

# Corporate brochure

URENCO has a pivotal role in the nuclear fuel supply chain, providing our customers with the enrichment service they need to produce low carbon electricity through nuclear generation.

As part of a balanced energy mix, low carbon electricity generated from nuclear power can help mitigate the effects of climate change on the world around us, including protecting Earth's magnificent glaciers from melting.

We are proud to play a role in reducing the global carbon footprint and helping to protect our planet.

# Urenco

# enriching the future



# About URENCO

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How URENCO supports the energy sector



# Welcome to URENCO

URENCO is a leading provider of uranium enrichment services to the world's nuclear energy industry. With operations across four countries, we ensure our customers around the world receive safe and reliable supplies of enriched uranium to fuel civil nuclear reactors.

Nuclear power plays a key role in meeting the world's low carbon energy demands. Using centrifuge technology designed and developed by URENCO, we have provided quality and expertise for more than 40 years, helping our customers to meet global energy consumption with a reduced carbon footprint.

Our robust position in the global nuclear market is due to our healthy business strategy, strong leadership and talented workforce. Nuclear is a long-term business, and we take a long-term view of our operations to ensure we meet the needs of our customers and our commitments to society and the environment.

Sustainability is embedded within our business – with dedicated focus areas covering economic, environmental and social issues monitored by Sustainability Champions across all our sites and with Board-level oversight. The enrichment of uranium is sustainable for generations to come – both in the processes it deploys and the low carbon end product it delivers.

It is what we call 'enriching the future'.

# What we do

URENCO is a global business serving a range of utility customers, who provide low carbon electricity through nuclear generation. Our customers source the feed, uranium hexafluoride ( $UF_6$ ), and we provide a service to enrich the material to meet their specifications, enabling them to continue to the next stage of the nuclear fuel supply chain.

Supplying the world with fuel to generate low carbon energy is just part of what we do – our commitment to sustainability and educating the next generation on the importance of nuclear in our energy mix is a core part of our culture.

# Our facilities

We have four uranium enrichment facilities. These are located at Almelo in the Netherlands; Capenhurst in the UK; Gronau in Germany and Eunice, New Mexico in the USA. Our Head Office is located close to London.

We are the only company in the world to operate enrichment facilities in four countries under four different regulatory regimes. This geographical reach and diversity of supply are distinct competitive advantages which allow us to respond flexibly to the needs of our customers. We have a strong forward order book which allows us to plan production volumes many years in advance.

We are firmly committed to leading the way in responsible uranium stewardship and have several subsidiaries dedicated to overseeing our work in this area. These include URENCO ChemPlants Limited, which is responsible for the construction of our Tails Management Facility (TMF) in the UK, and Capenhurst Nuclear Services Limited (CNS)<sup>1</sup>.

Our Stable Isotopes business in the Netherlands draws on our expertise and capabilities in centrifuge technology to produce a variety of products for medical, industrial and research applications.

# Our customers

As a global leader in enrichment services, we supply more than 50 customers in 19 countries. We build robust, long-term partnerships supporting customers to deliver on their goals and respond flexibly to their requirements.

We regularly survey our customers to assess the quality of our services, and the strength of our customer relationships were analysed in our Global Customer Survey. In 2014, 81% of URENCO customers said they were 'very satisfied' with their enrichment services, and 76% said they were 'very satisfied' with their relationship with URENCO.

# The Treaty of Almelo

Our leadership position and longevity can be traced back to the Treaty of Almelo.

Signed in 1970 by the UK, Dutch and German governments, the Treaty of Almelo laid the foundations for international co-operation. At its core was a commitment to promote the peaceful application of nuclear power and to harness atomic expertise for use in energy, science and medicine. It created a platform for the joint development of centrifuge enrichment technology and put robust safeguards in place to protect this technology from misuse and proliferation.

Under the terms and principles of the Treaty, URENCO has become a market leader of enrichment services globally. As URENCO has grown, it has extended its international co-operation through treaties with the USA and France. By complying with these agreements and living our values (see page 8), we continue to focus on quality, reliability and the highest standards of uranium stewardship and corporate responsibility.



# Inside a centrifuge cascade hall at a URENCO enrichment facility.

# Our culture

URENCO company culture underpins our business model.

