

# URENCO'S

## Role In The Nuclear Fuel Chain

WISE/NIRS Nuclear Monitor #783-784 A special double issue of the WISE/NIRS Nuclear Monitor  
[www.wiseinternational.org/nuclear-monitors](http://www.wiseinternational.org/nuclear-monitors)

This issue of the Nuclear Monitor is a lightly edited version of a report written by Dirk Bannink (Laka Foundation) and Peter Diehl (WISE Uranium), commissioned and published by World Information Service on Energy (WISE).

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The original report was produced with financial assistance from IUCN NL, Wetlands International and Both ENDS, partners in the Ecosystem Alliance. The views expressed, the information and material presented and the geographical and geopolitical designations used in this product do not imply the expression of any opinion whatsoever on the part of IUCN NL, Wetlands International or Both ENDS or the institutions and organisations providing these three organisations with funds.

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# Introduction

This special double-issue of the WISE/NIRS Nuclear Monitor focuses on URENCO (Uranium Enrichment Company Ltd.) and its subsidiaries. URENCO is one of the four major uranium enrichment suppliers worldwide, operating enrichment plants in the UK (Capenhurst), Germany (Gronau), the Netherlands (Almelo) and the US (Eunice, New Mexico). URENCO has contracts with more than 50 nuclear utilities in 19 countries, and supplied 31% of the world market for enriched uranium as of December 2013.

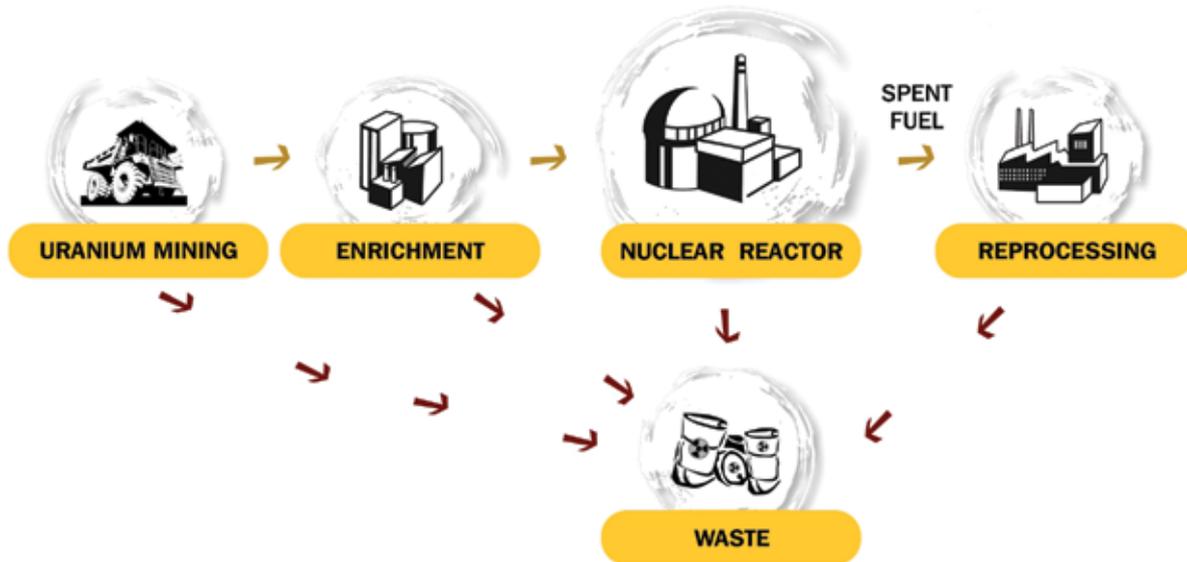
The report raises questions and concerns about a range of issues:

- The viability of some of URENCO's operations because of the excess of global enrichment capacity;
- The lack of transparency surrounding URENCO's activities (for example the origin and destination of nuclear materials processed at URENCO plants);
- The adequacy of nuclear safeguards (URENCO's name will forever be associated with the A.Q. Khan proliferation network);
- Environmental and public health concerns associated with URENCO's routine operations as well as incidents and accidents; and
- URENCO's circumscribed notion of Corporate Social Responsibility, in particular concerns over the long-term management of depleted uranium / uranium hexafluoride.

Plans to privatise URENCO form a backdrop to this report. Privatisation carries with it the risk of a worsening of existing problems such as the lack of transparency, and the risk of URENCO enrichment technology fanning weapons proliferation.

# 1. What is uranium enrichment?

Enrichment means the raising of the concentration of a certain isotope<sup>1</sup> of interest in an element. Although not limited to uranium, the term is mostly used for the enrichment of the isotope U-235 in uranium (see simplified graph of nuclear fuel chain).



Source: Friends of the Earth, Australia

Natural uranium mostly consists of the isotope U-238, while the fissile isotope U-235 that is able to sustain a nuclear chain reaction makes up for only 0.72% of the atoms (or 0.711% of the mass).

The use of natural uranium as a fuel is only possible in certain reactor types, such as Heavy Water Reactors (HWR), graphite moderated reactors (such as the Russian RBMK type), or Gas Cooled Reactors (GCR). However, 88.5% of the current net nuclear generating capacity in the world is from Light Water Reactors (LWR), such as Pressurized Water Reactors (PWR) and Boiling Water Reactors (BWR).<sup>2</sup> In these reactor types, a nuclear chain reaction can only be obtained if the fraction of the fissile isotope U-235 in the uranium fuel is raised from 0.72% to approx. 3% to 5%. The process of raising the fraction of the isotope U-235 in the uranium is called enrichment.

Commercially available enrichment technology is now almost exclusively based on gas centrifuges. In these centrifuges, a gaseous uranium compound (uranium hexafluoride - UF<sub>6</sub>) is exposed to strong gravity fields, separating the lighter from the heavier isotopes. As the enrichment obtained in a single centrifuge is not sufficient, several centrifuges are connected to so-called cascades. In commercial enrichment plants, many such cascades are operated in parallel to obtain the required throughput.

In addition to the stream of enriched uranium, the enrichment process generates a by-product stream of uranium with a concentration of U-235 lower than in natural uranium, the so-called depleted uranium (DU), or tails, with typically 0.2% - 0.3% U-235. The depleted uranium represents more than 85% of the mass output of the enrichment plant.

<sup>1</sup> Isotopes are atoms of the same element (e.g. uranium) that have the same atomic number but different mass numbers (for uranium for instance 233, 235, 238).

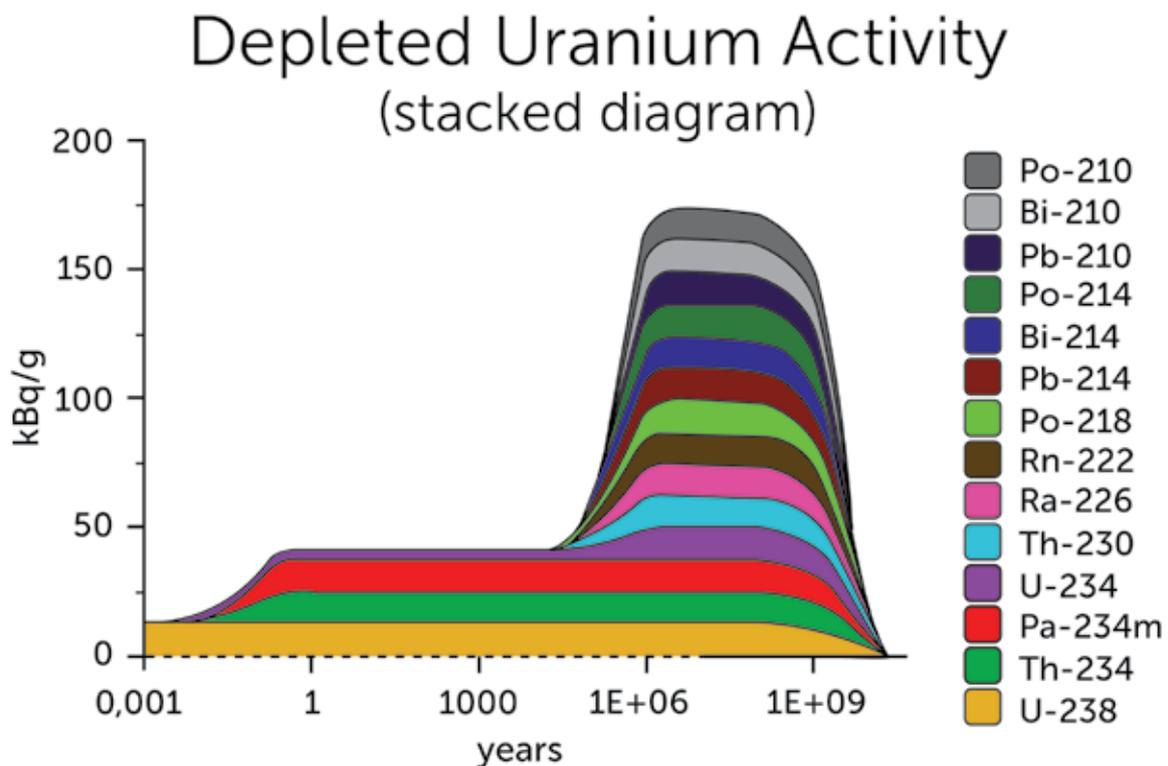
<sup>2</sup> Nuclear Power Reactors in the World, RDS 2-33, IAEA 2013

The depleted uranium hexafluoride also is filled into cylinders, which are then stored in open cylinder yards next to the enrichment plant, awaiting a decision about their further fate. Over the decades, the USA alone has accumulated more than 700,000 t of depleted uranium hexafluoride. Globally, about 1.2 million tonnes of depleted uranium are now stored.<sup>3</sup>

Theoretically, it is possible to reintroduce the depleted uranium hexafluoride into the enrichment plant to extract more of the fissile U-235 still contained. Changes in the economics might make this feasible, such as an increase of uranium prices and/or decrease of enrichment cost - possibly as a result of future technology advances. However, re-enrichment is not very effective as a means to reduce the mass of the stockholdings of depleted uranium, as it turns most of the material into secondary tails.

Ultimately, all depleted uranium that is not re-used must be disposed of. As the tails in the form of UF<sub>6</sub> are not suitable for this, the companies now have begun to deconvert it to the less hazardous oxide form of U<sub>3</sub>O<sub>8</sub>. But there is no such repository in existence yet .

The disposal of depleted uranium presents unprecedented challenges, due to the sheer volume of concentrated alpha radiation-emitting material, and due to the unusual property that it becomes more hazardous with time: radioactivity starts to increase after 50,000 years, reaches its maximum activity after around 2 million years and remains at this level for a billion years.<sup>4</sup>



3 [www.powermag.com/nuclear/Nuclear-Waste-Disposal-Sites-Still-Rare-After-All-These-Years\\_5471.html](http://www.powermag.com/nuclear/Nuclear-Waste-Disposal-Sites-Still-Rare-After-All-These-Years_5471.html)

4 <http://www.wise-uranium.org>, Peter Diehl, January 2014

## 2. General political framework of the EU regarding nuclear energy as well as uranium mining and import

One of the three treaties signed in Rome, Italy, in 1957, establishing the European Economic Community (EEC), was the Treaty to establish the European Atomic Energy Community (Euratom). The general objective of the Treaty is to contribute to the formation and development of Europe's nuclear industries, so that all Member States can "benefit from the development of atomic energy", and to "ensure security of supply". It is important to note that Euratom's powers are limited to civil uses of nuclear energy.

