Nuclear Power:

The Critical Question

First hand reports from
the frontlines of the nuclear fuel chain

"If you say, you do not know that your steak comes from a cow, people will think you are really stupid – but with energy it is the same." Alain de Halleux, interviewee.

A quarter of Germany´s electricity comes from nuclear power plants. Those of us at WECF wanted to know what´s actually behind nuclear energy production. And that is why we followed the path of uranium, the raw material of nuclear power, from the mine to enrichment and milling through power production and waste storage across the world.

As a result, we encountered individuals who have been effected by the nuclear fuel chain. In this booklet, insiders report on their direct experience with uranium mining and enrichment, with nuclear disasters and with the storage of radioactive substances. They offer testimony about the internal operation of nuclear power plants, the use of depleted uranium (DU) munitions in war zones and the impacts of nuclear fuel reprocessing.

All who testified have one thing in common: They know that the road to the future must be different than the uranium path of the past.

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WECF

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Women in Europe for a Common Future (WECF) is a network of environmental, health and women's organisations that advocates for a healthy environment for all. Energy and climate protection are one of WECF's priorities. WECF implements practical solutions in over 40 countries and informs politicians at national and international level (www.wecf.eu). WECF has charitable, non-profit status and is recognised as a non-governmental organisation at the United Nations Economic and Social Council (UN-ECOSOC). WECF is an official partner of the United Nations Environment Program (UNEP) and is also a member of the European Committee for Environment and Health (EEHC).

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For more information: www.antenna.nl/wise or contact: wiseamster@antenna.nl

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First hand reports from the frontlines of the nuclear fuel chain

Thank you

For helping with our publication, for your commitment for a better world and for your involvement in working for a secure future full of sustainable energy. We thank you most sincerely.

Dr. Souad Al-Azzawi, Iraq
Janine Allis-Smith, England
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Cam Walker, Australia
Jean Yvon, France

and the entire WECF team.

Content

"*So we have to stand up and say that this is not the right way to act.*"

We invite you ...

... to a journey through the many stages of the transformation of uranium. We wanted to know what is involved in the production of nuclear power and what impact it has - here in Germany and around the world. What does it mean for us and our environment, if more and more countries produce energy from nuclear power plants?

So we 've set out on a journey following the trail of uranium, as uranium is the raw material that nuclear power plants need for electricity production.

What is involved in the process of uranium mining, enrichment, waste reprocessing and storage?

And what can we actually accomplish with renewable energy?

Along the way, we met women and men who told us about their experiences. Painful experiences that have also effected many people in other countries as well. We assembled the key facts through research and conducting interviews.

We are committed to sharing these stories and this knowledge because nuclear energy is deadly. It destroys lives and habitats. It works to destroy health and can irreversibly effect our genetic makeup. Essentially, all of our futures are effected by nuclear production.

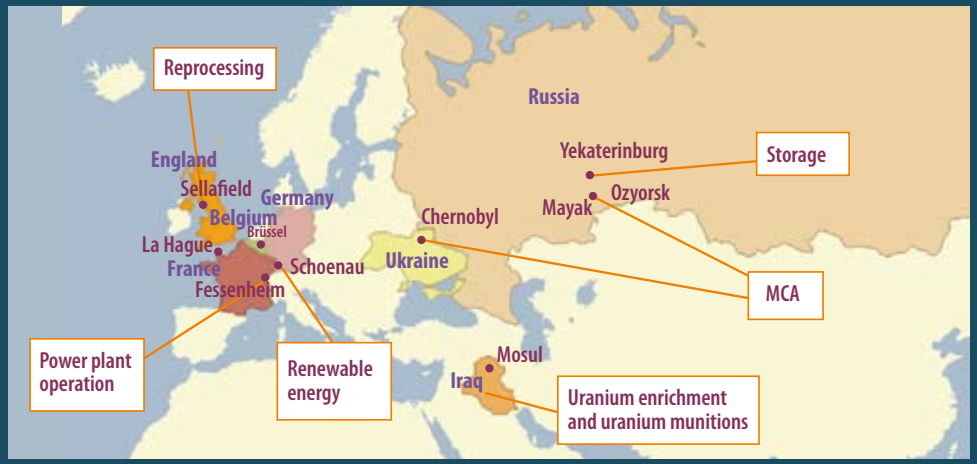
In our book we share stories of strong individuals who are speaking out, some of whom, despite harassment, job dismissals and death threats, have not stopped telling the truth publicly. Therefore, we are grateful to them for telling their truth.

There are better solutions and ways to meet our energy needs than nuclear power.
We have definitively learned this on our uranium journey. More than ever, we are committed to aligning ourselves to the words of one of our interviewee's, Alain de Halleux:

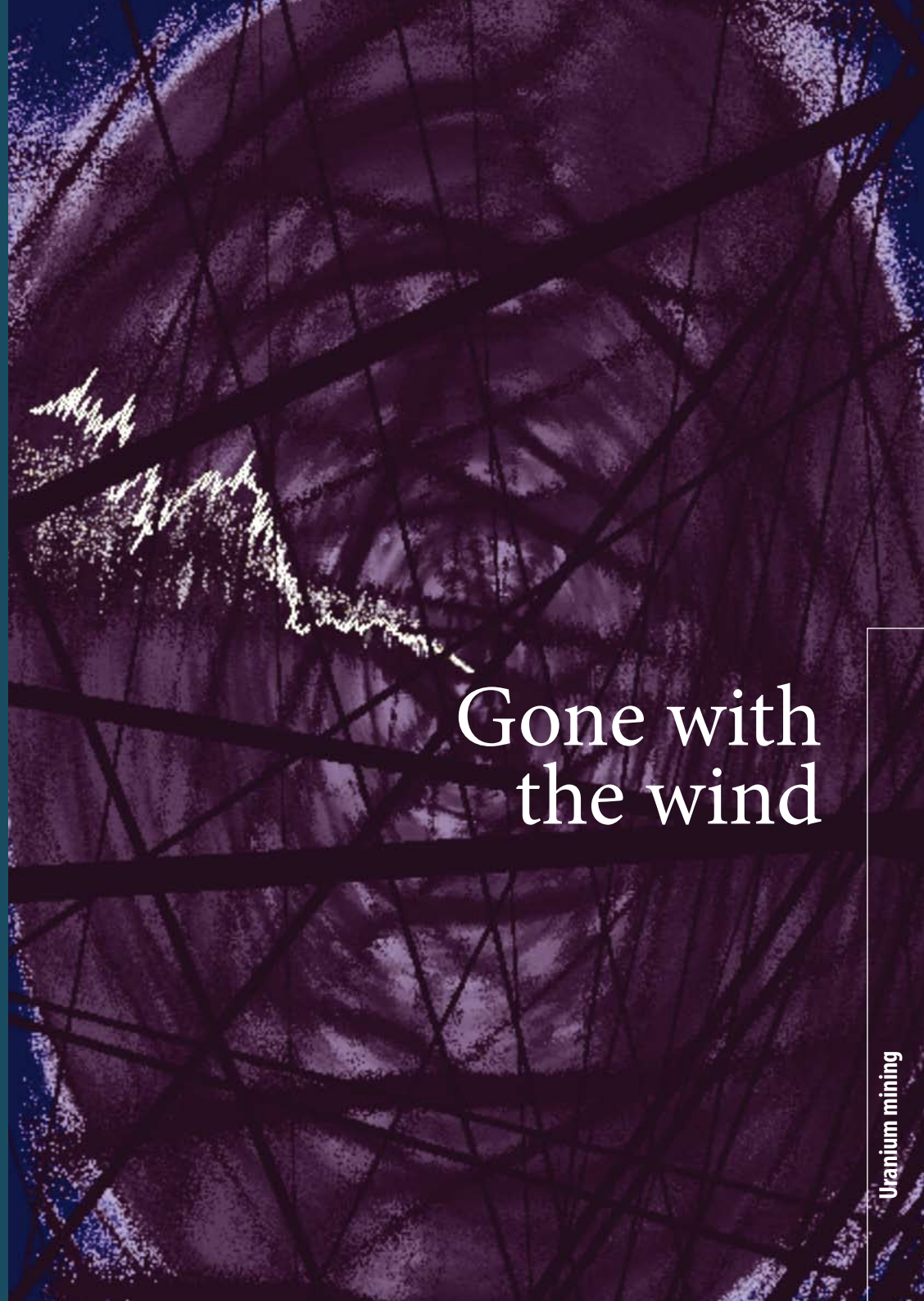
" We have to stand up and say that this (nuclear) is not the right way."

Your WECF team

Our stops along the way



From uranium mining to storage sites, uranium, the raw material of each nuclear power plant, covers a long and dangerous distance. Worldwide, at each stop along the nuclear chain, people come into contact with it and are effected by the far-reaching consequences. This map shows the locations that we have focused on in this booklet. Meanwhile, in Germany, renewable energies have caught up with nuclear power and now can easily displace it from the market.



Gone with the wind

"It was like a war zone."

Right next to the village in which Carletta Garcia grew up, was once located the world's largest open-pit uranium mine. The mining has not only destroyed most of her family, but also the whole culture and economy of her tribe.

What was it like to live that close to a uranium mine?
I grew up in Paguate Village, near the Jackpile Mine, located in the Pueblo of Laguna in New Mexico. It was in a beautiful valley. We had gardens and we would picnic there on Sundays. At that time nobody knew the potential danger of uranium. The mine opened in 1953, when there was a boom in uranium mining. It was in operation 24/7. As I grew up, all I remember is the dynamite blastings. It was like a war zone: Every day around 12 o'clock they would sound off a siren and blast this massive amount of dynamite. It shook our whole Mesa. We were sitting at lunch and sometimes the wind was just right and the dust would settle on our dinner and we would eat that along with our food. The ladies at that time would dry food and deer meat outside and all of that would be contaminated and we ate that.
When people built their homes, they would bring in the rocks and soil from the mining area, because it was free. They plastered their homes, they built ovens (to cook traditional breads and corn) and it was all contaminated.
But mining was the big thing, it brought in a lot of money. We went to town, to Pizza Hut, we did all these things we couldn´t do before because of the money. But the only thing they didn't tell us was, that we were being contaminated

In the 70's women were employed in the mines, so you and your mother started working there?
Yes. When my mother started she operated a dump truck, with which she transported high-grade uranium ore. In 1979, when I was 19, I also started to work in the mine. All this time we were inhaling and ingesting uranium particles and at lunch we would sit and eat on top of the stock-piles of uranium ore. We were never told that it was dangerous. My mother was a single mother, so she needed the job. It was a high paying job at that time, it helped us to become affluent. People bought vehicles and nice things for their homes during the "boom".

