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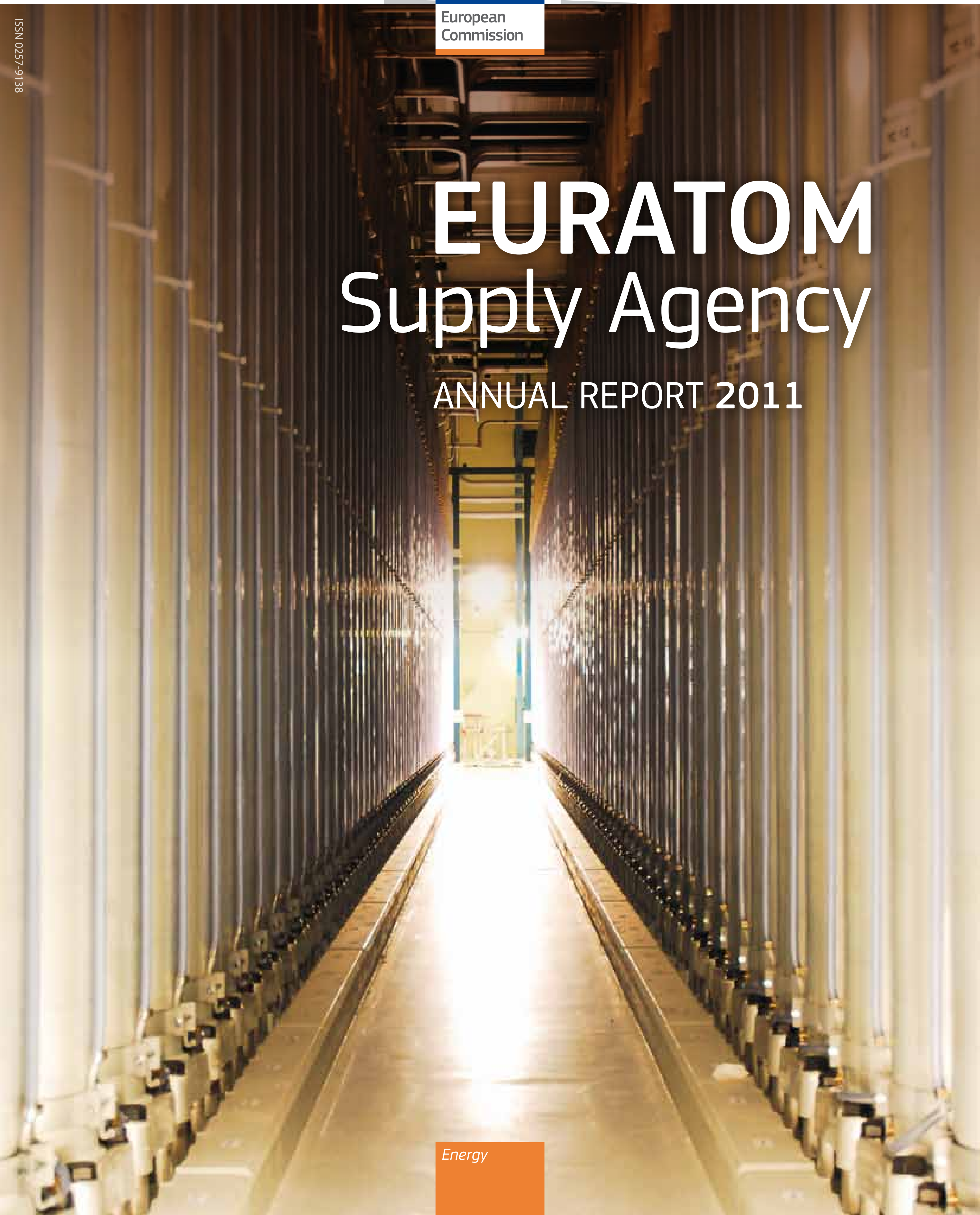

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Abbreviations

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

Foreword

Dear reader,

The Euratom Supply Agency warmly invites you to discover its 2011 *Annual Report*. As in previous years, we have tried to put our activities in their international context by briefly describing the most important developments in the nuclear field.

In 2011, the nuclear industry was marked by a wide-scale natural disaster which triggered the nuclear accident at the Fukushima-Daiichi power plant in Japan on 11 March.

This accident has drawn renewed political attention to the need to minimise risk and guarantee the most robust levels of nuclear safety, security and non-proliferation. Guaranteeing the highest possible standards of nuclear safety, security and emergency preparedness and response remains a central concern of nuclear energy policy, in Europe as much as globally.

In the EU, in the wake of the Fukushima accident, a programme of comprehensive risk and safety assessments of nuclear power plants was launched by the European Commission in close cooperation with national regulators and the nuclear industry. The conclusions of these 'stress tests' are due in late autumn 2012. Proposals to improve the legal and regulatory framework governing the safety of nuclear installations should follow by the end of the year.

In the aftermath of the Fukushima accident, the global nuclear fuel market became exposed to greater uncertainty. ESA's *Annual Report* gives concise insights into EU Member States' responses to this incident. In the short term, demand for uranium decreased and the uncertainty concerning the future share of nuclear in the energy mix in some countries could have a negative impact on the conclusion of supply contracts by utilities. A slowdown in bringing new sources of uranium into production or expanding the existing capacity at global level has been observed. However, the longer-term outlook for the global nuclear industry should not change drastically. A number of newcomers, in particular Asian countries, are likely to press ahead with their civil nuclear development plans and are actively engaged in securing their future needs by acquiring uranium mining assets, concluding supply contracts or developing the industrial capacity required for nuclear services. The latest *World Energy Outlook*, released by the International Energy Agency (IEA) in November 2011, also mirrored the uncertainty described above. The IEA's central *New Policies Scenario* assumed that nuclear output would rise by more than 70 % over the period to 2035. However, the *Low Nuclear Case Scenario* assumed that no new reactors would be built in OECD countries, only half of the projected additions in non-OECD countries would be completed and the operating life of existing nuclear power plants would be shortened.

I have taken on the responsibility of ESA Director-General at a particularly challenging and complex time for the development of nuclear energy. I am strongly convinced that this climate of increasing uncertainty adds to the importance of the role of ESA when it comes to exercising its powers, defined in Chapter 6 of the Euratom Treaty. In close cooperation with the Advisory Committee representing EU Member States' nuclear authorities and/or industry, we will continue the activities of our nuclear fuel market observatory to promote transparency and predictability on the market. We are ready to discuss the fine-tuning of our method of calculating price indices. We will strive to demonstrate the benefits of earlier involvement of ESA in commercial negotiations for supplies of nuclear materials than in the current contract conclusion practice. In this context, ESA will be focusing on the issue of HEU and LEU (up to 20 %) supplies to the EU, which are required for producing medical radioisotopes and fuelling research reactors, but for which the EU is entirely dependent on a couple of external suppliers. ESA would like to play a more active role in conclusion of these supply contracts and, in parallel and in the longer term, we will be discussing ways for the European industry to develop capacity to produce LEU up to 20 % itself in order to avoid foreseeable shortages in the future.

I am looking forward to continuing the fruitful cooperation with stakeholders. I am counting on a trustful and fully transparent approach from all involved in the EU, as this is the only way to ensure that ESA's activities produce a mutually beneficial result and contribute effectively to the security of supply of nuclear materials in Europe.

Stamatios Tsalas
Director-General of the Euratom Supply Agency

1. Nuclear energy developments in the EU and ESA activities

EU nuclear energy policy in 2011

The accident at the Fukushima-Daiichi nuclear power plant in Japan, following the earthquake and tsunami on 11 March 2011, has drawn renewed political attention to the need to minimise risk and guarantee the most robust levels of nuclear safety and security, including the non-proliferation aspects. Guaranteeing the highest possible standards of nuclear safety, security and emergency preparedness and response remains a central concern of nuclear energy policy, in Europe as much as globally.

The European Commission's response to the events at Fukushima was immediate. Together with national regulators and the nuclear industry, the Commission launched an EU-wide programme of comprehensive risk and safety assessments of nuclear power plants. Several Member States went beyond the agreed requirements and decided to include decommissioned plants or other nuclear facilities in these 'stress tests' as well. The European Council also asked the Commission to 'review the existing legal and regulatory framework for the safety of nuclear installations' and to 'propose by the end of 2011 any improvements that may be necessary'. Finally, given the potential cross-border implications of nuclear accidents, the European Council asked the Commission to invite the EU's neighbours to take part in the stress tests. Switzerland and Ukraine are participating fully in this programme.

The Commission's interim report to the Council on the stress tests ([1]) was adopted on 24 November, with a final report due in June 2012 after the peer review is completed.

On 15 December 2011, the Commission adopted the communication *Energy Roadmap 2050* ([2]). To achieve the goal of cutting emissions by over 80 % by 2050, Europe's energy production will have to be almost carbon-free. *Energy Roadmap 2050* focuses on how to achieve this without disrupting energy supplies or competitiveness. Based on analysis of a set of scenarios, the document explores ways to address climate change with the goal of decarbonising the EU economy, while at the same time ensuring security of energy supplies and economic competitiveness. This should allow Member States to make the energy choices required and create a stable business climate for private investment, especially until 2030.

Nuclear Safety Directive

The deadline for transposing the Nuclear Safety Directive adopted in 2009 ([3]) into the national legislation of the Member States was 22 July 2011. The Commission started infringement proceedings against 12 Member States ([4]) that failed to meet this deadline. A number of these proceedings have been closed in the meantime following notification of the transposition measures. The main objective of the Directive is to establish a Community framework to maintain and promote continuous improvements in nuclear safety.

As part of the process of reviewing the Euratom legislative framework governing nuclear safety and in line with the mandate given by the European Council in March 2011, in December the Commission launched an open public consultation which ran until the end of February 2012 on decarbonisation of the European power sector and the related regulatory initiatives necessary beyond 2020.

([1]) COM(2011) 784 final of 24 November 2011.
([2]) COM(2011) 885/2 final of 15 December 2011.
([3]) Council Directive 2009/71/Euratom, OJ L 172, 2.7.2009, p. 18.
([4]) Belgium, Denmark, Estonia, Greece, Italy, Cyprus, Latvia, Austria, Poland, Portugal, Slovakia and the United Kingdom.

Safe management of radioactive waste and spent fuel and decommissioning

In July, the Council adopted the Directive establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste ([5]). While reaffirming that the ultimate responsibility lies with Member States, the Directive creates a strong EU framework imposing significant obligations on them.

Member States will have to draw up national programmes and notify them to the Commission by 2015 at the latest. These national programmes must include plans with a firm timetable for the construction of disposal facilities, together with a description of the activities needed to implement disposal solutions, cost assessments and a description of the financing schemes. Member States are also required periodically to convene international peer reviews to exchange experience and ensure that the highest standards are applied. This must be done at least every 10 years. Exports to countries outside the EU are allowed only under very strict and binding conditions.

The Commission published the Seventh Situation Report on radioactive waste and spent fuel management in the EU ([6]). This provides information on production, storage and disposal and on national bodies and policies. Another Commission Situation Report covered uranium mine and mill tailings ([7]). Based on earlier studies, it provided information on the nature and status of legacies and on ongoing activities and specific EU legislation. It also spelled out possible further Commission activities in this area.

In the field of nuclear decommissioning, the Commission adopted a proposal for a Council Regulation which would extend the current financing of decommissioning work in Bulgaria, Lithuania and Slovakia until 2017–20, although with more limited budgets. In 2011, these three countries received EUR 258 million to help them advance with the decommissioning programmes at Kozloduy (units 1 to 4), Ignalina (units 1 and 2) and Bohunice (units 1 and 2). Member States were also consulted on their decommissioning funding practices in preparation for the third decommissioning policy report, which is due to be adopted in 2012.

Transport of radioactive materials

The Commission has proposed a new Regulation ([8]) which would facilitate the transport of radioactive materials. The current national reporting and authorisation procedures would be replaced by a single registration valid across the whole EU while maintaining the safety levels achieved.

Radiation protection legislation

On 29 September 2011, the European Commission adopted a proposal for a Council Directive laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation ([9]). As required by Article 31 of the Euratom Treaty, the draft has been presented to the European Economic and Social Committee for its opinion.

On 27 June 2011, the European Commission adopted a proposal for a Council Directive laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption ([10]). On 27 October 2011, the draft was endorsed by the European Economic and Social Committee. It was then transmitted to the Council for further discussion and adoption.

Supply of radioisotopes

Following the findings in its communication ([11]) and the relevant Council conclusions 'Towards the secure supply of radioisotopes for medical use in the EU' ([12]), the Commission kept up a close dialogue with stakeholders to discuss the form and main objectives of the European-level solution envisaged to safeguard the mid and long-term security of supply of molybdenum-99 (Mo-99). Three stakeholder meetings offered an excellent forum to discuss the subject, as they gathered together all EU links in the supply chain: a U-target manufacturer, all EU research reactor operators who already produce Mo-99 on a large scale, or are in a position to do so in the next few years, Tc-99 m generator producers, the Association of Imaging Producers and Equipment Suppliers (AIPES), the European Association of Nuclear Medicine (EANM) and the OECD/NEA. Following the meetings, establishment of a European observatory on the supply of medical radioisotopes was proposed. This will be further discussed in 2012.

In 2011, the Commission also participated actively in the work of the OECD/NEA High-Level Group on the Security of Supply of Medical Radioisotopes (HLG-MR) ([13]), which oversees international efforts to address the reliability of supplies of medical radioisotopes, including development of a full-cost recovery method for irradiation services.

([5]) Council Directive 2011/70/Euratom, OJ L 199, 2.8.2011, pp. 48–56.
([6]) SEC(2011) 1007 final of 22 August 2011.
([7]) SEC(2011) 340 final of 11 March 2011.
([8]) COM(2011) 518 final of 30 August 2011.
([9]) COM(2011) 593 final of 29 September 2011.
([10]) COM(2011) 385 final of 27 June 2011.
([11]) COM(2010) 423 final of 6 August 2010.
([12]) http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/trans/118234.pdf
([13]) http://www.oecd-nea.org/med-radio/

Bilateral nuclear cooperation agreements

Australia, Canada and the USA

Implementation of the nuclear cooperation agreements between the European Atomic Energy Community (Euratom) and Australia, Canada and the USA continued throughout 2011 to the satisfaction of all involved. Regular consultation meetings were held.