Unlike most of the EEC Treaties, no major changes have ever been made to the Euratom Treaty, which remains in force. The European Atomic Energy Community has not merged with the European Union (EU) and therefore retains a separate legal personality, while sharing the same institutions. The Treaty amending the EU and EC Treaties, which was signed in December 2007, changed certain provisions of the Euratom Treaty via its "Protocol No 12 amending the Treaty establishing the European Atomic Energy Community". These changes are limited to adaptations to take account of the new rules established by the amending Treaty, particularly in the institutional and financial fields.<sup>5</sup>

According to the Treaty, the specific tasks of Euratom are:

- to promote research and ensure the dissemination of technical information
- to establish uniform safety standards to protect the health of workers and of the general public and ensure that they are applied
- to facilitate investment and ensure the establishment of the basic installations necessary for the development of nuclear energy in the EU
- to ensure that all users in the EU receive a regular and equitable supply of ores and nuclear fuels
- to make certain that civil nuclear materials are not diverted to other (particularly military) purposes
- to exercise the right of ownership conferred upon it with respect to special fissile materials
- to establish joint undertakings

The Euratom Treaty establishes two specific bodies: the Safeguards Office (which carries out physical and accounting checks in all nuclear installations in the Community) and the Supply Agency (Article 2(d) and 52 of the Treaty). The Euratom Supply Agency (ESA) ensures a regular and equitable supply of ores, source materials or other fissionable materials to EU users. The main task of the ESA is "to ensure that all users in the EU receive a regular and equitable supply of ores". The ESA Rules set the manner in which demand is to be balanced against supply of ores and source materials.<sup>6</sup> It has "an exclusive right to conclude contracts relating to the supply of ores and source materials coming from inside the EU or from outside".<sup>7</sup>

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5 Treaty establishing the European Atomic Energy Community (Euratom), [http://europa.eu/legislation\\_summaries/institutional\\_affairs/treaties/treaties\\_euratom\\_en.htm](http://europa.eu/legislation_summaries/institutional_affairs/treaties/treaties_euratom_en.htm)

6 Euratom Supply Agency (ESA), Legal Basis, <http://ec.europa.eu/euratom/lb.html>

7 Euratom Supply Agency (ESA), Procedures - Conclusion of supply contracts; <http://ec.europa.eu/euratom/procedures.html>

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

As the market is becoming increasingly complex, the remit of the ESA was widened by the Council Decision of 2 February 2008 amending ESA's statutes which entrusted the Agency with a new task: the creation of a nuclear market observatory. The Nuclear Observatory should provide the Euratom Community with expertise, information and advice on any subject connected with the operation of the market in nuclear materials and services.<sup>8</sup>

But actual factual information about for example purchase of uranium by utilities is very limited. In many reports a Disclaimer says "ESA ensures confidentiality and physical protection of the commercial data."

The Euratom Supply Agency has legal personality and financial autonomy and is under the supervision of the Commission, which issues directives to it and possesses a right of veto over its decisions.<sup>9</sup>

## Mining

The EU mining policy is determined by two Directorates of the European Commission: DG Transport and Energy and DG Enterprise. The first Directorate deals with the energy extractive industry and the second one with the non-energy extractive industry. Mining had been specifically excluded from much of the environmental policy developed by DG Environment. Reviews of relevant legislation show how the mining industry has been favourably treated compared to other industrial sectors.<sup>10</sup>

Council Directive 96/29/Euratom requires that member states shall require prior authorisation in particular for the operation and decommissioning of any facility of the nuclear fuel cycle and exploitation and closure of uranium mining.<sup>11</sup>

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8 [http://ec.europa.eu/euratom/observatory\\_en.html](http://ec.europa.eu/euratom/observatory_en.html)

9 [http://europa.eu/legislation\\_summaries/institutional\\_affairs/treaties/treaties\\_euratom\\_en.htm](http://europa.eu/legislation_summaries/institutional_affairs/treaties/treaties_euratom_en.htm)

10 Amezaga, Jaime M. and Kroll, Adeline, European Union Policies and Mine Water Management. Mine Water and the Environment (2005) 24: Supplementary Material © Springer Verlag 2005: p.3  
[http://link.springer.com/content/esm/art:10.1007/s10230-005-0081-3/file/MediaObjects/10.1007\\_s10230-005-0081-3.pdf](http://link.springer.com/content/esm/art:10.1007/s10230-005-0081-3/file/MediaObjects/10.1007_s10230-005-0081-3.pdf)

11 Final European Atomic Energy Community Report On the implementation of the obligations under the Convention on Nuclear Safety. Commission of the European Communities, Brussels, 1 October 2007: p.18;  
[http://ec.europa.eu/energy/nuclear/legislation/doc/2007\\_4492\\_report\\_en.pdf](http://ec.europa.eu/energy/nuclear/legislation/doc/2007_4492_report_en.pdf)

### 3. History of uranium enrichment market

In the beginning all uranium enrichment was for the production of nuclear weapons. In the 1950's the US expanded their World War II enrichment capacity to three huge diffusion plants with a total capacity of 17 million SWU.<sup>12</sup> The British also constructed diffusion plants for their weapons programmes. The British plant at Capenhurst with a small capacity (400 tSWU)<sup>13</sup> opened in 1953<sup>14</sup> and was dismantled in 1982.<sup>15</sup> The Soviet Union also started a military uranium enrichment program. Export of uranium enrichment services (first exclusively to countries inside the Soviet-bloc) is performed by Tenex (founded in 1963).<sup>16</sup>

In the mid-1950's in the formative years of the EEC, the French proposed that the Community should embark upon an enrichment project. But the US stepped in with an offer Europa "could not refuse" of state-subsidised enrichment from the big US-diffusion factories. By accepting the US offer, collaboration on enrichment technology in EEC was postponed for another 15 years.<sup>17</sup>

#### Breaking the US monopoly

From a virtual monopoly on enrichment services outside the Soviet Bloc throughout the 1960's and most of the 1970's, the US share of foreign demand had diminished to less than 60% by the end of 1982.<sup>18</sup> France was the first country to break the monopoly and signed an agreement with Tenex in March 1971 for the supply of enriched uranium.<sup>19</sup> By 1975, 8.8% of imported enriched uranium in the Euro-9<sup>20</sup> came from the USSR.<sup>21</sup>

The position of the US as the dominant world supplier of EU eroded fast in the 1970's and early 1980's for a number of reasons<sup>22</sup>:

- the perception was important that the US was an unreliable source of enriched uranium fuel, due to closing its order books in 1974 because outstanding contracts exceeded US production capacity (for four years no new orders were accepted).
- as US policy moved toward the Nuclear Nonproliferation Act of 1978, more restrictions were placed on foreign buyers of the enriched uranium

These factors heightened foreign nations' interest in developing their own enrichment facilities.

#### Multinational cooperation

Early in the 1970's, the URENCO company was set up by the Federal Republic of Germany, the United Kingdom and The Netherlands and started construction of their own enrichment capacity. In September 1975 URENCO made its first commercial delivery of enriched uranium. While these deliveries were relatively small and came from pilot

12 The nature of the uranium enrichment industry & Its Implications for Australia, Ed Kaptein, submission to Select Committee on Uranium Resources, Parliament for South-Australia, March 1980

13 tonnes Separative Work Units = a measurement of the effort required to separate isotopes of uranium. The capacity of enrichment plants is measured in tonnes SWU per year (tSWU)

14 Ed Kaptein, p.1

15 <http://nuclearweaponarchive.org/Uk/UKFacility.html>

16 <http://atomenergoprom.ru/en/org/enrich/>, retrieved January 10, 2014

17 Enrichment clubs come on stream, Financial Times, July 19, 1979

18 Uranium Enrichment: Investment Options for the Long Term, October 1983, Congress of the United States; p.15

19 De Tijd, NL, March 16, 1971

20 Euro-9 = Federal Republic of Germany, France, Italy, Netherlands, Belgium, Luxemburg, Ireland, UK and Denmark

21 Supply of the community countries with enriched uranium, Eurostat BP 1907, August 1976

22 Uranium Enrichment: Investment Options for the Long Term, October 1983, Congress of the United States, p.16/17

plants, URENCO gained importance.<sup>23</sup> In 1977, production plants were inaugurated in Almelo, the Netherlands, and Capenhurst, UK.<sup>24</sup> Production at the German Gronau plant started in August 1985.<sup>25</sup>

Eurodif was founded in 1973 as a joint venture between then-five participating partners: Belgium, France, Italy, Spain and Sweden (in 1975 Iran bought Sweden's 10%). In 1979, the Eurodif gas diffusion plant at Tricastin, France, started production and expanded capacity rapidly to 10,800 tSWU a year, and became the world's second largest supplier of enriched uranium.<sup>26</sup> Currently Areva<sup>27</sup> owns in total directly and indirectly a majority of 59.65% of the Eurodif shares.<sup>28</sup>

## Small number of producers

In 1976 only five nations had facilities larger than that of a pilot plant for the enrichment of U-235. These were US, United Kingdom, France, Russia and China. All of their existing plants were built initially for the purpose of fulfilling military objectives. Of the five, only the US and Russia had sufficient capacity beyond its own national needs to sell some enrichment services abroad.<sup>29</sup>

In 1992, global production capacity (actual production was much less, due to chronic overcapacity) was 43,500 tSWU and still concentrated at a very limited number of producers: the US (19,400 tSWU), Soviet Union (10,000), Eurodif (10,800) and URENCO (2,700) held approx. 90% of total capacity. China, Japan and South Africa accounted for most of the other 5%.<sup>30</sup>

At present that situation is more or less the same: a small number of producers dominating the enrichment market. But important changes within those producers and technology have taken place: the US has now totally lost its position as market leader. Further, the long domination of the diffusion plants ended and the rise of centrifuge technology seems unstoppable. Areva closed the diffusion plant permanently on June 7, 2012<sup>31</sup> as replacement capacity at Georges Besse II (centrifuge) reached 1.5 million SWU/yr.<sup>32</sup> And URENCO opened a new centrifuge enrichment production plant in the US<sup>33</sup> which reached a capacity of 2,700 tSWU/yr by the end of June 2013.<sup>34</sup>

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23 Nuclear Engineering International, November 1976 ,p.52-54

24 URENCOcentecnews, n4, November 1977

25 atw, January 1986

26 <http://www.areva.com/EN/operations-800/eurodif-production-natural-uranium-enrichment.html>

27 The French Eurodif share was managed by CEA. A branch of this public research body Commissariat à l'Énergie Atomique (CEA – Atomic Energy Commission), was created to manage all its industrial activities, mainly through the Compagnie Générale des Matières Nucléaires (Cogema – General Company for Nuclear Materials), a private company set up in 1976. In 2001 this merged with Framatome, the nuclear reactor builder, to create the Areva group. Source: Nuclear power, the great illusion. Promises, setbacks and threats, Global Change, October 2008, p. 35

28 Mycle Schneider: Nuclear France Abroad Paris, May 2009, p 20

29 Enrichment Supply and Technology Outside The United States, S. A. Levin & S. Blumkin, Union Carbide Corporation, Nuclear Division, 01-1977

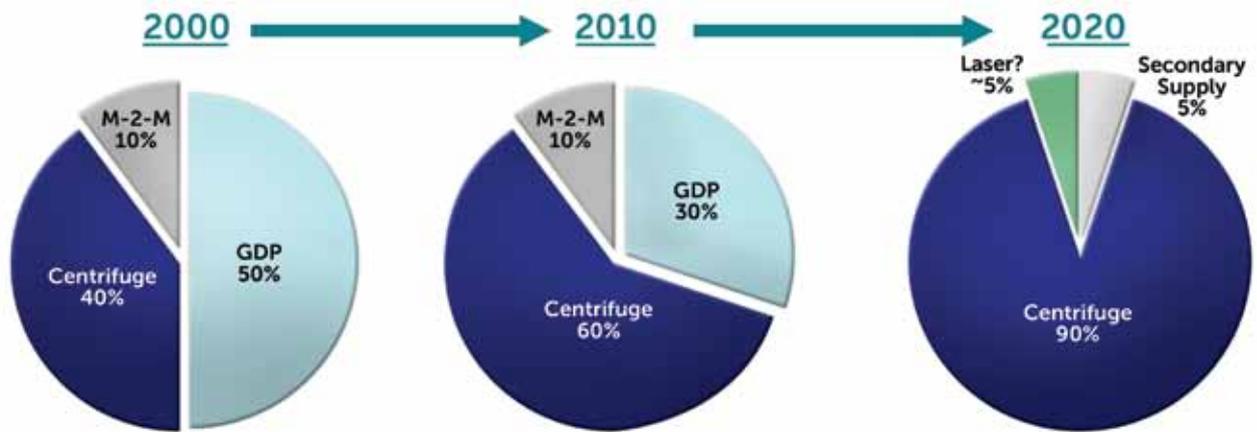
30 Conversie en verrijking van Uranium, presentation drs. H.Rakhorst UCN, KIVI Symposium 9-10-92, except figures URENCO: Jahrbuch der Atomwirtschaft 1993, p.58

31 EURODIF's Uranium Enrichment Plant Ceases Production Permanently, <http://ndreport.com/eurodifs-uranium-enrichment-plant-ceases-production-permanently/>

32 <http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/France/>

33 Building and operating URENCO USA, <http://www.URENCO.com/page/33/URENCO-USA.aspx>

34 URENCO Group – Half - Year 2013 Unaudited Financial Results, <http://www.URENCO.com/page/584/URENCO-Group--Half-Year-2013-Unaudited-Financial-Results.aspx>



