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Recycling, a strategic asset for the nuclear industry

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“It is urgent to initiate the low-carbon transition”
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To achieve the carbon neutrality objective by 2050, the challenge is immense – it involves no less than converting 80% of the energy used by humanity within the space of 30 years, by switching from fossil energy sources to low-carbon ones. With such a challenge, the issue is no longer renewable energies versus nuclear energy. There will be renewable energies, that’s a fact. Nuclear energy will also be needed. This is essential for three reasons.

Firstly, a developed society needs energy in general, and electricity in particular 24/7 for manufacturing, travel, heating, etc. We therefore need sources of power generation that are available continuously and on demand. Nuclear energy meets that need.

Secondly, in a world with a population that is growing, having reached nearly 8 billion people, the preservation of the climate and resources has become primordial. In this regard, nuclear power emits 40 times less CO2 than gas... and even 4 times less than solar power. It also uses a very small amount of raw materials: 100 grams of uranium produce as much energy as one metric ton of oil.

Lastly, everyone on this planet is yearning for development, for themselves and for their children. Is the degrowth advocated by certain people compatible with this aspiration? I don’t think so. There will be no development in degrowth, but only through science, industry and innovation. This is also something that the nuclear industry provides, notably in France and particularly at Orano, with high-skilled jobs, sustainable industrial areas in the regions, men and women who invent tomorrow’s technologies and who are more than ever committed to fighting climate change.

It is thus with genuine pride that I assume the chairmanship of the Board of Directors of Orano – a great French and international company recognized for its expertise and technological know-how. I will strive to write a new chapter in its history, in a global context marked by an unprecedented health crisis and the challenge posed by global warming.

Editorial by Claude Imauven
Chairman of the Board of Directors

www.orano.group
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能源是我们的未来。不要浪费！
Orano signs a contract with Russian group Rosatom for a future depleted uranium defluorination facility on the Zelenogorsk site. Orano will supply the construction equipment as well as technical assistance for the installation and commissioning of the facility.
SERVICES TO POWER PLANTS

Orano signs a contract worth nearly €100 million with EDF for the provision of services until 2024, with the option of two additional years, to support the operation of the nuclear power plants of Paluel (Seine-Maritime), Civaux (Vienne) and Gravelines (Nord).
AND ALSO...

→ PNGMDR
FROM APRIL 17 TO SEPTEMBER 25, 2019
Orano played an active role in the public debate held in preparation for France’s 5th National Radioactive Waste and Materials Management Plan 2019-2021 (PNGMDR). This is a first in the review of the PNGMDR.

→ Enhanced cooperation with Japanese electricity company TEPCO
OCTOBER 3, 2019
This agreement concerns the dismantling of facilities on the Fukushima site. Orano will provide its expertise for the design, construction and operation of buildings dedicated to the retrieval and packaging of nuclear waste. It will also provide TEPCO’s teams with its technical know-how in the operation of facilities dedicated to the processing, management and storage of radioactive materials.

→ Two new dismantling contracts in Germany
OCTOBER 2019
Electricity company RWE awards a contract to Orano and EWN for the entire Mulheim-Kärlich site, as well as a contract for two additional lots on the twin reactors of the Biblis power plant. Operations mainly conducted under water, using proven remote-controlled robot technology.

→ Japanese electricity company NFI renews its confidence in MOX fuel production
FEBRUARY 5, 2020
Contract won for the production of 32 MOX fuel assemblies for reactors 3 and 4 of the Takahama nuclear power plant operated by Kansai Electric.

→ Replacement of the dissolver wheel in the R1 facility of the la Hague plant
FEBRUARY 2019
Large-scale maintenance operation performed in record time thanks to numerous technological innovations.

→ Commercial qualification of UF₆ produced by the Philippe Coste plant
OCTOBER 2019
Being the world’s most modern uranium conversion facility, the Philippe Coste plant supplies uranium hexafluoride to the Georges Besse II enrichment plant.

→ Start of construction of the UO₂ unit at Malvési
OCTOBER 2019
A major milestone was reached in the project with the pouring of the “first concrete” for the new facility. It will allow the production and marketing of up to 300 metric tons of uranium per year in the form of a high-quality oxide.

→ Successful drop test for the TN® Eagle cask
DECEMBER 2019
A technical feat that makes it possible to file for approval with the French Nuclear Safety Authority (ASN) and deliver the first casks in 2022.

Orano mobilized to cope with the Covid-19 pandemic

In the face of the global Covid-19 pandemic, the Orano group took full account of the scope of the health crisis at a very early stage, firstly to safeguard the health of its employees. From the end of January 2020, Orano informed its employees of the precautions to be taken in relation to the epidemic unfolding in China. As it developed, the group regularly informed its staff, as well as its service providers, on barrier measures. Face masks were also distributed. Ensuring the safety of everyone in the workplace remains an absolute priority. Thanks to employee commitment and mobilization, Orano was able to continue those of its activities necessary for power generation, either totally or partly, while ensuring the safety and protection of the people working on site. This health crisis has shown how the nuclear industry is key to ensuring continuous power generation, which is indispensable for all citizens. In a context of global crisis, Orano remains committed to its electric utility customers throughout the world.
At the helm of Orano since its creation, Philippe Knoche is an ambassador convinced by the importance of nuclear energy in the low-carbon transition. Flashback on statements that confirm the group’s involvement in the global warming debate. Extracts.

**France Info – “Le 6 h/9 h 30” – Interview**
NOVEMBER 26, 2019

“We need to explain to people that, without nuclear energy, we would emit more CO$_2$.”

**L’Opinion – Interview**
SEPTEMBER 12, 2019

“It is important that people understand that nuclear energy provides an opportunity to combat climate chaos. And that Orano remains a precious technological gem for the country.”

**Franceinfo:**
NOVEMBER 14, 2019

“We need to explain to people that, without nuclear energy, we would emit more CO$_2$.”

**No** need here to convince you of the imminence and scope of the impending climate challenge. Re-establishing the truth on nuclear energy is thus a key issue for the industry, but it is also crucial for the whole of society, who must make informed decisions to efficiently combat global warming, using realistic solutions.

Most studies forecast that electricity consumption will double by 2050, solely on the basis of the global population increase and the growth of developing countries. Today, 1 billion people are still without electricity. However, this challenge must be met while drastically reducing CO$_2$ emissions.

The simulations made by the IPCC(1) speak for themselves. To maintain global warming below the 2 °C target, aggregate CO$_2$ emissions since the start of the industrial revolution should not exceed 3,000 Gt CO$_2$.

