URANIUM *Atlas*

Facts and Data about the Raw Material of the Atomic Age

Nuclear Free Future Foundation

ROSA LUXEMBURG STIFTUNG

Beyond Nuclear

IPPNW

IMPRINT

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URANIUM
Atlas

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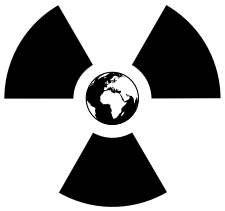

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PREFACE

by Winona LaDuke

A creation story of the Diné, an Indigenous Nation in the Southwest of the United States, speaks of two kinds of yellow dust: the first humans were told that the yellow dust of corn pollen would secure their life. The other yellow powder however would endanger it. They were instructed to leave the other yellow powder – uranium – in the soil and never dig it up. If it were taken from the ground, they were told, a great evil would come.

And the evil came. Uranium, traded globally, even has a name reminiscent of this story from the beginning of time. It is called yellowcake. More than three thousand Diné, who are also called Navajo, worked in the uranium mines in the 1950s, without special work clothes or any kind of radiation protection. Covered in radioactive dust, they walked home to their families – and without knowing it, contaminated their loved ones. People are still dying in Dinétah, the land of the Navajo. The danger is not contained, since almost a thousand abandoned mines still contaminate the region.

When we, the Indigenous people of Turtle Island – that's what we call North America in our tribal language – fight against uranium mining, we do this shoulder to shoulder with all Indigenous peoples everywhere in the world, fighting for the same goals. This is not only about our survival, but about the survival of all creatures. We are all one family. The industrial society wages war against the Earth. We see ourselves as children of this Earth and therefore this war is a war against us.

The first inhabitants of the Australian continent delivered a similar warning: He who disturbs the sleep of the rainbow serpent unleashes evil forces which cannot be tamed by humans. The Aboriginals in the Northwest of the continent say that by tearing up the uranium veins, we awaken the sleeping snake. You do not need to be a rocket scientist to see that the nuclear path is a path over the edge of a cliff.

Uranium is not just lying there, waiting for its exploitation. That is the image the media and textbooks want to convey: raw materials are waiting, eager to uphold western civilization and the modern world's infrastructure. It should be noted that uranium mining is not the only threat – oil extraction from tar sands also leaves behind dead and uninhabitable landscapes. But what we don't see is where the resources come from and what devastation is left behind after their exploitation. What kind of civilization does not allow its people to learn the truth? In our Indigenous cultures we teach our kids that we humans are responsible for the consequences of our actions. However, we can only assume this responsibility when we know the consequences of our actions. The industrial society we live in is afraid of the truth.

The best minds in the nuclear establishment for decades have agonized over the question: where to dispose of the nuclear waste? In the United States, one solution appeared very attractive: dispose of the waste on Indian reservations - in a cloak-and-dagger operation! Thus we, the Indigenous people, are at the beginning and the end of the nuclear chain. Each nation committing to nuclear energy must understand that they are complicit. Uranium is killing us.

I would like to refer to another prophecy, this time coming from my people, the Anishinabe, also called Ojibway. This prophecy talks of a time when we will be at a crossroads and have to choose between two paths: the one path is worn and scorched, the other hardly traveled and green. We are now at this crossroads. The future is shown as green, also for us Indigenous people. In order to reduce their CO_2 emissions, the United States needs to build clean power plants with an output of 185,000 megawatts within the next ten years. We can contribute to this goal, because where we live the winds blow regularly and the sun shines as well. The reservations offer a potential of 200,000 megawatts. We, the Indigenous people, are in a position to implement alternatives in the most wasteful and destructive country on Earth. But we need to be alert, since the nuclear industry tries to sell its lies that it is working to save the environment. We must all work together and choose the green path – not the worn and scorched path.

Let's meet on the green path. Let's leave uranium in the ground.

Winona LaDuke, born in 1959, activist, author and member of the Anishinabe Nation, lives on the White Earth Reservation in northern Minnesota, USA. In 1977, while just out of high school, she spoke at the United Nations in Geneva and for the first time revealed that most North American uranium was extracted on Indigenous lands.

THE URANIUM PATHWAY

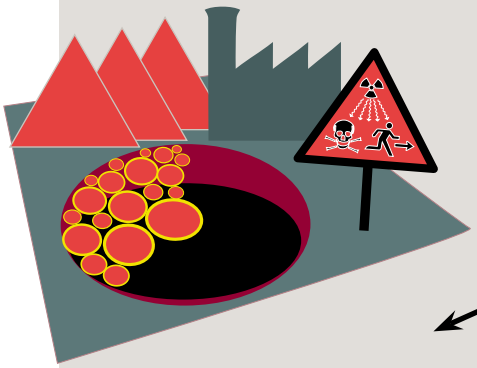
From out of the Ground to a Legacy of Waste

In 1789, Heinrich Klaproth isolated a new element from a mineral called pitchblende. He called it uranium after the planet Uranus. It is an unstable, radioactive heavy metal with the atomic number 92. The Nuclear Age started in 1938 when nuclear fission was discovered. Uranium became the raw material for nuclear bombs and nuclear energy.

10,000 t of uranium ore => **1 t of uranium in yellowcake** => **7.11 kg** fissile **uranium-235**

MINING METHODS

Uranium can be found in different uranium minerals. Uranium ore consists of these minerals and the surrounding rock. To extract the ore, varying amounts of material - the spoil - need to be removed, depending on the location. Uranium concentration in the ore varies significantly. For a "normal" uranium content of 0.1 percent for example, 1,000 tonnes of ore need to be extracted for one ton of uranium. For a long time, uranium was extracted exclusively using either the underground or open pit mining methods. Starting in the 1980s, in-situ leaching has been the preferred process.



THE MINING HERITAGE

As much as 99.9 percent of the uranium ore is left behind in the tailings ponds. Even after a mine closes, the tailings are the reason that mining areas remain radioactively contaminated. In the USA, these regions have been termed a "National Sacrifice Area". They are mostly located on the lands of Indigenous peoples.

PROCESSING

With conventional extraction, the ore is mechanically broken up, ground down and the uranium is then extracted by chemical leaching. This produces uranium oxide U_3O_8 with 99.284 weight percent of non-fissile uranium-238 and only 0.711 weight percent of fissile uranium-235. The yellowcake that is produced contains up to 75 percent uranium. The resulting toxic sludge, the so called tailings, are permanently stored in huge ponds above ground.

Yellowcake
URANOXIDE-Concentrate (U_3O_8)
contains approx.
75 % URANIUM

CONVERSION

In conversion plants, yellowcake is first converted into uranium tetrafluoride (UF_4) and then uranium hexafluoride (UF6) required for uranium enrichment.

Many people living in nuclear states around the world are actively opposed to uranium mining. Resistance is even growing in the countries where uranium is mined. At least 70 percent of the uranium in circulation worldwide is mined on the land of Indigenous communities and tribal peoples. On every continent,

R E S I S

ENRICHMENT

There are 13 uranium enrichment plants operating worldwide. Globally, 38 fuel-rod factories produce fuel for the world's nuclear plants. Even though Germany is abandoning nuclear power, it remains an indefinite part of the uranium economy with an enrichment plant and a nuclear fuel factory.

Fissile **URANIUM-235**

Enriched to **3-5 %**

Enriched to approx. **90 %**

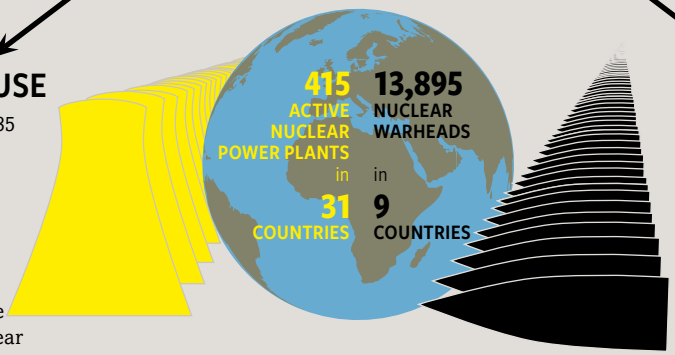
DEPLETED URANIUM

A DANGEROUS BY-PRODUCT

Depleted uranium (DU) mostly contains uranium-238 and only 0.2 to 0.3 weight percent of uranium-235. This extremely dense heavy metal is essentially nuclear waste, but is categorized as raw material and is used for armor-piercing ammunition.

CIVILIAN USE

Uranium-235 enriched to three to five percent, is used for the production of fuel rods for nuclear power plants in 31 countries. More than 70 % of nuclear energy worldwide is produced in the United States, France, China, Russia and South Korea.



MILITARY USE

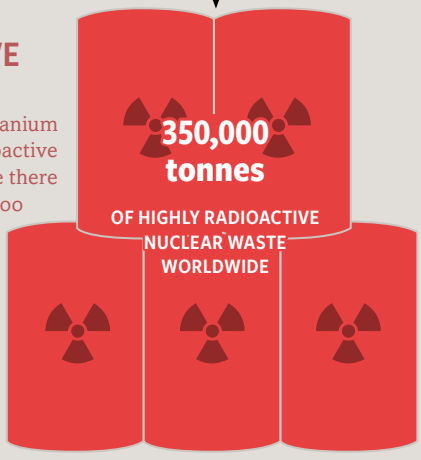
Uranium-235 enriched to more than 90 percent is used for nuclear weapons. When a nuclear bomb is detonated, the fissile material (or plutonium) creates a critical mass. This results in a nuclear chain reaction and a nuclear explosion.

REPROCESSING

In reprocessing plants in China, France, India, Pakistan and Russia, plutonium is extracted from spent fuel rods. This multiplies the overall amount of nuclear waste by a factor of ten.

RADIOACTIVE WASTE

At every stage, from uranium mining to reprocessing, radioactive waste is produced. Worldwide there are approximately 350,000 tonnes of highly radioactive waste awaiting safe storage – not including the waste dumps at the uranium mines. No country on Earth has yet opened a storage site for these radioactive waste deposits.



CONTROLS?

The initial task of the International Atomic Energy Agency (IAEA) in Vienna, Austria, was to promote and establish the civilian use of nuclear energy in UN members states. Today, while still promoting nuclear power, it also focuses on deterring the spread of enriched uranium and plutonium.

Indigenous representatives are demanding: Leave uranium in the ground! The Australian rainbow serpent has become a symbol for the worldwide movement: According to an Aboriginal warning, the serpent is sleeping below ground and must not be awakened, because mankind cannot tame her powers.

T A N C E

DEADLY ORE

The horrors of a nuclear war or a nuclear meltdown color public perception of uranium. However, even without such an outcome, the mining of uranium ore harms human life.

The nuclear chain must always begin with the mining of uranium to produce fissile material. In most countries, little is known about this first phase. Mining companies and countries where uranium is extracted hide behind a mask of silence concerning the health risks. Operators of nuclear power plants talk about "clean" and low-CO_2 power generation. Fuel rod manufacturers and operators of uranium enrichment plants refuse to provide information on where their raw material, uranium, comes from.

Uranium is a chemo-toxic heavy metal while at the same time it is radioactive since it is an unstable element

Uranium exists everywhere on Earth but mostly in very low concentrations. The Rössing mine in Namibia is at the lower end of the scale of mineable deposits with a uranium content of 0.03 weight percent. Yet, there are even plans to mine deposits with concentrations as low as 0.017 or even 0.01 weight percent. The mine with the highest uranium concentration in the world – of 13 weight percent – is Cigar Lake in Canada. This means that in order to achieve a significant yield, large amounts of ore must be extracted in open pit or deep mining operations: with a uranium concentration of 0.1 percent, 999.9 kilograms of waste remain per mined ton of ore. This waste then contaminates the environment for thousands of years.

The reason for this is due to the properties of the raw material: uranium is a heavy metal which, like lead and mercury, is toxic to humans and animals. At the same time, uranium is not a stable element, but is radioactive even in its natural form and thus radio-toxic. It decays into other elements which emit alpha, beta and gamma radiation, until, at the end of the decay chain, only stable lead-206 remains. Therefore, the fine and coarse dust released during uranium mining is full of radioactive particles and the air is contaminated by radon gas – one of the main reasons for the high incidence of lung cancer in miners. Drinking water and the food chain are contaminated by uranium and its radioactive decay products. But an organism can be damaged even if only exposed to low doses of radiation.

Miners perform strenuous physical labor and, as a result, can have difficulty breathing. In open pit as well as in underground mining, they are exposed to noise, dust, heavy metals, radon and ionizing radiation. Groundwater and pit waters are contaminated. Consequently, it is the miners who suffer the most from work-related as well as secondary diseases. But their families can be also contaminated via food, clothing, drinking water and toxic and radioactive dust particles.

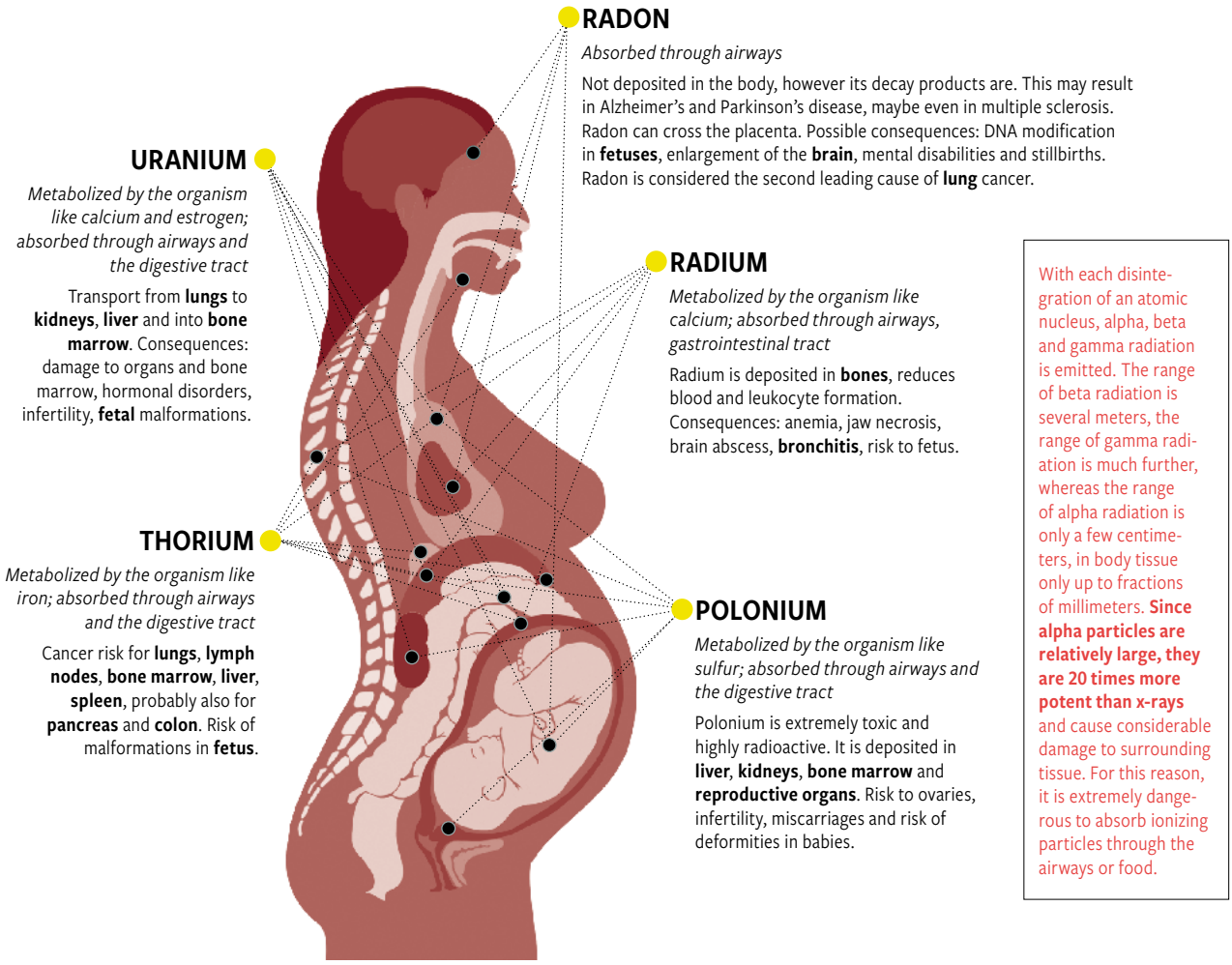
As early as the end of the Middle Ages, the term "Schneeberger lung disease" was well known. Workers from mines in the German Ore Mountains (Erzgebirge) around Schneeberg suffered from this disease. At the time, nobody had an explanation for the many mysterious deaths. Today we know that it was lung cancer – caused by radon and uranium dust. When uranium and its radioactive decay products disintegrate, alpha, beta and gamma radiation is emitted. Ionizing radiation can kill affected body cells. If the cells survive, their genetic material can be damaged. These diseased cells transmit the damaged genetic material to their "descendants", so that, even decades later, malignant tumors may occur. Since, in addition to ionizing radiation, heavy metals also have toxic effects, the overall risk of contracting cancer is significantly higher for uranium miners and their families. A fetus is especially vulnerable, since its organism is still developing. Stillbirths occur and

The Duration of Infinity

The uranium decay chain from uranium-238 to lead-206

Attacks on Organs, Brain, Fetuses and Bones

The effect of uranium, thorium, radium, radon and polonium on the body



With each disintegration of an atomic nucleus, alpha, beta and gamma radiation is emitted. The range of beta radiation is several meters, the range of gamma radiation is much further, whereas the range of alpha radiation is only a few centimeters, in body tissue only up to fractions of millimeters. **Since alpha particles are relatively large, they are 20 times more potent than x-rays** and cause considerable damage to surrounding tissue. For this reason, it is extremely dangerous to absorb ionizing particles through the airways or food.

women have fertility problems. Children in mining regions contract leukemia much more frequently than in other regions. For adults, the most typical diseases are lung and throat cancer, cardiovascular and immunodeficiency diseases and mental disorders. Indigenous people in mining regions also report cases of renal insufficiency and an increase in type 2 diabetes. Here, the data situation is still patchy and cannot yet be scientifically proven. However, since the information from all continents is similar, there is a high probability that many diseases are a direct result of uranium mining.

The German Federal Office for Radiation Protection (Bundesamt für Strahlenschutz BfS) in Berlin confirms the findings in a study, the only one of its kind in the world: in a cohort study, 59,000 miners who worked in uranium mining for the Wismut company were examined. The results of this study, also published in the *British Journal of Cancer*, show an increase in the lung cancer rate of 50 to 70 percent, as well as 7,000 radiation-induced deaths among the 59,000 study participants (11.9 percent). A significant correlation between time worked in the mines and cancer risk (a 21 percent higher risk per month worked in the mines) was detected. Smokers and non-smokers among the miners had the same increased risk so that smoking was ruled out as a possible confounder.

Nuclear energy clearly violates human rights. For example, miners in Niger and Namibia are officially expected to tolerate a radiation exposure of 20 millisieverts per year. This corresponds to 2,000 chest x-rays. In the United States, the Radiation Exposure Compensation Act (RECA) became law in 1990 and recognizes that uranium miners and some downwind communities are entitled to compensation and health care as a result of their exposure to radiation from atomic weapons testing or uranium mining, and milling. RECA provides a onetime 100,000 US dollars payment to workers who may have developed cancer or other specified diseases after exposure. However, many workers died before getting compensation and many others have not been approved. There are legislative efforts to provide coverage for more uranium workers and downwind communities and extend the current legislation beyond 2022. ●

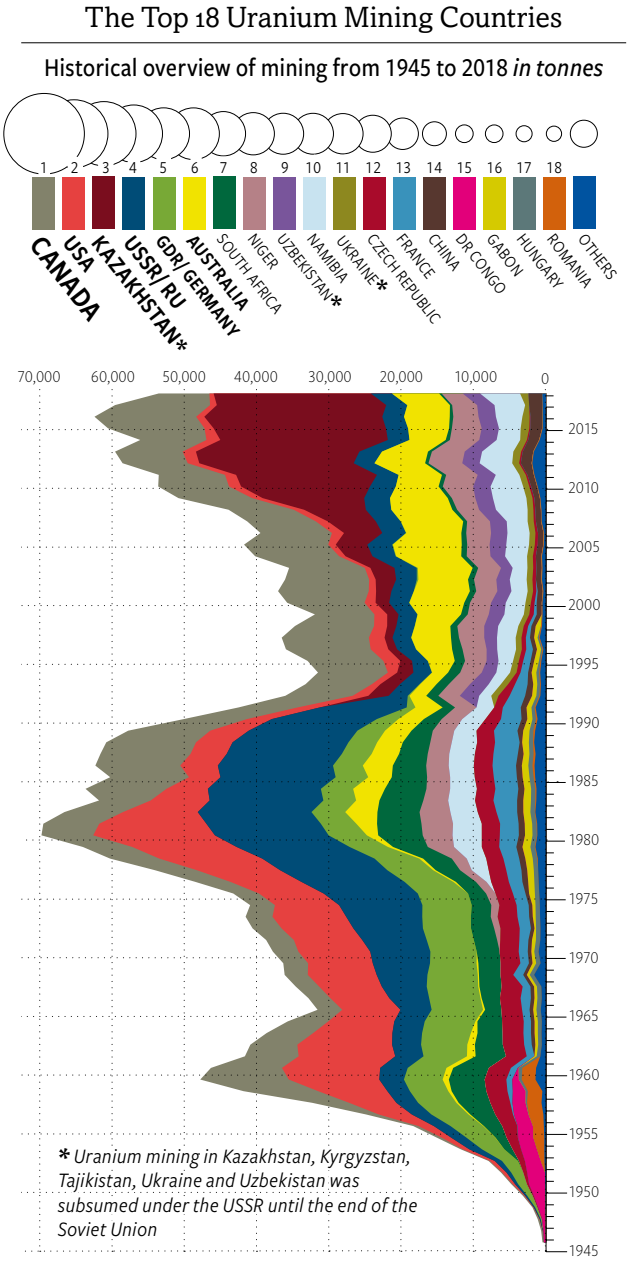
Further Information

Health Hazards for Uranium Mine and Mill Workers: wise-uranium.org/uhm.html
British Journal of Cancer: nature.com/articles/6603403; nature.com/articles/6604776

COLONIAL HERITAGE

Until the 1970s, military demand was used to justify uranium mining. It had negative health impacts from the start, on local populations, but especially on Indigenous societies.

The US government sourced the raw materials for the Manhattan Project – the development of the first nuclear bomb during World War II – from the former Belgian Congo and from Canada. Uranium was discovered in the Congolese Shinkolobwe mine at the beginning of the 1920s and was later systematically mined. The ore contained up to 65 percent of uranium, more than ore from any other mine in the world. In Canada, uranium was discovered in 1930 in the region around Great Bear Lake. While no US president has ever apologized for the nuclear devastation in Hiroshima and Nagasaki, the Canadian Dene – themselves victims of uranium mining – did just that, 53 years after the bombs were dropped. Since some of the uranium used for the first bombs came from mining on their territory, they felt they shared a responsibility for the devastation caused by these bombs.



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Uranium mining cannot be separated from systemic colonialism. Even a superficial glance at the comparison between where raw materials are extracted and where nuclear energy is used, points to the parallels with colonial and neo-colonial exploitation. From the 1940s until the 1980s, the majority of uranium used for US, British and French nuclear bombs and reactors came from existing, former or "internal" colonies. Canadian uranium also came from Indigenous territories of the Dene, land which they had never ceded. The Dene still suffer from the effects of uranium mining today. Canadian uranium also came from the Elliott Lake region – where the neighboring reservation is also still radioactively contaminated. In 2015, the James Bay Cree of Quebec prevented the opening of new uranium mines. A moratorium on uranium mining remains in place in this region. Both the history and the current status of uranium mining are closely linked to the violation of Indigenous rights.

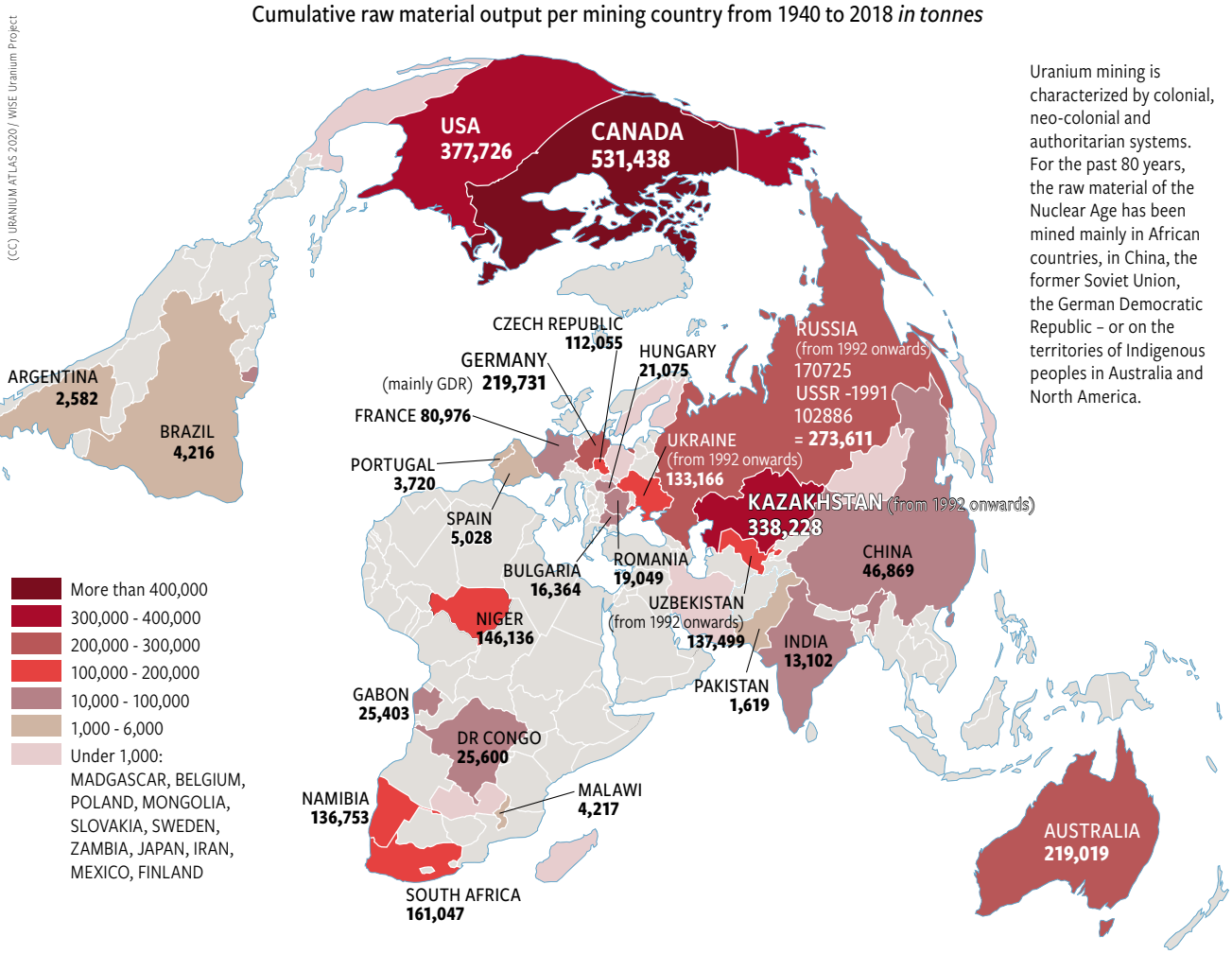
While after World War II, the US government issued a buy-back guarantee for uranium mined at home, which attracted a huge number of private companies, uranium mining in France and the Soviet Union was exclusively reserved for the state. The whole of Africa became of interest, while a huge mining industry developed in the former East Germany and in former Czechoslovakia.