**M2M: Megatons to Megawatts program**  
Source: USEC (assuming deployment of planned facilities)

**Table 1: Enrichment capacity end 2013<sup>35</sup> (in tSWU/y)**

Location	Capacity 2013 <sup>36</sup>	2020 (expected) <sup>37</sup>
Russia (total)	26,000 <sup>38</sup>	37,000
USA URENCO	2,700 <sup>39</sup>	5,700
Netherlands URENCO	5,500 <sup>40</sup>	6,200
United Kingdom URENCO	5,000 <sup>41</sup>	5,300
Germany URENCO	4,200 <sup>42</sup>	4,200
France Areva GB II	3,700 <sup>43</sup>	8,200
China	2,500 <sup>44</sup>	8,000
Japan	500 <sup>45</sup>	1,500
Iran	946 <sup>46</sup>	-
USA Global Laser E.	-	3,000
USA Areva	-	3,300
various (Brazil/Pakistan/Iran)	-	1,000
<b>Total</b>	<b>49,659</b>	<b>83,400</b>

<sup>35</sup> Compiled from different sources, Laka Foundation, Jan. 2014

<sup>36</sup> June-December 2013

<sup>37</sup> World Nuclear Association: <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Conversion-Enrichment-and-Fabrication/Uranium-Enrichment/>, update Laka 1-2014

<sup>38</sup> Nuclear Engineering International, October 9, 2013: <http://www.neimagazine.com/features/featuregoodbye-gaseous-diffusion/>

<sup>39</sup> URENCO Group – Half-Year 2013 Unaudited Financial Results, <http://www.URENCO.com/page/584/URENCO-Group--Half-Year-2013-Unaudited-Financial-Results.aspx>

<sup>40</sup> URENCO Group – Half-Year 2013

<sup>41</sup> URENCO Group – Half-Year 2013

<sup>42</sup> URENCO Group – Half-Year 2013

<sup>43</sup> Low Enriched Uranium From France, Daniel W.Klett, Capital Trade Incorporated, September 10, 2013

<sup>44</sup> International Panel on Fissile Materials, Global Fissile Material Report 2013, p.17

<sup>45</sup> IPFM, p.18

<sup>46</sup> WNA

## Overcapacity & Costs

According to Euratom enrichment capacity still exceeds demand. In 2012, the industry put demand for enrichment services at below 50,000 tSWU. However, capacity reached 65,600 tSWU that year. According to the latest – still optimistic – forecasts of growth in nuclear power production, the SWU oversupply situation will not be resolved before 2020 at the earliest.<sup>47</sup>

One of the important reasons for the rapid change towards centrifuge enrichment is the costs: and especially the high power consumption of diffusion compared to centrifuge enrichment. The gaseous diffusion process consumes about 2500 kWh (9000 MJ) per SWU, while modern gas centrifuge plants require only about 50 kWh (180 MJ) per SWU. About 140 tSWU is required to enrich the annual fuel loading for a typical 1000 MWe light water reactor at today's higher enrichment levels.<sup>48</sup>

Enrichment costs per SWU have continuously decreased over the past few years after relatively high prices from 2007-2010. The January 2014 spot price of 1 SWU was about US\$99 (72 euro).<sup>49</sup>

## 4. Advantages, disadvantages and dangers of uranium enrichment<sup>50</sup>

### Advantages:

- The use of enriched rather than natural uranium allows for the use of light water rather than heavy water as a reactor coolant.
- The use of enriched uranium rather than mixed oxide (MOX) avoids all the problems connected to the use of plutonium (higher radiation hazard for workers, proliferation hazard, etc.).

### Disadvantages:

- Current commercial uranium enrichment technologies require the uranium to be in the form of a gas. The uranium compound used for this purpose is uranium hexafluoride (UF<sub>6</sub>). The uranium therefore has to be converted to UF<sub>6</sub> first, and, after enrichment, converted back to an oxide form.
- The enrichment process has a considerable power consumption, although this is now sharply reduced by the replacement of old gaseous diffusion technology with much more efficient gas centrifuges.
- Enriched uranium presents a criticality hazard during transport and manufacturing processes.
- Approximately 30% - 40% of the fissile isotope U-235 remains in the depleted uranium stream, as it cannot be extracted economically.
- The depleted uranium hexafluoride generated in the enrichment process as a by-product has to be managed and ultimately disposed of.
- Enriched uranium presents a proliferation hazard regarding classified centrifuge technology know-how and also concerning the enriched uranium product itself, as the separative work required to enrich a certain amount of reactor-grade uranium further to bomb-grade (> 90% U-235) is lower than that required to produce that reactor-grade uranium from natural uranium in the first place (see World Nuclear Association graph).

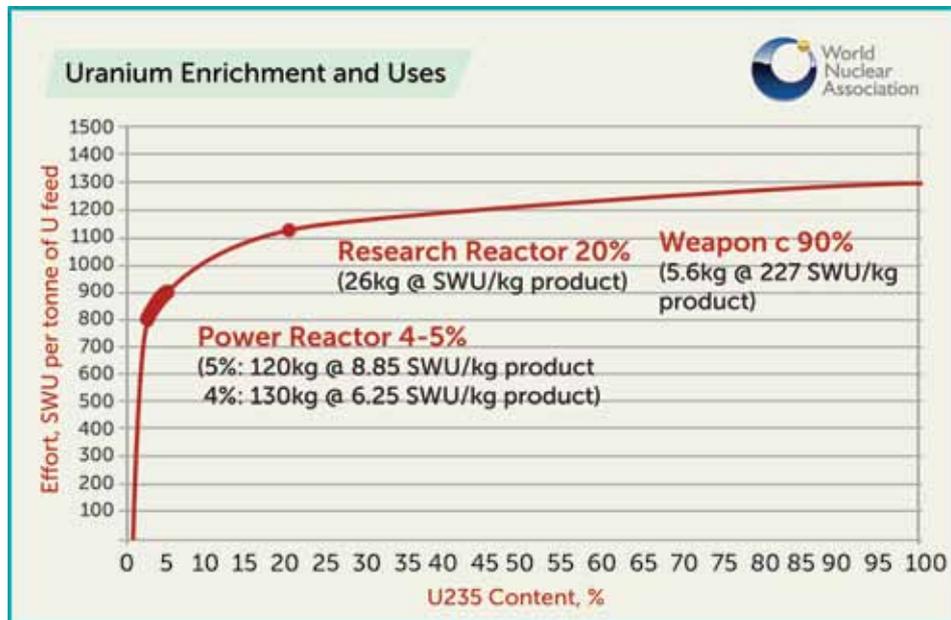
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47 [http://ec.europa.eu/euratom/observatory\\_segments\\_e.html](http://ec.europa.eu/euratom/observatory_segments_e.html)

48 <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Conversion-Enrichment-and-Fabrication/Uranium-Enrichment/>

49 [http://www.uxc.com/review/uxc\\_PriceChart.aspx?chart=spot-swu-full](http://www.uxc.com/review/uxc_PriceChart.aspx?chart=spot-swu-full)

50 [http://www.uxc.com/review/uxc\\_PriceChart.aspx?chart=spot-swu-full](http://www.uxc.com/review/uxc_PriceChart.aspx?chart=spot-swu-full)



### Hazards from normal operation:

- gamma radiation from UF<sub>6</sub> (whether natural, enriched, or depleted).
- neutron radiation from UF<sub>6</sub> (originating from the interaction of the uranium's alpha-radiation with the fluorine in the UF<sub>6</sub>); near cylinders holding enriched uranium, for example, up to 70% of the radiation exposure can be due to neutron radiation.
- high gamma radiation from cylinders containing UF<sub>6</sub> heels (residue left from unloading of cylinder by heating: the radioactive decay products grown in from the uranium do not form gaseous compounds with fluorine and therefore don't sublime, they rather stay in the cylinder, but now are no longer shielded by the uranium), the radiation from a cylinder containing heels is around 100 times higher than that from a full cylinder - the heels thus are responsible for the highest radiation fields encountered in an enrichment plant; the emptied cylinders still containing the radiating UF<sub>6</sub> heels are sent back to the sender for cleaning and reuse.

### Hazards from accidents:

- toxicity hazard from accidental UF<sub>6</sub> releases (contact with water - even atmospheric humidity - leads to formation of corrosive hydrofluoric acid (HF) and toxic uranyl fluoride (UO<sub>2</sub>F<sub>2</sub>)).
- hazard of cylinder rupture, if, for example in a transport accident, a UF<sub>6</sub> cylinder is engulfed in an externally fuelled fire; if the whole contents of a UF<sub>6</sub> cylinder is released during a fire, lethal air concentrations of toxic substances can occur within distances of 500 to 1,000 metres.
- hazard of cylinder rupture, if an overfilled UF<sub>6</sub> feed cylinder is erroneously heated for unloading.
- criticality hazard from enriched uranium (if the amount of enriched uranium present in one location exceeds the critical mass, heavy gamma and neutron radiation bursts from uncontrolled chain reactions can result in lethal radiation doses to persons standing nearby).
- accidents with depleted UF<sub>6</sub> storage in open cylinder yards (leaks caused by corrosion, cylinder manipulation errors, plane).

## 5. The URENCO company

URENCO's principal activity is the provision of a service to enrich uranium to provide fuel for nuclear power utilities. Its enrichment service is mostly provided on a toll basis using customers' uranium. URENCO's shares are ultimately held one-third by the UK government (through Enrichment Investments Limited) one-third by the Dutch government (through Ultra-Centrifuge Nederland Limited), and one-third by German utilities (through Uranit UK Limited, owned by E.ON Kernkraft GmbH and RWE Power AG (both 50%)).<sup>51</sup>

URENCO fulfils its customer requirements through its four operational enrichment plants in the UK (Capenhurst), Germany (Gronau), the Netherlands (Almelo) and the US (Eunice, New Mexico). In the four enrichment facilities a total of 1600 people are employed.<sup>52</sup>

Since 1990 URENCO also utilises its centrifuge technology for medical and industrial purposes through its research unit Stable Isotopes (located in Almelo). Although this is not a major part of URENCO's business in purely financial terms, it is considered by the company to be of great value from commercial, social and environmental perspectives.<sup>53</sup>

Enrichment Technology Company Limited is a joint venture company owned in equal share by URENCO and Areva. ETC, formed in October 2003, has the exclusive responsibility to develop, manufacture, supply and install gas centrifuges.<sup>54</sup> A drop in expected installation of new centrifuge capacity forced the company in October 2012 to announce massive lay-offs: up to two-thirds of worldwide jobs will be lost in the coming years: 1400 of the 2000. For the Almelo plant this means a loss of 240 of total 800 jobs.<sup>55</sup>

### URENCO Netherlands:

Besides the state, initially the following companies invested in URENCO by taking shares: 45% of Ultra Centrifuge Nederland was owned by industry: RSV & VMF Stork 7.5 %; and Philips, Shell and DSM each 10%.<sup>56</sup> After the decision in the late 1970's to enlarge enrichment capacity, necessary to fulfil the giant and much criticised contract with the military regime in Brazil, the industry declined to invest in the company.<sup>57</sup> Departing from the original intention of the government that the companies take over all shares in the long term, the government decided to invest 214 million euro and to give a loan guarantee. This larger financial involvement resulted in a larger state share in 1980: 98.9%.<sup>58</sup> In 2009 the Dutch State bought the remaining 1.1 % shares for 17 million euro from the industry, making it a 100% state company.<sup>59</sup>

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51 Company website,  
[www.urenco.com](http://www.urenco.com), visited December 2013/January 2014

52 URENCO, Annual Report 2012, p4

53 Company website

54 <http://www.urenco.com/page/54/Enrichment-Technology-Company-Limited.aspx>

55 <http://www.rtvost.nl/nieuws/default.aspx?cat=1&nid=172266>

56 Tweede Kamer, zitting 1976-1977, 14 261, nr 2

57 Tweede kamer, zitting 1979-1980, 16 256, A-C

58 Tweede kamer, zitting 1979-1980, 16 256, nr 3

59 Minister van Financien, October 12, 2009: Betreft Uitkoop minderheidsaandeelhouders in Ultra-Centrifuge Nederland N.V. About buying out minority shareholders UCN.

## Privatisation:

Less than four years later, in May 2013, the government published its intention to sell the entire Dutch stake in the URENCO Group.<sup>60</sup>

The main reason to sell the shares in URENCO arises from changes relating to the control and the share ownership of the company. Since it was set up, the Netherlands, the United Kingdom and the German private shareholders have held URENCO's shares indirectly and in equal proportions so that in practice the status quo surrounding the exercise of control over the undertaking has been maintained. But because the German private shareholders RWE and E.ON decided to investigate the sale of their interests in URENCO and since the British government made its desire to sell its shares in URENCO known in April 2013, the Dutch government aired its intent to sell.