Yet, at the end of 2017, we had already emitted over 70% of that aggregate amount. If we do nothing, at the current pace of production, we will have reached that limit within 20 years or so. The deadline may seem far away, but the battle must be won right now. The countdown has started. In this regard, nuclear energy provides concrete and realistic solutions for the low-carbon transition. It is in a key position to contribute, alongside renewable energies, to tackling the major climate challenges, whose effects are now an obvious reality.

(1) IPCC: Intergovernmental Panel on Climate Change.
Philippe Knoche

CHIEF EXECUTIVE OFFICER OF ORANO

"Coal was the energy of the 19th century, and oil was that of the 20th century. CO₂-free electricity will be that of the 21st century."

"69% of French people believe that nuclear energy contributes to climate change."

"Orano wants to be a driving force in the urgent fight against climate change."

"10% of nuclear electricity in France is produced from materials recycled by Orano."

Nuclear energy contributes to the production of low-carbon electricity. The world’s nuclear power fleet thus avoids the emission of 2 billion metric tons of CO₂ equivalent per year, i.e. the equivalent of the production of 400 million cars. However, nuclear energy is also an energy that saves on raw materials through recycling: at present, the raw materials recycled by Orano produce electricity for one out of every ten lightbulbs powered by nuclear energy in France.

Recycling reduces the consumption of natural resources by preserving energy resources: 100 grams of uranium produce as much energy as one metric ton of oil. It also allows a 5-fold reduction in the volume of the most radioactive waste and a 10-fold reduction in its long-term radiotoxicity.

Our ambition for tomorrow is to recycle even more and with other applications. We already achieve this with lead-212 for cancer treatments. We are now working on the re-use of radioactive isotopes for batteries with a very long lifespan, as well as for the aerospace industry and medical research. And in power generation, the goal is to produce more than 30% nuclear electricity from recycled materials.

To find out more: read our feature on recycling on page 16.
PRECONCEIVED IDEAS

“Nuclear energy: an industry that is recruiting and innovating.”

With 2,600 businesses and over 200,000 jobs, nuclear energy is currently France’s third biggest industry, behind the aeronautics and automotive industries. It is a high skill industry that recruits over 7,000 people per year for technical jobs with high added value, and the French know this: 56% of them (and 67% in the 18-34 age group) consider nuclear energy as a job-creating industry. Orano accounts for 16,000 employees worldwide, including 13,000 in France, mainly in Normandy, Auvergne-Rhône-Alpes, Occitanie and Île-de-France. And the group is still recruiting, with 1,000 new hires on open-ended contracts planned for 2020, as many as in 2019. Nuclear energy is also a major economic and political asset for France. 77% of people living near the sites of la Hague and 68% of those living near Tricastin/Melox consider Orano’s industrial sites to be safe.

Answers to nuclear energy preconceptions

Fake or not fake?

In April 2019, BVA and Orano conducted a survey of 3,000 French people over the age of 18 to find out more about their knowledge and perceptions of the nuclear industry.

More answers on our website: https://www.orano.group/ideesrecues/

“It’s dangerous!”

According to the survey conducted by Orano and BVA, the production of non-recyclable waste and the risk of accidents are what worry people most. Yet, 96% of the used fuel is recyclable, and the nuclear industry’s safety and security requirements are the most stringent of all industries worldwide. Nuclear operators are in charge of the cleaning, maintenance and servicing of their facilities in order to minimize any accident risk and anticipate abnormal situations. Thus, on Orano’s nuclear sites and transport equipment, 100 crisis drills are conducted each year in-house and/or with local authorities. However, people’s perception is not the same throughout the country. The majority of people living near the sites of Orano la Hague and Orano Tricastin consider them safe.

“It’s not transparent!”

The nuclear industry is very strictly controlled and overseen by the authorities. The French Nuclear Safety Authority (ASN) regularly conducts both scheduled and unannounced inspections. Any anomaly or incident on a nuclear site is reported to the authorities. Moreover, the notion of information and transparency concerning nuclear operations has been enshrined in French law since 2006. In this respect, publications are produced annually by nuclear operators and made available to the public, in particular via the websites of companies in the industry. Orano thus publishes transparency and nuclear safety (TSN) reports for the plants of la Hague, Tricastin, Melox and Malvési. Nuclear energy is often the subject of public debates, such as for the 5th National Radioactive Waste and Materials Management Plan (PNGMDR).

“An energy of the future”

To meet global needs, society is facing a dual challenge: increasing power generation while reducing our greenhouse gas emissions. The sources of low-carbon energy have been clearly identified: nuclear energy and renewable energies. By nature, renewable energies are intermittent – they depend on the sun or wind, for example – and electricity cannot be stored on a large scale. They cannot, on their own, ensure stable power generation. They must be backed by another source of adaptable, low-cost and low-carbon energy. French people know that nuclear energy is the only energy that meets these criteria: 54% of them think that tomorrow’s energy mix will consist of nuclear and renewable energies.

“It’s expensive!”

For over two-thirds of French people, nuclear energy is an energy which is expensive to produce. Major investments are of course required for the construction of power plants: their operation, maintenance and dismantling. However, all these expenses are costed right from the project design phase, and put into perspective in relation to the income generated by nuclear energy for France. Result: nuclear energy is actually one of the least expensive sources of electricity, allowing France to have an electricity price which is among the lowest in Europe.

70% This is the extra paid by a German household for its electricity bill compared to a French household.

69% of French people think that nuclear energy produces CO2 and contributes to climate change. In actual fact, nuclear energy is one of the energies that emit the least amount of greenhouse gases in the world. Its very low level of CO2 emissions makes it an indispensable energy for the low-carbon transition. All of the IPCC’s scenarios call for more nuclear energy. If the current trend continues, to comply with the climate targets we will need to increase global nuclear capacities by a factor of 6.

The nuclear industry is also very respectful of the natural environment it needs to supply electricity, i.e. uranium ore. 61% of French people think that the fuel used in power plants to produce electricity can be recycled, and they are right! The recycling of used fuel makes it possible to preserve natural resources and reduce the volume of the most radioactive waste.

PRODUCTION OF CO2 (MtCO2/yr)

<table>
<thead>
<tr>
<th>Fuel</th>
<th>820</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>490</td>
</tr>
<tr>
<td>Solar</td>
<td>48</td>
</tr>
<tr>
<td>Nuclear</td>
<td>12</td>
</tr>
<tr>
<td>Wind</td>
<td>11</td>
</tr>
</tbody>
</table>
More than 50 years ago, France opted for the recycling of used fuel in order to recover nuclear materials and reduce the quantity and danger of the most radioactive waste. The recoverable materials can be re-used to make new fuel that will in turn be used to produce electricity. In France, 10% of nuclear electricity comes from recycled materials. An expertise that is recognised worldwide and exported.

