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Energy

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Abbreviations

CIS	Commonwealth of Independent States
ESA	Euratom Supply Agency
Euratom	European Atomic Energy Community
IAEA	International Atomic Energy Agency
ITRE	European Parliament Committee on Industry, Research and Energy
IEA	International Energy Agency
NEA	Nuclear Energy Agency
(US) DoE	United States Department of Energy
(US) NRC	United States Nuclear Regulatory Commission
USEC	United States Enrichment Corporation
ERU	enriched reprocessed uranium
EUP	enriched uranium product
HEU	high-enriched uranium
lb	pound
LEU	low-enriched uranium
MOX	mixed-oxide fuel (uranium mixed with plutonium oxide)
RET	re-enriched tails
RepU	reprocessed uranium
SWU	separative work unit (see glossary for detailed definition)
tHM	(metric) tonne of heavy metal
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)
MW/GW	megawatt/gigawatt
MWe/GWe	megawatt/gigawatt (electrical output)

Foreword

Dear reader,

I am pleased to present to you the annual report of the Euratom Supply Agency (ESA) for 2013.

The report follows the same structure as in previous years. Chapter 1 outlines the activities of the Nuclear Safety and Fuel Cycle Directorate of the European Commission's Directorate-General for Energy, as well as ESA's activities in 2013. Chapter 2 gives an overview of the world market for nuclear fuels, while Chapter 3 contains ESA's specific evaluations of the fuel market in the EU. Last, but not least, Chapter 4 sets out the Agency's work programme for 2014.

We continued, in the course of the year, to assume responsibility for the EU common supply policy, in the interest of regular and equitable access to supply for EU users. In close cooperation with the Agency's Advisory Committee, we kept on promoting, through the activities of the Nuclear Market Observatory, transparency and predictability in that field.

2013 was a remarkable year for the Agency as its mission was further acknowledged and enhanced.

We saw the Agency's market-monitoring role widened to cover the supply of medical radioisotopes in the EU. As a response to the increased fragility of the current production chain, which is based on a low number of ageing research reactors, and to the potential scarcity of high-enriched uranium (HEU) required to feed the chain, ESA was assigned the chair of the dedicated European Observatory, set up in 2012, to help to implement a policy adopted by the European Council, with a view to ensuring the continuity of supply of medical radioisotopes in the EU.

We take particular pride in contributing, in this way, to handling a major issue of public health in Europe.

As I pointed out in last year's report, ESA has focused, in particular, on the supply of metal low-enriched (< 20 %) uranium (LEU). We facilitated the activity of a dedicated Working Group, set up by decision of the Agency's Advisory Committee, and were pleased to see it accomplish its task, in 2013, within the assigned time frame. The group conducted a strategic, technical and economic study on the establishment of a European LEU (< 20 %) production facility, and came up with operational conclusions, approved and endorsed by the Advisory Committee, which will guide the Agency's activities in the coming years.

Security of fuel supply for research reactors is, thereby, addressed, in the interest of both scientific research and the production of radioisotopes, for the period after the future conversion of these reactors to operate with LEU. The group's activity was praised as a good example of proactive action, conveying to citizens a strong positive message on the EU.

Last but not least, 2013 was also a year of change for the Agency. The experience and wisdom of six members of our personnel were lost; the interest and the motivation of the six new colleagues who replaced them were gained. I can assure you that the Agency's new team is already doing a great job and I trust that our work will remain of high quality.

Stamatios Tsalas

Director-General of the Euratom Supply Agency

1. Nuclear energy developments in the EU and ESA activities

EU nuclear energy policy in 2013

With the objective of implementing and further developing the framework for nuclear safety, security and non-proliferation and in order to reduce the risk of an industrial accident in the civil nuclear industry with likely significant environmental/health impacts, a number of measures were taken at EU level, including the following.

Stress tests

Following the Fukushima accident, the March 2011 European Council called not only for comprehensive and transparent risk and safety assessments ('stress tests') of all EU NPPs but also for similar tests in the EU neighbouring countries and worldwide.

The Commission and the European Nuclear Safety Regulators Group (Ensreg) will keep track of progress with the implementation of the national action plans submitted during 2013. Presentations and in-depth discussions on the status of these plans took place at a dedicated workshop organised by Ensreg in Brussels in April 2013.

The Commission organised in 2013 an EU review team from the Ensreg group as well as from its own services for conducting a peer review of stress tests carried out in Taiwan. Regarding neighbouring countries not included in the 2011/12 European peer reviews, i.e. Armenia, Belarus, Russia and Turkey, separate meetings were organised in 2013, to discuss their stress tests.

Nuclear safety directive

In the spirit of the nuclear safety philosophy of continuous improvement, the Commission adopted its formal proposal COM(2013) 715 on 17 October 2013 amending Council Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations. The legislative proposal, under discussion in the Council, introduces EU-wide nuclear safety objectives addressing specific technical issues across the entire life cycle of nuclear installations (siting, design, construction, commissioning, operation, and decommissioning of nuclear plants), including on-site emergency preparedness and response. It also reinforces monitoring and exchange of experiences, by establishing a European system of topical peer reviews of nuclear installations.

Nuclear third party liability and insurance

Further preparatory work has been carried out to see how the situation as regards nuclear third party liability and insurance could be improved in the EU in case of a severe nuclear accident. The expert group which was created in 2011 adopted a set of recommendations at the beginning of the year, indicating that further action could be taken, subject to community competence, in three specific areas:

1. claims management and related matters;
2. insurance, operators' pools and other financial guarantees; and
3. compensation amounts.

In addition, an online public consultation was carried out to ascertain stakeholders' views on the need for EU action and a Stakeholder Conference on Nuclear Third Party Liability and Insurance was organised in January 2014.

Off-site nuclear emergency preparedness and response

During the stress tests in 2011–12, it was acknowledged that nuclear off-site emergency preparedness and response measures providing public protection in case of a nuclear emergency are an important area to be reviewed by Ensreg and the Commission. As a first step, the Commission engaged a contractor to review the state of current emergency preparedness arrangements in the EU and neighbouring countries and to propose recommendations for potential improvements, particularly at the European level.

European Commission — IAEA memorandum of understanding on nuclear safety

In September 2013 the European Commission and the International Atomic Energy Agency signed a memorandum of understanding on nuclear safety ([1]), which establishes a framework for cooperation to help improve nuclear safety in Europe. The document was signed by EU Energy Commissioner Oettinger and IAEA Director-General Amano. It creates an enhanced framework for planning various forms of cooperation, such as expert peer reviews and strengthening of emergency preparedness and response capabilities. It will allow both organisations to benefit from each other's work, avoid duplication of efforts and contribute to greater nuclear safety worldwide.

Convention on Nuclear Safety

The Commission advocates improvements in the global legal framework for nuclear safety, especially the Convention on Nuclear Safety (CNS), with the aim of increasing its effectiveness, governance and enforceability. The Council of the EU has mandated the Commission to ensure during negotiations that the proposed improvements are compatible with the objectives and provisions of the Treaty and secondary legislation. At the second extraordinary meeting of the CNS in August 2012, it was decided to establish a Working Group on Effectiveness and Transparency, whose task was to present to the sixth review meeting of the CNS in 2014 a list of actions to strengthen the CNS and to propose, where necessary, amendments to the Convention. The Working Group's final report, delivered in November 2013, was accompanied by a recapitulatory list of 68 actions. In addition, the Commission adopted in October 2013 the report of Euratom for the sixth review meeting of contracting parties to the CNS.

Safe management of radioactive waste and spent fuel

Following adoption in 2011 of the Council directive establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste ([2]), extensive support was provided to the Member States in 2013 for the implementation of the directive. The deadline for Member States to notify transposition of this directive into their national legislation was 23 August 2013. A comprehensive plan has been drawn up to assess the measures notified by all Member States. The Commission will take all measures necessary to ensure full and correct implementation of the directive.

([1]) C(2013) 5641 final, 5.9.2013.

([2]) OJ L 199, 2.8.2011, pp. 48–56.

Community system for the registration of carriers of radioactive materials

In 2013 discussions continued on the Commission's draft proposal for a Council regulation establishing a Community system for registration of carriers of radioactive materials that had been adopted in September 2012. Under this proposal, the existing national reporting and authorisation procedures would be replaced by a unique registration valid across the whole EU while the safety levels reached would be maintained. Intensive discussions with Member States on different options have taken place in the ad hoc Council Working Group established by the Irish Presidency and in the ITRE Committee of the European Parliament, which adopted a report.

Radiation protection

The new Euratom basic safety standards directive — Council Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom ([3]) — was adopted by the Council of the European Union on 5 December 2013 and entered into force on 6 February 2014. It modernises European radiation protection legislation by taking account of the latest scientific knowledge and technological advancement, as well as of operational experience with current legislation, and consolidates the existing set of five directives into one single piece of legislation. The BSS directive offers better protection for workers, members of the public and patients, and strengthens the requirements on emergency preparedness and response, taking account of lessons learned from the Fukushima accident. Member States are required to bring into force the laws, regulations and administrative provisions necessary to comply with the directive by 6 February 2018.

Council Directive 2013/51/Euratom laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption ([4]) has to be transposed in the Member States by November 2015.

In 2013 the Commission adopted a draft revised proposal for a Council regulation laying down maximum permitted levels of radioactive contamination of food and feed following a nuclear accident or any other case of radiological emergency (revision of Council Regulation (Euratom) No 3954/87). After having received the opinion of the European Economic and Social Committee, the Commission adopted its final proposal on 10 January 2014 ([5]).

([3]) OJ L 14, 17.1.2014, pp. 1–73.

([4]) OJ L 296, 7.11.2013, pp. 12–21.

([5]) COM(2013) 943 final, 10.1.2014.

Bilateral nuclear cooperation agreements

Implementation of the nuclear cooperation agreements between the European Atomic Energy Community (Euratom) and Australia, Canada, Japan, Kazakhstan, Ukraine and the United States continued throughout 2013, to the satisfaction of all involved.

In July 2013 the Euratom–South Africa nuclear cooperation agreement was signed. The agreement stipulates that the two parties will cooperate in 'the supply of nuclear and non-nuclear materials, equipment and related technologies associated with civil nuclear power.' They will also promote 'peaceful uses of nuclear energy, including commercial exchanges, taking into account that South Africa has large uranium reserves' ([6]).

In 2013 negotiations continued with Canada to update and consolidate the current cooperation agreement which dates from 1959 and has subsequently been amended five times.

During 2013, the Commission continued preliminary consultations on a cooperation agreement with the Russian Federation, which so far have not given rise to formal negotiations.

European Nuclear Safety Regulators Group (Ensreg)

Ensreg is composed of senior officials from all 28 EU Member States' national regulatory authorities responsible for nuclear safety, radioactive waste safety or radiation protection, plus representatives of the Commission. It is an expert group of the Commission with the objective of assisting in furthering a common approach in Europe to the safety of nuclear installations and the safe management of spent fuel and radioactive waste. Ensreg held four meetings during 2013. It continued its leading role in the stress test exercise by organising a workshop where the country-specific action plans arising from the stress test findings were presented and peer reviewed. It also convened a successful second Ensreg conference on the topic of 'Nuclear Safety in Europe' which was held in Brussels, in June. Ensreg continued to support implementation and reporting in relation to both the nuclear safety directive and the nuclear waste directive, and was instrumental in the preparation of the revised nuclear safety directive.

European Nuclear Energy Forum (ENEF)

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

The eighth ENEF plenary meeting held in Prague in May 2013 was attended by over 250 participants. It focused on the importance of affordable and reliable energy and the need to look at the whole energy system approach to strike a balance between competitiveness, security of supply and sustainability. ENEF has produced highly valuable material that contributes to the wider horizontal debate on the energy mix of the future. As an example, in November 2013, a study on the economic aspects of nuclear energy was released and is available on the ENEF website ([7]).

EU support for nuclear decommissioning assistance programmes

In December 2013, the Council adopted two regulations on EU support for nuclear decommissioning assistance programmes, in Lithuania and in Bulgaria and Slovakia ([8]), covering the period 2014–20. The first regulation establishes a programme for the implementation of EU financial support for measures linked to the decommissioning of units 1 and 2 of the Ignalina NPP in Lithuania. The amount earmarked for implementing the Ignalina programme over the period 2014–20 is set at EUR 450 818 000 at current prices. The second regulation establishes a programme for the implementation of EU financial support for measures connected with the decommissioning of units 1 to 4 of the Kozloduy NPP in Bulgaria and units 1 and 2 of the Bohunice V1 NPP in Slovakia. A total of EUR 293 032 000 has been set aside for the period 2014–20 for implementing the Kozloduy programme, while a total of EUR 225 410 000 has been set aside for the Bohunice programme at current prices.

Main developments in the EU Member States

Drawing on the lessons learned from the findings of the 2011 and 2012 stress tests and the national action plans derived therefrom, the various legislative measures initiated or continued at EU level during 2013 showed an overall will to strengthen the safety- and security-related nuclear legal framework. The EU players continued to make their presence felt on the nuclear market, albeit with contrasting attitudes, according to each country's perception of nuclear energy's role in future national power generation strategies.

A mixture of cheaper European electricity prices and carbon credits, alongside falling demand for electricity, made things more difficult for a form of energy seen as too capital intensive with considerable lead times. While projects under way in France and Finland had suffered construction delays and cost overruns already in 2012, a final decision on new builds in the United Kingdom is still pending and has been postponed in the Czech

([6]) OJ L 204, 31.7.2013, pp. 3–10.

([7]) http://ec.europa.eu/energy/nuclear/forum/doc/final_report_dhaeseleer/synthesis_economics_nuclear_20131127-0.pdf

([8]) 2011/0363 (NLE), 16635/13 COR 1, 16633/13 COR 1, 11.12.2013.

Republic. Lithuania is working closely with regional partners — Estonia and Latvia — on addressing issues raised by the potential Visaginas NPP project investors, while in Slovakia the joint venture for the Bohunice project is still under discussion. Moreover, apart from Germany's highly contested nuclear fuel rod tax, in place since January 2011, Finland's parliament approved in 2013 a so-called windfall profits tax on nuclear power reactors and hydropower plants built before 2004, while France envisages taxing the profits of its NPPs to help fund growth in renewable power and energy efficiency.

Hungary aims to increase its use of nuclear power to between 60 % and 70 % of total electricity generating capacity within 10 years, compared to the current level of 47 %. Recent assurances, stemming mainly from the acknowledgement of the competitive advantage that nuclear power provides to the industry, came from France, that no additional reactors would be shut down apart from the two-unit NPP at Fessenheim, scheduled for closure in 2016.

In moving towards entering the nuclear market, Poland has chosen the service company to provide site and environmental surveys for the site selection of the country's first NPP, expected to be launched by 2025. With a view to securing current levels of, and potentially even increasing, EU uranium production, news of a new uranium mining project scheduled to begin soon at a new uranium ore deposit in eastern Romania has been reported. Berkeley Resources Ltd indicated that the Retortillo deposit project is close to receiving the mining licence.