Doubts within coalition parties only grew after a round table debate in December 2013. The main argument for selling the Dutch share was the inability to exercise sufficient control to effectively safeguard the public interest. Another possibility surfaced: not selling but buying a majority of shares or even the entire consortium. In its May 2013 letter the cabinet anticipated this possibility and "is of the opinion that acquiring shares in URENCO is not a realistic alternative, in terms of the accompanying budgetary effect alone."<sup>61</sup>

After the round table and a second debate in Parliament in February 2014, a coalition of Socialists and Christian Democrats in the Dutch Parliament tried to convince the government to again investigate the possibility of buying 51% of URENCO's shares. However a majority voted against the proposal in Parliament. In the fall of 2014 the Dutch Government will present a new position paper and proposal to the Parliament.

**Table 2: URENCO SWU production 1976-2013 (in 1000 SWU)**<sup>62</sup>

Year	Total capacity	Annual Production				Total production
		NL	UK	BRD	USA	
1976	75	40	20			60
1980	460	220	190			410
1985	1500	780	480	50		1310
1990	2600	1100	800	400		2300
2000 <sup>63</sup>	4800	1500	1800	1200		4500
2013 <sup>64</sup>	17400	5500	5000	4200	2700	17400

## Customers and market share:

URENCO's capacity reached 17,400 tonnes of separative work per year (tSW/y) at the end of June 2013. URENCO will continue with the capacity expansion programme in order to achieve a capacity of 18,000 tSW/a by 2015.<sup>65</sup>

URENCO Group has contracts with more than 50 utilities in 19 countries<sup>66</sup>, proudly announcing its first contract in the United Arab Emirates.<sup>67</sup> Customer countries are not listed anywhere (let alone a list of customer utilities), however a world map with customer countries is published in the latest Annual Report.<sup>68</sup>

<sup>60</sup> Letter Minister van Financien, May 23, 2013, Intended sale of shares in URENCO. Available in English at: [www.government.nl/files/documents-and-publications/parliamentary-documents/2013/05/23/intended-sale-of-shares-in-URENCO/intended-sale-of-shares-in-URENCO.doc](http://www.government.nl/files/documents-and-publications/parliamentary-documents/2013/05/23/intended-sale-of-shares-in-URENCO/intended-sale-of-shares-in-URENCO.doc)

<sup>61</sup> Letter Minister van Financiën, May 23, 2013

<sup>62</sup> Data for 1976-1990 from URENCO/UCN, Annual Reports 1976-1990

<sup>63</sup> URENCO Annual Report 2000, p 5-7, figures Almelo, Capenhurst, Gronau are estimates of actual production figures

<sup>64</sup> URENCO Group – Half - Year 2013 Unaudited Financial Results, <http://www.URENCO.com/page/584/URENCO-Group--Half-Year-2013-Unaudited-Financial-Results.aspx>

<sup>65</sup> URENCO Group – Half - Year 2013 Unaudited Financial Results

<sup>66</sup> URENCO Annual Report 2012, p. 4

<sup>67</sup> URENCO Annual Report 2012, p. 13

<sup>68</sup> URENCO Annual Report 2012, p. 4

The company's order book extends beyond 2025 and reflects URENCO's global customer base: 46% USA, 37% Europe, 17% Rest of World.<sup>69</sup> Contracts are signed typically for 10 years or more. During 2012, URENCO's market share increased from 29% to 31%.<sup>70</sup>

## Turnover & other financial details

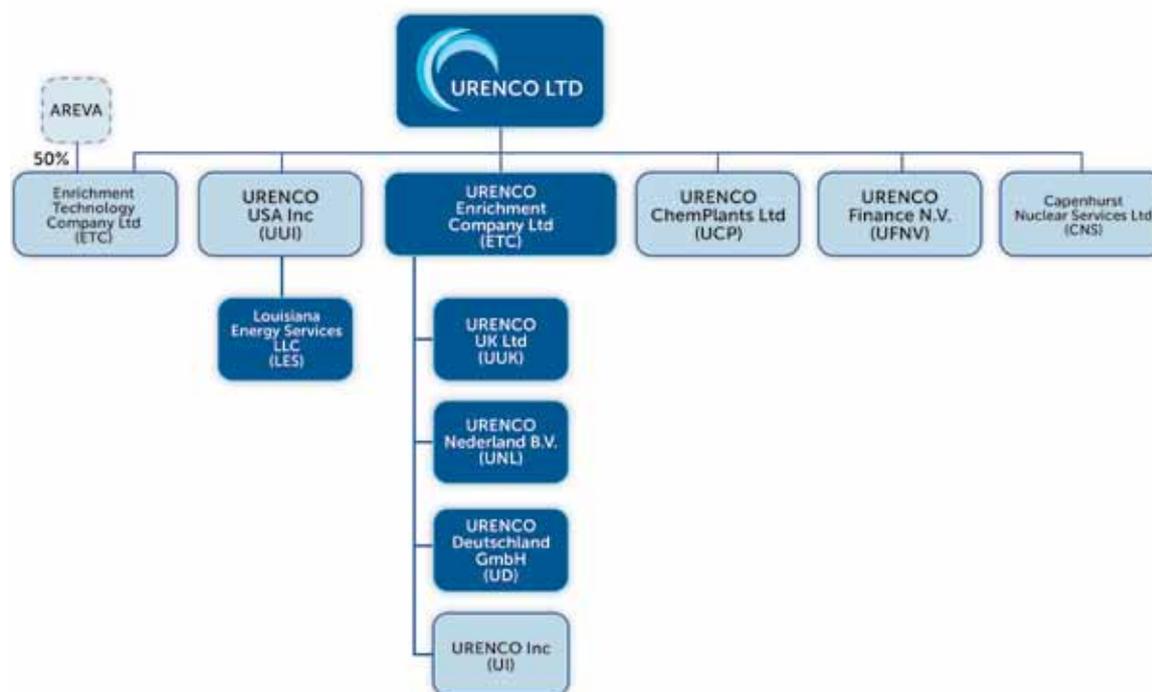
Financial reports are a part of URENCO's Annual Reports. However, URENCO Group does not breakdown financial results per location. No results for the Almelo location are published, this is made possible by an exemption based on Art. 403 of Dutch taxation legislation<sup>71</sup>. Article 403 provides that if the parent company formally declares it is liable for all obligations of its subsidiary, the subsidiary has no obligation to publish financial reports.

The financial results published in the Annual Report of Ultra-Centrifuge Nederland NV, the holding company for the Dutch part, are (except the costs of the holding company) the URENCO Group results divided by three;<sup>72</sup> it has no relationship with the results of the Almelo URENCO plant.

**Table 3: Financial results URENCO**

(million euro)<sup>73</sup>

Year	Turnover	Net income
2000	655.6	100,3
2011	1,302.4	359,1
2012	1,601.4	401,5



(source: URENCO website)

69 URENCO Annual Report 2012, p. 17

70 URENCO Annual Report 2012, p. 2

71 Personal communication Laka Foundation with URENCO Almelo, January 13, 2014.

72 Jaarverslag 2012, UCN NV, May 2013, p.23

73 URENCO Annual Reports 2000, 2012

## 6. Accidents and incidents related to URENCO

Almelo, The Netherlands:

The most well-known 'incident' involving URENCO is the Khan affair. It is now well known that the 'father' of Pakistan's nuclear weapons programme, Abdul Qadeer (AQ) Khan, had his scientific roots in the Netherlands in the 1960's and 1970's. At that time he had access to what was supposed to be highly secret uranium enrichment technology: the URENCO ultra centrifuge project. Thanks to security problems, as well as deliberate and unwitting help from former teachers and colleagues, he was able to build a global nuclear information network and business. From Pakistan, ultracentrifuge technology, knowledge and materials were exported to Libya, Iran and North Korea. A mixture of legal and illegal transactions, involving businessmen from all over the world as well as individuals in the higher circles of the military and political elite in Pakistan, allowed nuclear proliferation to proceed much faster than even those most familiar with the issue expected.<sup>74</sup>

A selection of other incidents concerning URENCO's Almelo plants

- **UF6 truck crashes on A1 motorway in the Netherlands:**  
On May 21, 2003, a British truck carrying UF6 crashed into a Polish truck carrying paraffin on A1 (Amsterdam-Hengelo) near Bathmen, The Netherlands. The UF6 truck was part of a convoy of 12 British trucks hauling uranium hexafluoride from Preston (England) to URENCO's enrichment plants in Almelo (The Netherlands) and Gronau (Germany). The British driver was injured. There was no leakage of UF6.<sup>75</sup>
- **Explosion in centrifuge manufacturing plant at Almelo site:**  
At approx. 22:30 hrs. on July 23, 2008, an explosion occurred at the centrifuge manufacturing plant of URENCO's subsidiary ETC at Almelo. The approx. 25 employees present in the shop evacuated the building without problems.<sup>76</sup>
- **Gas release causes death of two workers from asphyxiation in centrifuge manufacturing plant:**  
Two men died in an accident at the Enrichment Technology Company (ETC) in Almelo. On March 29, 2013, a release of the noble gas argon caused the asphyxiation of two workers; one of them died the same day, the other on April 2. ETC is a joint venture of URENCO with Areva for the development and production of gas centrifuges and the design of complete uranium enrichment plants.<sup>77</sup>
- **Two waste water spills:**  
In 2013, the enrichment plant at Almelo reported two incidents to the Dutch regulatory authorities (Kernfysische Dienst), both incidents (on January 13 and July 27) were spills of wastewater in a working area.<sup>78</sup>

<sup>74</sup> A.Q. Khan, URENCO and the proliferation of nuclear weapons technology. May 2004. Greenpeace.

<http://www.laka.org/info/publicaties/Khan/Khan.pdf>

<sup>75</sup> De Twentsche Courant Tubantia May 21/22, 2003

<sup>76</sup> NU.nl July 24, 2008

<sup>77</sup> Westfälische Nachrichten April 2, 2013

<sup>78</sup> [http://www.ilent.nl/onderwerpen/leefomgeving/nucleair\\_en\\_straling/nucleair/nucleaire\\_installaties/ongewone\\_gebeurtenissen\\_2013/](http://www.ilent.nl/onderwerpen/leefomgeving/nucleair_en_straling/nucleair/nucleaire_installaties/ongewone_gebeurtenissen_2013/), retrieved December 23, 2013)

## A selection of incidents concerning URENCO's Gronau plant

- **Worker exposed to uranium hexafluoride:**  
On Jan. 21, 2010, at 14:32 hrs., a worker at URENCO's Gronau enrichment plant was exposed to uranium hexafluoride, when preparing a transport cylinder for a pressure test. The cylinder had been delivered as "empty and cleansed". The amount of uranium hexafluoride released is unknown, but was only a few grams, according to URENCO's estimates. The worker suffered contamination of his arms and legs and was hospitalised. The contaminated area of the plant was isolated and the contaminated air released via the stack. The release to the environment was equivalent to one sixth of the permissible weekly amount. The environmental monitoring around the plant detected no unusual features.<sup>79</sup>
- **Small release of uranium hexafluoride:**  
On July 23, 2011, a small release of uranium hexafluoride occurred in an autoclave in the Gronau enrichment plant. UF<sub>6</sub> concentrations in room air remained below acceptable limits.<sup>80</sup>
- **Smouldering fire in switchbox:**  
On June 7, 2012, a smouldering fire occurred in a switchbox at the Gronau enrichment plant. The fire was automatically detected and extinguished. According to URENCO, the switchbox was implemented in multiple instances, allowing for a continued safe operation of the plant. No risks were expected for the employees or the environment, as there was no radioactivity present in the area concerned.<sup>81</sup>
- **Fire on board of vessel Atlantic Cartier in Hamburg port - UF<sub>6</sub> heels in the hold:**  
In the late evening of May 1, 2013, fire broke out on the lower decks of the vessel Atlantic Cartier, while berthed in the Hamburg port (Germany). The shipment comprised 4 cylinders of type 30B containing a total of 40 kg of UF<sub>6</sub> heels from enriched UF<sub>6</sub>, sent from Areva Richland, Washington, USA, to URENCO Almelo in the Netherlands.<sup>82</sup>

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79 North Rhine-Westphalia Ministry of Economics, January 22, 2010