Our purpose	Ourvision	Our mission	
We play a key part in meeting the world's need for reliable, low carbon energy.	We believe the world needs nuclear energy to meet the demands of sustainable global energy. We can help the transition to a low carbon economy through the deployment of our enrichment services and technology.	Our mission is to be the supplier of choice within our sector and a key contributor to sustainable energy.	
Our duty to the Treaty of Almelo			
The Treaty of Almelo enshrines the enduring purpose and principles of URENCO regardless of ownership.			

# Our five values

Inspired by our culture, five values guide everything we do at URENCO – from our strategic and operational decision-making to our day-to-day activities.



Safety

We operate to the highest standards of safety, environmental and security requirements.



Integrity

We conduct all our relationships with honesty, fairness and respect.





Development

and products.

We respond to best meet We are committed to the our customers' needs sustainable development by flexibly deploying our of our business by skills and capabilities. continuously developing our employees, services



We are committed to making profits to secure our future and reward our shareholders and employees.

Profitability

# Our five strategic pillars

URENCO's strategy to deliver its mission is focused on providing excellent customer service. The implementation of our strategy is based on five strategic pillars:





International

presence and

collaboration

Geographic spread

and reach

We maximise the

### Responsiveness

### Customer-focused relationships

We maintain close. long-term relationships with our customers and we are committed to delivering for them. Our technology enables us to respond flexibly to our customers' needs and market dynamics. In this respect we carry out long-term planning and preparations while making sure we always meet our commitments.

advantage of our global presence to provide security of supply for our customers. URENCO always aims to share best practice and improve our processes and efficiencies. Our

operations in Europe and the USA give us a unique advantage that supports us in serving more than 50 customers in 19 countries worldwide

Again, in 2014 we met 100% of our customer delivery commitments.

As of June 2015, our order book extends beyond 2030.

### 8



### **Highly motivated** and committed people

### Talent and retention

To ensure we can build our strength as a global leader in enrichment services, we invest substantially in our people's skills and development. Our aim is to make URENCO an employer of choice. We are also committed to creating one URENCO: four enrichment facilities around the world with our dedicated, highlyskilled workforce united as one.

During 2014, more than 300 employees took part in leadership development training programmes.



### Responsible long-term business

### Sustainability

Sustainability goes to the very core of our business. For URENCO, sustainability means health, safety, environment, asset integrity, safeguards, security, ethical conduct and social performance We are committed to continuous improvement in these areas. Our sustainability agenda has Board-level support and is embedded across every aspect of our business.

In 2014, URENCO established a network of Sustainability Champions who are responsible for delivering on the initiatives across the Group.



### **URENCO's** centrifuge technology

### Over 40 years' operational experience

URENCO has successfully and reliably operated gas centrifuge technology for more than 40 years. Our experience and expertise enables us to operate our technology efficiently and effectively which means we can provide a flexible and responsive service to ou customers worldwide.

We are making better use of our resources to deliver uranium feed.







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### Our operations and customers

URENCO operations

Customers

All data as at 31 December 2014. Visit www.urenco.com for the latest figures.

### Our business Our role in the nuclear fuel supply chain

URENCO plays a key role in the global nuclear fuel supply chain, ensuring countries have a secure source of low carbon energy. We use centrifuge technology to provide uranium enrichment services to customers, who then generate low carbon electricity using nuclear energy.





Here we outline the key stages in the nuclear fuel supply chain:

### 1. Mining

Uranium ore is extracted, purified and milled to become uranium oxide, also known as yellow cake.

### 2. Conversion

Uranium oxide is chemically converted into uranium hexafluoride (UF<sub>c</sub>) and transported to one of our enrichment facilities.

### 3. Enrichment and feed materials

URENCO's enrichment process starts with the arrival of customers' UF<sub>c</sub> at our enrichment facilities. We heat UF<sub>6</sub> to turn it into a gas and feed it into our gas centrifuges.

The centrifuge separates the two isotopes contained in uranium: U<sub>235</sub> and U<sub>238</sub>. The lighter U<sub>235</sub> is generally enriched to up to 5%, which is sufficient to sustain a continuous fission reaction in a nuclear power plant. The flexibility of our centrifuges allows us to conserve feed material and therefore provide Enriched Uranium Product (EUP) and natural uranium in addition to enrichment services.

### 4. Fuel fabrication

The customers' enriched uranium is transported to fuel fabricators, where it is converted into pellets before being loaded into fuel rods.

### 5. Nuclear power generation

The fuel rods are transported to nuclear power stations, where they power the nuclear reactors. Fuel rods are placed into reactors and used to generate steam, which in turn drives turbines which power generators.