Two plants handle used fuel treatment and processing operations for French and foreign electricity companies. Located 25 kilometers to its west of Cherbourg, the Orano la Hague site treats used fuel coming from nuclear reactors, for its first recycling phase. It is the world’s largest industrial facility of this type, with over 36,000 metric tons of used fuel already treated, of which 25,000 for EDF. Located in the Gard department, the Orano Melox site produces MOX fuel assemblies to power light-water reactors in various countries. Melox is the world leader in this market, with over 2,800 metric tons produced since the commissioning of the plant.

Thanks to Orano’s technologies, which are unique in the world on an industrial scale, 96% of the used nuclear fuel used in reactors is recyclable.
Production of MOX fuel in the Orano Melox plant (Gard).

**ANALYSIS**

10,000 metric tons of fuel out of a capacity of 14,000 metric tons, i.e. 70% of their total capacity. At the current filling rate, these pools can still take in the equivalent of around 10 years’ storage. By recovering a large part of the nuclear materials, recycling avoids the accumulation of used fuel in pools.

THE VIRTUES OF RECYCLING

Recycling reduces the consumption of natural resources, while also reducing the volume of the most radioactive waste by a factor of 5 and its long-term radiotoxicity by a factor of 10. Recyclable materials as a whole represent a considerable energy reserve – the equivalent of 8 years of electricity consumption in France. For people in France, the cost of recycling represents less than 2% of the country’s total electricity bill.

**TOTALLY SAFE FUEL HANDLING AND STORAGE BEFORE TREATMENT**

On arrival at the site of la Hague, used fuel is extracted from its packaging. The operation is conducted remotely, using automated equipment in rooms with 1.2-meter thick concrete walls. Once unpacked, the fuel is placed in a pool, under 9 meters of water, for a period averaging 5 years, during which its temperature drops, its radioactivity thus decreases in a natural way.

**SEPARATION OF COMPONENTS AND RECOVERY OF RECYCLABLE MATERIALS**

After storage in the pool, the used fuel is sheared and then immersed in a nitric acid solution that dissolves the nuclear material. A chemical unit is tasked with separating the recyclable materials from the non-recyclable final waste. At the end of these operations, 96% of the material can be recovered. The plutonium and uranium are then separated and purified. The plutonium is mixed with depleted uranium to produce a new fuel – MOX – which is a mixture of uranium and plutonium oxides.

**SAFE AND RELIABLE PACKAGING OF FINAL WASTE**

Only 4% of the nuclear materials stemming from used fuel ends up as waste. This consists of fusion products. They are calcined and then vitrified, i.e. mixed with molten glass and then poured into stainless steel containers. This packaging provides safe and stable storage for tens of thousands of years and is certified by 10 safety authorities around the world. This waste represents a small volume: 5 grams per year per inhabitant, i.e. the weight of a 20 euro-cent coin. Structural metal component waste is compacted and put into containers. France has thus chosen a safe and responsible way of handling its waste.

**TEMPORARY STORAGE THAT IS SAFE AND SUSTAINABLE, PENDING FINAL STORAGE**

French waste is stored on the Orano la Hague plant in dedicated premises, pending its transfer to the deep geological repository planned under the Cigéo project. The recycling of nuclear materials reduces the risk of saturation of the long-term storage facilities. The pools at the Orano la Hague plant currently contain 10,000 metric tons of fuel out of a capacity of 14,000 metric tons, i.e. 70% of their total capacity. At the current filling rate, these pools can still take in the equivalent of around 10 years’ storage. By recovering a large part of the nuclear materials, recycling avoids the accumulation of used fuel in pools.

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**THE 3 VIRTUES OF RECYCLING**

- Saves natural resources
- 5-fold reduction in the volume of the most radioactive waste
- 10-fold reduction of that waste’s radiotoxicity over the long term

**A HIGH-SKILL INDUSTRY**

This assembly stemming from the recycling of used fuel has already been used to power 44 reactors across the world and contributes to the supply of 10% of the nuclear electricity produced in France. A great source of energy for the future: the use of MOX in France has avoided the use of 18,000 metric tons of natural uranium, representing more than 2 years of consumption for the French nuclear fleet. Starting in 2025, the recycling of the uranium contained in used fuel will bring the amount of electricity produced with recycled materials to 25%. This figure could increase to 30% with MOX 2 – a new type of fuel produced from the multi-recycling of nuclear fuel – which will be used in pressurized-water reactors and, subsequently, in a new generation of fast neutron reactors.

**DID YOU SAW MOX?**

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**DISCOVER THE PRODUCTION OF MOX ON VIDEO**

1 gram of plutonium or 100 grams of uranium have the same energy potential as 1 metric ton of oil.
Economies of raw materials linked to recycling

10%

Today

Plutonium recycled

25%

2025

Uranium recycled

+ plutonium recycled

30%

In the future

Uranium recycled

+ plutonium recycled

+ multi-recycling

A STRATEGIC INDUSTRY FOR FRANCE

Orano is a leading international player in the treatment and recycling of fuel. The recycling technologies are used, or have been used, by numerous countries: UK, France, Belgium, the Netherlands, Germany, Switzerland, Italy, Russia, Australia, Japan and China. Electricity producers that call on Orano must handle the waste from their recycled used fuel in their own country, as required by French law. Under France’s Multi-Year Energy Program (Programmation pluriannuelle de l’énergie – PPE), the French Government confirmed the choice of treatment-recycling for the management of used fuel. The recovery of the materials is crucial for the future: numerous research avenues are being explored to separate or treat other radioactive components of used fuel and further reduce the remaining portion of final waste.

A COUNTRY THAT USE OR HAVE USED RECYCLED USED FUEL

UK, France, Belgium, the Netherlands, Germany, Switzerland, Italy, Russia, Australia, Japan and China.

Glovebox training, Ecole des métiers, la Hague.

SAVING RAW MATERIALS BY RECYCLING

5-fold reduction in the volume of high-level waste

1 assembly of MOX fuel can light a city of 100,000 people for a year

96% of used fuel is recyclable

5% Recyclable material

96% Uranium

25% Plutonium

10% Fission products

04% Structural metal components

PNGMDR: A PUBLIC DEBATE

Between April and September 2019, a public debate took place concerning the 5th National Radioactive Waste and Materials Management Plan (PNGMDR).

The aim was to take stock of existing management methods for radioactive waste and materials, while assessing needs in terms of storage facilities for those which still do not have a final management solution. Following the publication, on September 25, 2019, of the summary and round-up of the debate, the French Ministry for the Ecological and Inclusive Transition and the French Nuclear Safety Authority announced their decision regarding the preparation of the next PNGMDR.
It is urgent to commit to the low-carbon transition

Energy and climate expert Jean-Marc Jancovici calls on us to heed the urgency of taking action to tackle global warming.