80 Ministerium Bauen und Verkehr des Landes Nordrhein-Westfalen, July 25, 2011

81 Westfälische Nachrichten, June 8, 2012

82 Advance Notification of Export Shipment, RSB Logistic, March 14, 2013, NRC ADAMS Acc. No. ML13214A187

## A selection of incidents concerning URENCO's Capenhurst plant

- **Three safety related equipment items found out of operation, after URENCO forgets maintenance:**  
URENCO UK Limited - Capenhurst reported on 17th December 2009 that during a periodic review of the Plant Maintenance schedule, the licensee identified that some safety related equipment items had not been placed on to the Plant Maintenance Schedule; some since 2005. This potential shortfall related to extensions to the latest enrichment facility, which was actively commissioned over the period 2005 to 2009. Consequently, affected safety related equipment items may not have been maintained in accordance with the plant safety case. Urgent checks were made of the safety related equipment items, three were found to be out of operation but of low safety significance, and were promptly repaired.<sup>83</sup>
- **Unexpected enhanced site perimeter radiation levels detected:**  
In late 2008 and subsequently confirmed in 2009, some unexpectedly enhanced levels of radiation were measured, at the boundary of the URENCO UK Limited licensed site, at levels still well below any regulatory limits, but nevertheless warranting further investigation.<sup>84</sup>
- **Leakage of radioactive liquor:**  
Sellafield Limited - Capenhurst Works reported on 24 July 2009 the leakage of radioactive liquor from one of the uranium hexafluoride ("Hex Tails") cylinders, currently stored inside a building. The leak was discovered during routine plant surveillance. The hole in the leaking cylinder was promptly sealed by the site fire brigade.<sup>85</sup>
- **Fire at URENCO's Capenhurst enrichment plant:**  
A nuclear scare was triggered at URENCO when a fire started in a non radiologically contaminated solvent degreaser tank, located within a pump maintenance workshop. The non-radioactive degreaser solvent fire led to evacuation of the enrichment facility control room for about an hour. The proximity of the fire to radioactive uranium meant a carefully prepared action plan was set in motion. Firefighters wearing breathing apparatus and staff from the plant put the fire out using a CO<sub>2</sub> extinguisher. There were no injuries to personnel and the public were not affected. Monitoring of the perimeter of the site confirmed that there was 'no significant release of radioactive material'.<sup>86</sup>

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83 HSE Office for Nuclear Regulation: Quarterly statement of nuclear incidents at nuclear installations; 2010, 1st Quarter

84 NII site inspector's quarterly report to the local stakeholder group for 1st October to 31 December 2009, Jan. 25, 2010

85 HSE Office for Nuclear Regulation: Quarterly statement of nuclear incidents at nuclear installations; 2009, 4th Quarter

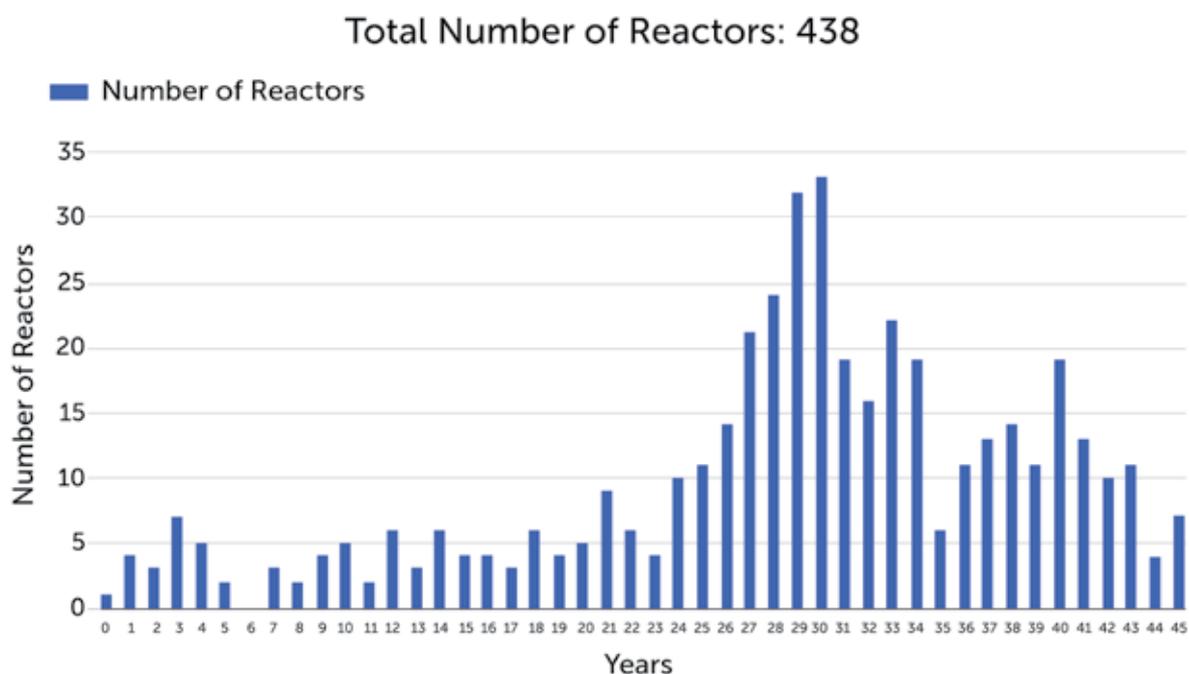
86 HSE Office for Nuclear Regulation: Quarterly statement of nuclear incidents at nuclear installations; 2012, 1st Quarter

## 7. Future perspective of URENCO and the uranium enrichment market

Gas centrifuge is the winner on the global uranium market but the transfer from gaseous diffusion to centrifuge enrichment technology is now complete with the June 2013 shut down of the last large diffusion plant at Paducah in the US. With a market share of 31 % URENCO is the second largest producer (after Tenex).

Despite the closure of the Paducah Gaseous Diffusion Plant, the enrichment market remains over-supplied by around 12% in 2013. It is estimated that 85% of 2020 requirements are already contracted.<sup>87</sup>

The commercial outlook for URENCO depends on many factors, of which the expected capacity increase of nuclear power is the most important. According to IAEA 71 nuclear reactors are under construction, about 40% of those in China.<sup>88</sup> However, many of the reactors outside China have been under construction for 10 or more years,<sup>89</sup> and it is unlikely that all those reactors will actually come online. The large majority of the existing nuclear reactor fleet is between 27 and 34 years old (see table),<sup>90</sup> with 15% (64 reactors) 40 years or older.



87 Nuclear Engineering International, October 9, 2013

88 PRIS, <http://www.iaea.org/PRIS/WorldStatistics/UnderConstructionReactorsByCountry.aspx> retrieved January 14, 2014

89 Nuclear Power Status Report 2013, Annex7, p.137

90 <http://www.iaea.org/PRIS/WorldStatistics/OperationalByAge.aspx> (status January 2014)

Despite very optimistic reports about hundreds of reactors planned (e.g. the World Nuclear Association lists 45 countries -which do not currently have it- actively considering embarking upon nuclear power programs)<sup>91</sup> this has to be seen. Due to the financial crisis many firmly planned units have been cancelled (e.g. Borssele 2 -and 3- in The Netherlands) or delayed. In the past year in the US even operating reactors have been closed due to financial reasons.<sup>92</sup>

Scenarios for the year 2030 have been published by the World Nuclear Association (2030: high 700GW)<sup>93</sup> the IAEA (2030: low 435 GW; high 722 GW)<sup>94</sup> and the IEA (2035: 580 GW)<sup>95</sup>. The figures vary between roughly 300 and 750 GW. Given the many years usually required from planning to implementation and actual operation, doubling the installed capacity in the next 17 years is not very realistic. Therefore it is very likely that the existing trend (no growth of total installed nuclear capacity) will continue in the coming years.

**Table 4: Installed nuclear capacity 1960-2013**<sup>96</sup>

Year	Number of reactors	Total capacity MW (e)
1960	15	1087
1970	84	17656
1980	245	133037
1990	416	318253
2000	435	349999
2010	441	375277
2014	438	374332

In addition, China's apparent plan to rapidly increase enrichment capacity by utilizing indigenous centrifuge technology must be considered. China's enrichment capacity is expected to mainly cover domestic needs until 2030, although there is currently already some modest export to Western-Europe and US<sup>97</sup>. But, it is foreseeable that in the region with the largest growing nuclear power capacity the increase of enrichment capacity will be highest too. This leaves no or only minor market opportunities for URENCO in those regions.

91 <http://www.world-nuclear.org/info/Country-Profiles/Others/Emerging-Nuclear-Energy-Countries/>

92 Laka Foundation: Golf van sluitingen kerncentrales VS, Kernenergienieuws, 30 August 2013

93 <http://www.nei.org/News-Media/News/News-Archives/Uranium-Supply-Will-Meet-Demand-Beyond-2030,-WNA-S?feed=News>

94 [http://www.iaea.org/OurWork/ST/NE/Pess/assets/rds1-33\\_web.pdf](http://www.iaea.org/OurWork/ST/NE/Pess/assets/rds1-33_web.pdf) p.17

95 <http://www.platts.com/latest-news/electric-power/london/iea-cuts-global-forecast-for-growth-in-nuclear-8903116>

96 IAEA; Nuclear Reactors in the World, Edition 2013

97 Nuclear Engineering International, October 9, 2013

Factors which will also influence the future of enrichment, but difficult to predict, are the use of thorium and plutonium (MOX) as fuel.

The conclusion of the above considerations should be that it is difficult to forecast the future of nuclear energy and the profitability of URENCO in 2025 or 2050. As shown by the downsizing of the centrifuge production plant ETC<sup>98</sup>, the market stagnates, with almost no orders after 2025. Consolidating its current market share (31%) seems likely, although the total volume of the future market is unknown.

One important factor for the commercial outlook of URENCO is innovation in enrichment technology. The only technology that will probably be able to compete with centrifuge enrichment is laser-technology. But, like nuclear fusion, the expectations of laser-enrichment are already many decades old and it never lived up to its expectations.

## Laser-enrichment

Many sources expect laser-enrichment being the only technology capable of endangering the domination of gas centrifuge technology in the global enrichment market. However, laser-enrichment was seen as very promising way back in the 1970's when it was expected to replace gas diffusion technology. Many countries have done research on laser enrichment, but the technology is still not commercially viable. USEC suspended work on AVLIS (Atomic Vapour Laser Isotope Separation) in 1999 having spent US\$ 1.9 billion<sup>99</sup>. In 2003 France's Commissariat à l'Energie Atomique (CEA) ended research into laser enrichment too, having spent over 1 billion euro on the project<sup>100</sup>. However, the Australian SILEX (Separation of Isotopes by Laser Excitation) technology is now looking most promising (although USEC stopped funding that in 2003 too)<sup>101</sup>. Global Laser Enrichment -owned by GE (51%), Hitachi (25%) and Cameco (24%)<sup>102</sup> - already has a licence to construct and operate a commercial uranium enrichment plant using SILEX technology in the US<sup>103</sup>. However, actual construction of a full scale commercial laser enrichment plant is still a long way ahead.

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98 <http://www.rtvost.nl/nieuws/default.aspx?cat=1&nid=172266>

99 US Enrichment Corp shuts down AVLIS; LaserFocusWorld, August 1, 1999; available at: <http://www.laserfocusworld.com/articles/print/volume-35/issue-8/departments/washington-report/us-enrichment-corp-shuts-down-avlis.html>

100 Nuclear Fuel, January 19, 2004

101 USEC Ends Funding of Research on SILEX Process; USEC News, April 30, 2003, <http://www.usec.com/news/usec-ends-funding-research-silex-process>

102 Silex: Uranium Enrichment Update, April 4, 2013; <http://www.silex.com.au/downloads/asxannouncements/uranium-enrichment-update-4-april-2013>

103 World Nuclear News, February 26, 2013

## 8. URENCO: customers, contracts and secrecy

It is very hard to track down from which mine the uranium used in a specific nuclear power plant is coming from. Or, the other way around, in which nuclear power plants the uranium mined in a specific mine is ending up as fuel. Information is scarce and scattered. Companies do not disclose this information, nor do governments. In most cases it is also almost impossible to track down the origins of the uranium enriched in a certain enrichment plant comes from. We will describe why that is the case and give examples of the failure and/or the unwillingness to disclose information by the URENCO governments.

### Movement and ownership

The utilities running nuclear plants purchase the uranium ore concentrate directly from the uranium mining companies. There exists no official uranium market place: for long-term contracts, the utility concludes an agreement with a miner to purchase certain amounts of uranium in regular delivery batches over a certain time period, while for short-term requirements, the utility invites tenders from a number of providers and buys the batch from a provider of its choice.

Due to the lack of a market place, there also is no official price quotation for uranium. The uranium price figures presented by UxC, TradeTech, and others, are based on polls sent out to the parties involved in recent purchasing contracts.

The utility then contracts conversion, enrichment, and fuel fabrication services for its uranium batch with the respective providers of such services (e.g. URENCO for enrichment).

Enrichment contracts usually transfer the ownership of the depleted uranium generated in the process to the enrichment company.

The details of all these contracts are subject to trade secret and thus are not public. For the European Union, the Euratom Supply Agency (ESA) collects all relevant information, but will not release it.