### 6. Electricity generation

At the end of the nuclear fuel supply chain, the nuclear power plants provide a secure source of low carbon energy – generating electricity for homes, schools, hospitals, offices and industries around the world.



URENCO's part in the process starts with the delivery of customers' uranium hexafluoride ( $UF_6$ ) to our enrichment facilities.  $UF_6$  is the most suitable form of uranium for enrichment because it is easily turned into a gas when heated.



### Heating UF<sub>c</sub> to turn it into a gas

UF<sub>e</sub> is delivered to our enrichment facilities by approved suppliers in internationally standardised transport containers.

At our enrichment facility we connect the transport container holding UF<sub>e</sub> to the plant feed system. It is then heated in order to vaporise the  $UF_6$  and turn it into gas at sub-atmospheric pressure.

### Spinning UF<sub>6</sub> in high speed centrifuges to enrich it

We feed the UF<sub>6</sub> gas into a centrifuge casing containing a cylindrical rotor which spins at high speed, separating uranium's two isotopes. The heavier isotope U<sub>238</sub> is forced closer to the wall of the rotor than the lighter U<sub>se</sub>. As a result, the UF<sub>c</sub> slightly enriched in U<sub>225</sub>. We repeat the process over and over again in a series customers' specifications.

### Compressing and cooling the enriched uranium

up to 5% of the  $U_{235}$  isotope) is fed from the centrifuge cascades into a compressor and then into a cooling box containing a cylinder. As it cools, the UF<sub>6</sub> vapour solidifies in cylinders. We homogenise the UF, in the cylinders and check the quality We weigh all cylinders to comply with the accounting and tracking requirements of the European Atomic Energy Community Regulatory Commission (USNRC) and the International Atomic Energy Agency (IAEA).

### Storing and converting depleted uranium centrifuge is partially depleted in U<sub>235</sub> This by-product is known as 'tails'. We collect and cool tails in a cooling box containing a cylinder, weighing it to ensure all material can be accounted for. Tails still contain a low concentration of U<sub>227</sub> and can be re-enriched if economically viable.

We store tails at our enrichment facilities in internationally approved containers pending deconversion to a chemically stable form – uranium oxide  $(U_3O_0)$ - for long-term storage.

As well as storing tails at our facilities, we currently contract a third party to chemically convert depleted UF<sub>e</sub> into U<sub>3</sub>O<sub>8</sub>. We are constructing our own Tails Management Facility to conve<u>rt UF</u> to creates hydrofluoric acid, a valuable chemical used globally by industry.

Construction of the Barakah Nuclear Power Plant, in the Western Region of Abu Dhabi, UAE.



As a global leader in enrichment services, URENCO supplies more than 50 customers in 19 countries.

Below is a profile of one of our customers, Emirates Nuclear Energy Corporation.

### Profile: Emirates Nuclear Energy Corporation

مؤسسة الإمارات للطاقة النووية Emirates Nuclear Energy Corporation

The Emirates Nuclear Energy Corporation (ENEC) is working to deliver safe, clean, efficient nuclear energy to the United Arab Emirates (UAE) – energy that is needed to support the UAE's social and economic growth.

Energy demand in the UAE is growing at an annual rate of about 9% – three times the global average. Developing a reliable supply of electricity is critical to the future growth of the nation.

ENEC is taking on this challenge, with four APR1400 nuclear energy generating units currently under construction at Barakah in the Western Region of Abu Dhabi and a target of delivering electricity to the UAE grid in 2017. By 2020, it is projected that ENEC's four units will produce nearly a quarter of the nation's electricity needs.



In 2012, ENEC and URENCO signed a long-term contract for the supply of enrichment services to the UAE peaceful nuclear energy programme, an important part of ENEC's comprehensive fuel supply strategy. URENCO looks forward to continuing with a reliable supply of enrichment services to ENEC and supporting the UAE's long-term nuclear energy plans.



### Our business Safety

Safety is our number one priority and focus across the Group. We always seek to operate to the highest standards of safety, environmental and security requirements, for the protection of our employees, the communities where we operate, the suppliers we work with and the customers we supply.

Our four enrichment facilities and subsidiaries comply fully with all regulatory requirements to ensure the safe handling of uranium and other chemicals. The safety culture embedded across the Group is maintained through regular training of employees across all business areas.