Did you know about the danger of radiation? They never told us about radiation and we never had dosimeter badges. They paid us very well, $15 an hour. For someone who was 19 in 1979, that was a lot of money. I was young and impressionable. When you are young, you don´t think of the future, you think about the immediate, about going down to the shops, buying some nice things.
But around 1993 my mother discovered 2 lumps under her arm. She had cancer. Then she went through six years of intense chemotherapy.
My husband died 4 years ago from pancreatic cancer. He didn´t work in the mine, but his brothers did. They brought home their laundry and it was being washed with the family's wash. Also his house was less than 100 feet away from the train tracks that carried the uranium ore from the mine to the crusher site. Along that route, if you take a Geiger counter, you can still read the traces of the ore there. The train was open, they never covered it, so it is all contaminated there.

"We did all these things we couldn´t do before, but we didn´t know that we were being contaminated."

What people don´t realise is, if their parents worked in the mines, they were bringing the contamination into their homes.
Now we are still fighting the effects of what the mine has left for us. There are a lot of people who are sick, a lot of people dying. I myself have thyroid disease.
I am 50, still beautiful, but I am a widow. I am not going to live my golden years with my husband.

In 1981 the mines shut down due to a sudden price drop for uranium. What has changed since then for your tribe? Everybody who was employed at the mine was out of a job. So we went into a big recession. In our village, people were losing things that they had bought on credit. We had a high suicide rate and lots of divorces because of financial problems. And along with that we started getting sick. It changed our culture.
We no longer follow the different rituals by the solstices and equinoxes. We decided to do this at other times when it is convenient for us.
We are losing our own language. A lot of our children do not speak our language anymore.
The mine basically changed our health, our economy, our social status and our culture.
It was a big disruption in our lives. We went from being agriculturalists to working at dead-end jobs.

In 1999, shortly before she died, your mother, Dorothy Purley, won the International Nuclear Free Future Award due to her campaigning against uranium mining on Native American lands and territories. Has her life inspired you to keep going forward? Yes.
We live in this beautiful vessel, which we call earth. Whatever we do, remains, it does not leave. Nothing leaves our area. So we have to be careful in what we do and how we maintain things, because it is going to come back to haunt us. I fear for the generations that follow. I fear for my people, because they will continue to be plagued with different ailments like cancer, kidney diseases and diabetes ...

Have Native Americans been treated differently by the mining company compared to white Americans?
We call it Environmental Racism. Every time some trash is dumped or some radioactive waste site is set up, it is always near people of color.
I don´t know if it is a deliberate attempt by the government or not. It is just always like that.
Probably 98% of my colleagues in the mine were Native Americans. This means a lot.

Carletta Garcia, 50, is a Native American woman originally from Paguate Village in the Laguna Pueblo (about 50 miles west of Albuquerque, New Mexico). She now lives nearby in Acoma Pueblo and is the mother of four children.
Country: USA

The beginning of the end

Right at the beginning of uranium process, the most far-reaching environmental impacts are caused.
Like other metals uranium is found as ore mineral in rock. However, the actual uranium content in the ore amounts to only 0.5%. Historically, uranium has primarily been mined underground or in open pit mines.
More recently, however, solution-based "leaching" of uranium has gained importance. In the "liquid" process, sulphuric acid or sodium hydroxide is directly channelled into underground reservoirs and the uranium containing solution is pumped to the surface. The most economically important uranium mines are located in Australia, Canada, Kazakhstan, Brazil, India and more recently in Africa. For years, the quantities produced have not always covered the amount of uranium needed worlwide. This shortfall in the uranium market is primarily met through existing stockpiles, old nuclear weapons and reprocessed fuel elements.

Toxic tailings

The production of the yellow uranium concentrate, or "yellowcake", is done in processing plants near the mines. Sulphuric acid or alkali and large amounts of water are used to dissolve the uranium from the rock. The separation process leaves ever accumulating quantities of remainder rock and rubble – also known as tailings. These tailings are pumped into reservoirs in spite of containing many health damaging substances such as thorium, radium and heavy metals (including arsenic). The tailings continue to release 85% of their original radioactivity, only decreasing to a less dangerous level over a few hundred thousand years.

Yellowcake is a yellow powdery substance consisting of 70% uranium compounds and is the raw material used for the enrichment process to prepare nuclear fuel. Approximately two tons of ore have to be mined in order to produce one kilogram of yellowcake.

Contamination of humans and nature

Radioactive dust is released in both the mining and milling of uranium. If this dust reaches a human body, radioactive material attacks the cells. Uranium miners are therefore exposed to a highly increased risk of cancer. Additionally, in the areas surrounding the mines, cancer rates in the local populations are higher-than-average. Numerous leaks and crevasses in the mine can cause radioactive waste from the tailing basin to enter the water cycle and contaminate ground and drinking water, lakes, rivers and even the air we breathe. The wind blows radioactive dust from the dried tailings all over the landscape. Radon gas will also escape and if it is inhaled, it can cause lung cancer. Animals in the vicinity of Australian mines exhibit significantly increased sterility and mutation rates. Since most uranium mines are located in arid regions, the high water consumption used in the mining also promotes the desertification of these regions.

At the expense of indigenous peoples

The people who are most affected by uranium mining are indigenous peoples including the Native Americans (Navajo, Laguna, Acoma, and other tribes) in North America, the Tuareg in Niger, the Adivasi in India, and the Aboriginal people in Australia. About 70% of the uranium development areas are on indigenous peoples' lands. Since their way of life is strongly rooted in local ecosystems, the radioactive contamination essentially means the annihilation of their livelihoods and cultures. Again and again ancestral populations have had to move, established communities have been destroyed and traditions have been disrupted. Often, the development of new uranium mines is accomplished through undemocratic processes. For example, the Australian Government has overridden their environmental laws, including their Water Act, along with the law supporting the cultural heritage of indigenous peoples, in order to support the Olympic Dam mining company.

The husband of the 80 year old Navajo lady, Bettie Yazzie, died in 1974 from lung cancer after more than 10 years of working in the Union Carbide Corporation uranium mine in Colorado. Years later the U.S. government finally admitted and apologised for not having told them how dangerous uranium mining is.

Resounding success

"Nobody knows how the people are coping, assuming they are even still alive …"

After the gulf war, environmental engineer Souad Al-Azzawi looked into the effects of nuclear weapons on human populations. When she published her results, she received death threats.

In both Gulf Wars, American and British troops each used Depleted Uranium (DU) weapons. What were the consequences? Huge areas in Nasria and Basra going all the way to the Kuwait border are totally contaminated. More than two million Iraqis and American troops have received high doses of radiation.
A few years later, (after the major conflict), epidemiological studies in those regions showed a significant increase in children's Leukaemia, congenital malformations, sterility, and other diseases among Iraqis. Similar trends among the American military veterans were recorded as well. This gives us a better understanding of the type of weapons we are dealing with!

What happened to the people who were affected by the use of these kinds of weapons and how are they now? People's immune systems were highly effected and weakened by these weapons. In 1991, attacking Iraq with DU weapons was accompanied with imposing comprehensive economical sanctions. People were short on basic supplies and therefore massively weakened and their bodies couldn't fight against cancer or other related diseases. The deterioration of the health care system, lack of medicines, and proper treatment altogether caused the death of thousands of people. During the invasion of Iraq in 2003, DU weapons were also used against civilians in highly populated areas like Baghdad and Basra.

Are you or members of your family/friends affected by radiation as well? Yes, my husband died ten months ago. He was 58 years old and suffered from Aplastic Anaemia. The doctors told us that this disease is a basic form of Leukaemia. They think he was exposed to radiation. Three of my relatives suffer from cancer. There were continuous miscarriages in the family, and even sterility. A veteran of the 1991 Gulf War was unable to have children.

How is the situation today in Iraq in regarding DU weapons? As in any other occupied country, the situation in Iraq is deteriorating. With lack of services, environmental pollution, a general deterioration of health and six million refugees, it seems impossible to follow up on the DU contamination in Iraq. The United States intentionally prohibited any investigations related to this issue. They want to conceal the evidence related to this crime. International organisations should have conducted risk assessments such as those conducted in Kosovo, even though the DU contamination problem in Iraq is more serious than what happened in Kosovo. But 18 years after the first Gulf War and thousands of opportunities, nothing has been done.

"DU weapons are not only still used, but also even more destructive weapons using DU are being developed."

Have you ever had to deal with being threatened because of your research? Oh yes. During the 90's, I was told to keep away from this sensitive issue because my team of researchers and I would allegedly cause panic in the area of Basra, if we published our findings.
I wasn't allowed to present the results of my research publicly until 2001 – neither in Iraq nor abroad. After the occupation, the Bader Brigade militias kidnapped my son and my nephew. They were tortured for three days. Then they dumped them close to death on the roadside. I had to leave my hometown of Baghdad and live in Mosul after receiving death threats. Many of my colleagues and members of other research teams have been killed, imprisoned, or driven out of the country.

Souad Al-Azzawi, 55, is a scientist. A mother of three children, she recently lost her husband, who died of radiation exposure. She is vice-president of a private university in Mosul. She won the Nuclear-Free Future Award in 2003.

Country: Iraq

The use of uranium weapons in civilian populations has caused the worst birth defects – the gene pool is destroyed forever. Source: Souad Al-Azzawi

Uranium munitions – How waste becomes weapons

Uranium weapons contains depleted uranium (DU). As a waste product of the uranium enrichment process, DU accrues worldwide in large quantities. Compared with conventional munitions, using depleted uranium can double the effectiveness of a weapons penetration. Due to its high density, for example, uranium can penetrate steel.
The first time depleted uranium munitions were used, was in the 1991 Gulf War. In the Balkan war, in the late 1990's, NATO used 12 tons of depleted uranium munitions, and in the Iraq war, up to 165 tons have been fired so far.