All uranium imported into the European Union is officially “owned” by the Euratom Supply Agency (ESA).

Most uranium trade is subject to IAEA safeguards; additional restrictions may apply, such as:

- further safeguards obligations imposed by the governments of uranium-producing countries (in particular Australia and Canada)
- Nuclear Suppliers Group (NSG) policy (e.g. ban for nuclear trade with NPT non-signatory India, lifted in 2008)
- Euratom Supply Agency (ESA) policies (e.g. diversification of sources of supply)

## Confidentiality of the supply contracts

Transparency is very limited, even when governments reply to parliamentary questions the common answer is that data is commercial and will not be disclosed. Or, as put by the UK Secretary of State for Energy and Climate Change Mr Kidney in April 2010, “prohibitively expensive”.<sup>104</sup>

## German government also throws a cloak of secrecy over uranium imports.

In 2011, in a reply to a parliamentary question, the German government has government refused to disclose the origin countries of the uranium used in Germany's nuclear power plants.<sup>105</sup>

In the same reply to parliamentary questions the German government said it cannot disclose the origin of uranium enriched at the URENCO Gronau plant, because of

- a. the bilateral agreements between Euratom (Supply Agency) and third-countries (e.g. Australia, Canada, South Africa); and
- b. confidentiality of the private supply contracts of the utilities.<sup>106</sup>

In the reply to a follow up parliamentary question, the German government explained that the origin of the uranium could not be disclosed due to the confidentiality of the supply contracts.<sup>107</sup>

## The Netherlands

In the late 1970's, in a period that the possible import of uranium from Namibia (occupied by South Africa) was an issue in mainstream media, the government denied access to data about the origin of the uranium used in Dutch reactors. Answering parliamentary questions the Dutch minister of Economic Affairs replied on December 1, 1977 said that “for economic considerations, the origin of uranium purchased by NV SEP cannot be communicated”.<sup>108</sup> In the same response the minister explicitly claims that the Dutch government has no power to determine the origin of the uranium offered to URENCO for enrichment.<sup>109</sup>

In July 1979 the Dutch government refused to try to change the Treaty of Almelo in a way that customers had to disclose the origin of the uranium offered for enrichment.

## Available data: ESA and EIA reports

How difficult it is to find exact data is may be best symbolised by the official disclaimer, printed in most of Euratom Supply Agency's documents: “ESA ensures confidentiality and physical protection of the commercial data”. However, there is data published by the Euratom Supply Agency as well as the US Energy Information Agency, but only in very general terms.

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<sup>104</sup> Daily Hansard - Written Answers 6 Apr 2010 : Column 1229W

<sup>105</sup> Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten Ute Koczzy, Sylvia Kotting-Uhl, Hans-Josef Fell, weiterer

Abgeordneter und der Fraktion BÜNDNIS 90/DIE GRÜNEN – Drucksache 17/5858 – Herkunft des Urans in deutschen Atomkraftwerken, Deutscher Bundestag, Drucksache 17/6037; June 1, 2011

<sup>106</sup> Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten – Drucksache 17/5858; Question 21

<sup>107</sup> Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten Niema Movassat, Jan van Aken, Sevim Dagdelen, weiterer Abgeordneter und der Fraktion DIE LINKE – Drucksache 17/6165 – Menschenrechtsverletzungen und Umweltzerstörung durch Uranabbau in Niger, Deutscher Bundestag, Drucksache 17/6310; June 26, 2011

<sup>108</sup> Tweede Kamer, zitting 1977-1978, Aanhangels, Answer to question nr. 372; December 1, 1977

<sup>109</sup> Tweede Kamer, zitting 1978-1979, Aanhangsel, Answer to question nr. 1617; July 20, 1979

In 2012, demand for natural uranium in the EU represented approximately one third of global uranium requirements. EU utilities purchased a total of 18 639 tU in 127 deliveries under long-term and spot contracts, 807 tU or 4.5% more than in 2011.

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

Russia and Canada were the top two countries delivering natural uranium to the EU in 2012, providing 44% of the total. Uranium originating in Russia (including purchases of natural uranium contained in EUP) represented the largest proportion, with 5 102 tU or 27% of total deliveries, which was 13% up on 2011. It was followed by uranium of Canadian origin, with a 17% share or 3 212 tU, a year-on-year decline of 3%. In third place, uranium mined in Niger amounted to 2 376 tU or 13%, a strong 38% increase over 2011. Australia and Kazakhstan accounted for 12% each in 2012, an increase of 28% and a 15% decrease, respectively.<sup>110</sup>

A breakdown of ESA imports of natural uranium is shown in Table 5.

The other publicly available data is from the US (the US Energy Information Administration). In 2012 17% of the  $U_3O_8$ <sup>111</sup> delivered in 2012 to owners and operators of US civilian nuclear power reactors, was US-origin uranium. Australian-origin and Canadian-origin uranium together accounted for 35% of the 58 million pounds. Uranium originating in Kazakhstan, Russia and Uzbekistan accounted for 29% and the remaining 19% originated from Brazil, China, Malawi, Namibia, Niger, South Africa, and Ukraine. Owners and operators of US civilian nuclear power reactors purchased uranium for 2012 deliveries from 32 sellers, the same number as in 2011.<sup>112</sup>

For a breakdown of uranium purchased by owners and operators of US civilian nuclear power reactors by origin country see **Table 6**.

The physical movement of the uranium is as follows

What happens with uranium when it is mined? Which transports are needed before the uranium can be used in a nuclear reactor?

1. from the mine to the contracted conversion plant (as uranium ore concentrate in 200-litre-drums), then
2. to the contracted enrichment plant (as UF<sub>6</sub> in type 48Y cylinders), then
3. to the contracted fuel fabrication plant (as enriched UF<sub>6</sub> in type 30B cylinders), and finally
4. to the nuclear power plant for which it is intended (as enriched UO<sub>2</sub> in fuel elements).

**Additional transports are required:**

- where conversion is performed in subsequent process steps at different locations, such as Malvésí (U<sub>3</sub>O<sub>8</sub> to UF<sub>4</sub>) and Pierrelatte (UF<sub>4</sub> to UF<sub>6</sub>) in France, or Blind River (U<sub>3</sub>O<sub>8</sub> to UO<sub>3</sub>) and Port Hope (UO<sub>3</sub> to UF<sub>6</sub>) in Ontario, Canada,
- if the deconversion of the enriched UF<sub>6</sub> to UO<sub>2</sub> is not performed at the location of the fuel fabrication plant,

<sup>110</sup> [http://ec.europa.eu/euratom/observatory\\_segments.html](http://ec.europa.eu/euratom/observatory_segments.html), retrieved January 13, 2014

<sup>111</sup> Uranium quantities are expressed in the unit of measure U<sub>3</sub>O<sub>8</sub>e (equivalent). U<sub>3</sub>O<sub>8</sub>e is uranium oxide (or uranium concentrate) and the equivalent uranium-component of hexafluoride (UF<sub>6</sub>) and enriched uranium

<sup>112</sup> Uranium purchases and price, <http://www.eia.gov/uranium/marketing/#1>

- to return the “empty” but strongly radiating  $^{48}\text{Y}$  and  $^{30}\text{B}$  cylinders with UF<sub>6</sub> heels to the respective originating plants, where they are cleaned and reused,
- to send the depleted UF<sub>6</sub> from the enrichment plant to a deconversion plant (e.g. Usine W in Tricastin, France) to process it into the less problematic oxide form of U<sub>3</sub>O<sub>8</sub>, and then back to the originating enrichment plant, or on to some designated storage facility (e.g. Bessines in France, COVRA Vlissingen in the Netherlands) or disposal site.

While there are only a limited number of nuclear facilities, uranium is transported often over extremely long distances, as can be seen from the Koeberg-fuel example.<sup>113</sup>

**Box 1: The example of Koeberg Nuclear Power Plant, South Africa:**

- uranium mined in Namibia (so, either Rössing or Langer Heinrich)
- conversion to UF<sub>6</sub>: location unknown, but likely at Areva's Malvési and Pierrelatte plants, France
- enriched in the European Union (so, either Areva's Georges Besse II Tricastin plant in France, or one of URENCO's plants in the UK, The Netherlands, or Germany)
- production of fuel pellets at Areva's Richland plant, Washington, USA
- fabrication into fuel rods at Areva's ANF Lingen plant, Germany
- fabrication into fuel assemblies at Areva's FBFC Romans plant, France

For some of these transports, information is available in the public domain, in particular for cross-boundary shipments to and from the USA, where details are released by the Nuclear Regulatory Commission (NRC) some months after the transport has reached its destination; however, information about the mine of origin is only given for transports of uranium ore concentrate (if at all). As URENCO provides enrichment services, only the conversion plant of origin, or the fuel fabrication plant destined for further processing, respectively, can be identified for material processed at URENCO, if at all. For UF<sub>6</sub> export shipments from the USA, the country of origin of the uranium ore concentrate (from which the UF<sub>6</sub> was produced) can in some cases be tracked down in the applicable export licence, but often there is quite a number of possible origin countries listed.

In some cases, information is available for transports through certain ports (e.g. Hamburg and Bremen in Germany, as obtained from the state governments in response to parliamentary questions).

## The example of Borssele nuclear power plant

EPZ, the operator of the Borssele nuclear power plant, discloses the origin of the uranium it uses on its website:<sup>114</sup>

- 2000 - 2002 and 2004 - Re-enriched tails
- 2003 and 2007 - Reprocessed uranium and ex-military high enriched uranium
- 2005, 2006 and 2008 - 2011 - Kazakhstan
- 2012 - Reprocessed uranium and ex-military high enriched uranium

However, the origin of the re-enriched tails are unknown. In the 2011 Annual Report, EPZ announced a new enrichment contract “for the coming years” (no exact period is mentioned) with URENCO. The origin of the uranium enriched at URENCO, is Canada (no mine or mining company is mentioned).<sup>115</sup>

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<sup>113</sup> A December 2013 NRC-document sheds some light on where the fuel for the Koeberg NPP comes from: <http://pbadupws.nrc.gov/docs/ML1334/ML13345A552.pdf>

<sup>114</sup> <http://epz.nl/kernenergie/hoe-werkt-de-kerncentrale/de-brandstof/de-oorsprong-van-epzs-uranium>

<sup>115</sup> EPZ, Jaarverslag 2011 (Annual Report), p.17

Table 5: Purchase of Natural Uranium by EU utilities by origin, 1992-2012 (tU<sub>3</sub>O<sub>8</sub>)

Purchases of Natural Uranium by EU utilities by origin, 1992-2012 (tU)																						
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Russia	1.753	1.720	1.730	4.304	5.314	3.880	3.816	3.473	4.235	2.849	3.931	3.400	2.391	1.788	3.984	5.144	3.272	3.599	4.979	4.524	5.102	
Other CIS	0	0	1.964	674	758	446	720	1.245	1.273	1.035	2.052	1.059	481	1.246	1.057	1.618	2.143	2.195	3.275	3.871	2.414	
Australia	570	570	739	1.139	1.326	1.875	1.284	1.410	1.313	1.168	1.442	2.695	2.443	3.065	3.053	3.209	2.992	3.801	2.153	1.777	2.280	
Niger + Gabon (*)	2.900	3.796	2.737	4.205	3.686	4.328	4.834	2.348	2.810	2.085	1.806	2.396	2.746	2.390	3.355	3.531	1.845	1.854	2.082	1.726	2.376	
Canada	1.991	1.099	1.404	2.383	2.188	1.701	1.014	2.256	2.980	3.496	3.954	3.229	3.274	4.998	5.093	3.786	4.757	3.286	2.012	3.318	3.212	
South Africa + Namibia	1.204	1.515	564	643	644	1.104	1.515	1.243	1.706	1.325	1.422	604	1.080	951	978	1.003	944	860	1.207	1.124	1.762	
EU	2.285	2.061	1.985	1.420	1.547	1.473	978	705	63	647	680	298	129	5	472	526	515	480	556	455	421	
Heu feed	0	0	0	0	0	0	0	0	0	0	0	1.348	800	1.407	850	825	550	675	550	731	395	
Other + undetermined	1.035	1.554	2.829	1.286	615	731	1.807	1.254	1.044	295	583	433	373	529	1.336	432	520	329	432	128	256	
USA	0	0	0	0	0	0	0	0	0	0	0	0	0	757	488	402	398	318	320	180	241	
Malawi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	
Re-enriched tails	0	0	0	0	0	100	100	826	425	1.031	1.007	958	925	474	728	388	688	193	0	0	0	0
<b>Total</b>	<b>11.738</b>	<b>12.315</b>	<b>13.952</b>	<b>16.054</b>	<b>16.078</b>	<b>15.638</b>	<b>16.068</b>	<b>14.760</b>	<b>15.849</b>	<b>13.931</b>	<b>16.877</b>	<b>16.420</b>	<b>14.642</b>	<b>17.610</b>	<b>21.394</b>	<b>20.864</b>	<b>18.622</b>	<b>17.591</b>	<b>17.566</b>	<b>17.832</b>	<b>18.639</b>	

Source: Euratom Supply Agency

Disclaimer: the statistics and data analysis provided by ESA are for information purposes only. ESA does not bear legal liability for making use of them. ESA ensures confidentiality and physical protection of the commercial data.