### Radiological safety

Did you know?

generation.

All of our centrifuge plants are designed with the fail-safe principle, with no increased safety risks in the event of a loss of power, water, control, air or other inputs.

In the UK, Public Health England has calculated that, on average, people are exposed to about 2.7 millisieverts (mSv) of radiation a year from naturally occurring sources in homes, workplaces and medical exposures, including x-rays.<sup>2</sup> Many people who visit our enrichment facilities for the first time are

surprised at how low the levels of radiation involved in uranium enrichment actually are. The average radiation dose an employee working in a controlled environment at our UK enrichment facility received in 2013 was 0.40 mSv<sup>3</sup>, well below the natural radiation average calculated by Public Nuclear energy has the Health England. To put it into context, best safety record of any having one abdomen x-ray CT once a year major form of electricity exposes you to 20 times the amount of radiation as working in our UK enrichment facility.4

### Safeguards and regulatory requirements

Nuclear safeguards are fundamental to the secure operations of our enrichment facilities, and help to ensure that civil nuclear power remains a safe, secure and reliable energy source. URENCO operates in accordance with stringent industry and regulatory standards regarding nuclear safeguards. Across the Group, our centrifuge technology and enrichment facilities are verified and protected by international safeguard policies.

URENCO works closely with governments and organisations such as the International Atomic Energy Agency (IAEA), European Atomic Energy Community (EURATOM), European Safeguards Research & Development Association (ESARDA) and US Nuclear Regulatory Commission (NRC) to create and comply with safeguards regimes. Our commitment has assisted the implementation of international safeguards in the area of enrichment in other countries to the high standards set by the URENCO Group.

### Security

Each year, URENCO processes thousands of tonnes of uranium and operates sensitive gas centrifuge technology. We ensure the security of uranic material and our own technology and assets, and we have invested in comprehensive measures to ensure both the physical security of our sites as well as cyber security.

<sup>2</sup>Public Health England, March 2011, www.gov.uk/government/publications/ ionising-radiation-dose-comparisons/ionising-radiation-dose-comparisons.

<sup>3</sup>URENCO internal data.

<sup>4</sup>US Food and Drug Administration, What are the Radiation Risks from CT?, February 2015, http://www.fda.gov/Radiation-EmittingProducts/ RadiationEmittingProductsandProcedures/MedicalImaging/MedicalX-Rays/ ucm115329.htm.





Case study: Transport Our safety values extend to everything

by the nuclear industry, which has an licensing authorities regularly inspect URENCO's transports. We adhere to guidelines alongside all other national and we go beyond regulatory requirements in aspects of our own logistics procedures.

We place the utmost importance on the safe transportation of UF<sub>c</sub> at all stages of the enrichment process and only work with specialist audited transport suppliers. International certified containers used for the transportation of  $UF_{c}$  are designed and produced according to strict international regulations, which pose high demands on materials used to guarantee safety

we do - including transport.

The transport cylinders are manufactured from 16mm thick steel, and the cylinders are fitted with overpacks during transport to protect them in case of fire. The feed cylinders can hold 12.5 tonnes of UF<sub>c</sub>. The product cylinders are smaller in diameter than the feed cylinders and have a licensed protective casing. Both types of standards required for pressure vessels; they are tested at the time of manufacture and at five-year intervals thereafter.

### Did you know?

Around 20 million shipments of radioactive material take place every year. Packages containing radioactive material are designed to withstand severe accident conditions – there has never been a significant environmental release from a nuclear materials

At URENCO, sustainability is at the very heart of who we are and what we do. Nuclear power plays a key role in meeting the world's low carbon energy demands and its production requires processes that are efficient, safe and cost-effective.

Our commitment to sustainability runs through every aspect of our business. We live up to this commitment by focusing on six key areas of sustainability.



### Health and safety, safeguards and security

Health and safety, safeguards and security are crucial elements of our culture, which are championed by our employees and contractors across the Group. At all our facilities, our operations are scrutinised and regulated by government authorities. They approve the design and operating principles of our enrichment facilities and verify the systems we deploy to manage safety, security, safeguards and environmental protection.