Irreversible destruction of the gene pool

U_{238} is not only a radioactive alpha particle emitter, but also a chemical poison. Even low doses can damage internal organs. Higher concentrations cause heavy metals poisoning. Frequent miscarriages and genetic defects in newborns after the Kosovo war and in Iraq, are attributed to depleted uranium munitions. The gene pool of the affected population is destroyed forever.

Film tip The documentary "Deadly Dust" by Frieder Wagner depicts the harmful effects of depleted uranium bombs on people and the environment. Available at: www.ochowa-film@t-online.de.

Dust drifts without respect to borders

As of 2007, 18 countries have included depleted uranium munitions in their arsenals: UK, USA, France, Russia, Greece, Turkey, Israel, Saudi Arabia, Bahrain, Egypt, Kuwait, Jordan, Pakistan, Oman, Thailand, China, India and Taiwan.
Besides Iraq, depleted uranium weapons were already used in Afghanistan, Kuwait, Palestine, in Lebanon and Kosovo. The areas contaminated by depleted uranium include production facilities in the US and the UK, weapons testing grounds and storage sites, and, of course, the locations where accidents have occured and where military actions using depleted uranium weapons have taken place.
The clouds of dust contaminated with radioactivity are blown by the wind to areas hundreds of miles away from the site of conflict. Dust drifts, which contain the particles of depleted uranium, blow radioactive particles in dust storms to adjacent areas and countries.

Risky residue

Uranium must first be "enriched" in order to be processed into fuel rods for nuclear power generation. This process also creates highly toxic and radioactive residues.

For electricity generation current power plant models need the easily fissionable uranium isotope U_{235}. However, the yellowcake uranium concentrate only contains 0.7% U_{235}, the largest portion comprises of the more stable U_{238}. Therefore, yellowcake, if it is to be suitable for use in a reactor – needs to be "enriched" to a U_{235} content of 3% to 5%. The material to be enriched must also be available in gaseous form. Therefore, it is converted from yellowcake to the chemically aggressive and toxic substance, uranium hexafluoride. In a complicated process, the two isotopes of the uranium hexafluoride U_{235} and U_{238} are then separated from each other as much as possible. The part with the greater amount of U_{235} is called enriched uranium, the part with the lower amount of U_{235} is called depleted uranium (DU). The enriched material is then compressed into pellets in fuel element factories, pooled into fuel rods and then used as fuel in nuclear power stations. The depleted uranium cannot be used for electricity production.

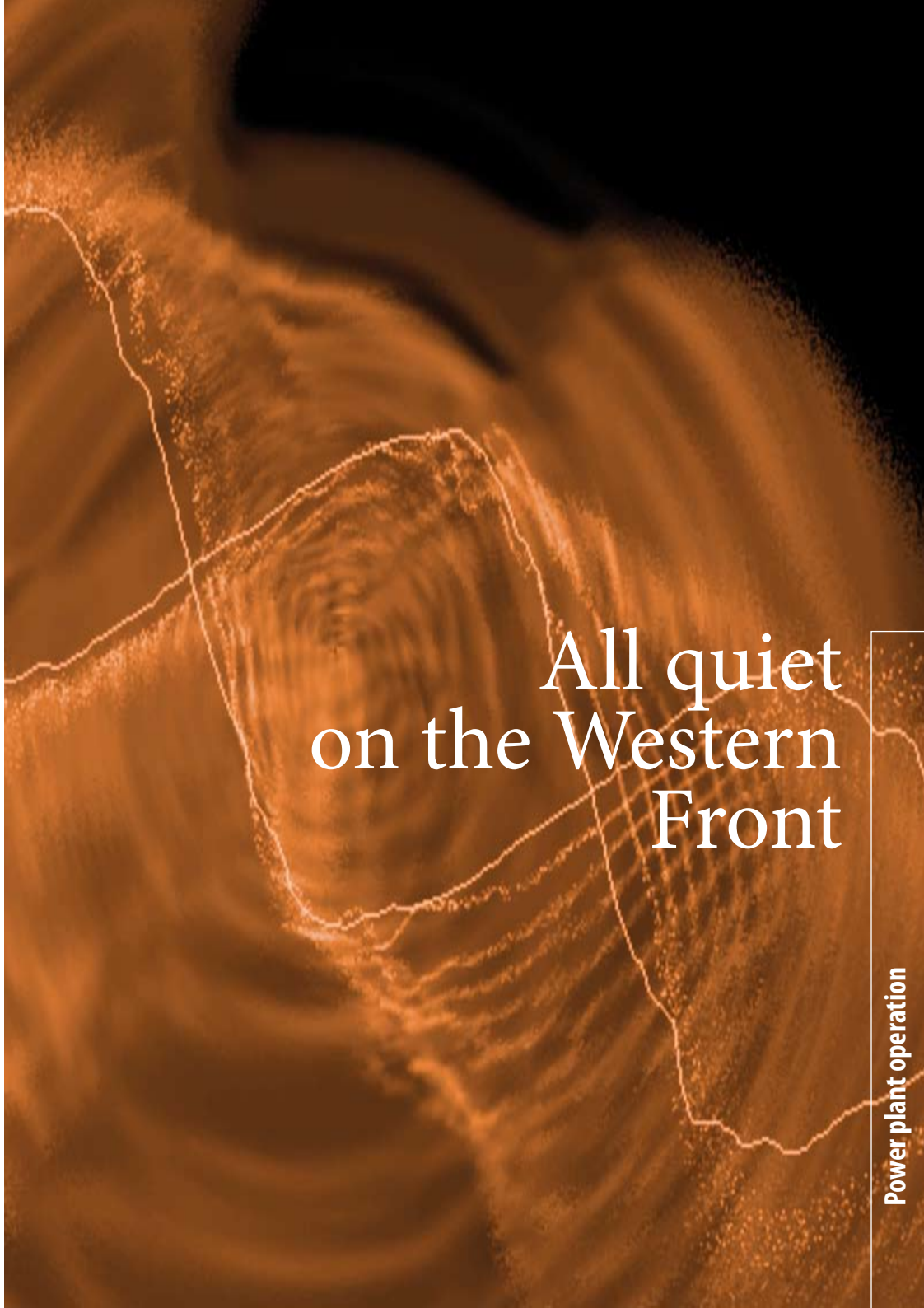
Uranium transports across Europe

For every ton of enriched uranium, at least seven tons of depleted uranium hexafluoride nuclear waste is created. In Europe, most radioactive remains are transported from Western Europe to Russia where, according to the enrichment company Urenco, the recovery of usable uranium is supposed to happen. From an economic perspective, the re-enrichment of the material is much more expensive than to mine for new natural uranium. For companies, it is primarily a convenient way to dispose of nuclear waste. Since 1996, a total of 27,000 tons of uranium waste from the German enrichment plant in Gronau has been sent to Russia. Worldwide, an estimated 1.1 million tons of depleted uranium is stored at enrichment plants.

Hazardous cargo

Radioactive waste producers carry a risk of their storage tanks leaking and potentially releasing radioactive waste into ground and drinking water. In July 2008, at the French enrichment plant in Tricastin, 30,000 litres of radioactive uranium solution was released from leaking tanks. Another problem is the risk of accidental explosions. According to the German Government, between early 2007 and October 2008, there were over 300 shipments of nuclear materials through Germany, mostly on public streets. These shipments also pass without escort through inner cities. The uranium is transported as gaseous UF6. Upon contact with humidity, a leak of UF6 would release corrosive hydrofluoric acid. Barrels of UH were found outdoors steadily emitting nuclear radiation. In the Tomsk region, where an enrichment plant is located, the local human life expectancy is only 48 years.

The nuclear waste resulting from uranium enrichment is transported largely through unprotected metropolitan and suburban areas.
Source: aaa-West, http://anti-atom-aktuell.de



All quiet on the Western Front

"The main problem is not the health damages, but the unacceptable conditions of work."

Alain de Halleux shot the ARTE documentary "Nothing to report?" about the working conditions near French nuclear power plants. For the research, the movie maker spent two years with the staff of the nuclear power plant.

Why did you want to make a movie on this subject and what experiences did you have during your research?
Because the Swedish reactor Forsmark almost exploded in July 2006, I wanted to understand what exactly goes on in a nuclear power plant (NPP). So I decided to speak to the regular workers. After several months of research in many EU countries, I noticed that no one in this industry wanted to let me into the plants or answer my questions.
I was, for example, at Sellafield. But the workers were not willing to speak to me. They were afraid of losing their jobs. The same in Sweden: They were all frightened. At a NPP, you belong to a community, living totally isolated from the rest of the world, close to the reactor. And if you "talk", you are a "squealer".
The nuclear industry has been keeping a big secret for many years and nobody talks about it. And if you do, you lose your job and everybody thinks you are a traitor.
In what countries could you actually talk with the NPP staff? The country where the people truly felt obliged to speak, was France. In this country that is leading the nuclear industry, things are going badly. The willingness of the workers to talk is proof enough. This country has 54 nuclear reactors and one of them, Fessenheim, is right next to the German border. The French are trying to prolong the permitted operating time, although it actually should close. Some workers even call it the "death-NPP".
And the workers are talking now, because they are scared?
Yes, they fear to go to work, because the nuclear power plants are so unsafe.
50 years ago all the workers kept silent, because they wanted to protect their industry against the anti-nuclear movement. In France they are starting to talk now, because they dread the way the industry is being managed today will lead to a huge disaster. Therefore, they have taken the responsibility to speak in front of my camera. And that in turn is frightening.
How are the working conditions in a nuclear power plant? Formerly, all activities were executed by the workers directly employed at the NPP. There was kind of a collective memory. Today the workers are no longer employed directly at the NPP or the energy corporation, but as a subcontractor of another company. They are not officially in the nuclear industry and the contractors must constantly move from one nuclear power station to the next, because the contracts expire on average every two years, due to European legislation. Thus, the collective memory is lost. Furthermore, the workers in the NPP come directly from university and have no experience, yet they give the commands. It is totally absurd. To be able to give instructions, you really have to know what you are doing.
Is it therefore more of a security problem?
There is a huge security problem. People from the nuclear industry say they have everything under control. That worries me, because such statements imply that they have no idea of the actual situation, or they deny it. Otherwise, they would say: "Yes, there is a problem, we must act immediately." They are so damn sure, when they say that this is not the same technology as the Chernobyl nuclear power station. And that is true. But the worker is in the central to safety. And the worker, that is the subcontractor, is treated very badly there. Many of them commit suicide and the divorce rate among the employees is very high.