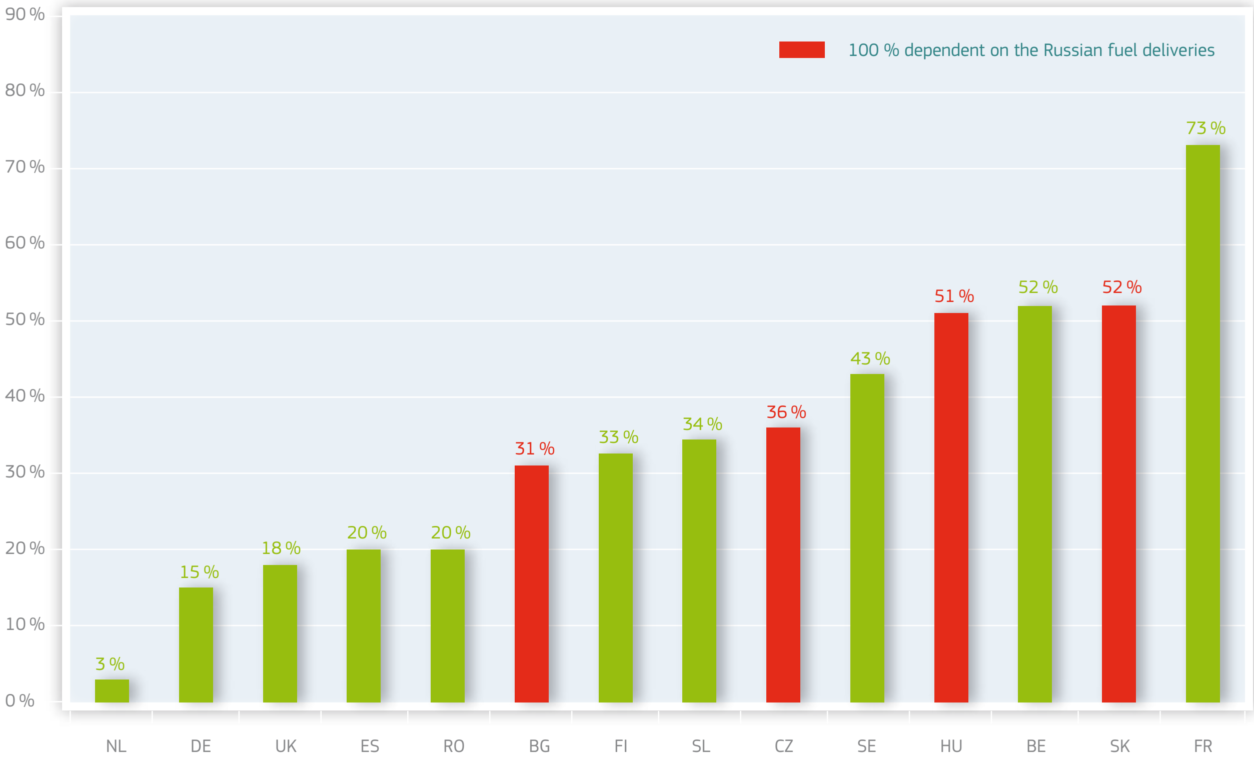
Table 1 Nuclear power reactors in the EU in 2013

Country	Reactors in operation (under construction)
Belgium	7
Bulgaria	2
Czech Republic	6
Germany	9
Spain	7
France	58 (1)
Hungary	4
Netherlands	1
Romania	2
Slovenia/Croatia (*)	1
Slovakia	4 (2)
Finland	4 (1)
Sweden	10
United Kingdom	16
Total	**131 (4)**

(*) Croatia's power company HEP owns a 50 % stake in the Krsko NPP in Slovenia.
Source: WNA.

As shown in Table 1, at the end of 2013, a total of 131 nuclear power reactors were in operation in the EU, with four more under construction, the same number as in 2012. The 131 operating NPPs produce 26.4 % of electricity in the EU with a large spread between different Member States — see Figure 1 — and by different types of reactors. How things might evolve over time is shown in Figure 2.

Figure 1 Nuclear power share of total electricity production in the EU (2013)



Source: IAEA PRIS.

Figure 2 Net generating capacity in the EU by vendor origin of reactor in MW — 2013–32

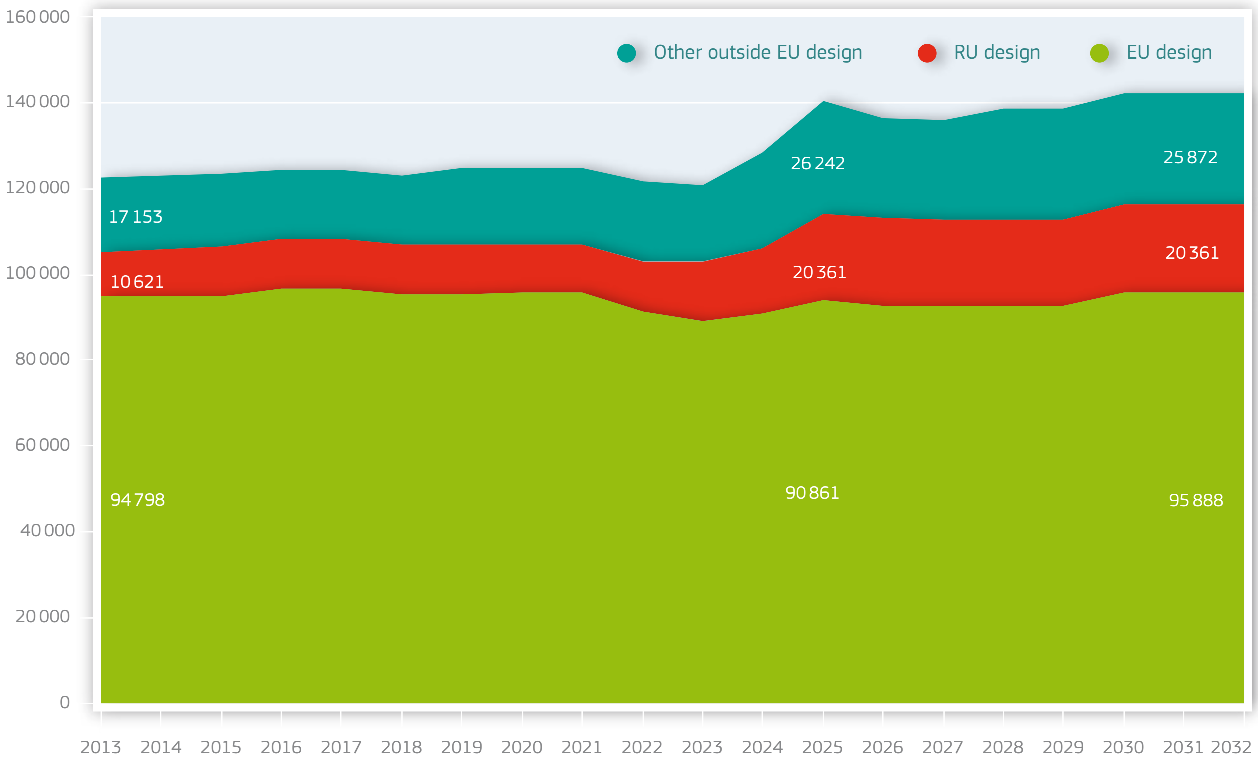


Figure 1 shows the share of electricity production from NPPs in the EU. Four countries, namely Bulgaria, Czech Republic, Hungary and Slovakia operating exclusively VVER reactors are dependent on deliveries of fuel assemblies from one fabricator to the countries' nuclear reactor fleets (additionally, in Finland, two out of the four operating reactors are VVER-type, which represents 36 % of the country's electricity production).

Figure 2 shows a forecast developed by ESA recently with regard to net generating capacity scenario in the EU by type of reactor in the period 2013–32. It takes nuclear phase-out strategy in Belgium and Germany into account. A typical lifetime of the currently operating reactors was assumed at 40 years. Having regard to the fact that in principle extending the lifetime of operating nuclear reactors is economically attractive and it is likely that many of the European nuclear reactors could apply for lifetime extension in the future, a flat 20-year extension rate was assumed for all the reactors. On the other hand no future capacity uprates were counted. With regard to new reactor builds the projection includes reactors currently under construction, planned for construction and proposed by countries but not yet decided for construction. The two most recent are considered on the basis of the latest EU countries' policies and decisions.

Country-specific developments in 2013

Belgium: The Doel 3 and Tihange 2 reactors that were shut down in the summer of 2012 after the detection of hydrogen flakes in the reactor vessel material remained offline during the first quarter of 2013. In May the Belgian Federal Agency for Nuclear Control confirmed that Electrabel had addressed its safety regulatory requirements in a satisfactory manner and therefore, in June, both reactors were reconnected to the grid. An additional set of post-restart requirements were still to be met by the licensee before starting up after the next planned plant outage in 2014. The Belgian government confirmed on 18 December 2013 its 2012 decision to postpone by 10 years the shutdown of Tihange 1.

Bulgaria: The referendum held on 27 January on the issue of construction of a new NPP at the Belene site was declared invalid due to a low turnout. With regard to the extension of the Kozloduy NPP, Bulgaria must decide whether the new build will be a Westinghouse AP1000 reactor, with financing possibly provided by the American Export-Import Bank. Negotiations between Bulgarian Energy Holding and Toshiba Corporation on the financial structuring of the project for building an AP1000 reactor are ongoing following a decision of the Council of Ministers.

Regarding disposal of the radioactive waste arising from the decommissioning of units 1 and 2 of the Kozloduy NPP, the plan submitted by Bulgaria under Article 37 of the Euratom Treaty in February 2012 has been approved by the European Commission. The plan for units 3 and 4 is under preparation.

Czech Republic: According to the Ministry of Industry and Trade's latest state energy policy paper, the target date for the completion of the two proposed new nuclear reactors at the Temelin site has been postponed to 2030, a reaction to the low electricity prices and the uncertainly about when they might recover. Reluctance of the government and some politicians to provide the investor CEZ, a.s. with the cost–difference guarantee for electricity from the new project adds to the uncertainty over the fate of the estimated USD 10.6 billion–USD 16 billion project.

In April, the Czech Republic became the seventh 'HEU-free' country under the Russian Research Reactor Fuel Return programme (RRRFR), after having sent to Russia the final shipment of its HEU.

Germany: A commission formed by 33 representatives of political parties, churches, trade unions, environmental groups and industry has been entrusted with the task of developing the criteria, which must afterwards be approved by Germany's parliament, for choosing a final spent fuel repository site. Under a recently approved law on site selection, the Gorleben salt mine, the country's current interim storage facility for spent fuel, will not be ruled out as a final repository site, but other potential sites will also be analysed.

The Hamburg Fiscal Court has sought a preliminary ruling from the Court of Justice of the European Union on whether Germany's nuclear fuel rod tax violates EU law, before making a final ruling itself on the legality under German law.

Spain: Enresa, the Spanish agency responsible for radioactive waste management and nuclear plant decommissioning, will attend to the design, construction and operation-related works for the Almacen Temporal Centralizado (ATC), a centralised high-level waste (HLW) and spent fuel interim storage facility it plans to have built in Spain, while Westinghouse Electric Company will provide the main engineering services. Expected to begin operating in 2017, following granting of all necessary regulatory approvals and licensing, the facility could provide dry storage for 6 700 tHM of spent fuel and vitrified HLW from reprocessing activities in an area 283 m long by 78 m wide.

A decision to shut down the Santa María de Garoña NPP was taken in July 2013 when the operating licence expired. However, within 1 year the operator can request an operating lifetime extension.

End-of-year statements from Berkeley Resources Ltd indicated that the Retortillo deposit project is close to receiving the mining licence.

France: In order to receive an additional 10-year operating licence for its 920-MW Fessenheim 2 unit, EDF must implement several safety-related improvement measures, based on the results of the post-Fukushima stress tests and be fully compliant with the regulatory requirements imposed by the national nuclear safety regulator ASN. Similar activities are currently ongoing at the Fessenheim 1 unit.

In mid-2013, AREVA announced that the reactor vessel had arrived at the EPR that is under construction at the Flamanville nuclear plant site in France. In the meantime, the vessel has been installed in the reactor building.

In line with the country's drive to massively reduce its current dependence on nuclear power and fossil fuel consumption, the government plans to put forward proposals for carbon emissions taxation, as well as for taxes on the profits of the currently operating 58 NPPs. The carbon and nuclear tax proposals should be submitted to the parliament in early 2014, to be voted on by the end of the year, and could result, by 2016, in savings as high as several billion euros, which could help fund growth in renewable power and energy efficiency.

The recent assurances by France's Industry Minister that no additional reactors would be shut down apart from the two-unit NPP at Fessenheim, scheduled for closure in 2016, stem mainly from the acknowledgement of the competitive advantage that nuclear power provides to French industry. Another important criterion supporting the government's statement is the increased CO_2 emission generated by the reopening of coal plants as a result of the nuclear phase-out decision in Germany. A new energy law, which should shed some light on France's future policies, is expected to be adopted by the end of 2014.

Lithuania: Safe nuclear energy development remains a necessary integral part of the Lithuanian energy supply mix.

According to the government position, the Visaginas NPP project might be continued with comprehensive participation of regional partners (Estonia, Latvia and their utility companies) and with economic viability of the project improved. In this regard all of the project's potential investors (regional partners and Hitachi) have carried out an economic viability assessment of the Visaginas NPP project, and identified certain outstanding issues requiring the attention of the project-hosting government as well as the governments of the Baltic states. Furthermore the strategic investor Hitachi submitted a proposal for the improvement of financial conditions for the project. During a meeting of all three Baltic prime ministers in November 2013, these developments were discussed and evaluated favourably and it was decided first of all to address the outstanding issues indicated by potential investors.

Hungary: The country aims to increase its use of nuclear power to 60 % or 70 % of total electricity generating capacity within 10 years, compared to the current level of around 50 %. In January 2014, an intergovernmental agreement was signed with Russia, aiming at building two additional reactors at Paks NPP.

The final 49.2 kg of remaining HEU in Hungary has been shipped from Hungary to Russia, concluding the removal of 239 kg of Hungarian HEU that began in 2008, under the Russian Research Reactor Fuel Return programme, part of the United States-led Global Threat Reduction Initiative, or GTRI.

Hungary and South Korea have signed a 40-year cooperation agreement on nuclear energy, which focuses on cooperation in research and development, design, construction and operation of nuclear reactors for peaceful purposes.

Netherlands: Ministerial approval has been given to extend the life of the Borssele nuclear plant until 2034, effectively making its operating life 60 years. Urenco has received the award of best employer of 2013 for companies with fewer than 1 000 employees. Furthermore, an agreement has been reached between the government and 40 public and private bodies on a report entitled 'Energy for sustainable growth.' This agreement contains far-reaching targets of 14 % renewables by 2020 and 16 % by 2023. Finally, preparatory work for a new research reactor, the so-called Pallas reactor, as successor to the HFR is ongoing.

Poland: In early 2013, the Polish utility PGE announced that the Australian services company Worley Parsons had been chosen to carry out, from 2013 to 2015, site and environmental surveys, on the basis of which the utility will decide on the site of the country's first NPP. The Australian company will also provide various licensing and permitting services needed for the estimated launch, by 2025, of Poland's first reactor. Four government-owned companies have signed a letter of intent establishing ownership in the company that will build and operate the country's planned first NPP, expected to come online in 2025: Polska Grupa Energetyczna (PGE), the largest Polish utility — 70 %; Tauron and Enea, two smaller utilities — 10 % each; and the copper miner KGHM — the remaining 10 %. The agreement needs to undergo antitrust approval procedures and to be accepted by the four firms' governing boards.

Romania: Romania has signed two nuclear cooperation agreements with China, including a letter of intent between the Romanian utility Nuclearelectrica and CGNPC, which are likely to ensure the latter plays a role in the construction of new reactors at the Cernavoda NPP. Shortly after the agreement was signed, Candu Energy expressed its interest in supplying two CANDU 6 heavy water reactors for the construction of Cernavoda 3 and 4 in Romania, as well as to oversee construction and commissioning of those units.