Uranium mining began in the then Belgian Congo and Canada. Today Kazakhstan is by far the most important mining country

It was only in the 1970s, when the civil generation of nuclear energy began, that uranium became a commercial commodity and uranium mining became a lucrative field of business for private companies. While in 1950 barely 4,800 tonnes of uranium were mined, by 1980 almost 70,000 tonnes were extracted, more than ever before or since. At the time, the price on the spot market was more than 40 US dollars for

Uranium for the World

Cumulative raw material output per mining country from 1940 to 2018 *in tonnes*

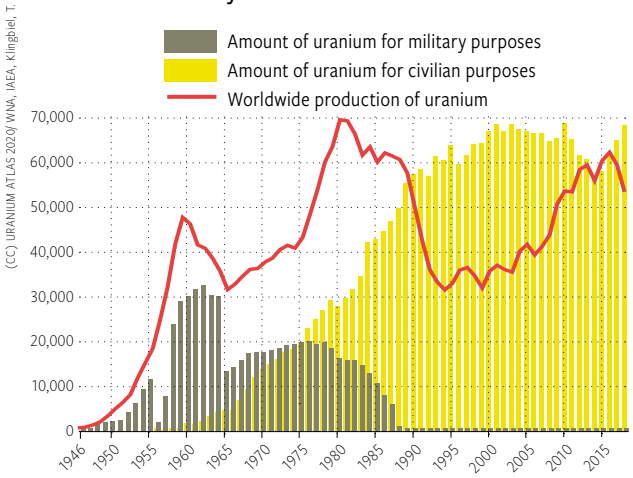


Uranium mining is characterized by colonial, neo-colonial and authoritarian systems. For the past 80 years, the raw material of the Nuclear Age has been mined mainly in African countries, in China, the former Soviet Union, the German Democratic Republic – or on the territories of Indigenous peoples in Australia and North America.

a pound of uranium (454 grams). The less attention mining companies paid to the health of their workers and the security of mines and tailings, the higher their profits. And since uranium mining was then – and is now – a non-issue in the minds of the public, hardly anybody cared about essential safety measures, radiation protection and health standards.

Production and Use of Uranium

Civilian and military demand from 1946 to 2018 *in tonnes*



With the end of the Cold War, the military demand for uranium ended. As a consequence of the nuclear power plant disaster in Chernobyl, and in large part the one in Fukushima as well, along with the decommissioning of nuclear power plants in Japan, the civilian demand for uranium also fell significantly. Furthermore, after 1990, the nuclear powers started to meet their fuel needs in part through the dismantlement of their nuclear missiles. In 2002, the spot market price for uranium plummeted to a historic low of eight US dollars. In 2007, it rose to more than 100 US dollars and has currently dropped down to 24.55 US dollars (as of February 12, 2020). In 2002, only 37,000 tonnes of uranium were mined worldwide. In 2018, the mining yield was 53,500 tonnes (see pp. 26-27).

Historically speaking, Canada has always been by far the largest uranium producer worldwide: 531,000 tonnes between 1940 and 2018, contributing one sixth of the world's uranium supply. Next are the USA, followed by Russia (and before that, the former Soviet Union), Kazakhstan, the German Democratic Republic and Australia. As of 2009, Kazakhstan has become the highest producing country. However, the government there has disclosed little information about its uranium mining operations and certainly none regarding possible problems. ●

Further Information

World map of nuclear devastation: hibakusha-worldwide.org
Worldwide uranium mining: uranium-network.org, wise-uranium.org

SUPPLIER TO THE WEALTHY NORTH

From the beginning, the framework of colonialism defined uranium mining in Africa. For many decades, South Africa was the main uranium supplier on the African continent. Today, Namibia and Niger have taken its place.

In Africa, uranium mining started in the 1930s in the Congo – then under Belgian colonial rule – at the Shinkolobwe mine, where people worked under horrific conditions. The miners supplied the raw material for the construction of the nuclear bomb, working only with their hands and using the simplest of tools. The Belgian mining company, Union Minière, had absolute control over all of the country's natural resources. Radiation protection and health protection were completely neglected. Anyone who opposed this colonial plundering of the country's resources suffered draconian punishments.

Until 1950, one third of the uranium mined worldwide came from this mine and was mainly exported to the USA. In 1960, Belgian colonial rule formally ended. However, that did not mean that the country was no longer exploited. The mining operations financed the civil war there, and up to 20 billion US dollars of Congolese assets ended up in accounts abroad according to the *Financial Times*. Golden Misabiko, president of ASADHO Katanga, opposed this government despotism and, in 2009, he revealed the secret agreement between then President Joseph Kabila (DR of Congo) and President Nicolas Sarkozy (France), which gave Areva, a French state company, exclusive access to the uranium resources of the country. Consequently, Misabiko was arrested and tortured before he could flee into exile.

With the growing development of nuclear energy in the 1960s, uranium companies started to prospect for uranium in several African countries

With the development of nuclear energy, the focus shifted to a growing number of other countries in Africa. Although Niger became independent in 1960, the French government and the nuclear company Areva continued their colonial exploitation. Uranium mining began operation in 1971 in Arlit at the southern edge of the Sahara and was expanded to Akokan three years later. In 2018, Niger was the fifth largest uranium producer worldwide. However, the uranium wealth brought no benefits to the people of Niger, even though, in the meantime, 146,000 tonnes of uranium had left the country, an amount equivalent to a market price of nine billion US dollars. The country remains one of the poorest in the world, but with an inheritance – nuclear waste. Almoustapha Alhacen founded the local NGO Aghirin`man – which in the Tuareg language means "Protection of the Soul" – and had scientists from the independent French CRIIRAD laboratory examine the Arlit terrain. "What happens there borders on negligent physical injury", reports CRIIRAD director Bruno Chareyron. "In drinking water for example, the radioactivity is ten to one hundred times higher than the limits recommended by the WHO." As in other mining regions, roads were paved with radioactive rock residues while 35 million tonnes of radioactive waste was discarded out in the open without any kind of protection. Background radiation is 200 times higher than permitted. Niger is not the only African country where Areva (now calling itself Orano) prospected for uranium: the company was also active in Gabon, but ended uranium mining there 20 years ago. Here as well, tailings and waste dumps have not been cleaned up.

Rio Tinto, one of the world's three largest mining companies, opened the first uranium mine in Namibia in 1976, the Rössing mine. Additional mines followed – with all the negative effects for the miners: although they continued to receive pay when they were sick, they had to pay their own medical costs. One lawsuit against Rio Tinto failed because two workers missed the deadline for claiming damages. Today, Namibia is the fourth largest producer of uranium in the world.

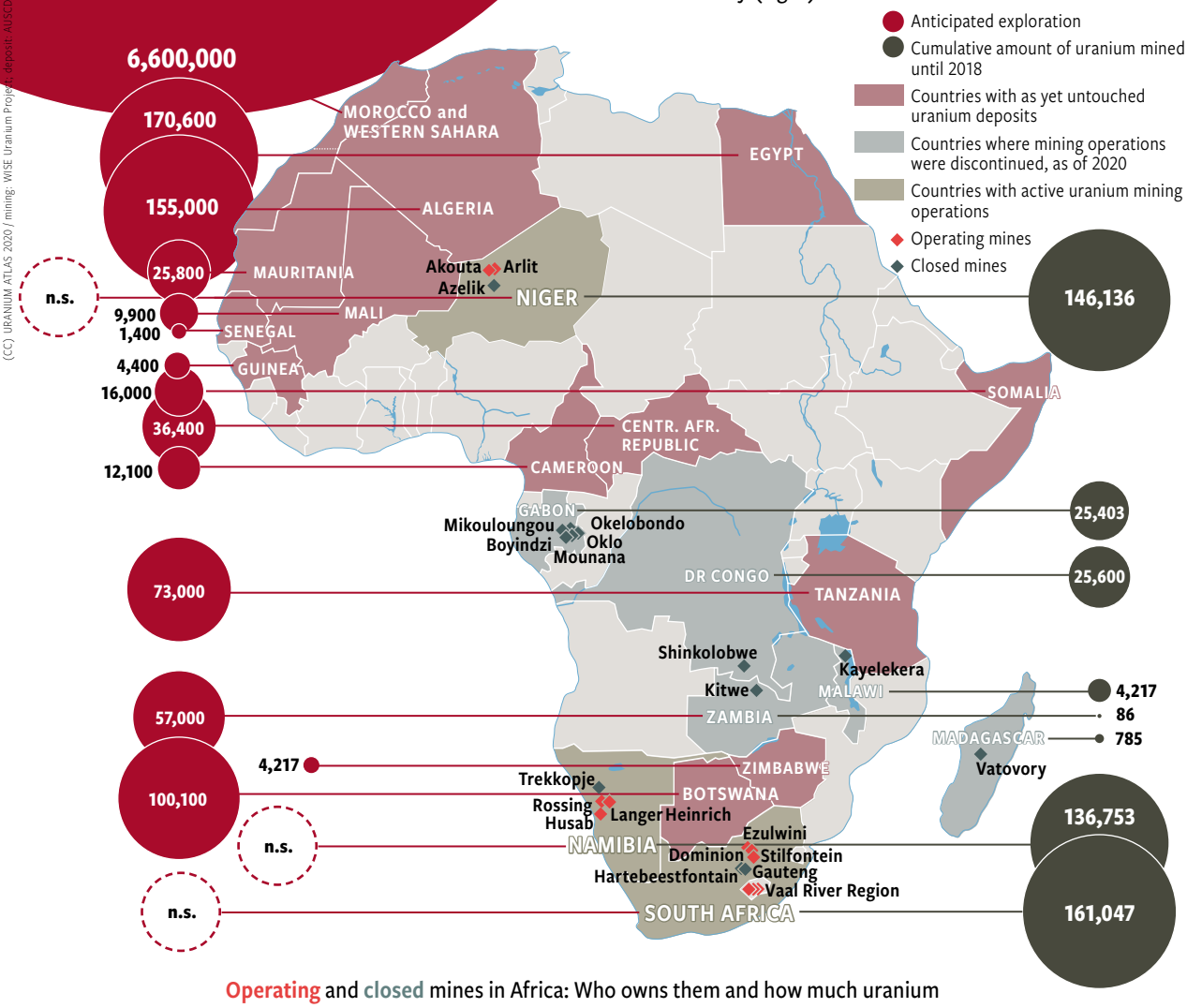
In South Africa, uranium was just a side product of gold mining, but the yield was big enough to make South Africa the most important uranium producer on the African continent. With the South African gold rush already underway at the end of the 19th century, and with the mining companies at the time having no interest in uranium, the heavy metal was simply left on the rock piles as radioactive waste. The miners and their families lived right next to these dumps. Since the dumps contain more uranium than some new uranium mines, companies started to mine the waste rock deposits. Under the South African apartheid system, it was a decades-long standard procedure to pay workers who showed symptoms of a disease their last monthly wage and then dismiss them.

Many new uranium mining applications were made over the past several decades, as the example of Tanzania shows: the German Uranerzbergbau GmbH prospected for uranium in Tanzania from 1978 to 1982. There was frustration among many residents in villages close to the south Tanzanian Mkuju River project, according to Tanzanian human rights activists. "For more than ten years now, they talk about research and exploration. What the people in the neighboring communities get is employment for just a few and for the rest the dust raised by cars and trucks", reports an activist from Songea, who does not want to be named for safety reasons.

The increased price for uranium in the years 2007 and 2008 led to a veritable boom in exploration activities in Africa. However, because the price of uranium dropped again (see p.27), no new mines have been opened apart from Husab and Langer Heinrich in Namibia and Kayelekera in Malawi. As a result of the low prices, the South African company, Mintails, had to file for bankruptcy, while Areva was saved from bankruptcy using taxpayers' money and Paladin just barely

Uranium under African Soil

The mines of Africa, the amount of unmined uranium deposits (left) and the overall amount of uranium mined until today (right) *in tonnes*



Operating and **closed** mines in Africa: Who owns them and how much uranium has been extracted from them so far?

DR CONGO

◆ **Shinkolobwe**: 25,600 tonnes, first uranium mine worldwide. Open pit and underground mining since approx. 1938, closed in 1960. Ever since: illegal extraction

GABON

◆ **Mounana**: 5,760 tonnes, open pit and underground mining, 1960–1999

◆ **Oklo**: 14,649 tonnes, open pit and underground mining, 1970–1985

◆ **Okelobondo**: 3,144 tonnes, underground mining, closed in 1988

◆ **Boyindzi**: 2,471 tonnes, underground mining, 1980–1991

◆ **Mikouloungou**: 85 tonnes, open pit mining, 1997–1999

Owner of all mines in Gabon: Areva/state of Gabon

MADAGASCAR

◆ **Vatovory**: 785 tonnes, open pit mining, 1950s, state of France

MALAWI

◆ **Kayelekera**: 4,217 tonnes, open pit mining, 2009-2014. 85% owned by Lotus Resources, closed in 2014

NAMIBIA

◆ **Rössing**: 66,722 tonnes, open pit mining since 1976, 68% owned by CNNC in 2018

◆ **Husab (Rössing Süd)**: 1,332 tonnes, open pit mining since 2016. 90% owned by Taurus Minerals Ltd

◆ **Langer Heinrich**: 16,416 tonnes, open pit mining since 2007, mothballed in 2018. 75% owned by Paladin, 25% by CNNC

◆ **Trekkopje**: 437 tonnes, open pit mining, 2011-2013. 51% owned by Orano, 49% by CGNPC

NIGER

◆ **Arlit**: Open pit mining since 1971. 64% owned by Orano, 36% by the state of Niger

◆ **Akokan (Akouta)**: Underground mining since 1974. 34% owned by Orano (formerly Areva), 31% by Niger, 25% by OURD, 10% by ENUSA. 30% drop in production from 2015 to 2018. Akokan and Arlit: 75,986 tonnes since 1998

◆ **Azelik**: 615 tonnes, open pit and underground mining, 2007-2015. 37% owned by CNNC, 33% by state of Niger, 25% by ZXJOY Invest., 5% by Korea Resources Corp.

ZAMBIA

◆ **Kitwe**: 86 tonnes in the 1950s

SOUTH AFRICA

In South Africa, uranium is extracted as a by-product of gold mining. In charge since 1967: the Nuclear Fuels Corporation of South Africa, today an affiliate of Anglo Gold Ashanti.

Main mines:

◆ **Ezulwini** (formerly Randfontein): 217 tonnes, 2011–2017

◆ **Vaal River Region (Kopanang, Moab Khotsong)**: 2,817 tonnes, 2011–2017

◆ **Stilfontein** (N.A.)

◆ **Dominion** (N.A.)

◆ **Hartebeestfontain** (N.A.)

◆ **Gauteng** (N.A.)

avoided going under. At the same time, Chinese companies who, through a high rate of government ownership are less profit-oriented in the short-term, seized the opportunity these failures presented: CNNC secured the right to uranium deposits, promoted the exploration of new deposits, bought shares in the Langer Heinrich mine, and then planned to take it over. In 2016, the Husab mine in Namibia was quietly put into operation. ●

Further Information

Greenpeace: Left in the dust. AREVA's radioactive legacy in the desert towns of Niger

Film: Uranium Mining – what are we talking about? Günter Wippel, 76 Min., on Youtube

RADIOACTIVE HUNTING GROUNDS

Canada is currently the second-largest uranium producer in the world. The Indigenous people, on whose territories the mines are located, were never informed about the hazards and risks involved. The consequences of mining continue to pose a severe threat to their health.

The story goes that, long before Europeans arrived on their territory, a group of Indigenous hunters returned from hunting caribou and pitched camp for the night near the Great Bear Lake close to a rock they called "Somba Ke". Among them was a Shaman, who sang and drummed until dawn. When the sun came up, he spoke to the hunters of his vision: men with white skin would arrive and tear up the earth in the very place they were camping. They would drill a hole and bring up something from the depths of the earth. They would make sticks from it and these would be flown to the other side of the globe by an iron bird. On the ground where the iron bird dropped the sticks, all life would be destroyed. The victims in his vision looked like the people of the tribe, but they were not. In the future, the medicine man warned, people should stay away from the rock.

In the 1930s, when the Eldorado Gold Mine was opened on lands belonging to the Sahtú Dene on the Eastern shore of the Great Bear Lake in the Northwest Territories, nobody remembered this prophecy. When pitchblende (a uranium oxide) was found, the company abandoned the gold and made their profit from extracting radium (a decay element of uranium) instead. Many hunters gave up hunting and took the new jobs offered to them at Port Radium, as the mining area was now called. Unaware of the risks, they carried bags full of ore on their shoulders to the ships waiting in the harbor. Now the hot item was uranium. The shipments were secretly transported to Port Hope in Ontario Province for further processing and, from there, the yellowcake made its way south to Los Alamos, New Mexico. Until 1971, the US government was the sole purchaser of Canadian uranium – mostly for military purposes.

Decades later, many Indigenous miners died from cancer; it was then that people began to remember the old warning. The village of Déline, formerly Fort Franklin, home to most of the miners, was soon called "Village of Widows". In 2005, the government issued a report, which acknowledged the poor information given to the people and made recommendations for community improvements; but no recommendations were issued for any kind of compensation. Douglas Chambers, a physician working for the Canadian government, stated in an interview with the Canadian state broadcaster CBC that "the potential risk of cancer associated with transporting the ore concentrate is extremely small, and in fact so small it would not be detectable."

In 1998, a delegation of women from Déline traveled to Japan and asked the Hibakusha, the survivors of Hiroshima and Nagasaki, for their forgiveness, since their husbands had mined and transported the uranium that was eventually used in the atomic bombs "Little Boy" and "Fat Man". Their journey was a pilgrimage: Indigenous people of North America believe that healing requires circles to be closed in order to allow for reconciliation.

The largest uranium deposits in Canada were found in 1949 in the Athabasca Basin and in 1954 near Elliot Lake, moving production to the provinces of Saskatchewan and Ontario, where it was mainly the Cree and Anishinabe (Ojibway) who were affected. The Beaverlodge Mining Area was established on the northern shore of Lake Athabasca, a conglomerate of the state-owned Eldorado Nuclear Ltd. and the municipality of Uranium City, which became a boom town for three decades with almost 6,000 inhabitants. In 1982, the mines closed and, by 2016, had left behind a ghost town of no more than 73 inhabitants.

In Ontario, Denison Mines and Rio Algom operated a total of twelve mines, and the small town of Elliot Lake awarded itself the title "Uranium Capital of the World". By the end of the 1950s, 74 percent of Canadian uranium came from there. In the 1970s, the miners began to strike, alarmed by the high number of lung cancer cases. These protests were supported by the Anishinabe on the nearby Serpent River Reservation on the northern shore of Lake Huron. Five of the Elliot Lake mines were closed during this time, the other seven in the 1990s. Tailings were cleaned up by Denison and Rio Algom, but without any government approval.

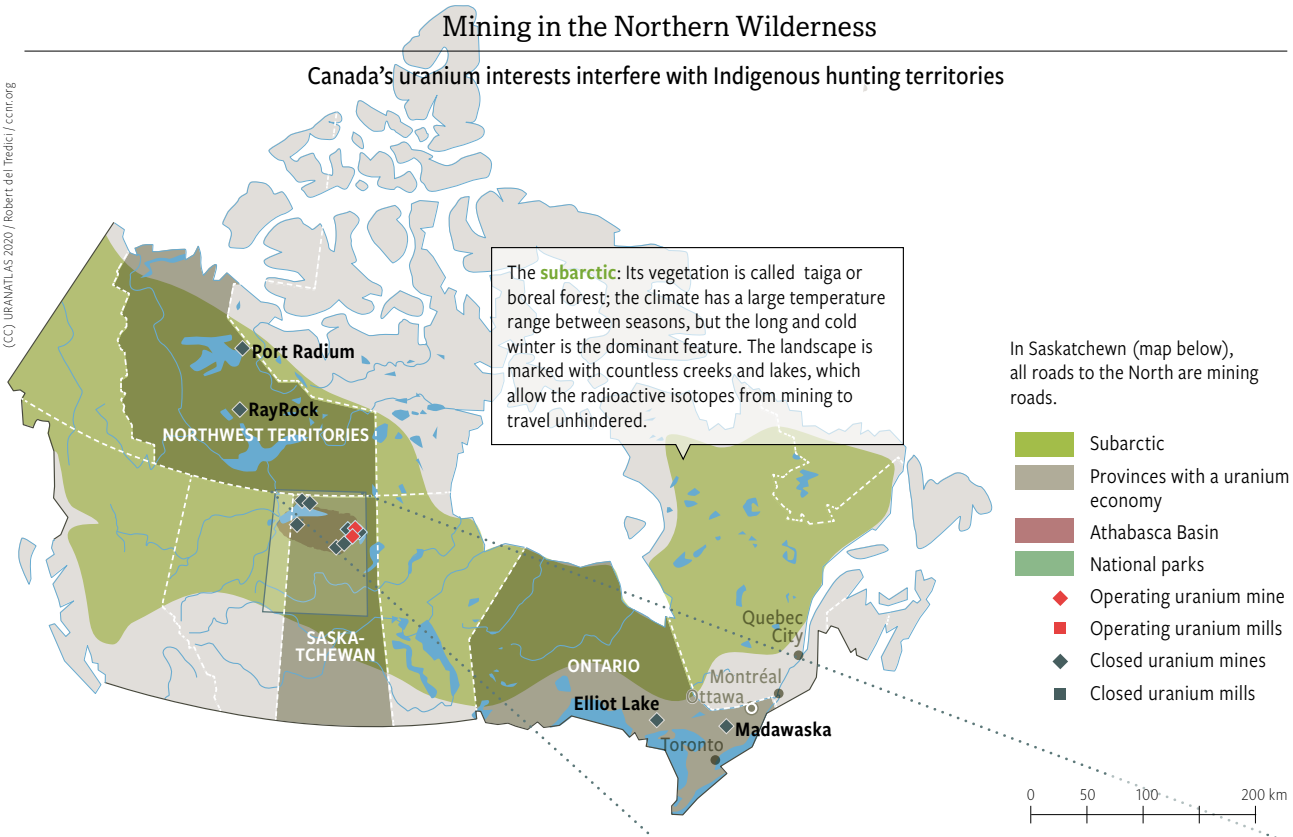
The subarctic is home to hunting societies: radioactive materials travel easily in the open tundra environment

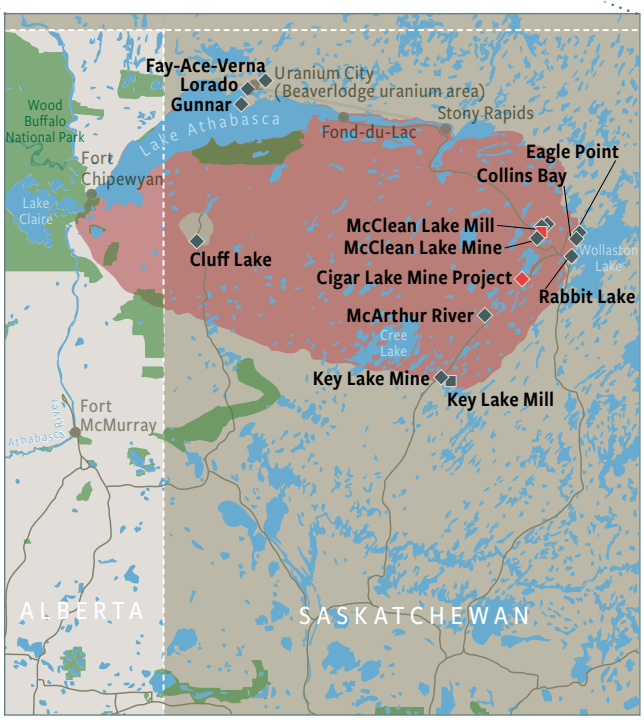
In Saskatchewan, the Gunnar Mine southwest of Uranium City was closed in 1964, leaving behind 4.4 million tons of tailings. The government did not begin cleanup operations until 50 years later, at an estimated cost of around 280 million Canadian dollars. The last working mines remained in Saskatchewan: McArthur River and Cigar Lake. In 2019, in the aftermath of Fukushima, McArthur River was shut down indefinitely by its operating companies, Cameco and Orano. Cigar Lake continues to operate, since the uranium content of the ore is extraordinary high, mostly between 10 and 13 percent, in some cases even as much as 20 percent. The mine was shut down in early 2020 due to the Covid-19 pandemic.

The three roads leading to the north of the province of Saskatchewan were built exclusively for the uranium mines. They cut through "Treaty 10 Land". While the first seven

Mining in the Northern Wilderness

Canada's uranium interests interfere with Indigenous hunting territories





treaties with First Nations, beginning in 1871, were made across the country to advance European settlements and the Canadian Pacific Railway, the motive for treaties 8 to 11, ending in 1921, was the extraction of resources.

The Athabasca Basin is part of the subarctic region in the Canadian Shield of Northern Saskatchewan and Alberta. It is dotted with lakes, streams and swamps and from October to May is normally covered in snow. Climate change has now altered these weather patterns – a severe threat to people who depend mainly on hunting, trapping and fishing. In the tundra region, radioactivity from the uranium mines and the adjacent mills, including waste rock deposits, cannot be contained. The Indigenous hunters, who were never warned about the hazards and risks of radioactivity, have reported malformed fish and even moose fetuses with two heads.

Canada's north is still a wilderness area, sparsely populated and isolated from the large cities in the south. For a long time, Indigenous resistance fell on deaf ears. However, when First Nations activists met like-minded people at the first international conferences of the Canadian anti-nuclear movement in the 1980s, and at the World Uranium Hearing in 1992 in Salzburg, a resistance network was established, which today has found a voice as a united force.

The Canadian government is now considering the establishment of two nuclear waste dumps in Ontario – and is looking at awarding new licenses for the extraction of oil from its tar sands, which have already transformed large parts of Alberta into a moonscape. "We will not stop fighting", says Dene hunter Don Montagrand. "We are fighting for our children."

At the beginning of the new millennium, uranium was found east of James Bay in the north of Quebec province. A protest march by Cree youth in December 2014, from Mistissini to Quebec City and then Montreal – a distance of more than 850 kilometers – was followed by a World Uranium Symposium in Quebec City. In 2015, the provincial government terminated the negotiations with Strateco Resources and declared a moratorium until further notice. ●

Further Information

Excellent overview: ccnr.org, miningwatch.ca
Jim Harding: Canada's Deadly Secret, Saskatchewan Uranium and the Global Nuclear System, Fernwood Publishing 2007

FIRST PEOPLES, LAST TO BE PROTECTED

The story of the Nuclear Age began on the homeland of North America's Indigenous peoples. From uranium mining to atomic bomb tests to the perpetual search for radioactive waste storage sites, the primary target remains Native lands.

On December 2nd, 1942, shortly after Enrico Fermi and his team achieved the first controlled nuclear chain reaction underneath a disused viewing stand at the "Stagg Field" football stadium in Chicago, the Italian physicist transmitted an encrypted message to his colleagues at Harvard University: "The Italian navigator has landed in the New World." When asked "How did the natives react?", he answered: "Very friendly!" This coded language told the Harvard researchers that the experiment had been successful. The use of a historical metaphor – the landing of Christopher Columbus in the "New World", which proved disastrous for Indigenous people – was not just symbolic, but typical of the Nuclear Age: The first atomic bomb, Trinity, was developed in New Mexico at Los Alamos, adjacent to the Tewa pueblos of Santa Clara and San Ildefonso. It was then tested in the White Sands desert on the territory of the Mescalero Apache.