"The workers have started to talk because they are afraid."

Because the pressure is so high? They know their work is very important for security, but at the same time nobody lets them do their work well, due to financial pressure.
If anything happens in the NPP now, it is no longer the chief executives who are responsible, but the workers, because they have signed papers saying they have done the work. This really is illogical, because they are poorly paid, but must bear all the responsibility. For me, that's slavery.
That does not sound very democratic ...
No. It is unacceptable that the people, who produce our energy, are treated like shit and nobody knows who they are. In former times, everybody used to know that coal came from the earth and that miners unearthed it. Nowadays, you switch on your computer and do not think for one second about the people who work in a nuclear power station. How can this be possible?
If you say, I do not know that my steak comes from a cow, people would tell you, how stupid you are, but with energy, it is exactly the same.
We do not know where our energy comes from and we do not know the people who produce it. That is unfair and also very dangerous.
What do you think, happens in the case of total meltdown? When a nuclear power plant explodes, we need about 600.000 people who will sacrifice themselves to solve the problem. Chernobyl was not a giant accident. It was just a big one. The situation would have been ten times worse, if we didn't have people who were willing to sacrifice themselves in the cleanup operation. In Europe, no one would volunteer, because no one is responsible. And we don't live in a dictatorship anymore.
Therefore we must stand up and say, that this is not the right way to act.

Alain de Halleux, 52, a nuclear scientist, lives with his four sons in Brussels. The former war photographer has shot several documentaries and teaches aikido among other pursuits.
Country: Belgium

Film tip Documentary "Nothing to report?" In the discussion about nuclear power there is an aspect often forgotten: the work situation of the nuclear power plant staff. This documentary gives voice to their concerns. Available at: www.dvdoc.be.

The cooling of nuclear fuel is a vital component of safety technology for nuclear power plants. Source: Kurt Michel, www.pixelio.de

Hot potato

With electricity from coal, oil and gas, the energy from most nuclear reactors is produced in a steam generating power plant. However, the heat from nuclear power is not produced by combustion, but rather by fission.

Just under 3% of global energy is generated by 439 nuclear power plants. In nuclear power stations, large amounts of energy are produced by the fission of a uranium nuclei inside fuel rods. The released neutrons, in turn, generate more fission and set neighboring atoms into motion and a chain reaction is created. If this process is not controlled, it can lead to a meltdown. In the worst scenario, radioactivity can leak uncontrollably. Water is commonly used to control the speed and temperature of the reactions. The resulting heat from the nuclear fission is transferred to the water, thereby creating steam, which drives the turbines, and electricity is generated.

Risk in detail

The most common types of nuclear power plants are light water reactors, where water serves as coolant and particle brake. There are two types: boiling water and pressurised water reactors. In the somewhat simpler constructed **boiling water reactor.** The same water which surrounds the fuel elements, drives the generators. Especially with this model, severe hydrogen explosions have occured in the german NPPs of Gundremmingen in 1987, Krümmel in 1999 and Brunsbüttel in 2001. In the pressurised water reactor, nuclear fission and electricity production are separated by two water circuits. But, both types of reactors pose technical risks. There are frequent leaks and cooling problems. This can be very dangerous, if during an emergency shutdown, the emergency systems still have to deal with the cooling of high temperatures. At a new reactor in Harrisburg, Pennsylvania, the cooling systems failed after an emergency shutdown in 1979, which almost resulted in a meltdown. Also, the emergency power supply is very vulnerable in both models. In 2006, at Forsmark in Sweden, half of the power sets shut down. The nuclear power plant employees acted without functioning measurement systems. According to the former heads of the design department, it was only seven minutes away from a meltdown. The NPPs Krümmel and Brunsbüttel, but also Isar 1 and Gundremmingen are very similar in the design to Forsmark. In **heavy water reactors**, heavy water (D20) is used for cooling and is very costly to produce. In **graphite reactors**, graphite is used as a neutron brake. Examples of this type of reactor are the Soviet RBMK reactors. But the most well known is, Chernobyl. A variety of these type of reactors are still in operation in Russia. A special type of graphite reactor, are **high-temperature reactors** (pebble bed reactors). They work with fuel balls as the neutron brake. This technology, however, has never gone beyond the testing phase. **Breeder reactors** in addition to electricity production, are simultaneously used to "breed" fuel-grade plutonium, which is then, in turn, used in other power stations. The security risk is considerably higher, because plutonium is much more explosive and hazardous than uranium. With the exception of small research reactors, not a single "fast breeder" is currently in operation.

MCA
Maximum Credible Accident

"Mayak is history. People have short memories."

Nadezhda Kutepova is a lawyer and a grass roots activist campaigning for the rights of the victims of the famous Mayak nuclear accident.

You grew up in the closed city of Ozyorsk, where the Mayak nuclear plant was built. What was your life like there?

During my childhood I was surrounded by an eerie atmosphere of secrecy, everywhere there were guards with weapons behind barbed wire.
My parents forbade me to say where I came from when I was outside of Mayak. Many workers in our nuclear power plants have become alcoholics.
After work, they got drunk, because they believed that alcohol removes radionuclides. Gradually I got used to the fact that many of our friends died of cancer. We all lived in constant fear. But officially they always said: "Everything is fine."

Many people suffered permanent damage from the nuclear accident at Mayak. You represent some of the victims in court. Can you freely practice your legal work?

No! The authorities persecute us regularly.
They drag our reputations through the mud, complicate our work and insult us as spies.
In 2008, the police arrived with a search warrant for our office. Even my child was visited by the security authorities in the kindergarten and the teachers were asked if I was a good mother and if I always pay my fees on time.
I do not feel safe and want my children away from this place. If the situation becomes too dangerous, I will need to seek political asylum.

2000 pregnant women were forced to clean up after the disaster. You represent many of them professionally. What happened to them and their children?

As liquidators, the women were doing all the (kinds of) work done in the nuclear industry until the eighth month of pregnancy - without protective clothing and masks. Many of the women died and many of their children never lived beyond childhood. Until 1991, it was forbidden for the mothers to talk with their children about the disaster. Therefore, many children who survived and whose mothers have died before 1991, do not know that their pregnant mothers were involved in the cleanup.

"In Russia only the nuclear industry makes money. The consequences of accidents and pollution are borne by the state."

What is the situation today in your area?

In Ozyorsk, which has only existed for 60 years, the second cemetery is crowded.
Every day ten people die, there are so many cancers and disabled children. But the people remain silent and bury their heads in the sand. They fear for their jobs and their incomes.
Everybody wants to develop nuclear technology, but the people of our region suffer for this, but no one cares.

Nadezhda Kutepova, 37, is the founder of the human rights organization Planet of Hopes. She lives with her four children in Ozyorsk.
Country: Russia

Source: Timo Vogt, www.randbild.de

"After our return from Chernobyl, we were mentally and physically shattered."

After the major nuclear accident in Chernobyl in 1986, one million liquidators went to Chernobyl to "clean up". Natalia Manzurova is one of a group of liquidators who are still alive.

At the time of the meltdown, you were one of the few female radiobiologists in Russia. Why did you choose this profession?

It was my destiny. When my parents were young, they were told to get to the station with their belongings. They did not know where they were being taken. They arrived in a city which was just being built, the present Ozyorsk.
There, they collaborated in the construction of the nuclear plant Mayak. Nobody knew it. All of them, including my parents, had to sign papers not to tell to anyone where they lived and worked.
For five years, they were not allowed to leave the city. When I found out, at the age of 26, what my parents had been doing, it was clear to me that I wanted to explore the consequences of their activities.

Why does a 30 year old single mother risk her health in a disaster area like Chernobyl?

We were sent there as experts. For me it was my professional duty. In addition, I met a woman, who had been evacuated from Chernobyl. Her eyes were full of pain, I can´t forget it. If you were a doctor, wouldn´t you help a deadly ill person even though they may infect you. But if I had known how terribly my family and I would have to suffer, how the state, which we defended with our lives, would defraud us, I would never have done this work.

How did you work in this highly contaminated area?

We wore protective clothing and masks.
However, for two years, the radiation was so strong that the non-protected parts of the face received a special radiation tan. We had no instruments to measure the radiation within the area, so we could avoid an excessive dose.
As experts we were aware of the effects of radiation and of the importance of following the safety instructions: taking off special clothing properly, and safety when eating, drinking and going to the toilet.

How have you and your colleagues fared after this mission? I had stomach problems and terrible headaches. Then I had a thyroid operation.
At the age of 42 I was declared incapable of work and dismissed without any financial compensation. And my colleagues? Only a few are still alive. And they are very sick. Often, families have broken apart. The liquidators have the highest suicide rate in the country.

Natalia Manzurova, 58, lives with her daughter in Ozyorsk. She founded the "Association of Chernobyl Invalids", which advocates for the interests of the former liquidators.
Country: Russia

Boundless

The worst case scenario in a nuclear power plant is that radioactivity leaks uncontrollably and in large quantities. To date, the worst nuclear accidents have taken place in Chernobyl and Mayak.

In Chernobyl two reactors are still in operation. Source: Natalia Manzurova

Mayak

The big Mayak nuclear plant in the southern Urals was one of the production facilities for the first Soviet atomic bomb. It was part of the "exclusion zone" which had been created in 1945 between Chelyabinsk and Yekaterinburg, in order to cut off Soviet nuclear weapons production from the outside world.
In the first years of operation, all the radioactive waste from Mayak's plutonium production was dumped in the nearby Techa river. The residents were left in the dark about this. Therefore, for sudden deaths, people used to call it "river disease". In 1957, due to failure at the cooling plant, a tank filled with highly radioactive waste exploded (also known as the "Kyshtym" accident). One year later, an area 300 km long and 70 km wide was declared a restricted zone. Hundreds of thousands of people developed chronic radiation sickness due to the high doses of radioactivity.
For years, radioactive liquids from the reprocessing plant leaked into the neighboring Lake Karachay. When the lake dried up in 1967, heavily contaminated dust was spread by the wind across large areas. Today, radioactive waste from reprocessing is still stored in open reservoirs at the Mayak site.