With the objective of ensuring the security of nuclear fuel supplies, bilateral cooperation with these three international partners has been further developed by negotiating revised Euratom agreements.

A renewed agreement with Australia was signed in September 2011 and entered into force on 1 January 2012, with wider scope than the previous Euratom-Australia agreement.

The agreement with Canada is being renegotiated. The initial agreement was signed in 1959 and has been amended five times. It therefore needs to be revised and consolidated in order to make it easier to implement.

Russian Federation

In order to advance cooperation with the Russian Federation in this area, including a comprehensive bilateral cooperation agreement on peaceful uses of nuclear energy, in late 2011, agreement was reached to set up a new nuclear working group under the EU-Russia Energy Dialogue.

South Africa

The Council adopted a negotiating mandate for a new agreement between Euratom and South Africa in October 2010. The negotiations for this agreement with South Africa were concluded in 2011 and the text was submitted to the Council for approval in early 2012.

European Nuclear Safety Regulators Group (ENSREG)

ENSREG ([14]) held four meetings in 2011 and played a key role in drafting the specifications for the nuclear stress tests together with the Commission. Its other main activities included advising the Commission on the Community legislation on radioactive waste and spent fuel management, supporting transposition and implementation of the Nuclear Safety Directive — including establishing a common method for the periodic safety self-assessments and a system for coordinating the international peer reviews — and preparing guidelines on regulators' transparency.

ENSREG organised the first European Nuclear Safety Conference, which was held In Brussels on 28 and 29 June 2011 with the Commission as co-organiser.

European Nuclear Energy Forum (ENEF)

During ENEF's ([15]) sixth plenary meeting in Prague, in the light of the Fukushima accident, the more than 300 participants took stock of the post-accident responses at European level. ENEF called for a detailed accident analysis and for the findings and lessons learnt to be fully implemented. ENEF welcomed the Europe-wide comprehensive safety and risk assessments of nuclear power plants and highlighted the value added by national and European initiatives continuously to improve nuclear safety.

ENEF discussed the contribution made by nuclear energy to a low-carbon electricity mix, pointing out the opportunities and threats in the long term. Nuclear power should not be looked at in isolation or in comparison with other generation sources. A generally available, reliable and affordable supply of electricity to consumers via the electricity grid of the future is what is at stake. The particular need for stable conditions for financing the low-carbon electricity system — a challenge facing not only the nuclear industry — was highlighted. Contributions from Member States wishing to introduce nuclear power, from vendors and from operators of nuclear power plants showed that plans to use nuclear power for electricity generation have not changed fundamentally after Fukushima.

Nuclear research and innovation

Following the nuclear incident in Fukushima, specific attention must be paid to research and innovation in nuclear safety for present and future nuclear facilities, while pursuing the efforts to support waste management and radiation protection. Keeping a strong European dimension to nuclear research and innovation is critical in order to hold on to expertise and technological leadership, at a time when the European Union is willing to promote excellence in nuclear safety worldwide.

([14]) ENSREG is composed of senior officials from the national regulatory authorities responsible for nuclear safety, radioactive waste safety or radiation protection from all 27 Member States in the EU plus representatives of the Commission. Its objective is to further a common approach to the safety of nuclear installations and to safe management of spent fuel and radioactive waste (http://www.ensreg.eu).

([15]) ENEF was established in November 2007 as a platform to promote a broad discussion among stakeholders on the opportunities, risks and transparency of nuclear energy.

At the end of 2011, the Commission made its proposal for financing nuclear research and innovation under Horizon 2020, which will be further discussed by the Council and the European Parliament in 2012.

Education and training

In a communication on education and training in the nuclear energy field in the EU ([16]), the Commission provided the first comprehensive picture of education and training in the nuclear sector at European level, identified the current challenges and presented the full spectrum of EU, national or international initiatives planned or in progress which could address the challenges identified in the most efficient and systematic manner possible. A sufficient number of well-trained and experienced staff is the key to responsible use of nuclear energy. This is true in all areas: design, construction, operation, fuel cycle, decommissioning, waste management, radiation protection, licensing and the activities of regulatory authorities.

Main developments in the EU Member States

The Fukushima-Daiichi accident had a very significant, though uneven, impact on the EU Member States' nuclear policies.

In July 2011, Germany approved legislation calling for an irrevocable gradual phase-out of nuclear energy in the country by 2022. In a referendum in June, Italian voters rejected a recent law that could have allowed a nuclear revival in the country. Conditional agreement on a nuclear phase-out by 2025 was reached by the political parties forming the government in Belgium. At the same time, Bulgaria, the Czech Republic, Lithuania, the Netherlands, Romania, Slovakia, Finland and the United Kingdom continued their ongoing projects or approved initiatives to expand their nuclear capacity. Political support for future new construction or capacity expansion was confirmed in Hungary, Poland, Romania and Slovenia. France also continued all its ongoing projects to develop its nuclear capacity but, for the first time, the share of nuclear in the future generation mix has become a political issue between the two main political parties on the eve of the 2012 elections. The Finnish mining company Talvivaara Sotkamo Ltd continued preparations to start natural uranium production at the Sotkamo mine in 2012. This would add a new, though relatively tiny, uranium mine in the EU.

As shown in Table 1, at the end of 2011, a total of 134 nuclear power reactors were in operation in the EU with six more under construction. Compared with the 2010 figures, nine reactors fewer are in operation after eight were shut down in Germany in the wake of the Fukushima-Daiichi accident and the Oldbury 2 unit was closed in the United Kingdom.

Table 1 Nuclear power reactors in the EU in 2011

Country	Reactors in operation (under construction)	Nuclear electricity as % of total electricity generated
Belgium	7	54.0
Bulgaria	2 (2)	32.6
Czech Republic	6	33.0
Finland	4 (1)	31.6
France	58 (1)	77.7
Germany	9	17.8
Hungary	4	43.2
Netherlands	1	3.6
Romania	2	19.0
Slovakia	4 (2)	54.0
Slovenia	1	41.7
Spain	8	19.5
Sweden	10	40.0
United Kingdom	18	17.8
Total	134 (6)	

Sources: IAEA and WNA

([16]) COM(2011) 563 final of 16 September 2011.

Belgium: At the beginning of December 2011, the newly formed federal government decided on a conditional nuclear phase-out, as already announced in the 2003 nuclear phase-out law. The law provides for a shutdown of the three oldest reactors in the country by 2015 and a complete exit by 2025. The government has to decide by mid 2012 on the closure of the three oldest reactors, subject to the security of power supplies.

Bulgaria: In September, Bulgaria's National Electric Company (NEK) and AtomStroyExport agreed to extend the validity period of the 2006 agreement on construction of the Belene NPP until the end of March 2012 in order to carry out additional market and financial studies.

Czech Republic: The Czech power group CEZ set a deadline of 2 July 2012 for bids to expand the Temelin NPP (units 3 and 4). Three candidates have been preselected to bid: Areva (EPR), Westinghouse (AP1000) and a consortium formed by AtomStroyExport, Gidopress and Skoda JS (MIR 1200). The final decision is expected in 2013. The new units are planned to be operational by 2025. The Czech firm ALTA and Russia's TVEL signed a joint venture agreement on nuclear cooperation, including establishment of a nuclear technology centre to promote exchanges of nuclear technologies.

Finland: Natural uranium production (between 300 and 500 tU/year) as a by-product is due to start at the Sotkamo nickel mine in 2012. Among other authorisations, in November 2011, the Commission and ESA authorised the mine owner, Talvivaara Sotkamo Ltd, to sell the uranium it produced to the investor in the mine, Canadian Cameco, under an offtake agreement containing conditions tied to security of supply on the EU market. Operation of the Olkiluoto 3 NPP (EPR) is now scheduled to start in August 2014 (instead of 2013). For the Olkiluoto 4 NPP, construction of which was approved in principle in May 2010, TVO was considering EPR, ABWR, ESBWR, EU-APWR or APR-1 400 reactor types. Pyhäjoki, in northern Finland, has been selected as the site for building the new NPP of the consortium Fennovoima. Construction is expected to begin in 2015: Areva (EPR) and Toshiba (ABWR) have been invited to bid and the reactor supplier will be selected in 2012 to 2013.

France: At the end of June, Areva Chief Executive Officer Mrs Anne Lauvergeon was succeeded by Mr Luc Oursel, former chief operating officer. In December he presented the company's five-year strategic plan 'Action 2016' aiming to consolidate Areva's leadership in the nuclear industry. In 2011, major steps were taken in construction of the Flamanville 3 EPR reactor: by the end of 2011 around 88 % of the civil engineering work and over 20 % of the electromechanical assemblies had been completed. EDF provided new targets for the estimated completion schedule, with the first marketable generation due in 2016. On 4 July 2011, the French nuclear safety authority (ASN) issued a recommendation in favour of continuing operation of the Fessenheim 1 unit, commissioned in 1978, for an additional 10 years conditional on the forthcoming conclusions of additional safety inspections and the completion of certain works.

Germany: In the wake of the nuclear accident in Japan, Germany imposed a three-month moratorium on further extension of the operating lifetime of its 17 nuclear units. At the end of May, the government announced an irrevocable phase-out of nuclear energy by 2022 without abolishing the nuclear tax introduced in 2010 (in relation to the extensions agreed then). The laws necessary for this gradual phase-out were adopted in July. The German energy authority confirmed that the approximately 8 800 MW of nuclear capacity shut down following the Fukushima accident would not be turned on again in the event of shortages in wintertime. The German nuclear power utilities started to sue the government over continuing with the nuclear tax introduced in 2010 while also claiming that the country's plans to phase out nuclear power generation without providing any compensation were unconstitutional.

Hungary: On 3 October, Hungary's parliament approved the National Energy Strategy for the period up to 2030 which aims to ensure the long-term security of energy supplies. The strategy envisages continuing use of nuclear power as part of the energy mix, adding about 2 000 MW at the Paks NPP between 2022 and 2025 and extending the lifetimes of the four existing VVER-440 units, set to end between 2012 and 2017, by 20 more years.

Italy: In the wake of the Fukushima accident, the Italian government decided on a moratorium on the previous commitments to revive nuclear energy. Later, in a referendum held on 12 and 13 June, Italian voters rejected the plan that could have allowed construction of nuclear power plants in the country.

Lithuania: Lithuania selected GE-Hitachi Nuclear Energy's proposal for a 1 350 MW advanced boiling water reactor (ABWR) to be built by 2020 at Visaginas; a preliminary deal was signed on 16 December 2011. The Lithuanian parliament is expected to take a final decision on this contract in spring 2012. In December, PGE, the Polish state-owned company and, until then, one of the four partners in the project, decided to withdraw from participating.

Poland: In May, the government approved legislation amending the country's Nuclear Energy Law establishing the regulatory framework governing the entire nuclear investment process and the Polish Senate approved a bill allowing the construction of nuclear plants. Bidding is about to start and the company to construct the NPPs could be selected by mid 2013. Areva, Westinghouse and GE Hitachi and Fluor are expected to be among the bidders. The plans are to build two 3 000 MW power plants by 2020. Three potential sites on the Baltic coast have been shortlisted: Żarnowiec, Choczewo and Gąski.

Romania: The government decided to complete two additional units (1 400 MW) at the existing Cernavoda nuclear power plant by 2020. The feasibility studies and organisation of investments have been delegated to EnergoNuclear, a joint venture between the state nuclear operator (SN Nuclearelectrica) and other investors. Romania is also considering further increases in the country's nuclear capacity on a different site and completing the new facility by 2035. Detailed plans will be given in the new energy strategy which is currently being developed.

Slovakia: Building of units 3 and 4 at the Mochovce nuclear power plant continued. Unit 3 is expected to come into operation in the course of 2012. The plan to build a new unit at Jaslovske Bohunice has been delayed for five years. Consequently, it might not be finished before 2025.

Slovenia: In the proposal for the National Energy Programme for 2010–30, the authorities envisaged extending the operating lifetime of the Krško NPP, originally due to end in 2021, by another 20 years. The possibility of building a second reactor was also considered. However, no decision was taken on the application made by GEN Energija.

Spain: As part of the country's efforts to reduce electricity costs, Spain approved expansion of the capacity of units 1 and 2 at the Almaraz NPP by 70 MWe to 1 050 MWe each. Following a decision of the Spanish High Court, the 460 MW Garona NPP will be closed in 2013, despite the National Safety Commission's recommendation that it be granted approval to operate until 2019. Units 1 and 2 at the Ascó NPP, with generating capacity of about 1 000 MW each, were granted an extra 10 years of life, until 2021. The two reactors have been in operation since 1983 and 1985, respectively, and their lifetime may eventually be extended to more than 40 years, as the Sustainable Energy Law amended in 2011 currently envisages.

Sweden: The government maintained its 2010 decision to allow the building of new reactors (an existing reactor may be replaced by a new one, on condition that the total number of reactors — currently 10 — must remain unchanged). In March 2011, applications were submitted to the Radiation Safety Authority and to the Environmental Court to build the spent fuel repository at Forsmark in the municipality of Östhammar.

The Netherlands: In 2011, two applications were submitted to build a new reactor near the Borssele nuclear power plant ([17]). In July, the German company RWE Power AG acquired a 30 % interest in the Borssele nuclear power plant (owned by EPZ), after signing an agreement with the Dutch energy company Delta Energie.

United Kingdom: In July, the UK Parliament approved the Nuclear National Policy Statement confirming the selection of eight nuclear sites deemed suitable for the construction of NPPs by 2025 and introducing planning reforms to speed up construction. EDF Energy submitted applications for the site licence and the environmental permit necessary for the two Areva EPRs it plans to construct at the Hinkley Point C site by 2018. The UK nuclear regulator granted interim design approval for Westinghouse's AP1000 and EDF-Areva UK's EPR reactors. After having reassessed the prospects for the Sellafield MOX plant in the aftermath of the Fukushima accident, the Nuclear Decommissioning Authority decided to close it as soon as practicable. Authorisation for extension of operation of the Oldbury 1 unit, the world's oldest operating power reactor, was granted until the end of 2012. Magnox decided to close it by the end of February 2012. Oldbury 2 was closed in mid 2011.

