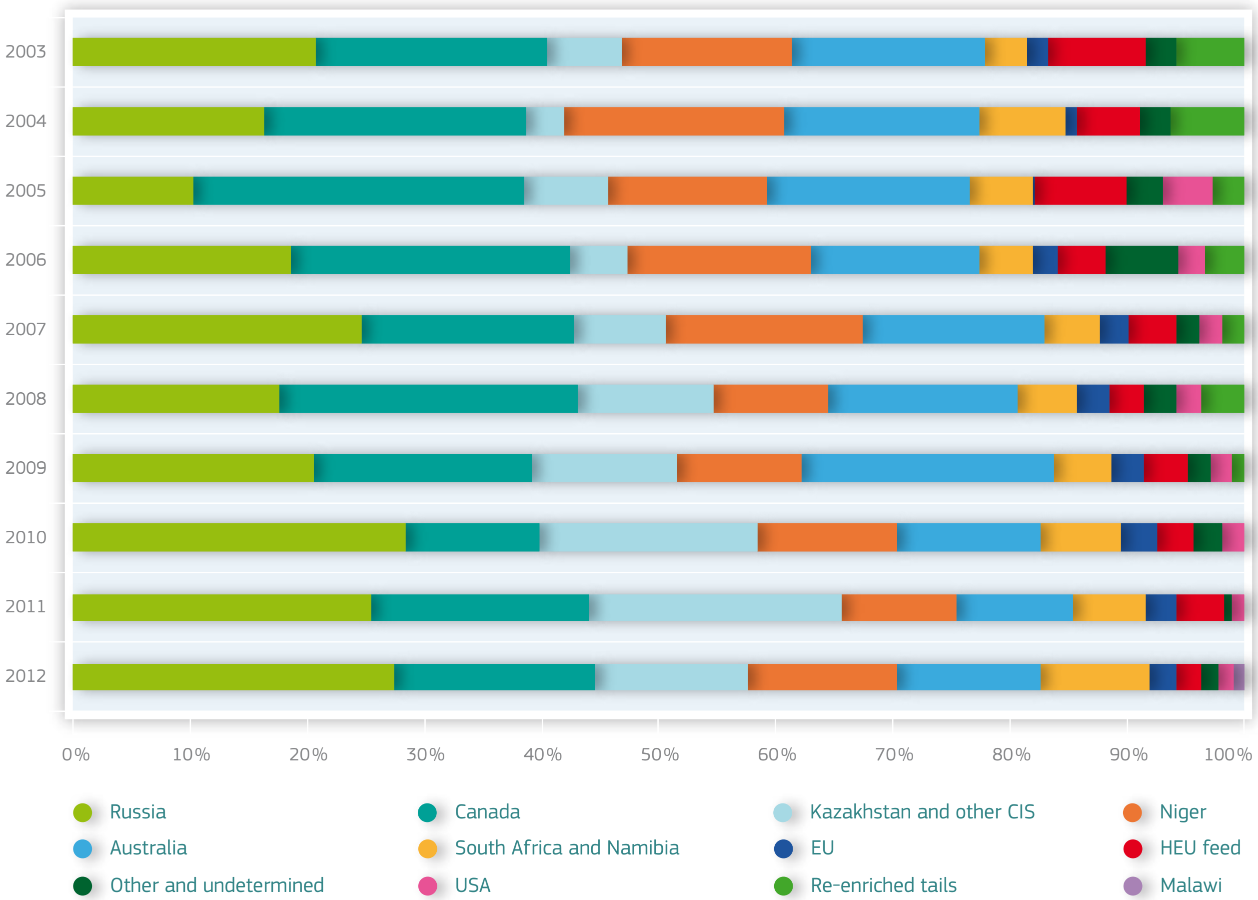


Figure 7 Purchases of natural uranium by EU utilities by origin, 2003–12 (tU) (%)



* The figure does not present more detailed information due to the lack of comparable data over the whole 10-year period.

Special fissile materials

Conclusion of contracts

Table 6 shows the aggregate number of contracts, notifications and amendments ([7]) relating to special fissile materials (enrichment services, enriched uranium and plutonium) dealt with in 2012 in accordance with ESA's procedures.

Deliveries of low-enriched uranium

In 2012, the enrichment services (separative work) supplied to EU utilities totalled 12 724 tSW, delivered in 2 070 tonnes of low-enriched uranium (tLEU) which contained the equivalent of 17 131 tonnes of natural uranium feed. In 2012, enrichment service deliveries to EU utilities increased by 2 % as compared with 2011, with NPP operators opting for an average enrichment assay of 4.26 % and an average tails assay of 0.25 %.

Table 6 Special fissile material contracts concluded by or notified to ESA

Type of contract	Number of contracts concluded/ notifications acknowledged in 2012	Number of contracts concluded/ notifications acknowledged in 2011
A. Special fissile materials		
New contracts	**42**	**49**
Purchase (by an EU utility/user)	8	12
Sale (by an EU utility/user)	11	2
Purchase/sale (between two EU utilities/end-users)	4	3
Purchase/sale (intermediaries)	11	24
Exchanges	6	8
Loans	2	0
Contract amendments	**11**	**11**
TOTAL ([1])	**53**	**60**
B. Enrichment notifications ([2])		
New notifications	**1**	**7**
Notifications of amendments	**12**	**24**
TOTAL	**13**	**31**

([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.