The population at Mayak suffers to this day. Source: Timo Vogt, www.randbild.de

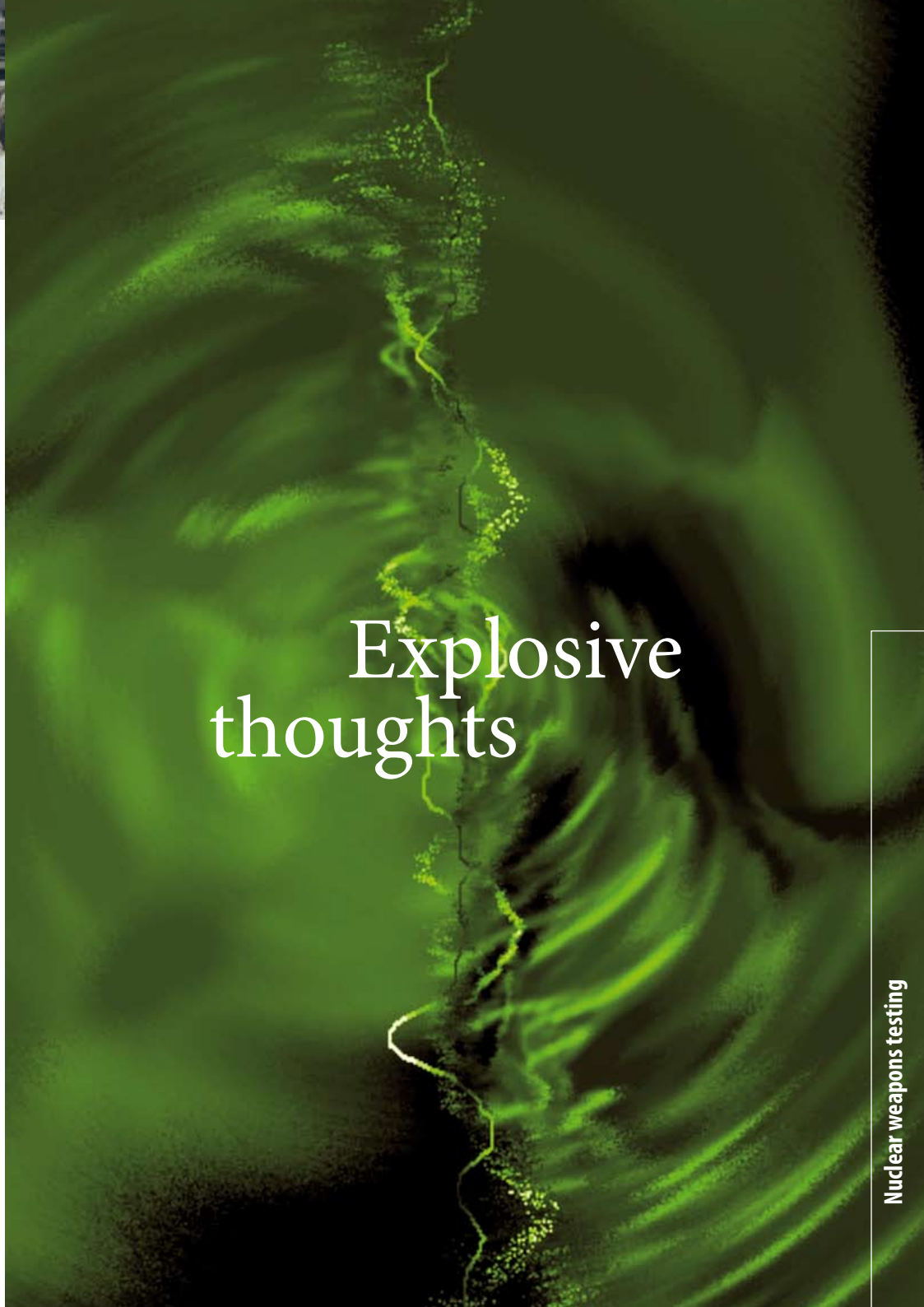
Chernobyl

In 1986, the nuclear power plant disaster at Chernobyl changed the world overnight. Across several countries, huge areas were contaminated with radioactive material. Nearly a million people were sent to Chernobyl as "liquidators" - a high level clean up crew. Their work prevented a major disaster: They extinguished the reactor core fire and entombed the reactor in concrete. Months after the accident, they were still busy cleaning up. According to a study by the International Physicians for the Prevention of Nuclear War (IPPNW) and the Society for Radiation, between 1986 and 2006, at least 50,000 to 100,000 liquidators died. About 90% of those still alive today are invalids. In Ukraine, Belarus and Russia, cancers have increased. Additionally, there has been a dramatic increase in the incidence of physical and mental illness, such as diseases of the nervous or circulatory system.

Tens of thousands of babies in the Chernobyl region were born with genetic damage. Future generations will be affected by genetic defects in even greater numbers because the damage to human genetic material is seriously multiplied in each subsequent generation. However, the adverse impact of radioactivity is by no means limited to Eastern Europe. Studies show an increase of disease and deaths, related to Chernobyl - in Europe and around the world. However, an overall presentation of the health consequences of the disaster is impossible as data is still kept secret and research and the publication of studies is being thwarted.

Closed cities – don´t officially exist

In Soviet times, cities were built to serve the research and development needs of Soviet military technology, especially nuclear weapons. These so-called "closed cities" were not to be found on maps and were only known by their postal codes. For people with foreign passports the closed cities were forbidden territory. In some of them, not even Soviet citizens from outside were allowed to enter.
Since the collapse of the former Soviet Union, most of the large closed cities have been opened, however some nuclear industry sites and military bases still require special permission to enter.



Explosive thoughts

"And then it started to snow on Rongelap ..."

In 1954 the atomic bomb "Bravo" was detonated at Bikini Atoll. As a child, Lijon Eknilang played in the fallout.

Do you still remember when the bomb was detonated near your island, Rongelap? I was eight years old then and it was my birthday, the 1st of March. A huge ray of light covered the whole sky. Shortly afterwards we heard a deafening noise and the ground began to waver. From the loud noise our ears hurt. We were very scared because we did not know what it all meant. The elders said that a new world war had begun. I remember that we were crying.

The radioactive fallout descended on Rongelap. Two days later, the entire island was evacuated and you were allowed to return after three years.

What was this like for you? On our return in 1957 a lot had changed. Some of our food crops were completely gone. Others had no more fruit. What we ate, was causing blisters on our lips and mouth and we were suffering from severe stomach pains and nausea. We reported to the doctors about these problems. They just told us we were not cooking our food properly. We knew that could not be true, because our food had been prepared for centuries in this way.

How are the people doing today? Many people suffer from thyroid tumors, stillbirths, eye diseases, liver and stomach cancer and leukemia. Even people who were not living on Rongelap in 1954, but arrived after 1957, began to suffer from the same diseases as we were. Foreign doctors called these people the "control group" and they told us that the cases of illness among them would prove that our illnesses were not caused by the nuclear fall-out. We did not believe them and later learned that the islands from which this so-called "control group" came from, had also been contaminated during the nuclear tests.

And how are you personally? For me, one of the worst outcomes was, that I could not have anymore children. I had seven miscarriages. During one miscarriage, after four months, I gave birth to a fetus with severe abnormalities, he had only one eye. Sometimes I had the feeling that I was carrying a child in me. Then I was very happy, because I was looking forward to the child, but then I got scared, which kind of a baby would it be?

Does this happen to many women in your nation? Many women have cancers of the female organs and malformed foetuses . In our culture, reproduction difficulties are a sign that women were unfaithful to their husbands. So many of my friends keep silent about the strange births that they have experienced.

Then you all left Rongelap again, because life on the island was too dangerous. How was it for your people to leave their home behind?

It was very difficult for us, especially for old people. Three of them disappeared with grief into their huts and never came out again, until they died. It is our homeland. Where we belong to. It is our memory of our dead, the souls of our ancestors live there. Our land is everything to us, and it has been destroyed by the U.S. government. But we had to think about the future for our children. We would not want them to get all the diseases we are suffering from now.

"We had heard from the missionaries of "snow", but this was the first time that we saw white particles falling from the sky ..."

Lijon Eknilang, 63, was born on Rongelap Atoll and lived there during the nuclear tests. Today, she resides on the island of Ebeye.
Country: Marshall Islands

Abbreviated version of the interview "Lernen aus dem Leid" from the book Pacific Women Speak Out For Independence and Denuclearisation, kindly supported by the German publisher Pazifik Netzwerk e. V.

Tropical paradise: Here not only the sun radiates. Source: Peller, www.aboutpixel.de

Even the researchers of the U.S. "Manhattan Project" (to create the atomic bomb) were very shocked by the extent of injury. Source: U.S. Archives

Contaminated paradise

The Republic of Marshall Islands is located in the western Pacific Ocean. The island nation comprises 29 atolls with 1,200 large and small reef islands. After the end of World War II, the islands fell under U.S. administration. Between 1946 and 1958, the U.S. conducted 67 nuclear tests in its Trust Territory, including the ignition of the largest-ever hydrogen bomb created – code named "Bravo" – on Bikini Atoll, the fallout fell on the island of Rongelap. The islands were evacuated due to radioactive contamination, and soon after were determined again to be " habitable" by the U.S. government. But in the 1970s they had to restrict them from residence again, because the contamination level was too high and still is, to this day. Some areas have even been declared restricted zones for 24,000 years. Although the Marshall Islands have been politically independent since 1979, the United States still has a strategically important missile rocket base in the archipelago. In return, the Marshall people receive substantial financial grants from the U.S. government.

Human guinea pigs

The great explosive force of nuclear weapons and the generation of energy in nuclear power plants occur in the same way: atomic nuclei fission and subsequent release of energy.

Research on nuclear fission was motivated by military intentions from the start. In 1942, in the U.S. the construction of the atomic bomb began under the leadership of the physicist Robert Oppenheimer, in the top secret "Manhattan Project". The first nuclear weapon was tested in July 1945 in Alamogordo in the desert of New Mexico.