(\*) Gabon has ceased uranium production since 1999.

Table 6: Uranium purchased by owners and operators of US civilian nuclear power reactors by origin country and delivery year, 2008-2012.  
(thousand pounds U<sub>3</sub>O<sub>8</sub> equivalent; dollars per pound U<sub>3</sub>O<sub>8</sub> equivalent) (1 pound -lbs- = 0.4536 kg)

Origin Country	Deliveries in 2008			Deliveries in 2009			Deliveries in 2010			Deliveries in 2011			Deliveries in 2012		
	Purchases	Average Price	Weighted-Average Price												
Australia	12,758	41.59	W	11,164	52.25	W	7,112	51.35	W	6,001	57.47	W	6,724	51.17	W
Brazil	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Canada	9,791	48.72	W	8,975	42.25	W	10,238	50.35	W	10,832	56.08	W	13,584	56.75	W
China	0	--	--	0	--	--	0	--	--	0	--	--	0	--	--
Czech Republic	W	W	W	W	W	W	W	W	W	0	--	0	0	--	--
Germany	0	--	--	0	--	--	W	W	W	0	--	0	0	--	--
Hungary	0	--	--	0	--	--	W	W	W	0	--	0	0	--	--
Kazakhstan	3,818	60.61	W	4,985	43.41	W	6,830	47.81	W	9,728	53.71	W	6,234	51.69	W
Malawi	0	--	--	0	--	--	W	W	W	780	65.44	W	W	W	W
Namibia	3,880	54.79	W	5,732	47.30	W	4,913	47.90	W	6,199	56.74	W	5,986	54.56	W
Niger	W	W	W	2,001	47.55	W	587	49.00	W	1,744	54.38	W	2,133	50.45	W
Russia	12,080	27.64	W	7,938	37.98	W	10,544	50.28	W	10,199	56.57	W	7,643	54.40	W
South Africa	783	27.50	W	W	W	W	W	W	W	1,524	53.62	W	1,243	56.45	W
Ukraine	0	--	--	0	--	--	W	W	W	W	W	W	W	W	W
United Kingdom	W	W	W	0	--	--	0	--	--	0	--	--	0	--	--
Uzbekistan	1,923	56.06	W	1,424	46.65	W	1,865	48.57	W	1,808	55.99	W	2,576	52.80	W
<b>Foreign Total</b>	<b>45,633</b>	<b>43.47</b>	<b>W</b>	<b>42,777</b>	<b>45.35</b>	<b>W</b>	<b>42,895</b>	<b>49.64</b>	<b>W</b>	<b>49,626</b>	<b>55.98</b>	<b>W</b>	<b>47,713</b>	<b>54.07</b>	<b>W</b>
United States	7,720	59.55	W	7,053	48.92	W	3,687	45.25	W	5,205	52.12	W	9,807	59.44	W
<b>Total Purchases</b>	<b>53,353</b>	<b>45.88</b>	<b>W</b>	<b>49,830</b>	<b>45.86</b>	<b>W</b>	<b>46,582</b>	<b>49.29</b>	<b>W</b>	<b>54,831</b>	<b>55.64</b>	<b>W</b>	<b>57,520</b>	<b>54.99</b>	<b>W</b>

W = Data withheld to avoid disclosure of individual company data. -- = Not applicable.  
Notes: Totals may not equal sum of components because of independent rounding. Weighted-average prices are not adjusted for inflation.  
Source: U.S. Energy Information Administration: Form EIA-858 "Uranium Marketing Annual Survey" (2008-2012).

## 9. URENCO's Corporate Social Responsibility

Companies are required by law to report on a wide range of aspects related to the financial performance of their operations. Reporting on non-financial aspects (such as social and environmental impacts) of corporate activity, on the other hand, is largely left to voluntary initiatives and 'soft law' guidelines and recommendations.

URENCO's website states that the company "understands that it cannot act in isolation of its local community. The company must take responsibility for the outcome of its operations by understanding how it impacts on neighbouring communities and how it can make a positive contribution."

All employees are made aware of clear codes of conduct, including anti-bribery and corruption policy and the (zero-tolerance) consequences of its implementation and key requirements. URENCO also has a whistle blowing policy in place which provides all employees with a route to report any concerns regarding fraud, corruption or professional misconduct.<sup>116</sup>

One of the corporate responsibilities URENCO mentions specifically is sustainability. The company's 2012 Sustainability Report starts as follows: "Acting responsibly throughout our business and endeavouring to be a good corporate citizen is a critical aspect of our leadership in the industry.". The SR 2012 has been created in line with the Global Reporting Initiative (GRI) and URENCO commissioned DNV Two Tomorrows Limited to undertake independent assurance.<sup>117</sup> The GRI-checklist is available at the company's website.<sup>118</sup>

The GRI is a multi-stakeholder process that aims to develop a common global framework for sustainability reporting. The sustainability reporting guidelines developed by the GRI are globally acknowledged to be an important voluntary tool that companies can use to facilitate and improve reporting on non-financial aspects of their operations. URENCO has published a sustainability report according to the GRI guidelines since 2005.<sup>119</sup>

URENCO is not a member of the United Nations Global Compact: the largest corporate sustainability initiative in the world – with 10,000 signatories based in more than 140 countries,<sup>120</sup> and Local Networks existing or emerging in over 100 countries.

URENCO focuses on four key areas of sustainability:<sup>121</sup>

- **Managing health, safety and security**
- **Minimising our environmental impact**
- **Developing our position as an employer of choice**
- **Supporting education and cultural projects**

<sup>116</sup> URENCO Sustainability Report 2012, p.23

<sup>117</sup> URENCO SR2012, p.33

<sup>118</sup> <http://www.URENCO.com/download/806/GRI-Checklist.aspx>

<sup>119</sup> URENCO SR2012, p.32

<sup>120</sup> <http://globalcompactfoundation.org/about-ungc.php>

<sup>121</sup> URENCO SR2012, p.9

All this is applicable only to the four URENCO enrichment facilities: "URENCO will encourage and expect commitment to good health, safety and environmental practice from all of its employees and others undertaking work at UEC locations."<sup>122</sup> No mention is made of uranium mining as such. There is no indication that chain responsibilities (other than at the URENCO locations) plays any role in URENCO's policy. This is not surprising since URENCO's policy is that it is only selling enrichment services. It does not mine uranium nor do they own the uranium at any time. And therefore it has no responsibility for matters beyond its facilities (and transportation to and from its facilities).

However is it responsible for the by-product of enrichment -depleted uranium- because enrichment contracts usually transfer the ownership of the depleted uranium generated in the process to the enrichment company. Currently URENCO stores DU at the enrichment facilities pending further re-enrichment or conversion to a chemically stable form – uranium oxide (U<sub>3</sub>O<sub>8</sub>) – for long-term storage.<sup>123</sup>

In the years 1997<sup>124</sup> – 2009<sup>125</sup> depleted uranium from the URENCO consortium was transported for re-enrichment to Russia under a contract signed with Tenex in 1995.<sup>126</sup>

Many argued this was export of radioactive waste, but URENCO denied all accusations. URENCO simply stated it had a contract for re-enriching the uranium to natural levels, but the fact is that almost all material stayed behind at the enrichment plants in Russia. According to the Dutch environmental minister the depleted uranium is not waste but a commodity. Twenty percent of the material is transported back to URENCO in the form of re-enriched (to the natural level of 0.7% U-235) uranium.<sup>127</sup> This means 80% of the material was left behind and has to be stored indefinitely in Russia. Currently a special storage hall (VOG<sub>2</sub>) at the Dutch central radioactive waste storage facility (COVRA) is being built for the URENCO depleted uranium.<sup>128</sup>

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122 Companies website, retrieved 3-1-2013: <http://www.URENCO.com/page/82/Environmental-policy.aspx>

123 URENCO Annual Report 2012, p.7

124 Nuclear Fuel, October 19, 1997

125 Rosatom says uranium tail contracts will not be renewed, citing economic infeasibility; Bellona, June 1, 2009

126 Letter Tenex to URENCO Enrichment Co., May 31, 2005

127 Tweede Kamer, answers to parliamentary questions nr. 1429, February 23, 2007

128 COVRA, December 2013: COVRA dient aanvraag in voor wijziging Kernenergiewet vergunning

## 10. URENCO: proliferation treaties and safeguards

The URENCO facilities are subject to national law. Dutch nuclear installations are subject to permits under the 1963 Nuclear Energy Act and the equivalent legislation is in existence in the United Kingdom and Germany. The ETC plant is not considered to be a nuclear facility by Dutch law,<sup>129</sup> but for proliferation reasons is most important, because it holds the proliferation-prone technology to manufacture the centrifuges.

The URENCO installations are also subject to a number of special safety instructions, and positions held by members of staff are designated as positions involving confidentiality. Technology, know-how and products are subjected to specific permit obligations arising from the Strategic Goods Decree, the 2012 Strategic Services Act and Council Regulation (EC) No 428/2009 of May 5, 2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items.<sup>130</sup>

### Treaties of Almelo, Washington, Cardiff and Paris

The most important treaties concerning URENCO are of course treaties establishing the cooperation between United Kingdom, Germany and The Netherlands, and later with France (Areva).

URENCO's corporate structure is based on the legal foundation provided by the Treaty of Almelo, signed on March 4, 1970. The treaty contains provisions regarding non-proliferation, nuclear safeguards, information protection, withdrawal from and termination of the treaty, and a defined decision making process. Significantly, the treaty established a supervisory Joint Committee comprised of representatives from the three governments that must make all its decisions – including on any sale of shares – by consensus.<sup>131</sup>

In 2005, the three URENCO governments and France signed the Treaty of Cardiff, which provides for both URENCO's and Areva's 50% ownership in the ETC and their use of ETC know-how at their uranium enrichment plants. The uranium enrichment know-how that URENCO developed for over three decades was transferred to the ETC, and both URENCO and Areva were licensed to use the technology to sell enrichment services to the world market. The parties to the treaty must make sure that present or future ETC shareholders do not obtain classified information beyond that necessary for the safe operation of enrichment plants.<sup>132</sup>

Two additional government-to-government treaties have been put in place to accommodate the expansion of ETC technology into the United States. The 1992 Treaty of Washington between the three URENCO governments and the United States permitted the construction and operation of the enrichment plant in New Mexico.<sup>133</sup> And the 2011 Treaty of Paris opened the way for the construction, which is still pending, of an enrichment facility in the United States that would be owned by Areva and outfitted with ETC-supplied centrifuges.<sup>134</sup>

In principle, all centrifuge enrichment plants operating in Europe and the United States using ETC technology are so-called black boxes; that is, the technology inside the plants is not available to the enrichment firms – URENCO and Areva – that operate the plants. In practice, these projects have a few “grey” areas, where the ETC has

<sup>129</sup> ETC is not included in the list of Dutch nuclear facilities

<sup>130</sup> Letter Minister of Finance, Dijsselbloem, 23 May 2013

<sup>131</sup> Text Treaty of Almelo: <https://zoek.officielebekendmakingen.nl/trb-2005-266.pdf>

<sup>132</sup> Text Treaty of Cardiff: [www.official-documents.gov.uk/document/cm70/7046/7046.pdf](http://www.official-documents.gov.uk/document/cm70/7046/7046.pdf)

<sup>133</sup> Text Treaty of Washington: [www.official-documents.gov.uk/document/cm80/8047/8047.pdf](http://www.official-documents.gov.uk/document/cm80/8047/8047.pdf)

<sup>134</sup> Text Treaty of Paris: [www.official-documents.gov.uk/document/cm80/8047/8047.pdf](http://www.official-documents.gov.uk/document/cm80/8047/8047.pdf)

shared a limited amount of compartmentalised classified information with nuclear regulators seeking assurance that the plants are safe and with individuals who are building centrifuges that will be installed in the plants.<sup>135</sup>

## Non-Proliferation Treaty and safeguards

Under the 1968 Nuclear Non-Proliferation Treaty (NPT), non-nuclear-weapon states' obligations on centrifuge manufacturing fall under two IAEA safeguards regimes: those with Comprehensive Safeguards Agreements (CSAs), and those who further implement the strengthened measures of the Additional Protocol (AP) to their CSAs. All URENCO countries (UK, Germany, Netherlands, France and USA) have signed, ratified and put into force the Additional Protocol.<sup>136</sup>

Though each non-nuclear-weapon state's CSA is individual, all follow the form and content of a standard text, 'INFCIRC/153', (INFCIRC is the IAEA abbreviation for "Information Circular") which obliges a country to provide information on all nuclear material and facilities, and to allow agency inspectors to verify these declarations. The resulting verification regime focuses largely on nuclear material accountancy to check the accuracy of declared materials in declared facilities. As such there are no requirements regarding centrifuge production facilities. CSAs were designed in an age when centrifuge enrichment technology was still in its infancy. The underlying assumption was that the production of highly-enriched uranium through conspicuous gaseous diffusion plants would be readily detectable, and that the proliferation risk came instead from the diversion of material from declared facilities.