ESA operations

Mandate and core activities

A common nuclear market in the EU was created by the Euratom Treaty. Articles 2(d) and 52 of the Treaty established ESA to ensure a regular and equitable supply of nuclear fuels to EU users. To perform this task, ESA applies a supply policy based on the principle of equitable access to sources of supply.

In this context, ESA focuses on enhancing the security of supply of users located in the European Union and shares responsibility for the viability of the EU nuclear industry. In particular, it recommends that EU utilities operating nuclear power plants maintain stocks of nuclear materials, cover their requirements by entering into long-term contracts and diversify their sources of supply.

ESA's mandate is, therefore, to exercise its powers ([18]) 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 (imports into or exports from the EU, 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 to purchase, with the right of first refusal, over nuclear materials produced in the Member States.

Based on 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.

([17]) In early 2012, due to the difficult economic and financial situation, in combination with overcapacity and, hence, low electricity prices, the plans were put on hold for at least two to three years.

([18]) Under the supervision of the European Commission (Article 53 of the Euratom Treaty).

In 2011, ESA started to scrutinise potential risks to the security of supply of HEU and LEU (up to 20 %) which are required to produce medical radioisotopes (Mo-99). Neither HEU nor LEU (up to 20 %) is currently produced in the EU, which is thus 100 % dependent on a couple of external suppliers. More active involvement by ESA will be sought in assessing the requirements for these fissile materials and in conclusion of contracts. This suggests that ESA should participate at the initial stage of commercial negotiations already.

Some 290 transactions, including contracts, amendments and notifications of front-end activities, were processed by ESA in 2011. In this way, the Agency ensured security of supply of nuclear materials.

Market observation

Besides this *Annual Report*, which is the Agency's main publication and is available on the ESA website, the nuclear observatory also offers the *News Digest*, *Price Trends*, *Quarterly Reports* and descriptions of the global nuclear fuel cycle. For readers inside the European Commission, the Agency also produces a weekly one-page *Nuclear News Brief*. For ESA and Directorate-General for Energy managers dealing with nuclear issues, the Agency also prepares and delivers a daily comprehensive business intelligence report *ESA Nuclear Observatory Daily News*, with a typical issue being almost 30 pages long.

ESA's website was completely redesigned in 2011. The new design makes it more user-friendly and offers a broader range of information from ESA's various publications. Moreover, the nuclear observatory, which is part of the ESA website, was also expanded with new data from the Agency's *Annual Report*. Data are published with the aim of making the EU nuclear market more transparent and providing fuller insights into developments on the market. ESA also continued issuing its bimonthly *Nuclear News Digest*.

ESA publishes, on an annual basis, different types of natural uranium prices that are in line with other traditional price indicators. Greater transparency about the EU natural uranium market reduces uncertainty and strengthens security of supply.

The *Quarterly Uranium Market Report* reflects global and specific EU 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. During 2011, ESA *Quarterly Uranium Market Reports* also incorporated the quarterly spot price index for natural uranium, whenever the condition of a minimum of three ordinary spot contracts was fulfilled.

In 2011, ESA issued six *Nuclear News Digests* and four *Quarterly Uranium Market Reports*. ESA's 2010 *Annual Report* was published in July 2011. ESA also presented its annual calculation of different types of average natural uranium prices: MAC–3, multiannual and spot prices.

The reliability of market analyses depends largely on the accuracy of the data collected. This is ensured by requiring EU nuclear energy users and producers to provide information on their estimated future requirements, contracted purchases and the quantities of nuclear materials actually delivered (*ex ante*, current and *ex post* market data) and by screening open source information.

Activities of the Advisory Committee

The Advisory Committee assists the Agency in carrying out its tasks by giving opinions and providing analyses and information. This assistance also extends to preparing various reports. The Committee acts as a link between ESA and both producers and users in the nuclear industry.

In 2011, the Advisory Committee changed its line-up as the three-year mandate of the previous members expired in June.

The outgoing Advisory Committee met on 5 May 2011. The main items on the agenda were: the Committee's opinion on ESA's 2010 *Annual Report*, assessment of ESA's accounts and budgetary situation in 2010 and the budget for 2012 and presentation of the latest developments in relation to the bilateral Euratom agreements with non-EU countries and of the EU response to the Fukushima incident.

The members of the newly appointed Advisory Committee, whose mandate runs until 31 May 2014, met for the first time on 13 October 2011. The Committee elected its Chairperson — Ms Marlies Hoedemakers from the Netherlands — and two vice-chairpersons, Mr Martin Oliva from the United Kingdom and Mr Miroslav Šedina from the Czech Republic. The newly appointed Advisory Committee then discussed the following issues: update of the ESA nuclear observatory website; the possibility of organising a seminar on 'Prospective European Nuclear Demand'; the regular review of the bilateral Euratom agreements; and the state of play with the EU stress tests. The new Advisory Committee also suggested seeking closer involvement of ESA in the supply of LEU and HEU required for producing medical radioisotopes, as there is currently a risk of a shortage.

Due to the changes in the composition of the Advisory Committee, no meetings of the Working Group on Prices and Security of Supply were held during 2011. However, at its meeting on 13 October 2011, the Advisory Committee discussed the results of the Working Group's activities since it was set up. The Advisory Committee also proceeded to appoint the new members of the Working Group, which is expected to meet in the first half of 2012.

International cooperation

ESA has a long-standing and well-established relationship with two major international organisations in the field of nuclear energy: the IAEA and the NEA, which is a specialised agency of the OECD. During 2011, 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.

The Joint NEA/IAEA Uranium Group is a permanent body in which ESA regularly participates as a member. It meets regularly twice a year and its main output is the *Red Book on Uranium* series, which is the most authoritative biannual publication on uranium resources and demand worldwide.

In 2011, ESA started to take part in the NEA High-Level Group on the Security of Supply of Medical Radioisotopes in its capacity as the EU body that plays a role in the market for nuclear materials that are used as fuel and targets for production of medical radioisotopes.

Furthermore, ESA continued to participate, on an ad hoc basis, in working groups and the nuclear fuel plenary sessions of the World Nuclear Association. At the January 2011 WNA plenary session, ESA presented its latest analysis of the EU nuclear market.

ESA administrative issues

Implementation of the budget

Following the European Parliament vote on the EU budget, the Commission's budget covered ESA's administrative expenditure in 2011. The 2011 annual accounts are available on ESA's website (http://ec.europa.eu/euratom/index_en.html).

At the end of 2011, based on the Commission's proposal, the European Parliament voted in favour of re-establishing the specific budget line for ESA in the General Budget of the European Union for 2012.

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.

2. World market for nuclear fuels

This chapter presents a short overview of the main developments affecting the global supply and demand balance and security of supply at different stages of the fuel cycle in 2011.

In 2011, world civil nuclear power generation capacity totalled about 365 GWe and world reactor requirements for natural uranium were estimated to be around 63 000 tU, approximately 10 % lower than in the previous year.

The Fukushima accident has affected nuclear growth in the short term around the world. In the medium term, the nuclear industry will face disturbances, as some countries have already decided to phase out. However, the global situation in terms of energy supply and demand remains relatively unchanged, and developments in China, India, South Korea, Russia and the USA will be particularly crucial in determining the long-term role of nuclear energy in electricity supply.

According to the conclusions of the 2011 WNA *Global Nuclear Fuel Market* report ([19]), the Fukushima accident has affected the demand and supply forecasts for nuclear fuel and the development of nuclear energy capacity. However, in the 'Reference scenario', which assumes that most countries will continue with their pre-Fukushima plans, nuclear power generation capacity is expected to grow to 471 GWe by 2020 and 614 GWe by 2030. World uranium requirements are projected to grow at a similar rate, reaching about 108 000 tU in 2030. The International Atomic Energy Agency's (IAEA) annual low and high projections for nuclear power growth up to 2030 also expect nuclear energy to grow, but at lower rates than the pre-Fukushima estimates.

Supply of nuclear fuels

The expected future increase in demand will have to be covered mostly by an increase in primary supply. Uranium production from new mining projects should provide 38 % by 2020 and 60 % by 2030. Worldwide uranium resources are generally considered sufficient for at least several decades, with uranium mining spread across the globe. Nevertheless, secondary sources will continue to be required, although at a diminishing rate. Consequently, the adequacy of supply will probably depend on whether mine production is ramped up fast enough to step in for falling secondary supply and keep up with rising demand. In view of the uncertainty about the availability of secondary supplies, decisions on long-term mining projects have to be taken now, as new uranium deposits take an average of 15 years to develop from scratch.

Interest in uranium exploration and mine development continued in 2011. Expansion of BHP Billiton's Olympic Dam mine in South Australia received approval under federal environmental law. Annual uranium production capacity would increase progressively from around 4 000 t U_3O_8 today to approximately 19 000 t U_3O_8 by 2021. If it materialises, this expansion would extend the life of the mine from about 20 years to more than 100.

In the same way, the Cigar Lake project is progressing, as Cameco Corporation has completed the second shaft to reach the main mine workings and signed agreements to process all Cigar Lake ore at McClean Lake. Cameco expects to resume full mine development and construction activities in 2012 and remains on schedule to start ore mining by mid 2013.

Rio Tinto has completed a USD 623 million acquisition of the Canadian uranium exploration company Hathor, after a three-month battle with Cameco. This acquisition will add to its portfolio further exploration activities, located in northern Saskatchewan, including the Roughrider deposit, with an estimated 17.2 million lb U_3O_8 in indicated resources and 40.7 million lb U_3O_8 in inferred resources.

([19]) WNA, *The Global Nuclear Fuel Market — Supply and Demand 2011–2030.*

Namibia's government has granted Extract Resources a 25-year mining licence for its Husab uranium project, increasing estimated proven and probable reserves by 37 % to 280 million t U_3O_8 (319.9 million lb U_3O_8). China has also gained access to the Husab uranium deposit, under the USD 990 million deal signed by China Guangdong Nuclear Power Corporation for acquisition of Kalahari Minerals plc, as Kalahari owns 43 % of Extract Resources. With the Chinese-Uzbek joint venture to start mining in the Navoi Region of Uzbekistan by 2013, China is entering the uranium mining industry dynamically.

By contrast, following a drop in demand and prices for uranium after the Fukushima accident and on account of lower deposit estimates, Areva has suspended its two African mining projects in Trekkopje and Bakouma.

Table 2 Prospective world uranium production (in tU)

Country	2012	2013	2014	2015	2020	2025	2030
Kazakhstan	18530	21323	22788	22788	25249	25378	21211
Africa	9817	10315	10549	11183	18472	27119	29390
Canada	7720	7720	7720	8335	12013	12013	13213
Australia	6647	5608	5670	6408	6331	9040	10326
Russia	3076	3302	3908	4032	5253	6105	5354
Uzbekistan	2250	2250	2250	2250	2250	2250	2250
USA	1783	2221	2264	2479	3222	2481	2253
All others	2398	2405	2347	2478	3015	4525	5397
Total	52221	55144	57496	59953	76805	88911	89394

Source: WNA, *The Global Nuclear Fuel Market — Supply and Demand 2011–2030* — 'Reference Scenario'

Natural uranium production

Global uranium production in 2011 decreased by 1 % compared with the 2010 figure, totalling approximately 53 000 tonnes uranium (tU), instead of the forecast production of 56 000 tU.

As in 2010, the top three uranium-producing countries were Kazakhstan, Canada and Australia. Kazakhstan remained the world's largest uranium producer in 2011, for the third year in a row, with total production of almost 19 500 tU. In Australia, a significant increase in production at BHP Billiton's Olympic Dam mine, mainly due to the resumption of activities after the mine closure in 2009, was offset by the decline in production at ERA's Ranger mine, which was hit hard by a five-month suspension of the processing plant's operations due to above-average precipitation in the wet season.

Canada, Namibia, Russia and the USA all reported a decline in production levels which did not prove to be directly linked to the Fukushima accident. In Canada, the decline was still due to the fact that uranium production in McClean Lake was halted in June 2010. At the Rossing mine in Namibia, the production level was affected by lower grades, lower extraction rates, bad weather and ongoing development work in the pit.

As shown in Table 3, eight uranium-producing countries account for more than 90 % of global uranium extraction.

In the long term, the rapidly growing Asian markets could create some uncertainty about the adequacy of the anticipated world production to meet the steadily growing demand. However, the broad geographical distribution of uranium resources and variety of mining projects will ensure that the rising demand will be sufficiently met.