Starting in 1947, the US government studied the impact of ionizing radiation on uranium miners and their family members, from the Diné, as well as the Laguna and Acoma Pueblos

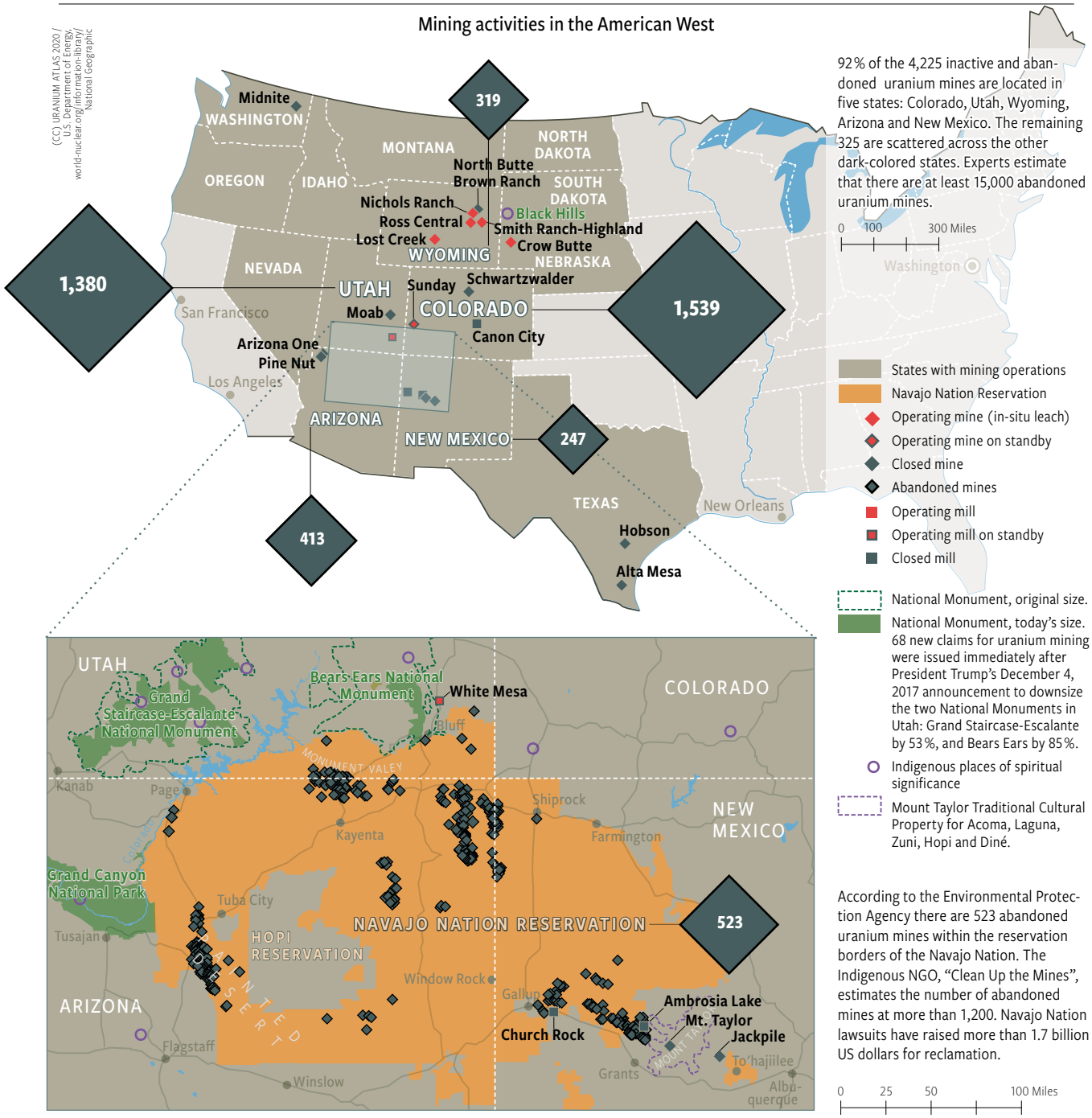
Although the US arms manufacturers at Los Alamos and Livermore were still using uranium from Canada, the Belgian Congo and Portugal, the government subsidized uranium exploration in the American Southwest, including on the Navajo Reservation, leading to an unprecedented uranium boom. From the 1940s until 1971, the US government was the sole purchaser of uranium – mainly for military purposes. Many members of the Diné (as the Navajo call themselves in their native language) and the Laguna and Acoma Pueblos, found jobs in the mines and mills, but were never informed about the dangers, nor were they provided adequate safety equipment. They worked underground in conditions that were contaminated by radon, a radioactive gas whose decay products produce alpha radiation, which the miners inhaled. When they arrived back home, their discarded work clothes, covered with mine dust, contaminated their homes and families. There is hardly a Diné, Acoma or Laguna family that has not lost someone to lung cancer. The growing number of cancer cases finally led to intense lobbying that resulted in the passing of the Radiation Exposure Compensation Act. Receiving compensation is not easy: claims can be forfeited when paperwork is missing or if the affected people are smokers. Furthermore, the Act does not apply to affected residents living near radioactive waste dumps. In 2002, Doug Brugge, then at Tufts University School of Medicine in Massachusetts, reported that the US government deliberately avoided dealing with the health hazards for the Diné and other Native and non-Native miners: "The position of scientists in the government who were knowledgeable and who often argued for protection was seriously compromised." Rafael Moure-Eraso, an occupational physician at the University of Massachusetts, concluded in 1999: "Uranium miners were unwilling and unaware victims of human experimentation to evaluate the health effects of radiation." By 1990, four million tonnes of uranium ore had been mined on the Navajo Nation Reservation. In 2005, the Navajo Tribal Council passed a law that prohibits further mining on the reservation.

The Grand Canyon, declared a World Heritage Site 40 years ago by UNESCO, is once again attracting the interest of uranium mining companies. From 1959-1963, uranium was extracted at the south rim. The Grand Canyon stretches 277 miles (446 kilometers) along the Colorado River in Northern Arizona. In August 2019, the Nuclear Energy Institute (NEI), on behalf of the interests of the US nuclear industry, wrote the Trump administration, requesting that uranium be classified as a resource of importance for reasons of national security and asked for a minimum purchasing quota of 25 per cent for operators of nuclear power plants. However, what the industry means by "national security" is securing the domestic power supply and an end to plant operators importing cheaper uranium from Kazakhstan, Uzbekistan, Canada and Russia. Two Canadian companies, Energy Fuels and UR-Energy, are leading this initiative. The NEI effort seeks to overturn the 2012 executive order by President Barack Obama, which protected the Grand Canyon and a surrounding area of one million acres (4,073 squarekilometers) from uranium mining operations until 2032, not including existing contracts and claims.

On October 30th, 2019, the US House of Representatives passed a bill to ensure a permanent ban on uranium mining in and around the Grand Canyon. But prospects for passage in the US Senate are uncertain, and the White House could still veto the bill.

The Havasupai, living at the bottom of their "Grandmother Canyon", are currently fighting for the integrity of their sacred springs. The Colorado Plateau upstream from the Grand Canyon has hosted uranium mining since the 1940s: The mill tailings pile at Moab, on the banks of the Colorado River, is still being reclaimed at a cost of more than 1 billion US dollars. Shaft production at the Canyon Mine began in the 1980s, but was never completed. Now, Energy Fuels Inc. is using a 30-year old permit to complete shaft construction, not withstanding the Canyon's UNESCO label and the millions of tourist dollars it contributes to Arizona's economy.

The US American Uranium Boom: Where the Atomic Age began



Uranium exploration and mining permits on Indigenous lands violate the 1978 American Indian Religious Freedom Act. Yet, the Lakota in South Dakota are still fighting to stop new uranium mines in their sacred "He Sapa" mountains, or Black Hills. Similar cultural violations affect the Hopi, Diné, Jicarilla Apache, Laguna and Acoma Pueblo in the Southwest, as well as the Spokane in Washington State. However, the Acoma Pueblo recently preserved their sacred Mount Taylor from uranium mining, a rare victory. The Hopi, Zuni, Diné, Ute, Paiute and Apache are struggling to protect the shrines of their ancestors in the Bears Ears National Monument in Utah. The Navajo Nation has a 1.7 billion fund – proceeds from law suits against uranium companies and the US government – to clean up abandoned uranium mines on the reservation. The battle cry to ban uranium mining now resonates across the world, extending from Indigenous lands in North America to those in Africa and Australia. ●

Further Information

Beyond Nuclear International: beyondnuclearinternational.org/2020/01/19/grand-canyon-under-nuclear-attack/
Black Hills: grist.org/justice/get-the-hell-off-the-indigenous-fight-to-stop-a-uranium-mine-in-the-black-hills/
Excellent resources: sric.org; swuraniumimpacts.org; defendblackhills.org; cleanupthemines.org, wise-uranium.org, uranium-network.org

SECRET ORE

Uranium has been mined in Asia since World War II.
To date, most of the uranium producing countries have made very little information public.

Ming-Kush, Mailuu-Suu, Kajy Sai, Shakavtar, Sumsar, Ak-Tüz and Orlovka – before the collapse of the Soviet Union in 1991, most of these cities in Kyrgyzstan were unheard of. But it was in these places that uranium was mined for the Soviet nuclear weapons program. Ming-Kush in the east, and Mailuu-Suu in the south of the country, were among the most highly developed cities in Central Asia, but with one giant flaw: they were closed off from the outside world. Nobody was allowed to talk about the fact that these were the locations where uranium was extracted to manufacture nuclear weapons. Uranium mining was suspended even before the breakup of the Soviet Union. A planned resumption of operations was banned by the Kyrgyz Supreme Council in May of 2019 after massive protests.

Uranium mining in Asia started during World War II in Tabošar, the present-day Istiklol in the north of Tajikistan. According to a decree by Soviet leadership in 1942, four tonnes of uranium were supposed to be produced in just a few months, to supply the raw material for the first Soviet nuclear bomb. As in Kyrgyzstan, uranium mining and processing in Tajikistan was also treated as a state secret by the Soviet regime. When the last mine was closed in 1992, a total of 20,000 tonnes of uranium had been extracted.

Kazakhstan began exploring for uranium deposits during World War II. According to data issued by the International Atomic Energy Agency (IAEA), a total of 30 commercially viable deposits, with a capacity of more than 1,000 tonnes, were discovered in five regions of Kazakhstan. By the mid-1950s, the Soviets began uranium mining operations, established four production centers and extracted around 70,000 tonnes of uranium before the Soviet Union dissolved. These operations were conducted under strict secrecy. Today, the country is by far the largest uranium producer in the world and in 2018 it produced three times as much as second-placed Canada.

Until 1990, uranium was almost exclusively mined in underground and open pit mines. Today, the state-owned company Kazatomprom, established in 1997, uses only the in-situ leaching (ISL) process. Two regions with sandstone formations are suitable for ISL: Chu-Syrdarya in the south, with the world's largest uranium deposits, and Kokshetau in the north. Since ISL extraction does not leave behind radioactive tailings, the company classifies uranium mining as unproblematic. Scientists see it quite differently: "In most applications of the technique, there have been extreme occurrences of groundwater contamination. At some sites, this contamination has migrated considerable distances to impact on potable drinking water supplies", says Gavin Mudd from the Royal Melbourne Institute of Technology.

In Russia, 93,980 tonnes of uranium were mined until the breakup of the Soviet Union. As the country began its process of nuclear disarmament, one mine after the other was closed due to economic inefficiency. Nowadays, Rosatom is in charge of the civil and military nuclear industry and thus also of uranium mining. In 2004, the state-owned company first employed the ISL process in Dalur and is still using it at the three remaining uranium mines in operation today. However, there is never any mention of uranium mining in Rosatom's 224-page annual report, except for a few key figures and some raw production numbers. There is also no mention of any problems. Uranium expert, Paul Robinson, reports that there are homes in the vicinity of uranium mines in Krasnokamensk where radon levels have been found at up to 28,000 Bq/m³ – some 190 times the allowable indoor radon standard, a level at which radon removal or treatment would be required in the US. In Russia, however, there is no follow-up on these cases.

There is also no program for the cleanup of decommissioned mines. Any environmental organization attempting to address this issue immediately feels the heavy hand of the state. All NGOs that receive money from outside the country must register as "foreign agents". Oleg Bodrov, a nuclear physicist, even had to resign from his post as head of the organization "Green World", after he advocated for the shutdown of all nuclear power plants in Russia and an end to uranium mining.

With a massive expansion of its civil nuclear program, China's domestic uranium production is no longer sufficient

Things are no better in China. In 1964, the country detonated its first atomic bomb and has been mining uranium for the generation of electricity ever since. Anyone criticizing uranium mining is considered an enemy of the state, as became obvious with NFFA-winner Sun Xiaodi: Rich uranium deposits were found in Gansu Province and one of the largest mines – Uranium Mine No. 792 – was opened there in 1967. Sun Xiaodi, who managed a warehouse in the region, began asking questions about health effects and radiation exposure. In 1994, he was fired. After he gave an interview to a French journalist in 2005, he was placed under house arrest and in 2009, according to IPPNW, was sentenced to two years in prison for incitement of the public.

So far, almost 47,000 tonnes of uranium have been extracted by the state-owned company CNNC. Since China is massively expanding its civil nuclear program, its own

Former Soviet Republics as Central Uranium Suppliers

uranium production is no longer sufficient: the country extracts around one third of its demand from its own territory, one third from foreign mines where CNNC holds stakes, and purchases the rest on the open market.

In 1998, Pakistan tested its first atomic bomb and currently operates five nuclear reactors. To date, the country has extracted just over 1,600 tonnes of uranium. In order to secure its uranium needs, the country has negotiated long-term contracts with China.

A total of 535 tonnes of uranium, a comparatively small amount, was mined in Mongolia. Even though uranium deposits of more than 100,000 tonnes have been documented, mining was suspended before the turn of the century. Nevertheless, the Mongolian government has awarded a total of 107 exploration licenses. Along with Areva/Orano, Indian, Chinese, Japanese and Russian companies are interested in resuming mining operations in the country.

Under the terms of the Iran Nuclear Deal – known as the Joint Comprehensive Plan of Action (JCPOA) – Iran was put under very strict international scrutiny, including inspections, to ensure it does not enrich uranium beyond commercial grade. JCPOA was in place to prevent Iran from developing nuclear weapons but is now in jeopardy after the US withdrew. As of 2018, Iran had mined 195 tonnes of uranium.

Along with Pakistan, Israel and South Sudan, India is one of the four countries that have not signed the nuclear Non-Proliferation Treaty. For this reason, India has only been allowed to import uranium since 2008 by a decision of the Nuclear Suppliers Group and at the instigation of the USA. Until then, the country was unable to produce the uranium needed for its nuclear power plants. However, India is the only democratically ruled uranium mining country in Asia. Uranium mining began in Jadugoda in 1967, enabling India to develop nuclear power. Currently, India operates 22 nuclear reactors at seven power plants and therefore has a huge demand for fuel. Although the country has large uranium reserves, the state-owned Uranium Corporation of India (UCIL) had, until 2018, only extracted 13,000 tonnes of uranium. One reason is public resistance: UCIL had planned three underground mines and one open pit operation near Lambapur-Peddagattu. A massive protest movement by the local population was able to prevent these mines from operating. Similarly, plans for new uranium mines in the Meghalaya region have been put on hold. ●

Further Information

Jadugoda health study: ippnw.org/pdf/jadugoda-health-survey.pdf
China: savetibet.org/chinese-activist-receives-anti-nuclear-prize-for-campaign-against-uranium-mine-in-tibet

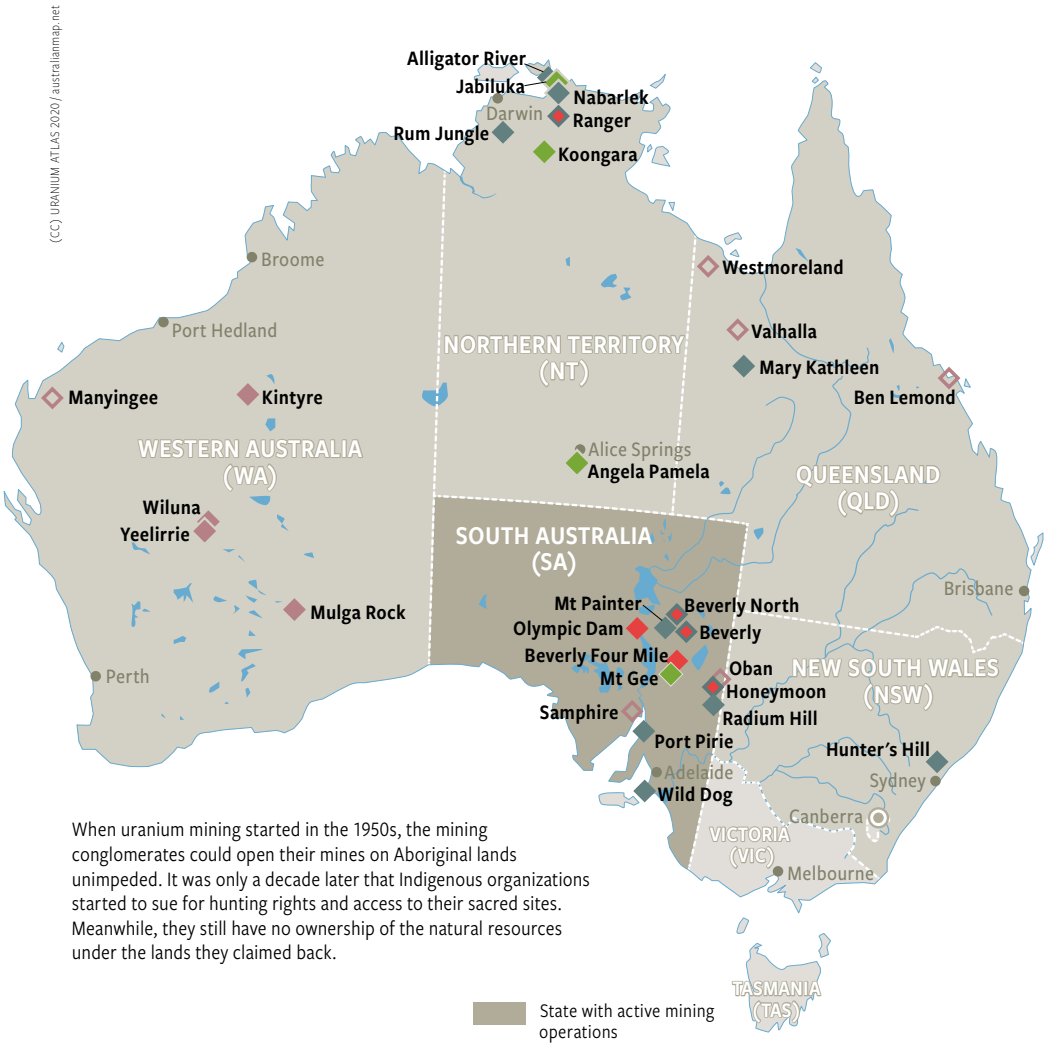
ANCIENT WARNINGS

The first peoples of the continent have a great sense of responsibility for the treasures buried in the earth, treasures that should never be brought to the surface. Their descendants continue to speak truth to power against the uranium mining companies.

In every landscape, the Indigenous people of Australia see a manifestation of the creative forces of ancient times, a power of the past that still resonates today. Thus, their bond with the environment is very deep: humans can never appropriate nature, they can only tend and care for it. The land mass was first settled 15,000 years ago; even today, Aboriginal people remember the names of places that have been under water for 15,000 years, places named by their ancestors when New Guinea and Tasmania were still connected to the continent via land bridges. Songs and dances help preserve the knowledge from the past in the collective memory. This includes warnings not to hurt the interior of the earth. The most well-known message is that of the rainbow serpent. The serpent created the mountains and lakes and sleeps under the earth. It is said that its sleep shall not be disturbed; otherwise deadly forces will be unleashed that humans cannot control. The rainbow serpent, according to today's First Nations people, is the guardian of the uranium veins. The late Joan

Yellowcake Country

Mining operations in the five continental states, as of 2019



When uranium mining started in the 1950s, the mining conglomerates could open their mines on Aboriginal lands unimpeded. It was only a decade later that Indigenous organizations started to sue for hunting rights and access to their sacred sites. Meanwhile, they still have no ownership of the natural resources under the lands they claimed back.

The names of mines and the names of **Aboriginal nations and clans** *on whose lands the mines are located:*

Operating mines
Beverly Four Mile (SA), Adnyamathanha
Olympic Dam (SA), Kokatha

Temporarily closed mines / in preparation for cleanup
Beverley (SA), Adnyamathanha
Beverley North (SA), Adnyamathanha
Honeymoon (SA), Ngurunta, Wilyakali
Ranger (NT), Mirarr

Closed mines
Alligator River (NT), Gagudju, Amarak, Iwaidja
Hunters Hill (NSW), Wallumedegal
Mary Kathleen (QLD), Kalkatunga, Mitakoodi
Mt Painter (SA), Adnyamathanha
Narbalek (NT), Madjawrr
Port Pirie (SA), Nukunu
Radium Hill (SA), Wilyakali
Rum Jungle (NT), Kungarakan, Warai
Wild Dog (SA), Kaurna

Planned new mines
Kintyre (WA), Martu
Mulga Rock (WA), Ngadju
Wiluna (WA), Tarlpaa
Yeelirrie (WA), Tjiwarl, Koara

Advanced exploration of the deposit
Ben Lomond (QLD), Juru, Gia
Manyingee (WA), Baijungu
Oban (SA), Ngurunta, Wilyakali
Samphire (SA), Barngarla
Valhalla (QLD), Kalkadoon
Westmoreland (QLD), Gangalidda, Garawa

Successful prevention of planned mines
Angela Pamela (NT), Arrernte
Jabiluka (NT), Mirarr
Koongara (NT), Djok
Mt Gee, Adnyamathanha

Wingfield, an activist of the Kokotha Nation in South Australia, gave an insight into the living earth at the 1992 World Uranium Hearing in Salzburg, when she talked about Galda, the stumpy-tailed lizard and the Olympic Dam uranium mine: "The first shaft dug goes right through the stomach of the lizard. At that shaft they mine uranium, the yellowcake, gold, silver, copper, lead, all the materials found in that area. When you open up a real lizard, you will find exactly the same colors you found deep down inside the earth."

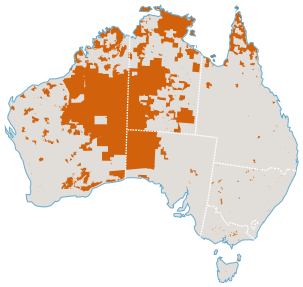
Uranium mining started in Australia in 1954, although there were extractions for medical research in 1906. By the late 1950s, Australia was the world's sixth largest uranium producer with an overall production of more than 212,000 tonnes; currently the country ranks third on the list of worldwide producers after Kazakhstan and Canada. At more than one million tonnes, the country has the largest mineable uranium resource in the world. Uranium mining has always taken place close to First Nations communities and far away from white cities. For decades, the traditional owners of the lands were not granted any kind of land rights, so when mining operations started, there were neither negotiations nor compensation payments. Only in 1993 did the federal parliament in Canberra pass the *Native Title Act* – a law intended to secure the traditional land rights of all Aboriginal peoples. While the government proclaimed this law to be a landmark recognition of Aboriginal rights, the people affected continue to see much the same inequality as before: when a company wants to mine for uranium, the burden of proof lies with the Native Title claimants; they have to prove that they have had an uninterrupted relationship with their lands until the present day – an insult to those who have lived there since time immemorial.

Once "Terra Nullius"

The change in ownership title in areas of Australia from1960 onwards

1960
In the course of the colonialization of Australia by the United Kingdom and the takeover by white immigrants, Aboriginal peoples were initially completely dispossessed. Even in 1960, they did not own a single square kilometer of the land. The government gave the mining conglomerates unlimited mining rights on Aboriginal land.

2020
Indigenous peoples, communities and politicians have been advocating and litigating for land rights and native title since the middle of the 1960s. And they have been successful, as the map shows. Native title and land rights claims continue to be made and granted, meaning that the amount of land restored to Indigenous peoples is likely to continue to grow over the coming years.



restored Aboriginal land

Australia does not operate its own nuclear power stations. Uranium is mined exclusively for export. New mines have been prevented due to resistance from Aboriginal communities

Even when Native Title is recognized, traditional owners are still forced to negotiate with the mining companies, or are excluded altogether. If no agreement is reached, the projects of the mining company take precedence over recognition of the Indigenous land rights. There is no legal instrument to veto such decisions. Communities and groups who want to refuse access to the lands are often excluded from negotiations. Companies regularly use tactics of divide and rule by offering financial rewards to agreeable discussion partners, which creates lasting family disputes and erodes community. Uranium mining is only permitted in South Australia and the Northern Territory. Victoria, Tasmania, New South Wales and the Capital Territory of Canberra have long standing bans on uranium mining. Queensland and West Australia have bans on uranium mining but these bans were lifted under different governments and then reintroduced.

But despite all this, some successes have bolstered the hopes of the Aboriginal nations: Jeffrey Lee, the last descendant of the Djok, refused to sell Koongara, the land of his ancestors in the Northern Territory. The French company Areva outbid itself to extract the estimated 14,000 tonnes of uranium buried beneath his lands. Jeffrey refused every single offer and wanted to make Koongara part of the Kakadu National Park. He traveled to Paris with a delegation and succeeded in winning the support of UNESCO, which had already declared the park a World Heritage Site in 2003. At the same time in the same region, Yvonne Margarula (see photo on title page), the Mirrar senior Traditional Owner, and her community had fought against the opening of the Jabiluka mine – and even successfully stopped construction in 2005.

The resistance against the Ranger mine right next to the national park made an impact. Uranium had been mined there since 1980, mostly for Japan, Korea, Taiwan, Germany and USA. More than 200 incidents of environmental contamination have been documented. In 2019, production was finally stopped.

In the Northern Territory, on the lands of the Arrernte people, operations at the Angela Pamela mine were stopped by sustained community opposition. All mining and processing operations must finish at Ranger by 2021, and the clear focus is now on the complex and costly job of rehabilitation. In South Australia, local grassroots forces stopped the plan to extract uranium deposits in the Arkaroola wilderness reservation on Adnyamathanha land. However, in 2008, the state of Western Australia allowed uranium mining; as of 2020 there are still no operating mines in WA, although four projects have state and federal environmental approvals – Kintyre, Wiluna, Yeelirrie and Mulga Rock. Communities at each of the four sites continue to oppose these mines and have led protest actions, court challenges and community campaigns to try and stop them. ●

Further Information

Australian Conservation Foundation: Campaign "nuclear free", acf.org.au
Don't Nuke the Climate Australia: dont-nuke-the-climate.org.au

FOR THE BOMB AND BEYOND

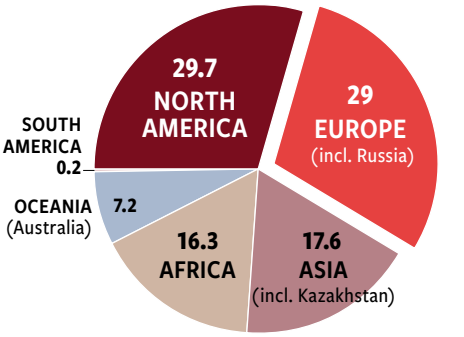
At the start of 2020, there were still 124 nuclear power plants in operation in the EU, making it the world's largest consumer of uranium. The nuclear fuel is imported from outside the EU and there is strong opposition to any new uranium mining in Europe.

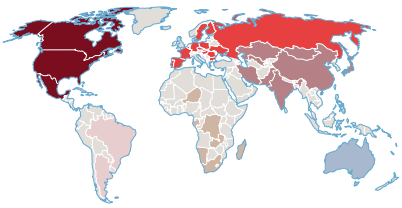
The last mine in Central Europe was closed in 2017 when the Rožná mine, southeast of Prague, terminated its operations. Rožná was first opened in the 1950s, employed 4,000 people in its heyday in the 1970s and produced a total of 4,000 tonnes of uranium. Today, the Crucea mine in Romania is the only uranium mine still active in the EU. This is only due to the fact that the national uranium company operating the mine was kept afloat with a million euro loan after the Romanian company Nuclearelectrica decided to buy cheaper uranium from Canada. The EU Commission has declared the state subsidies for the operator of the Crucea mine incompatible with EU law and ordered the government to recover 13 million euros plus interest. The operator is de facto bankrupt and the further operation of the mine is uncertain. Outside of the EU, only Russia and the Ukraine still have ongoing uranium mining operations. As elsewhere, the history of uranium mining in that region is long and disastrous. In January of 1945, at the end of World War II, Soviet geologists started to prospect for uranium in Bulgaria. They had been in competition with Nazi Germany to build a nuclear bomb, just

Europe's Share of Global Uranium Production

Cumulative uranium mining in individual countries from 1945 to 2019 *in tonnes*

Share of uranium mining by continent from 1945 to 2018 *in percent*

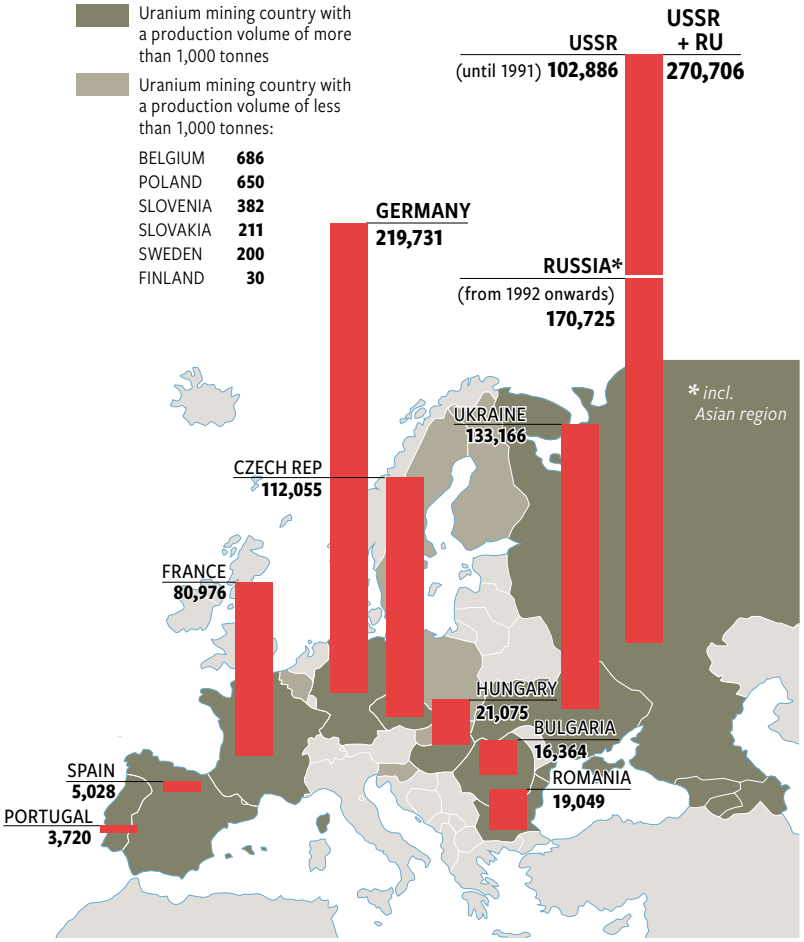




Uranium mining country with a production volume of more than 1,000 tonnes

Uranium mining country with a production volume of less than 1,000 tonnes:

BELGIUM	686
POLAND	650
SLOVENIA	382
SLOVAKIA	211
SWEDEN	200
FINLAND	30



as the Americans had been with the Manhattan Project.