It has been reported that uranium mining might soon begin at a new uranium ore deposit located in eastern Romania, at Grinties commune. Estimated at a total value of approximately EUR 90 million, the investment will most probably be covered from the state budget, and mainly by the National Company of Uranium SA Bucharest. Currently, the two-reactor Cernavoda NPP obtains the necessary uranium from the country's only active uranium mine, located in north-eastern Romania, which is close to being mined out.

Slovakia: The Slovak Ministry of Economy held discussions with Rosatom with regard to the ownership of the project for building up to two new reactors at the Bohunice NPP. CEZ, currently holding a 49 % stake in a joint venture signed with Slovakia for this project, might be interested in selling its stake to Rosatom, in which case the two new units added at Bohunice NPP could be Russian VVER reactors, with a combined capacity of up to 2 400 MW.

Construction of units 3 and 4 of the NPP in Mochovce by Slovenske Elektrarne (SE) continued in line with the updated schedule. Negotiations between the shareholders on the budget progressed, as all parties recognised the value of the largest private investment in Slovakia for energy security and the economy.

Finland: Fennovoima has concluded a contract with Rusatom Overseas for the construction of a 1 200-MW PWR at the Pyhäjoki site, scheduled to begin producing electricity in 2024. Organised as a cooperative producing electricity at cost for its owners, Finnish power companies and electricity-intensive industry, Fennovoima allowed Rosatom to acquire a 34 % stake in the project.

The Olkiluoto NPP, operated by Teollisuuden Voima Oyj (TVO), achieved the highest ever production result in its history in 2013. In the Olkiluoto 3 project, the civil construction works have been mainly completed and the main reactor components are installed. Reactor containment pressure and leak-tightness tests have been completed. However, for the time being, TVO will not provide an estimate of the start-up time of unit 3.

The Finnish parliament approved the power plant tax (so-called windfall tax) in December 2013 concerning nuclear, hydro and wind plants built before 2004. It will be applied from the beginning of 2014, provided that the European Commission considers that it does not constitute illegal state aid for those plants that are not subject to the tax.

Sweden: OKG has been endeavouring to bring back into service two of the three Oskarshamn BWR units it operates, unit 1 and unit 3, temporarily taken off the grid for various reasons, such as unplanned maintenance or malfunctioning turbine valves. The 661-MW Unit 2 had already been shut down for major modernisation and is expected to reconnect to the grid around September 2014.

After some years of low availability Vattenfall reports that Forsmark NPP had an all-time high generation during 2013. The three units generated 25.2 TWh and the energy availability was 89.5 % in total. Ringhals NPP generated 26.7 TWh in 2013, the third highest yearly generation ever and, during the high-load winter season, the energy availability for Vattenfall's seven nuclear units was 97 %.

Vattenfall has started an environmental impact assessment for new nuclear power in the vicinity of Ringhals NPP. The assessment is part of the long-term investigation of prerequisites/basis for replacement of existing reactors in Sweden.

United Kingdom: According to a press release issued in March by the Department for Energy and Climate Change and the Department for Business Innovation and Skill, the United Kingdom has put forward a new comprehensive energy strategy where nuclear power is seen to play a key role in the country's future low-carbon energy mix, alongside renewable generation and carbon capture and storage. Building on the United Kingdom's more than 20 years of experience and capability in areas such as operating and extending the life of existing reactors, supplying enrichment and new fuel services, reprocessing of spent fuel and decommissioning, the new strategy is designed to increase economic standing in those areas and generate more than 40 000 new jobs.

EDF Group and the United Kingdom government finally agreed on pricing terms over the construction by 2023 of two 1 650-MW European pressurised reactors at the Hinkley Point C site in Somerset, in a deal worth GBP 14 billion (USD 22 billion). The project is presently awaiting a decision from the European Commission's DG Competition, which has opened an in-depth investigation to examine whether United Kingdom plans to subsidise the construction and operation of a new NPP at Hinkley Point (by establishing a feed-in tariff ensuring that the operator of the Hinkley Point nuclear plant will receive a stable revenue for a period of 35 years despite the volatility of the wholesale electricity price) are in line with EU state-aid rules.

Hitachi and its UK subsidiary Horizon Nuclear Power signed a cooperation agreement with the United Kingdom whereby Hitachi must obtain governmental loan guarantees to contribute financially to the construction of two proposed ABWRs (advanced boiling water reactors) at Wylfa Newydd NPP. Horizon Nuclear Power expects to make a final investment decision in 2018 on its NPP construction project in the United Kingdom.

With a view to developing a generic design assessment of VVER-type reactors for the United Kingdom and assessing the feasibility of licensing, building and adapting such reactors to the United Kingdom market, Rolls-Royce signed in September a cooperation agreement with the Russian nuclear firm Rosatom and the Finnish utility Fortum. The cooperation covers various fields, including potential plant site evaluation, engineering and safety work, as well as providing expertise in areas such as spent fuel management and safety.

A report on international practice on geological disposal of intermediate level radioactive waste, high-level radioactive waste and/or spent fuel was published by the Nuclear Decommissioning Authority (NDA) in September. At the same time, a public 3-month consultation was launched by the government, aimed at exploring ways of involving local communities in decisions relating to the choice of radwaste disposal facilities in the United Kingdom. NDA also announced its intention to grant Nuclear Management Partners (a consortium consisting of AREVA, AMEC and URS) a 5-year extension to their contract to manage the Sellafield reprocessing complex.

A memorandum of understanding has been signed between the United Kingdom and China in the nuclear field, encouraging the United Kingdom to allow Chinese companies to take partial ownership in its reactors and also providing for UK companies to participate in China's nuclear industry.

ESA operations

Mandate and core activities

A common nuclear market in the EU was created by the Euratom Treaty. Article 52 of the treaty established the Euratom Supply Agency (ESA) to ensure a regular and equitable supply of nuclear fuels to EU users in line with the objectives of Article 2(d). To this end, ESA applies a supply policy based on the principle of equal access of all users to ores and nuclear fuel. It focuses on enhancing the security of supply to users located in the EU and shares responsibility for the viability of the EU nuclear industry. In particular, it recommends that Euratom utilities operating NPPs maintain stocks of nuclear materials, and cover their requirements by entering into long-term contracts with diversification of their sources of supply in order to prevent excessive dependence of EU users on any single, third-country source of supply. Diversification should cover all stages of the fuel cycle from mining to fuel fabrication.

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

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

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

ESA processed 279 transactions, including contracts, amendments and notifications of front-end activities, in 2013. In this way, the Agency ensured the security of supply of nuclear materials.

ESA's 2012 annual report was published in July 2013. As every year, ESA presented its annual calculation of different types of average natural uranium prices: MAC-3, multiannual and spot prices.

In 2013, in line with its statutory obligations, ESA's Nuclear Fuel Market Observatory continued to release the bimonthly *Nuclear News Digest*, *Quarterly Uranium Market Reports*, *Price Trends* and the weekly *Nuclear News Brief* (for readers in the Commission). Greater transparency in the EU's natural uranium market reduces uncertainty and strengthens security of supply.

In 2013, ESA issued four *Quarterly Uranium Market Reports* and six *Nuclear News Digests*. The *Quarterly Uranium Market Report* reflects global and specific Euratom developments on the nuclear market. This includes general data about natural uranium supply contracts signed by EU utilities, descriptions of activity on the natural uranium market in the EU and also the quarterly spot-price index for natural uranium whenever three or more ordinary spot contracts have been concluded.

Supply of medical radioisotopes

The observatory role of ESA was widened in 2013 to cover aspects of the supply of medical radioisotopes in the EU, in the light of Council conclusions 'Towards the secure supply of radioisotopes for medical use in the EU' (dated 2010 and 2012), prepared in response to increased fragility of the current production chain, which relies on an unsustainably low number of ageing research reactors, and in an effort to obtain the necessary supplies of nuclear material for HEU targets used for radioisotope production. ESA thus took on in 2013 the task of coordinating Commission services' actions undertaken to improve the security of supply of Mo-99/Tc-99 m — the most vital medical radioisotope — taking over chairmanship of the European Observatory on the supply of medical radioisotopes set up in 2012. The Observatory is aimed at bringing together all relevant information to assist the decision-makers of the EU institutions and national governments in defining strategies as well as policies for their implementation. The Observatory has four general strategic objectives: to support secure Mo-99/Tc-99 m supply across the EU; to ensure that the issue of Mo-99/Tc-99 m supply is given high political visibility; to encourage the creation of a sustainable economic structure of the supply chain; and to establish periodic reviews of the supply capacities and demand. To reach these objectives the Observatory, composed of members from the EU institutions and various industry stakeholders, functions through four working groups: 1 — Global reactor scheduling and Mo-99 supply monitoring; 2 — Full-cost recovery mechanisms; 3 — Management of HEU–LEU conversion and target production; and 4 — Capacity and infrastructure development. In 2013, two plenary meetings of the Observatory were held (in February and July), at which the reports prepared by the working groups were discussed. In the light of the feedback provided by the Observatory, a topic on high-density LEU uranium fuel for research reactors and targets for the production of medical radioisotopes was included in the Euratom Horizon 2020 work programme (2014–15), with a contribution from Euratom of between EUR 4 and 6 million.

Activities of the Advisory Committee

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

In 2013, the Advisory Committee met twice. At the first meeting (23 April), the main topics on the agenda were the Committee's opinion on the ESA's 2012 annual report, assessment of the ESA's accounts and the 2012 budgetary situation, the budget for 2014, a presentation of the latest developments regarding the bilateral Euratom agreements with non-EU countries and the post-Fukushima EU follow-up actions. The Committee discussed also the activities of its working group (WG) on prices and security of supply as well as of its WG on European production of low-enriched (< 20 %) uranium. The terms of reference of the latter group, developed at its first two meetings, were formally approved by the Committee.

The second meeting took place on 14 November. The Committee discussed progress achieved by its WGs. It took note of the status report of the WG on prices and security of supply, which dealt with two subjects: evaluation of the Agency's Quarterly Spot Index and revision of the 2005 task force report 'Analysis of the nuclear fuel availability at EU level from a security of supply perspective'. The members evaluated the methodology for calculating the ESA's Quarterly Spot Index. Several simulations of possible development of the index were performed by the ESA's staff on the basis of historical data but the current approach was kept in place for the time being. With regard to an analytical report, a risk assessment methodology was carefully examined and updated and the scope of the study was scrutinised and approved for further analysis. Preparation of the report is ongoing.

The WG on European production of LEU (< 20 %) was set up in May 2012. It managed to carry out its task within the assigned time frame. The WG conducted a strategic, technical and economic study on the establishment of a European dedicated facility, thereby addressing security of fuel supply for research reactors, in the interest of both scientific research and the production of medical radioisotopes, for the period after the research reactors' conversion to operate with LEU (foreseeably, in the 2020s). The WG's activity was praised as a good example of proactive action, conveying a positive message on the EU. The Committee endorsed and approved the final report of the WG on European production of LEU (< 20 %), which leads to the conclusion that the establishment of a European enrichment facility for this purpose is technically and legally feasible, as well as, under certain conditions, economically sustainable. Moreover, ESA was recommended to explore the possibility of a framework contract with the EU's traditional supplier countries with a view to securing supply of LEU (< 20 %) in the long term.

The Committee also took note of the estimate of ESA's revenue and expenditure for the financial year 2015 and formally confirmed its already expressed, positive opinion on ESA's annual accounts for 2012. Updates were provided both on the activity of the European Observatory on the supply of medical radioisotopes and on the bilateral Euratom agreements currently under negotiation. In addition, a presentation on the role of nuclear energy in EU energy policy was given to the Committee by a member of the Commission's DG Energy staff.

International cooperation

ESA has long-standing and well-established relationships with two major international organisations in the field of nuclear energy: the IAEA and the NEA. In 2013, ESA continued its cooperation with both these organisations by participating in two WGs — the joint NEA/IAEA Uranium Group and the NEA High-Level Group on the Security of Supply of Medical Radioisotopes (HLG-MR). Especially, the cooperation with the HLG-MR, which oversees international efforts to address the challenges of medical radioisotope supply reliability, was intensified in 2013, following the establishment of the European Observatory on the supply of medical radioisotopes.

Additionally, ESA continued to participate, on an ad hoc basis, in WGs and the nuclear fuel plenary sessions of the World Nuclear Association (WNA). ESA participated in the WNA Symposium in September 2013, provided an update of the work of the European Observatory on the supply of medical radioisotopes at the HLG-MR meetings held in January and July 2013 and presented its latest analysis of the EU nuclear market at the joint NEA/IAEA Uranium Group meeting in November 2013.

ESA administrative issues

Financial accounts and implementation of the budget

In the aftermath of Croatia's accession in June 2013, ESA's capital has reached EUR 5 856 000, increased by EUR 32 000. An instalment of 10 % of the capital has been called up and the Agency's statutes were amended accordingly.

The Agency has completed the implementation of its accounting and financial organisation and an accounting officer, attached directly to the director-general, is responsible for the Agency's accounts.

The Agency's budget remained stable in 2013, amounting to EUR 104 000. The budget in 2013 was financed by own revenues (bank interest on the paid-up capital, or approximately EUR 6 000) and a contribution from the Commission's heading 32.01.06 'Euratom contribution for operation of the Supply Agency' (EUR 98 000).

Off-budget expenditure represents the bulk of ESA's administrative expenses, which are financed directly by the Commission on the appropriate lines of the EU budget. Salaries are paid by the Commission and not charged to the Agency's budget in line with the provisions of Article 4 of ESA's statutes. The basic categories of off-budget expenditure include staff, premises, infrastructure, training and some IT equipment.

The financial statements of the ESA as of 31 December 2013 reveal a budget execution in the order of EUR 99 000 or 95 % of commitment appropriations (against 99 % in 2012). The final annual accounts are available on ESA's website (http://ec.europa.eu/euratom/index_en.html).

It should be borne in mind that the budget of ESA provides funding only for the running costs of the Agency. Unused amounts are returned to the EU budget.

External audit by the Court of Auditors

The European Court of Auditors (ECA) audits ESA's operations on an annual basis. The Court's responsibility is, on the basis of its audit, to provide the European Parliament and the Council with a statement of assurance as to the reliability of the annual accounts and the legality and regularity of the underlying transactions.

ESA takes due account of the opinions expressed by the Court. In 2013, the ECA provided an unmodified opinion on the reliability of the accounts and on the legality and regularity of the underlying transactions for the financial year 2012.

High staff turnover

There was high staff turnover in 2013 as had been anticipated. The Agency managed to fill six vacancies with experienced and highly qualified officials. ESA succeeded in keeping itself fully operational, without any interruption or delay in file processing, and managed to quickly integrate new staff through knowledge sharing.

At the end of 2013, ESA had 17 permanent posts and one contract agent post.

2. World market for nuclear fuels

This chapter presents a short overview of the main developments in 2013 affecting the global supply and demand balance and security of supply at different stages of the fuel cycle. The information has been gathered from various specialised publications.

According to the reference scenarios of WNA's latest report on *The global nuclear fuel market — Supply and demand 2013–30*, world reactor requirements for natural uranium were estimated at around 65 000 tU in 2013, approximately 5 % higher than WNA's 2012 figure, and world civil nuclear power generation capacity was declared as totalling about 370 GWe.

Overall, it could be argued that 2013 was a steady year for the nuclear industry. The number of operational nuclear reactors remained unchanged at 435, with four new grid connections in China and India, for a total capacity of 4 077 MWe and four closures, all in the United States, totalling 3 576 MWe. Construction works began on 10 new projects, totalling 11 688 MWe of gross generating capacity, four of them in the United States, three in China and two in new nuclear countries, the United Arab Emirates and Belarus, the first country in Europe to begin construction of its first NPP in three decades. That brings the number of reactors currently under construction to 71, an increase in capacity of 75 GWe. Although two units operated until September, Japan's entire nuclear fleet was shut down at the end of 2013, any future decision on restart being dependent on regulatory approval according to new safety criteria. A draft energy plan issued at year-end reversed the phase-out policy adopted by the previous government and underlined the need for Japan to continue to use nuclear power as a key energy source under stricter safety regulations. China's nuclear generation rose to 110.71 million MWh in 2013, 12.6 % higher than in 2012.