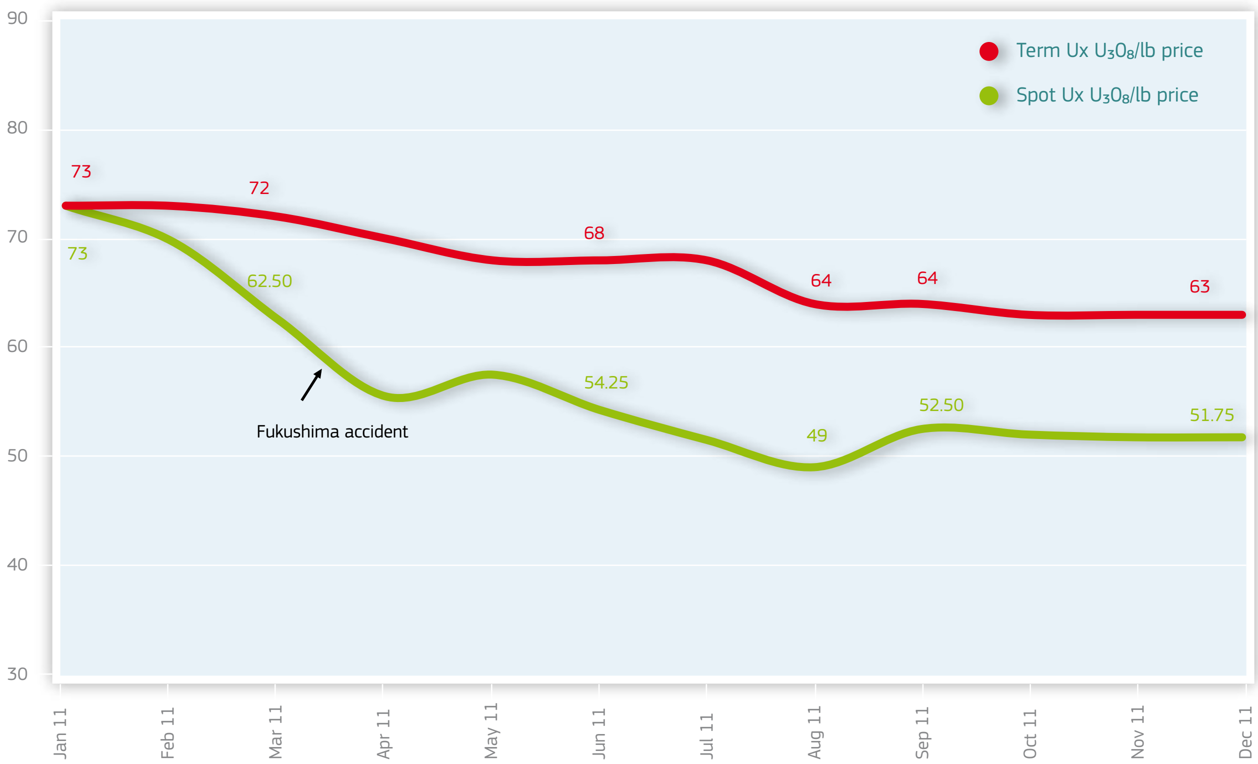
During the first two months of 2011, the spot U_3O_8 price continued to recover from the effects of the global financial crisis that began in late 2008. It was mainly boosted by China's plans to expand its reactor fleet. In January, it reached its peak for the year at USD 73/lb. Hit by the Fukushima accident, the spot U_3O_8 price fell to USD 62/lb in March. Uncertainty continued to cloud the spot uranium market and the spot price fell to its lowest value of the year, USD 49/lb U_3O_8, in August. However, it then recovered to USD 52/lb U_3O_8 by September and remained stable until the end of the year, closing at USD 51.75/lb U_3O_8.

Table 3 Natural uranium production in 2011 (compared with 2010, in tonnes of uranium)

Region/country	Production 2011	Production 2010	Share in 2011(%)	Share in 2010 (%)	Change 2011/10 (%)
Kazakhstan	19451	17803	36	33	9
Canada	9145	9783	17	18	–7
Australia	5983	5900	11	11	1
Niger	4351	4198	8	8	4
Namibia	3258	4496	6	8	–28
Russia	2993	3562	6	7	–6
Uzbekistan	2500	2400	5	4	4
USA	1537	1660	3	3	–7
Ukraine	890	850	2	2	5
China	885	827	2	2	7
Malawi	846	670	2	1	26
South Africa	582	583	1	1	0
Others	1073	931	2	2	15
Total	**53494**	**53663**	100	100	–0.3

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

Worldwide, supply and demand for natural uranium remained in balance in 2011. Primary production of uranium accounted for 53 000 tU or 75 % of the world supply. The remaining 17 000 tU were provided by or derived from secondary sources, including stockpiles of natural and enriched uranium, down-blending of weapons-grade uranium, 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, due to increasing primary production, mainly in Kazakhstan. In the long term, the downward trend will continue, with secondary sources reaching around 13 000 tU per year after 2013 due to the significant decline in the quantity of LEU derived from Russian down-blended HEU. Therefore, recycling of reprocessed uranium (ERU) and plutonium (MOX) needs to play a more significant role in order to fill in the gap.

Conversion

Five major commercial conversion companies are operating worldwide, in Canada, France, the Russian Federation, the United Kingdom and the United States. According to the WNA *Global Nuclear Fuel Market — Supply and Demand (2011–2030)*, in the immediate future the market has an adequate supply base. In 2011, world nameplate conversion capacity was estimated at 76 000 tU which was well above the global demand for conversion services, estimated to be around 59 000 tU. As conversion facilities operate at less than 100 % of their nameplate capacity, actual primary conversion supply totalled around 46 500 tU whereas secondary conversion supply provided for 15 000 tU.

Table 4 Commercial UF_6 conversion facilities (tonnes of uranium/year)

Company	Nameplate capacity in 2011 (tU as UF_6)	Share of global capacity (%)
Atomenergoprom (Rosatom) (RUS)	25 000	33
Cameco-Springfields (CAN, UK)	18 500	24
ConverDyn (USA)	15 000	20
Comurhex (Areva) (France)	14 000	19
CNNC (China)	3 000	4
Ipen (Brazil)	90	0
Total nameplate capacity	75 590	
Total operating capacity	55 531	
Actual reported production	46 500	

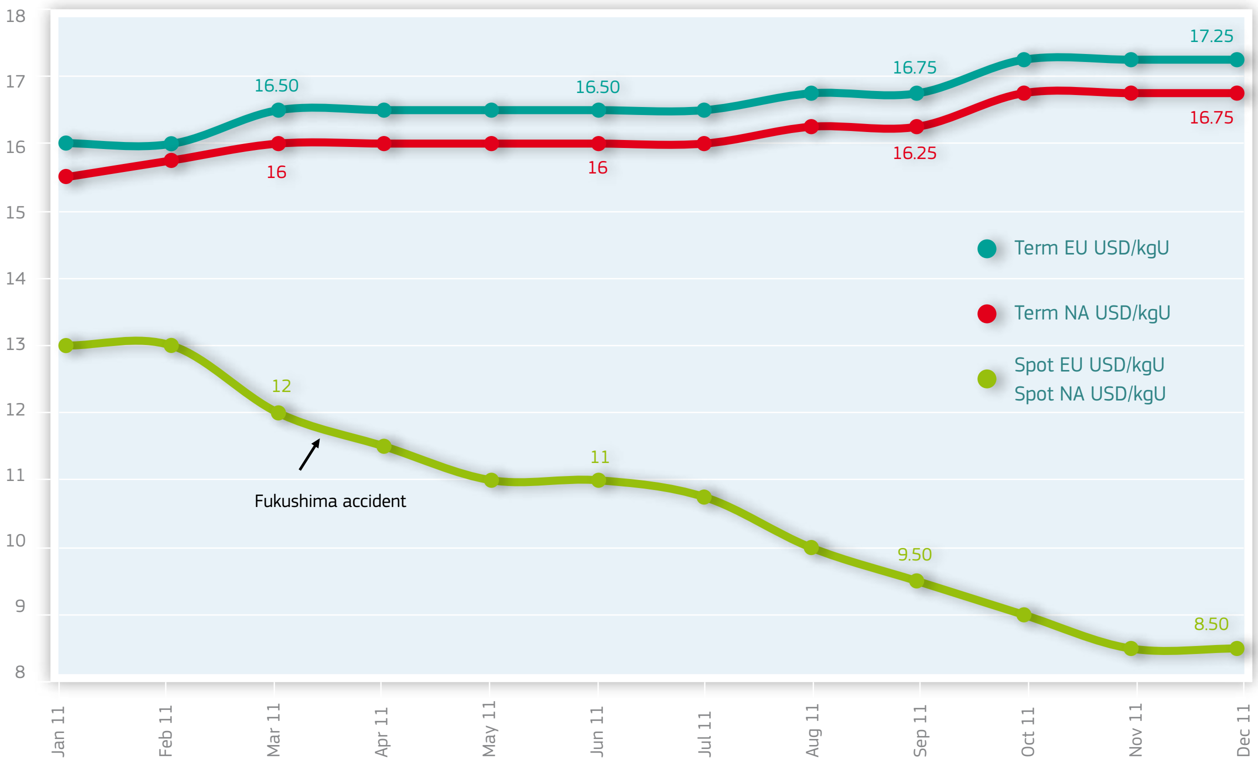
Source: WNA, *The Global Nuclear Fuel Market — Supply and Demand 2011–2030*

In the aftermath of the Fukushima accident, major converters shifted their supply strategies to adapt to lower demand for fuel and price levels. Thus, Areva (Comurhex) suspended uranium conversion operations at its Malvesi and Pierrelatte plants for the last two months of the year. At the same time, Cameco also announced its intention not to extend the toll processing agreement for operation of the Springfields plant after 2016. Similarly, Rosatom and TVEL expressed their intention to consolidate conversion production, using only the Seversk site in future.

As regards prices, Ux spot conversion prices, both European and North American, decreased by approximately 30 % in 2011, ending at USD 8.5/kgU in December 2011. However, long-term conversion prices posted an 11 % annual increase, with the long-term EU price ending 2011 at USD 17.25/kgU.

Although current spot conversion prices do not support new capacity-building, new investment projects are required since demand for conversion will continue to grow, reaching 83 000 tU by 2020.

Figure 2 Uranium conversion price trends (USD)



Source: The Ux Consulting Company

Enrichment

More than 95 % of the reactors operating in the world require enriched uranium fuel. Even though demand is expected to rise, mainly in Asia, the current commercial enrichment nameplate capacity of around 65 000 tSW is estimated to be sufficient to cover demand until 2020.

At the same time, the world uranium enrichment industry, dominated by four major suppliers, will soon be dominated solely by centrifuge technology. In view of the estimated higher demand, providers of enrichment services will need to invest in new capacity expansion projects.

Table 5 Operating commercial uranium enrichment facilities with approximate 2011 capacity

Company	Nameplate capacity (tSW)	Share of global capacity (%)
Atomenergoprom (RUS)	28 600	44
Urenco (UK/DE/NL)	13 000	20
USEC (USA)	11 300	17
Areva-Eurodif (France)	10 800	17
CNNC (China)	1 300	2
JNFL	0	0
World total	65 000	

Source: WNA, *The Global Nuclear Fuel Market — Supply and Demand 2011–2030*

In 2011, despite growing uncertainties on the nuclear market, there were significant developments on the enrichment market.

The USEC-Techsnabexport (Tenex) supply contract, signed in March 2011, came into force in December 2011, after the signature of the Administrative Arrangements of Russia and of the US Intergovernmental Agreement on cooperation in the field of peaceful use of atomic energy (US/Russia 123 Agreement). The agreement is a successor of the former 'Megatons to Megawatts' programme, ending in 2013. Under the terms of the contract, Tenex will supply 21 million SWU to USEC from 2013 to 2022, worth USD 2.8 billion. Tenex will provide up to about half of the LEU levels presently supplied from Russia (about 2.5 million SWU per year), with an option to match present levels. The new supplies will come from mined uranium enriched in Russia.

Simultaneously, the signature of the Administrative Arrangements under the 123 Agreement also brought into force a Memorandum of Understanding between Tenex and USEC on the establishment of a joint venture in the USA to build an uranium enrichment plant based on Russian centrifuge technology.

In April, Areva started commercial production of low enriched uranium at the South Unit of the George Besse II enrichment facility in France. The planned annual production capacity of 7.5 million SWU at George Besse II should be reached by 2016. At the same time, Areva put on hold the start of construction of the Eagle Rock Enrichment Facility (EREF) in Idaho Falls, due to reported operating losses and later than foreseen licensing by the US NRC.

Russian enriched uranium supplier Tenex had a record volume of orders worth USD 3.3 billion. According to the press, in 2011, Rosatom invested approximately USD 198 million in Electro-Chemical Plant (ECP). This is part of a USD 1.6–2.3 billion investment programme intended to modernise and expand the capacity of ECP and expected to continue until 2020.

Urenco continued to increase its enrichment capacity throughout 2011 in accordance with customer commitments under long-term contracts, taking its total capacity in the EU to more than 14 600 tSW at the end of the year.

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 France, Germany, the Russian Federation and the USA, but fuel is also manufactured in other countries, often under licence from one of the main suppliers.

The Fukushima accident affected MOX fuel use worldwide in several ways. As an immediate effect, shipments of MOX fuel from France to Japan were rescheduled, and the Tennessee Valley Authority (USA) started requiring additional assessments before deciding whether to introduce MOX fuel in US plants.

In addition, the UK Nuclear Decommissioning Authority decided to shut down its Sellafield MOX fuel plant.

Nevertheless, according to the conclusions of the WNA's latest market report, fuel fabrication will not become a bottleneck in the world nuclear fuel market. The current western fuel fabrication capacity outweighs demand by approximately 40 %. The excess capacity until 2020 seems to be sufficient under all requirements scenarios to satisfy the anticipated demand for both first cores and reloads, but new investments could be required if the upper scenario unfurls in 2030.

As for future investment, Rosatom has revealed plans to invest almost USD 1 billion in fuel fabrication technologies, dry and wet fuel storage and fast-neutron reactors at its Mining and Chemical Factory (GKhK) based in the Krasnoyarsk region. In the meantime, TVEL (part of Rosatom) has received a domestic Russian licence for exporting fuel to Armenia, Bulgaria, the Czech Republic, Finland, Hungary, Slovakia and Ukraine. The licence is valid until 2016 and will cover exports of uranium enriched with isotope uranium-235 (no more than 5 %) in the form of fresh reactor fuel.

As regards the fuel fabrication joint venture between Areva and KazAtomProm, the two companies agreed to build a facility at the Ulba Metallurgical Plant, which would provide annual capacity of 400 tU of fuel mainly bound for the Asian market. The plant is to be started in 2014.

Reprocessing

Worldwide, reprocessing is considered when it is economically attractive compared with natural uranium fuel. Spent fuel is currently being reprocessed on a commercial scale in France, Japan, the Russian Federation and the United Kingdom. Around 100 000 tonnes of spent nuclear fuel has already been reprocessed in the civil nuclear sector. Recycling reprocessed fuel not only reduces natural uranium requirements but also can considerably decrease the quantities of radioactive waste which have to be safely stored.

To date, no nation has ever achieved a fully closed commercial nuclear fuel cycle, including spent fuel reprocessing, breeder reactors and associated fuel fabrication, waste stream management and other systems. The country that has almost managed to close the fuel cycle is France, which operates a large reprocessing plant at La Hague. Current reprocessing programmes are mainly viewed by their proponents as interim steps toward a commercial nuclear fuel cycle based on fast reactors.