### Key initiatives and achievements:

- Group-wide ZERO HARM safety campaign
- Regular training programmes Cross-site safety audits
- Compliance with all industry and

regulatory standards

- IAEA representation and membership, ESARDA membership<sup>5</sup>
- European enrichment facilities management systems certified to EN ISO 14001 (environmental) and ISO 9001 (quality)
- Stringent on-site security measures and precautions
- Co-organised the Nuclear Industry Security Summit in Amsterdam
- Enrichment facilities in the Netherlands and Germany are certified to ISO 27001 (IT security)

Environmental impact

We are committed to minimising the environmental impact of our business and achieving greater efficiencies across our facilities. Minimising our environmental impact goes hand in hand with our long-term commitment to a low carbon energy future.

### Key initiatives and achievements:

- Developing and reviewing environmental objectives
- Minimising waste and use of natural resources
- Engaging employees on environmental issues
- Assessing the environmental credentials of potential partners and suppliers
- Our Head Office building continues to be rated 'good' under BREEAM certification – the world's foremost environmental assessment method and rating system for buildings

### Supplier of choice

URENCO has always believed that building long-term relationships with our customers is at the core of our sustainable business. Being a supplier of choice is the mark of this commitment.

Our customers choose us for a number of reasons – namely our reliability in meeting their delivery requirements, our diversity of supply and our desire to respond flexibly to their changing needs.

### Key initiatives and achievements:

- Strong financial and commercial performance
- Deliveries planned well in advance to maximise efficiency
- 100% customer delivery, on time and in full
- Combined pick-ups and deliveries in Europe to limit the number of empty vehicles on roads

### **Employer of choice**

URENCO wants to be recognised as an employer of choice that offers an inspiring and fulfilling working environment for all our employees. We are proud to have an immensely capable and engaged workforce and we strive to inspire and challenge our employees, to manage their performance effectively and fairly and to recognise their achievements.

### Key initiatives and achievements:

- Employee survey and HR forum
- Initiatives to help minimise workplace stress
- Flexible working
- Initiatives at our enrichment facility in Germany led to a successful audit of berufundfamilie (job and family life)
- URENCO Nederland won the Best Employer 2013 award in the category 'Organisations with fewer than 1,000 employees' in an annual survey by research companies Effectory and Intermediair

<sup>5</sup>International Atomic Energy Agency and European Safeguards Research and Development Association, respectively.

### **Community engagement**

Building strong links with the local communities where we operate is a core aspect of our sustainability programme and one of our principal responsibilities as an industry leader.

Across the URENCO Group, we support local communities through both practical and financial investments focused on education, environment, healthy living and culture. Through our community and education programmes, we work to enhance people's understanding of our business and our industry. We also aim to nurture interest in science among school children and raise awareness of career opportunities within science, technology and engineering.

### Key initiatives and achievements:

- Sponsorship of local events
- Regular council and local liaison meetings
- Practical and financial donations to local and regional charities
- Richie science workshops and annual Richie Lecture
- Volunteer activities each employee can dedicate one day a year to a specific community initiative
- Highly commended at PRCA Awards 2014 for sustainability programme
- Founding member of Duurzaam Network Almelo (DNA) in the Netherlands, a community-wide sustainability network of local businesses from many different sectors

### **Asset integrity**

The smooth ongoing running of our plant components, systems and infrastructure is vital to the success of our business. As URENCO is a long- term business, it is imperative to ensure the multiple elements of our business function efficiently now and in the future. As such, asset integrity lies at the very heart of URENCO's overall strategy.

URENCO runs a rigorous asset integrity programme designed to maintain exceptional operational standards. This provides a strong foundation for the other core areas of focus in our business.

### Key initiatives and achievements:

- Group-wide asset integrity audit
- Focus on asset integrity, upgrade and improvement across the Group



Our success is built on the quality, commitment and professionalism of our employees. We are proud to have an immensely talented workforce and we strive to inspire and challenge our colleagues in their chosen roles.

The success of URENCO is underpinned by our people, in whom we continually invest to ensure we have the expertise and leadership to sustain our business long into the future. Our people are one of our core strategic strengths – their skills and expertise are valuable assets.

> As a multi-national group with several subsidiaries, the range of skills and experience at URENCO varies considerably. We'd like to introduce you to just a few of our valued employees to learn more about their areas of focus.

Did you know? Nuclear energy provides career opportunities across a diverse range of fields. Jobs are often long-term, with internationally transferrable skills.