Table 7 Providers of enrichment services delivered to EU utilities

Enricher	Quantities in 2012 (tSW)	Share in 2012 (%)	Quantities in 2011 (tSW)	Share in 2011 (%)	Change in quantities 2012/11 (%)
AREVA/Eurodif and Urenco (EU)	7 211	57	6 717	54	7
Tenex/TVEL (Russia)	5 218	41	5 057	40	3
USEC (USA)	174	1	643	5	– 73
Others ([1])	122	1	90	1	35
TOTAL	12 724	100	12 507	100	2

([1]) Including enriched reprocessed uranium.

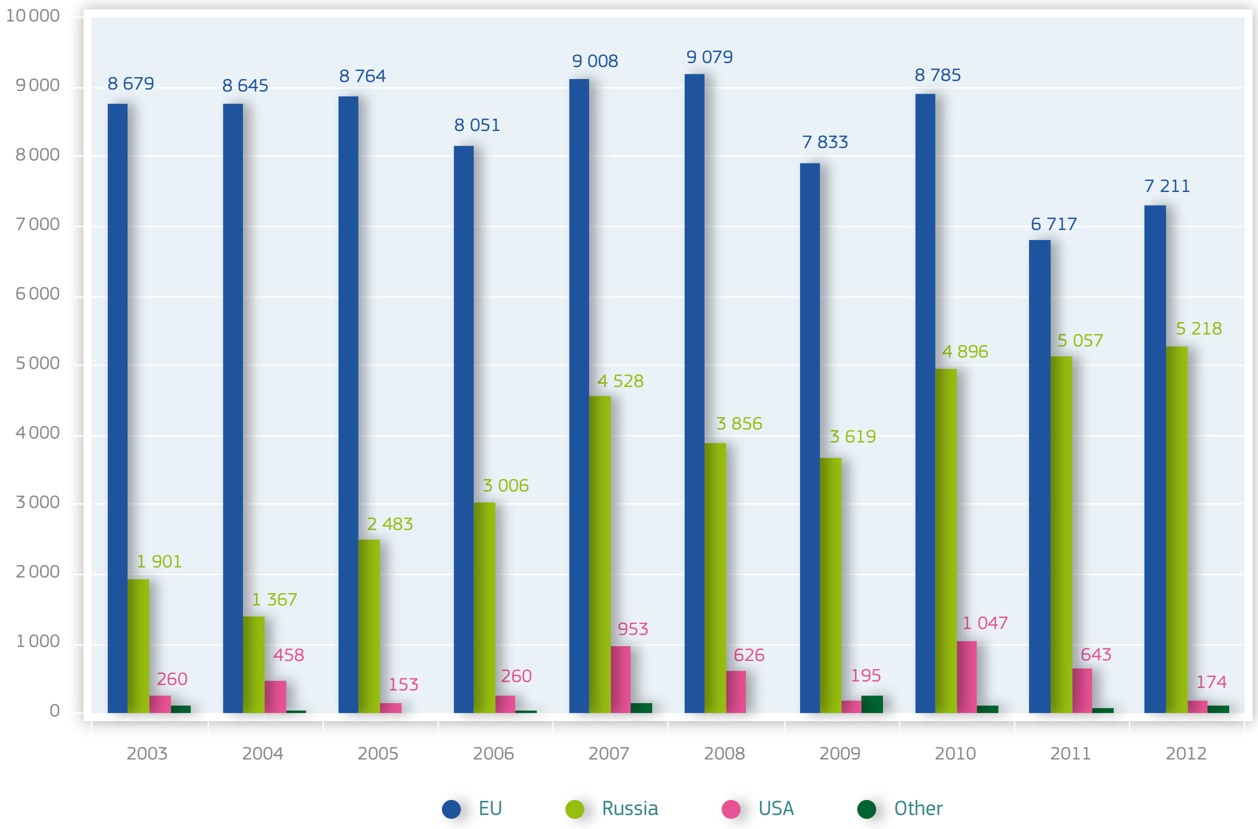
([7]) The aggregate number of amendments includes all the amendments to existing contracts processed by ESA, including technical amendments that do not necessarily lead to substantial changes in the terms of existing agreements.

As regards the providers of enrichment services, over half (57 %) of the EU requirements were met by the two European enrichers (AREVA-Eurodif and Urenco), totalling 7 211 tSW, an increase of 7 % in market share year-on-year.

Deliveries of separative work from Russia (Tenex and TVEL) to EU utilities under purchasing contracts totalled 5 218 tSW, an increase of 3 % as compared with 2011. The aggregate total includes SWUs delivered under 'grandfathered' contracts under Article 105 of the Euratom Treaty, which covered approximately 10 % of total requirements in the EU. The fuel supply contracts concluded before accession to the EU remained in force. Russian enrichment services delivered under regular contracts accounted for 31 % of total requirements.

Enrichment services provided by USEC decreased substantially in 2012, totalling 174 tSW and accounting for 1 % of the total enrichment services supplied to EU utilities.

Figure 8 Supply of enrichment to EU utilities by provider, 2003–12 (tSW)



Plutonium and mixed-oxide fuel

Mixed-oxide (MOX) fuel is produced by mixing uranium and plutonium (Pu) recovered from spent fuel. Use of MOX fuel has an impact on reactor performance and safety measures, so reactors have to be adapted for this kind of fuel (if the percentage of MOX fuel in the core rises above a certain level) and obtain a licence before using it. MOX fuel behaves similarly (though not identically) to the uranium-based fuel used in most reactors. The main reasons for using MOX fuel are the possibility of using plutonium recovered from spent fuel, non-proliferation and economic considerations. It is widely recognised that reprocessing spent fuel and recycling recovered plutonium together with uranium in MOX fuel increase the availability of nuclear material and contribute to security of supply.