About 200 tonnes of MOX and ERU fuel are used annually, which equals about 2 % of new nuclear fuel, 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 (see the list in Annex 6) or their procurement organisations in an annual survey concerning the amounts of fuel loaded into reactors, estimates of future fuel requirements, quantities, origins and acquisition prices of natural uranium and separative work, future contracted deliveries and inventories. In 2011, 18 nuclear utilities, located in 14 EU Member States, were operating 134 commercial nuclear power reactors generating 861 TWh. Nuclear electricity generation accounted for 28 % ([20]) of the energy mix in the EU-27 and 34 % of the nuclear electricity generated worldwide.

Fuel loaded into reactors

During 2011, 2 583 tU of fresh fuel were loaded into commercial reactors in the EU-27. It was produced by using 17 465 tU of natural uranium and 1 195 tU of reprocessed uranium as feed, which had been enriched with 13 091 tSW. The quantity of fresh fuel loaded decreased by 5 % year-on-year, 128 tU less than the 2010 figure. In 2011, NPP operators opted for an average enrichment assay of 3.56 % and an average tails assay of 0.25 %.

Future reactor requirements (2012–31)

EU utilities have estimated their gross reactor requirements for natural uranium and enrichment services over a period of 20 years, taking into account possible changes in national policies or regulatory systems resulting in construction of new units, extensions of lifetime, 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		
2012–21	18 870 tU/year (gross)	16 947 tU/year (net)
2022–31	17 594 tU/year (gross)	16 180 tU/year (net)

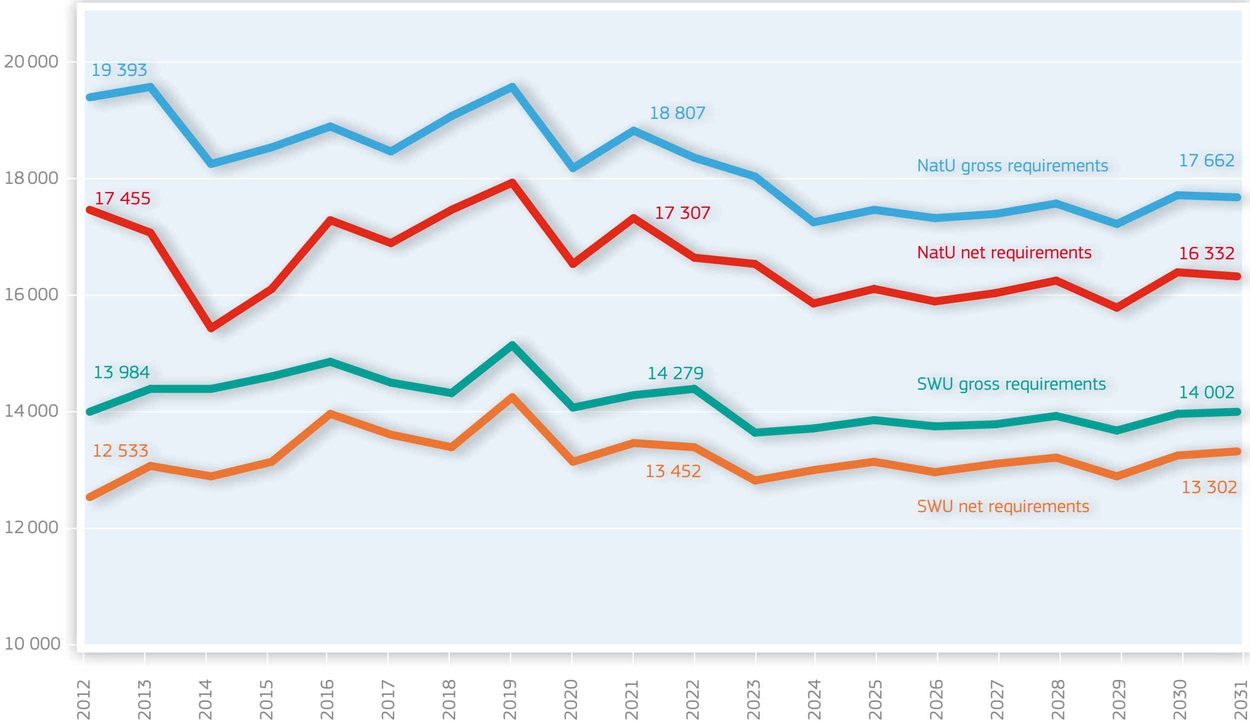
Enrichment services average reactor requirements		
2012–21	14450 tSW/year (gross)	13 343 tSW/year (net)
2022–31	13 866 tSW/year (gross)	13 107 tSW/year (net)

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 on gross requirements downwards by approximately 10 % (2 100 tU and 1 200 tSW respectively) for the period 2012–21 and by approximately 17 % (3 500 tU and 2 900 tSW respectively) for 2022–31, in line with the uncertainty spread by the Fukushima accident. In the long term, the impact of the accident will be deeper, as exemplified by Germany's post-Fukushima decision to phase out nuclear power completely by 2022.

([20]) Eurostat energy statistics, 2010 data on primary energy production.

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



Supply of natural uranium

Conclusion of contracts

In 2011, ESA processed a total of 75 contracts and amendments, of which 47 (63 %) were newly concluded contracts. Of the 41 new purchase/sale contracts, 59 % involved EU utilities and the remainder were signed by intermediaries. Table 6 gives further details of the type of supply, terms and parties involved.

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

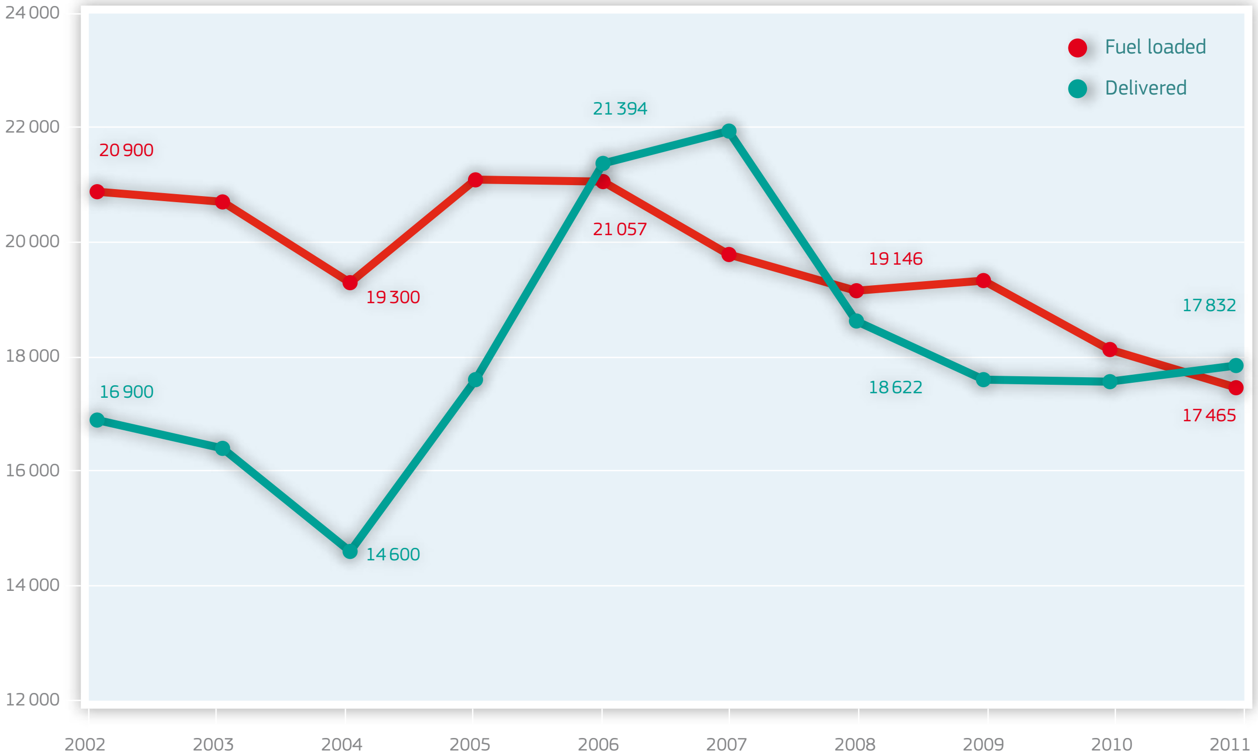
Type of contract	Number of contracts concluded in 2011	Number of contracts concluded in 2010
Purchase/sale by an EU utility/user	**24**	**21**
— multiannual (1)	8	4
— spot (1)	16	17
Purchase/sale by intermediaries	**17**	**9**
— between intermediaries (2) (multiannual)	4	4
— between intermediaries (2) (spot)	13	5
Exchanges and loans (3)	**6**	**10**
Amendments	**28**	**15**
TOTAL	75	55

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

(2) Purchase/sale contracts between intermediaries — neither the 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.

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



Volume of deliveries

The deliveries taken into account are those made to EU utilities or their procurement organisations in 2011, excluding research reactors. They also include the natural uranium equivalent contained in enriched uranium purchases, when stated.

In 2011, demand for natural uranium in the EU equalled one third of global uranium production. During the year, EU utilities purchased a total of 17 832 tU (an increase of 266 tU from the 2010 figure) in 133 deliveries under long-term and spot contracts. As in previous years, long-term supplies remained the main source for meeting the demand in the EU. Deliveries of natural uranium to EU utilities under long-term contracts accounted for 17 179 tU (of which 16 293 tU with reported prices) or 96 % of the total deliveries, whereas the remaining 4 % (653 tU) were purchased under spot contracts. On average, the quantity of natural uranium delivered under long-term contracts was 145 tU per delivery compared with 44 tU per delivery under spot contracts.

Natural uranium contained in the fuel loaded into reactors in 2011 totalled 17 465 tU. The difference between natural uranium delivered and natural uranium contained in fuel loaded turned positive for the first time in four years, in line with the shutdown of eight German reactors in the aftermath of the Fukushima accident of March 2011.

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 1980–2011).

Average prices of deliveries

In order to enhance market transparency, ESA publishes, on an annual basis, three EU natural uranium price indices, 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 the purchase contracts concluded in recent years is mainly agreed using sophisticated price formulae, made up of uranium price and inflation indices, mainly for new multiannual contracts but also for a non-negligible percentage of the spot contracts.

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 weighing the prices paid against 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 influenced the level of the calculated price indices. The exchange rate situation in 2011 was marked by appreciation of the euro in nominal effective terms against the US dollar. On average, compared with 2010, the US dollar weakened by 5 % against the euro, with the annual average ECB EUR/USD rate rising to 1.39, from 1.33 in 2010. Consequently, the year-on-year changes in ESA's price indices expressed in US dollars have a deeper impact, as the weakness of the US dollar is reflected in higher dollar-denominated prices.

An average conversion price is also calculated by ESA, based on reported conversion prices and market information available. In order to establish a natural uranium price which excludes the conversion cost if the latter was not specified, ESA applied a rigorously calculated average conversion price of EUR 9.67/kgU (USD 13.46/kgU) for 2011, 10 % higher (16 % in USD/kgU) than in 2010, when ESA's calculated conversion price was EUR 8.76/kgU (USD 11.61/kgU). For comparison, the end-of-month yearly average of the UxC and TradeTech spot and long-term conversion prices for North America and the EU in 2011 was USD 13.43/kgU (EUR 9.65/kgU), approximately equal to ESA's calculation of USD 13.46/kgU.

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 2011 was calculated as

EUR 107.43/kgU contained in U_3O_8	(35 % up from EUR 79.48/kgU in 2010)
USD 57.52/lb U_3O_8	(42 % up from USD 40.53/lb U_3O_8 in 2010)

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 2011 was calculated as

EUR 83.45/kgU contained in U_3O_8	(35 % up from EUR 61.68/kgU in 2010)
USD 44.68/lb U_3O_8	(42 % up from USD 31.45/lb U_3O_8 in 2010)

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 concluded or whose pricing method has been amended within the last three years, having deliveries during 2011 was calculated as

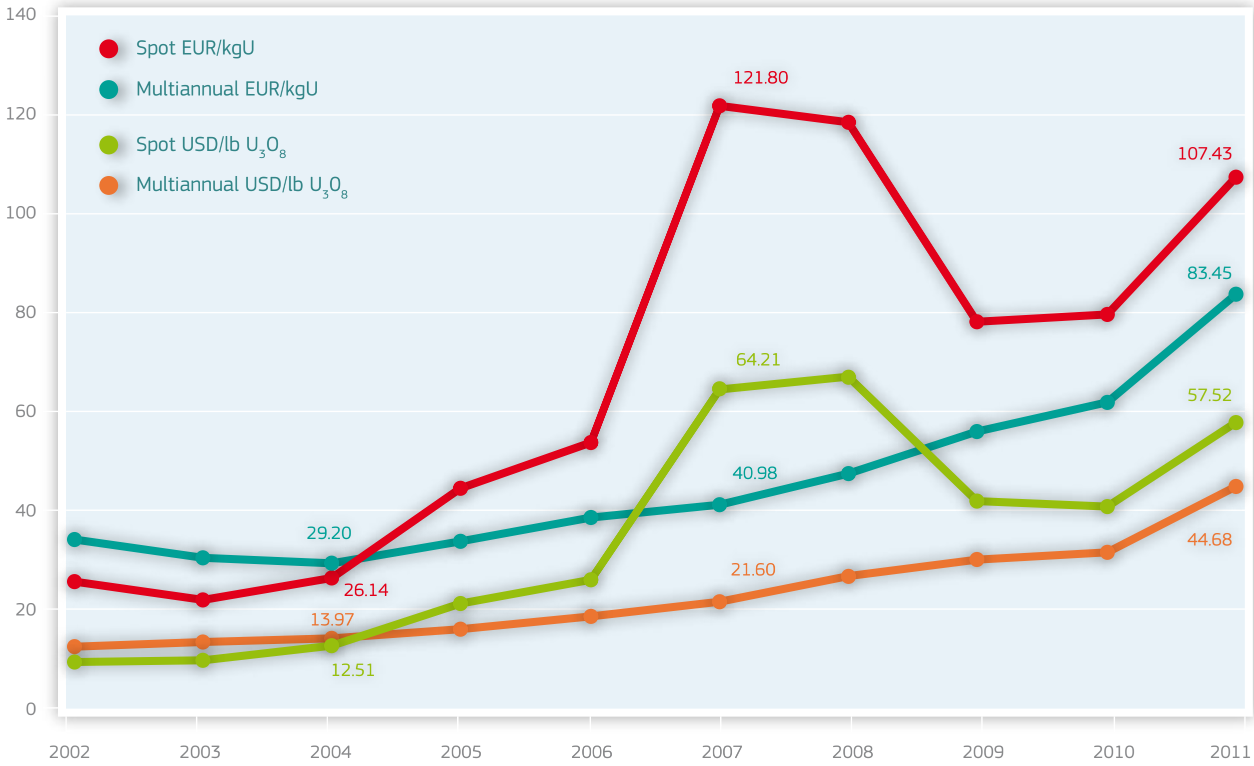
EUR 100.02/kgU contained in U_3O_8	(28 % up from EUR 78.12/kgU in 2010)
USD 53.55/lb U_3O_8	(34 % up from USD 39.83/lb U_3O_8 in 2010)

The **ESA U_3O_8 spot price** reflects the latest developments on the uranium market as it is calculated from contracts providing for either only one delivery or for deliveries extending over a maximum of 12 months. In 2011, the ESA spot U_3O_8 price was EUR 107.43/kgU (or USD 57.52/lb U_3O_8), in line with the annual average natural uranium price of USD 57/lb U_3O_8 published by major consulting companies and higher than the yearly average of USD 47/lb U_3O_8 in 2010, giving a 21 % year-on-year increase. Moreover, price data were narrowly distributed, all falling within the range of EUR 95 to EUR 127/kgU (USD 51-68/lb U_3O_8). The calculated range is in line with the annual price fluctuation published by Ux Consulting, from the high peak of USD 73/lb U_3O_8 recorded in January, boosted by China's plans to expand its reactor fleet, to the low of USD 49/lb U_3O_8 in August 2011, affected by the uncertainty clouding the post-Fukushima market.