The bombings of Hiroshima and Nagasaki followed shortly afterwards, instantly killing 225,000, and killing and maiming thousands more over the following years.

According to information from the International Physicians fort the Prevention of Nuclear War (IPPNW), up to 1998, there were 2058 nuclear tests in numerous locations. To quantify that, between 1945 and 1998, every ten days a test took place. There were 500 nuclear bombs ignited above ground, in the atmosphere, under water or on the Earth. Approximately three times as many tests took place underground after the signing of the Partial Test Ban Treaty in 1963. The tests were conducted primarily in the Pacific Islands, Nevada (USA), Kazakhstan, Russia and China.

Radioactive fallout occurs after the explosion of an atomic bomb. Source: U.S. Archives

Uncontrolled chain reaction

The explosive energy of nuclear weapons is produced by the splitting of atomic nuclei. When a neutron hit a fissionable nucleus, it decays, releasing large amounts of energy.

A chain reaction is set in motion. As a result of nuclear weapons testing, scientists hopes to gain information on pressure waves, temperature, amount of radiation and the potential direction of the radioactive cloud.

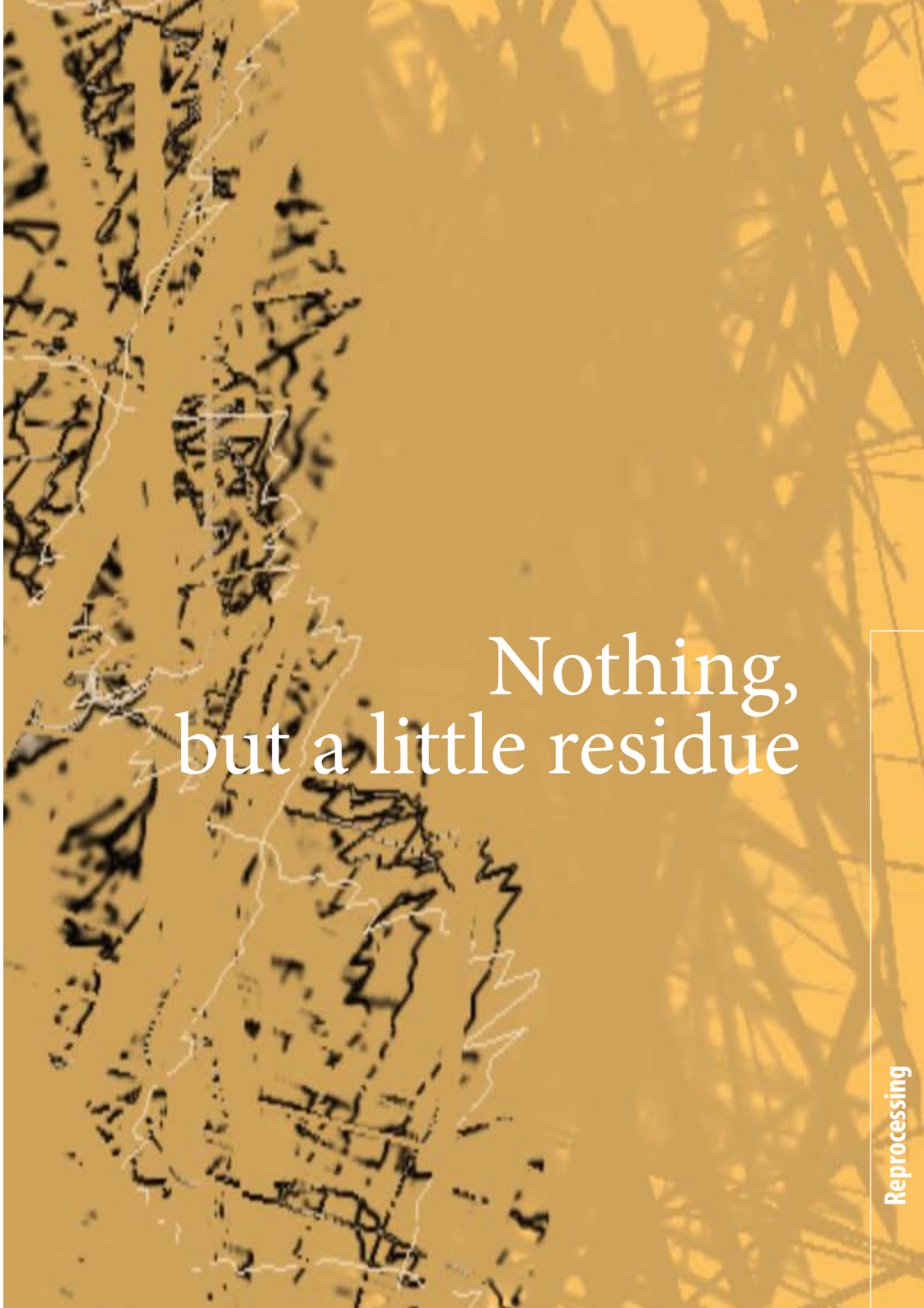
Deadly rain

After the detonation of an atomic bomb, there is a release of so-called "nuclear fallout", an intensely radioactive material. The larger radioactive particles fall down immediately after the explosion and leave a fatal amount of radiation on the ground. Smaller radioactive particles are later thrown into the air. They travel, over large distances, and contaminate soil, air and food products. These particles can cause the symptoms of acute radiation sickness: dizziness, vomiting, cramps, diarrhea, fever, bleeding from mucous membranes, and loss of hair, all of which normally lead to death within a short time. Local weather conditions determine the nature of the fallout.

After the atomic bombs on Hiroshima and Nagasaki, black rain fell, a dark, thick, oily precipitation, full of radioactivity. In the Marshall Islands, radioactive ash rained down, which the inhabitants of the Marshall Islands thought was a kind of "snow".

Local explosion, global radiation

As a result of the nuclear tests, the global exposure is greatly increased. This has led, and will continue to lead in the future, to a reduction in human health. An IPPNW study has looked at 430,000 fatal cancers worldwide, which are thought to be as a direct result of the long-term consequences of nuclear testing. Radiobiologists at the University of Munich, Germany, estimate this number could even be as high as three million.



Nothing, but a little residue

"For Sellafield workers, public criticism can mean dismissal."

Janine Allis-Smith loved to play with her baby at the beach on the Cumbrian coast, where the nuclear reprocessing plant Sellafield is also situated. At the age of 12, Lee developed leukaemia. Lee survived, but many other children who lived near Sellafield, did not.

For you, Sellafield is responsible for your son's leukaemia?
Yes. According to British Nuclear Fuels, the amount of radioactive material that was poured from Sellafield into the Irish Sea, was 100 times higher than today.
Then I used to go with my son to the beach near to the reprocessing plant. Lee loved to get dirty as a baby, he played games of covering himself in beach mud and sand. I'd clean him up by throwing a bucket of seawater over him and the game would start all over again. Harmless fun,
I thought then, but now I am convinced it wasn't.
Didn't you know anything about the dangerous radiation? Scientists knew since the '50s, that Plutonium from Sellafield - as a part of a deliberate experiment on the people of Cumbria - was deposited on our beaches and has accumulated there. We were not informed about that fact.
In 1983, a documentation showed that the cancer rate among the children in the neighboring village to Sellafield was ten times higher than the national average. According to experts, this could not be a coincidence, and they asserted that the radioactivity from Sellafield was responsible. Nine months later, 12 year old son Lee, was diagnosed with leukaemia.
How did you feel after the diagnosis? The harsh medical treatment in the year that followed, the initial desperate panic and shock at the diagnosis, the tears, the fear and the pain of having to explain leukaemia to Lee and his younger brother, Steve, still haunts me.
How did other mothers react, whose children were also affected? Mothers do not talk openly about their fears and suspicions, especially when a family member is working in the nuclear plant. Sellafield is the largest employer in West Cumbria and, taking into account the record unemployment in the region, there is almost no choice.
Could you criticise openly at all? My outspoken views were not appreciated by those working at Sellafield and its supporters who saw me as a threat to jobs. But I could face the angry phone calls, the hostile letters in the local newspaper and even ignore the damage done to my old car, which was covered in anti-nuclear stickers, and sometimes used to get a good kicking if it was left unattended. Only once did I feel like giving up. When taking Lee for a hospital check-up, my car developed some kind of knocking and I had to stop on the motorway. The rescue patrol man told me that the loose nuts on both front wheels could not have happened by chance.
What do you think Cumbria's future will look like?
Maybe I am naïve, but I hoped that after nearly 60 years of Sellafield reprocessing in Cumbria, and being seen as the nuclear dustbin by the rest of the world, that we were going to have a better, safer and cleaner future. That our prosperity would come from non-polluting industries other than nuclear power. That tourism would expand and, in addition to our wonderful Lake District National Park, we could include our beautiful coast which would no longer be dominated and threatened by the nuclear industry. But will it ever happen? With support from the authorities for new nuclear power stations and the promise of the jobs they will bring, maybe I am also naïve to believe that people around Sellafield would want to remember that the 25 year old question "what caused the childhood leukaemia´s around the plant?" has never been answered.

"Future generations will probably have to pay a very high price for today's job promises."

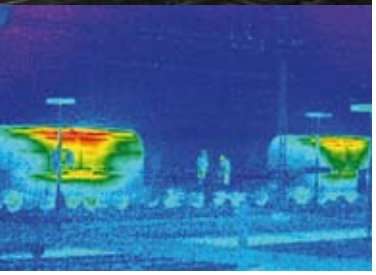
Janine Allis-Smith, 67, two children, lives with her partner near the coast of Cumbria. Since her son fell ill, she is an active member of the anti-nuclear movement.
Country: England

Beach games with far-reaching consequences. Source: Janine Allis-Smith

The Lake District seems to invite one to walk and swim. Source: www.cumbriaphoto.co.uk

Outstanding vacation

The Lake District is a popular tourist destination. With its ridges, lakes and coast, it is home to the largest national park in Great Britain. The park includes, Scafell Pike, at 987 m, the highest mountain in England. However, the otherwise idyllic region is also the location for most of the nuclear plants in England. Also Sellafield, with its tragic noteriority is located there. Most visitors do not know that nine million litres per day of radioactively contaminated water are transferred directly from the reprocessing plant at Sellafield, into the Irish Sea. According to Greenpeace, the total amount of radioactivity, which has been released into the environment over the the entire operating time, corresponds to the radioactive contamination which was released at the total meltdown from Chernobyl.