However, the Soviets were no better able to guess how close Hitler's war industry was to completing the so-called "wonder weapon" touted by Nazi propaganda, than the Americans were; after all, it was Otto Hahn who first discovered controlled nuclear fission in Berlin in 1938. After World War II, the Soviet bomb project continued. By May of 1945, uranium explorations were carried out in the Czech region of Jáchymov and in the Erzgebirge mountain range in German Democratic Republic. Driven by the arms race during the Cold War, miners in Saxonia and Thuringia extracted 231,000 tonnes of uranium before the fall of the Iron Curtain, while in Czechoslovakia 100,000 tonnes were mined.

Until the end of the 1950s, miners in Czechoslovakia and East Germany mined uranium under dismal conditions. In East Germany, many were even conscripted against their will. More than half a million people worked for the East German Wismut company during this period. In the Russian part of the Soviet Union, "only" around 100,000 tonnes of uranium were mined until its breakup.

In East Germany, uranium mining was discontinued after reunification, while in the Czech Republic it only ended in 2017. Over the past 25 years, German taxpayers have spent around 6 billion euros for cleanup efforts to remove the legacy of uranium mining operations in Saxonia and Thuringia – more than any other country or company. In the Czech Republic, the government has so far invested around 540 million euros for cleanup operations and plans to spend three times as much again until 2040.

In West Germany, the nuclear industry also prospected for uranium in the 1950s. Uranium was mined, at least for a time, in Menzenschwand in the Black Forest, Müllenbach near Baden-Baden, Mähring in the Upper Palatinate and Weißenstadt in the Fichtelgebirge mountain range. In Ellweiler in Rhineland-Palatinate, between 1961 and 1989, it was processed into yellowcake to provide the raw material for the production of fuel rods. After it was detected that too much radon was being emitted from the illegal waste dumps and the permitted limits had been exceeded, the operator filed for bankruptcy. The government then had the piles cleaned up at the cost of converted 3.5 million euros of taxpayer money. Because there were no economically attractive deposits in West Germany, there was never any large-scale commercial mining there.

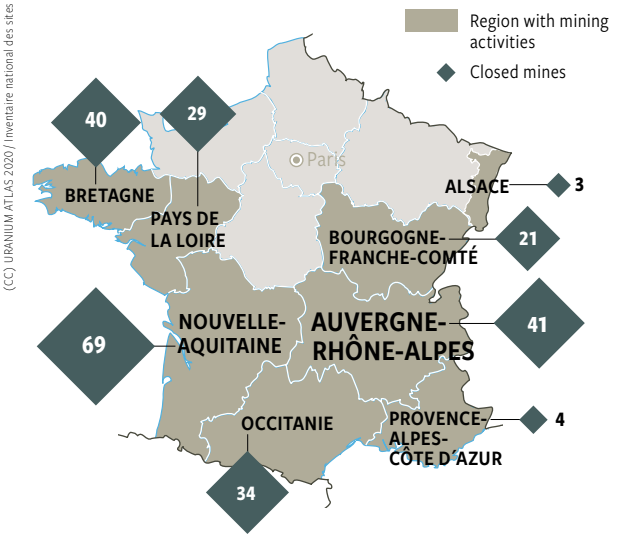
France had 241 uranium mine sites. Closing the mines did not eliminate the hazards caused by the radon gas they released

The nuclear industry in France had larger deposits at their disposal: in all, there were 241 uranium mines, which extracted around 81,000 tonnes of uranium. Among them were smaller mines with just one shaft but also large mines such as Mas Lavayre and Margnac-Peny with a total yield of 5,000 to 10,000 tonnes. All deposits in France have been largely exploited, and the last mine was closed in 2001, but almost none were properly cleaned up. In all of the French mining areas examined by the radiation protection expert Bruno Chareyron, director of the research laboratory CRIIRAD, the radiation exposure levels were far above normal background

Fuzzy French Numbers

Former uranium mine sites in France

After World War II, the French state scoured the country for uranium in order to keep up with the arms race, resulting in **241 mine sites**. The last one was closed in 2001. However, the exact count is obscured by the presence of multiple small mines at one site, and by efforts of landowners to hide the existence of abandoned mines in order to maintain their property values.



radiation. He concluded that the radiological hazard for local residents persists and is not eliminated by simply closing the mines.

Even Portugal, which does not have a single nuclear power station, was among Europe's uranium producers. By 1991 it had produced a total yield of 3,720 tonnes from its 91 uranium mines. In neighboring Spain, whose last mine closed in 2001, production was more than 5,000 tonnes. As in most countries with uranium mining operations, the toxic legacy was inadequately cleaned up.

Despite this, in 2019, the British-Australian energy company, Berkeley Energia, announced plans to enter the business of uranium mining with the so-called Salamanca project in Spain. Since then, thousands have protested against these plans, pointing to the risks involved. Portugal, a direct neighbor, was not included in the environmental impact assessment, which violated EU law. Consequently, the "Stop Uranio" movement brought the matter before the Petitions Committee of the European Parliament. Spanish authorities have since revoked all permits and stopped the construction of a required access road.

The example of Spain shows that an end to uranium mining in Europe will not happen in isolation. Only persistent protests were able to prevent new mining projects. The low price of uranium and the nuclear industry's economic crises are further contributing to the end of uranium extraction. ●

Further Information

Danish Institute for International Studies: diis.dk/en/projects/governing-uranium
The Bulletin of the Atomic Scientists: thebulletin.org/
Commission de Recherche et d'Information Indépendantes sur la Radioactivité: criirad.org

SUCCESSFUL RESISTANCE

For years, the price of uranium has remained at rock bottom and with it the entire uranium industry. At the same time, more and more groups are taking up the fight against the destruction of their natural environment.

For the past 20 years, the nuclear industry has tried to sell us on a nuclear renaissance. However, the reality looks quite different: by the start of 2020, the European Union (including the United Kingdom) still had 124 operational nuclear reactors – approximately one third of all reactors worldwide – but 61 less than in 1989, when nuclear energy was at its historic all-time high. Five reactors are currently under construction in the EU (see p. 33). The situation is similar in the US and Canada: between 1996 and 2015, not a single nuclear power plant was completed. Only Watts Bar II in Tennessee went online in 2016 after being "under construction" for 43 years. "The driving force behind this may be the production of tritium needed for the US nuclear weapons program", says Dr. Alex Rosen, co-president of the board of IPPNW Germany.

After the 2011 Fukushima disaster, all 54 reactors in Japan were taken offline. At the beginning of 2020, nine reactors had been brought online again, but all new projects had been halted. Since Fukushima, Germany, Belgium, Spain, Switzerland and South Korea have opted for a nuclear phaseout. The production of nuclear power has fallen worldwide by more than ten percent and consequently the worldwide demand for uranium has diminished: from 68,646 tonnes before the Fukushima disaster to 56,585 tonnes in 2014. While there has been a slight increase in nuclear energy production and uranium demand since 2014, this is almost entirely due to new power plants in China. Rather than the promised renaissance, nuclear power is in stagnation.

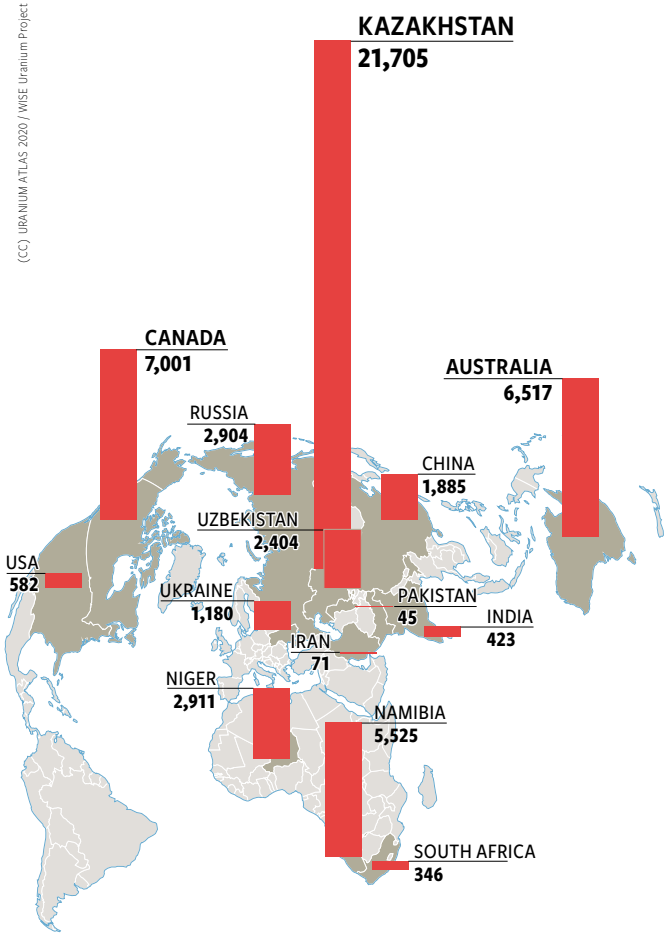
With a 40 percent share of worldwide production, Kazakhstan is currently the most important uranium supplier. The country has held this position since 2009. The state-owned Kazatomprom mines uranium exclusively using the in-situ leach method. Since this produces no tailings and contamination remains invisible, government officials proclaim this to be a "clean technology". Kazatomprom then delivers the yellowcake to Russia, China, India, France, Canada and the USA. In order to keep the uranium price high, the state-owned corporation cut back production by five percent in 2017 and by 20 percent in 2018.

Developments in recent years have had dramatic effects on the price of uranium. Since 2016, the price has hovered below 30 US dollars (per pound), making most mines uneconomical; new mines are rarely opened, and existing mines are being closed or sold. By 2014, Paladin had closed its Kayelekera mine in Malawi as it would have cost millions to continue uranium mining there. In Niger, Areva invested 1.9 billion euros in the Imouraren mine but never actually started uranium mining there; in Namibia, the Klein corporation closed the Trekkopje mine years ago since the mine had only made losses. The Langer Heinrich mine in Namibia pushed the Australian Paladin corporation to the verge of bankruptcy and was mothballed in 2018. In Mali, the Faléa mine lies unexploited. In Canada, the McArthur River mine was closed, while in Australia, the Ranger Deeps mine was developed but never put into operation. In the United States, the Trump administration is trying to revive closed mines, and even open new ones, including in the Grand Canyon area, so far without success.

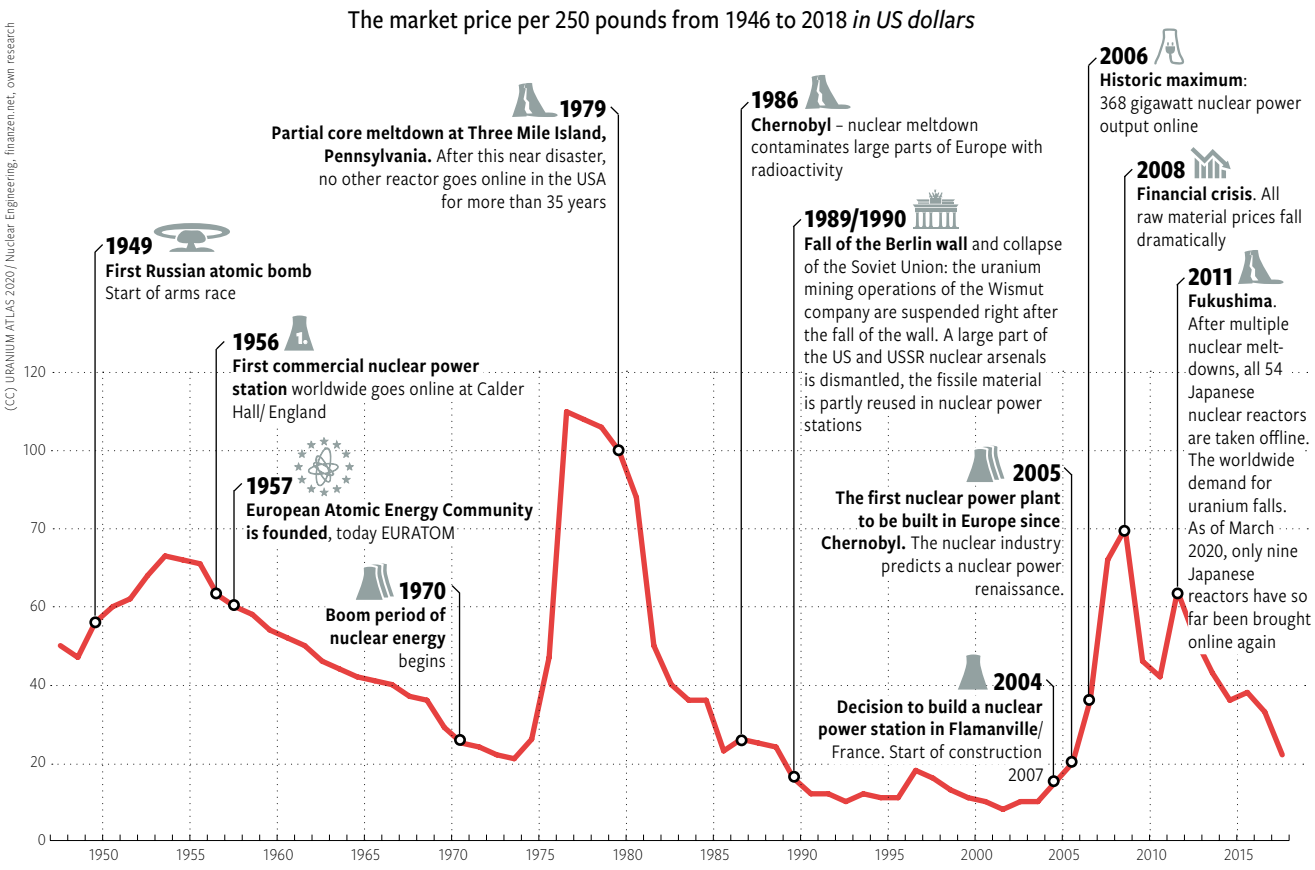
For now, mining companies are waiting for the uranium price to recover. At the same time, more and more people in Africa, Australia, North America and Europe are fighting against uranium mining and the destruction of their livelihoods. For example, in 2003, uranium miner Almoustapha Alhacen invited independent scientists from France to Niger and had them measure the radiation contamination around the uranium mining town of Arlit. The result: dramatically elevated levels, an explanation for the many cancer cases

Leading Providers

Worldwide uranium production in 2018 *in tonnes*



The Development of the Uranium Trade against the Background of Key Events



there. Uranium giant Areva cited only its own measurements to claim that the situation did not pose a threat. However, Areva had to contend with an unexpected adversary in Australia: UNESCO declared the area around Koongara – where Areva had hoped to mine uranium – a part of the Kakadu National Park World Heritage Area.

With their protests scarcely recognized outside of the African continent, activists from Niger, Tanzania, Malawi and South Africa joined forces and founded the "African Uranium Alliance". Besides resistance against new mining projects, their main focus was to raise awareness of the plight of workers in the mines: very often, protective equipment, dosimeters and adequate safety regulations were missing in the mines.

Since Fukushima, the production of nuclear power has decreased by over ten percent worldwide. Accordingly, the demand for uranium went down and thus the price of uranium

In West African Mali, the government issued a license in 2007 to explore uranium deposits in the Faléa region. Since then, the citizens group ASFA21 has fought against mining operations in this area. In 2015, young people from all over Africa climbed Tanzania's Mount Kilimanjaro, to call for a "Ban on Uranium Mining" from Africa's highest mountaintop. Tanzania was chosen for this declaration because the government wanted to make the country one of the leading uranium producers and to exploit the uranium deposits found in the 1970s and 1980s. Because resistance was so massive, some of the explorations of possible mining sites on fields and grazing lands could only happen under police protection. The march up to the summit of Mount Kilimanjaro was designed as a highly visible sign for these protests.

However, some governments do more than just take note of these protests. In Malawi in 2017, eight activists from Tanzania were incarcerated for more than 100 days as "foreign agents", because they wanted to witness uranium mining and its consequences in Malawi. In Russia, anti-nuclear activists had to flee into exile after the government also classified them as "foreign agents", while those who stay in the country are intimidated and threatened. In Turkey as well, anti-nuclear activists do not want to be named due to the current political climate. The public will rarely hear about protests happening in dictatorial and autocratic regimes such as Kazakhstan and China.

Anti-uranium activists are even criminalized in Spain. However, massive protests there as well as in the Czech Republic have at least forestalled new uranium mines for the moment. Worldwide, the movement has adopted the slogan of the Indigenous people of North America: "We are not protesters, we are protectors". They see themselves as protecting the environment and point to renewable energy – which is becoming less and less expensive – as an alternative to nuclear energy. ●

Further Information

Banning uranium mining: u-ban.org, uranium-network.org
Climbing of Mount Kilimanjaro: twitter.com/kproject2015?lang=en

A "WHO'S WHO" OF URANIUM MINING

Uranium mining around the world is a near monopoly. It is controlled by a handful of companies with the ten largest conglomerates responsible for 87 percent of uranium production and all of the exploitation of Indigenous people

Uranium mining is dominated by just a few players: the two state-owned conglomerates Kazatomprom (Kazakhstan) and Rosatom (Russia), as well as Cameco (Canada) and the French Orano Group, which has been spun off from the de facto bankrupt Areva and was saved with taxpayer money. These four were responsible for 56 percent of the world's uranium production in 2018. If you add CGN Uranium Resources, a subsidiary of the state-owned Chinese National Nuclear Corporation (CNNC), the big five represent a global market share of 66 percent. These big players are active wherever the raw material of the Nuclear Age is mined – and that is mostly on the lands of Indigenous people. While all of the big uranium conglomerates come from the Global North, most of the uranium is mined in the Global South.

For decades, Areva/Orano has been a central actor and widely networked in the global uranium and nuclear business: the conglomerate has 17 shares in uranium deposits in Canada, two in Niger, three in Gabon, two in Mongolia and three in Jordan. In each of these countries, Areva/Orano is mining its 13.5 percent share of the world's uranium on Indigenous lands. By the 1960s, Orano, or its predecessor companies, had begun uranium mining in Niger and had explored other uranium deposits in Africa. In Niger, the company owns 63.4 percent of the Arlit mine, 37 percent of the Somaïr mine and 56 percent of the Imouraren deposit. In Kazakhstan, the largest uranium producer worldwide since 2009, Orano has shares in the uranium mines of Tortkuduk and Myunkum. In Canada, it owns 37 percent of the Cigar Lake and 30 percent of the McArthur River mines. By 2018, Canada was responsible for 17.4 percent of the world's uranium production. The uranium came mainly from these two mines.

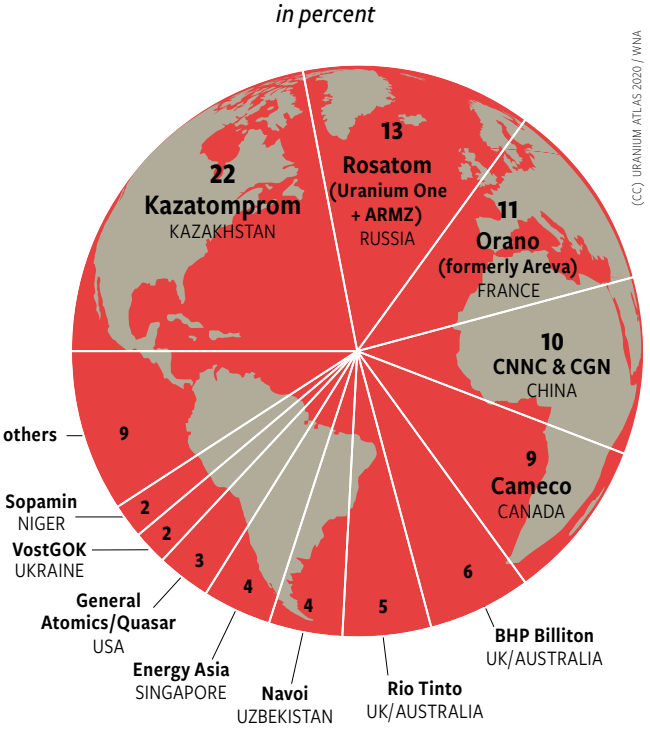
These shares represent not only mining, but also exploration, securing of new deposits and possible future profits. Some mines have been temporarily closed, in other places the project did not progress beyond exploration, because, subsequent to the Fukushima disaster, the demand for uranium has dropped. Orano's business model is supported by the state: two examples, French special forces have been deployed to secure the uranium mines in Niger; and, the French state – and thus the taxpayer – saved Areva/Orano from bankruptcy at the cost of 4.5 billion euros. This has allowed Orano to press ahead with its nuclear madness. The WISE Uranium Project has inducted the Orano/Framatome/Areva/Cogéma conglomerate into the "Hall of Infamy".

Other conglomerates proceed much along the same lines: The state-owned CNNC is not only China's leading operator of nuclear power stations and responsible for uranium mills in China, the company also buys up fissile materials in other regions of the world. It owns 49 percent of the Semizbai and Irkol mines in Kazakhstan. In Namibia it holds 25 percent of the shares in Langer Heinrich – with the option to extend its ownership to 49 percent as soon as operations are resumed – and it also owns 49 percent of the Zhonge exploration project in Namibia. The Chinese company is also active in Russia, Zimbabwe and Australia.

In 2013, the state-owned Russian company Rosatom took over the Canadian mining company Uranium One and, in a single stroke, became one of the most powerful global players. Rosatom holds 94.4 percent of the shares, with the remainder held by the Russian Finance Ministry. This takeover has resulted in Rosatom holding shares in five mines in the USA,

The Largest Uranium Mining Companies

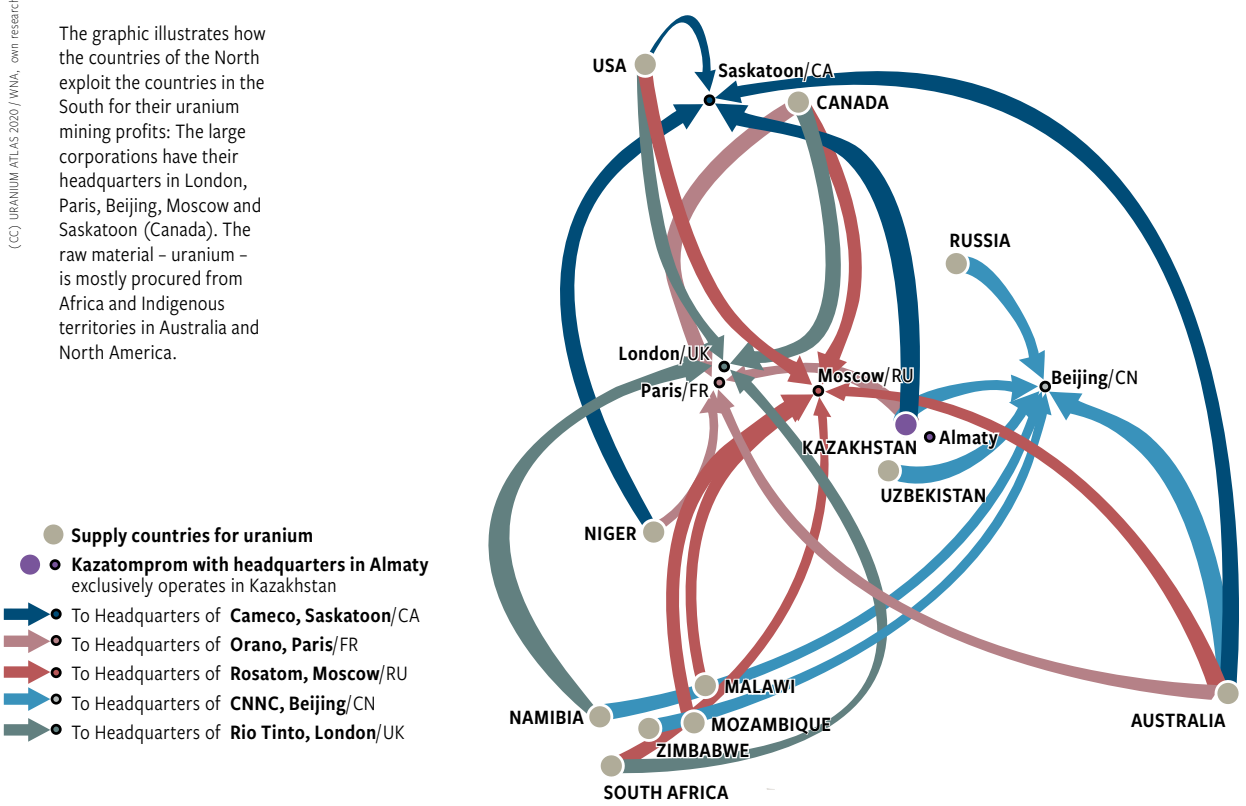
World market shares in 2018
in percent



The Strings are Pulled in the North

Uranium mining corporations and their supply countries

The graphic illustrates how the countries of the North exploit the countries in the South for their uranium mining profits: The large corporations have their headquarters in London, Paris, Beijing, Moscow and Saskatoon (Canada). The raw material – uranium – is mostly procured from Africa and Indigenous territories in Australia and North America.



three mines in Canada and several projects in Mozambique and Tanzania.

Rosatom has offices in South Africa and Australia and is the world's second largest uranium producer with a yield of 7,289 tonnes in 2018. Because Rosatom is also trying to promote the construction of new nuclear power stations, many threads come together at the corporate headquarters. China, India, Turkey, Iran and Hungary are on its contact and order lists.

The Canadian uranium giant Cameco can also be found wherever there are deposits of the raw material for nuclear bombs and nuclear power stations. It has 20 shareholdings in its own country, ten in the USA, and more in Kazakhstan, Niger and Australia. Cameco has also made its way into the WISE "Hall of Infamy".

In contrast, Kazatomprom, operates 17 uranium mines all of which are in Kazakhstan, and was the world's largest uranium producer in 2018 with 11,000 tonnes of uranium mined. The company has no foreign shares but allows other companies access to Kazakhstan's uranium deposits. Mining conglomerates such as the Australian-British Rio Tinto – number seven in the worldwide uranium business – make money with everything they can extract from the earth: iron, copper, gold, aluminum, diamonds, coal or bauxite, just to name a few. They mine for uranium not only in Australia, but also in Namibia, South Africa, Canada and the USA.

A look at the ten largest uranium mines in the world underlines the neo-colonial character of the business model: Cigar Lake and McArthur River are located on lands of the Cree and Dene Nations; Olympic Dam and Ranger on lands of the Kokatha, and Mirarr; Somaïr on the territory of the Tuareg. Five mines are located in Kazakhstan, an authoritarian country, which does not allow resistance to uranium mining. The price for keeping the nuclear power stations in South Korea, China, Japan, Russia, the EU and the USA online is paid by the people in the mining regions: their health and livelihoods are destroyed. The exact pathway of uranium is hard to follow: the mining companies do not disclose where they deliver the uranium and the power plant operators do not reveal where the uranium for their plants comes from. This includes Germany: when the uranium enrichment facility in Gronau was asked where they source their uranium, the answer was: "That's classified information!" ●

Uranium mining is a neo-colonial business model. Five of the world's ten largest uranium mines are located on the land of Indigenous peoples, and are generating profits for the financial centers of the North

Further Information

Company news: wise-uranium.org, rubric Uranium Mining Companies
Cindy Vestergaard: Governing Uranium Globally, 2015, PDF on researchgate.net

A RESPONSIBILITY ABANDONED

Uranium mining is never a benign process. It leaves behind radioactive and toxic waste with decay products that are even more hazardous than the mined uranium. However, there is virtually no management of these old mines.