On the uranium supply side, there have been a number of deferments, especially as a reaction to decreasing prices. This led to the market being characterised by uncertainty throughout most of 2013. Two years after the Fukushima accident, the downward revision of both future nuclear demand and nuclear generating capacity growth expectations reflects the fact that the nuclear industry has understood the challenges it faces when planning new builds or lifetime operation extensions, in terms of developing and reviewing safety standards for new and existing NPPs. Thus, in the reference policies scenario presented in WNA's 2013 report, uranium future demand is expected to reach 97 450 tU in 2030, about 11 000 tU less than the 2011 estimates, while in 2030 worldwide nuclear generating capacity is estimated at 574 GW — about 40 GW lower than the 2011 projection. According to the new policies scenario (described in the *World energy outlook 2013*), global nuclear generation will grow from 2 584 TWh in 2011 to 4 300 TWh in 2035, its share in total generation remaining constant at 12 %. Growth in generation is underpinned by a corresponding expansion of capacity, which is expected to rise to 578 GW in 2035.

The rate of expansion of nuclear power will continue to be mainly policy driven, expanding in markets where there is a supportive policy framework, which, in some cases, actively seeks a larger role for nuclear in the mix in order to achieve energy security aims. But policy frameworks can also hinder or eliminate nuclear power, often as a result of public opposition: even where there is no explicit ban, long permitting processes, such as in the United States, can significantly hinder development by increasing uncertainty about project completion and increasing costs.

Natural uranium production

In 2013, global uranium production increased by 2 % as compared with the 2012 figure, totalling approximately 59 500 tonnes of uranium. As in 2012, the top three uranium-producing countries were Kazakhstan, Canada and Australia.

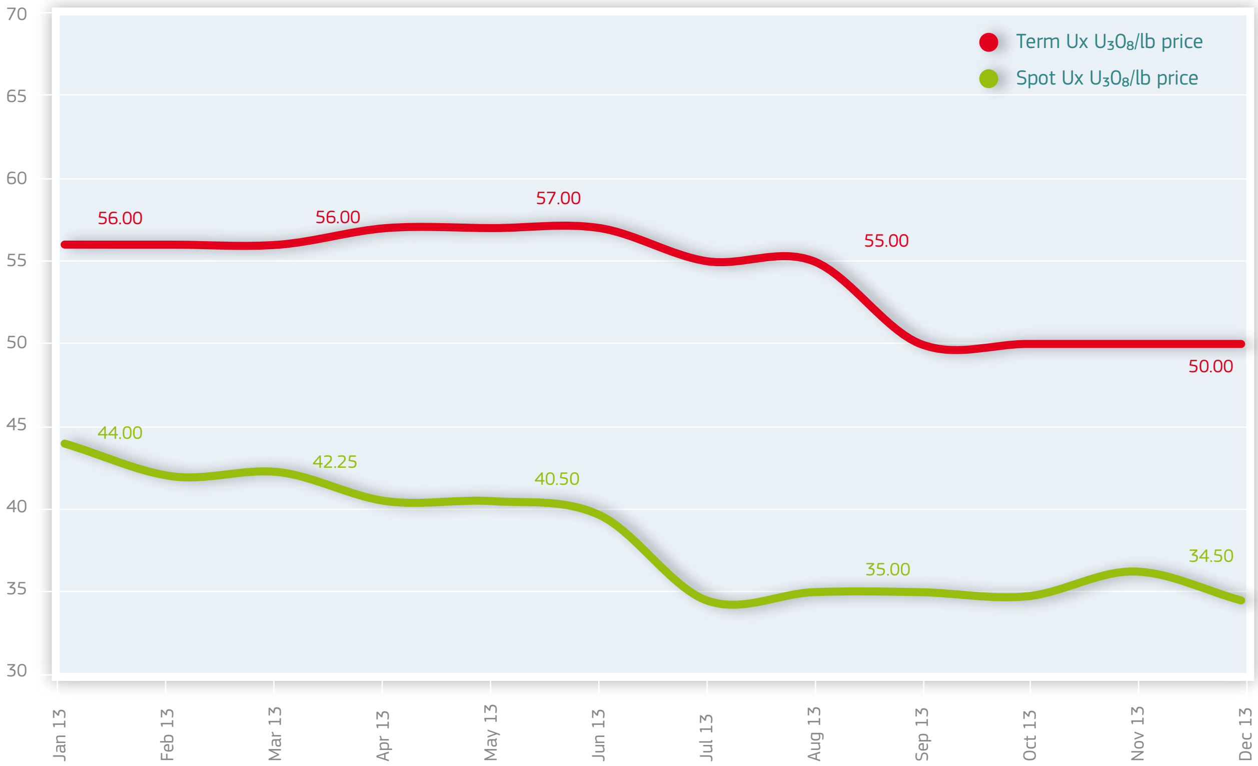
Kazakhstan remained the world's leading uranium producer in 2013, with 38 % of total uranium production worldwide. The country's uranium production accounted for 22 501 tU in 2013, a 6 % increase compared to the 2012 output of 21 317 tU. Canada's production in 2013 was, at around 9 000 tU, a 4 % increase over the 2012 figure. Australia's production level dropped by 12 % to around 6 100 tU.

Table 2 Natural uranium preliminary production in 2013 (compared with 2012, in tonnes of uranium)

Region/country	Production 2013 (preliminary)	Production 2012 (final)	Share in 2013 (%)	Share in 2012 (%)	Change 2013/12 (%)
Kazakhstan	22501	21317	38	37	6
Canada	9347	8998	16	15	4
Australia	6154	6991	10	12	– 12
Niger	4539	4667	8	8	– 3
Namibia	4308	4495	7	8	– 4
Russia	3154	2872	5	5	10
Uzbekistan	2423	2400	4	4	1
United States	1846	1596	3	3	16
China	1490	1500	2	3	– 1
Others	1281	1032	2	2	24
Malawi	1115	1101	2	2	1
Ukraine	923	960	2	2	– 4
South Africa	538	465	1	1	16
Total	**59619**	**58394**	**100**	**100**	**2**

Source: Data from the industry and WNA, *The global nuclear fuel market — Supply and demand 2013–30* (totals may not add up due to rounding).

Figure 3 Monthly spot and term U_3O_8/lb prices (USD)



Source: The Ux Consulting Company.

Price volatility increased slightly during 2013. The spot price started the year at USD 42.75 per pound (almost USD 10 less than its 2012 starting value) and increased slightly by the end of January to USD 44.00, which represented the highest peak for the year. Over the next couple of months, the spot price started to slip, falling to USD 42 by the end of February and then to USD 40.50 by the end of April. By the first week of June, the price hit USD 40.00 and during that month it fell below the USD 40.00 mark, the first time since March 2006, and prior to the 2007 run-up. The spot price quickly deteriorated during July to USD 34.50 and, by the first week of September, it hit its 2013 low of USD 34.00 per pound. It steadied for about 2 months before showing a slight increase at the end of November, when it reached USD 36.25. Some year-end transactions concluded in a context of limited demand resulted in the spot price losing momentum during December, thus ending the year at USD 34.50 per pound, almost USD 10 less than its January 2013 level. The long-term price began the year flat, holding steady at USD 56.00 for 3 more months, before inching up a dollar to USD 57.00 in April, where it held for another 3 months. The indicator slipped by 2 dollars to USD 55.00 by the end of July. The term indicator reflected additional downward pressure and fell 5 dollars by the end of September, hitting the USD 50.00 per pound mark. Term activity remained low throughout the rest of the year and the indicator was unchanged as 2013 came to a close.

Secondary sources of supply

In 2013, some of the uranium supplied to the market continued to come from secondary sources, including stockpiles of natural and enriched uranium, the down-blending of weapons-grade uranium, the reprocessing of spent nuclear fuel, re-enrichment of uranium tails and savings of uranium through underfeeding.

Over recent years, secondary supplies have shown a downward trend, which will continue due to the decline in the quantity of LEU derived from Russian down-blended HEU brought about by the end of the United States–Russia Megatons to Megawatts programme. The Megatons to Megawatts agreement between the United States and Russia reached its end in November 2013, as the last shipment of LEU obtained from down-blending HEU from dismantled nuclear warheads was sent from Tenex to USEC under the corresponding 1994 implementing contract. Over 20 years of execution of the agreement, 500 MTU of HEU has been down-blended and provided to USEC as LEU.

Uranium exploration and mine development projects

In 2013, despite falling uranium prices which led to the cancellation or deferment of a number of ongoing uranium exploration and mine development projects, worldwide the market for nuclear fuels showed confidence towards plans to expand production.

Presently, world known resources of uranium are more than adequate to meet reactor requirements to well beyond 2020 ([9]).

CNSC, Canada's Nuclear Safety Commission, has granted a construction and operating licence, valid from 1 July 2013 until 30 June 2021, to the Cigar Lake uranium mining project in northern Saskatchewan. Although this represents a step forward for the project, ongoing since 2005, Cameco, the mine operator, was forced to delay the expected 2013 start-up of the mine until the first quarter of 2014.

Due to unfavourable market conditions and low uranium prices, the Rosatom-owned companies ARMZ (Russian-based) and Uranium One (Canadian-based) stated their intentions to stop development of or to place under maintenance several ongoing projects, a move which might lead to a combined total uranium reduction of up to 4 000 tU. Uranium One plans to put the brakes on its Australian project, the Honeymoon mine, whose 2012 production reached 121 tU (out of a design capacity of 339 tU/y), as well as on the expansion of its United States Willow Creek ISR project (current design capacity of 500 tU/y, 2012 yield of 239 tU). With regard to the company's Tanzanian Mkuju River mine, its future remains uncertain. As for ARMZ, it made public its intention to stop developing Mine 6 at the Priargunsky Mining and Chemical Combine (MMC), to close down Mine 2 and to reduce the design capacity of the Khiagda deposit, along with its development schedule. Development of its Elkon deposit will also be put off for the time being.

In a recently published official report, Greenland's government confirmed the country's right to trade all domestic commodities, including uranium, without asking for the Danish government's permission, but simply keeping it informed of all such dealings. Allowing extraction of uranium in Greenland was subject to a parliamentary vote on 24 October, the positive outcome of which further opened up the country to investors from Australia to China eager to tap its vast mineral resources. The move will not only allow the mining of uranium deposits, but also of rare earths, minerals used in 21st century products from wind turbines to hybrid cars and smart phones, currently mostly extracted in China.

Energy Resources of Australia (ERA) hopes to regain its status as a major uranium producer through developing the Ranger 3 Deeps mine, for which it formally started in 2013 the regulatory approval process. Majority-owned by Rio Tinto, ERA has been faced with lower production levels and revenues ever since mine production at Ranger ceased.

A new uranium production facility, with an estimated yearly production of about 60 tU (156 000 pounds U_3O_8) was

([9]) WNA, *The global nuclear fuel market — Supply and demand 2013–30.*

inaugurated in April in Iran. Located at Ardakan, in the central province of Yazd, the facility is within 120 km of two underground uranium mines, Saghand 1 and 2, which reportedly have only recently begun operating.

According to statements from China Guangdong Nuclear Power Corp. (CGNPC), construction works at the Husab uranium mine in Namibia started in April 2013. CGNPC expects that the first mining campaign at the 320 million pound U_3O_8 deposit will begin before the end of 2015.

Cameco Australia Pty Ltd signed a non-binding joint venture (JV) term sheet with Mega Uranium Ltd for potential exploration at the Kintyre Rocks uranium project, in the East Pilbara region of Western Australia. Provided that a definitive agreement is reached, Cameco's initial stake in the exploration project might amount to 51 %, and it may opt to acquire, 4 years later, an extra 19 % share, by solely financing additional exploration activities worth AUD 4 million.

In 2013, the Ministry of Energy and Mineral Resources of Tanzania granted its first domestic uranium mining licence. The beneficiary is Mantra Tanzania, the Tanzanian subsidiary of the Russian company ARMZ, which had been trying for the last 2 years to obtain state approval to explore the Mkuju River uranium project, that has estimated total resources of over 42.4 tonnes U_3O_8 (93.3 million pounds).

50 000 tonnes (130 million pounds U_3O_8) of inferred resources grading 0.01 % U_3O_8 have been discovered during exploration at the Zoovch Ovoo project, which AREVA's Mongolian subsidiary has been developing in the Dornogobi province, Mongolia. The mine might be amenable to *in situ* recovery extraction.

Conversion

Four major commercial primary conversion companies, operating in Canada, France, Russia, the United Kingdom and the United States, meet the majority of the global demand for UF_6 conversion services. In 2013, world nameplate conversion capacity was estimated at around 76 000 tU, which was well above the global demand for conversion services, estimated to be around 62 000 tU. Part of the supply, around 20 000 tU, continued to be provided by the secondary conversion sources (almost all secondary uranium sources which displace demand for primary UF_6 conversion services).

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

Company	Nameplate capacity in 2013 (tU as UF_6)	Share of global capacity (%)
Atomenergoprom (Rosatom) (Russia)	25 000	33
Cameco (Canada, United Kingdom)	18 500	24
ConverDyn (United States)	15 000	20
Comurhex (AREVA) (France)	14 000	18
CNNC (China)	3 650	5
Ipen (Brazil)	40	0
Total nameplate capacity	76 190	100

Source: WNA, *The global nuclear fuel market — Supply and demand 2013–30.*

In 2013, the major converters continued their modernisation and capacity ramp-up projects. Last year, Comurhex became the first converter to have reached the historic production milestone of 400 000 tU converted into UF_6. With regard to the Comurhex II project, the main industrial equipment has been installed and active testing will soon be initiated on the various conversion process stages. Due to current market conditions, the nominal capacity of the plant has remained at 15 000 tU/y, with progressive starting of the units planned by 2015.

Initiated already in 2012, the facility upgrades at ConverDyn (seismic and natural disaster preparedness) were completed during the second quarter of 2013, and, following thorough inspections, the United States Nuclear Regulatory Commission allowed Metropolis Works to resume its UF_6 production.