Experts’ reports on the climate emergency are proliferating. Where do we currently stand?

Jean-Marc Jancovici: The intense “development” that our species went through in the 19th and 20th centuries was essentially based on the growth of abundant, seemingly limitless energy, accessible to a large number of people with an army of mechanical slaves, ranging from mills to container vessels, and tractors to cranes, as well as textile plants, telecommunications networks, etc. For more than 40 years now, these fuels have accounted for over 80% of the world’s supply of energy, which is constantly increasing, feeding a fleet of machines that does likewise.

As a result, CO₂ emissions have seen exponential growth, unhindered by the numerous climate conferences and experts’ reports. These emissions are increasing greenhouse gases, which inject more energy into the climate mechanism and alter it. This gives rise to changes in temperatures, rainfall, the frequency and intensity of fires, floods, droughts, storms and other “anomalies”, the melting of the ice caps and glaciers causing a rise in sea levels that will exceed several meters and, in the end, harsher living conditions for a growing proportion of the world’s population.

Is it too late to act?

J.-M. J.: Since excess CO₂ will remain in the atmosphere for a very long time, the consequences will continue to intensify long after we have started to lower emissions. Consequently, when we are at a standstill, it won’t be enough to just move into first gear; we need to go straight into fifth. Very clearly, to meet the target of limiting global warming to below 2°C, we need to start lowering man-made greenhouse gas emissions by 4% a year, starting tomorrow. This would allow a 3-fold reduction in global emissions by the time my children reach my age. How? By drastically reducing our consumption, and by opting for low-carbon energy sources such as nuclear energy and renewable energies, with the latter often being more appropriate for heating than for electricity.

On a global scale, we firstly need to shut down all power plants running on coal, gas or oil. Domestically, priority actions concern buildings (insulation, low-carbon heating using heat pumps and wood), transportation (reduction in the weight and power of cars, use of public transit systems, urban development programs, short supply circuits, etc.), etc.

What is the place of nuclear energy in the energy transition?

J.-M. J.: Based on the fission of a nucleus, rather than on the combustion of organic residues (fossil fuels), nuclear energy is one of the low-carbon energies (despite the emissions linked to upstream and downstream operations) with emissions 50 times lower than those of gas-generated electricity and 150 times lower than those of coal-generated electricity.

Yet nuclear energy only produces 10% of the world’s electricity. This proportion must increase rapidly for this technique to contribute to a reduction in emissions. In France, there is a gulf between the perception of risks in civil nuclear power and actual facts. For example, 69% of French people think that nuclear energy contributes to global warming (while the nuclear reaction actually emits zero CO₂), and that nuclear waste (which has never caused a single death) poses more risks than road accidents or domestic accidents (the latter accounting for 20,000 deaths per year in France). Nuclear energy is often seen on an equal footing with climate change (a choice between a rock and a hard place), even though climate change has the potential to reduce the life expectancy of billions of people. They are not in the same league!

What about renewable energies?

J.-M. J.: These are historically the energies we used before fossil fuels (sun, wood, wind and water). Wind and solar power – which are the most frequently mentioned in speeches and in the amounts invested – are not in the same league as nuclear energy, which is due to the great chemical stability of CO₂. Because CO₂ is inert in the atmosphere, climate change will continue to amplify for decades, centuries or millennia, depending on how we look at it. However, the cards we still hold will enable us to reduce the impact for our children and our grandchildren. It’s up to us to act!

If we want to preserve most of these “modern” comforts while combating climate change, nuclear energy will provide that as a supplement to renewable energies, which are better suited for heat production (fuel, manufacturing industry, heating) rather than electricity.

You’re often branded as pessimistic, even alarmist...

J.-M. J.: People prompting others to look at problems in a realistic way are often faced with the same criticism, but I would much prefer to have only good news to share with people.

The persistence of climate change is one of the most staggering things: if tomorrow we suddenly stopped emitting greenhouse gases worldwide, in one hundred years’ time, 40% of the excess CO₂ we have created would still be there after a thousand years. This persistent effect is due to the great chemical stability of CO₂. Because CO₂ is inert in the atmosphere, climate change will continue to amplify for decades, centuries or millennia, depending on how we look at it.

“Theour economic systems have not yet taken into account the finite nature of the planet’s resources, and the world is hooked on fossil fuels. In Europe, we have been under an energy decline since 2007, which weighs down our economies’ GDP growth.”

Jean-Marc Jancovici

Partner at Carbone 4, a carbon strategy consulting firm
Founder and Chairman of the think tank The Shift Project
Lecturer at Mines ParisTech

Jancovici Lecturer at Mines ParisTech Partner at Carbone 4, a carbon strategy consulting firm Founder and Chairman of the think tank The Shift Project Lecturer at Mines ParisTech
GLOBAL WARMING

With climate change, the dwindling of fossil resources and CO₂ emissions continuing their mad rush into the atmosphere, it is urgent to take action worldwide to drastically tackle global warming. The equation is simple: we need to limit the rise in temperatures to below 2 °C between now and 2050, while doubling our power generation to meet global demand. The 21st century will be that of low-carbon electricity.

PEAK, DID YOU SAY PEAK?

In 2008, global production of conventional oil (nearly ¾ of total oil production) peaked at 69 million barrels a day (Mb/d), subsequently falling by a little more than 2.5 Mb/d. The International Energy Agency (IEA) deems that this decline is irreversible, confirming forecasts made in the late 1990s due to the gradual dwindling of underground oil reserves.

NUCLEAR ENERGY, THE PRIME SOURCE OF LOW-CARBON ELECTRICITY

In OECD countries, nuclear energy accounts for 40% of low-carbon power generation.

WE HAVE TO ACT... QUICKLY

Despite the string of climate conferences, CO₂ emissions keep rising, judging by the atmospheric CO₂ concentration measured since 1995. Who can rein in the runaway of climate mechanisms?

Nuclear energy accounts for 40% of low-carbon electricity in OECD countries.
"The management and development of skills are strategic issues for Orano"

Hélène Derrien
Head of People & Communications for the Orano group

What is your approach to HR management? Hélène Derrien: Our role is to support the corporate project by bringing all employees together with the same vision. After the group’s reconfiguration, we are entering a new phase of the transformation – that of development, which must be responsible and human – with the will to work on Orano’s attractiveness, the development of skills and career paths, the commitment of everyone and new ways of working. All of this in an environment that prioritizes quality of life at work.

How can Orano be attractive? H. D.: Firstly by providing meaning. Joining Orano means joining a highly-skilled industry recognized worldwide and involved in the energy transition and the fight against global warming by contributing to the production of a low-carbon and safe energy of the future. It also means getting involved in a dynamic project environment, with stimulating assignments and challenges.