In 2012, MOX fuel was used in a number of reactors in Germany and France. The quantity of MOX fuel loaded into nuclear power plants in the EU totalled 10 334 kg Pu in 2012, a 10 % increase over the 9 410 kg Pu used in 2011. Use of MOX resulted in estimated savings of 897 tU and 622 tSW (see Annex 5).

Inventories

Uranium inventories owned by EU utilities at the end of 2012 totalled 52 362 tU, an increase of 10 % from the end of 2011 and 21 % from the end of 2007. The inventories represent uranium at different stages of the nuclear fuel cycle (natural uranium, in-process for conversion, enrichment or fuel fabrication), stored at EU or foreign nuclear facilities.

Figure 9 Total uranium inventories owned by EU utilities at the end of the year, 2007–12 (tonnes)

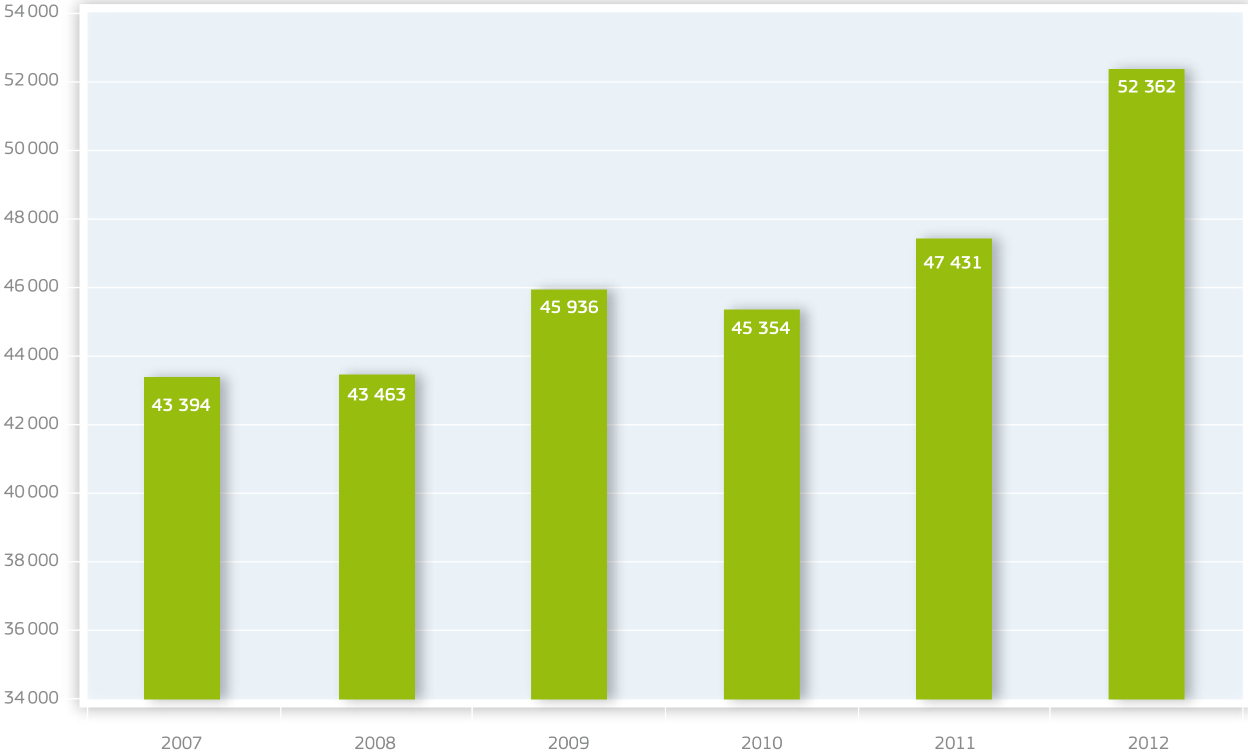


Figure 9 shows the level of total uranium inventories owned by EU utilities at the end of the year, expressed as natural uranium equivalent.

EU utilities' uranium inventories have increased substantially since 2007, after successive years of positive growth rates, with the exception of 2010, when there was a slight decline.

The dynamics of the aggregate natural uranium inventories do not necessarily reflect the difference between the total natural uranium equivalent loaded into reactors and uranium delivered to EU utilities, as the level of inventories is subject to movements of loaned material, sales of uranium to third parties and one-off national transfers of material.

Based on average annual EU gross uranium reactor requirements (approximately 18 000 tU/year), uranium inventories could fuel EU utilities' nuclear power reactors, on average, for almost 3 years.