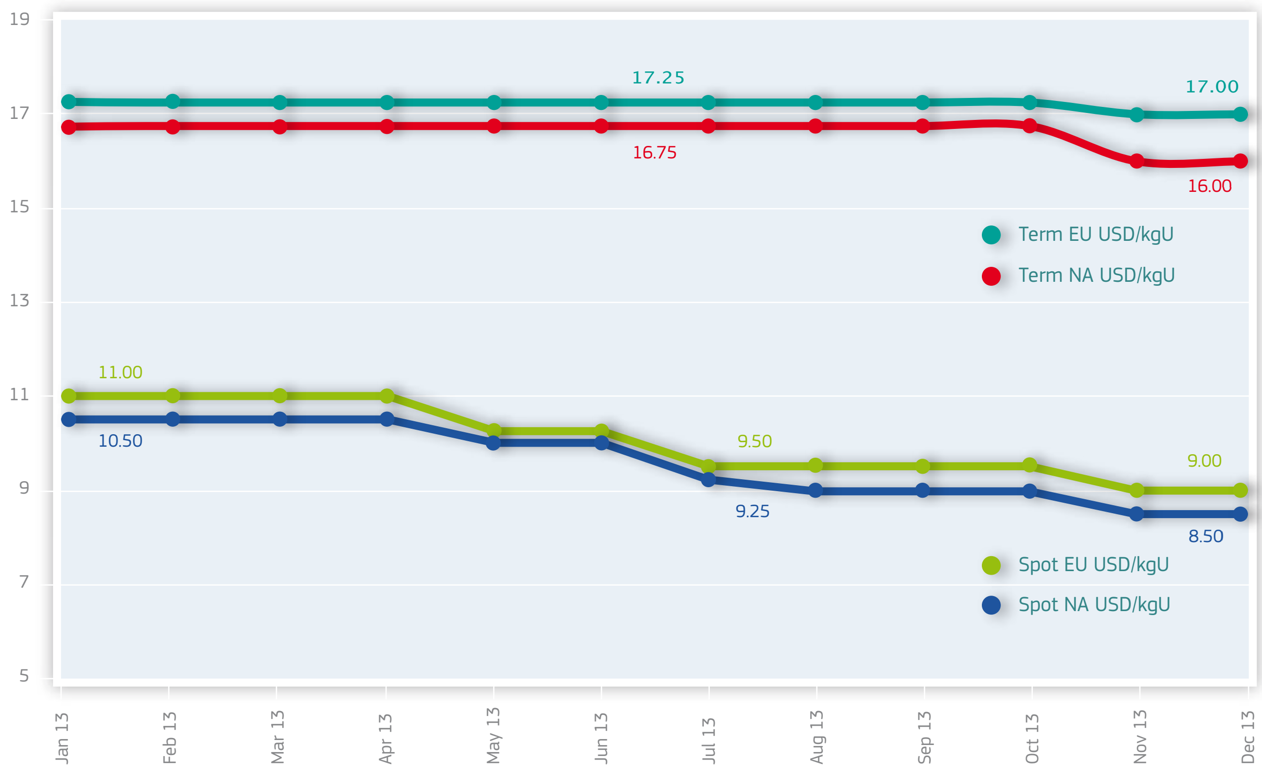
The licence amendment process, necessary for the modernisation and environmental remediation of Cameco's Port Hope conversion plant, was due to begin last year. In 2013, the facility became subject to the provisions of the Toxics Reduction Act, which requires regulated facilities in Ontario to track, quantify and report annually on the toxic substances they use, create, release, dispose of, transfer and contain in products, and to develop plans to reduce the use and creation of these substances.

Also last year, Canada signed a nuclear cooperation agreement with Kazakhstan, under which the two nations plan to jointly invest in the construction, in Kazakhstan, of a uranium conversion facility, estimated to reach a production capacity of 6 000 tU/y. Construction is scheduled to begin in 2018.

According to the latest market analyses of the reference cases on supply and demand of conversion services, the conversion market seems to be in a balanced position for the immediate future. However, in light of the estimated decrease in the availability of secondary sources (to around 13 000 tU/y beyond 2017) and the anticipated increase in requirements (to approximately 94 000 tU/y by 2030), a gap is likely to emerge between supply and demand in the post-2017 period. As acknowledged before, conversion remains a critical step in the nuclear fuel cycle and therefore, in order to ensure that UF_6 production will meet the demand and cover the estimated gap in the supply–demand balance, primary converters should continue to take measures to increase capacity utilisation at existing plants, build new capacity and/or prolong the operating lifetime of present facilities.

According to analysts, spot and term conversion market activity fell during 2013, which contributed to downward pressure on prices. As a result, spot prices slipped throughout the year, and the term indicators registered their first decline in 2 years. The European and North American spot conversion prices maintained the level of USD 11.00 and USD 10.50 per kgU, respectively, through the first quarter of the year. However, during the second quarter of 2013, both prices continued to slip, falling to the level of USD 8.50 (NA) and USD 9.00 (EU) at the end of November, and remaining unchanged in December. The EU and NA term prices started the year at USD 17.25 and USD 16.75 per kgU, respectively. After holding at their previous levels for 2 years, the term indicators finally slipped slightly in November to USD 17.00 (EU) and USD 16.00 (NA).

Figure 4 Uranium conversion price trends (USD)



Source: The Ux Consulting Company.

Enrichment

In 2013, the demand for enrichment services was evaluated at around 50 000 tSW. Despite estimates pointing to an increase in enrichment requirements over the 2013–30 period, mainly due to the new nuclear builds planned in Asia and the Middle East, the current commercial enrichment nameplate capacity of slightly over 56 000 tSW is considered to be sufficient to cover demand until 2020.

Table 4 Operating commercial uranium enrichment facilities with approximate 2013 capacity

Company	Nameplate capacity (tSW)	Share of global capacity (%)
Atomenergoprom (Russia)	28 000	50
Urenco (United Kingdom/Germany/ Netherlands/United States)	17 700	32
USEC (United States)	0	0
AREVA-GBII (France)	7 500	13
CNNC (China)	2 900	5
JNFL (Japan)	75	0
World total	56 175	100

Source: UxC special report — Enrichment supplier assessment.

As to the next decade's SWU supply–demand outlook, it is estimated that planned investments in extending current centrifuge capacity, as well as in building new centrifuge and laser projects, should allow the enrichment sector to properly address the growing requirements of the commercial nuclear sector worldwide well into 2030.

Looking at the supply generated by secondary enrichment sources, such as MOX fuel or ERU (estimated at about 3 million SWU/y until 2020 and 4 million SWU/y into the next decade), and the surplus Russian capacity freed following the completion of the 20-year Russia–United States HEU Agreement, the market beyond 2013 might appear as characterised by a situation of significant over-supply. However, the market has shown that this overcapacity of SWU is mainly used by individual enrichers to underfeed uranium, a trend which will continue, generating around 2 000 tU/of uranium per year and keeping the market in balance.

Areva's Georges Besse II centrifuge enrichment plant expansion is well on track towards achieving, by 2016, a full production capacity of 7.5 million SWU. Located at the Tricastin site on the lower Rhône river, the plant has two separate units, South and North. In production since April 2011, the South unit has two new centrifuge cascades added every month and has reached about 70 % of its production capacity. Following completion of civil engineering works and pre-operational testing, the North unit started commercial production in late March 2013.

According to Urenco USA's official statements released in September, the New Mexico enrichment facility has already reached the level of 3.0 million SWU of annual production capacity, only 39 months after the first centrifuge cascade started enriching uranium, in June 2010.

USEC Inc. closed the Paducah gaseous diffusion plant (GDP) in Kentucky in May 2013. Having been in operation for more than 60 years, the plant's technology is too expensive to compete with today's more efficient gas centrifuge technology. Official statements also confirmed that the tails re-enrichment programme, launched by the DOE, USEC, Energy Northwest, TVA and Bonneville Power at Paducah in May 2012, failed to be extended until 30 September 2013. USEC expects to continue operations at the site for at least one more year, so as to manage inventory and continue to meet customer orders. In December, USEC announced it would file for bankruptcy protection under the restructuring process it is undergoing, thus hoping to meet its obligations to stakeholders, including suppliers, customers and employees.

USEC will remain without an internal supply of SWU until the construction of the envisaged commercial American Centrifuge Plant (ACP). Given that the ACP has been significantly delayed, it could be 2016 or 2017 before initial ACP production begins and 2018 or 2019 before a completed 3.8 million SWU can be achieved.

China National Nuclear Corporation (CNNC) has reported the addition, in 2013, of a domestically produced uranium enrichment centrifuge at the Lanzhou facility, which marks another step towards China's solid development of its own nuclear power industry. Latest reports indicate an estimated total indigenous enrichment capacity, including Russian and Chinese centrifuges, of 8.5 million SWU/y by 2020.

Fabrication

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

In 2013, fuel fabricators were active on the global nuclear fuel market. In March, AREVA announced that it had completed the first fabrication of fuel assemblies for a European pressurised reactor at its facility in Romans, France. The fuel assemblies will be used at the Taishan NPP in China, expected to begin operation in 2014 (Unit 1) and in 2015 (Unit 2). The French fabricator signed a contract with the United States utility Exelon, for the provision, starting in 2016, of nuclear fuel fabrication services corresponding to 12 reloads for the Dresden and Quad Cities NPPs in Illinois. The agreement also provides that AREVA will continue to supply the Three Mile Island NPP in Pennsylvania with fuel fabrication services for six additional reloads, as well as with engineering services.

Jiangsu Nuclear Power Corporation and China Nuclear Energy Industry Corporation have signed a contract worth approximately USD 1 billion with TVEL, for the supply, until 2025, of nuclear fuel (initial cores, plus six subsequent reloads) to the Russian-built Units 3 and 4 at the Tianwan NPP. The agreement provides also for the supply of components which will enable China to eventually fabricate its own fuel for all four reactors at Tianwan. China already fabricates fuel for Units 1 and 2 of this NPP.

Demand for fuel fabrication reflects more or less the growth in nuclear generating capacity. However, despite future growth projections (based mainly on the recovery of Japan's nuclear industry), in the Western world, the existing fuel fabrication capacity, ensured by several equally reliable PWR/BWR/CANDU-type fuel fabricators, is considered more than sufficient to meet current demand, including projected first core reloads, well into 2020. However, with regard to the VVER-type reactors supplied by Russia, the lack of a reliable alternative (except for the VVER test fuel delivered by Toshiba Westinghouse to Ukraine under a United States–Ukraine governmental agreement) might lead to fuel fabrication causing a bottleneck in the world nuclear fuel market.

Reprocessing and recycling

The recovery of uranium and plutonium through reprocessing of spent fuel is nowadays done in France and Russia. Fabrication of the recovered material for further use in reactors requires dedicated conversion, enrichment and fabrication facilities.

In 2013, the use of reprocessed uranium and plutonium was limited. Besides EU supply, in April 2013 MOX fuel from Europe (20 MOX fuel assemblies produced by AREVA) was shipped to Japan for the first time since the Fukushima accident in 2011.

It is expected that the recycling of reprocessed uranium (ERU) and plutonium (in MOX fuel) will still play a role in meeting the demand for nuclear fuel, as they represent replacements for fresh LEU in the fuel fabrication process. However, future developments in this area will continue to depend upon natural uranium price levels and timely processing by the existing facilities. Currently, around 100 t/y of ERU are produced at MSZ in Elektrostal for AREVA contracts. Based on the information available on secondary supplies, it is estimated that supply of ERU and MOX fuel will displace usage of enrichment capacity up to the level of 3 million SWU/y until 2020 and 4 million SWU/y into the next decade, mainly due to Japan's resuming use of MOX fuel ([10]).

In June, details were made public with regard to the signing of a new strategic agreement between AREVA and Japan Nuclear Fuel Ltd (JNFL), pursuant to which both companies will strive to bring the Rokkasho-Mura reprocessing plant into commercial operation.

([10]) WNA, *The global nuclear fuel market — Supply and demand 2013–30*, p. 203.

3. Supply and demand for nuclear fuels in the EU

This overview of nuclear fuel supply and demand in the EU is based on information provided by the utilities or their procurement organisations in an annual survey of acquisition prices for natural uranium, the amounts of fuel loaded into reactors, estimates of future fuel requirements, quantities and origins of natural uranium and separative work, and future contracted deliveries and inventories. At the end of 2013, there were 131 commercial nuclear power reactors operating in the EU, located in 14 Member States and managed by 18 nuclear utilities. There were four reactors under construction in France, Slovakia and Finland. According to the latest available data published by the Commission in 2013, EU-28 gross electricity generation from nuclear amounted to 882.4 TWh in 2012 and nuclear gross electricity generation accounted for 26.7 % of total EU-28 production ([11]).

Fuel loaded into reactors

In 2013, 2 343 tU of fresh fuel was loaded into commercial reactors in the EU-28. It was produced using 17 175 tU of natural uranium and 1 024 tU of reprocessed uranium as feed, enriched with 12 617 tSW. The quantity of fresh fuel loaded increased by 3 % (i.e. 72 tU more than in 2012). In 2013, the fuel loaded into EU reactors had an average enrichment assay of 3.78 % and an average tails assay of 0.24 %.

Future reactor requirements (2014–33)

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

Natural uranium — average reactor requirements		
2014–23	18 204 tU/year (gross)	16 292 tU/year (net)
2024–33	16 382 tU/year (gross)	14 935 tU/year (net)

Enrichment services — average reactor requirements		
2014–23	14 515 tSW/year (gross)	13 251 tSW/year (net)
2024–33	13 236 tSW/year (gross)	12 450 tSW/year (net)

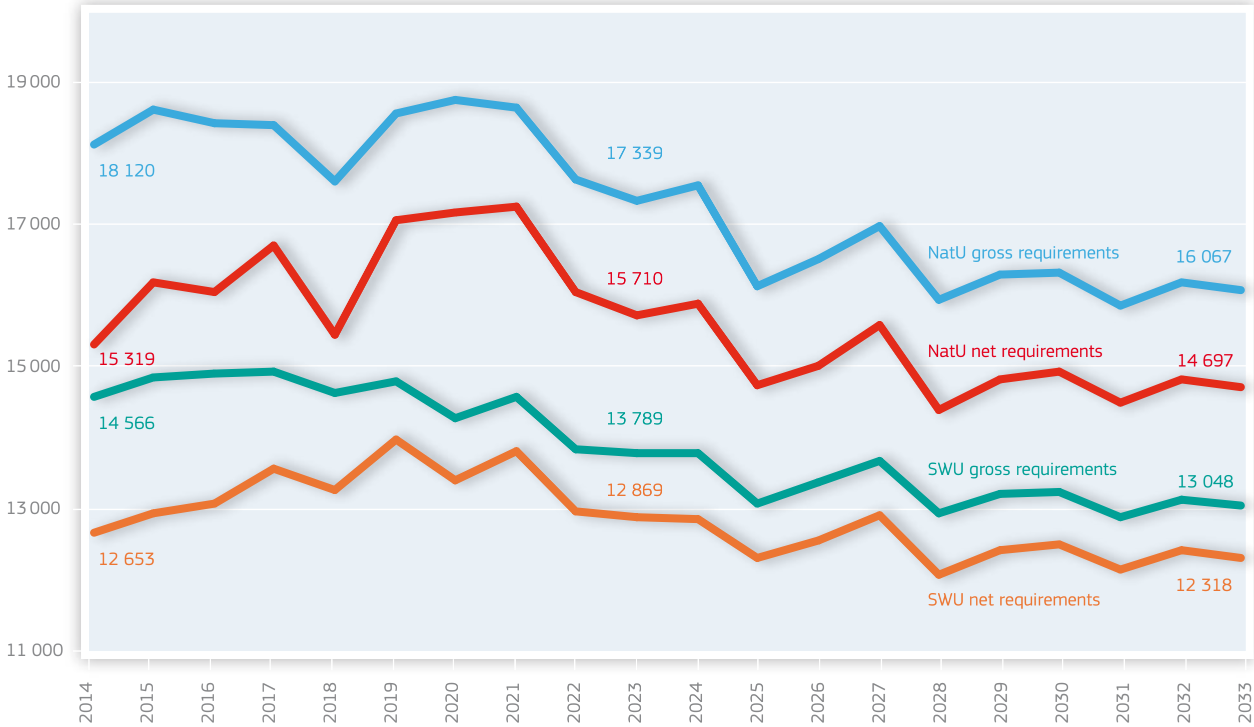
Estimates of future reactor requirements for uranium and separative work, based on data supplied by all EU utilities, are shown in Figure 5 (see Annex 1 for the corresponding figures).

Compared with last year's annual survey, future aggregate requirements declared by the utilities have decreased for both decades. For the period 2014–23, forecasts of average gross requirements for natural uranium have fallen by 2 % (– 304 tU) and for separative work by 1 % (– 120 tSW). Likewise, for 2024–33, the drop in demand for gross natural uranium is calculated at 3 % (– 521 tU) and for enrichment services at 1 % (– 129 tSW).