Kevin Longuet de la Giraudière,
Manager of the Chemical and Enrichment Facility on the Tricastin site

"Nobody should feel trapped in their job. If someone has a dream or a goal, Orano will help them build a path to achieve it. I’m very happy to have made this choice."

Kevin went on numerous trips to carry out assignments for Orano Mining. But it was in France that his life really changed. After having worked with the Orano Mining teams, his yearning to get back to the fundamentals of his engineering profession took hold. It was then that he asked for a transfer to the Tricastin site, in the production teams, and more specifically in performance. Leaving Paris and the world of strategy for an operational position is the biggest step that Kevin had to take in his career at Orano.

He delved into a new world, with new habits to be adopted and a vocabulary to re-learn. Kevin rose to that challenge through successful integration and the help of his new colleagues. Today, he is already in his third job at the Tricastin site. He gradually took on more responsibilities as his skills developed. After his role in performance, he became Head of Production and then Facility Manager in the Georges Besse II enrichment plant. His stint in production improved his knowledge and comprehension of the industrial environment – a must at Orano, where the safety and security culture is omnipresent.

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Kevin Longuet de la Giraudière, Manager of the Chemical and Enrichment Facility on the Tricastin site

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With touch screens, applications dedicated to the life of the site, holographic terminals and collaborative tools, the move into the new headquarters Prisme building is accompanied by more digital technology, more sharing and more cross-functionality.

At Orano’s new head office in Châtillon, transformation and innovation can be seen everywhere. The work environment is mobile and connected, and the open-space premises promote sharing, closeness and conviviality. Training sessions are provided to enable everyone to master the digital and connected tools. These new ways of working are also applicable to the Executive Management and will eventually be deployed group-wide.

“By including more diversity, we increase performance.”

HÉLÈNE DERRIEN

“Coach” to help their staff develop in their jobs, and imagine, with each person, their advancement prospects within the organization. This is a crucial stage of managerial transformation: giving employees the means to remain committed and have confidence in the future.

Has the Orano group adopted new ways of working?

H.D.: Yes, these have been around for a while now, but the use of new ways of working was stepped up with the fitting out of our new head office building – Le Prisme – in Châtillon. The site has focused on open spaces, the digitalization of tools, a flex-office approach for greater cross-functionality, interaction and a quicker response. Everything has been designed to create conviviality and fluid exchanges. We also promote remote work, in line with the wishes of a large number of employees. We strive to give all Orano employees the means to blossom in an attractive work environment.

How do you adapt the skills to industry needs?

H.D.: Every year, Orano conducts a skills review. This mapping provides us with a vision of the skills to maintain, integrate and train, and enables us to identify job sectors experiencing skills shortages and feed back individual needs. Three thousand training courses are offered to employees to support their skills development. The courses are provided by the École des métiers as well as through reference pathways and independent modules to fit in with each employee’s requirements. We are proud to have very highly-skilled jobs in our specialized industry and a level of expertise recognized worldwide through our 700 experts. For us, the development of skills is a key requirement for the recognition and expertise of our activities. We attach special importance to this as it is essential to reach the highest level of human expertise and technical knowledge to ensure the satisfaction of our customers.

Orano is a young company, recognized for its high tech, its innovation culture, its international scope and its job diversity. Another factor is its attractiveness: we give every employee the means to carve their own career paths and employability, get training throughout their careers and bounce back on new paths. We also want to be inclusive by promoting profile diversity and integrating people with disabilities in our jobs. This also involves taking in trainees on work-study programs, gender diversity within the teams and the recruitment of beginner and experienced profiles from all types of backgrounds.

We hire over 1,300 people on permanent contracts every year, and we have regular exchanges with labor representatives to set up programs to promote the development of employees.

“We wanted Prisme to be a welcoming place for all Orano head-office employees, with bright, comfortable spaces, along with small and medium-sized meeting rooms, and warm, common spaces. The site was designed with the help of numerous employee volunteers. As a result, the teams moved into this new head office with enthusiasm as it meets their expectations, and they have had time to imagine themselves in it.”

Laurence Levallois
Manager of the Prisme project

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Laurence Levallois
Manager of the Prisme project
RECYCLING
WHAT
GLoveBox
IN THE CASING UNIT
WHERE
Orano Melox
The Orano Melox plant produces MOX fuel assemblies stemming from recycled used fuel to power light-water reactors in various countries. Melox is the world leader in this market, with over 2,800 metric tons of MOX fuel assemblies produced.

ENRICHMENT
WHAT
RecII Storage Facility for 48 Y Cylinders
WHERE
Georges Besse II Enrichment Plant
The fully renovated Orano Tricastin site has the world's most modern facilities. It is a specialist in several essential activities in the nuclear fuel cycle: conversion, enrichment and transformation of uranium, as well as the maintenance and storage of uranium matter shipping casks.

MINING
WHAT
Ore Processing Plant
WHERE
Muyunkum Site (Kazakhstan)
In Kazakhstan, as part of the Katco joint venture, Orano is the largest ISR mining player with over 40,000 metric tons of uranium produced since 2006. In-Situ Recovery (ISR), which is suited to deposits with a low uranium content, is a competitive and environmentally-friendly exploration technique.
**CONVERSION**

**What**

Flame Reactor

**Where**

Philippe Coste Conversion Plant

At the new Philippe Coste plant, a flame reactor is used to transform UF₄ (uranium tetrafluoride) into UF₆ (uranium hexafluoride). This is the second stage in uranium conversion. The UF₆ will subsequently be enriched before undergoing a quality check.

**ORANO PROJECTS**

**What**

Employee Using Virtual Reality with a VR Helmet

Since 2012 and the creation of the first virtual reality room, Orano Projects has thoroughly mastered these technologies, which make it possible to handle, observe and analyze engineering projects, and optimize construction projects.

**DISMANTLING**

**What**

Dismantling of Large Components of the Primary Cooling System

**Where**

Würgassen Power Plant, Germany

Orano has developed cutting-edge expertise in reactor core cutting processes, relating to the equipment inside the vessel, the vessel itself or the dismantling of the primary coolant loop, involving waste packaging and disposal.

**TRANSPORT AND PACKAGING**

**What**

Arrival at the Rail Terminal for Used Nuclear Fuel

**Where**

Valognes

The containers are designed to be genuine steel fortresses, with up to 100 times more steel than the radioactive substances transported. To ensure their robustness during transport, they undergo extremely severe crash tests to test their resistance to falls, fire and water. These containers comply with stringent international regulation.

**PORTFOLIO**
**ORANO MED**

**WHAT**
Deposit on a filter of a drop of lead-212

**WHERE**
Orano Med – Bessines-Sur-Gartempe

Lead-212 is a rare radioactive isotope produced by Orano Med for cancer treatment. It is used in targeted alphatherapy, an innovative approach in nuclear medicine making it possible to target and destroy cancer cells while limiting the impact on surrounding healthy cells.