Future contractual coverage rate

EU utilities' aggregate contractual coverage rate for a given year is calculated by dividing the maximum contracted deliveries in that year — under already-signed contracts — by the utilities' estimated future net reactor requirements in the same year. The result is expressed as a percentage.

$$\text{Contractual coverage rate of year X} = 100 \times \frac{\text{Maximum contracted deliveries in the year X}}{\text{Net reactor requirements in the year X}}$$

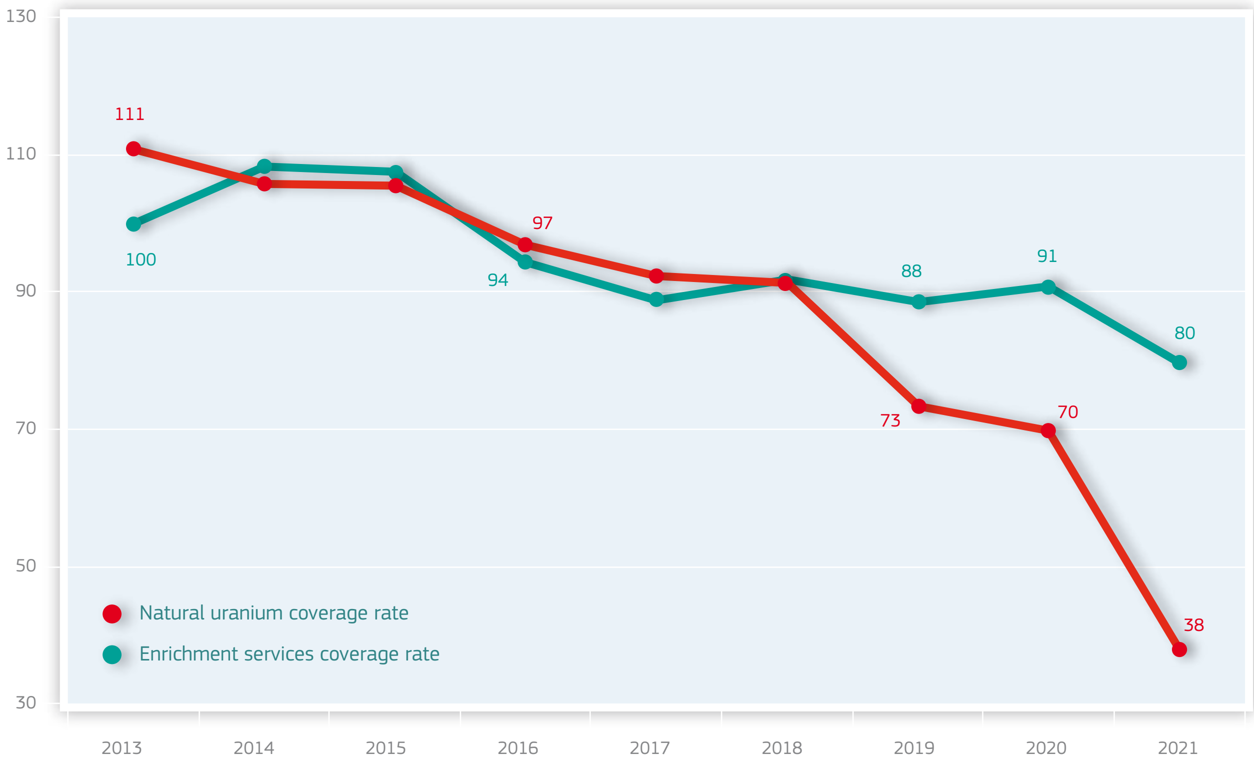
As regards reactor requirements, a distinction is made between demand for natural uranium and demand for enrichment services. Average net reactor requirements for the period 2013–21 are estimated at approximately 17 000 tU and 13 500 tSW per year.

Figure 10 shows the contractual coverage rate for natural uranium and SWUs for EU utilities. Quantitative analysis shows that EU utilities are covered well above their estimated net reactor requirements until 2015, in terms of both natural uranium and enrichment services, under already-signed contracts.

The natural uranium coverage rate from 2016 to 2018 is over 90 % and above and equal to 70 % in 2019 and 2020 respectively. Enrichment services coverage is about 90 % for the period 2016–20.

In general and taking their inventories into account, EU utilities' reactor requirements for both natural uranium and enrichment services are sufficiently covered in the short and medium term.

Figure 10 Coverage rate for natural uranium and enrichment services, 2013–21 (%)



ESA findings, recommendations and diversification policy

ESA continues to monitor the market, especially supplies of natural and enriched uranium to the EU, in order to ensure that EU utilities have diverse sources of supply and do not become over-dependent on any single source. It does this by exercising its rights to sign contracts and by compiling comprehensive statistical reports on trends on the nuclear market. One key goal for long-term security of supply is to maintain the viability of the EU industry at every stage of the fuel cycle.

ESA recommends that utilities cover most of their current and future requirements for natural uranium and enrichment services under long-term contracts with diverse sources of supply. In line with this recommendation, deliveries of natural uranium to the EU under long-term contracts accounted in 2012 for 96.2 % of total deliveries. As regards mining origin, the relative shares of individual producer countries changed in comparison with the previous year, with, Russia, Canada, Niger, Australia and Kazakhstan together providing almost 82 % of the natural uranium delivered to the EU. In 2012, there was a substantial increase in deliveries of uranium of African and Australian origin (up 49 % and 28 % respectively) and a 13 % decrease in uranium from the CIS. EU-origin deliveries fell by 7 % as compared with the previous year.

Regarding the diversification of sources of supply of enriched uranium to EU utilities, over half (57 %) of the SWUs delivered in 2012 were provided by the two European enrichment companies, AREVA-Eurodif and Urenco. The remaining services were delivered mostly by Russia's Tenex/TVEL, as the American company USEC's EU market share dropped to 1 % in 2012, down from 5 % the year before.