The drop in natural uranium requirements for a third consecutive year depicts a smooth adjustment trend for future EU demand. In line with that, the annual average rate of negative growth over the whole period is – 1 % for demand for both uranium and enrichment services, which is, however, sufficient to maintain a significant share for nuclear energy in the EU energy mix.

([11]) Eurostat energy statistics, 2013, data on primary energy production.

Figure 5 Reactor requirements for uranium and separative work (EU-28) (tonnes NatU or SWU)



Supply of natural uranium

Conclusion of contracts

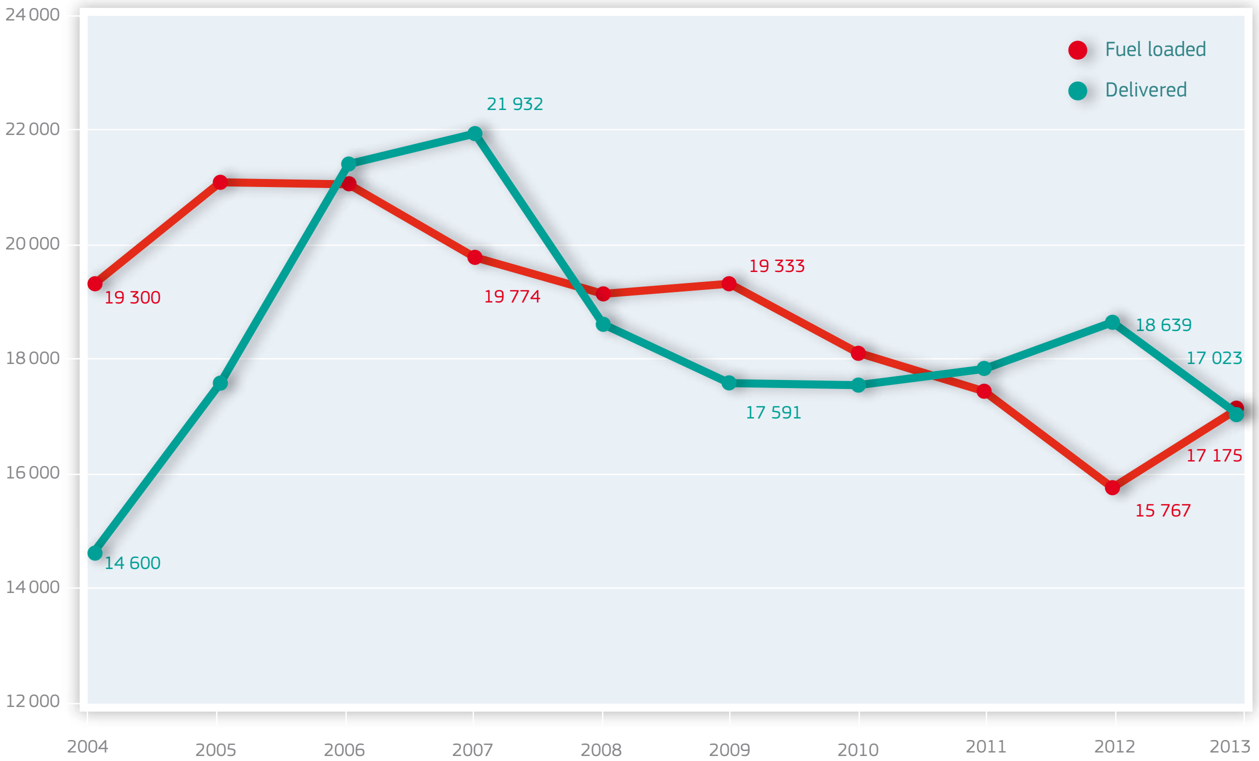
In 2013, ESA processed a total of 76 contracts and amendments, of which 50 (66 %) were newly concluded contracts. Out of 47 new purchase/sale contracts, almost 40 % involved EU utilities and the remainder were signed by intermediaries. Table 5 gives further details of the type of supply, terms and parties involved.

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

Type of contract	Number of contracts concluded in 2013	Number of contracts concluded in 2012
Purchase/sale by an EU utility/user	**18**	**18**
— multiannual (1)	2	10
— spot (1)	16	8
Purchase/sale by intermediaries	**29**	**21**
— between intermediaries (2) (multiannual)	6	5
— between intermediaries (2) (spot)	23	16
Exchanges and loans (3)	**3**	**5**
Amendments	**26**	**19**
TOTAL (4)	76	63

(1) Multiannual contracts are contracts providing for deliveries extending over more than 12 months, whereas spot contracts provide either for one delivery only or for deliveries over a maximum of 12 months, whatever the time between conclusion of the contract and the first delivery.
(2) Purchase/sale contracts between intermediaries — neither the buyers nor the sellers are EU utilities/end-users.
(3) This category includes exchanges of ownership and U_3O_8 against UF_6. Exchanges of safeguards obligation codes and international exchanges of safeguards obligations are not included.
(4) In addition, there were transactions for small quantities (Article 74 of the Euratom Treaty) which are not included here.

Figure 6 Natural uranium feed contained in fuel loaded into EU reactors and natural uranium delivered to utilities under purchasing contracts (tonnes NatU)



Volume of deliveries

The deliveries taken into account are those to EU utilities or their procurement organisations in 2013, excluding research reactors. Also taken into account is the natural uranium equivalent contained in enriched uranium purchases, when stated.

In 2013, demand for natural uranium in the EU represented approximately one third of global uranium requirements. EU utilities purchased a total of 17 023 tU in 132 deliveries under long-term and spot contracts, 1 615 tU or 8.7 % less than in 2012. As in previous years, long-term supplies constituted the main source for meeting demand in the EU. Deliveries of natural uranium to EU utilities under long-term contracts accounted for 15 809 tU (of which 14 997 tU with reported prices) or 92.9 % of the total deliveries, whereas the remaining 7.1 % (1 214 tU) was purchased under spot contracts. On average, the quantity of natural uranium delivered was 150 tU per delivery under long-term contracts and 45 tU per delivery under spot contracts.

Natural uranium contained in the fuel loaded into reactors in 2013 totalled 17 175 tU. The difference between natural uranium delivered and natural uranium contained in the fuel loaded was negative. Quantities of natural uranium feed contained in fuel loaded into EU reactors and natural uranium delivered to utilities under purchasing contracts are shown in Figure 6 (see Annex 2 for the corresponding table for 1980–2013).

Average prices of deliveries

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

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

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

Since uranium is priced in US dollars, the fluctuation of the EUR/USD exchange rate influences the level of the price indices calculated. The year 2013 was marked by an appreciation of the euro in nominal effective terms against the dollar. On average, the euro appreciated by 3 % against the US dollar as compared with 2012, with the annual average ECB EUR/USD rate rising to 1.33 from 1.28 in 2012, which consequently had an impact on the final dollar-denominated ESA prices.

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

1. **ESA spot U_3O_8 price:** the weighted average of U_3O_8 prices paid by EU utilities for uranium delivered under spot contracts in 2013 was calculated as:

EUR 78.24/kgU contained in U_3O_8	(20 % down from EUR 97.80/kgU in 2012)
USD 39.97/lb U_3O_8	(15 % down from USD 48.33/lb U_3O_8 in 2012)

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 2013 was calculated as:

EUR 85.19/kgU contained in U_3O_8	(8 % down from EUR 90.03/kgU in 2012)
USD 43.52/lb U_3O_8	(1 % down from USD 44.49/lb U_3O_8 in 2012)

3. **ESA 'MAC-3' new multiannual U_3O_8 price:** the weighted average of U_3O_8 prices paid by EU utilities, only for multiannual contracts which were concluded or for which the pricing method was amended in the past 3 years and under which deliveries were made in 2013, was calculated as:

EUR 84.66/kgU contained in U_3O_8	(18 % down from EUR 103.42/kgU in 2012)
USD 43.25/lb U_3O_8	(15 % down from USD 51.11/lb U_3O_8 in 2012)

The ESA U_3O_8 spot price reflects the latest developments on the uranium market as it is calculated from contracts providing either for one delivery only or for deliveries over a maximum of 12 months. In 2013, the ESA U_3O_8 spot price was EUR 78.24/kgU (or USD 39.97/lb U_3O_8), 20 % lower than in 2012. Price data were widely distributed, mostly falling within the range of EUR 69.19 to EUR 110.20/kgU (USD 35.34 to USD 56.29/lb U_3O_8). The ESA long-term U_3O_8 price was EUR 85.19/kgU U_3O_8 (USD 43.52/lb U_3O_8), 8 % lower than in 2012. Long-term prices paid varied widely, with approximately 70 % (assuming a normal distribution) falling within the range of EUR 58.05 to EUR 107.51/kgU (USD 29.65 to USD 54.92/lb U_3O_8). Normally, traded long-term prices go at a premium to spot prices as buyers are willing to pay a risk premium to lock in future prices. However, the ESA long-term U_3O_8 price is not forward looking. It is based on historical prices contracted under multiannual contracts, which are either fixed or calculated on the basis of formulae indexing mainly uranium spot prices. Spot prices are the most widely indexed prices in long-term contracts. On average, the multiannual contracts which led to deliveries in 2013 had been signed 9 years earlier. For the first time in 9 years, ESA's spot price in 2013 was lower than its long-term price.

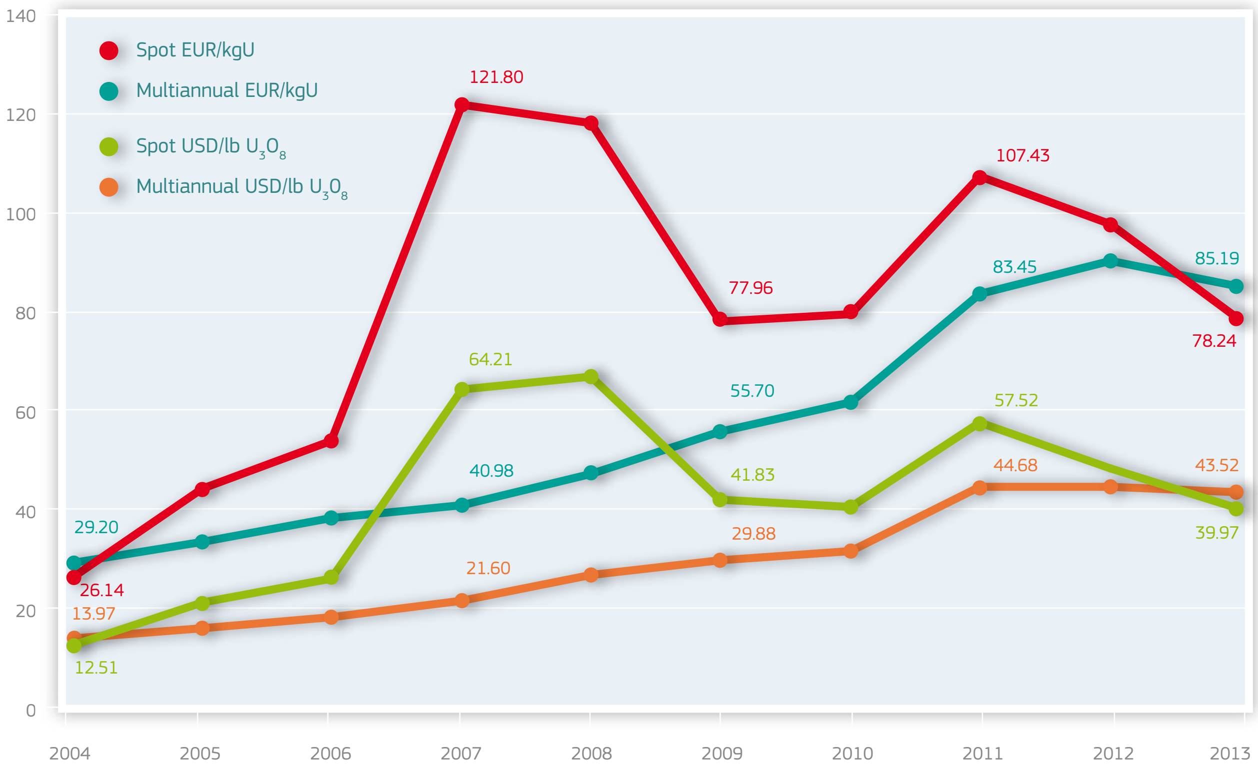
The ESA MAC-3 multiannual U_3O_8 price data were distributed within a wide range, with approximately 80 % of prices reported falling between EUR 74.18 and EUR 111.28/kgU (USD 37.90 to USD 56.85/lb U_3O_8). The ESA MAC-3 index takes into account only long-term contracts signed recently (2011–13) or older long-term contracts for which the uranium pricing method was amended during the same period, thus incorporating current market conditions and providing insights into the future of the nuclear market.

The ESA long-term U_3O_8 price paid for uranium originating in the CIS ([12]) was about at the same level as the prices for uranium of non-CIS origin. By contrast, the ESA MAC-3 multiannual U_3O_8 price paid for uranium originating in CIS countries was 26 % lower than the price for uranium of non-CIS origin.

Figure 7 shows the ESA average prices for natural uranium since 2004. The corresponding data are presented in Annex 3.

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

Figure 7 Average prices for natural uranium delivered under spot and multiannual contracts, 2004–13 (EUR/kgU and USD/lb U_3O_8)



Origins

In 2013, natural uranium supplies to the EU continued to come from diverse sources. In general, the origins of natural uranium supplied to EU utilities have remained unchanged since 2012. With regard to four big uranium-producing regions (the CIS, North America, Africa and Australia), deliveries from all except North America decreased in 2013.

Kazakhstan and Canada were the top two countries delivering natural uranium to the EU in 2013, providing 40 % of the total. Uranium originating in Kazakhstan represented the largest proportion, with 3 612 tU or 21 % of total deliveries, which was 60 % up on 2012 and accounted for a considerably higher share of the European market in 2013. It was followed by uranium of Canadian origin, with a 19 % share or 3 156 tU, a year-on-year decline of 2 %. In third place, uranium mined in Russia (including purchases of natural uranium contained in EUP) amounted to 3 084 tU or 18 %, a strong 40 % decrease over 2012. Niger and Australia accounted for 13 % and 12 % in 2013, a decrease of 6 % and 12 %, respectively.

Natural uranium mined in the CIS (Russia, Kazakhstan and Uzbekistan) accounted for 7 349 tU, or 43 % of all natural uranium delivered to EU utilities, a 7 % decrease from the year before.

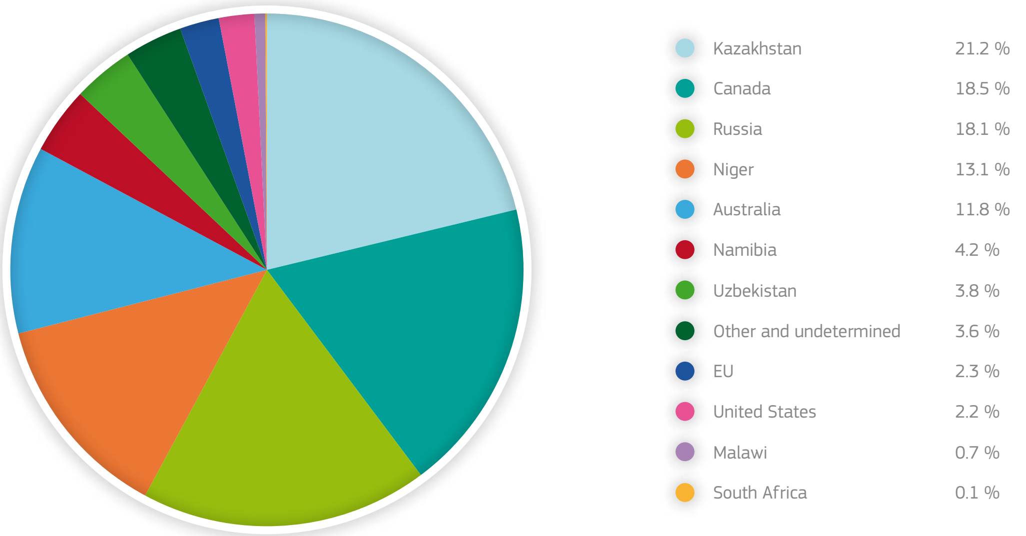
Deliveries of uranium of North American origin totalled 3 536 tU (21 %), an increase of 2 % from 2012.