**DISMANTLING AND SERVICES**

**WHAT**
Robot Riana™ SC

This miniature robot allows the safe and reliable radiological mapping of containers.

**ORANO TRICASTIN**

**WHAT**
Report on a reactor of a drop of lead-212

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**PORTFOLIO**

**ALL OUR ACTIVITIES ON VIDEO**

**ENRICHMENT**

**WHAT**
Georges Besse II

**WHERE**
Orano Tricastin

Recognized as Europe’s largest enrichment complex, the new Georges Besse II platform provides the best guarantees in terms of competitiveness, energy saving, technical reliability and reduction of the environmental impact. The production plant uses the latest generation centrifuges available worldwide.

**TRANSPORT AND PACKAGING**

**WHAT**
Transport of MOX fuel

**WHERE**
Cherbourg

Orano TN is the world’s no. 1 nuclear transport player, handling over 5,000 transport operations per year by rail, road or sea for its customers: nuclear electricity companies, fuel-cycle players and research institutes. All transport operations are continuously monitored in real time. Pacific Egret is one of the world’s safest ships. It handles the safe shipment of MOX fuel from the Melox plant to Japan, which required 2 years of preparation and a 2-month journey.

**DISMANTLING AND SERVICES**

**WHAT**
Robot Riana™ SC

This miniature robot allows the safe and reliable radiological mapping of containers.

**ORANO MED**

**WHAT**
Deposit on a filter of a drop of lead-212

**WHERE**
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Lead-212 is a rare radioactive isotope produced by Orano Med for cancer treatment. It is used in targeted alphatherapy, an innovative approach in nuclear medicine making it possible to target and destroy cancer cells while limiting the impact on surrounding healthy cells.
This professional training center is unique in France in the Trihom network. It enables professionals working in other industries to learn about nuclear energy or improve their knowledge in four major areas: dismantling, welding, piping systems, and bolted assemblies. This center aims to increase French expertise in strategic professions that require high-level technical skills and safety. It materials the will of all players to make the French industry an industry of excellence and provides solutions for job sectors experiencing shortages.

Over 2,500 professionals from the nuclear industry and other sectors are expected every year in this training center or on one of the adjacent training worksites.

In September 2019, the leading French player in nuclear training – an Orano subsidiary – inaugurated training facilities of over 2,200 m² in Beaumont-en-Véron, Val de Loire. In these new facilities, built at a cost of €3 million, a new professional skill development center opened up for nuclear industry players, among others.

Trihom is a training institute and a subsidiary of the Orano group. It provides certificate-based training solutions on training worksites, which are identical reproductions of nuclear facilities, but without the radiation risk. Its offering comprises over 300 tried and tested courses, as well as an engineering department able to design custom modules using innovative technologies: e-learning, animated design, and virtual reality.

For the past 33 years, I’ve been working in industrial welding and piping systems, whether in the petrochemical, pharmaceutical, or nuclear industries (including 10 years of management in EDF’s nuclear fleet). I am therefore skilled in all welding processes, which I am proud to pass on as a trainer and tutor – a role I’ve carried out for the past 15 years.*

Yann Bigot
In charge of the professional skill training center

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www.trihom.fr
Lead-212 is a very rare radioactive alpha isotope that comes from thorium. Orano’s expertise in cutting-edge nuclear technologies has made it possible to develop a unique process for the extraction and purification of lead-212. This rare metal is the subject of several avenues of research and is appearing in promising new treatments based on nuclear medicine called “targeted alphatherapy”. Compared with existing therapeutic methods (chemotherapy, radiotherapy, etc.), this innovative therapeutic approach should make it possible to recognize and destroy cancer cells in a selective way, thus limiting the impact on surrounding healthy cells.

TWO LEAD-212 PRODUCTION UNITS

It is in the Maurice Tubiana laboratory – unique in the world –, located in Bessines-sur-Gartempe, Haute-Vienne, that Orano Med extracts lead-212 of the required high purity for pre-clinical and clinical trials of new cancer treatments. The DDPU (Domestic Distribution and Purification Unit), located in Plano, Texas (USA), is a laboratory entirely dedicated to the development of new therapies based on lead-212 and to the production of lead-212. The site is also Orano Med LLC’s head office in the United States.

MAKING THE SUCCESS OF TARGETED ALPHATHERAPY A REALITY

Orano Med’s goal is to develop a new generation of targeted cancer therapies using the unique properties of lead-212. Its strategy rests on two objectives: developing a solid portfolio of lead-212 therapies and ensuring a reliable supply of this isotope. Orano Med’s expertise covers the chemical properties of lead-212, as well as lead-212 conjugation and radiolabeling technologies applicable to numerous biological molecules (antibodies, peptides, etc.) and capable of recognizing molecular targets expressed in various types of malignant tumors. These efforts are primarily aimed at pathologies for which there are still major needs for therapeutic solutions.

www.oranomed.com
Each reinforced concrete NUHOMS HSM is about 19 feet high, 9 ½ feet wide, and 20 ½ feet long — and weighs 306,100 pounds (including a 16,000-pound door). “This project was a huge undertaking by the entire team, taking months of planning and preparation,” said CNS Nuclear Projects Manager Chris Pelchat. “It will now allow Cooper to store all their used fuel on site, which supports operation through their current licensed operating date of 2034.”

The two teams quickly came together to sandbag the fabrication area and ensure dry areas to keep the project on schedule,” said Pelchat. From the Orano TN team’s perspective, Steve Bostic said, “We implemented our highest standards of operational excellence to deliver this cast-on-site project to our customer on time and within budget, in spite of the historic flooding that we experienced during execution.”

The team completed the five-month project on time, under budget, and with no safety or human performance incidents. As with any project, the countless moving parts and complexities due to each unit’s weight and size made this a major accomplishment. Everyone involved worked closely together as a single team to move through the project with purpose, predictability and precision. In his 15 years on the job, Pelchat said this project was the best experience he has ever had with an outside crew performing work on site.

In early fall 2019, a combined team from Orano TN and Cooper Nuclear Station (CNS) completed the fabrication and installation of 22 NUHOMS Horizontal Storage Modules (HSMs) for the future storage of used nuclear fuel at the CNS on-site interim dry fuel storage facility. Chris Pelchat, Nuclear Project Manager at CNS, and Steve Bostic, Project Manager at Orano TN US, tell us about their experience.

Steve Bostic
ON-SITE PROJECT COORDINATOR

“Our commitment to behave as partners in sharing ownership for problems and solutions never wavered, and ultimately sustained us throughout the safe and successful project.”