ESA observes that EU utilities' dependence on foreign suppliers of enrichment services is decreasing, mainly due to the sharp drop in USEC's share of the European market. Enrichment services of Russian origin delivered under contracts concluded by ESA accounted for 31 %, while enrichment services delivered under contracts 'grandfathered' under Article 105 of the Euratom Treaty accounted for 10 % of total deliveries. In practice, 'grandfathered' contracts keep certain EU utilities entirely dependent on a single external supplier ([8]).

ESA welcomes the use of reprocessed uranium, either by downblending HEU to produce power-reactor-grade fuel or by its re-enrichment (in Russia), on the basis that such

([8]) The significant differences in supply patterns and, therefore, in the diversification of sources of supply is due to the fact that utilities with Western technology traditionally obtain uranium and services (e.g. enrichment) under separate contracts from diverse sources, whereas utilities using Russian technology usually purchase fabricated fuel assemblies from a single supplier under the same contract (including supply of uranium and enrichment).

practices increase security of supply. Furthermore, blending reprocessed uranium with HEU of military origin is conducive to nuclear disarmament and the non-proliferation of nuclear materials. ESA therefore takes account of these positive aspects of reprocessed fuel use when implementing its diversification policy. HEU downblended with reprocessed uranium and re-enriched reprocessed uranium fuel accounted for approximately 7 % of the total fuel loaded into EU reactors in 2012.

ESA also recommends that EU utilities maintain adequate strategic inventories and use market opportunities to increase their stocks, depending on their individual circumstances. The aggregate stock level at the end of 2012 totalled 52 362 tU, which could fuel EU utilities' nuclear power reactors, on average, for almost 3 years.

On the supply side, ESA monitors the situation of EU producers which export nuclear material mined in the EU, as it has option rights over such material under Article 52 of the Euratom Treaty. Where the material is exported from the EU under long-term contracts, ESA requires the contracting parties to accept certain conditions relating to the security of supply on the EU market ([9]).

Following thorough analysis of the information gathered from EU utilities in the annual survey at the end of 2012, ESA concludes that, in the short and medium term, the needs of EU utilities for both natural uranium and enrichment services are well covered. However, in the long term, planned reactor deployment in Asian countries could affect the security of supply to the EU nuclear market.

([9]) ESA imposed conditions relating to the security of supply of the EU market on the long-term export contract concluded between the Talvivaara mine in Finland and a foreign investor in 2011, and to the amendment submitted in 2012.

4. ESA work programme for 2013

In line with its tasks under Chapter 6 of the Euratom Treaty and its Statutes, ESA's work programme for 2013 is built around four specific objectives.

1. **Exercising ESA's exclusive rights and powers in order to maintain a regular and equitable supply of ores and nuclear fuels in the European Atomic Energy Community**

The limited production of nuclear materials within the EU creates a need to diversify sources of supply to a satisfactory degree in order to guarantee the security of nuclear fuel supply to EU utilities. By evaluating and signing supply contracts for nuclear materials and acknowledging transactions covering provision of the entire cycle of nuclear fuel services, ESA will continue to guarantee security of supply. It will maintain a focus on the supplies of HEU and LEU required for producing radioisotopes and fuelling research reactors.

2. **Observing developments in the nuclear fuel market in the context of security of supply**

ESA will continue to seek advice from its Advisory Committee on further development of the Nuclear Observatory, including assessments of information tools created by the Agency. In this regard, ESA will further develop the activities of the Advisory Committee's Working Group on Security of Supply Scenarios.

3. **Increasing cooperation with international organisations and non-EU countries**

In order to efficiently carry out the Nuclear Observatory's tasks and to contribute to security of supply, ESA will actively pursue its relations with international bodies.

4. **Monitoring relevant research and development activities and evaluating their impact on ESA's security of supply policy**

ESA will continue to follow developments in nuclear technology in order to anticipate possible changes in demand for nuclear fuel.

Exercising ESA's exclusive rights and powers in order to maintain a regular and equitable supply of ores and nuclear fuels in the European Atomic Energy Community

Since its inception, the Agency's main task has been to apply the principle of equal access to supplies of nuclear materials for all users in the EU Member States, paying particular attention to the diversification of sources of supply, which is a key priority of EU energy policy.

ESA monitors the diversification of sources by evaluating and signing the supply contracts for ores, source materials and special fissile materials produced within or outside the EU (Article 52 of the Euratom Treaty). Notifications to ESA of contracts for processing, converting or shaping materials (Article 75 of the Treaty) and of transactions involving small quantities (Article 74) also give the Agency an overview of needs and industrial capacity in the Union.

The exemption from the principle of diversification for contracts concluded before the EU accession of certain Member States will apply until the contracts expire ([10]). New supply contracts for these utilities are being assessed in the light of the diversification policy.

([10]) Article 105 of the Euratom Treaty protects the rights acquired under these contracts until they expire.

ESA will continue to scrutinise potential risks to the security of supply of the HEU and LEU which are required to produce medical radioisotopes (Mo-99) and fuel research reactors. Neither HEU nor such LEU is currently produced in the EU. ESA will be further actively involved in assessing requirements for these fissile materials.