Clara Analyst, Business Intelligence **URENCO Head Office** 

department. Based at URENCO's Head Office, just outside Technology Company Limited (ETC) in Germany – so has URENCO Group.

into a shape and form that can be used by other teams to

Edwin

Edwin has worked for URENCO Nederland for 17 years in for all operational issues and for the development of his



# Shift Manager **URENCO** Nederland

- and he works closely with URENCO's Central Technology



Senior Radiation Protection Adviser URENCO UK

Working Group was established, which Nicola is a member

Outside of her day-to-day responsibilities, Nicola is a ambassador, which has enabled her to work with local



Marcel Deputy Shift Manager URENCO Deutschland

Marcel has worked for URENCO Deutschland for almost ten



Facilities Maintenance URENCO USA

Higher National Certificate (HNC) in mechanical engineering.



# Recycling Craft Technician **URENCO UK**

For further information on careers at URENCO, please visit our careers portal: www.urenco. . com/careers.



The control room at one of our enrichment facilities.

Our key contribution How URENCO supports the energy sector

At URENCO, we are keen to increase the public's understanding of the nuclear industry and the key role it plays in meeting the world's growing need for reliable low carbon energy. We are committed to engaging transparently with our stakeholders, to explain our enrichment process and provide an education on the industry we supply. We believe that in doing so, we can help educate and inform public opinion on our industry.

Initiatives around education and STEM (science. technology, engineering and maths) are important to URENCO and its employees, and we provide many different opportunities for young people to pursue engineering and other scientific careers through apprenticeships as well as education programmes.

### Education

We proactively support our nuclear industry peers in the provision of education and information for a wide variety of stakeholder audiences. We also strive to encourage the next generation of talent, to ensure that we and other businesses in the industry can be confident of having enough skilled people to sustain our success.

To encourage young people into our industry, we support science and education initiatives in the local communities in which we operate and are also closely involved with universities and international science education programmes. We want young people to understand that not only is the nuclear sector a reliable and rewarding industry to be a part of – it provides an opportunity for an innovative and exciting career.

Our extensive connections with universities across the Group include research programmes at Oxford University and the University of Manchester Dalton Nuclear Institute. Our enrichment facility in the Netherlands is a key supporter of research at the Technical University of Delft and in Germany we have a partnership with research university RWTH Aachen. We also offer annual scholarships at New Mexico Junior College, USA, for students pursuing an Associate of Applied Science in Energy Technology.

### Site visits

We also increase understanding of our business and the benefit of nuclear energy through visits to our enrichment facilities. We receive on average 8,800 visitors at our four enrichment facilities each year, including local interest and community groups, government representatives, industry peers and customers across all URENCO sites.





## **Case study:** The Richie Programme

We live in a world facing enormous energy challenges. How are we to develop a lowcarbon economy while sustaining growth? How are we to meet growing demand for the Earth's natural resources? How can we preserve our natural environment in the face of increasing urbanisation?

These problems can only be addressed by nurturing a new generation of science leaders.

Richie is our science ambassador and the figurehead of URENCO's education outreach, with a mission to inspire schoolchildren to engage in STEM subjects. Richie workshops across the Netherlands, the UK, Germany, and the USA have helped to educate schoolchildren about energy and science, and to build skills in practical investigation. Group-wide, more than 80.000 pupils have participated globally since the programme began.

The Richie programme was highly commended by a leading public relations body in the UK and the success of the initiatives has enabled us to share the Richie workshops even further. In the UK, we have partnered with the British Science Association (BSA), one of the leading organisations promoting science and society. Richie is now an active part of the BSA's CREST Star Framework, a UK-wide award scheme enabling children

"The children really enjoyed to solve STEM problems through practical investigation. The scheme enabled URENCO the activity, especially the to roll out a set of Richie-inspired classroom materials across the UK, thus enabling a experiment. I think greater number of pupils to understand explaining the concept of the enrichment process and how this links into nuclear energy and the wider separation by using a concepts of energy and electricity. Richie has washing machine helped connections with over 800 schools both in the UK and internationally through the BSA. them put it into a real-life URENCO and the BSA held the first Richie scenario – which they could Lecture in December 2014 at the Royal understand much better." Society. Pupils heard a lecture on the

world's future energy challenges from Sir David King, the UK Government's Special Representative for Climate Change, and based activities and games.

The inaugural lecture was a big success, with over 150 schoolchildren attending. It allowed Richie to connect with a new target age group of children just about to make their choices for GCSE. Feedback from students and teachers was very positive.

- Teacher from Tower Hamlets primary school in London, UK

"The children had a good day and enjoyed the prizes and activities."