The **ESA long-term U_3O_8 price** was EUR 83.45/kgU as U_3O_8 (USD 44.68/lb U_3O_8). Long-term prices paid were widely scattered, with approximately 70 % (assuming a normal distribution) falling within the range of EUR 60 to EUR 118/kgU (USD 32-63/lb U_3O_8). Long-term prices published by consulting companies showed a yearly average of USD 67/lb U_3O_8, 10 % higher than in 2010. 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 2011 had been signed nine years earlier.

However, the **ESA 'MAC-3' new multiannual U_3O_8 price** data were distributed within a narrower range, with approximately 70 % of prices reported falling between EUR 80 and EUR 119/kgU (USD 43-64/lb U_3O_8). The ESA MAC-3 index takes into account only recently signed long-term contracts (within the period 2009–11) or older long-term contracts whose uranium pricing method was amended during the same period, thus incorporating current market conditions and providing insights into the future of the nuclear market.

Figure 5 Average prices for natural uranium delivered under spot and multiannual contracts, 2002–11 (EUR/kgU and USD/lb U_3O_8)



The ESA long-term U_3O_8 price paid for uranium originating in the Commonwealth of Independent States (CIS) ([21]) was 13 % higher than the prices for uranium of non-CIS origin. By contrast, the ESA spot U_3O_8 price and the ESA 'MAC-3' new multiannual U_3O_8 price paid for uranium originating in CIS countries were 12 % and 14 % lower, respectively, than the prices for uranium of non-CIS origin.

Figure 5 shows the ESA average prices for natural uranium since 2001. The corresponding data are presented in Annex 3.

Origins

In 2011, natural uranium supplies to the EU continued to come from diversified sources.

Russia, Canada and Kazakhstan were the top three countries of origin and provided 59 % of the natural uranium delivered to the EU in 2011. Uranium originated in Russia (including purchases of natural uranium contained in EUP) took the largest share, feeding EU reactors with 4524 tU (25 %), which, however, was 9 % down on 2010. It was followed by uranium of Canadian origin, with a 19 % share or 3318 tU, a strong 65 % increase from the 2010 figure (2012 tU).

In third place, uranium mined in Kazakhstan provided 2659 tU or 15 %, showing a year-on-year decline of 6 %.

In general, the origins ([22]) of natural uranium supplied to EU utilities have remained unchanged since 2010. However, the shares of the four big uranium-producing regions (the CIS, North America, Africa and Australia) have shifted substantially.

Natural uranium mined in the CIS (mainly Russia, Kazakhstan, Uzbekistan and Ukraine) accounted for approximately half of the natural uranium delivered to EU utilities, or 9125 tU (51 %).

Deliveries of uranium of North American origin totalled 3498 tU (20 %), making this the only region which increased its share on a year-on-year basis, whereas all the rest showed a downward trend.

African-origin uranium deliveries declined to 2899 tU (16 %) from 3290 tU in 2010. Uranium extracted from Niger accounted for 1726 tU or 10 % of the total deliveries to EU utilities and for 60 % of all African-mined uranium.

Similarly, Australian-origin uranium totalled 1777 tU (or 10 % of total deliveries), a decrease of 17 % from last year (2153 tU).

([21]) The Commonwealth of Independent States has 10 Member States, namely: Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Ukraine and Uzbekistan.

([22]) The uranium mined in a particular country also includes uranium mined by companies owned outside that country.

European uranium delivered to EU utilities originated from the Czech Republic and Romania and covered approximately 3 % of the EU's total requirements (a total of 455 tU). The amount of HEU feed used increased to 731 tU or 4 % in 2011, while no deliveries of re-enriched tails material were reported by EU utilities.

Figure 6 Origins of uranium delivered to EU utilities in 2011 (% share)

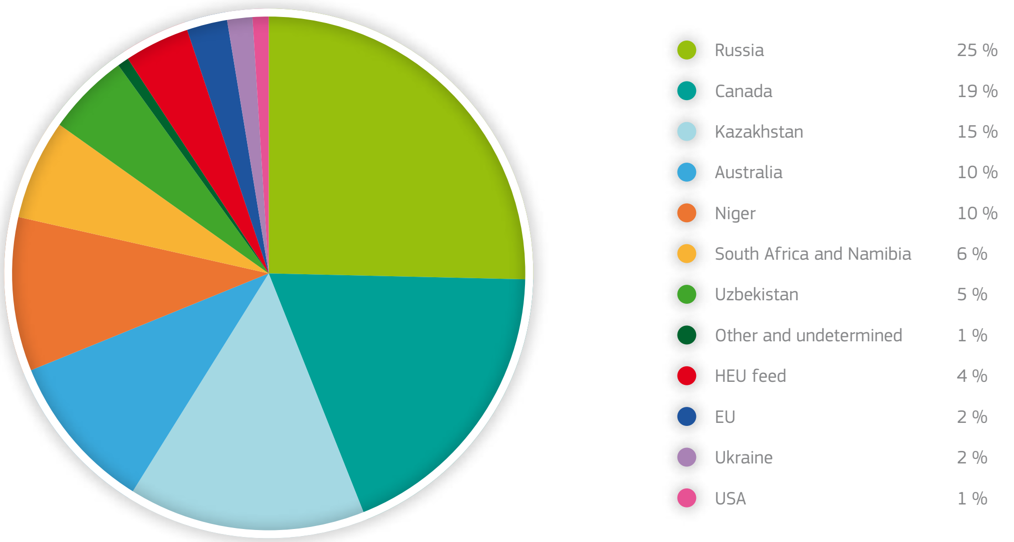
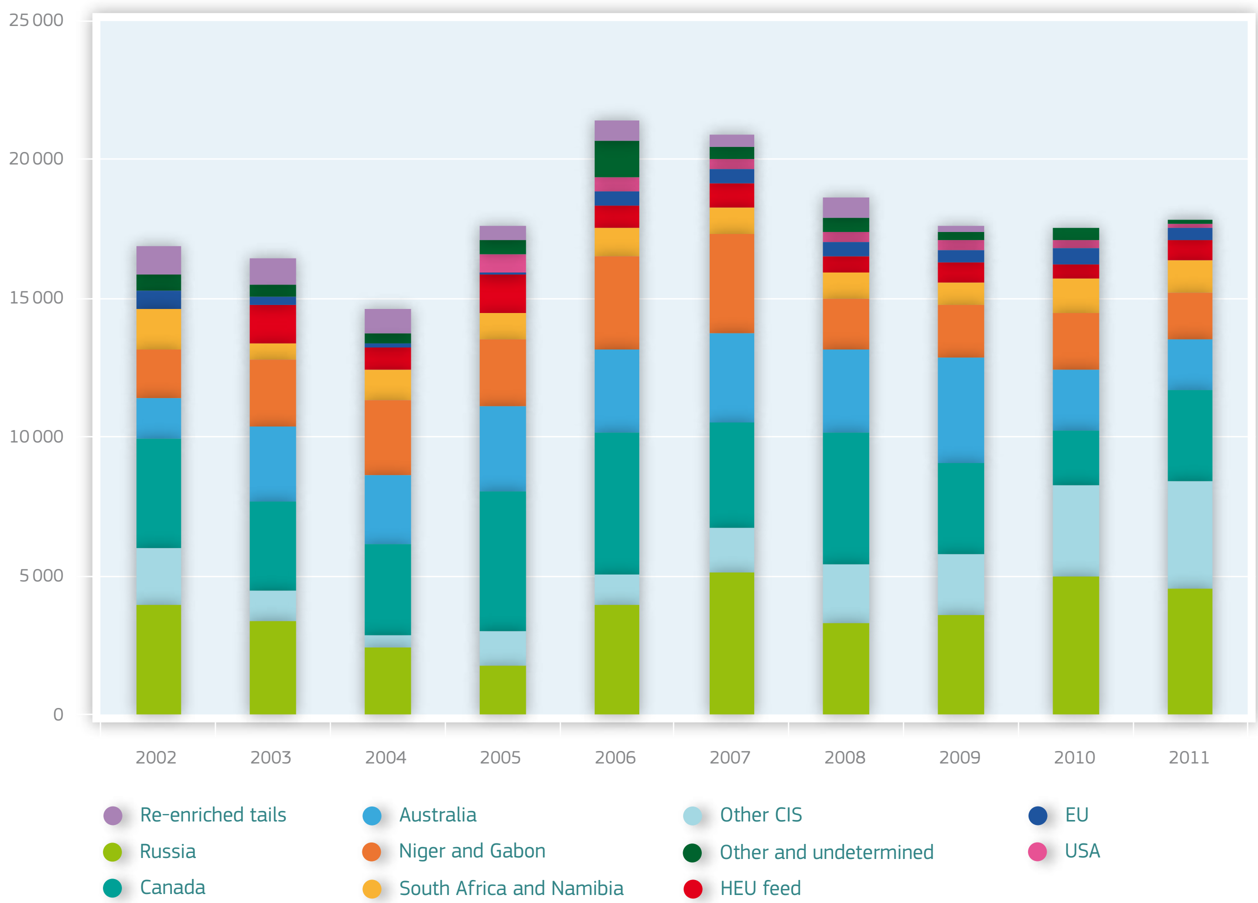


Figure 7 Purchases of natural uranium by EU utilities by origin, 2002–11 (tU)



Special fissile materials

Conclusion of contracts

Table 7 shows the aggregate number of contracts, notifications and amendments ([23]) relating to special fissile materials (enrichment services, enriched uranium and plutonium) dealt with during 2011 in accordance with ESA's procedures.

Deliveries of low-enriched uranium

In 2011, the enrichment services (separative work) supplied to EU utilities totalled 12 507 tSW, delivered in 2 166 tonnes of low-enriched uranium (tLEU) which contained the equivalent of 17 877 tonnes of natural uranium feed. In 2011, enrichment service deliveries to EU utilities decreased by 16 % compared with 2010, with NPP operators opting for an average enrichment assay of 3.91 % and an average tails assay of 0.25 %.

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

Type of contract	Number of contracts 2011	Number of contracts 2010
A. Special fissile materials	**60**	**61**
Purchase (by an EU utility/user)	12	11
Sale (by an EU utility/user)	2	7
Purchase/sale (between two EU utilities/end-users)	3	3
Purchase/sale (intermediaries)	24	15
Exchanges	8	13
Loans	0	1
Pool ([1])	0	0
Total ([2])	**49**	**50**
Contract amendments	**11**	**11**
B. Enrichment notifications ([3])	**7**	**21**
Notifications of amendments	24	17

([1]) Transactions related to transfers of special fissile materials between different operators acting under one historical owner of the material.
([2]) In addition, there were transactions for small quantities (Article 74 of the Euratom Treaty) which are not included here.
([3]) Contracts with primary enrichers only.

Table 8 Providers of enrichment services delivered to EU utilities

Enricher	Quantities in 2011 (tSW)	Share in 2011 (%)	Quantities in 2010 (tSW)	Share in 2010 (%)	Change in quantities 2011/10 (%)
Eurodif and Urenco (EU)	6 717	54	8 785	59	– 24
Tenex/TVEL (RUS)	5 057	40	4 896	33	3
USEC (USA)	643	5	1 047	7	– 39
Others (1)	90	1	127	1	– 29
TOTAL	12 507	100	14 855	100	– 16

([1]) Including reprocessed re-enriched uranium.