In line with the Council conclusions of 18 December 2012 calling for Community support for the conversion of HEU to LEU targets, ESA committed itself to participating in the process. It did so mainly by assessing the risks of conversion from HEU to LEU targets for the production of medical radioisotopes and by heading up the dedicated working group of the European Observatory on the Supply of Medical Radioisotopes which is due to issue its recommendations in the course of 2013.

Specific objective No 1

1. Exercise ESA's exclusive rights to conclude nuclear fuel supply contracts, pursuant to Article 52 of the Euratom Treaty, in conformity with ESA's supply policy and within the statutory deadline of 10 working days.

2. Acknowledge notifications of nuclear fuel transformation services, pursuant to Article 75 of the Euratom Treaty, in conformity with ESA's diversification policy and within the statutory deadline of 14 calendar days.

3. Acknowledge notifications of transactions involving small quantities, pursuant to Article 74 of the Euratom Treaty.

4. Assess the needs for HEU and LEU which are required to produce medical radioisotopes and to fuel research reactors; this includes facilitating the activity of the relevant Advisory Committee Working Group.

5. Participate in the development of the European Observatory on the Supply of Medical Radioisotopes; in particular, support and lead the activities of the working group on the management of conversion from HEU to LEU targets.

6. Support the Commission's nuclear materials accountancy staff, on request, in verification of contract data contained in prior notifications of movements of nuclear materials.

7. Verify, on request, the conformity of draft bilateral agreements between the EU Member States and non-EU countries with Chapter 6 of the Euratom Treaty.

8. Contribute, on request, to the preparation of Commission proposals on broader nuclear energy or general EU energy issues.

Observing developments in the nuclear fuel market in the context of security of supply

As secretariat to the Advisory Committee's Working Group on Security of Supply Scenarios, ESA will continue to facilitate the group's activities to increase the transparency of the nuclear fuel cycle market in the EU.

ESA will continue to fine-tune its market observation capacity in order to respond better to operators' expectations.

These measures lay the foundation for building up comprehensive overviews of the situation and trends on the nuclear fuel cycle market. ESA's annual report, quarterly uranium market report and weekly nuclear news digest, circulated within the Commission, will remain the main ways to present the nuclear market observatory's analyses. ESA's website will be regularly updated by the Nuclear Observatory, offering direct access to information about market developments.

ESA's Nuclear Market Observatory will keep up close cooperation with the energy observatory of the Commission's Directorate-General for Energy.

Specific objective No 2

To deliver on its market observation and monitoring responsibilities, ESA will do the following.

1. Continue to support the activities of the ESA Advisory Committee's Working Group on Security of Supply Scenarios to prepare for the next annual report.

2. Regularly update information published by ESA's own nuclear market observatory, in particular by the regular publication of quarterly uranium market reports, the nuclear digest and ad hoc studies.

3. Publish its annual report, including market analyses, by June 2013.

4. Continue to publish yearly natural uranium price indices: long-term, medium-term, spot and quarterly price indices.

Increasing cooperation with international organisations and non-EU countries

The quality and neutrality of ESA's analyses of the nuclear fuel cycle market provided are being sought more and more by groups of international experts. In order to raise the profile of its activities as a market observatory and to carry out its other tasks efficiently, ESA will keep in regular contact not only with international nuclear organisations such as the IAEA and the NEA, but also with a number of international players on the nuclear fuel market. It has, in particular, reactivated its membership of the World Nuclear Association (WNA) and the World Nuclear Fuel Market (WNFM).

Specific objective No 3

1. Pursue contacts with international authorities, companies and nuclear organisations.

2. Participate in the negotiation of Euratom cooperation agreements with non-EU countries and monitor their implementation as regards trade in nuclear fuel.

3. Take part in the dialogue with Russia on nuclear energy matters.

4. Seek appropriate contacts with the United States in view of the possible supply of HEU and LEU required for the production of medical radioisotopes.

Monitoring relevant research and development activities and evaluating their impact on ESA's security of supply policy

ESA will actively monitor research and development activities in all EU and international R & D fora which will have an impact on nuclear fuel-cycle management (e.g. reprocessing waste, reducing the volume of waste, improving reactor efficiency) and thus directly influence the nuclear fuel market.

Specific objective No 4

1. Continuously monitor technological developments relating to fuel-cycle management, with a view to adapting the Agency's security of supply policy as appropriate.

2. Review the latest technological developments relating to fuel cycle management in Advisory Committee meetings or at specifically organised events, where appropriate.

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This report and previous editions are available on ESA's website (http://ec.europa.eu/euratom/index_en.html).

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 (http://europa.eu/index_en.htm).

This provides access to the websites of all European institutions and other bodies.

The Internet address of the European Commission's Directorate-General for Energy is: http://ec.europa.eu/energy/index_en.html

This website contains information on areas such as security of energy supply, energy-related research, nuclear safety and liberalisation of the electricity and gas markets.

Glossary

MW stands for megawatt or one million watts and is a measure of electrical output. **MWe** refers to electrical output from a generator, **MWt** to thermal output from a reactor or heat source (e.g. the gross heat output of a reactor itself, typically around three times the MWe figure).

Generation IV (or Gen-IV) reactors are a set of nuclear reactor designs currently being developed in the research cooperation within the Generation IV International Forum. Current reactors in operation around the world are generally considered second or third-generation systems. The primary goals of Gen-IV are to improve nuclear safety, improve resistance to proliferation, minimise waste and consumption of natural resources and reduce the cost of building and running such plants. These systems employ a closed fuel cycle to maximise the resource base and minimise the high-level waste to be sent to a repository. Most of them are fast-neutron reactors (only two operate with slow neutrons, like today's plants). They are not expected to be available for commercial construction before 2030.