- Teacher from Oasis Academy Coulsdon in London, UK

Schoolchildren participate in URENCO's Richie programme – a key component of our educational outreach on STEM subjects.



Our key contribution **Technology** 

# Technology development

With our industry-leading centrifuge technology, URENCO is ideally placed to support the nuclear industry.

### **URENCO** centrifuge

The URENCO centrifuge consists of an ultra-light, thin-walled tube made from advanced materials, containing a cylindrical rotor that rotates at high velocity in a vacuum, on an almost frictionless bearing.

The gaseous UF<sub>6</sub> is fed into the centrifuge, where it adopts a rotational motion. The centrifugal forces push the heavier  $U_{238}$  closer to the wall of the rotor than the lighter  $U_{235}$ . The gas closer to the wall becomes depleted in  $U_{235}$ , while the gas nearer the rotor axis is slightly enriched in  $U_{235}$ . The centrifuge's electric motor produces heat at the base of the machine, causing a temperature profile along the length of the centrifuge, assisting the separation process.

The gaseous  $UF_6$  is fed through a pipe from the top of the centrifuge into the centre of the cylinder, where it takes up the rotational motion and also flows along the temperature gradient. The two streams of  $UF_{67}$  one enriched and one depleted in  $U_{235}$ , are removed from the centrifuge by two pipes.

Did you know? One nuclear fuel pellet the size of your fingertip produces as much energy as one tonne of coal.

As the enrichment level achieved by a single centrifuge is insufficient to obtain the desired concentration of  $U_{_{235}}$ , it is

therefore necessary to connect a number of centrifuges together – both in series and in parallel. This arrangement of centrifuges is known as a cascade.

### Centrifuge cascade

Passing through the successive centrifuges of the cascade, the  $U_{235}$  is gradually enriched to the required assay, typically between 3% and 5% by weight. In a uranium enrichment plant, several cascades are operated in parallel to form an 'operational unit' producing one  $U_{235}$  assay. Several operational units together form one enrichment plant.

This modular design enables centrifuge plants to be expanded in line with market demands. It also permits the most recently developed and qualified centrifuge technology to be introduced rapidly into plant operation, thereby gaining maximum economic benefits from the development programme.

Low energy consumption in the centrifuge process has turned out to be one of today's most important advantages. Because centrifuge rotors spin in a vacuum on almost friction-free bearings, modern plants with current types of centrifuges need only about 40 kWh of electricity to produce one unit of separative work. Thus, the specific energy consumption of the centrifuge is, by a factor of almost 60, less than the 2,400 kWh/ kgSW that diffusion plants need.



One of URENCO's centrifuge cascades.

# Nuclear technology – 'Enabling our every day'

The nuclear industry is much more than just generating low carbon electricity. Many aspects of our everyday life are made possible by nuclear technology and it is the backbone for many products we take for granted from those in the home to those used for medical treatments.

URENCO's campaign, 'Enabling our every day', explores the aspects of everyday life made possible by nuclear technology.





Nuclear technology improves the health of millions of people every day as it enables a variety of medical applications, from identifying conditions such as heart disease and a broad range of cancers, through to the sterilisation of bandages.

Using URENCO's world-leading centrifuge technology, URENCO's Stable Isotopes business, based in the Netherlands, produces a variety of products including medical radioactive isotopes. You can read more about medical uses of Stable Isotopes on page 41.

### Healthy eating

Food irradiation is a method of treating food to make it safer to eat and also keeps it fresh for longer. Currently, three different irradiation technologies exist using three different kinds of rays: gamma rays, electron beams, and x-rays. Unlike chemical treatments, irradiation leaves no residue and kills bacteria throughout the food, not just on the surface.

ed in food irradiatio

to preserve fruit,

egetables, meat and

ces. It is also used to

luding milk cartons

to help prevent the spread of bacteria

ifference to millions

all round the world -

many urenco co

That makes a

e food packaging



### Space travel

Over the last fifty years, nuclear technology has been used to power much of our space activity, including satellites.

Radioisotope Power Systems (RPS) provide electrical power for space missions supporting travel to some of the most hostile environments in the solar system (source: NASA). Looking ahead, RPS will continue to provide a long-term source of electrical power enabling future space exploration including journeys to Jupiter's ocean moon and to the moons orbiting other planets.