Mining is the oldest method developed by humans to extract riches from the earth. Once the so-called mineral resources are depleted, a gaping hole is left behind, and this has grave consequences, especially when it comes to uranium mining.

Whether uranium is mined below ground or through open pit mining, both methods leave behind enormous amounts of residue. These residues include the decay products of the uranium chain, many of which have half-lives of seemingly infinite duration. Problems are created from the start, beginning with the exploration process: Thousands of test drills are conducted in areas where uranium deposits are anticipated. The drilled shafts connect below ground where uranium seeps into groundwater and can then contaminate the drinking water, even in a region where uranium was never mined. Wind and rain can carry radioactive particles over large regions, whether they emanate from drill holes, waste dumps, tailings dams or abandoned mines. This effectively contaminates the soil and the produce grown in those areas. This problem could be minimized by covering the waste with clay, but this is rarely done as it costs money.

Australia and most African countries have no laws requiring corporations to conduct mandatory cleanup after mining

In addition, rivers transport radioactivity downstream from uranium mines, even after the mining operations have ceased. Nuclear radiation does not know man-made borders. For example, radioactive dust originating in Australia has been detected in the Arctic, according to South Africa-based geologist Stefan Cramer. Since the 1990s, below ground and open pit mining has been supplemented by in-situ leaching (ISL). About half of today's uranium extraction is conducted using this method. In ISL, sulfuric acid or ammonium bicarbonate is injected into underground deposits to separate the uranium ore from other elements. The extracted uranium is mixed with water and pumped above ground. When the chemicals used for ISL breach subterranean aquifers, long-term monitoring is required, but there is practically no way to fix the problems created by ISL.

While decommissioned mines have usually undergone at least some form of effective sealing procedure, such measures are not possible at "abandoned" mines. The operators of thousands of former mines that were worked during the "uranium rush" era of the 1950s and 1960s – mostly located in the southwest of the United States – simply disappeared and left the mines completely unattended. Today, that legacy is still marked by rusting structures in danger of collapse as well as abandoned open pits and shafts. Even when they appear in US Environmental Protection Agency (EPA) documents, these "abandoned mines" are not clearly marked.

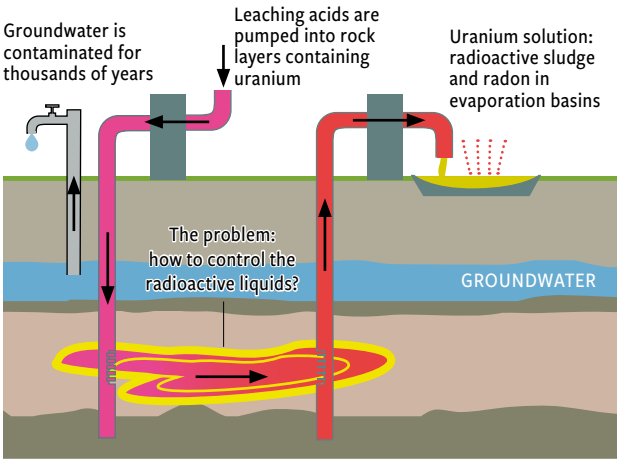
While requirements and guidelines for the cleanup of contaminated landscapes are in place for mining operations in general, there is no special status for uranium. As Paul Robinson, the mining expert at Southwest Research and Information Center (SRIC) in Albuquerque, New Mexico describes the situation: "The company gets the gold, the community gets the shaft." The *Surface Mining Control and Reclamation Act* of 1977, demands at least a minimum degree of cleanup from companies in the US. However, there is no such law in African states and only to a limited extent in Australia where cleanup commitments are purely voluntary. Once a corporation declares bankruptcy, the population is stranded with the mess. That is why an increasing number of civil society groups are starting to fight for their rights.

For example, in Australia there are three active uranium mines as well as 30 iron, 40 copper and 40 gold mines; seven nickel, five bauxite and 10 lead and zinc mines; plus about one hundred coal mining areas. The resistance of the Indigenous population is not only directed at uranium mining and its legacy, but also at coal and bauxite pits.

Chemical Leaching Underground

In-situ leaching (ISL), also called in-situ recovery (ISR)

Using injection drills, diluted sulfuric acid, hydrogen peroxide or ammonium bicarbonate is injected into rock layers containing uranium and, using a second drill, the resulting uranium-rich solution is pumped to the surface.

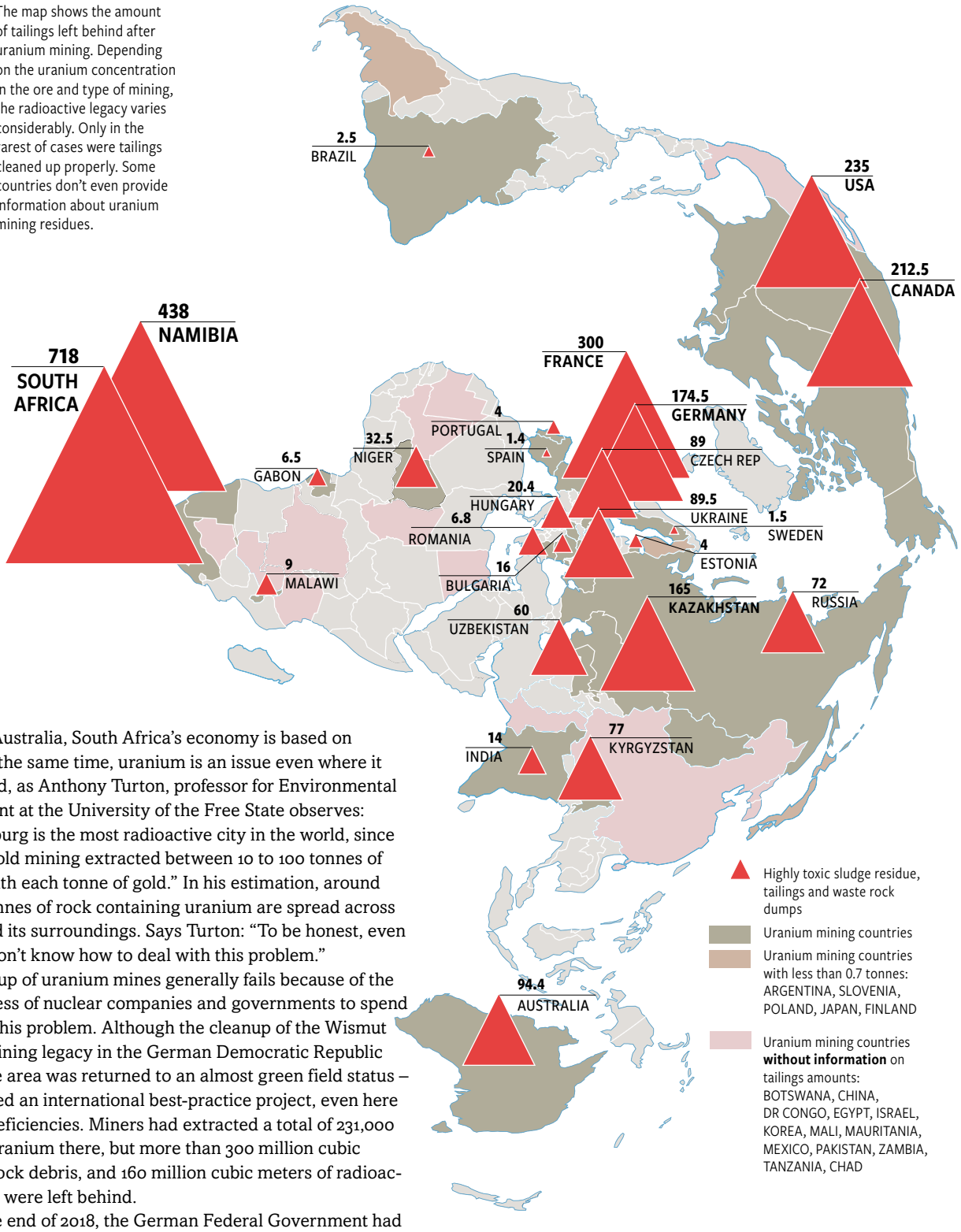


(CC) URANIUM ATLAS 2020 / WISE Uranium Project

The Legacy of Uranium Mining

Tailings per country 1940 to 2017 *in million of tonnes*

The map shows the amount of tailings left behind after uranium mining. Depending on the uranium concentration in the ore and type of mining, the radioactive legacy varies considerably. Only in the rarest of cases were tailings cleaned up properly. Some countries don't even provide information about uranium mining residues.



Like Australia, South Africa's economy is based on mining. At the same time, uranium is an issue even where it is not mined, as Anthony Turton, professor for Environmental Management at the University of the Free State observes: "Johannesburg is the most radioactive city in the world, since intensive gold mining extracted between 10 to 100 tonnes of uranium with each tonne of gold." In his estimation, around 600,000 tonnes of rock containing uranium are spread across the city and its surroundings. Says Turton: "To be honest, even today we don't know how to deal with this problem."

Cleanup of uranium mines generally fails because of the unwillingness of nuclear companies and governments to spend money on this problem. Although the cleanup of the Wismut uranium mining legacy in the German Democratic Republic – where the area was returned to an almost green field status – is considered an international best-practice project, even here there are deficiencies. Miners had extracted a total of 231,000 tonnes of uranium there, but more than 300 million cubic meters of rock debris, and 160 million cubic meters of radioactive sludge, were left behind.

By the end of 2018, the German Federal Government had spent 6.4 billion euros of taxpayers' money on the cleanup. This sum is expected to grow to eight billion euros by 2045. Despite this immense effort, the radioactive contamination cannot be completely eliminated because leachate containing uranium leaks out in many places and pollutes small rivers.

In almost all other regions of the world where uranium is mined, this problem is not even addressed. Neither mining companies nor governments are willing to provide the billions of dollars needed. That is why people continue to demand: "Keep uranium in the ground!" ●

Further Information

Tailings: wise-uranium.org, key word: Uranium Mill Tailings Inventory
Buddha Weeps in Jadugoda: documentary by Shri Prakash, 1999, on Youtube

FROM MAYAK TO CHURCH ROCK TO FUKUSHIMA

Nuclear meltdowns and ruptured dams, reactor fires and explosions: disasters that should never have happened.

The story of nuclear energy is also the story of its catastrophes. Mayak, Windscale, Three Mile Island , Church Rock, Chernobyl and Fukushima are some of the best known examples; six places where nuclear energy got out of control; six places which accelerated the decline of a technology that had once been launched euphorically. After 70 years of the so-called peaceful use of nuclear energy, we are instead left with melted reactor cores, uninhabitable regions, radioactive clouds and countless deaths.

Part of the story of these disasters, however, is also the attempt to conceal or downplay them. Cover-ups are an integral element of the nuclear industry. Initially, the triple meltdown in Fukushima in March of 2011 was a significant exception. Pictures of the collapsing nuclear reactors could be seen online around the world in real time. But the consequences are still trivialized today, even in Japan. Health effects, the extent of the contamination, the helplessness of aid workers and the enormous costs, are all downplayed.

But as early as its first decade, despite the growing enthusiasm for airplanes and cars with nuclear propulsion, and even for small reactors in each household, nuclear energy revealed its dark side: at Mayak and Windscale.

October 10th, 1957. In the northwest of England, on the coast of the Irish Sea, a fire erupts in the nuclear reactor Windscale I. Due to faulty temperature indicators and subsequent operating mistakes during maintenance work, the fuel channels overheat. Channel 20/53 glows red like a cherry. All attempts to cool down the reactor are unsuccessful: the core temperature rises to 1,300 degrees Celsius: Windscale is burning. While a fire blazes in the heart of the 2,000-tonne graphite block, radioactive smoke is continuously emitted through the smokestack. The people in the region are asleep in their beds, unaware of what is happening. All attempts to extinguish the fires using carbon dioxide and water fail. Finally, at the third attempt, the fire is finally put out. The population is only warned after the fire is extinguished. The milk of neighboring farms is collected and dumped into the sea; millions of liters of radioactively contaminated water seeps into the soil around the reactor.

By 1990, there are 70 investigative reports about the 1957 Windscale fire. Researchers try to convert the amount of released radiation into the number of deaths by cancer. In the end, they agree on a number: 100 victims. In the 1980s, a surge in leukemia cases causes concerns until memory slowly fades again. Windscale was even erased linguistically, with the complex renamed Sellafield in 1981.

Meanwhile, in September 1957, a tank with highly radioactive waste explodes in Mayak in Russia. Here, in the nuclear bomb factory of the Soviet Union, ten reactors produce plutonium for the Soviet nuclear weapons program. Even during normal operation, immense amounts of radioactivity are released into the environment. Nuclear particles and waste are disposed of either through the smokestacks or directly into the river Techa. When, in 1953, the local population begins to show signs of radiation effects, the first village in the vicinity is evacuated; by 1956 another 18 villages follow.

A year later, the explosion occurs and can be seen hundreds of kilometers away yet is officially declared to be a polar light event. At a height of 1,000 meters, the radioactive cloud travels in a northeasterly direction, leaving behind a radioactive trail 40 kilometers wide and 300 kilometers long. An area of 20,000 square kilometers with approximately 270,000 inhabitants is radioactively contaminated. More and more regions need to be evacuated.

The explosion is kept secret until Moscow finally admits to the disaster in 1989. According to assessments by the International Atomic Energy Agency, the Mayak explosion is the third-largest nuclear disaster in history after Chernobyl and Fukushima. Experts of the Helmholtz Center in Munich put it on the same hazard level as Chernobyl. The radioactivity level released in Mayak may have been even higher.

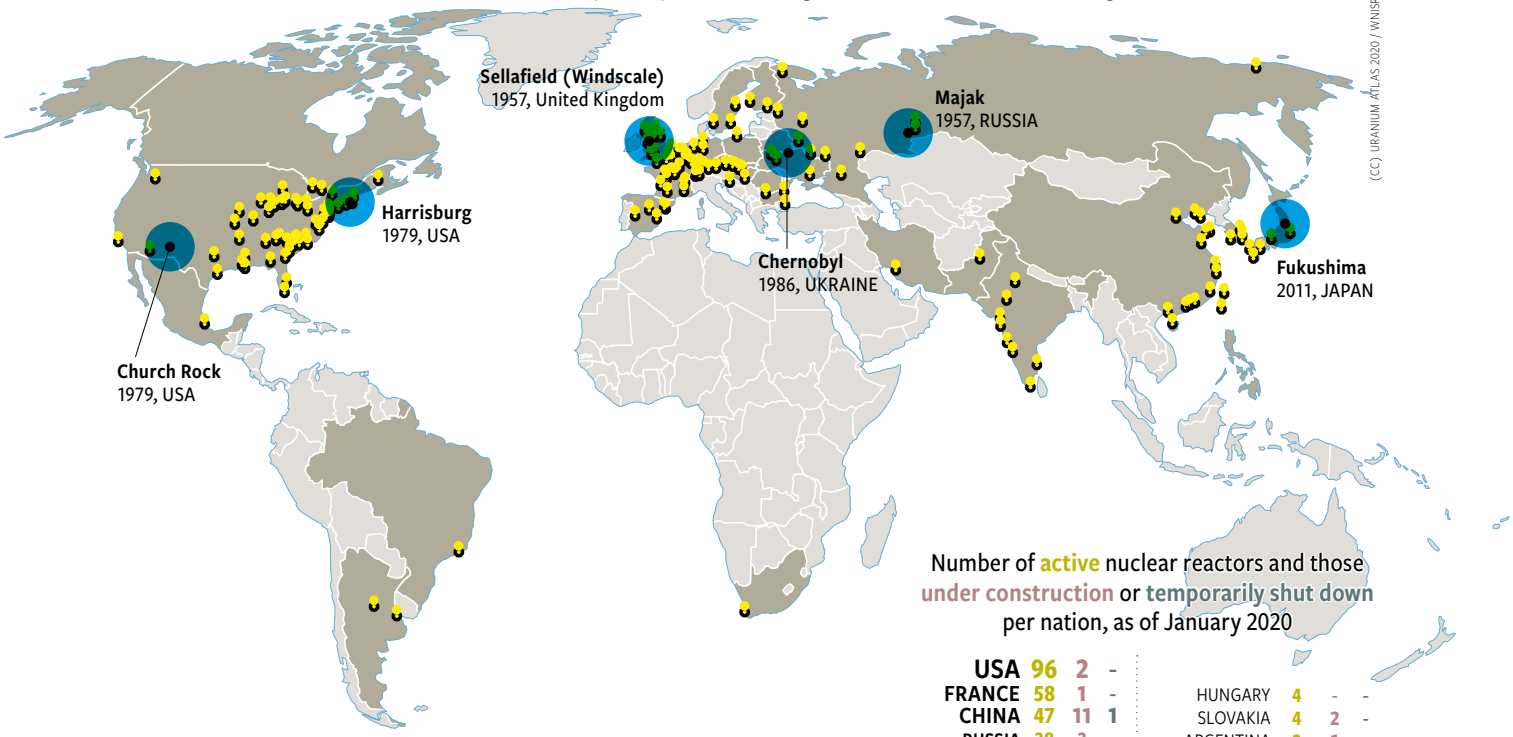
The United States experienced its own two nuclear disasters in 1979. In March, a growing number of experts are fighting to control reactor Unit 2 at Three Mile Island near Harrisburg. The glowing reactor core gushes to the floor of the reactor pressure vessel in a cascading torrent. It is a miracle that the pressure vessel holds. Three fourths of the core, made up of 36,816 fuel rods, melts at temperatures of almost 2,800 degrees Celsius. Failed cooling water pumps, two incorrectly set valves at the back-up pumps, a note on the control panel covering the valve indicators, and several operating errors lead to the disaster.

Chernobyl and Fukushima brought the world spectacular images and could not be kept secret – other disasters however were very well hidden from the public

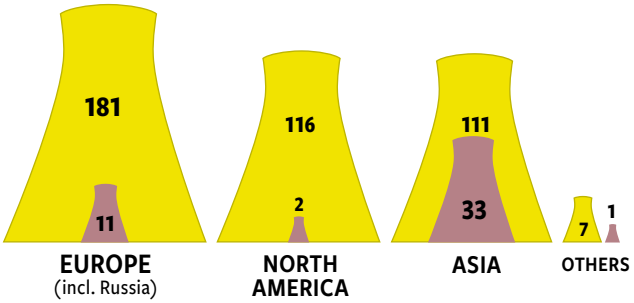
Children and pregnant women in an eight-kilometer radius are evacuated. At least 70,000 people flee the region. Nobody knows how much radioactivity was released into the environment. The statement of the lieutenant governor of the state of Pennsylvania, Bill Scranton, is unforgettable: “We have everything under control. There are no risks for the health and safety of the population.”

"Peaceful" Use of Nuclear Energy – a Summary

Sites of all active nuclear power plants and the great disasters of the Nuclear Age



Number of active nuclear reactors and those under construction on the different continents, as of January 2020



Number of active nuclear reactors and those under construction or temporarily shut down per nation, as of January 2020

USA	96	2	-
FRANCE	58	1	-
CHINA	47	11	1
RUSSIA	38	3	-
SOUTH KOREA	23	4	-
INDIA	21	7	-
CANADA	18	-	1
UNITED KINGDOM	15	2	-
UKRAINE	15	-	-
JAPAN	9	1	24
SWEDEN	7	-	-
BELGIUM	7	-	-
SPAIN	7	-	-
GERMANY	6	-	-
CZECH REP	6	-	-
PAKISTAN	5	2	-
TAIWAN	4	-	-
SWITZERLAND	4	-	-
FINLAND	4	1	-
HUNGARY	4	-	-
SLOVAKIA	4	2	-
ARGENTINA	3	1	-
BRAZIL	2	-	-
BULGARIA	2	-	-
MEXICO	2	-	-
ROMANIA	2	-	-
SOUTH AFRICA	2	-	-
ARMENIA	1	-	-
IRAN	1	1	-
NETHERLANDS	1	-	-
SLOVENIA	1	-	-
UAE	-	4	-
BANGLADESH	-	2	-
BELARUS	-	2	-
TURKEY	-	1	-
WORLDWIDE	**415**	**47**	**26**

In July of the same year, a tailings dam bursts in Church Rock, sending shock waves through the US nuclear industry. Church Rock is a village in the territory of the Diné tribe in the state of New Mexico. There are 20 uranium mines in operation in the area. In the largest one alone, more than 1,000 tonnes of uranium oxide are produced each year thoughout the 1970s. Hundreds of thousands of tonnes of radioactive waste are disposed of in huge tailings basins. On July 16th 1979, the walls of one of the basins burst. More than 1,000 tonnes of radioactive waste, and an estimated 90 million gallons of radioactive waste water, end up in the Puerco River. This remains the biggest accidental release of radioactive waste in the history of the United States. Three years later, the uranium industry abandons this site.

The Church Rock and Mayak disasters remain largely unrecognized. On the other hand, Chernobyl and Fukushima, the two "classic" nuclear meltdowns, are household names. They produced spectacular images and could not be kept secret. Even in the US, Three Mile Island is well known, while almost no one has heard of Church Rock, which happened the same year. In addition, the global public was more sensitized to the risks of nuclear disasters in 1986 and even more so in 2011.

Millions were able to follow the track of the radioactive clouds from Chernobyl and Fukushima. In Japan, they even briefly considered the evacuation of metropolitan Tokyo with its 30 million inhabitants. In Chernobyl, Russian military planes drained the rain clouds with chemical agents, before they could reach Moscow. Many details have become known, but the suffering and the medical consequences for millions of people have disappeared in the noise of statistical data. From Windscale to Fukushima: these six names stand for accidents that, according to risk studies, should not have happened at all, or only once in one hundred thousand years. But they happened with a far higher frequency and their legacy will live on for a very long time. ●

Further Information

Stephanie Cooke: In Mortal Hands – A cautionary history of the Nuclear Age. Bloomsbury, 2009
International Uranium Film Festival: uraniumfilmfestival.org

A QUESTION OF POWER

The WHO is supposed to pursue independent health policies. However, when it comes to nuclear issues, it is controlled by the IAEA. And under the EURATOM treaty, the European Union continues to promote nuclear energy.

On July 29, 1957, when the International Atomic Energy Agency (IAEA) was established under the auspices of the United Nations (UN), it seemed convenient to form an alliance with the UN World Health Organization (WHO), established nine years earlier. The experts wanted to profit from each other's experience. The industrialized nations had decided to use nuclear fission for civil purposes, a technology promising true wonders; the new organization was slated to promote worldwide dissemination of nuclear energy. At the same time, the effects of nuclear radiation on the human body were starting to be studied following the US nuclear tests in the South Pacific. On May 28th, 1959, the two organizations concluded a cooperation agreement, referred to as WHA12-40.

It states: "The International Atomic Energy Agency and the World Health Organization agree that, with a view to facilitating the effective attainment of the objectives set forth in their respective constitutional instruments, within the general framework established by the Charter of the United Nations, they will act in close co-operation with each other and will consult each other regularly in regard to matters of common interest." It continues: "Whenever either organization proposes to initiate a program or activity on a subject in which the other organization has or may have a substantial interest, the first party shall consult the other with a view to adjusting the matter by mutual agreement."

Until the Chernobyl, Ukraine disaster in 1986, this agreement had never received much attention. However, it wasn't until the WHO announced the official number of deaths from the nuclear accident, that the real importance of the agreement became evident. The WHO figures only acknowledged 30 dead workers and firemen who lost their lives as a direct result of the disaster. Today, in light of the many cancer deaths, it puts the death toll at 6,000. The organization International Physicians for the Prevention of Nuclear War (IPPNW, Nobel Peace Prize 1985) estimates up to 1.4 million deaths.

Then, in March of 2011, another nuclear catastrophe occurred, in Fukushima, Japan. In April of 2014, three years after the triple nuclear meltdowns there, UNSCEAR, the UN Scientific Committee on the Effects of Atomic Radiation under the auspices of the IAEA, published its first report relating to the nuclear catastrophe. The authors claimed that "no significant change in future cancer rates are to be expected which could be linked to the radiation exposure from the accident."

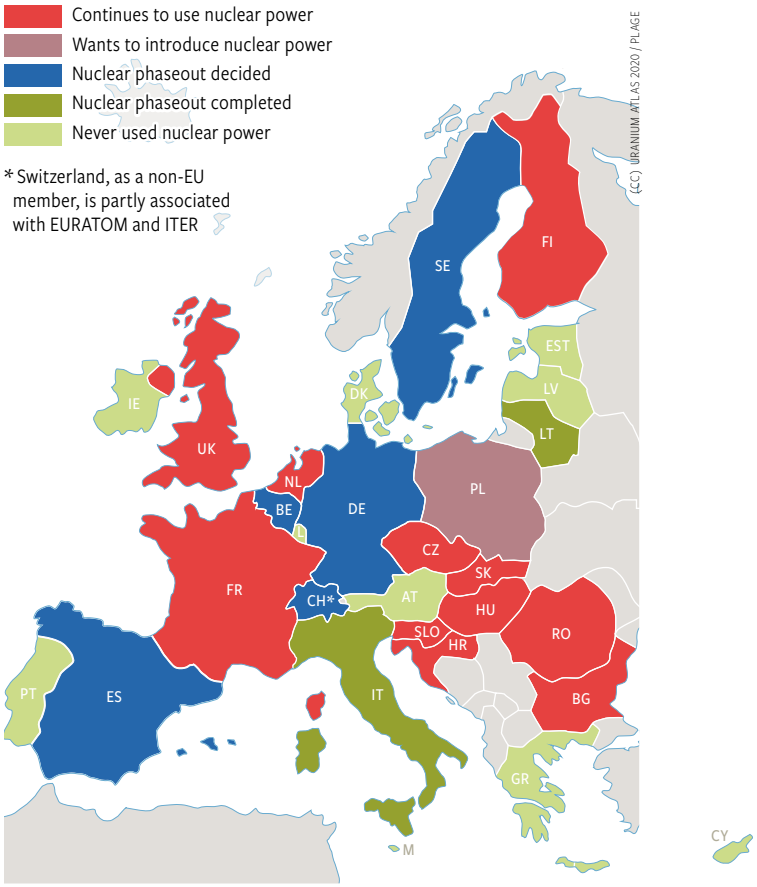
Dr. Alex Rosen, a pediatrician and co-president of IPPNW Germany, criticizes this attempt to play down the consequences: "The fact that cancer doesn't carry a label of origin, and can never be clearly linked to a specific cause, is used to deny any causality. We already know these tactics from the tobacco and the asbestos industries."

Rosen's view is supported by Richard Horton, the editor-in-chief of the medical journal "The Lancet"; in volume 383 dated June 21, 2014 he wrote: "when it comes to Chernobyl and Fukushima and the threat of radioactive contamination, the truth may not have been fully told. And WHO has a responsibility to get to that truth, however uncomfortable it might be for member-states or related agencies."

In the meantime, the IAEA has concluded cooperation agreements with the Japanese foreign ministry, the Fukushima Prefecture and Fukushima Medical University, which ensure that no party shall publish confidential information or classified material without the express consent of the other party.

EURATOM: Everyone Pays

Nuclear energy in the EU countries and Switzerland



The WHO denies it is subject to censorship. There has been a statement on its website since February of 2001, proclaiming that its commitment to the IAEA: "... does not in any way imply a submission of one organization to the authority of the other so as to affect their independence and responsibilities under their respective constitutional mandates."

However, there is no cooperation on equal terms between the WHO and the IAEA because the WHA12-40 agreement ensures an imbalance, inherent in the differing interests of the two organizations: As a UN organization, the WHO represents the health interests of the public and not the interests of an industry; the IAEA is fully backed by the nuclear industry and the nuclear weapons establishment. De facto, the IAEA is no more than a lobby organization, affiliated with the United Nations by an agreement.