Vianney Bruned joined the teams at Orano Mining in February 2019 as a Data Scientist. Since then, he has travelled to numerous Orano mining sites, in particular in Niger, to create a Proof of Concept (PoC) that would make it possible to collect on-site data from the trucks and carry out predictive maintenance. My encounter with the operator in Niger was an eye-opener. As a Data Scientist, I work on a computer every day. Discovering the mining site, the pit and the Somaïr teams, and talking directly with the operator — it’s another reality. Operating a mine seems both difficult and fascinating. For this assignment, I had come with a process engineer. The aim was to help him on a data analysis project. But when I arrived on site, I realized that I didn’t have all the information I needed for further analysis.

My interest was thus drawn to another project under way: Truck Box. The idea is to install IoT tools in the trucks on the mining site to collect data (GPS, speed, engine temperatures, etc.) to carry out predictive maintenance. When I arrived, the teams were in the GPS data recovery phase. My involvement made it possible to reflect on how to make use of this data. I then worked on the more general issue of management of the fleet of trucks in collaboration with the managers of the operation to produce a PoC.

The idea was to set up a process and a web application that would provide better knowledge to the operator based on data from the mining cycles.

“A Data Scientist must work in close collaboration with on-site operators and technical experts. The success of a digital project rests on the combined work of the three professions.”
When they announced that I had won, I couldn’t believe it. I was stunned. When I left, my first reflex was to call my loved ones because, in my family, chemistry is a passion. Of course, I also told my colleagues who had supported me, so that they heard the news first-hand. I was extremely happy!

Among the candidates, I was particularly afraid of the Israeli one, because he had published a large number of papers in prominent scientific journals and had numerous contacts. However, after an hour’s deliberations, the panel announced the winner: it was France, it was me.

I had thoroughly prepared my presentation with the teams at Orano Projects, i.e. those from Communications and the Corporate Office, which financed the project. Microfluidics – which are already widely used in the medical sector – consists in massively reducing the volumes of samples and liquid and solid waste in the analysis of the fuel cycle. It has a dual interest: ensuring safety for operators and reducing costs.

On November 6, 2019, for the very first time, an anti-collision/indoor drone was introduced and deployed at Orano’s la Hague plant, in a zone-4 active unit – a space which is not accessible to operators, encased, unit and very cramped. A technical feat on the part of Aeraccess, a start-up specialized in the design of military drones. Thomas Posluszny, Product Design Engineer in the start-up, tells us how the project came about.

We received Orano’s request in 2018 to produce a customized drone to access delicate areas that cannot be inspected by people. A partner had put us in contact with Orano. The project immediately appealed to us: it was a real technological challenge! Prior to that, in order to inspect inaccessible areas, Orano’s teams used long poles passed through conduits just 10 cm in diameter. The challenge? To design a drone capable of passing through these same conduits and then flying inside the zones to detect any anomalies.

The project was set up in four phases:

• a study phase involving the rapid design of the first prototype of a foldable, anti-collision/indoor drone to confirm its feasibility;
• the drone development phase – we went from an object detection rate of 50% to nearly 95%, and integrated precautionary measures in case of collision;
• an assistance phase to Orano during their passive tests conducted in the Beaumont research hall to refine the anti-collision and flight stability parameters;
• a test phase in which our drone was tested by Orano on its own on the la Hague plant: 3 hours of operation and 12 minutes of flight – a success! ●

At the age of 29, Marion Losno, Material Studies Engineer at Orano Projects, received the European Nuclear Society HSC PhD Award in Brussels, on October 31, 2019. In the space of 20 minutes, she convinced a panel of European scientists – 4 people, 4 countries and a great winner. Her topic: microfluidics.

When they announced that I had won, I couldn’t believe it. I was stunned. When I left, my first reflex was to call my loved ones because, in my family, chemistry is a passion. Of course, I also told my colleagues who had supported me, so that they heard the news first-hand. I was extremely happy! Among the candidates, I was particularly afraid of the Israeli one, because he had published a large number of papers in prominent scientific journals and had numerous contacts. However, after an hour’s deliberations, the panel announced the winner: it was France, it was me.

“This prize rewards 5 years of work, after a doctoral thesis at the CEA and 2 patents filed.”

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On the day, I was concentrating hard from the time I got up, with the desire to win. I told myself: “Marion, you’ve got to give it all you’ve got.” I think that this is what made the difference.

In the future, I’d really like to manage teams, to get other people on board with me and work together throughout a project to get our group to progress even further. ●
When we roll out a revival plan, we undertake to support a region’s economic development and the creation of jobs in key local industries. We listen to local economic development players and government representatives to meet local needs with SMEs, non-profit organizations and training institutes. With the involvement of employees, we support local entrepreneurs, finance innovative projects, promising SMEs in the fields of services to industry and non-profit organizations working towards a social and solidarity-based economy. We also work with organizations that support employment and training in the regions’ sectors experiencing manpower shortages. For example, Orano supported the construction, in the Drôme department, of one of the largest automotive recycling sites in Europe, handling 35,000 vehicles per year. Through this project, GPA increased its workforce to 200 employees.

Philippe Guay
HEAD OF REGIONAL DEVELOPMENT

"We can be proud of the revival actions conducted by the group near our different sites in France. With 1,122 jobs created between 2017 and 2019, our initial objective set by the French State was exceeded! These initiatives are part of the group's CSR policy and in line with local needs."

Located in Tashkent, Nurlikum Mining will carry out exploration work and subsequently – if the results of this work prove to be as good as we expect – mining operations in Uzbekistan, particularly in the Djengeldi region, in the heart of the province of Kyzylkum, which is rich in uranium deposits. Once the exploration permits have been obtained, the initial field work should start, in the first half of 2020. This partnership with the Republic of Uzbekistan constitutes a real recognition of Orano’s expertise, especially in the highly-competitive In-Situ Recovery (ISR) process, as well as its ability to conduct ambitious mining projects and deploy the best practices of a responsible mining player, in particular regarding the environment and transparency.

"This promising partnership rests on great mutual trust."

We fervently hope that it will be fruitful, and that the results of the work we are initiating will enable us to start up new mines in the years to come. •
Orano recovers nuclear materials so that they can contribute to the company’s development in the field of energy, as well as research in nuclear medicine.

The group offers products and services with high added value throughout the entire nuclear fuel cycle, from raw materials to waste treatment.

Its activities, from mining to dismantling, as well as in conversion, enrichment, recycling, logistics and engineering, contribute to the production of low-carbon electricity.

Orano and its 16,000 employees use their expertise, their permanent search for innovation, their mastery of cutting-edge technology, as well as an unwavering dedication to safety and security to serve their customers in France and abroad.