### Smoke alarms

Until they beep, we often take the smoke alarms in our homes for granted, forgetting they are keeping us safe. Many household smoke alarms contain a small amount of radioactive material which can detect smoke particles and trigger the alarm. They are the ultimate safety device and emit minimal radiation, much less than from many other consumer products, including colour television sets.







### **Clear vision**

If you're a contact lens wearer, you'll know that cleansing your lenses with a solution is an important part of your daily routine. To maintain high standards of hygiene, contact lens solutions are sterilised with radiation to remove irritants and allergens.

As well as contact lens solutions, radiation is also used to sterilise beauty products including mascara and false eyelashes, which are used by millions every day around the world.

Our commitment to innovation will ensure that URENCO remains an industryleader in technology and sustainability. Innovation enhances efficiency, security and reliability – all of which are crucial to our business model.

We believe that the nuclear industry will grow in the future and form an increasingly crucial part of a sustainable global energy mix. We seek to adapt our processes to benefit customers in different markets and parts of the world. For example, in the future we hope to provide fuel for Small Modular Reactors (SMRs) that provide energy in countries with no established national grid or infrastructure. In this way, through the current generation of larger reactors and evolving SMR technology, nuclear can meet present and future market needs. URENCO's businesses outside of enrichment leverage our expertise and technology to benefit science and stimulate industrial innovation. Subsidiaries such as Stable Isotopes support URENCO's robust business strategy as well as core principles founded as part of the Treaty of Almelo.

### Did you know?

Each year, more than one million patient treatments are performed using radioactive sources made from Stable Isotopes' enriched materials.

# Case study: Stable Isotopes

Nuclear technology allows for the separation of isotopes for medical, research and industrial applications, and URENCO's Stable Isotopes business harnesses our centrifuge technology and enrichment processes to enable progress in these fields.



Since 1990, Stable Isotopes has used its expertise and capabilities in centrifuge technology to produce a variety of these isotopes and is continuously exploring potential new applications. Our Stable Isotopes business applies the enrichment principle to a range of elements, working in partnership with customers across the USA, Europe and Asia to deliver the high-quality materials they need for research and product development.

Based in Almelo in the Netherlands, Stable Isotopes is testament to our commitment to continual development. The company's product range includes several dozen isotopes of more than ten elements, with research being carried out into many more. Committed to the highest standards of quality and continuous improvement, Stable Isotopes aims to broaden the diversity of its portfolio to meet the demands of its specialist and high-tech customer base.

# Industry

Stable lsotopes generates the majority of its sales from products with an industrial application. The most important products in this field are depleted zinc oxide and depleted zinc acetate (DZO/DZA), for which we supply a significant proportion of the world market. DZO and DZA are used as a corrosion inhibitor in nuclear reactors. They also reduce the already minimal dose rate of maintenance workers in nuclear power plants and are widely deployed across the nuclear energy industry.

### Medicine

Stable Isotopes focuses on two specific areas of the medical market – diagnostics and therapy. Approximately 100,000 people in the Europe Middle East and Africa (EMEA) region benefit from radioactive diagnostics produced from Stable Isotopes' products.

Using isotopes, images can be obtained via a gamma camera in nuclear diagnostics. Gamma cameras can accurately detect disease progression and staging in vital organs. Stable Isotopes' products are used for a range of diagnostics applications, including for respiratory, thyroid and pulmonary diseases, as well as infections and inflammation.

Stable Isotopes is also producing materials that assist in the application of brachytherapy, the procedure of using temporary irradiation very close to an area of disease (in particular cancer and stenosis). There are also significant opportunities in the area of palliative care of pain arising from secondary metastasis derived from the spread of breast, prostate and lung cancers. Stable Isotopes also helps to advance medical science by participating in the EU sponsored 'Trace 'n Treat' programme, which is aimed at training students in the area of molecular technology for nuclear imaging and radionuclide therapy.

### Research

Stable Isotopes collaborates with research institutes in the fields of nuclear physics, health and nutrition. Several of Stable Isotopes' products have been used to create super heavy elements or study extremely small particles such as neutrinos.

The company's enriched zinc products have been used in nutrition studies focused on optimising the diet of children in developing countries.

### **Future developments**

Looking ahead, Stable Isotopes is exploring ways to increase the flexibility of its production capacity so it can respond to changes in the market and continue to meet customer demand. R&D projects include several products that can be used for the production of radioisotopes for therapeutic and diagnostic purposes.

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