SWU stands for 'separative work unit'. SWUs measure 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. As a standard indicator of enrichment services, the concept of SWU is very complex, as it is a function of the amount of uranium processed and the degree to which it is enriched (i.e. the extent of increase in the concentration of the U-235 isotope relative to the remainder). The unit — strictly 'kilogram separative work unit' or kg SWU, when feed and product quantities are expressed in kilograms (but usually shown in graphs as SWU, or tSW for 1 000 SWU) — is a measure of the quantity of separative work (indicative of energy used in enrichment).

Annexes

Annex 1
EU-27 gross and net requirements (quantities in tU and tSW)

(A) From 2013 until 2022

Year	Natural uranium		Separative work	
	Gross requirements	Net requirements	Gross requirements	Net requirements
2013	18 405	16 167	14 705	13 151
2014	18 002	15 644	14 409	12 848
2015	18 987	17 136	15 143	13 666
2016	18 310	17 206	14 674	13 763
2017	18 618	17 129	14 930	13 706
2018	18 315	16 230	14 682	13 394
2019	18 591	17 006	14 819	13 931
2020	18 541	16 983	13 905	13 036
2021	18 747	17 274	14 585	13 778
2022	18 563	17 027	14 499	13 649
Total	**185 080**	**167 802**	**146 352**	**134 922**
Average	**18 508**	**16 780**	**14 635**	**13 492**

(B) Extended forecast from 2022 to 2031

Year	Natural uranium		Separative work	
	Gross requirements	Net requirements	Gross requirements	Net requirements
2023	17 194	15 627	13 494	12 622
2024	17 674	16 309	13 401	12 675
2025	16 779	15 411	13 365	12 637
2026	16 443	15 008	13 095	12 318
2027	16 891	15 561	13 447	12 747
2028	16 891	15 557	13 447	12 744
2029	16 555	15 132	13 177	12 408
2030	16 798	15 468	13 378	12 678
2031	16 798	15 468	13 378	12 678
2032	17 007	15 677	13 471	12 771
Total	**169 027**	**155 217**	**133 652**	**126 279**
Average	**16 903**	**15 522**	**13 365**	**12 628**

Annex 2
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 (tSW)	Natural U (tU)	% spot	Enrichment (tSW)
1980		9600		8600	(*)	
1981		9000		13000	10.0	
1982		10400		12500	< 10.0	
1983		9100		13500	< 10.0	
1984		11900		11000	< 10.0	
1985		11300		11000	11.5	
1986		13200		12000	9.5	
1987		14300		14000	17.0	
1988		12900		12500	4.5	
1989		15400		13500	11.5	
1990		15000		12800	16.7	
1991		15000	9200	12900	13.3	10000
1992		15200	9200	11700	13.7	10900
1993		15600	9300	12100	11.3	9100
1994	2520	15400	9100	14000	21.0	9800
1995	3040	18700	10400	16000	18.1	9600
1996	2920	18400	11100	15900	4.4	11700
1997	2900	18200	11000	15600	12.0	10100
1998	2830	18400	10400	16100	6.0	9200
1999	2860	19400	10800	14800	8.0	9700
2000	2500	17400	9800	15800	12.0	9700
2001	2800	20300	11100	13900	4.0	9100
2002	2900	20900	11600	16900	8.0	9500
2003	2800	20700	11500	16400	18.0	11000
2004	2600	19300	10900	14600	4.0	10500
2005	2500	21100	12000	17600	5.0	11400
2006	2700	21000	12700	21400	7.8	11400
2007	2809	19774	13051	21932	2.4	14756
2008	2749	19146	13061	18622	2.9	13560
2009	2807	19333	13754	17591	5.2	11905
2010	2712	18122	13043	17566	4.1	14855
2011	2583	17465	13091	17832	3.7	12507
2012	**2271**	**15767**	**11803**	**18639**	**3.8**	**12724**

(*) Data not available.

Annex 3
ESA average prices for natural uranium

Year	Multiannual contracts		Spot contracts		New multiannual contracts		Exchange rate
	EUR/kgU	USD/lb U_3O_8	EUR/kgU	USD/lb U_3O_8	EUR/kgU	USD/lb U_3O_8	EUR/USD
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			1.47
2009	55.70	29.88	77.96	41.83	(**) 63.49	(**) 34.06	1.39
2010	61.68	31.45	79.48	40.53	78.11	39.83	1.33
2011	83.45	44.68	107.43	57.52	100.02	53.55	1.39
2012	**90.03**	**44.49**	**97.80**	**48.33**	**103.42**	**51.11**	**1.28**

(*) The spot price for 2001 was calculated on the basis of an exceptionally low total volume of only 330 tU covered by four transactions.
(**) ESA's price method took account of the ESA 'MAC-3' new multiannual U_3O_8 price, which includes amended contracts, from 2009 onwards.