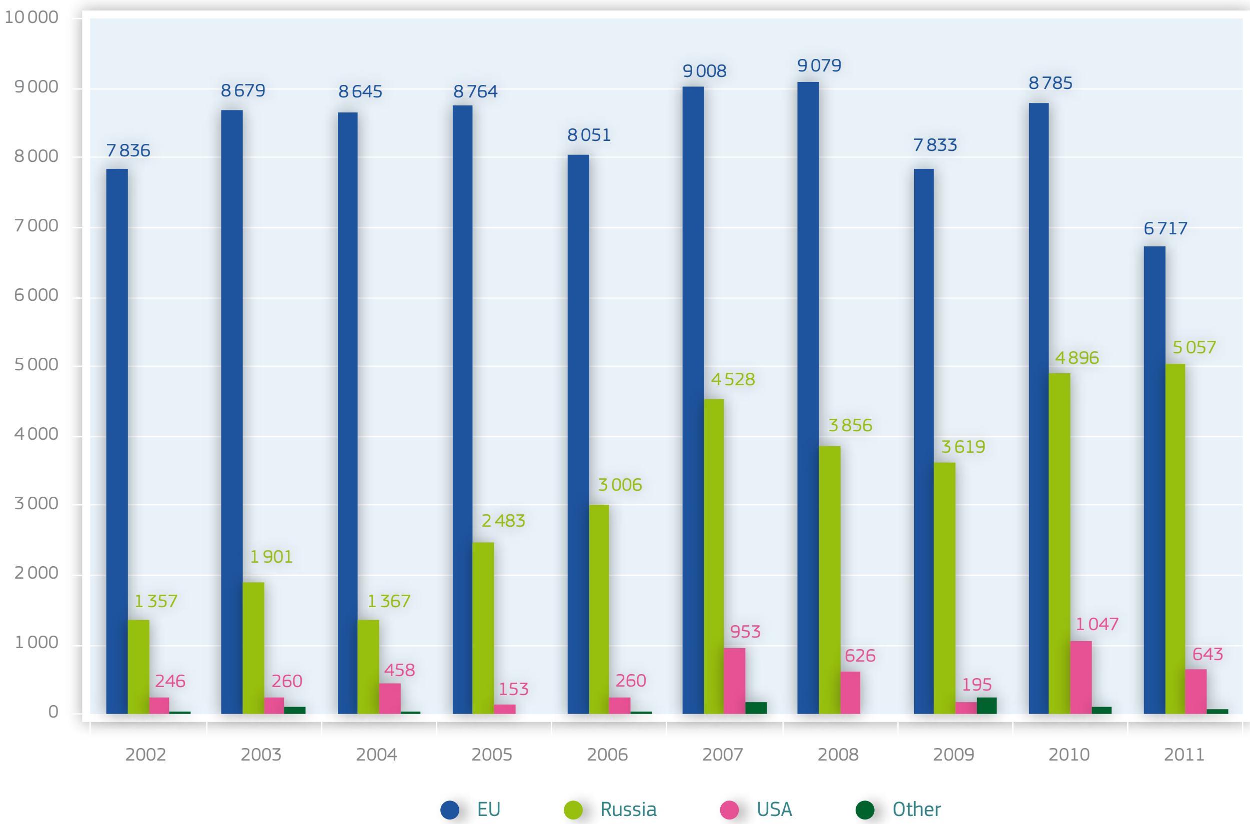
([23]) The aggregate number of amendments includes all the amendments to existing contracts processed by ESA, including technical amendments that do not necessarily lead to substantial changes to the terms of existing agreements.

As regards the providers of enrichment services, over half (54 %) of the EU requirements were met by the two European enrichers (Areva-Eurodif and Urenco) totalling 6 717 tSW. In 2011, Eurodif's gaseous diffusion plant was being replaced by the George Besse II centrifuge technology plant, which is expected to reach full capacity in 2016.

Deliveries of separative work from Russia (Tenex and TVEL) to EU utilities under purchasing contracts totalled 5 057 tSW, an increase of 161 tSW or 3 % compared with 2010. The aggregate total includes SWUs delivered under 'grandfathered' contracts under Article 105 of the Euratom Treaty, which covered 9 % 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 2011, totalling 643 tSW and accounting for 5 % of the total enrichment services supplied to EU utilities.

Figure 8 Supply of enrichment to EU utilities by provider, 2002–11 (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. Reactors, therefore, have to be adapted for this kind of fuel (if the percentage of MOX fuel in the core rises beyond a certain percentage) and to 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 to use plutonium recovered from spent fuel, non-proliferation and economic aspects. 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, hence, security of supply.

In 2011, MOX fuel was used in a number of reactors in France and Germany. The quantity of MOX fuel loaded into nuclear power plants in the EU totalled 9 410 kg Pu in 2011, a 12 % decrease from the 10 636 kg Pu used in 2010. Use of MOX resulted in savings estimated at 824 tU and 571 tSW, as shown in Annex 5.

Inventories

Uranium inventories owned by EU utilities at the end of 2011 totalled 47 343 tU, an increase of 4.4 % from the end of 2010 and of 13 % from the end of 2006. Uranium 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, 2006–11 (tonnes)

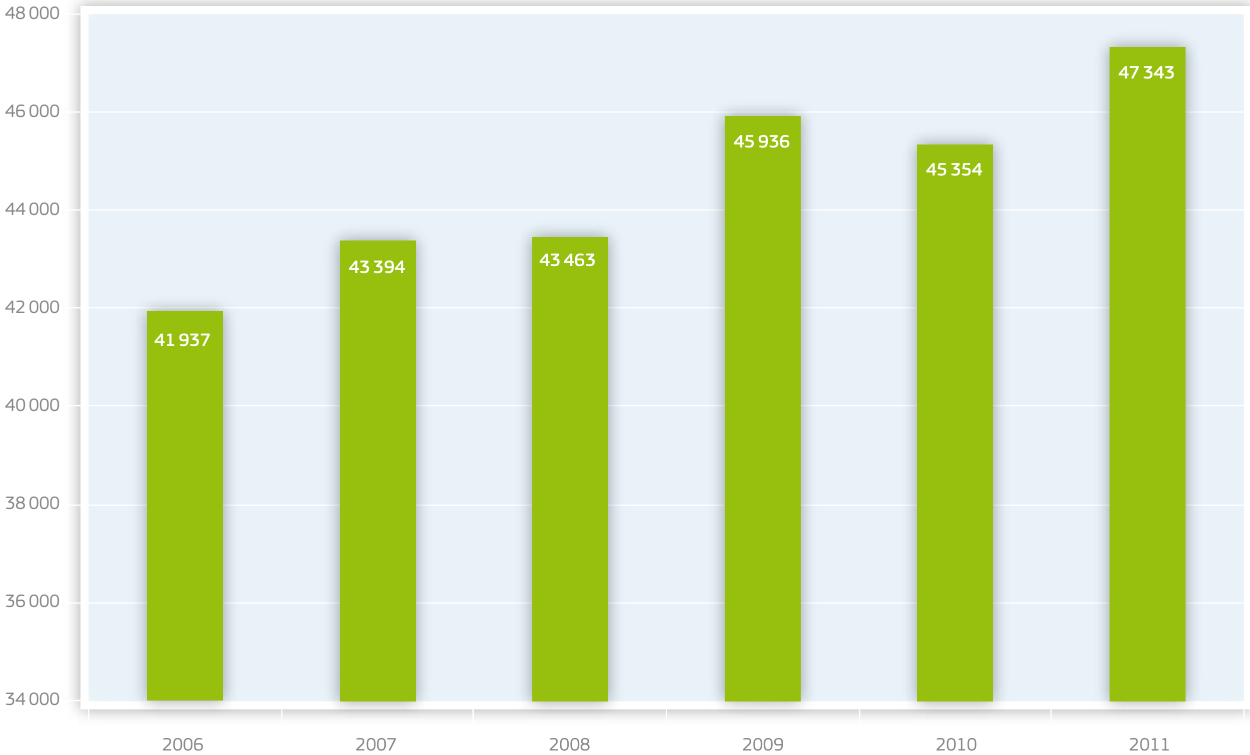


Figure 9 shows the level of total uranium inventories owned by EU utilities at the end of the year, expressed as natural uranium equivalent.

EU utilities' uranium inventories have increased substantially since 2006, after successive years of positive growth rates, with the exception of 2010 when there was a slight decline. The average annual growth rate of uranium inventories from 2007 to 2011 was 2 %.

The dynamics of the aggregate natural uranium inventories do not necessary 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 at least two and a half years.

Future contractual coverage rate

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

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

Reactor requirements are distinguished in terms of demand for natural uranium and demand for enrichment services. Average net reactor requirements for the period 2012–21 are estimated at approximately 17 000 tU and 13 000 tSW per year.

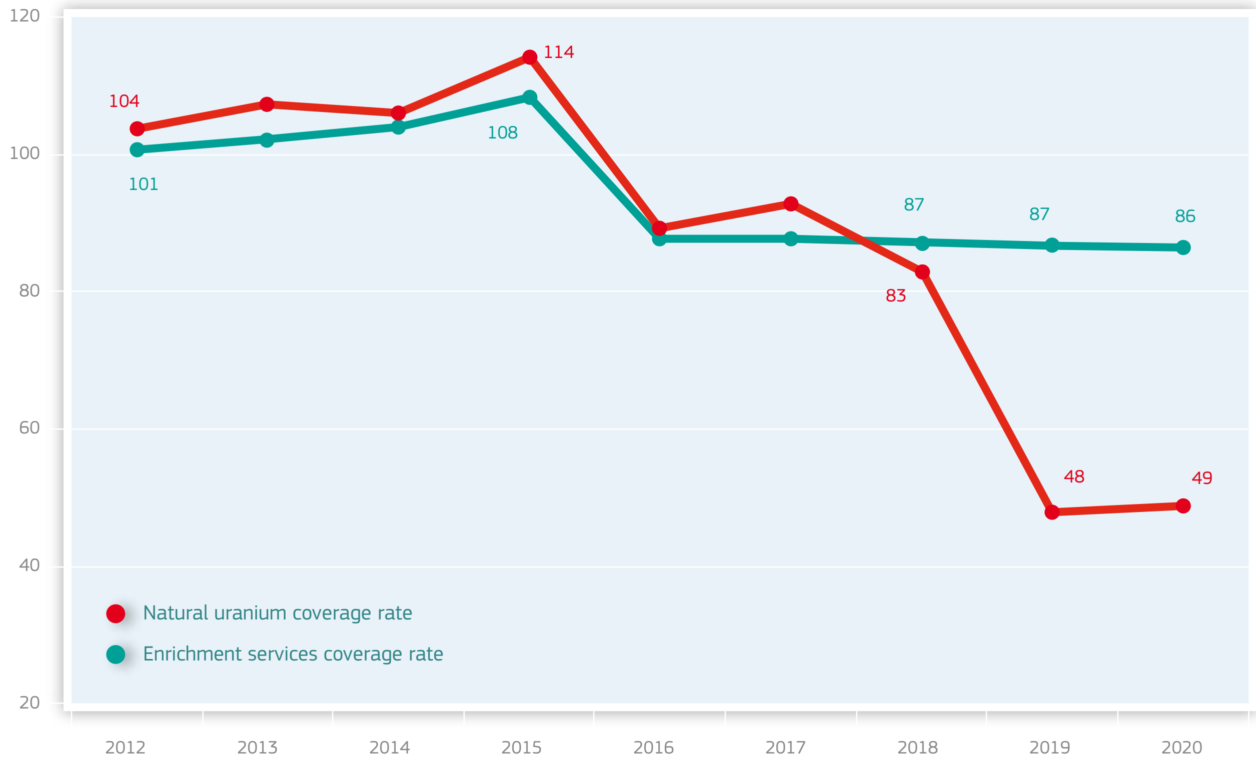
Figure 10 shows the contractual coverage rate for natural uranium and SWUs for EU utilities. Quantitative analysis shows that EU utilities are covered well above their estimated net reactor requirements until 2015, both in terms of demand for natural uranium and for enrichment services under already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

The natural uranium coverage rate from 2016 to 2018 is above 80 % while after 2019 approximately half of the reactor requirements are covered.

Enrichment services coverage is calculated at over 80 % for the whole period between 2016 and 2020.

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

Figure 10 Coverage rate for natural uranium and enrichment services, 2012–20 (%)



ESA findings, recommendations and diversification policy

The Euratom Supply Agency continues to monitor the market, especially supplies of natural and enriched uranium to the EU, in order to ensure that EU utilities have diversified sources of supply and do not become over-dependent on any single source. This is accomplished by validating or refusing to sign contracts and by comprehensive statistical reporting 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 diversified sources of supply. In line with this recommendation, in 2011, deliveries of natural uranium to the EU under long-term contracts accounted for 96 % of the total deliveries. As regards mining origin, the share of individual producer countries did not change considerably in comparison with the previous year, with Canada, Kazakhstan and Russia together providing 59 % of the natural uranium delivered to the EU.

Regarding diversification of sources of supply of enriched uranium to EU utilities, over half of the SWUs delivered in 2011 were provided by the two European enrichment companies, Areva-Eurodif and Urenco.

As regards external providers of enrichment services, the US-based enricher USEC supplied 5 % of the total enrichment services delivered, whereas the major external supplier of SWUs was Tenex/TVEL (Russia), which provided 40 % of the enriched uranium delivered to the EU. 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 9 % of total deliveries. In practice, 'grandfathered' contracts keep certain EU utilities entirely dependent on a single external supplier ([24]). According to the data available on future contractual coverage, dependence on external providers of enrichment services is expected to decrease in the short term. ESA estimates that EU utilities' dependence on foreign suppliers of enrichment services is temporary and related to the transition from gaseous to centrifuge technology at the Areva enrichment plant in France.

([24]) The significant differences in supply patterns and, therefore, in 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 diversified sources, whereas utilities using Russian technology usually purchase fabricated fuel assemblies under the same contract (including supply of uranium and enrichment) with a single supplier.

Concerning enrichment of reprocessed uranium by down-blending HEU or by re-enrichment (in Russia), ESA generally welcomes reprocessing of spent fuel and considers that the availability of recycled uranium increases the security of supply of EU users. Furthermore, blending reprocessed uranium with HEU of military origin is beneficial for nuclear disarmament and non-proliferation of nuclear materials. Therefore, when implementing its diversification policy, ESA takes into account these positive aspects of use of reprocessed fuel. Enriched reprocessed uranium fuel accounted for approximately 5 % of the total fuel loaded into EU reactors in 2011.

The Euratom Supply Agency also recommends that EU utilities maintain an adequate level of strategic inventories and use market opportunities to increase their stocks, depending on their individual circumstances. The aggregate stock level at the end of 2011 totalled 47 343 tU, which could fuel EU utilities' nuclear power reactors, on average, for at least two and a half years.

On the supply side, ESA monitors the situation of EU producers which export nuclear material mined in the EU, as the Agency possesses option rights over such material under Article 52 of the Euratom Treaty. In cases where the material is exported from the EU under long-term contracts, ESA requires the contracting parties to accept certain conditions related to the security of supply on the EU market ([25]).