<table>
<thead>
<tr>
<th>Our strength</th>
<th>Our ambition</th>
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</thead>
<tbody>
<tr>
<td>An uncompromising culture of safety and security.</td>
<td>Making nuclear energy increasingly reliable and competitive.</td>
</tr>
<tr>
<td>A unique customer portfolio in the nuclear industry.</td>
<td>Getting the most out of nuclear materials, in particular through recycling, so that they contribute to the development of society.</td>
</tr>
<tr>
<td>Recognized industrial know-how and state-of-the-art facilities.</td>
<td>Remaining the world’s leading player in the production and recycling of nuclear materials, waste management and dismantling.</td>
</tr>
<tr>
<td>Leading technologies and expertise that is unique in the world.</td>
<td>Continuing to reduce our carbon footprint and remaining on course as a responsible player.</td>
</tr>
</tbody>
</table>

Women and men who are recognized for their skills, their commitment and their ability to meet new challenges.
Our activities

MINING
Our mining operations cover uranium exploration, production and marketing worldwide, as well as the remediation of former mining sites. Orano ranks among the world’s leading uranium producers.

NUCLEAR PACKAGES AND SERVICES
Throughout the fuel cycle, Orano provides its unique expertise in the design, certification and production of capsules, as well as the associated transport, whether overland, sea or rail, with the highest level of risk control.

URANIUM CONVERSION AND ENRICHMENT
With a unique integrated industrial platform, and the world’s most modern facilities – the Philippe Coste conversion plant and the Georges Besse II enrichment plant – Orano is recognized throughout the industry for its technical skills and cutting-edge processes.

DISMANTLING AND SERVICES
With 50 years’ experience, Orano is a benchmark supplier in the field of operations support for nuclear sites (work-site logistics, specialized maintenance and radiological security), as well as the management of radioactive waste and the dismantling of end-of-life equipment and facilities.

USED-FUEL RECYCLING
Thanks to the performance of its la Hague and Melox plants which are the only ones to operate on an industrial scale – Orano is the recognized international leader in the reprocessing and recycling of used fuel.

ENGINEERING
Engineering operations involve engineering consulting services, contracting and project management assistance, design and construction engineering, plant commissioning and operational support. The teams operate in the group’s own facilities as well as for external customers, in France and worldwide.

ORANO MED
Orano Med – a subsidiary of Orano – is a company that brings together biotechnologies and nuclear technology to develop new therapies to fight cancer.

The nuclear fuel cycle

Fuel production
Nuclear power plants
Electricity generation
Cigéo project
Medium-high level long-life waste

Orano Tricastin
2nd stage of conversion
(Philippe Coste plant)
Enrichment
(Georges Besse II plant)
Storage of valuable materials
Deposited uraninates (Tricastin and the Bessines mining site), reprocessed uranium, etc.

Orano Malvési
1st stage of conversion

Orano Melox
Recycling – Production of MOX fuel

Cigéo project
Medium-high level long-life waste

Orano la Hague
Reprocessing of used fuel

ORANO MED
Orano Med – a subsidiary of Orano – is a company that brings together biotechnologies and nuclear technology to develop new therapies to fight cancer.
### IN BRIEF

#### 2019 key figures

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>3.7 billion euros</td>
</tr>
<tr>
<td>Backlog</td>
<td>29.9 billion euros</td>
</tr>
<tr>
<td>Employees</td>
<td>16,000 employees, including 13,000 in France</td>
</tr>
<tr>
<td>Disability Rate</td>
<td>&gt;5% Rate of employment of people with disabilities</td>
</tr>
</tbody>
</table>

#### REVENUE FROM MAIN ACTIVITIES

<table>
<thead>
<tr>
<th>Activity</th>
<th>Revenue (million euros)</th>
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</thead>
<tbody>
<tr>
<td>Mining</td>
<td>1,280</td>
</tr>
<tr>
<td>Front End</td>
<td>902</td>
</tr>
<tr>
<td>Back End</td>
<td>1,588</td>
</tr>
</tbody>
</table>

#### Top 3 worldwide in our key activities

- Mining
- Back End
- Front End

#### WORK SAFETY

<table>
<thead>
<tr>
<th>Measure</th>
<th>2019 Value</th>
<th>2018 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workplace accident frequency rate with lost time</td>
<td>1.8 (vs. 1.5 in 2018)</td>
<td></td>
</tr>
<tr>
<td>Occupational injury severity rate in 2019</td>
<td>0.08 (vs. 0.03 in 2018)</td>
<td></td>
</tr>
</tbody>
</table>

#### SECURITY

- Number of events ranked on the INES scale in 2019:
  - 7 - Major accident
  - 6 - Serious accident
  - 5 - Accident
  - 4 - Accident
  - 3 - Serious incident
  - 2 - Incident
  - 1 - Anomaly
  - 0 - Discrepancy

- Rate of employment of people with disabilities: 16,000 employees, including 13,000 in France
- Investments: 554 million euros
- Percentage of women in managerial recruitments: 35%
- Rate of women in managerial recruitments: 554 million euros
Executive Committee
April 2020

From left to right

David Claverie,
Finance

Laurence Gazagnes,
Security, Health, Safety & Environment

Jacques Peythieu,
Chemistry-Enrichment BU

Alain Vandercruyssen,
Dismantling & Services BU

Patrick Champlaine,
Commercial & Marketing

Corinne Spilios,
Performance

Guillaume Dureau,
Projects BU

Frédéric de Agostini,
Nuclear Packages & Services BU

Hélène Derrien,
People & Communications

Nicolas Maes,
Mining BU

Pascal Aubret,
Recycling BU

Philippe Knoche,
Chief Executive Officer
Board of Directors

May 15, 2020

Board of Directors steers and oversees the company's activities and results, and deliberates on strategic and financial decisions.

Members of the Board of Directors(1)

Claude Imouven
Chairman and Independent Director

Philippe Knoche
Chief Executive Officer, Director

French State represented by Bruno Vincent
Director

François Delattre
Director appointed upon a proposal of the French State

Patrick Pelata
Independent Director

Marie-Hélène Sartorius
Independent Director

Bernard Bastide
Director representing the employees

Alexia Dravet
Director representing the employees

François Jacq
Director appointed upon a proposal of the French State

Cécile Seller
Director appointed upon a proposal of the French State

Philippe Soulé
Director appointed upon a proposal of the French State

Marie-Solange Tissier
Director appointed upon a proposal of the French State

Board Committees

To perform its duties, the Board of Directors is supported by four specialized committees which issue opinions and recommendations to the Board.

Strategy and Investment Committee

Compensation and Nominating Committee

End-of-Life Obligations Monitoring Committee

Audit and Ethics Committee

IN BRIEF

(1) An additional director is being appointed.