Deliveries of uranium from Africa decreased by 29 %, down to 3 083 tU from 4 318 tU in 2012. Uranium extracted from Niger accounted for 2 235 tU and for 72 % of all African-origin uranium. A substantial decrease was reported in deliveries of uranium extracted in South Africa, Namibia and Malawi.

Similarly, Australian-origin uranium totalled 2 011 tU. European uranium delivered to EU utilities originated in the Czech Republic and Romania and covered approximately 2 % of the EU's total requirements (a total of 421 tU), which is no change compared to 2012.

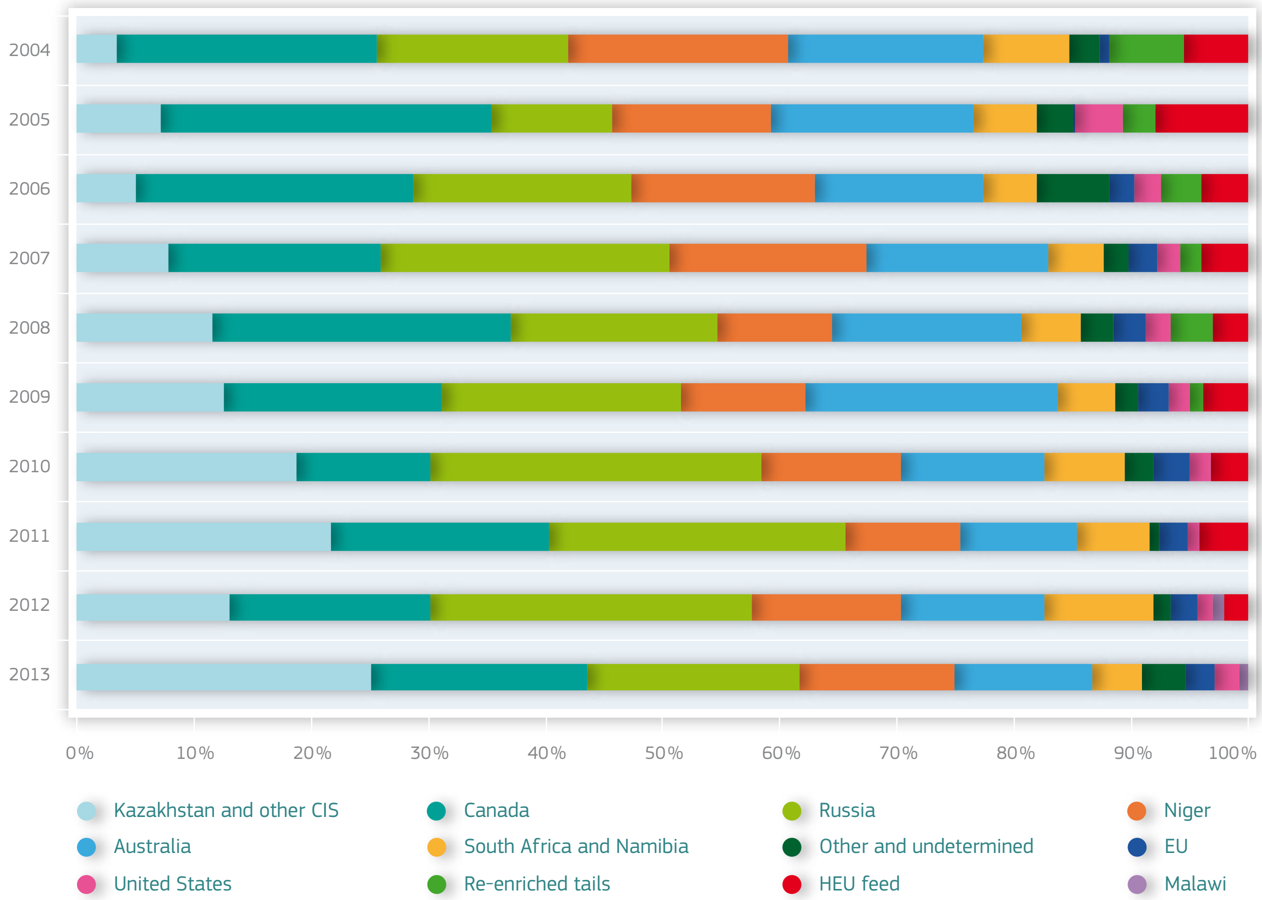
Small deliveries of re-enriched tails material were reported by EU utilities.

Figure 8 Origins of uranium delivered to EU utilities in 2013 (% share)



Totals may not add up due to rounding.

Figure 9 Purchases of natural uranium by EU utilities by origin, 2004–13 (tU) (%)



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

Special fissile materials

Conclusion of contracts

Table 6 shows the aggregate number of contracts, notifications and amendments ([13]) relating to special fissile materials (enrichment services, enriched uranium and plutonium) dealt with in 2013 in accordance with ESA's procedures.

Deliveries of low-enriched uranium

In 2013, the enrichment services (separative work) supplied to EU utilities totalled 11678 tSW, delivered in 1953 tonnes of low-enriched uranium (tLEU) which contained the equivalent of 15371 tonnes of natural uranium feed. In 2013, enrichment service deliveries to EU utilities decreased by 8 % as compared with 2012, with NPP operators opting for an average enrichment assay of 4.05 % and an average tails assay of 0.24 %.

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

Type of contract	Number of contracts concluded/ notifications acknowledged in 2013	Number of contracts concluded/ notifications acknowledged in 2012
A. Special fissile materials		
New contracts	**42**	**42**
Purchase (by an EU utility/user)	7	8
Sale (by an EU utility/user)	9	11
Purchase/sale (between two EU utilities/end-users)	2	4
Purchase/sale (intermediaries)	20	11
Exchanges	2	6
Loans	2	2
Contract amendments	**25**	**11**
TOTAL ([1])	**67**	**53**
B. Enrichment notifications ([2])		
New notifications	**1**	**1**
Notifications of amendments	**12**	**12**
TOTAL	**13**	**13**

([1]) In addition, there were transactions for small quantities (Article 74 of the Euratom Treaty) which are not included here.
([2]) Contracts with primary enrichers only.

Table 7 Providers of enrichment services delivered to EU utilities

Enricher	Quantities in 2013 (tSWU)	Share in 2013 (%)	Quantities in 2012 (tSWU)	Share in 2012 (%)	Change in quantities 2013/12 (%)
AREVA/Eurodif and Urenco (EU)	6956	60 %	7211	57 %	– 4 %
Tenex/TVEL (Russia)	4249	36 %	5218	41 %	– 19 %
USEC (United States)	354	3 %	174	1 %	104 %
Others ([1])	119	1 %	122	1 %	– 2 %
TOTAL	11678	100 %	12724	100 %	– 8 %

([1]) Including enriched reprocessed uranium.

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

As regards the providers of enrichment services, 60 % of the EU requirements were met by the two European enrichers (AREVA-Eurodif and Urenco), totalling 6 956 tSW, which was an increase of 3 percentage points in market share year on year.

Deliveries of separative work from Russia (Tenex and TVEL) to EU utilities under purchasing contracts totalled 4 249 tSW, a decrease of 19 % as compared with 2012. The aggregate total includes SWUs delivered under contracts 'grandfathered' under Article 105 of the Euratom Treaty, which covered approximately 8.5 % 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 28 % of total requirements.

Enrichment services provided by USEC increased in 2013, totalling 354 tSW and accounting for 3 % of the total enrichment services supplied to EU utilities.

Figure 10 Supply of enrichment to EU utilities by provider, 2004–13 (tSW)

Plutonium and mixed-oxide fuel

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

In 2013, MOX fuel was used in a number of reactors in Germany and France. The quantity of MOX fuel loaded into NPPs in the EU totalled 11 120 kg Pu in 2013, an 8 % increase over the 10 334 kg Pu used in 2012. Use of MOX resulted in estimated savings of 1 047 tU and 740 tSW (see Annex 5).

Inventories

Uranium inventories owned by EU utilities at the end of 2013 totalled 53 982 tU, an increase of 3 % from the end of 2012 and 24 % from the end of 2008. The inventories represent uranium at different stages of the nuclear fuel cycle (natural uranium, in-process for conversion, enrichment or fuel fabrication), stored at EU or foreign nuclear facilities.

Figure 11 Total uranium inventories owned by EU utilities at the end of the year, 2008–13 (tonnes)

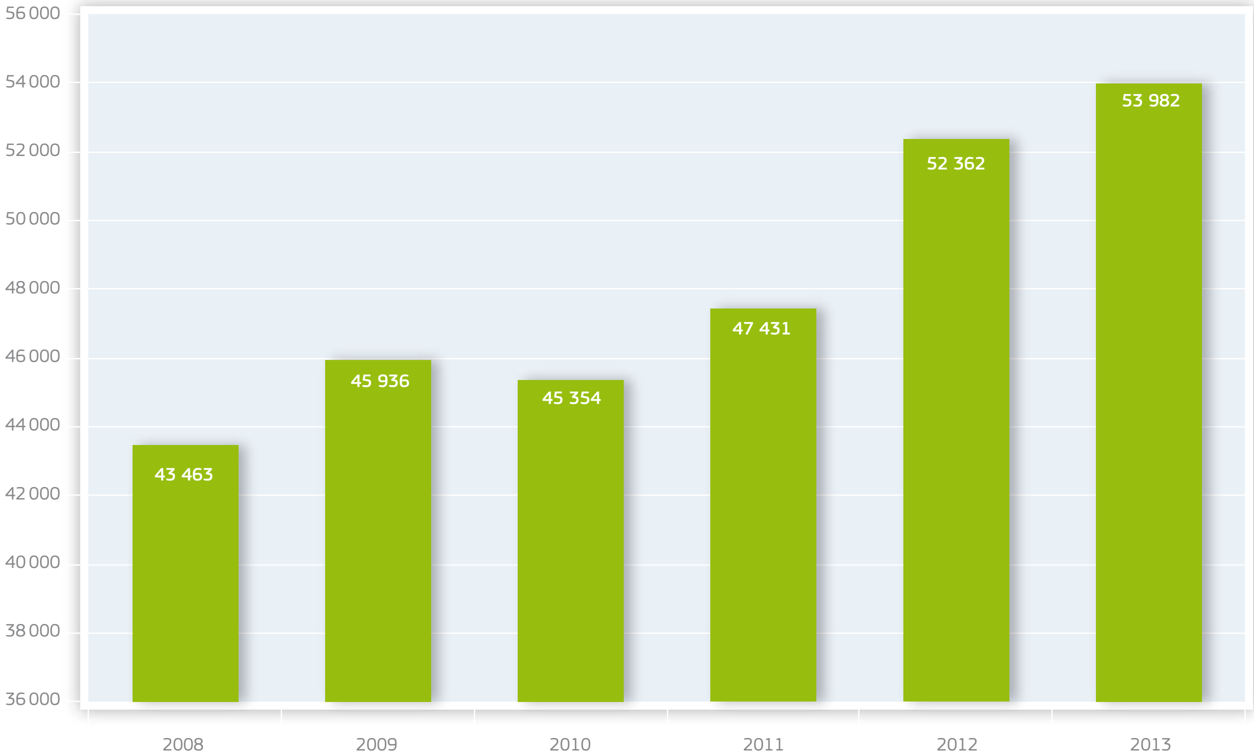


Figure 11 shows the level of total uranium inventories owned by EU utilities at the end of the year, expressed as natural uranium equivalent.

EU utilities' uranium inventories have increased substantially since 2008, after successive years of positive growth rates, with the exception of 2010, when there was a slight decline.

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

Based on average annual EU gross uranium reactor requirements (approximately 17 000 tU/year), uranium inventories can fuel EU utilities' nuclear power reactors, on average, for 3 years, ranging from 0 to 6 years.

Future contractual coverage rate

EU utilities' aggregate contractual coverage rate for a given year is calculated by dividing the maximum contracted deliveries in that year — under already-signed contracts — by the utilities' estimated future net reactor requirements in the same year. The result is expressed as a percentage. Figure 12 shows the contractual coverage rate for natural uranium and SWUs for EU utilities.

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

As regards net reactor requirements (denominator), a distinction is made between demand for natural uranium and demand for enrichment services. Average net reactor requirements for the period 2014–23 are estimated at approximately 16 300 tU and 13 300 tSW per year, respectively (see Figure 5).

Quantitative analysis shows that EU utilities are covered well above their estimated net reactor requirements (above 100 %) until 2015, in terms of both natural uranium and enrichment services, under already-signed contracts.

NatU coverage: Supply of natural uranium is fully guaranteed from 2014 to 2018 with a contractual coverage rate of over 90 %. In the long term, the uranium coverage rate remains above 70 % from 2019 to 2020 and drops sharply to 40 % for the period 2020–21.

SWU coverage: Enrichment services supply is well secured for the whole period 2014–20, with a contractual coverage steadily above 90 % and over 80 % between 2021 and 2022.

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

Figure 12 Coverage rate for natural uranium and enrichment services, 2014–22 (%)

ESA findings, recommendations and diversification policy

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

ESA recommends that utilities cover most of their current and future requirements for natural uranium and enrichment services under long-term contracts from diverse sources of supply. In line with this recommendation, deliveries of natural uranium to the EU under long-term contracts accounted in 2013 for 92.9 % of total deliveries. As regards mining origin, the relative shares of individual producer countries changed in comparison with the previous year, with Kazakhstan, Canada, Russia, Niger and Australia together providing almost 83 % of the natural uranium delivered to the EU. In 2013, there was a decrease in deliveries of uranium of African and Australian origin (down 29 % and 12 % respectively), and a 7 % decrease in uranium from the CIS. EU-origin deliveries maintained the same level as in 2012.

Regarding the diversification of sources of supply of enriched uranium to EU utilities, 60 % of the SWUs delivered in 2013 were provided by the two European enrichment companies, AREVA-Eurodif and Urenco. The remaining services were delivered mostly by Russia's Tenex/TVEL (36 %), and by the American company USEC (3 %), which closed its enrichment plant at the end of May 2013.

ESA observes that EU utilities' dependence on foreign suppliers of enrichment services is decreasing, mainly due to the drop in Tenex/TVEL's share of the European market. Enrichment services of Russian origin delivered under contracts concluded by ESA accounted for 36 %, while enrichment services delivered under contracts 'grandfathered' under Article 105 of the Euratom Treaty accounted for approximately 8.5 % of total deliveries. In practice, 'grandfathered' contracts keep certain EU utilities entirely dependent on a single external supplier ([14]).

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

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

practices increase security of supply. Furthermore, blending reprocessed uranium with HEU of military origin is conducive to nuclear disarmament and the non-proliferation of nuclear materials. ESA therefore takes account of these positive aspects of reprocessed fuel use when implementing its diversification policy. HEU downblended with reprocessed uranium and re-enriched reprocessed uranium fuel accounted for approximately 6 % of the total fuel loaded into EU reactors in 2013.