Following thorough analysis of the information gathered from EU utilities in the annual survey conducted at the end of 2011, ESA concludes that, in the short and medium term, the needs of EU utilities are well covered. The future contractual coverage rate for EU utilities both in the form of natural uranium and of SWU is above 80 % at least until 2018. However, while there is still some uncertainty following the Fukushima accident, in the long term, planned reactor deployment in Asian countries could potentially hinder the security of supply of the EU nuclear market.

([25]) In 2011, ESA imposed conditions related 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.

4. ESA work programme for 2012

In line with the tasks conferred on it under Chapter 6 of the Euratom Treaty and its revised statutes, ESA's 2012 work programme is built around five 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 itself creates a need to diversify sources of supply to a satisfactory degree in order to guarantee security of supply of nuclear fuel to utilities in the EU. By evaluating and signing supply contracts for nuclear materials and acknowledging the transactions covering provision of the entire cycle of nuclear fuel services, ESA will continue to guarantee security of supply. It will focus in particular on the issue of the supplies of HEU and LEU (up to 20 %) which are 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 contribute to the relaunching of the activities of the Working Group on Security of Supply Scenarios and Prices of the newly appointed Advisory Committee. ESA will continue to seek advice from the Advisory Committee on further development of the nuclear observatory, including assessment of information tools created by the Agency. In parallel, ESA will take further measures to improve its data processing system.

3. **Increasing cooperation with international organisations and third countries**

In order to carry out its tasks as a nuclear observatory efficiently and to contribute to security of supply, ESA will actively pursue relations with international entities.

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

ESA will continue monitoring developments in nuclear technology in order to acquire the latest available knowledge on possible changes in demand for nuclear fuel and, thus, be able to evaluate adequately the impact on security of supply of nuclear fuels to EU utilities.

5. **Making ESA's internal organisation and operations more effective**

In order to streamline the contract-handling process, ESA will update its internal Manual of procedures for the contracts sector. ESA will examine ways to review the contract conclusion procedure for transactions involving HEU and LEU (up to 20 %) required for producing medical radioisotopes (Mo-99) and fuelling research reactors. It will also evaluate the need for a dedicated internal Manual of procedures for the markets sector. Moreover, the fact that budgetary autonomy has been re-established for ESA in 2012 will require it to continue to put appropriate administrative arrangements in place.

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 put into practice the principle of equal access to supplies of nuclear materials for EU Member States, paying particular attention to diversification of sources of supply which is a key priority of EU energy policy.

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), ESA monitors diversification of sources. 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.

ESA will continue to scrutinise potential risks to the security of supply of HEU and LEU (up to 20 %) which are required to produce medical radioisotopes (Mo-99) and to fuel research reactors. Neither HEU nor LEU (up to 20 %) is currently produced in the EU. More active involvement of ESA in assessing the requirements for these fissile materials and in the contract conclusion procedure will be sought.

The existing exemption from the principle of diversification for Member States equipped with Russian-design reactors and which had concluded long-term supply contracts before they joined the EU runs until the supply contracts expire ([26]). New supply contracts for these utilities are being assessed against the principles of diversification policy.

As an additional contribution to the security of supply guarantees, ESA will continue to monitor commercial and security stocks of nuclear materials available in the EU and will publish an evaluation report on this subject by the end of 2012.

Given the importance of making use of secondary sources, ESA will continue to assess the state of play with use of reprocessed uranium and of HEU of military origin by EU utilities in the light of security of supply objectives. An analysis will be finalised by the end of 2012.

Specific objective No 1

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

2. Acknowledge notifications of nuclear fuel transformation services, as provided for by Article 75 of the Euratom Treaty, in conformity with ESA diversification policy within the statutory deadline of 14 calendar days.

3. Acknowledge notifications of transactions involving small quantities, as provided for by Article 74 of the Euratom Treaty.

4. Assess the needs for HEU and LEU (up to 20 %) required for producing medical radioisotopes and for fuelling research reactors.

5. Continuously monitor commercial and security stocks of nuclear materials available in the EU and publish an evaluation report by the end of 2012.

6. Draw conclusions about ESA's policy on recourse to reprocessed uranium and HEU of military origin as a secondary source of supply in the light of non-proliferation, safe waste management and tighter security of supply objectives to be prepared by the end of 2012.

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

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

9. Contribute, upon request, to 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

Taking into account that the new members of the ESA Advisory Committee were appointed in the second half of 2011, with a mandate running until June 2014, in its role as secretariat ESA will contribute to the relaunching of the activities of the Advisory Committee's Working Group on Security of Supply Scenarios and Prices. ESA will continue to facilitate the Working Group's activities to increase the transparency of the nuclear fuel cycle market in the EU.

The continuous upgrading of ESA's data processing methods should allow the Agency to fine-tune its market observation capacity and respond to the expectations of operators better.

These measures will also 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 analyses by the nuclear market observatory. ESA's website will also include a special page on the activities of the nuclear observatory offering direct access to information about developments on the market.

ESA's nuclear market observatory will seek to cooperate more closely with the energy observatory of the European Commission's Directorate-General for Energy.

Specific objective No 2

To boost its market observation and monitoring activities ESA will:

1. relaunch the activities of the ESA Advisory Committee's Working Group on Security of Supply Scenarios and Prices with the objective of preparing for the next report in 2013;

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

2. regularly update and widen information published by ESA's own nuclear market observatory, including regular publication of *Quarterly Uranium Market Reports* and ad hoc studies;

3. publish its *Annual Report*, including market analyses, by June 2012;

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

Increasing cooperation with international organisations and third countries

The quality and neutrality of the analyses of the nuclear fuel cycle market provided by ESA 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 OECD's Nuclear Energy Agency (NEA) but also with a number of international players on the nuclear fuel market.

Specific objective No 3

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

2. Monitor Euratom international agreements concerning trade in nuclear fuel.

3. Take part in the negotiations with Russia on the draft agreement on peaceful uses of nuclear energy.

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

ESA will actively monitor research and development activities in all EU or international R & D forums 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 related to fuel cycle management, in particular in the context of the SET-Plan fission technologies initiative and turn the knowledge acquired into security of supply policy applied by the Agency.

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

Making ESA's internal organisation and operations more effective

This is an internal task to make the Agency more effective and efficient. Moreover, taking into account that the EU budgetary authority voted in favour of re-establishing ESA's budgetary autonomy in the general budget of the EU for 2012, additional new tasks will have to be taken on by ESA staff.

Specific objective No 5

1. Finalise the Manual of procedures for the contracts sector, review the current practice, including use of the simplified procedure and, in particular, the procedures for transactions involving HEU and LEU, and consider production of a Manual of procedures for the markets sector.

2. Ensure sound financial and budgetary management taking into account ESA's new budgetary situation as of 2012.

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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).

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

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

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

Glossary

MW stands for megawatt or one billion watts, which measures electric output. **MWe** refers to electric 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 decrease 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 as today's plants) and they are not expected to be available for commercial construction before 2030.

SWU stands for 'separative work unit' which measures the effort made in order to separate the fissile, and hence valuable, U-235 isotopes from the non-fissile U-238 isotopes, both of which are present in natural uranium. 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 is strictly 'kilogram separative work unit' or kg SWU (but in graphs, it is usually shown as SWU or tSW for 1 000 SWU) and measures the quantity of separative work (indicative of energy used in enrichment) when feed and product quantities are expressed in kilograms.

Annexes

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

(A) From 2012 until 2021

Year	Natural uranium		Separative work	
	Gross requirements	Net requirements	Gross requirements	Net requirements
2012	19393	17455	13984	12533
2013	19570	17065	14399	13077
2014	18255	15431	14384	12904
2015	18537	16102	14616	13125
2016	18876	17277	14845	13947
2017	18453	16886	14489	13614
2018	19074	17459	14301	13405
2019	19555	17937	15139	14231
2020	18178	16549	14066	13147
2021	18807	17307	14279	13452
Total	**188698**	**169468**	**144502**	**133434**
Average	**18870**	**16947**	**14450**	**13343**

(B) Extended forecast from 2022 until 2031

Year	Natural uranium		Separative work	
	Gross requirements	Net requirements	Gross requirements	Net requirements
2022	18361	16626	14379	13403
2023	18028	16530	13623	12808
2024	17230	15865	13715	12989
2025	17468	16103	13859	13133
2026	17307	15872	13739	12962
2027	17375	16045	13790	13090
2028	17562	16232	13928	13228
2029	17217	15794	13672	12904
2030	17729	16399	13955	13255
2031	17662	16332	14002	13302
Total	**175937**	**161798**	**138663**	**131074**
Average	**17594**	**16180**	**13866**	**13107**

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		9 600		8 600	(*)	
1981		9 000		13 000	10.0	
1982		10 400		12 500	< 10.0	
1983		9 100		13 500	< 10.0	
1984		11 900		11 000	< 10.0	
1985		11 300		11 000	11.5	
1986		13 200		12 000	9.5	
1987		14 300		14 000	17.0	
1988		12 900		12 500	4.5	
1989		15 400		13 500	11.5	
1990		15 000		12 800	16.7	
1991		15 000	9 200	12 900	13.3	10 000
1992		15 200	9 200	11 700	13.7	10 900
1993		15 600	9 300	12 100	11.3	9 100
1994	2 520	15 400	9 100	14 000	21.0	9 800
1995	3 040	18 700	10 400	16 000	18.1	9 600
1996	2 920	18 400	11 100	15 900	4.4	11 700
1997	2 900	18 200	11 000	15 600	12.0	10 100
1998	2 830	18 400	10 400	16 100	6.0	9 200
1999	2 860	19 400	10 800	14 800	8.0	9 700
2000	2 500	17 400	9 800	15 800	12.0	9 700
2001	2 800	20 300	11 100	13 900	4.0	9 100
2002	2 900	20 900	11 600	16 900	8.0	9 500
2003	2 800	20 700	11 500	16 400	18.0	11 000
2004	2 600	19 300	10 900	14 600	4.0	10 500
2005	2 500	21 100	12 000	17 600	5.0	11 400
2006	2 700	21 000	12 700	21 400	7.8	11 400
2007	2 809	19 774	13 051	21 932	2.4	14 756
2008	2 749	19 146	13 061	18 622	2.9	13 560
2009	2 807	19 333	13 754	17 591	5.2	11 905
2010	2 712	18 122	13 043	17 566	4.1	14 855
2011	**2 583**	**17 465**	**13 091**	**17 832**	**3.7**	**12 507**

* data non available

Annex 3
ESA average prices for natural uranium

	Multiannual contracts		Spot contracts		New multiannual contracts		Exchange rate
Year	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**

* The spot price for 2001 was calculated on the basis of an exceptionally low total volume of only some 330 tU under four transactions.

** ESA introduced the ESA 'MAC-3' new multiannual U_3O_8 price, including contracts with amendments, to its price method for the first time in 2009.

Annex 4
Purchases of natural uranium by EU utilities by origin, 2002–11 (tU)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Russia	3931	3400	2391	1788	3984	5144	3272	3599	4979	4524
Other CIS	2052	1059	481	1246	1057	1618	2143	2195	3275	3871
Canada	3954	3229	3274	4998	5093	3786	4757	3286	2012	3318
Australia	1442	2695	2443	3065	3053	3209	2992	3801	2153	1777
Niger	1806	2396	2746	2390	3355	3531	1845	1854	2082	1726
South Africa and Namibia	1422	604	1080	951	978	1003	944	860	1207	1124
HEU feed	0	1348	800	1407	850	825	550	675	550	731
EU	680	298	129	5	472	526	515	480	556	455
USA	0	0	0	757	488	402	398	318	320	180
Other and undetermined	583	433	373	529	1336	432	520	329	432	128
Re-enriched tails	1007	958	925	474	728	388	688	193	0	0
Total	**16877**	**16420**	**14642**	**17610**	**21394**	**20864**	**18622**	**17591**	**17566**	**17832**

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	4050	490	320
1997	5770	690	460
1998	9210	1110	740
1999	7230	870	580
2000	9130	1100	730
2001	9070	1090	725
2002	9890	1190	790
2003	12120	1450	970
2004	10730	1290	860
2005	8390	1010	670
2006	10210	1225	815
2007	8624	1035	690
2008	16430	1972	1314
2009	10282	1234	823
2010	10636	1276	851
2011	**9410**	**824**	**571**
Grand total	**151182**	**17856**	**11909**

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 2011

Areva NC and Areva NP (formerly Cogéma)
BHP Billiton (formerly WMC)
Cameco Canada
Cameco Inc. Corporation USA
CNU
DIAMO
ERA
Internexco GmBH
ITOCHU International
KATEP (Kazakhstan State Corporation for Atomic Power and Industry)
KazAtomProm
Nufcor International
NUKEM GmbH (Advent International)
NUKEM Inc.
Rossing Uranium
Tenex (JSC Techsnabexport)
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 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' new multiannual U_3O_8** price is a weighted average of U_3O_8 prices paid by EU utilities, but only under multiannual contracts concluded or whose pricing method has been amended within the previous three years and with deliveries during the reference year, i.e. contracts concluded between 1 January 2009 and 31 December 2011. 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 (make sure that no individual contracts are revealed), ESA price indices are calculated only if there are at least five relevant contracts.

Starting from 2011, ESA introduced the **ESA quarterly spot U_3O_8 price**, which is a spot price indicator published *on a quarterly basis*, provided at least three new spot contracts have been concluded by EU utilities.

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

Definition of spot v long-term contracts

The difference between spot and multiannual contracts is:

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

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

Data requested on natural uranium deliveries during the year

The following details are requested: ESA contract reference number, quantity (kgU), delivery date, place of delivery, mining origin, 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, such as between intermediaries or for sales by utilities, purchases by non-utility industries or barter deals, are excluded. Deliveries for which it is not possible reliably to establish the price of the natural uranium component are 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. It compares, in particular, 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 its own sources and on prices from specialised trade press publications.

Independent verification

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

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

Data protection

Confidentiality and physical protection of commercial data are ensured by using stand-alone computers, which are 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.

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.

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