"If anyone came up with the idea to open the Castor containers, they would be exposed to such a high direct exposure to radiation from the fuel elements, that through combustion-like damage, death would occur.", said a spokeswoman in the information video of the Federal Office for Radiation Protection, about the Castor. In the Castor, temperatures are hundreds of degrees Celsius, and at the surface up to 80 degrees Celsius.
These extremely high temperatures are made visible by an infrared camera, see infrared picture of the Castor on the left. Source: Martin Storz, Greenpeace (above), Greenpeace (below)

Humbug package

Only 1% of the spent fuel can be made reusable through reprocessing.

Spent fuel from nuclear power plants consist of 96% non-disintegrated uranium and 1% plutonium. The rest of the contents are non-recyclable fission products such as ruthenium, rhodium and palladium. In the reprocessing plant these fuel elements are fractionalised into pieces, the radioactive contents separated through solution processes and the individual components isolated. Plutonium, uranium and other fission products are now almost completely separated and available. The isolated plutonium is processed into so-called "mixed oxide fuel" (MOX), in order to be able to generate electricity. The reprocessing of uranium is not currently viable due to its impurity. The target to reduce waste, is absurd.

Dangerous work, for 1% less nuclear waste

In spite of a highly technical effort, the amount of waste will be reduced by only 1%, since only the waste product of plutonium is re-used. The term “recycling” is therefore misleading, because 99% of the original material remains in the form of non-usable high-level waste solution. After a year of storage, radioactive waste is evaporated and fused with glass, then transported in Castor containers into intermediate storage facilities. As the power plant operators have to remove the products of reprocessing, extensive transportation over very long distances are necessary. Even Japanese power plant operators receive their reprocessed nuclear waste from the French plant at La Hague.

Radioactive waste and weapons-grade plutonium

The continuous discharges of radioactive effluents into the sea and the constant release of radioactive gases are a major problem. The radioactive liquids are stored for cooling at the reprocessing plants. In Sellafield, dangerous incidents occurred again and again: In 2005, highly radioactive liquid leaked for many months because the warning indicator was ignored. Due to the location of of La Hague and Sellafield directly on the coast, the adjacent coastal seas are permanently contaminated. The Federal Office for Maritime and Hydrographic estimates the amount of plutonium in the Irish Sea to be 200 kg. By comparison, the production of an atomic bomb only requires 5 kg of plutonium.
The plutonium recovered during reprocessing, is principally weapons-grade material, which can be mis-used for military purposes.

Simply swept under the carpet

"The nuclear industry in Russia is as sacred as the cow in India."

Olga Podosenova has already suffered the adverse effects of radiation herself. When she started to campaign for the end to Russian nuclear waste imports, she was dismissed.

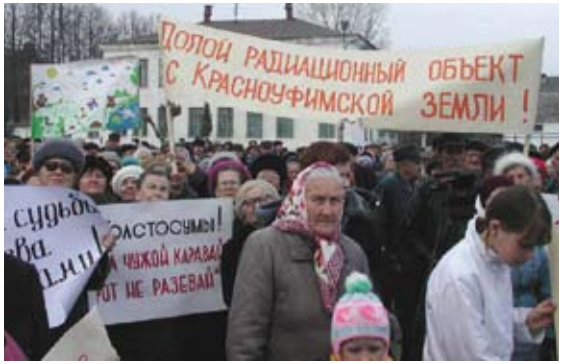
Why have you begun to mobilise against nuclear power?
Because I understood that my family and my children have no future if I do not deal with the problems that the nuclear industry has created. In 1989 I was with other students working at the onion harvest in Kolkhoz in the Sverdlosvk region. We were working on a field next to supposedly empty warehouses.
On the second day some of the students complained about severe pains in their joints.
On the third day, half of us could not get up, and on the fifth day we were all taken to the hospital. The doctors refused to make a diagnosis which could be connected to radioactivity. They just told us not to have children in the next ten years. Later, we learned that in the "empty" warehouses tons of radioactive material had been stored for years.
And how has your community responded to your political involvement? When I joined the anti-nuclear movement in 2001, they were about to enact a law that would allow the import and storage of nuclear waste in Russia. By then I was organising the first protest action in Ekaterinburg. The day after, I was summoned by my boss. He said that it was not possible to be involved in the anti-nuclear movement and to be a government servant. A day later, I was laid off.
Obviously, they couldn´t frighten you off, because today you are head of a Russian environmental organisation. What does this mean in a country like Russia?
To be against nuclear power in our region is not easy. Local authorities depend on the nuclear industry as well as on the position of the government regarding nuclear energy.
In the Urals, officials talk of nuclear power as "Deadman" – either you speak good of it or you have to be silent about it! For us it is very difficult to perform even the simplest actions such as educating the public. The people who live near nuclear plants still have the habit from the Soviet era, to keep silent. This complicates work. People who first ask us for help, suddenly stop communicating with us.

"Scientists have split the atom. Now the atom splits us."

You live in the Ural region, which is worldwide known as the most radioactively contaminated area. How does that affect the daily lives of people there?
The dangers of nuclear power are everywhere for us. My daughter knew from an early age that she should not drink the water from the tap and should not swim in many rivers and lakes. I know that my neighbor jumps up shocked every time, when he hears a loud noise, because he thinks that something has happened in the nuclear power plant. Those who split the atom, probably did not think about people like us. Now, the atom splits us, whether we like it or not.

Olga Podosenova, 37, lives with her family in Ekaterinburg. She is a journalist and the coordinator of the international environmental organisation Ecodefense.
Country: Russia

The people in the states of the former Soviet bloc defend themselves under difficult conditions, but still have success. Source: NGO "Ecodefense"



The business of nuclear waste – a dirty deal

For about 30 years the European nuclear industry has disposed part of their radioactive waste in Russia. According to estimates by the World Information Service on Energy (WISE), it's been around 100,000 tonnes. European Atomic Energy companies profit from the cheap price of storage and disposal in Russia and in the adjacent states. This situation was, and is still, abused by the West. Russia saw the import of nuclear waste initially as an attractive business model, because it desperately needed foreign exchange. The state-owned nuclear company, Rosatom, for example, earned 21 billion U.S. dollars for the import of 20,000 tons of highly toxic radicals from western nuclear facilities by 2000. The majority of the purchase contracts come from the 90s. Rosatom admitted in a public interview that the contracts at that time were concluded due to financial conditions and today would not be negotiated. Existing contracts have to be complied with, however, and the transportation cannot simply stop.

Profoundly undemocratic
Millions of signatures from people for a referendum failed to prevent a legal agreement in 2001 to allow nuclear imports in to Russia. The signatures were summarily declared invalid by the government.
The Chelyabinsk region, in which the world's largest nuclear plant – Mayak – is located, receives the Western radioactive waste.

Olga Podosenova and her colleagues from Ecodefense at an action, "No nuclear", during a speach at the citizens forum in the G8 summit. Source: NGO "Ecodefense"

Where to put the waste?

Each stage of the uranium processing and use creates large amounts of radioactive waste. Its half-life is up to 4.5 billion years. The question of the waste disposal remains unsolved.

Radioactive wastes differ greatly, primarily in terms of amount of radiation, heat, state, radiotoxicity and half-life.
For example, for plutonium the half-life is 24,000 years, for $U_{235,}$ 700 million years and for U_{238} (DU), 4.5 billion years.
Although the German Atomic Energy Act requires safe disposal, there is still no permanent repository there. Every year, 400 tonnes of used fuel is produced in Germany. In recent years, 16 intermediate storages have been created at the nuclear power plant sites. It must be assumed that in these outbuildings, nuclear waste is stored on a long-term basis. According to estimates by the German Federal Office for Radiation, in 2030, Germany will be confronted with 29,000 m^3 of radioactive waste. The disposal is predominantly financed with public funds. The costs for the research on final storage are borne by the government ministries alone.

Future uncertain

Nuclear waste disposal has many uncertainties. Insulation would have to be safely ensured over hundreds of thousands of years. Due to the immensely long period needed, safe assurance is impossible to guarantee. In order to insulate the waste as much as possible, scientists look for certain geographical properties.
One must assume, however, that geological conditions may change in the future. It is also uncertain, whether the desired geological characteristics actually exist anywhere in the storage site.
The long-term stability of the containment vessel is also not tested. Due to gas development in the waste, an increase in pressure may occure, leading to an explosion. Additionally, there is always the risk of infiltrating waterways. Thus, radioactive substances can pollute the groundwater, as it has been the case in Asse, Germany.
Numerous studies, including one from the United States National Academy of Sciences, come to the conclusion that it is only a matter of time until radionuclides pollute the biosphere, this means people, animals and plants.
In a 2001 bill from the U.S. Federal Government to amend the Atomic Energy Act, it says literally: The problem of permanent and safe disposal of highly radioactive nuclear material is "everywhere currently practically unresolved".

Asse salt mine Asse is a former salt mine in Lower Saxony, Germany. From 1965 to 1995, research and development studies for radioactive waste disposal were performed there. Since 1979, no storage of radioactive waste has taken place.
The Federal Office for Radiation Protection in early 2009 assumed the responsibility for the former experimental storage site and is looking into the best possible scenario for its closedown.

Radioactive monazite - stored in broken containers in an old, rundown warehouse in Krasnoufimsk. Source: NGO "Ecodefense"

Renewable´s light the way forward

"Being peaceful does not mean accepting everything. You have to do something to challenge injustice."

Germany currently has 20% renewables in the energy grid. The small community of Schoenau and their publicly-owned energy supply contributed much to this development. Ursula Sladek, a mother of five and an accredited primary school teacher is a co-founder of the Schoenau power station.

Why did you begin to deal with the issue of energy?

The trigger was the Chernobyl accident in 1986. Before then, to me, electricity just came from an outlet. Although I am a certified teacher, I have never actually worked in this profession. I gave birth to five children in quick succession, so I was busy with child rearing and housekeeping. Chernobyl exploded into our family idyll like a bomb and I realised that I had to take care of the world my children were living in. Since neither the politicians nor the utility companies seemed to draw any lessons from the disaster at Chernobyl, there was no alternative but to roll up our sleeves and do something ourselves.