As a result, when things get complicated, the WHO chooses to remain silent. For example, it never issued warnings regarding the use of uranium ammunition (see p. 40), which releases toxic and radioactive dust, endangering soldiers on both sides of a conflict as well as the civilian population. When radiologist Keith Baverstock, employed by the WHO from 1991 to 2003, wanted to publish new findings from the Armed Forces Radiobiology Research Institute – a division of the US Department of Defense – he was censored and vilified, prompting him to leave the organization. In 2007, the "Independent WHO" initiative was established in Geneva. It demands an independent health policy, especially in the field of threats.

Another document from the early days guarantees that the interests of the nuclear industry will be served: the EURATOM treaty, which established the European Atomic Energy Community on March 25th, 1957. Founding members were Belgium, Germany, France, Italy, Luxembourg and the Netherlands. This treaty was designed to disseminate and further develop nuclear energy in Europe. When the Treaty of Lisbon amended the Treaty on European Union and the Treaty establishing the European Community in 2007, the 50-year-old EURATOM treaty remained an integral part of the new alliance agreement. EURATOM provides the basis for financing European nuclear research. All member states pay into a joint fund, whether they operate nuclear power plants or not.

Sometimes, the World Health Organization is suspiciously quiet: It never issued warnings about uranium ammunition

"The EURATOM treaty undermines free trade", says Heinz Stockinger, founder of the Austrian anti-nuclear initiative PLAGE. "Without this excessive funding, the nuclear industry would be in no position to survive in the free market." Currently, this is evident in the European Commission's approval of the exorbitant subsidies for the Hinkley Point C nuclear power project in the UK, which is based on the EURATOM treaty. "The treaty is undemocratic and obsolete", Stockinger says. "The European Parliament has no decision-making authority in EURATOM issues."

In 2005, Austria, Hungary, Sweden, Germany and Ireland issued a statement regarding the EU constitution, emphasizing that the central stipulations of the EURATOM treaty have never been reformed since taking effect and need updating; for this reason they supported plans for a review conference. However, this conference is yet to materialize: the states operating nuclear power plants are determined to uphold the EURATOM privileges for the nuclear industry.

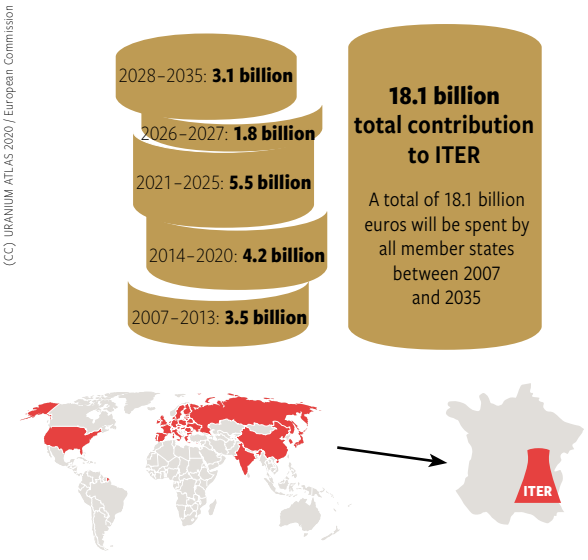
ITER: THE 35-NATION NUCLEAR RESEARCH PROJECT

ITER is a research project aimed at producing an unlimited amount of energy through nuclear fusion. The participants are all EU member states, along with Switzerland – through EURATOM – as well as the United States, China, South Korea, Japan, Russia and India. The fusion reactor has been under construction since 2007 at the Nuclear Research Center in Cadarache in the south of France.

The late Klaus Traube, chief designer of the fast breeder reactor in Kalkar, Germany, later a whistleblower, criticized the project: "In 1960, the nuclear industry had proclaimed that the fusion reactor would be a reality by 1970. In 1970, there was talk of completion by 1990. In 1990, a 2020 completion date was envisioned. Since 2000, there have been no further completion forecasts." Hermann Scheer, a now deceased solar energy pioneer, added in 2008: "The fusion reactor is a project of unrealistic nuclear pipe dreams. We need to use the fusion reactor called the sun. It can deliver infinite energy." ●

Investment in Nuclear Pipe Dreams in the Billions

Contributions to ITER from the 35 Nations *in Euros*



Further Information

Alternative data on radiological hazards: independentwho.org

THE NEW ARMS RACE

A nuclear war would have no victors.
Nevertheless, the nuclear-weapon states are modernizing their arsenals and developing “small nuclear weapons”.

At the beginning of February 2019, Donald Trump suspended the Intermediate-Range Nuclear Forces (INF) Treaty. This treaty, struck between the Soviet Union and the US in 1987, banned and eliminated ground-launched intermediate-range (500 to 5,500 km) nuclear missiles deployed between the Atlantic and the Ural Mountains. President Trump justified his decision by claiming that Russia had already violated the treaty by developing cruise missiles with a range of 2,600 kilometers. Meanwhile, Russia accused the US and NATO of violating the treaty by installing a missile defense shield and by using combat drones. Consequently, President Vladimir Putin also pulled Russia out of the treaty.

The US and Russia are modernizing their nuclear weapons arsenals. At the same time, the United Nations wants to ban these weapons altogether

The end of the INF Treaty poses a new threat specifically for Europe, as intermediate range missiles are not capable of crossing the Atlantic. However, this development could also open up new opportunities: “What would happen if Europe were to leave the geopolitical and nuclear policy of deterrence of the last decades behind once and for all?” asks Sascha Hach, long-time board member of the German section of the International Campaign to Abolish Nuclear Weapons (ICAN), which was awarded the 2017 Nobel Peace Price and the 2016 Nuclear Free Future Award. “We Europeans could create a neutral Europe, ending nuclear participation in NATO. This could enable a nuclear weapons-free Europe.”

In July of 2017, ICAN helped to draft a UN treaty banning nuclear weapons: 122 member states voted for the treaty, 81 countries have signed it, and 37 have ratified it (as of press time) – so far without the participation of any of the nuclear weapon states or NATO members. A principle reason for this is the involvement of NATO states in nuclear war preparation. One such example is the US military base in Büchel in Germany, where combat-ready nuclear bombs are still deployed. The nuclear threat persists, although it is often ignored by politicians, the media and the public. According to the Peace Research Institute, SIPRI, the nine nuclear powers possessed 13,895 nuclear warheads between them at the beginning of 2019. That is 600 warheads less than in the previous year – however, still more than enough to wipe out all life on Earth.

Despite this, the political thinking of our world leaders is not in synch with the efforts of ICAN and others. In 2009, Trump’s predecessor, Barack Obama, spoke of his vision for a nuclear weapons-free world. However he allocated more than one trillion US dollars to so-called “modernization” of the US nuclear arsenal. Then, under Trump, the US and Russia – the world’s two nuclear super powers – suspended the INF Treaty. Neither country requires new supplies of plutonium or highly enriched uranium, since, after deploying more than 70,000 nuclear warheads in the 1980s, they disarmed three quarters of them, but never destroyed the majority of the fissile materials.

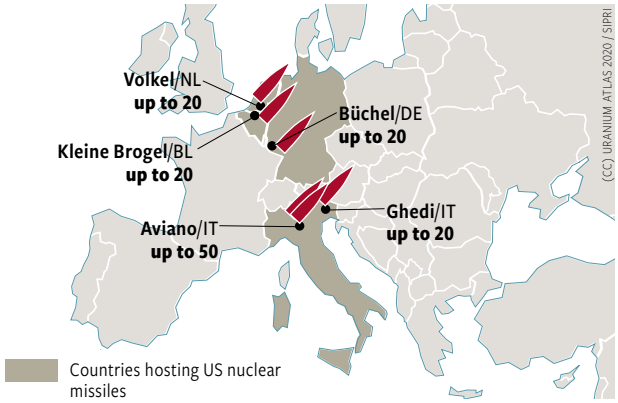
In its February 2018 Nuclear Posture Review, the US signaled its intention to have the capability of reacting to nuclear as well as “non-nuclear strategic attacks” with nuclear weapons. To that end, the US government is developing small tactical nuclear weapons, which could be deployed much more precisely, effectively lowering the threshold for a nuclear first strike.

While the US may talk of “small” nuclear bombs, these “small” bombs still have the destructive power of a Hiroshima bomb – the weapon that instantly killed an estimated 70,000 to 80,000 people on August 6th, 1945. A similar number of people are estimated to have died in the weeks and months after the attack. A study by IPPNW shows what a nuclear war would entail: A regional war with only 100 Hiroshima-sized nuclear bombs would result in a global famine and up to two billion subsequent deaths.

The only alternative to this scenario is a world without nuclear weapons. More and more people are actively working toward this goal. “Mayors for Peace”, an organization established in Japan in 1982, has been advocating since then for the abolition of all nuclear weapons. As of March 2020, 7,869 cities in 163 countries had joined the organization.

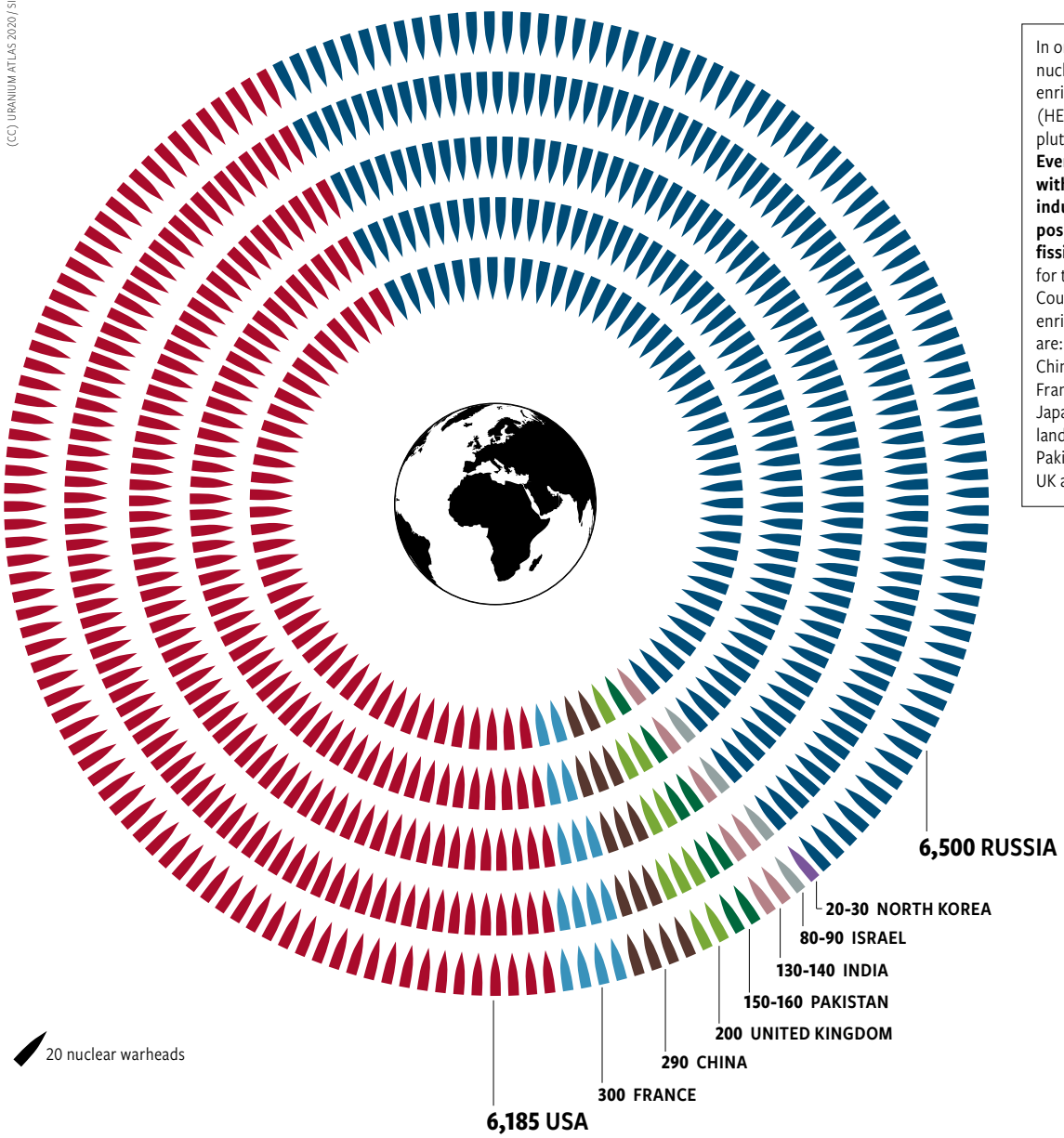
Nuclear Weapons in the EU

Number of nuclear weapons on US military bases in Belgium, Germany, Italy and the Netherlands



Permanent Threat to the World

Number of nuclear warheads per nation



In order to build a nuclear bomb, highly enriched uranium (HEU) or separated plutonium is needed. **Every country with a civil nuclear industry is in a position to produce fissile material** for this purpose. Countries capable of enriching uranium are: Argentina, Brazil, China, Germany, France, India, Israel, Japan, the Netherlands, North Korea, Pakistan, Russia, the UK and the US.

NO MONEY FOR BOMBS

Through its campaign "Don't Bank on the Bomb", ICAN is investigating the financial sources behind nuclear weapons construction. Between January 2017 and January 2019, banks invested 900 billion US dollars for this purpose. Just ten financial institutions were responsible for about half of this sum: Vanguard, BlackRock, Capital Group, State Street, Verisight (now called Newport Group), T. Rowe Price, Bank of America, JP Morgan Chase, Wells Fargo and Citigroup. However, this business model is becoming more and more stigmatized: ABP, the fifth largest pension fund worldwide, with assets of 500 billion US dollars, is excluding nuclear weapons manufacturers from its investments. KBC, a banking group with eleven million customers, has cut all financial ties with nuclear weapons manufacturers. Deutsche Bank declared it would no longer finance nuclear weapons production, much like other financial institutions in the US, the UK and France. All of us can ask our banks whether they grant loans to corporations dealing in nuclear weapons. ●

Further Information

IPPNW Study: Nuclear Famine. Two Billion People at Risk, as PDF at ippnw.org/nuclear-famine.html
Links: mayorsforpeace.org; icanw.org; dontbankonthebomb.com; armscontrol.org
"Nukes Ready To Fly" by Andrew Barr and Richard Johnson, National Post, 2012: nationalpostcom.files.wordpress.com/2012/05/fo0505_nuclearweaponsw1.pdf

BANNED SINCE 1996

The first nuclear bomb was detonated on July 16th, 1945 in Alamogordo, New Mexico. 2,057 additional tests followed, including by North Korea in 2017. More than one quarter of all bombs were detonated above ground. Radiation victims are still fighting for compensation today.

We are the most bombed nation in the world", say members of the Western Shoshone Nation when they talk about nuclear weapons testing. The US built the "Nevada Test Site" on their territory, about 100 km northwest of Las Vegas, in the Nevada desert.

The US military first conducted several dozen nuclear weapons tests after the conclusion of World War II, all of them in the South Pacific on the Enewetok and Bikini Atolls, which are part of the Marshall Islands. However, after the start of the Korean War in 1950, they instead chose to conduct most of their nuclear tests within the US "for reasons of national security". An area of 1,864 square miles in Nevada was declared a restricted military area. Between 1951 and 1992, the US Army detonated 928 nuclear bombs on this test site – one hundred of them above ground – until the passage in 1963 of the Treaty Banning Nuclear Weapon Tests in the Atmosphere.

"With the Ruby Valley Treaty, signed in 1863, the USA formally recognized two thirds of Nevada State as Western Shoshone sovereign territory", states the Society for Threatened Peoples. "In the 1930s, Western Shoshone territory illegally came within US authorities' jurisdiction." The Western Shoshone have never accepted this expropriation.

In the 1950s and 1960s, nobody was told about the radioactive clouds and the consequences of fallout – not the people living downwind in Las Vegas and elsewhere in the vicinity, nor the soldiers who were exposed to fallout only a few kilometers from the explosions and who were not given any protection. And least of all, the Western Shoshone. All the while, those in charge were well aware of the deadly risks, as recently declassified documents prove. By early 1953, a quarter of the sheep grazing on the test site land had perished. Seeing the carcasses of malformed lambs, even some with two heads, became a sort of strange normality.

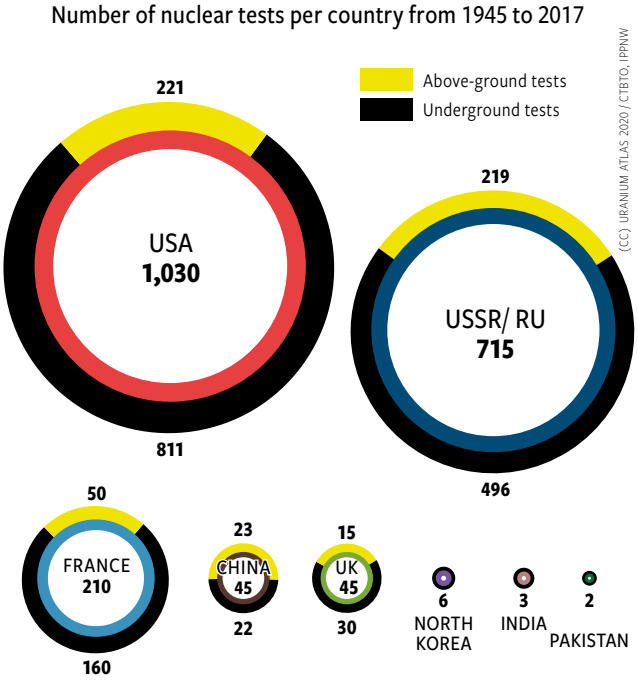
But the horrific effects of atomic testing did not end with malformed animals: "In the early '60s we began to experience all of the illnesses we are having now", says Lijon Eknilang, speaking about the Bikini tests in an article on the IPPNW website. She was just eight years old when, on March 1, 1954, the first US hydrogen bomb, "Bravo", was detonated on Bikini Atoll. "Many people suffer from thyroid tumors, stillbirths, eye problems, liver and stomach cancers and leukemia", said Lijon. "The most common birth defects on Rongelap and other atolls in the Marshall Islands have been 'jellyfish babies'. These babies are born with no bones in their bodies and with transparent skin. We can see their brains and their hearts beating. There are no legs, no arms, no head, no nothing. Some of these things we carry for eight months, nine months. The babies usually live for a day or two before they stop breathing."

Since 1990, radiation victims in the US have each received compensation of around 50,000 US dollars. A total of 2.13 billion US dollars has been paid out so far

It was not until 1990, with the passing of the Radiation Exposure Compensation Act, that the US government granted around 50,000 US dollars each in compensation to those suffering from cancer as a result of nuclear weapons tests and uranium mining. According to data released by the US Justice Department, 32,700 cases had been approved by March 2017, and more than 2.13 billion dollars paid out. That does not mean that all applications were approved. Those whose cancers could not clearly be linked to radioactive fallout or who "only" experienced stillbirths or suffered from mental disorders, were denied.

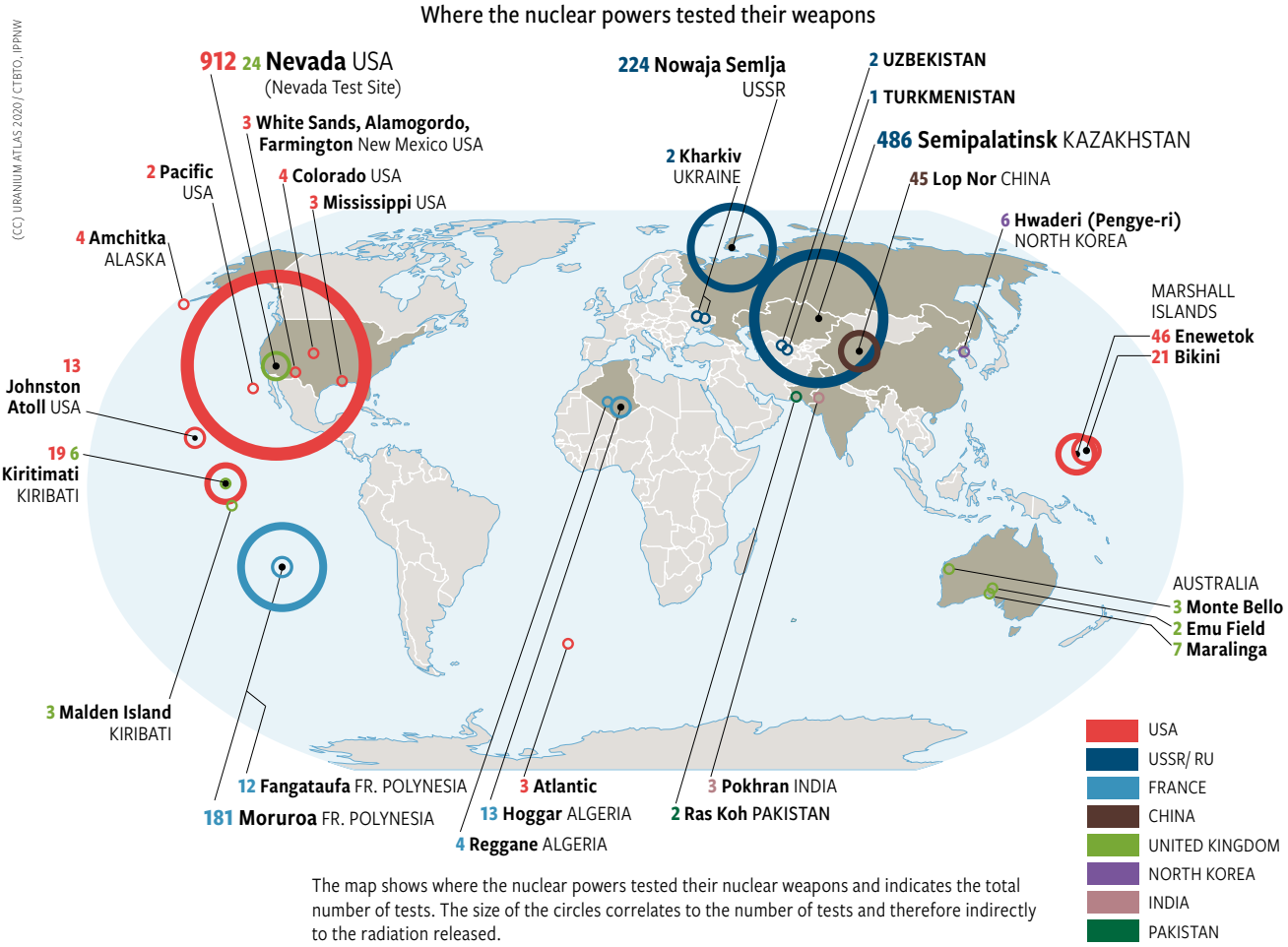
Global Testing Grounds

Number of nuclear tests per country from 1945 to 2017



Rehearsals for a Nuclear War

Where the nuclear powers tested their weapons



The map shows where the nuclear powers tested their nuclear weapons and indicates the total number of tests. The size of the circles correlates to the number of tests and therefore indirectly to the radiation released.

The Soviet Union had a similar test site to the one in Nevada in the US – in Semipalatinsk in today's Kazakhstan. From 1949 to 1989, the military carried out 486 nuclear weapons tests at this site. Prior to 1963, 160 of them were above ground. The explosive power of these tests was the equivalent of 2,500 Hiroshima bombs. The radioactive dust spread over an area the size of Germany; around 1.5 million people were exposed to radiation by the explosions. Karipbek Kuyukov knows the consequences. The man from Eastern Kazakhstan was born without arms and hands, a result of in vitro exposure to the radioactive contamination. He dedicates his life and his art – painting moving and evocative images using his mouth and toes – to a single mission; that "no one else suffers the devastating effects of nuclear weapons testing." He is fighting for the abolition of all nuclear weapons, but not for an end to uranium mining. Very much like the Kazakh government.

The Kazakhstan test site was closed down in 1991 – a success for which, among others, the Nevada-Semipalatinsk-Movement can take credit. It was established in 1989 as one of the first anti-nuclear movements in the Soviet Union. The organization's name is an affirmation of solidarity with the radiation victims in Nevada.

In Australia, the UK tested its nuclear weapons in the desert at Maralinga and Emu Field and on the Montebello Islands. Between 1952 and 1963, twelve nuclear bombs were detonated in regions that the Aboriginal people claim as their homeland. France detonated its first bomb in February 1960 in the Algerian part of the Sahara Desert and some years later moved its testing site to the uninhabited Mururoa Atoll in the South Pacific. China, India, Pakistan and North Korea have all tested their weapons in their own countries.

Meanwhile, the international community has negotiated a complete halt to nuclear weapons testing via the Comprehensive Test Ban Treaty (CTBT). Negotiations began in 1994 under the US Clinton administration, with the US aiming for a ban on all nuclear tests, an effort supported by Russia. In 1996, the UN General Assembly adopted the treaty with UN resolution 50/245.

Germany, Australia, Finland, Canada, the Netherlands and Japan are part of the Group of Friends of the CTBT, which vehemently lobbied for the treaty to take effect. A total of 184 countries signed the CTBT, and 167 ratified it. In order for the treaty to take effect, it must be ratified by Iran, Israel, Egypt, China, the US, India, Pakistan and North Korea. The last three countries on this list have not signed it and have even conducted nuclear tests since 1996. ●

Further Information

Test Ban Treaty: ctbto.org
Global Peace Index: visionofhumanity.org
Treaty on the Prohibition of Nuclear Weapons: PDF at icanw.org/the_treaty

DU: SHORT FOR "WAR WITHOUT END"

Uranium-238, a waste product of uranium enrichment, has been diverted into tank-piercing projectiles. Depleted uranium, known as DU, has an extremely high penetrating force – and fatal consequences.

Due to its density, depleted uranium is used as counterweight for aircraft wings and racing yachts. However, worldwide controversy has erupted over its military use: with three times the penetration force of a common grenade, a 30-millimeter depleted uranium projectile can cut into a tank like a hot knife through butter.

On impact, white-hot uranium dust reacts explosively with the oxygen inside the armored tank. A wall of flames, with temperatures of up to 5,000 degrees Celsius, will silence the cries of panic from the crew in seconds. For two seconds it is deathly silent. Then the fire reaches the ammunition stored in the tank. A huge explosion separates the tower from the rest of the tank. The blue and black pillar of fire and smoke soars straight up into the sky. It spreads radioactive and highly toxic nano dust particles over the battlefield and beyond – poisoning the soldiers on both sides as well as the civilian population, even long after the war is over. It seeps into the soil and contaminates the groundwater.

DU has a radioactive half life of 4.5 billion years. This means that once released, its radioactive particles will emit alpha radiation virtually forever. According to the principles and criteria of international humanitarian law, the principle of distinction between civilians and combatants, and due diligence obligations regarding the environment and the precautionary and preventive action principles, the use of uranium weapons is prohibited. The consequences of the use of DU ammunition also violate the standards of the International Protection of Human Rights (e.g. the right to a healthy environment) as well as environmental protection standards (protection from toxic substances). Ramsey Clark, former head of the US Department of Justice, called uranium ammunition a "Metal of Dishonor", a pun on the term "Medal of Honor", the highest distinction awarded to a member of the military by the US government.

With three times the penetration force of a common grenade, a 30-millimeter depleted uranium projectile can cut into a tank like a hot knife through butter

Uranium ammunition was first used in the Gulf War in 1991 in the south of Iraq by the US and the UK – with at least 320 tonnes of DU being dropped on Iraqi cities and tanks. Since then, many US soldiers have fallen ill or have died, leading to the concept of Gulf War Syndrome. The sick veterans are still struggling to get recognition for their "service-related disease". The subsequent use of DU spans more than a decade: three tonnes of DU were used during the war in Bosnia and Herzegovina in 1995; 9.45 tonnes in Serbia, Kosovo and Montenegro in 1999; and 145 tonnes in Iraq in 2003. Between 2001 and 2006, it was used in missions in Afghanistan, Syria and Somalia.