Annex 4
Purchases of natural uranium by EU utilities by origin, 2003–12 (tU)

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Russia	3 400	2 391	1 788	3 984	5 144	3 272	3 599	4 979	4 524	5 102
Canada	3 229	3 274	4 998	5 093	3 786	4 757	3 286	2 012	3 318	3 212
Kazakhstan and other CIS	1 059	481	1 246	1 057	1 618	2 143	2 195	3 275	3 871	2 414
Niger	2 396	2 746	2 390	3 355	3 531	1 845	1 854	2 082	1 726	2 376
Australia	2 695	2 443	3 065	3 053	3 209	2 992	3 801	2 153	1 777	2 280
South Africa and Namibia	604	1 080	951	978	1 003	944	860	1 207	1 124	1 762
EU	298	129	5	472	526	515	480	556	455	421
HEU feed	1 348	800	1 407	850	825	550	675	550	731	395
Other and undetermined	433	373	529	1 336	432	520	329	432	128	256
USA	0	0	757	488	402	398	318	320	180	241
Malawi	0	0	0	0	0	0	0	0	0	180
Re-enriched tails	958	925	474	728	388	688	193	0	0	0
Total	**16 420**	**14 642**	**17 610**	**21 394**	**20 864**	**18 622**	**17 591**	**17 566**	**17 832**	**18 639**

Annex 5
Use of plutonium in MOX in the EU-27 and estimated natural uranium (NatU) and separative work savings

		Savings	
Year	kg Pu	tNatU	tSW
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
2009	10 282	1 234	823
2010	10 636	1 276	851
2011	9 410	824	571
2012	**10 334**	**897**	**622**
Grand total	**161 516**	**18 753**	**12 531**

Annex 6
EU nuclear utilities contributing to this report

ČEZ, a. s.
EDF and EDF Energy
EnBW Kernkraft GmbH
ENUSA Industrias Avanzadas, S.A.
E.ON Kernkraft GmbH
EPZ
Fortum Power
Ignalina Nuclear Power Plant
Kozloduy NPP Plc
Nuklearna elektrarna Krško, d.o.o.
Magnox Ltd (UAM)
Oskarshamn Nuclear Power Plant (OKG)
Paks Nuclear Power Plant Ltd
RWE Power AG
Slovenské elektrárne, a.s.
Societatea Nationala Nuclearelectrica S.A.
Synatom sa
Teollisuuden Voima Oyj (TVO)
Vattenfall Nuclear Fuel AB

Annex 7
Uranium suppliers to EU utilities in 2012

AREVA NC and AREVA NP (formerly Cogéma)
BHP Billiton (formerly WMC)
Cameco Canada
Cameco Inc. Corporation USA
CNU
Deutsche Bank
DIAMO
ERA
EURODIF
Internexco GmbH
KazAtomProm
Nufcor International
NUKEM
Rio Tinto
Rossing Uranium
Tenex (JSC Techsnabexport)
Tradetech
TVEL
UEM
UG
Uranium One
Urenco Ltd

Annex 8
Calculation method for ESA's average U_3O_8 prices

ESA price definitions

In order to provide reliable objective price information, comparable with previous years', only deliveries made to EU utilities or their procurement organisations under purchasing contracts are taken into account for calculating the average prices.

In order to enhance market transparency, ESA calculates three uranium price indices on an annual basis.

1. The **ESA spot U_3O_8 price** is a weighted average of U_3O_8 prices paid by EU utilities for uranium delivered under spot contracts during the reference year.

2. The **ESA long-term U_3O_8 price** is a weighted average of U_3O_8 prices paid by EU utilities for uranium delivered under multiannual contracts during the reference year.

3. The **ESA 'MAC-3' multiannual U_3O_8 price** is a weighted average of U_3O_8 prices paid by EU utilities, but only under multiannual contracts which were concluded or for which the pricing method was amended in the previous 3 years (i.e. between 1 January 2010 and 31 December 2012) and under which deliveries were made during the reference year. In this context, ESA regards amendments which have a direct impact on the prices paid as separate contracts.

In order to ensure statistical reliability (sufficient amounts) and safeguard the confidentiality of commercial data (i.e. ensure that details of individual contracts are not revealed), ESA price indices are calculated only if there are at least five relevant contracts.

As from 2011, ESA introduced the **ESA quarterly spot U_3O_8 price**, an indicator published on a quarterly basis provided EU utilities have concluded at least three new spot contracts.

All price indices are expressed in US dollars per pound (USD/lb U_3O_8) and euros per kilogram (EUR/kgU).

Definition of spot v long-term/multiannual contracts

The difference between spot and multiannual contracts is:

- **spot** contracts provide either for one delivery only or for deliveries over a maximum of 12 months, whatever the time between conclusion of the contract and the first delivery;

- **multiannual** contracts provide for deliveries extending over more than 12 months.

The average spot-price index reflects the latest developments on the uranium market, whereas the average price index of uranium delivered under multiannual contracts reflects the average long-term price paid by European utilities.

Method

The methods applied have been discussed in the working group of the Advisory Committee.

Data collection tools

Prices are collected directly from utilities or via their procurement organisations on the basis of:

- 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, obligation code, 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 and currency of conversion, if known.

Deliveries taken into account

The deliveries taken into account are those made under natural uranium purchasing contracts to 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, e.g. those between intermediaries, 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 also excluded from the price calculation (e.g. uranium out of specification or enriched uranium priced per kg EUP without separation of the feed and enrichment components).

Data quality assessment

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. In particular, it compares the actual deliveries with the 'maximum permitted deliveries' and options. Where there are discrepancies between maximum 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 into a U_3O_8 price using an average conversion value based on reported conversion prices under the natural uranium long-term contracts.

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

European Commission

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