ESA also recommends that EU utilities maintain adequate strategic inventories and use market opportunities to increase their stocks, depending on their individual circumstances. The aggregate stock level at the end of 2013 totalled 53 982 tU, which could fuel EU utilities' nuclear power reactors, on average, for almost 3 years. However, the average conceals a wide range, and some utilities would be wise to consider increasing their stocks.

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

Following thorough analysis of the information gathered from EU utilities in the annual survey at the end of 2013, ESA concludes that, in the short and medium term, the needs of EU utilities for both natural uranium and enrichment services are well covered. However, there is a concern over the 100 % reliance on one single supplier for VVER fuel fabrication. In the long term, planned reactor deployment in Asian countries could affect the security of supply to the EU nuclear market.

4. ESA work programme for 2014

In line with its remit under Chapter 6 of the Euratom Treaty and its statutes, ESA's work programme for 2014 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 creates a need to diversify sources of supply to a satisfactory degree in order to guarantee the security of nuclear fuel supply to EU utilities. By evaluating and signing supply contracts for nuclear materials and acknowledging transactions covering provision of the entire cycle of nuclear fuel services, ESA will continue to guarantee security of supply. It will maintain a focus on the supplies of HEU and LEU required for producing medical radioisotopes and fuelling research reactors.

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

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

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

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

4. **Evaluating relevant research and development activities in view of their potential impact on ESA's policy for security of supply**

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

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

In order to streamline the contract handling process and the market observatory task, ESA will update its internal manuals of procedures for both sectors.

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

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

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

Exemption from the principle of diversification for contracts concluded before the EU accession of certain Member States will apply until the contracts expire ([15]). New supply contracts for these utilities are being assessed in the light of the diversification policy.

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

ESA will continue to scrutinise potential risks to the security of supply of the HEU and LEU which are required to produce medical radioisotopes (Mo-99/Tc-99 m) and fuel research reactors. Neither HEU nor such LEU is currently produced in the EU. ESA will be further actively involved in assessing requirements for these fissile materials and exploring the possibility of assuring their supply. As we are in a transition period from HEU to LEU targets and in some cases from HEU fuel to LEU fuel, it is very important to strive to obtain the necessary supplies in order to prevent any shortage in the production of medical radioisotopes.

Specific objective No 1

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

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

3. Clarify procedures concerning intermediaries and enrichment contracts.

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

5. Assess the needs for HEU and LEU which are required to produce medical radioisotopes and to fuel research reactors; explore the possibility of assuring their supply.

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

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

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

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

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

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

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

ESA's Nuclear Market Observatory will continue to cooperate closely with the energy observatory of the Commission's Directorate-General for Energy.

Following the 2013 widening of ESA's observatory role to cover aspects of the supply of medical radioisotopes in the EU, ESA will continue to chair the European Observatory on the supply of medical radioisotopes set up in 2012 and to coordinate the Commission services' actions undertaken to improve the security of supply of Mo-99/Tc-99 m — the most vital medical radioisotope. ESA plans to present in 2014 a report to the Council on activities following up the Council conclusions of 15 December 2009 on the security of supply of radioisotopes for medical use and the Council conclusions of 6 December 2010 and 18 December 2012 'Towards the secure supply of radioisotopes for medical use in the European Union'.

Specific objective No 2

To deliver on its market observation and monitoring responsibilities, ESA will:

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

2. Regularly update information published by ESA's own Nuclear Market Observatory, in particular by the regular publication of *Quarterly Uranium Market Reports*, the *Nuclear Digest* and ad hoc studies.

3. Publish its annual report, including market analyses, by June 2014.

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

5. Chair and lead the activities of the European Observatory on the supply of medical radioisotopes.

6. Develop a medical radioisotope section on ESA's website, offering direct access to up-to-date information on this subject.

7. Report to the Council on the follow-up to the Council conclusions on medical radioisotopes.

Increasing cooperation with international organisations and third countries

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

Specific objective No 3

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

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

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

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

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

ESA will actively monitor research and development activities in all EU and international R & D 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 relating to fuel cycle management, with a view to adapting the Agency's security of supply policy as appropriate.

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

Making ESA's internal organisation and operations more effective

This is an internal task aiming to make ESA more effective and efficient. This is especially important in the light of the re-establishment of the ESA's budgetary autonomy in the general budget of the EU in 2012.

Specific objective No 5

1. Review the current ESA practices and work arrangements; update the manual of procedures for the contracts and market observatory sectors.

2. Ensure sound financial and budgetary management taking into account ESA's budgetary autonomy.

3. Review/update the memorandum of understanding with DG Energy.

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

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

Further information

Additional information can be found on Europa, the European Union server (http://europa.eu/index_en.htm).

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

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

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

Glossary

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

High-enriched uranium (**HEU**) is uranium enriched to 20 % U-235 or more (usually up to 93 %).

Low-enriched uranium (**LEU**) is uranium enriched to less than 20 % U-235. For power reactors, it is usually 3.5–5.0 % U-235.

MW stands for megawatt or 1 million watts and is a measure of electrical output. MWe refers to electrical output from a generator, MWt to thermal output from a reactor or heat source (e.g. the gross heat output of a reactor itself, typically around three times the MWe figure).

SWU stands for 'separative work unit'. SWUs measure the effort made in order to separate the fissile, and hence valuable, U-235 isotopes from the non-fissile U-238 isotopes, both of which are present in natural uranium. As a standard indicator of enrichment services, the concept of SWU is very complex, as it is a function of the amount of uranium processed and the degree to which it is enriched (i.e. the extent of increase in the concentration of the U-235 isotope relative to the remainder). The unit — strictly 'kilogram separative work unit' or kg SWU, when feed and product quantities are expressed in kilograms (but usually shown in graphs as SWU, or tSW for 1 000 SWU) — is a measure of the quantity of separative work (indicative of energy used in enrichment).

Radioisotopes are used in medicine for the diagnosis and treatment of various diseases, including some of the most important ones, like cancers, or cardiovascular and brain diseases. Over 10 000 hospitals worldwide use radioisotopes for the *in vivo* diagnosis or treatment of about 35 million patients every year, including 9 million in Europe. The majority of today's nuclear medicine procedures are for diagnosis, with about 100 different imaging procedures available. Imaging using radioisotopes is often indispensable, for instance due to its ability to identify various disease processes early, long before other diagnostic tests. Technetium-99 m (Tc-99 m) is the most widely used (diagnostic) radioisotope. Europe is the second largest consumer of Tc-99 m, accounting for more than 20 % of the global market. The production of Tc-99 m is a complex process which includes irradiation of uranium targets in nuclear research reactors to produce Molybdenum-99 (Mo-99), extraction of Mo-99 from targets in specialised processing facilities, production of Tc-99 m generators and shipment to hospitals. Due to their short decay times, Mo-99 and Tc-99 m cannot be stockpiled and must be produced continuously and delivered to hospitals weekly. Any supply disruption can have negative and sometimes life-threatening consequences for patients. Unfortunately, the current Mo-99/Tc-99 m supply relies on a small number of production reactors. Moreover, as those reactors were constructed in the 1950s and 1960s, they are approaching the end of their lifespan, which creates an increasing need for planned maintenance shutdowns and a growing frequency of unplanned production interruptions. As a result, the global supply of radioisotopes has become more fragile, particularly in recent years.

Annexes

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

(A) From 2014 until 2023

Year	Natural uranium		Separative work	
	Gross requirements	Net requirements	Gross requirements	Net requirements
2014	18 120	15 319	14 566	12 653
2015	18 603	16 190	14 848	12 942
2016	18 415	16 044	14 896	13 068
2017	18 397	16 700	14 941	13 558
2018	17 597	15 441	14 627	13 277
2019	18 568	17 048	14 805	13 964
2020	18 741	17 167	14 282	13 401
2021	18 634	17 242	14 566	13 821
2022	17 623	16 056	13 834	12 960
2023	17 339	15 710	13 789	12 869
Total	**182 037**	**162 916**	**145 154**	**132 514**
Average	**18 204**	**16 292**	**14 515**	**13 251**

(B) Extended forecast from 2024 to 2033

Year	Natural uranium		Separative work	
	Gross requirements	Net requirements	Gross requirements	Net requirements
2024	17 543	15 894	13 794	12 861
2025	16 135	14 726	13 076	12 318
2026	16 520	15 012	13 379	12 548
2027	16 973	15 570	13 675	12 921
2028	15 943	14 389	12 935	12 072
2029	16 283	14 820	13 209	12 410
2030	16 312	14 942	13 231	12 501
2031	15 854	14 484	12 870	12 140
2032	16 189	14 819	13 139	12 409
2033	16 067	14 697	13 048	12 318
Total	**163 818**	**149 354**	**132 356**	**124 499**
Average	**16 382**	**14 935**	**13 236**	**12 450**

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
2012	2 271	15 767	11 803	18 639	3.8	12 724
2013	**2 343**	**17 175**	**12 617**	**17 023**	**7.1**	**11 559**

(*) Data not available.

Annex 3
ESA average prices for natural uranium

Year	Multiannual contracts		Spot contracts		New multiannual contracts		Exchange rate
	EUR/kgU	USD/lb U_3O_8	EUR/kgU	USD/lb U_3O_8	EUR/kgU	USD/lb U_3O_8	EUR/USD
1980	67.20	36.00	65.34	35.00			1.39
1981	77.45	33.25	65.22	28.00			1.12
1982	84.86	32.00	63.65	24.00			0.98
1983	90.51	31.00	67.89	23.25			0.89
1984	98.00	29.75	63.41	19.25			0.79
1985	99.77	29.00	51.09	15.00			0.76
1986	81.89	31.00	46.89	17.75			0.98
1987	73.50	32.50	39.00	17.25			1.15
1988	70.00	31.82	35.50	16.13			1.18
1989	69.25	29.35	28.75	12.19			1.10
1990	60.00	29.39	19.75	9.68			1.27
1991	54.75	26.09	19.00	9.05			1.24
1992	49.50	24.71	19.25	9.61			1.30
1993	47.00	21.17	20.50	9.23			1.17
1994	44.25	20.25	18.75	8.58			1.19
1995	34.75	17.48	15.25	7.67			1.31
1996	32.00	15.63	17.75	8.67			1.27
1997	34.75	15.16	30.00	13.09			1.13
1998	34.00	14.66	25.00	10.78			1.12
1999	34.75	14.25	24.75	10.15			1.07
2000	37.00	13.12	22.75	8.07			0.92
2001	38.25	13.18	(*) 21.00	(*) 7.23			0.90
2002	34.00	12.37	25.50	9.27			0.95
2003	30.50	13.27	21.75	9.46			1.13
2004	29.20	13.97	26.14	12.51			1.24
2005	33.56	16.06	44.27	21.19			1.24
2006	38.41	18.38	53.73	25.95			1.26
2007	40.98	21.60	121.80	64.21			1.37
2008	47.23	26.72	118.19	66.86			1.47
2009	55.70	29.88	77.96	41.83	(**) 63.49	(**) 34.06	1.39
2010	61.68	31.45	79.48	40.53	78.11	39.83	1.33
2011	83.45	44.68	107.43	57.52	100.02	53.55	1.39
2012	90.03	44.49	97.80	48.33	103.42	51.11	1.28
2013	**85.19**	**43.52**	**78.24**	**39.97**	**84.66**	**43.25**	**1.33**

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

Annex 4
Purchases of natural uranium by EU utilities by origin, 2004–13 (tU)

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Kazakhstan + other CIS	481	1 246	1 057	1 618	2 143	2 195	3 275	3 871	2 414	4 265
Canada	3 274	4 998	5 093	3 786	4 757	3 286	2 012	3 318	3 212	3 156
Russia	2 391	1 788	3 984	5 144	3 272	3 599	4 979	4 524	5 102	3 084
Niger	2 746	2 390	3 355	3 531	1 845	1 854	2 082	1 726	2 376	2 235
Australia	2 443	3 065	3 053	3 209	2 992	3 801	2 153	1 777	2 280	2 011
South Africa + Namibia	1 080	951	978	1 003	944	860	1 207	1 124	1 762	733
Other + undetermined	373	529	1 336	432	520	329	432	128	256	621
EU	129	5	472	526	515	480	556	455	421	421
United States	0	757	488	402	398	318	320	180	241	381
Malawi	0	0	0	0	0	0	0	0	180	115
HEU feed	800	1 407	850	825	550	675	550	731	395	0
Re-enriched tails	925	474	728	388	688	193	0	0	0	0
Total	**14 642**	**17 610**	**21 394**	**20 864**	**18 622**	**17 591**	**17 566**	**17 832**	**18 639**	**17 023**

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

Year	kg Pu	Savings	
		tNatU	tSW
1996	4 050	490	320
1997	5 770	690	460
1998	9 210	1 110	740
1999	7 230	870	580
2000	9 130	1 100	730
2001	9 070	1 090	725
2002	9 890	1 190	790
2003	12 120	1 450	970
2004	10 730	1 290	860
2005	8 390	1 010	670
2006	10 210	1 225	815
2007	8 624	1 035	690
2008	16 430	1 972	1 314
2009	10 282	1 234	823
2010	10 636	1 276	851
2011	9 410	824	571
2012	10 334	897	622
2013	**11 120**	**1 047**	**740**
Grand total	**172 636**	**19 800**	**13 271**

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 NPP
Kozloduy NPP Plc
Nuklearna elektrarna Krško, d.o.o.
Magnox Ltd (UAM)
Oskarshamn NPP (OKG)
Paks NPP 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 2013

AREVA NC and AREVA NP (formerly Cogéma)
BHP Billiton (formerly WMC)
Cameco Inc. Corporation USA
CNU
Cominak
Deutsche Bank
DIAMO
Energy US
ERA
Internexco GmbH
Itochuint
Aron
KazAtomProm
Nufcor International
NUKEM GmbH
Paladin Energy Ltd
Rio Tinto
Rossing Uranium
TENAM Corp.
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 provide reliable objective price information, comparable with previous years, only deliveries made to EU utilities or their procurement organisations under purchasing contracts are taken into account for calculating the average prices.

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

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

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

3. The ESA 'MAC-3' multiannual U_3O_8 price is a weighted average of U_3O_8 prices paid by EU utilities, but only under multiannual contracts which were concluded or for which the pricing method was amended in the previous 3 years (i.e. between 1 January 2011 and 31 December 2013) and under which deliveries were made during the reference year. In this context, ESA regards amendments which have a direct impact on the prices paid as separate contracts.

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

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

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

Definition of spot vs long-term/multiannual contracts

The difference between spot and multiannual contracts is:

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

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

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

Method

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

Data collection tools

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

- contracts submitted to ESA;

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

Data requested on natural uranium deliveries during the year

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

Deliveries taken into account

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

Other categories of contracts, e.g. those between intermediaries, for sales by utilities, purchases by non-utility industries or barter deals, are excluded. Deliveries for which it is not possible reliably to establish the price of the natural uranium component are also excluded from the price calculation (e.g. uranium out of specification or enriched uranium priced per kg EUP without separation of the feed and enrichment components).

Data quality assessment

ESA compares the deliveries and prices reported with the data collected at the time of conclusion of the contracts, taking into account any subsequent updates. In particular, it compares the actual deliveries with the 'maximum permitted deliveries' and options. Where there are discrepancies between maximum and actual deliveries, clarifications are sought from the organisations concerned.

Exchange rates

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

Prices which include conversion

For the few prices which include conversion but where the conversion price is not specified, given the relatively minor cost of conversion, ESA converts the UF_6 price into a U_3O_8 price using an average conversion value based on reported conversion prices under the natural uranium long-term contracts.

Independent verification

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

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

Data protection

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

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