The Additional Protocol is a legal instrument that provides the IAEA with more information and wider access rights, thereby strengthening its ability to verify that a country is not producing material for nuclear weapon purposes. The document 'INFCIRC/540' describes the standard obligations required under an AP. In contrast with INFCIRC/153, this document specifies in Article 2.a.(iv) that the participating state must provide the IAEA with a description of the scale of operations involved in centrifuge production.

INFCIRC/540 (the model Additional Protocol) makes an important contribution by outlining a system of 'Complementary Access' to inspectors. This expands the rights of the Agency to make visits to centrifuge manufacturing plants. There is no need to obtain agreement from the party and notification of a visit can be as short as 24 hours.<sup>137</sup>

While the Additional Protocol relates primarily to non-nuclear-weapon states party to the NPT, the foreword to INFCIRC/540 affirms that nuclear-weapon states and "other states" may also conclude an Additional Protocol. All the nuclear-weapon states have an Additional Protocol.

Because the nuclear-weapon states have nuclear material and activities outside safeguards, which they are under no obligation to declare, clearly the purpose of the Additional Protocol is not to strengthen the IAEA's capability to detect **undeclared** nuclear material and activities in those states. Accordingly, their Additional Protocols vary from the INFCIRC/540 model. The nuclear-weapon states' Additional Protocols operate so as to increase the information available to the IAEA regarding nuclear cooperation with and transfers to non-nuclear-weapon states.<sup>138</sup>

Another agreement the URENCO facilities are subject to (Article V, Treaty of Paris) is the IAEA Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Rev.4)<sup>139</sup> Principles of physical protection are realised through administrative and technical measures, including physical barriers. The measures for the physical protection of nuclear material in use and storage and during transport, and of nuclear facilities presented herein are recommended for use by States as required in their physical protection systems. These measures are based on the state of the art in physical protection hardware and systems and on the types of nuclear material and nuclear facilities.

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<sup>135</sup> <http://carnegieendowment.org/2013/10/21/would-URENCO-s-sale-pose-proliferation-risk/gqto>

<sup>136</sup> [http://www.iaea.org/safeguards/documents/AP\\_status\\_list.pdf](http://www.iaea.org/safeguards/documents/AP_status_list.pdf)

<sup>137</sup> Mikael Shirazi and Andreas Persbo, Trust & Verify 133, April-June 2011

<sup>138</sup> John Carlson: IAEA Additional Protocol, January 20, 2009: [www.icnnd.org/Documents/IAEA\\_Additional\\_Protocol.doc](http://www.icnnd.org/Documents/IAEA_Additional_Protocol.doc)

<sup>139</sup> <http://www.iaea.org/Publications/Documents/Infcircs/1999/infcirc225r4c.pdf>

## 11. URENCO in the United States

*Michael Mariotte, President of the US Nuclear Information and Resource Service, writes about URENCO's activities in the US:*

It took URENCO nearly two decades to build a uranium enrichment plant in the U.S. Now that it finally has done so, the company suddenly finds itself the only enrichment company in the country - so it has expansion on its mind.

But it wasn't an easy road to get there. The story begins in the summer of 1989, when then-Senate Energy Committee Chairman J. Bennett Johnston (D-LA) held a barbecue on the town square of Homer, Louisiana to announce that a "chemical" plant would be built on a tract of forest (conveniently owned by a friend of Johnston's) just outside of town. The company, called Louisiana Energy Services (LES), was really a consortium led by URENCO.

Some residents were suspicious and when they learned that the "chemical" involved was uranium, they both banded together into a multi-racial group called Citizens Against Nuclear Trash (CANT) and began deluging the Nuclear Information and Resource Service (NIRS) with daily phone calls for help.

In early 1990, I got a call from an aide to retiring Rep. George Miller (D-CA) who asked if I knew that Sen. Johnston had appended to a Minnesota public lands bill, and gotten through the Senate, several provisions relating to a uranium enrichment plant proposed to be built in northern Louisiana, near the small town of Homer.

It turned out that Johnston's bill would overturn existing law preventing foreign ownership of uranium enrichment plants, and would have dismissed Nuclear Regulatory Commission (NRC) requirements for adjudicatory hearings and even preparation of an Environmental Impact Statement (EIS) for this project.

That clearly wasn't acceptable. Rep. Miller agreed to hold a hearing on the issue in the Interior Subcommittee he chaired, and invited Sen. Johnston to testify. To his surprise, Johnston agreed to come over to the House and appear as a witness. I urged Rep. Miller to invite a representative from the citizen's group - Citizens Against Nuclear Trash - and at first his office balked. So we told them that if a representative didn't get to testify, we'd bring an entire busload of local residents to protest at the hearing. Problem solved, and Toney Johnson, a local real estate broker, came to Washington to speak.

The hearing became a circus. Sen. Johnston brought along a geiger counter and started waxing about how safe the uranium enrichment process is and thus no particular regulatory oversight was necessary. He turned on the geiger counter and held it to the microphone so everyone could hear it clicking slowly from the background radiation in the room. Then he held up a little uranium pellet, which he said was the product of an enrichment plant (one of his aides, not Johnston himself, had been carrying it in his pocket - Johnston may have been a con man, but he wasn't a fool) to the geiger counter and the clicks barely increased. Then he pulled an orange dinner-plate from his aide's bag and held it up to the geiger counter, which went crazy, clicking loudly and incessantly. Johnston smiled triumphantly: see, he said, this uranium pellet is less radioactive than a normal dinner-plate.

Then Toney Johnson came on and in a plain-spoken but fervent style, with a bit of southern religious overtones, gave the citizens' views - especially on the idea that no hearings or EIS would be needed. Taking on Sen. Johnston, Toney said, "Only God himself can say there will never be an accident at that plant."

Afterwards, it occurred to me that Miller and his staff might not have realised that the orange dinner-plate Johnston held up was a Fiesta ware relic. Decades earlier, to achieve the prized orange color, Fiesta ware was

made with a uranium glaze. It had been banned from commercial use for years because it was so radioactive. So I called the staff, and no, they didn't know that and yes, they were mightily pissed that Johnston had tried to pull a fast one on them.

So I called some Louisiana TV stations and newspapers, and nope, they hadn't known either. And one TV station got aggressive. They pointed out that the actual product of a uranium enrichment plant is uranium hexafluoride, a gas that is both radioactive and highly toxic. A reporter cornered Sen. Johnston and asked him about the Fiestaware, the uranium pellet he had been holding, and about uranium hexafluoride. Johnston evaded the questions. The reporter pointed out that if Johnston had been holding the actual product of the plant, the uranium hexafluoride, "it would have eaten right through his hand."

The reporter for that piece was fired the next day after a call from Johnston's office to the station's owner, but for the entire next week the Louisiana media roasted Johnston, who was running for re-election at the time. In fact, Johnston never again said a word, in public, about the project.

For his part, Rep. Miller allowed Johnston's repeal of the foreign ownership provision to go through, but refused to give Johnston anything else: the final legislation ensured a full adjudicatory hearing and a full EIS - which eventually proved to be the downfall of the project.

That forested tract of land owned by Johnston's friend sat on top of a hill and straddled a road. That road connected two small, poor Civil-War era African-American communities that each sat about 100 yards from the proposed plant site. Yet when the NRC prepared its Draft EIS for the project, both communities had disappeared from the map.

NIRS arranged for Washington attorney Diane Curran to represent CANT in the adjudicatory hearings we had saved in the legislation. She brought in attorney Nathalie Walker, of what was then Sierra Club Legal Defense Fund (now Earthjustice) in New Orleans to help. NIRS and the two lawyers drafted dozens of contentions for the hearing, including one on those disappearing communities. Later on, many more contentions were added, including one on LES/URENCO's financial qualifications to build the project.

In a deposition, the lawyers asked the site selection chief for LES how that site had been chosen. He replied that he'd driven around the area, and one potential tract of land was unsuitable, and another just looked too nice - with well-kept homes. But at the chosen site, he said, it looked run down and poor.

In 1994, President Clinton signed an executive order requiring federal agencies to consider environmental justice issues when making major decisions. Although as an independent agency, the NRC was exempt from the requirement, then Chairman Ivan Selin said the NRC would meet it anyway. And, in a landmark 1997 decision by the NRC's administrative hearing body, the Atomic Safety and Licensing Board, the URENCO project became the first of any kind ever denied a license on environmental justice grounds. To add insult to injury, the Licensing Board also ruled that the Louisiana Energy Service consortium was financially unqualified to build the project and denied a license on that ground too.

But rather than scurry back to Europe as we had hoped, URENCO popped up again a year or two later in central Tennessee, at a site near the restaurant chain Cracker Barrel's national headquarters - which put up the first \$5,000 to fight the project. Local citizens hired a friend of the community - who happened to be a nuclear industry consultant. Some thought it was a dangerous move but he quickly became appalled at URENCO's plans and within a year or so succeeded in getting all of the nearby counties to adopt stringent waste disposal and

emissions criteria that URENCO couldn't possibly meet. End of that project. The company then became interested in using an abandoned TVA site in Alabama; it only took us a couple months to beat them there.

But then URENCO hooked up with a new Senate Energy Committee Chairman, Republican Pete Domenici of New Mexico, who invited them to build their plant in the tiny town of Eunice on the Texas border. We tried again to stop them, but this time the NRC hearings were stacked against us; promised opposition from Governor Bill Richardson and the state of New Mexico didn't materialise, in the wake of the financial qualifications decision the NRC had changed its rules; and \$300,000 later, we lost and the plant was built and began operation in June 2010.

The initial phase of the plant could produce 1500 Separative Work Units (SWU); that has now more than doubled to 3200 SWU. And URENCO is continuing to add on, planning for an ultimate capacity of about 5700 SWU - enough to power about half of the current reactors in the U.S.

The company has been helped immeasurably by the failure of its main competitor, the U.S. Enrichment Corporation (USEC), which has closed both of its existing and decrepit gaseous diffusion enrichment plants and declared bankruptcy in March 2014. USEC has been hoping to obtain a taxpayer loan guarantee from the Department of Energy to build a new enrichment plant, using advanced centrifuge technology similar to URENCO's, but the company's precarious economic state has prevented the Department of Energy from doing so.

URENCO's only other potential competitor in the US, Areva, did obtain a \$2 billion loan guarantee from the Department of Energy to build an enrichment plant in Idaho, but after looking at the marketplace decided not to proceed. And that may still be URENCO's eventual downfall: it's betting on a continued and even growing nuclear sector in the US. But the reality is that nuclear power in the US is beginning to sink, and that process is expected to accelerate over the next several years. URENCO could easily discover that it has overbuilt despite its stated commitment to build only when it has sufficient contracts for enriched uranium to do so.

## WISE/NIRS Nuclear Monitor

The World Information Service on Energy (WISE) was founded in 1978 and is based in Amsterdam, the Netherlands.

The Nuclear Information & Resource Service (NIRS) was set up in the same year and is based in Washington D.C., US.

WISE and NIRS joined forces in the year 2000, creating a worldwide network of information and resource centers for citizens and environmental organizations concerned about nuclear power, radioactive waste, proliferation, uranium, and sustainable energy issues.

The WISE / NIRS Nuclear Monitor publishes information in English 20 times a year. The magazine can be obtained both on paper and as an email (pdf format) version. Old issues are (after 2 months) available through the WISE homepage: [www.wiseinternational.org](http://www.wiseinternational.org)

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Version	NGO's/ individuals	Institutions/ Industry
Paper 20x	100 Euro	350 Euro
Email/Pdf 20x	50 Euro	200 Euro

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**ISSN:** 1570-4629

**WISE/NIRS NUCLEAR**

**MONITOR**

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PO Box 50636  
1040 LC Amsterdam  
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