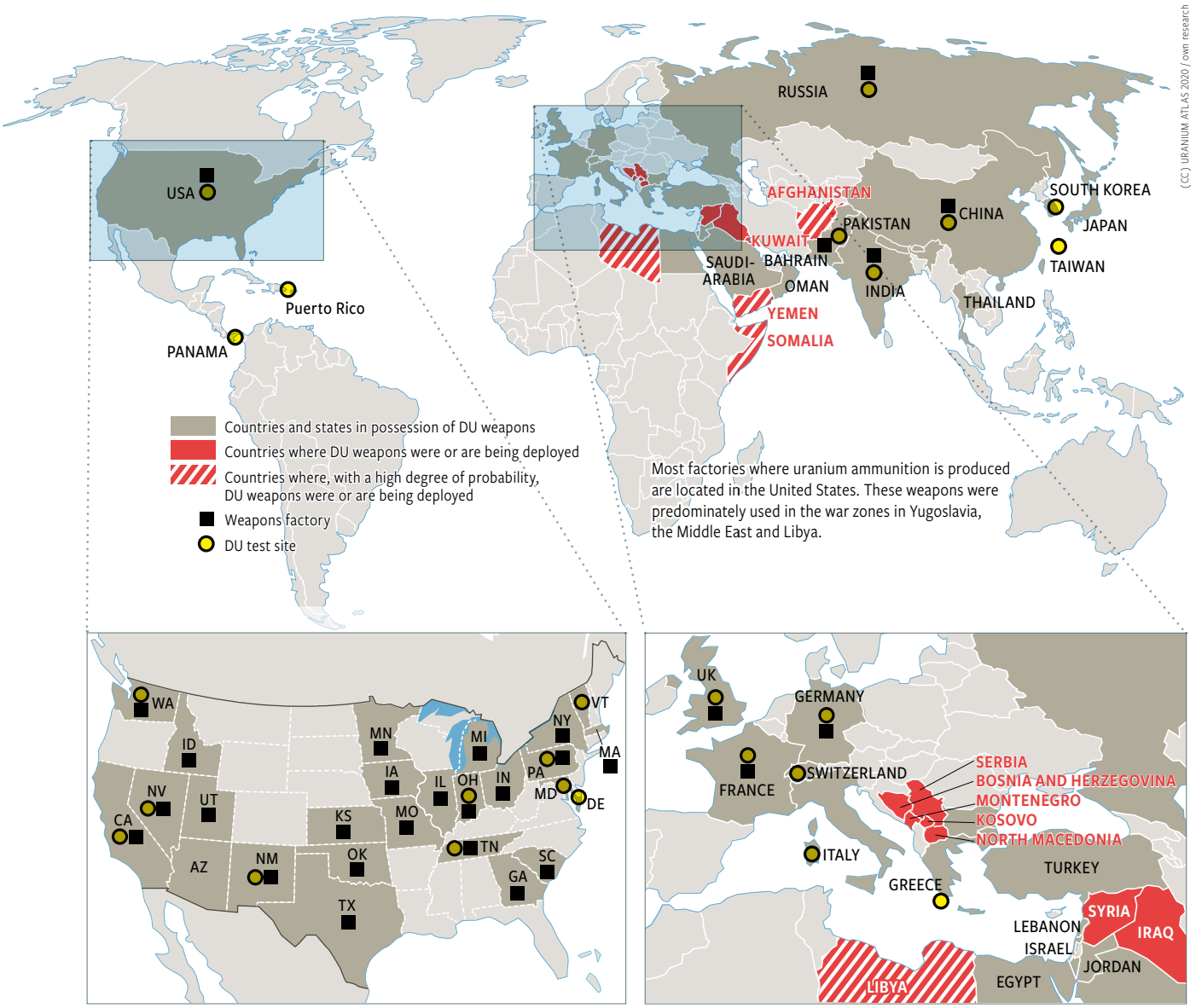
Where does the DU come from? Natural uranium ore consists mostly of uranium-238 and is therefore not suited for nuclear reactor fuel. For this, uranium-235 is needed, because it is capable of a nuclear fission chain reaction. However, uranium-235 only amounts to 0.7 percent of mined uranium. The uranium-235 share is increased through uranium enrichment: to 3-5 percent for the production of fuel rods for civilian reactors, or to 85 percent or higher for nuclear weapons. Depleted uranium is left behind as a waste product of this process, mostly consisting of uranium-238 and just 0.03 percent of uranium-235 (see pp. 8-9). Whether for military or civilian purposes, only about 5 percent of the total amount of depleted uranium is ever used at all. The vast majority of it is deposited in unmarked places, whereas it should be stored as nuclear waste in a safe, permanent repository.

When the US Air Force introduced its new A-10 Thunderbolt jet fighter 40 years ago, with an onboard gun capable of firing 4,200 rounds per minute of DU armor-piercing ammunition, these tests were conducted without any safety precautions or prior announcements; neither the US armed forces nor the population were informed of the health risks involved. A rise in morbidity among military personnel and civilians in the testing areas led to massive protests, so the tests were then relocated to places outside of the US mainland: to Vieques in Puerto Rico; Balboa West and Piñas in Panama; to Kumejima and Okinawa in Japan; Camp Doha in Kuwait; Koon Ni in South Korea; and to the military training area Grafenwöhr in Germany. The tests did not pass without incident: tanks loaded with DU ammunition caught fire and burnt out in Altenwalde, Gollhofen and Oberaltertheim in Germany.

In addition, several A-10 fighter jets crashed. In Kuwait, a US ammunition depot storing 3.5 tonnes of DU exploded. Other countries – among them the UK, France, Germany, Greece, the USSR and Switzerland – tested uranium ammunition within their own borders. The British military had a test site in Eskmeals in Northwest England and in Dundrennan in Scotland; France in the Polygone de tir near Bourges, 200 kilometers south of Paris. The German military tested on the premises of MBB, Rheinmetall and EADS in Unterlüss and in the asparagus region of Schrobenhausen. The Swiss company Contraves had a site in Ochsenboden. Salto di Quirra in the east of Sardinia, Europe's largest military training site in Italy, was available to all NATO members. The rate of cancer incidence there is very high and Greenpeace announced it had found sheep born with three legs and even two heads.

Uranium Weapons – an Unacknowledged Hazard

Countries where uranium weapons were and are being produced, tested and deployed



At least 18 countries have uranium weapons in their arsenals: the UK, the US, France, Russia, Greece, Turkey, Israel, Saudi Arabia, Bahrain, Egypt, Kuwait, Jordan, Pakistan, Oman, Thailand, China, India and Taiwan. The Honeywell subsidiary, Alliant Techsystems (ATK) in the US, is by far the biggest producer and exporter of uranium weapons worldwide. In September 2017, ATK was taken over by the world's largest weapons corporation, Northrop Grumman.

The UK, France, Russia, Pakistan and India also participate in the production of uranium ammunition. In Germany, physician Siegwart Horst Günther, and the documentary filmmaker Frieder Wagner, made this problematic issue public. In 1995, Günther smuggled casings of uranium ammunition from the Iraqi battlefields to Berlin and had them tested for radiation. He was subsequently charged with "dissemination of radioactive material" and jailed. At the same time, NATO declared this type of ammunition completely safe.

In 2003, the International Coalition to Ban Uranium Weapons (ICBUW) was established. It coordinates and brings together civil society efforts to ban uranium weapons and to help DU victims. The UN General Assembly discusses the issue of uranium ammunition every two years. The resolutions adopted there, with a large majority, emphasize the following priorities: transparency, the precautionary approach and support for the affected regions. These precautionary principles enjoy ongoing support from the European Parliament. Yet, even though the German army has no uranium weapons in its arsenal, Germany continues to undermine the UN process through abstentions. ●

Further information

Film: Deadly Dust – Depleted Uranium, Frieder Wagner, 93 min, on Youtube
Links: icbuw.eu; uraniumweaponsconference.de

FINAL DISPOSAL SITE: THE OCEANS

Between 1946 and 1993, the seas were abused as a nuclear waste dump. Up until 1975, even high-level radioactive nuclear waste was disposed of in the world's oceans.

The US demonstrated very early on how to quickly and cost-effectively dispose of nuclear waste: In 1946, the US put radioactive waste in 200-liter barrels and dumped them into the Pacific Ocean near the Farallon Islands, about 50 kilometers off the coast of California. As a result, the ocean became a nuclear waste dump. Decades later, the US government admitted to the International Atomic Energy Agency (IAEA) that up until 1970, the country had disposed of 90,000 barrels at different locations in the Pacific and the North Atlantic.

A statistic, published by the IAEA in the 1990s, shows that a number of other countries followed the US example: Belgium, Switzerland, France, Sweden, the Netherlands, Italy, Germany and most notably the UK, abused the Atlantic Ocean as a final nuclear dumpsite and collectively disposed of more than 100,000 tonnes of radioactive waste. Germany's part in this came in May of 1967, when 480 barrels of the country's radioactive waste were dumped into the Atlantic Ocean, 450 kilometers off the coast of Portugal.

Protests by Greenpeace, in particular, finally forced an end to nuclear waste being dumped into the oceans, a practice that ended in 1994

After the fall of the Iron Curtain, the Russian Federation admitted to the IAEA that in Soviet times, around 1,900,000 cubic meters of nuclear waste disappeared into the Arctic Sea and almost 150,000 cubic meters went into the Pacific Ocean and the Baltic Sea – among them disused nuclear submarines and at least 16 nuclear reactors from submarines.

In addition, six nuclear submarines (three from the US and three from the USSR) sank, complete with nuclear missiles on board. The boats are still lying at the bottom of the ocean, at a depth of between 1,700 and 5,500 meters.

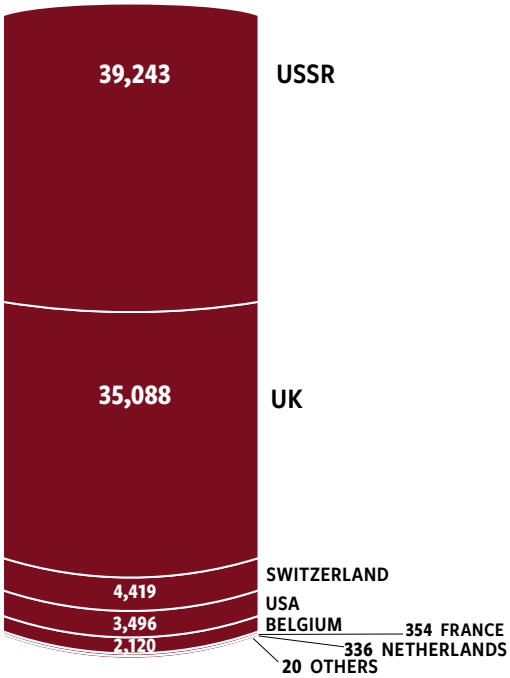
Today, nobody is able to provide exact numbers for the amount of high-level radioactive waste that was dumped into the oceans. The practice was not banned until 1975 when the London Convention on Marine Dumping came into force. However, even with the London Convention, low- and intermediate-level nuclear wastes were still allowed to be dumped. In 1985, the Nuclear Energy Agency, a subsidiary of the Organization for Economic Cooperation and Development (OECD), stated in a report that once the saltwater ate through the walls of the barrels, the radioactive contaminants in the ocean would be diluted and distributed over large areas. Consequently, the thresholds for radiation exposure were easy to adhere to.

However, highly publicized protests by Greenpeace finally brought about a change in approach. In 1994, all countries that had previously used the oceans as a nuclear waste dump signed a moratorium that still stands today. One can surmise just how much harm was done to the oceans from the nuclear waste dumped there decades ago, from the German government response to an inquiry by the Green Party in 2012: "The barrels were not designed to ensure a permanent containment of the radionuclides at the bottom of the ocean. Therefore, it has to be assumed that they are partially no longer intact and the radionuclides have been released."

That this is in fact the case, has been documented and made public by Greenpeace activists and journalists: Their films show fish and other sea creatures swimming around burst metal barrels containing radioactive waste. The commission in charge of monitoring the compliance with the treaty for the "Protection of the marine environment of the North-East

Out of Sight, Out of Mind

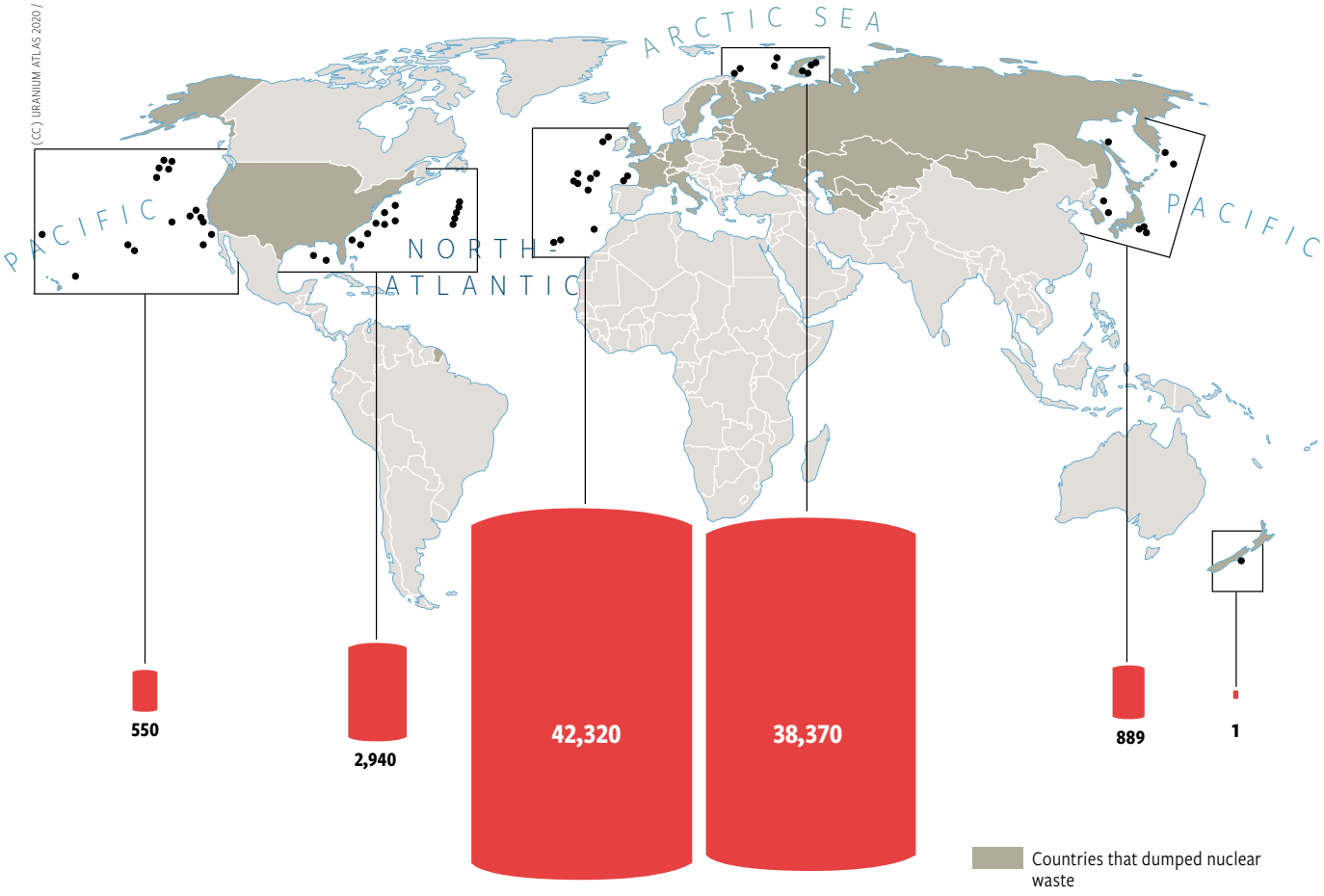
Nuclear waste dumped in the oceans by country
in terabecquerels



The following countries are included under "Others": RUSSIA, JAPAN, SWEDEN, NEW ZEALAND, GERMANY, ITALY and SOUTH KOREA

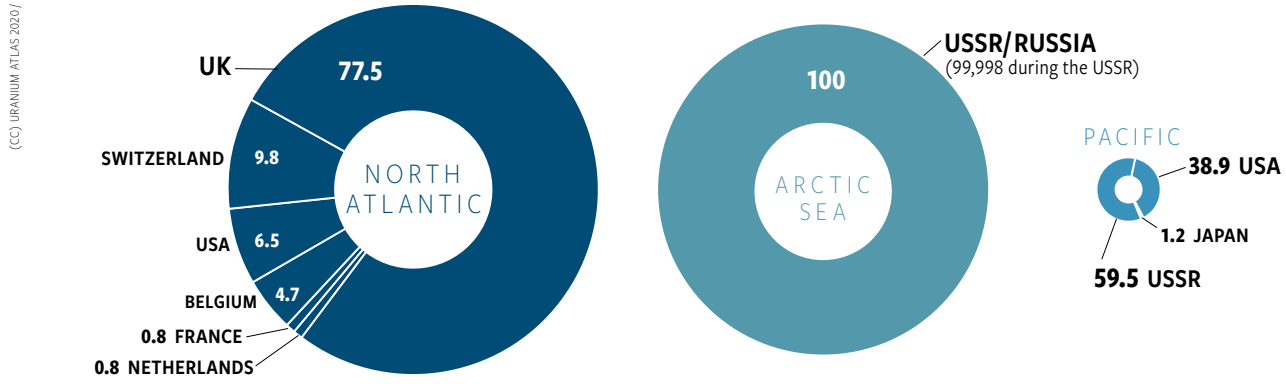
Dumped under Water

Nuclear waste disposed of in the oceans *in terabecquerels*



The Polluters and their Responsibility

Countries' share of nuclear waste dumped in the oceans in the respective region *in percent*



Atlantic" (OSPAR), which consists of 15 governments, including members of the EU, stated in 2010: "The analysis showed elevated concentrations of 238Pu in water samples collected at the dumpsites indicating leakages from the packages. At some locations also the concentrations of 293+240Pu, 241Am and 14C in the water were enhanced." Although it is clear that the released nuclear waste has contaminated the oceans, so far no efforts have been initiated to recover it. Most probably, the expenditure would be prohibitive since most of the barrels lie at the bottom of the ocean at depths of several thousand meters. Besides, the nuclear industry does not feel the need to take responsibility. ●

Further Information

Sea disposal of radioactive waste: iaea.org
Nuclear submarine: bbc.com/news/world-europe-48949113

DESTINATION UNKNOWN

There is only one final high-level nuclear waste repository under construction anywhere in the world – in Onkalo, Finland. Meanwhile more than 350,000 tonnes of high-level radioactive waste has already been generated globally, and this number increases by another 10,000 tonnes each year.

* *There is no standardized defnition of highly radioactive nuclear waste. Some states use heat generation as an indicator, others the radiation potential. The boundary between medium and highly radioactive nuclear waste is also not clearly defined. Quantities sometimes are given in tonnes, sometimes in cubic meters or even container numbers. Accordingly, the data on highly radioactive nuclear waste in the various nuclear states are only comparable to a limited extent.*

Country	USA	RUSSIA	FRANCE	GERMANY	JAPAN
Background	In 1987, the US Congress settled on a single site for the creation of a "permanent disposal site" – at Yucca Mountain in Nevada. At least 70,000 tonnes of high-level radioactive waste was supposed to be stored in the repository, which is located on the territory of the Western Shoshone. The state of Nevada, as well as the Western Shoshone, rejected the Yucca project and were supported by many environmental and anti-nuclear groups. The area is volcanically active.	While Russia has a final storage site for low- and intermediate-level waste, it is still in the exploratory phase for a high-level radioactive waste site. The Nishnekansky rock massif in the Krasnoyarsk region of Siberia is a potential option. The geological conditions are currently being assessed. If this site is considered unsuitable, then Russia will have to go back to the drawing board.	France intends to store its high-level radioactive waste in a clay rock formation 500 meters deep, near Bure in the Lorraine region. The tiny village of just 90 inhabitants voiced strong objections from the moment the plans were made public. As there are persistent doubts about the Bure location, the French government has not yet granted final approval. However, plans for alternative sites have been abandoned.	In order to come up with a selection process for a final storage site for high-level radioactive waste, Germany has set up a "Final Storage Commission". The commission is trying to determine the most suitable location in Germany. Currently, high-level radioactive waste is stored in Castor containers above ground. It will take decades to find and complete a final storage site.	Japan has a fundamental problem: its islands sit on four intersecting tectonic plates, so there is no guarantee that any rock layer will remain stable for a million years. Since nuclear energy has become extremely unpopular in Japan after the Fukushima disaster, no region is willing to take the nuclear waste. Japan's nuclear industry has no idea how to solve the problem.
Operating nuclear reactors under construction or permanently shut down (Status May 2020)	95 / 2 / 34	38 / 3 / 8	57 / 1 / 13	6 / - / 30	9 / 1 / 27
High-level radioactive waste*	**82,796 tonnes of spent fuel and 22,280 canisters of resolidified liquid waste, or vitrified liquid waste** (2020)	**22,449 tonnes of spent fuel and 18,640 cubic meters of liquid waste** (2016)	**9,681 tonnes of spent fuel, 3,200 cubic meters of liquid waste, 14,555 containers with vitrified nuclear waste** (2015)	**17,000 tonnes** (Anticipated by end of 2022)	**16,889 tonnes as well as 415 cubic meters of liquid waste** (March 2014)
Current status	All high-level radioactive waste sits at the country's reactor sites. The Yucca Mountain project was officially canceled in 2011.	Nuclear waste is managed by the nuclear industry. High-level radioactive waste is often stored out in the open without any kind of protection.	The government wants waste to be recoverable for 100 years. As long as there is no final repository, radioactive waste is stored at La Hague.	For now, high-level radioactive nuclear waste will be stored at the nuclear power plants as well as in the temporary storage sites Gorleben, Ahaus and Lubmin.	The high-level radioactive nuclear waste is stored in above-ground intermediate storage sites. After Fukushima, all sites underwent stress tests.
Storage/disposal sites					
	Cancelation but confusion	**Under exploration**	**Uncertainty**	**Ongoing search**	**No plan**
	Yucca Mountain could still be revived	**Krasnoyarsk is the only site being explored**	**Fundamental doubts regarding the Bure site**	**A decision could take decades**	**Too seismically active to be safe**

The first nuclear chain reaction took place in Chicago on December 2, 1942, as part of the Manhattan Project. On that fateful day, the first cupful of high-level radioactive waste was produced – for eternity. No plan was made then to dispose of this new type of waste. It was a problem to be solved later. Now it is "later" and there remains no permanent, safe, long-term solution for its disposal. What we know: a final storage site or disposal site for high-level radioactive nuclear waste must be secure for at least a million years, the timeframe during which radioactive waste poses a deadly risk. What we also know: mankind has absolutely no experience in planning for periods of such long duration.

It is very difficult to research data relating to nuclear waste, since the IAEA and the WNA do not make information publicly available. Countries with reprocessing plants are able to significantly reduce the volume of high-level radioactive nuclear waste, but reprocessing also hugely increases the amount of intermediate-level radioactive waste. ●

A "permanent disposal" site for radioactive waste must be secure for at least a million years – the time that radioactive waste continues to pose deadly risks

SWEDEN

Sweden began its search for a disposal site in 1977. The Swedish Nuclear Fuel and Waste Management Company, which was in charge of the search, selected the Forsmark site, 120 kilometers north of Stockholm, with a crystalline rock layer at a depth of 500 meters. There is already a nuclear power plant with three reactors in Forsmark. There is almost no resistance from the population in the area.

6,758 tonnes
(End of 2016)

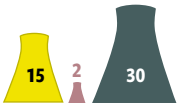
For now, the nuclear waste is stored in the vicinity of the Oskarshamn nuclear power plant.

Almost decided

Forsmark chosen as the final storage site

UK

The Lake District National Park in Cumbria remains the favored site for a radioactive waste repository, although it has been strongly opposed, largely because the area is geologically fragile. But when the UK's 15 nuclear reactors are all finally closed and decommissioned, there will be at least 4.77 million cubic meters of radioactive waste to dispose of - mostly high- and intermediate-level.



10,500 tonnes
(April 2016)

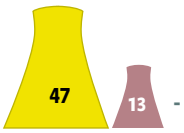
High-level radioactive nuclear waste is stored above ground at several locations, most of it at the reprocessing plant in Sellafield.

Still unclear

No political or public consensus on Cumbria

CHINA

China is the only country still building and opening new nuclear reactors in any significant numbers. Consequently, the amount of high-level radioactive nuclear waste is increasing. The government is exploring the possibility of building a final storage site deep underground near Xinchang in the Gobi Desert in the northwest of the country. So far, no decision has been taken.



3,973 tonnes
(End of 2013)

In China, irradiated nuclear fuel is stored in temporary regional storage sites. The state-run CNNC is in charge of operations.

Under preparation

The Gobi Desert is the targeted location

FINLAND

Onkalo means "cavity" and is the name of the Finnish deep underground final repository. It is located on the "nuclear peninsula" Olkiluoto, which already hosts two nuclear reactors. In 2015, the Finnish government granted a license for the construction of a final storage site in deep rock strata. The site is designed to hold 6,500 tonnes of nuclear waste, with storage operations expected to commence in the 2020s.

6,000 tonnes
(total projected amount)

Until the final underground repository is commissioned, all nuclear waste is temporarily stored at the Olkiluoto site.

Decided

Onkalo is supposed to be completed in 2020

SWITZERLAND

The last nuclear power plant is supposed to go offline in 2034. By then, the country will likely have accumulated 4,300 tonnes of high-level radioactive waste and another 92,000 cubic meters of low- and intermediate-level nuclear waste. In 1995 and 2002, Swiss citizens rejected two final storage sites. Currently, new sites for high-level radioactive nuclear waste are being considered, in Jura Ost, north of Lägern and Zürich Nordost.

4,300 tonnes
(projected by 2034)

Final storage will begin in 2050 at the earliest. Until then, nuclear waste is stored in an interim storage site and at the nuclear plant sites.

Three sites in the running

Jura Ost, north of Lägern, Zürich Nordost

AUSTRALIA

In the late 1990s, the idea of building a final disposal site for all of the world's nuclear waste ("Pangea") emerged in Australia. At the time, an alliance of environ- mentalists and Aboriginal people, on whose land the repository was to be constructed, prevented the project. The idea was resurrected in 2015, but after massive protests in 2017, it was again abandoned. Australian activists continue to monitor for any renewed moves to push this disposal option.

no nuclear waste

Australia does not operate nuclear power plants and therefore has no high-level radioactive nuclear waste to dispose of.

Shelved

The project failed due to community opposition

GAME OVER FOR NUCLEAR POWER

For decades, the nuclear industry boasted of a "nuclear renaissance". But the reality turned out to be very different: losses running into the billions, delays, and competition from renewable energy sources, which have become less expensive over time.

In the 1950s, it was predicted that nuclear power would be "too cheap to meter", but today it has proven to be "too expensive to matter". In 2017, so few new nuclear power plants went online that the installed nuclear capacity, i.e. the theoretical maximum output worldwide, only increased by one gigawatt. This amounts to a share of 0.4 percent of the total new power plant capacity of 257 gigawatts. Renewable energy, on the other hand, reached 157 gigawatts, achieving a share of 61 percent. Building new nuclear power plants has become virtually irrelevant for modern power markets.

Today, nuclear power plants produce electricity in 31 countries and have around a ten percent share of worldwide commercial power production. The contribution of the nuclear industry has decreased continuously since 1996, when its share in the electricity mix reached a historic peak of 17.5 percent. Taking into account transportation and heat demand, nuclear power stations today contribute 4.4 percent worldwide to commercial primary energy needs and less than two percent to final energy consumption. Nearly all indicators recorded in the annual World Nuclear Industry Status Report show that the nuclear industry had already reached its peak many years ago: in 2002, the number of reactors in operation reached its highest level with 438; by the beginning of 2019, only 415 reactors remained online.

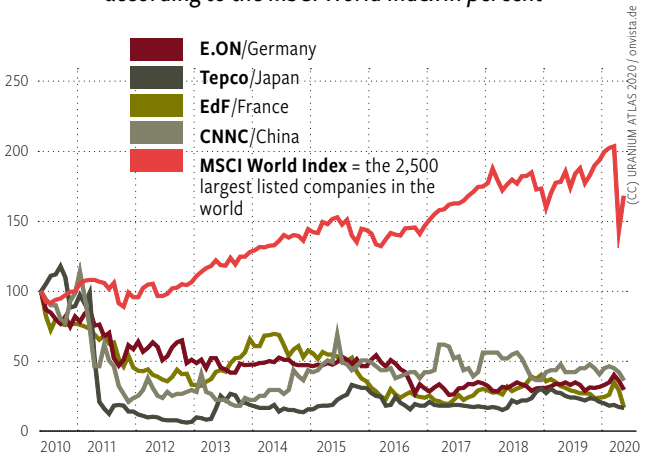
In 2006, nuclear power production was at its peak. In 1984 and 1985, 33 new reactors worldwide had come online, but only nine started up in 2018. In 1979, 234 reactors were under construction – the highest number ever achieved. By the beginning of 2019, 49 were under construction. A historic maximum was reached in 1976 with 44 new construction starts. In 2018, there were only five new construction starts.