And so you set up a parents' initiative?

Yes. We first dealt with the practical management of the situation post-Chernobyl. What can we safely eat? Can the children continue to play outside? Can you protect yourself against radiation? But we quickly realised that we would not be able to limit our engagement to only those problems. Our stated goal has been and still is to achieve the fastest possible withdrawal of the use of nuclear energy.

And what was your contribution to phasing out nuclear power?

We went to the regional energy supplier KWR - now under the umbrella of EnBW – to ask for support for low-power production. This is what we saw as an important step towards a nuclear phaseout. The response from KWR was clear: "We do not want to save any electricity, we want to sell electricity! You are damaging to the company and you should be happy that we are not taking action against you. "Even in the talks about the renegotiated concession contract at that time in Schoenau, KWR blocked the inclusion of environmental considerations. Since then, we have decided to take our power into our own hands.

That is why you bought the grid for 5.8 million DM from the old operator in 1997. How did you get so much money together?

We first made a detailed grid evaluation and it came in just under 3.9 million DM. This we got quite easily by selling shares to citizens and funding from the GLS common bank. But the KWR first demanded 8.7 million DM, more than double what we had! Such purchase price demands have increased today as a popular means by network operators to avoid or to protract grid takeovers. Ultimately, we paid 5.8 million DM - still far too much. We were able to raise the additional monies through a national fundraising campaign.

Subsequently you co-founded the citizen-owned utility company Schoenau. How did you do this virtually from scratch?

This was, of course, only possible with the support of many people. First we did a feasibility study with the participation of experts. By means of a so-called "service contract" we had the support of a major public agency, which helped us create the technical and organisational structure. After years of political struggle, two citizens' votes and a public campaign supported by environmental organisations, as well as religious, political and social groups, in 1997, our citizens group took over the power supply in Schoenau.

"Our vision is to decentralise the power supply and distribute its production amongst many hands."

To what extent was your success dependent on support from local authorities and the community?

The mayor and some of the city council members at that time were not in favor of us assuming control of the power supply. To implement this project, we carried out two public referendums. That was a tough fight, but I'm very proud of my fellow citizens who were dedicated to the issue of sustainable energy and allowed us to become the electricity suppliers in Schoenau. Meanwhile, we have become the flagship company in the city. We provide new jobs and ensure that the town of Schoenau, that relies economically on tourism, is well known.

How does someone become a customer?

An individual only has to fill out our application for the delivery of electricity and attach a copy of their electricity bill. Everything else we do for them. The transfer over takes about six weeks and is not complicated. We supply all over Germany and have around 85,000 customers.

Do they have to pay more than they would from conventional electricity providers?

That is hard to say arbitrarily. In Germany there are more than 900 electricity suppliers, which all have different prices. Sometimes we are more expensive, sometimes equal in price, sometimes cheaper than suppliers of nuclear and coal power. Usually, a electricity customer automatically thinks "Eco - this must be expensive!" Quite often, this is not the case, thus the transition to us as a green electricity provider is often worthwhile, not only environmentally but also financially.

Is it possible to replicate elsewhere what you have created in Schoenau? Yes. Schoenau is a very average, rather conservative place, of which there are hundreds very similar in Germany. It is not distinguished by a special spirit of resistance. We develop rules and requirements, which facilitate successful action. In this way we are happy to advise other initiatives to ensure that the example of Schoenau can set precedents everywhere in Germany.

Ursula Sladek, 62, is managing director of the Schoenau utility company. She won the Nuclear-Free Future Award in 1999.

Country: Germany

A sustainable supply of energy without nuclear power is feasible. Source: www.ews-schoenau.de

100% renewables in the German energy market are possible. Centralised power plants slow down the path to renewable energy. Source: projekt21plus

Priority for renewables

Sun, wind, water and biomass are conquering more and more of our electricity market. A 100% renewable energy supply is quite feasible with German technical capabilities and also brings enormous benefits to the German economy.

10 years ago, the amount of renewable energy in the German electricity mix was 5%. The big power companies approached the politicians at that time and they cautioned against developing too much renewable energy saying that they would be volatile and a renewables share of more than 10% would make it impossible to ensure the power supply. Today - in 2009 - nearly 20% renewable energy technologies are used in the German electricity grid and it is continually expanding. This increase was enabled by the German "Law for Promotion of Renewable Energies", or EEG. Previously, operators had many options to impede the connection of renewable energy to the electricity grid. The plant owners hardly received any money for their electricity and therefore an investment in renewable energy was financially unpredictable. The EEG now constitutes the legal guarantee that renewable energies are primarily fed into the grid, and that a clear commission for 20 years (also known as a "Feed-In Tariff") must be enacted. As a result, the renewable energy industry gained economic security and was determined to be credit worthy by banks. Medium-sized companies established themselves in the market. The competition for the traditional electricity supplier grew, inspired new business and strengthened the confidence of renewables. As of late 2009, the renewable energy sector has created over 280,000 new jobs in Germany. Professionals in the field of renewable energies now play a significant role in political consultation rounds.

It´s all in the mix

In 2007, a study (http://www.kombikraftwerk.de/index.php?id=27) demonstrated that with German technical capabilities, a supply of 100% renewable energy could be easily accomplished. This study also showed that it is important to intelligently weave the interrelationships of power producers, consumers, and storage technologies. The necessary centerpiece is a control system that brings together all the players. Several producers (water, wind, solar, biomass and geothermal energy) contribute their electricity. Consumers such as households, public buildings and industry are involved, for example through smart meters in the system. These meters allow for an on and off switching certain devices and thus track a temporary redistribution of electricity. If the wind is blowing around a lot, machinery or devices from industry or households are switched on. If less power is available, then consumers such as refrigerated stores can disconnect from the grid for some time. For some others, additional energy storage technologies are needed. This can be achieved through pumped-storage hydroelectric power plants, air storage, electric cars, or cooling and heating systems. European, so-called high-voltage transmission lines (HVDC), can redistribute large quantities of energy over great areas. Energy is thus sent where there is a need and the necessity to save the electricity is decreased.

Decentralized and flexible

Renewable energy sources need a flexible electricity market. Electricity producers, storage technologies and consumers interact closely together. Large central power stations, mostly run on coal or nuclear, cannot perform in a flexible way. The new players on the market must be able to adapt quickly to the existing electricity production and demand. Small block heating plants can achieve something like this, because these small motors can be accelerated and shut down within the shortest time. They can also be linked together into so-called virtual power plants and deliver efficiently as much electricity as is needed at the moment. These block heating plants can also eventually be heated with biomass (biogas or vegetable oil). Large, centralised and inflexible power plant owners who previously dominated the market structures, are being increasingly replaced by medium-sized companies or municipal utilities. This process is not proceeding without resistance from the existing market rulers, this is demonstrated by the massive advertising for nuclear energy and the escalating plans for new coal-fired power plants.

The added value remains in the region

Certain factors in this conversion system must be organised regionally. However, the essentials involved can be done at the local level. Here, people can participate directly in the energy supply. The advantages are obvious: The revenue from the energy industry remains in the region and can be reinvested there. Decentralised jobs are created locally. Hence, the entire process will promote the domestic economy in the long term. Above all, investment in renewable energy is an important step towards greater independence from fossil and other finite fuel resources.

Communal added value

Many municipalities have long ago recognised the social, economic and environmental importance and benefits of a sustainable, self-standing power and heat supply. For example, municipalities can supply themselves with heat from geothermal energy or biogas, build combined power plants, buy their own electricity grid or actively promote the development of renewable energy facilities. Some municipalities in Germany produce two to three times as much energy as they consume themselves.

Did you know? **When Germans consume only half as much electricity, the share of renewable energies in German electricity mix increases to 40% because renewables have priority. In Germany, electricity from renewable energy sources enters into the grid first, before coal and nuclear.**

Further reading

Links

www.greenpeace.org/international/campaigns/nuclear
Greenpeace International
www.ippnw.org
International Physicians for the Prevention of Nuclear War
www.nirs.org
Nuclear Information & Resource Service
www.nuclear-free.com
The Nuclear-Free Future Award
www.ucsusa.org/nuclear_power
Union of Concerned Scientists
www.wecf.eu
Women in Europe for a Common Future
www.wilpf.org
Women´s International League for Peace and Freedom
www.antenna.nl/wise
World Information Service on Energy

Books

Chernobyl, Twenty Years – Twenty Lives, published in English by Information Publishing House. ISBN 87-7514-147-7. The book is distributed by World Information Service on Energy (WISE). Can be ordered at WISE: wiseamster@antenna.nl

If You Poison Us: Uranium and Native Americans, by Peter H. Eichstaedt, published in 1994 by Red Crane Books, 2008 Rosina Street, Suite B, Santa Fe, New Mexico, 87505, http://www.mnmpress.org/?page=order.

Nuclear Power is not the Answer, by Helen Caldicott. First published by Melbourne University Press (2006), Australia, including a special preface for Australian readers. Reprinted and published by The New Press (2006), USA; ISBN 978 0 52285 251 6 and ISBN 0522 85251 3, http://www.helencaldicott.com/books.html

Pacific Women Speak Out For Independence and Denuclearisation, by Zohl dé Ishtar (Raven Press, Christchurch 1998) ISBN 0-473-05666-6. To be ordered from: http://www.nzine.co.nz/views/pacific_women.html

Films

Climate of Hope – by Scott Ludlam. Published in English by Information Publishing House. Distributed by WISE. Can be ordered at: wiseamster@antenna.nl

Deadly Dust – a documentary on uranium munition by Frieder Wagner. Can be ordered at: www.ochowa-film@t-online.de

Do it for Uncle Graham – documentary on the nuclear history of New Mexico, USA, by Just-Us Productions. Can be ordered at: www.doitforunclegraham.com

Tour de France for a nuclear phase-out – a documentary by Trojan tv production. (45 min./French spoken, English subtitled/2005). Can be ordered at WISE: wiseamster@antenna.nl

Uranium – is it a country? – a documentary on uranium mining made by the German initiative "Nuking the climate – Strahlendes Klima". Can be ordered at: http://nukingtheclimate.com

Hundreds of related films, documentaries and footage can be found and ordered via www.laka.org