From 2008 to mid-2018, 55 nuclear reactors went online with a total capacity of 49 gigawatts. The average construction time was ten years. However, at the same time, 52 reactors with an installed capacity of 38 gigawatts were decommissioned, which results in a negligible net increase of three reactors in a decade or one gigawatt per year. While annual power generation from renewable energy sources has significantly increased in the past decade – rising by approximately 4,000 terawatt hours (TWh) between 2007 and 2017 – production of nuclear power has decreased by 110 TWh (see graphic at far right on facing page).

Nuclear energy can no longer compete with coal and gas and even less with wind and solar. Investments in the construction of new nuclear reactors has become steadily more expensive and risky. Throughout the history of nuclear power, one in eight new construction plans has been abandoned before the reactor was commissioned. Most recently, in 2017, two reactors at the Virgil C. Summer site in the US state of South Carolina suffered this fate after massive delays and cost overruns were compounded by the bankruptcy of the manufacturer Westinghouse. This happened despite a 5 billion

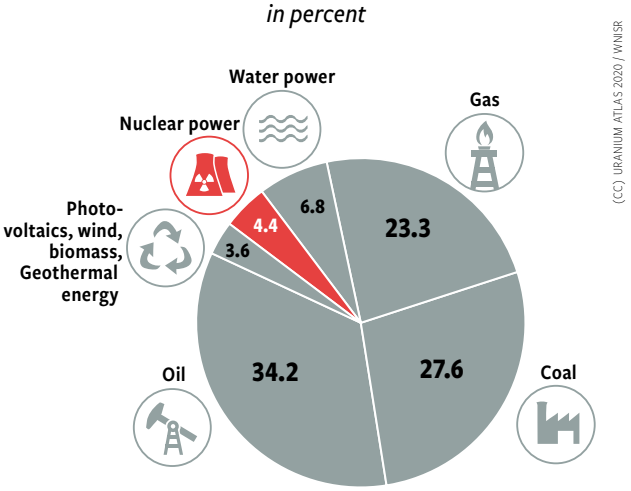
Nuclear Energy Cos. on a Downward Course

Share prices development of four large nuclear companies according to the MSCI World Index *in percent*



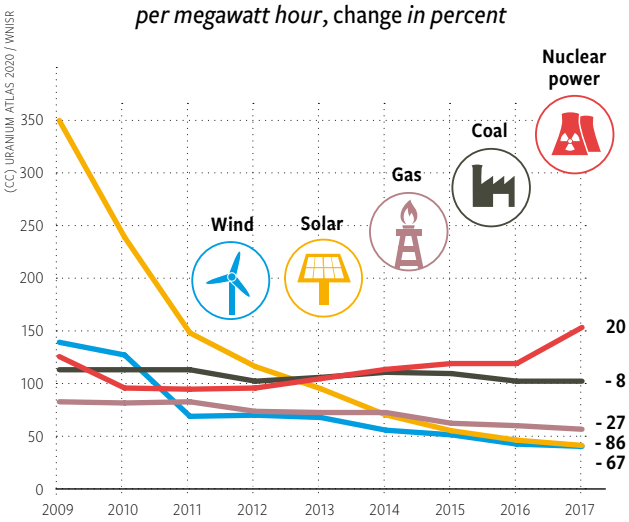
Nuclear Energy: Overestimated Importance

Worldwide market shares of primary energy sources in 2018 *in percent*



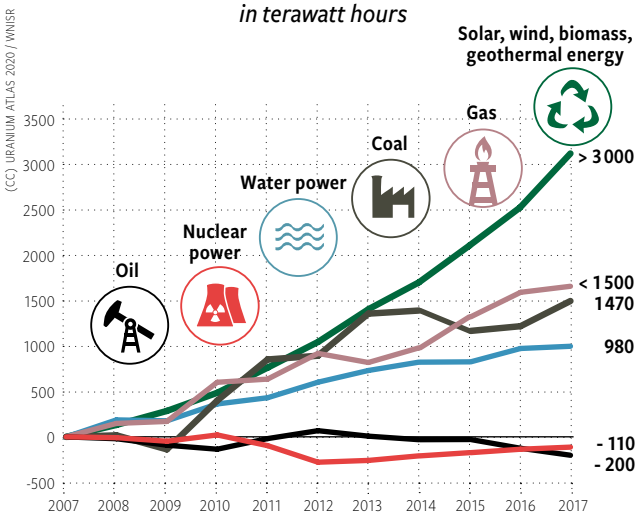
Nuclear Power: No Longer Competitive

Electricity generation costs of new power plants *in US dollars per megawatt hour*, change *in percent*



Renewables Outpacing Nuclear Energy

Annual new global electricity production *in terawatt hours*



US dollar investment from project sponsors and a 2.2 billion offer from Westinghouse parent company Toshiba to buy its release from the South Carolina project, an amount viewed as insufficient to complete the reactors.

Hitachi will probably have to write off 2.7 billion US dollars for the Wylfa Newydd nuclear power station project on the Welsh coast – costs already incurred before the start of construction and more than three times the amount that Hitachi paid the two German power companies E.ON and RWE five years prior, for the takeover of Horizon Nuclear Power Ltd., owner of Wylfa. Toshiba, which had already lost around 6 billion US dollars when Westinghouse went broke, pulled the plug on all overseas nuclear projects, including Moorside in the UK.

Entire national nuclear power plant construction programs have been canceled or "suspended", mainly for economic reasons – for example in Chile, Indonesia, Jordan, Lithuania, South Africa, Thailand and Vietnam. When the "Nuclear Renaissance" did not materialize, this had dramatic financial ramifications for nuclear corporations. Along with Westinghouse, historically the most important nuclear plant construction company, the French company Areva, which had earlier declared itself the "world market leader in nuclear energy", also had to declare bankruptcy. Areva (now Orano) had accumulated a loss of 10.5 billion euros over a six-year time period.

The financial difficulties for new construction projects are mostly caused by endless delays and dramatically rising costs. In Olkiluoto, Finland, construction of the first European Pressurized Water Reactor (EPR) began in 2005 (see p. 46). The expected completion date was 2009. Ten years later, in August 2019, it was anticipated that the reactor would be fueled up and go on line in October 2019. That did not happen, either. It was a similar story with the construction of the EPR in Flamanville, France. Construction began in 2007, with an expected completion date in 2012. But by October 2019, EDF announced it would only load fuel into the reactor at the end of 2022, with an expected startup date sometime in 2023.

Costs have soared for both projects. The Finnish EPR was supposed to cost three billion euros, the French one four billion euros. By the end of 2018, the costs had already exploded to 11 billion euros each. In December 2018, the French state-owned EDF began construction of the first of two proposed new EPR reactors at Hinkley Point C in the UK. By 2017, cost estimates had ballooned to 9.8 billion British pounds – four and a half times as much as initially calculated for the first EPR in Finland. The first EPR ever to produce electricity is Taishan-1, built in China between October 2009 and June 2018, also way behind schedule and with considerable cost increases, although not quite as dramatic as its European "predecessors".

In several countries, the construction of new nuclear power plants was aborted for economic reasons

Existing nuclear power plants have also come under economic pressure and many can no longer survive in liberalized energy markets. Six US reactors have been prematurely decommissioned, and a further dozen are expected to follow between now and 2025. Other reactors have been reprieved for a couple of years by direct subsidies from individual states. The economic decline also raises questions regarding effects on safety.

Adding to that is the fact that investments in electricity-saving technologies and energy-efficient devices often realize higher profits than investments in new nuclear power plants. For the last decade, the cost of building new nuclear power stations has risen significantly; wind and solar installations, on the other hand, have become increasingly more cost-effective and can compete with existing nuclear power plants and fossil fuels (see image above left and pp. 48/49). ●

Further Information

Mycle Schneider, Antony Froggatt et al.: World Nuclear Industry Status Report, PDF at worldnuclearreport.org

THE MYTH OF CLIMATE-FRIENDLY ENERGY

The nuclear industry is scrambling to deliver a so-called fourth generation reactor while using the crisis of climate change as an excuse to expand nuclear power. However, there are faster, significantly cheaper and far less dangerous options.

One kilogram of uranium-235 contains enough energy to generate 24 million kilowatt hours of heat; one kilogram of coal can only generate eight. As a result, the nuclear industry has always promoted nuclear power as a better alternative to fossil fuels, and is now using the climate crisis to justify its continued – and expanded – use. Any mention of the health risks of uranium mining, the possibility of a nuclear meltdown, and the still unsolved issue of the "permanent disposal" of highly radioactive nuclear waste, is studiously avoided.

According to the IAEA, an additional 900 gigawatts of nuclear energy globally is required in order to meet the climate goals of the Paris Agreement of 2016 – of course only achievable with massive government support. This would mean 600 to 700 new nuclear reactors, more than are in operation today (see pp. 32-33). Such a massive expansion of nuclear power plants would dramatically increase the existing safety risks and the inventory of nuclear waste, and would be an economic disaster for the respective countries (see pp. 46-47). In addition, expansion of nuclear energy would worsen its carbon footprint: like coal or crude oil, uranium must be extracted from the earth. However, the high-yield uranium deposits are already mostly depleted, making the development of new mines increasingly energy-intensive. The lower the grade of uranium ore, the higher the energy expenditure and the carbon

Onshore and offshore wind energy is one of the preferable alternatives to fourth generation nuclear reactors

footprint per kilogram. Why make ever larger investments in nuclear power when wind and solar energy are already far cheaper to produce?

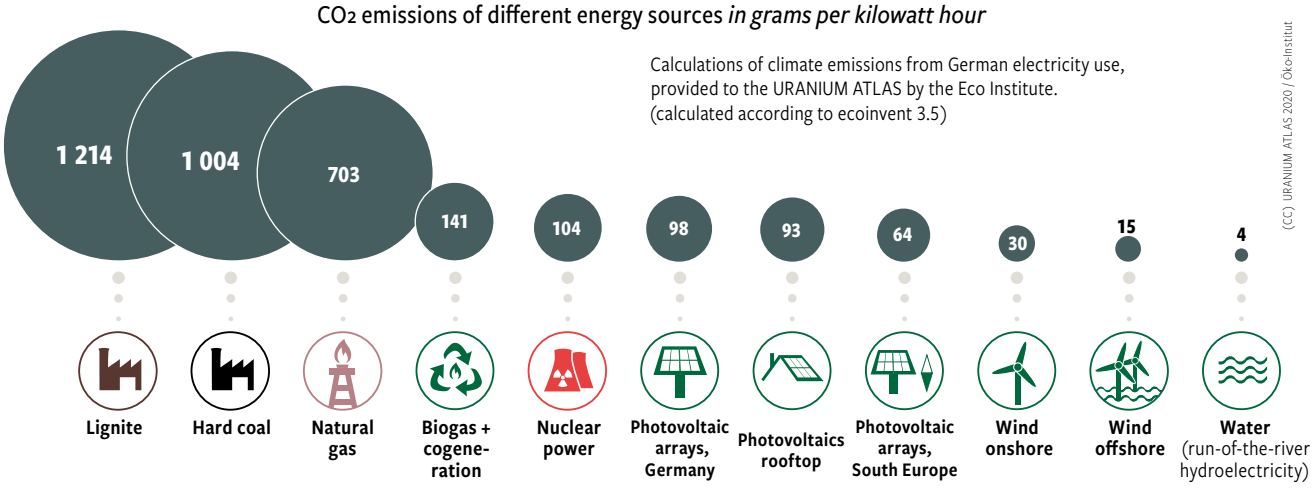
For almost 70 years, the nuclear industry has been highly subsidized and has never been able to stand on its own two feet economically. From cleaning up the damage caused by uranium mining, to routine operations to decommissioning and final storage of nuclear waste, the industry has neither calculated the real costs of its activities nor has it adequately disclosed its financial condition. Viewed as an essential component of the construction of nuclear weapons and the maintenance of nuclear submarine fleets, the nuclear power industry has always been a steady recipient of generous state subsidies.

Germany has decided to phase out nuclear energy and has begun decommissioning its second generation nuclear reactors. Third generation reactors are under construction in France, Finland and the UK, amid growing difficulties, and have recently come online in China, (see pp. 46-47). The

The Example of Germany: The Climate Burden of Electricity

CO_2 emissions of different energy sources *in grams per kilowatt hour*

Calculations of climate emissions from German electricity use, provided to the URANIUM ATLAS by the Eco Institute. (calculated according to ecoinvent 3.5)



(CC) URANIUM ATLAS 2020 / Öko-Institut

nuclear lobby is fond of boasting that Generation IV reactors will be far less problematic, but they remain untested and unproven.

In recent years, the concept of thorium reactors has re-emerged in energy discussions. A thorium-fueled reactor still needs uranium to fission, but produces less transuranic nuclear waste, which also remains radioactive for a shorter period; however it emits more radiation, complicating transport and storage. The claim that the existing long-lived transuranic nuclear waste from first and second generation reactors could be used as fuel in order to get rid of this waste, while at the same time generating energy, is highly questionable.

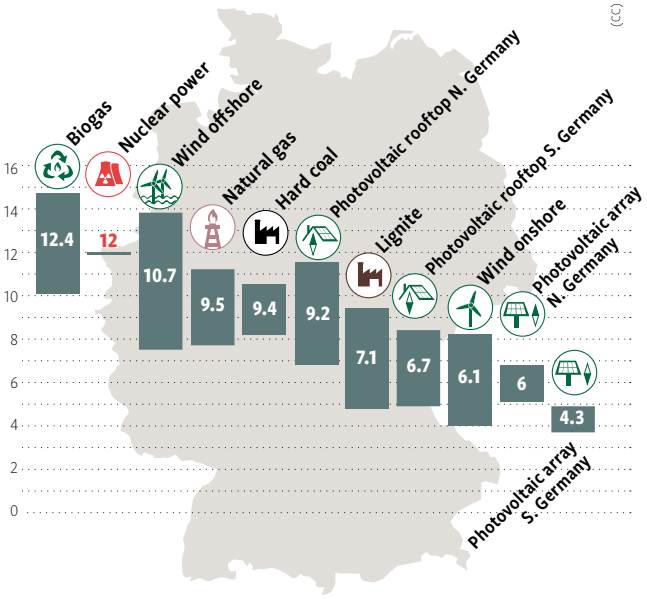
Small modular reactors (SMR) are also now being promoted, although the SMR concept is far from new. Russia for example, has a fleet of floating ones. There are several start-up designs in circulation, including from Bill Gates's Terrapower, NuScale and Rolls Royce. Their small size – generally 300MW or less – makes them highly uneconomical and inefficient in addressing climate change. They also still produce radioactive waste.

Even though Germany has decided to phase out nuclear power, research on Generation IV nuclear reactors is ongoing. At the behest of EURATOM, the Karlsruhe Institute for Technology (KIT) is participating in the development of these reactors. This undermines Germany's nuclear exit, since a genuine phaseout would also mean a halt to nuclear energy research.

Germany: The Real Price of Electricity

Electricity generation costs in Germany
in Euro cents per kilowatt hour

In 2018, the Fraunhofer Institute for Solar Energy Systems determined the costs of generating one kilowatt hour of electricity with new power plants. The graphic shows the price ranges and average prices of the respective energy systems.



(CC) URANIUM ATLAS 2020 / Fraunhofer-Institut

THE GLOBAL POTENTIAL OF RENEWABLE ENERGY

Globally, renewable energy is significantly cheaper than new nuclear energy and even competitive with currently operating coal, gas and nuclear power plants. Depending on location and region, these renewable energy contributions come from either on- or offshore wind turbines, hydropower plants or utility-scale solar plants, and deliver the cheapest electricity, according to the International Renewable Energy Agency.

In North Africa and on the Arabian Peninsula, utilityscale solar plants are delivering electricity for less than two US cents per kilowatt hour. Even in less sunny Germany, one kilowatt hour of solar power can be generated for little more than four US cents. In the windy regions of the northern hemisphere the cost rises to just three US cents per kilowatt hour. Nuclear power cannot compete economically with these resources. The global energy turnaround will come. The primary drivers for this are the enormous cost degression of renewables and the advancing technical innovations in storage technologies, supported by growing ecological awareness and ambitious climate protection targets. ●

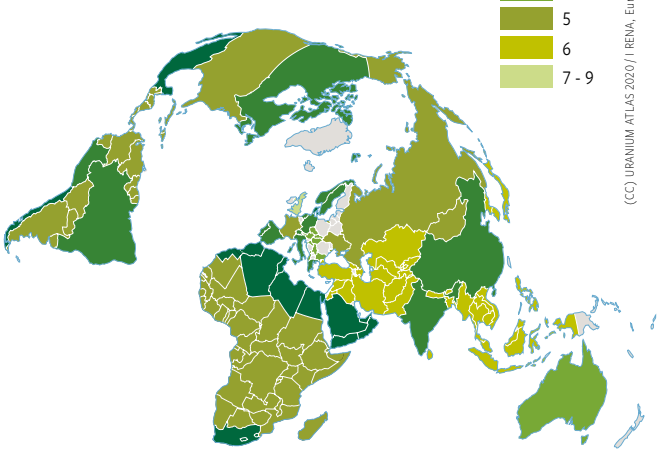
Further Information

IRENA: Renewable Power Generation Costs in 2017, PDF at irena.org

Renewable and Cost-effective

Electricity from new wind and photovoltaic installations
in US cents per kilowatt hour

The map shows the cheapest way to produce electricity by using renewable energy sources. In most regions, a kilowatt hour can be produced for a few US cents.



(CC) URANIUM ATLAS 2020 / I RENA, Eurosolar, own research

GLOSSARY

A

Aghirin'man: Human rights organization in Niger

ASADHO: African Association for the Defense of Human Rights, DR of Congo

B

Becquerel: Unit of radioactivity; one Becquerel signifies one radioactive disintegration per second

C

CRIIRAD: Commission for Independent Research and Information about RADiation, France

D

Depleted Uranium (DU): Waste product generated during uranium enrichment. Contains 0.2 - 0.3 weight percent of fissile uranium; half life 4.46 billion years

Dosimeter: Measuring instrument to determine the dose of nuclear radiation

E

EPR: European Pressurized Water Reactor, third generation nuclear reactor

EURATOM: European Atomic Energy Community of which all EU countries are members

F

Fallout: Radioactive emissions as a consequence of above ground nuclear weapon tests and reactor accidents

Fusion reactor: Nuclear installation designed to generate energy by fusion of atomic nuclei

I

IAEA: International Atomic Energy Agency; its task: to promote the civil use of nuclear energy and to prevent dissemination of nuclear weapons

ICAN: International Campaign to Abolish Nuclear Weapons

ICBUW: International Coalition to Ban Uranium Weapons

INF Treaty: Intermediate Range Nuclear Forces Treaty between the Soviet Union/ Russia and the US to ban land-based ballistic missiles, cruise missiles, and missile launchers with ranges of 500–1,000 kilometers (310–620 miles/short medium-range) and 1,000–5,500 km (620–3,420 miles/intermediate-range)

In-situ leaching (ISL): A process with which chemicals are injected into porous uraniferous strata in order to extract uranium

IPPNW: International Physicians for the Prevention of Nuclear War

ITER: International Thermonuclear Experimental Reactor Project aimed at achieving nuclear fusion

M

Manhattan Project: US military research project, 1939-1946, to develop atomic weapons

Maximum credible accident: Accidents such as Chernobyl and Fukushima that go beyond the category of "maximum credible accident" (MCA)

N

Nuclear chain reaction: Process of splitting an atomic nucleus which repeats itself automatically once started

Nuclear fission: Splitting of an atomic nucleus into several parts

Nuclear fuel rods: Produced in special factories for use in nuclear power plants

Nuclear meltdown: Accidents such as Chernobyl and Fukushima that go beyond a largest accident to be assumed. According to the nuclear industry, these types of accidents are too improbable to be worth adequately preparing for

Nuclear Non-Proliferation Treaty: Treaty on the Non-Proliferation of Nuclear Weapons. Prohibits the spread of nuclear weapons and furthers the goal of nuclear disarmament

Nuclear power plant: Consists of one or more nuclear reactors

Nuclear waste: Consists of low-, intermediate- and high-level radioactive waste. Irradiated nuclear fuel is very radioactive and the categories can be misleading as "low-level" does not mean harmless

Nuclear reactor: A single reactor unit that may constitute one or more at a nuclear power plant site. In the reactor core, fission of uranium generates heat and steam, which then drives a turbine

Nuclear Test Ban Treaty: Comprehensive Nuclear-Test-Ban Treaty (CTBT); prohibits the testing of nuclear weapons

Nuclear Prohibition Treaty: Treaty on the Prohibition of Nuclear Weapons (TPNW); Agreement to prohibit the development, production, testing, purchase, storage, deployment and use of nuclear weapons

P

PLAGE: Platform Against Nuclear Risks; Austrian NGO

R

Radioactivity: Process of spontaneous decay and transformation of unstable atomic nuclei of certain chemical elements emitting energy in the form of radiation

Rainbow Serpent: Mythological figure of Aboriginal creation stories

T

Tailings in uranium mining: Radioactive and highly toxic sludge residues generated when extracting uranium from the ore

Thorium: Chemical element and a decay product of uranium. There is interest in it as a raw material for Generation IV reactors currently still in the design phase

U

U-Ban: Campaign for a Worldwide Ban on Uranium Mining

Uranium: In its natural isotopic state it contains 0.711 weight percent of U-235 and 99.284 weight percent of U-238 as well as a very small amount of U-234. Present in different uranium minerals

Uranium-235: Fissile portion of uranium

Uranium-238: Non-fissile content of uranium

Uranium enrichment: The process of increasing fissile uranium content

Uranium exploration: Investigation of uranium deposits

Uranium mining: Early on, uranium was mined in open pits or below ground. Today, half of all uranium mining uses the in-situ leaching process

Uranium ore: Mixture of different uranium minerals within the rock; uranium concentration in the ore varies considerably: ore in Rössing, Namibia, has 0.03 %, ore in Cigar Lake, Canada, 13 %

Uranium ore processing: In conventional mining processes, the ore is first broken up, then milled. In the next step, uranium is chemically separated

Uranium oxide U_3O_8: First intermediate product after mining of uranium ore

W

Waste rock heap: Soil on top of uraniferous rock, removed in open pit mining and piled up in dumps

World Nuclear Association (WNA): International nuclear lobby organization with headquarters in London, UK

Y

Yellowcake: Yellow uranium concentrate powder optained from leach solutions, contains approximately 70 to 90 weight percent of U_3O_8. Uranium is traded in this specific form

NUCLEAR FREE FUTURE FOUNDATION

nuclear-free.com

Since 1998, the Nuclear Free Future Foundation has honored initiatives along with individuals who advocate for an end to the Nuclear Age and who show us the pathways toward ending military and civil use of nuclear energy. The foundation established the "Nuclear Free Future Awards" in the spirit of the "World Uranium Hearing", where in 1992, witnesses from five continents exchanged their experiences with the nuclear industry, with a focus on uranium mining. The Hearing produced the "Salzburg Declaration", in which the participants request a ban on uranium mining and demand: "Uranium and all radioactive minerals must remain in the earth!" Two years later, the declaration was accepted by the UN Human Rights Commission in Geneva. The "Nuclear Free Future Award" is presented annually at different venues: it started in Salzburg, Austria in 1998, but in later years it also travelled to Los Alamos, New Mexico, USA; St. Petersburg, Russia; Jaipur, India; Window Rock, Arizona, capital of the Diné Nation; Washington, DC; Basel and Heiden, Switzerland; Johannesburg, South Africa; in some years, it returns to Munich, Germany, where the home offices are located. This changing venue for the award ceremonies reflects the extent and the diversity of the global anti-nuclear and anti-uranium movement.

IPPNW

ippnw.org, ippnw.de, ippnw.ch

International Physicians for the Prevention of Nuclear War (IPPNW) is a non-partisan federation of national medical organizations in 62 countries. It was founded in 1980 by physicians from the United States and the former Soviet Union who shared a common commitment to advocate for the elimination of nuclear weapons from the world's arsenals. IPPNW received the Nobel Peace Prize in 1985. Although the Cold War ended with the collapse of the Soviet Union in 1991, the US and Russia retained thousands of nuclear weapons ready to launch at a moment's notice. Proliferation and the threat of nuclear terrorism have added to the nuclear danger in the post-Cold-War world.

In recent years IPPNW has learned that even a limited, regional nuclear war using a fraction of the world's nuclear weapons would cause irremediable harm to the Earth's ecosystems and could result in the starvation of as many as two billion people in a "nuclear famine." As advocates, the members extend their medical ethics beyond their profession and understand health as a social science. In 2006, IPPNW started the International Campaign to Abolish Nuclear Weapons (ICAN), which was awarded the Nobel Peace Prize in 2017 after facilitating the Treaty on the Prohibition of Nuclear Weapons.

BEYOND NUCLEAR

beyondnuclear.org

Beyond Nuclear is a US-based international watchdog and activist organization working for a benign and democratic world free from the twin threats of nuclear power and nuclear weapons. The central aim of Beyond Nuclear is to shut down nuclear power and end the harmful practices of uranium mining, nuclear powered electricity generation and the endless production of deadly radioactive waste. As a member of the International Campaign to Abolish Nuclear Weapons, Beyond Nuclear also draws attention to the inextricable link between nuclear power and nuclear weapons, and advocates for sustainable and peaceful solutions to global problems such as climate change and the threat of nuclear war.

Beyond Nuclear was founded in 2007 by four experienced anti-nuclear campaigners, who lend their expertise to a broad cross-section of issues, including reactor dangers, radioactive waste problems, human health, uranium mining and human rights, peace and disarmament, and impacts on wild and domestic animals and the environment. To assist and resource grassroots groups in North America and across the globe, Beyond Nuclear produces educational materials, reports, petitions, and online content, as well as engaging with decision-makers and the media.

ROSA-LUXEMBURG-STIFTUNG

rosalux.org

The Rosa-Luxemburg-Stiftung (RLS) is one of Germany's largest organizations for left-wing political education and is a political foundation affiliated with the party DIE LINKE, the German Left Party. The RLS has offices in over twenty locations around the world.

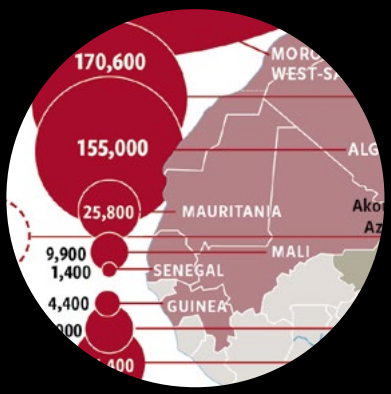
Established in 1990, the foundation's work is based on the beliefs of German socialist leader Rosa Luxemburg. Its mission is to strengthen emancipatory political forces and contribute to the development of alternatives for democratic-socialist societies worldwide. This includes the full realisation of democratic and social rights for all people, a socially just and ecologically global economic order, gender equality and feminism, international solidarity, and peace. Effectively, this will require overcoming the capitalist mode of production. Working together in solidarity with its partner organizations, the foundation strives to develop alternative concepts and approaches for a comprehensive process of ecological and social transformation, enabling the creation of a more united and just society. To achieve these goals, the RLS organizes political education initiatives, serves to stimulate innovative thinking, provides a venue for critical analysis and dialogue, and awards scholarships.

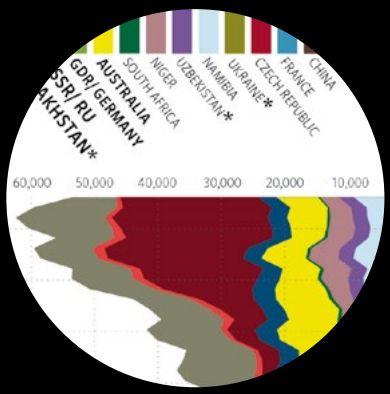
COLONIAL HERITAGE, page 12

From the very beginning, uranium mining harmed local populations, especially Indigenous peoples. Nothing much has changed since.

ANCIENT WARNINGS, page 22

The history of uranium mining in Australia is the history of Aboriginal peoples' resistance. They see the destruction of their sacred sites as the beginning of the destruction of the world.





DU: SHORT FOR "WAR WITHOUT END", page 40

Depleted Uranium (DU) is a waste product from uranium enrichment, being used as a weapon. The survivors of uranium ammunition deployed in war are still struggling. DU should be banned.

GLOBAL WARMING, page 48

All around the globe, renewable energy is considerably more cost-effective than nuclear power.