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Briefing: RWE and Cernavoda 7.4.2010

Romania's sole nuclear power plant (NPP) is situated near the town of Cernavoda in southwestern Romania. The NPP was planned in the 1970s as a flagship project of the former dictator Nicolae Ceausescu. While the original plan foresaw the construction of five units in Cernavoda, up until today, only two units have been built. Block 1 took up operation in 1996 and block 2 came online in 2007.

In November 2008, RWE and five further investors¹ entered into an agreement with the Romanian national energy company Societatea Nationala Nuclearelectrica (SNN) to build two further reactors, Cernavoda 3 and 4 at this site. According to this agreement, RWE will hold 9.15 % of the project's shares. The official estimates for project costs are cited at 4 billion Euros, but it is likely that the construction of Cernavoda will cost at least double this amount.

Along with Belene, Cernavoda belongs to the most controversial NPPs currently planned in Europe. Environment and civil society organizations are therefore calling upon RWE and other investors to cancel their involvement in this venture.

A recent poll commissioned by Greenpeace shows that 52% of Romanians are opposed to the construction of new nuclear power stations, 31% are in favor and 17% are undecided. This mirrors the findings from the European Commission's EuroBarometer survey in 2008, which found only 35% support for new nuclear power stations in Romania.²

Seismic Risks

Romania is one of the most earthquake prone countries in Europe and the project site is located in a region of high seismic activity. The most acute danger is posed by earthquakes originating in the Vrancea region which has been the epicenter for four large earthquakes (with a magnitude of over

6.9 on the Richter scale) since 1940.³ The 1977 earthquake in Vrancea killed over 1,500 citizens in Bucharest and destroyed large parts of the city. Like Bucharest, Cernavoda is situated only 150 km from Vrancea.

Cernavoda is surrounded by 3 further epicentral zones: Dulovo (100 km southwest), Sabla (115 km southeast) and Dobrogea in the northeast. Especially in Vrancea, Sabla and Dulovo, earthquakes

¹ The other five investors are: ENEL (9.15%), CEZ (9.15%), GDF Suez (9.15%), Iberdrola (6.2%) and ArcelorMittal (6.2%).

² http://ec.europa.eu/public_opinion/archives/ebs/ebs_297_en.pdf

3 See: [http://www-sfb461.physik.uni-karlsruhe.de/pub/web/sfb-
www/main/general/vrancea.html](http://www-sfb461.physik.uni-karlsruhe.de/pub/web/sfb-
www/main/general/vrancea.html)

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of over 7 on the Richter scale are expected. An evaluation commissioned by Austria's Federal Environment Ministry therefore comes to a critical assessment of the project's seismic hazards. It states: "Safety margins of the seismic design are still an important open question. (...) In respect to the earthquake risk, Romania does not comply with good international practice. This would require to assume for the design basis of the safe shutdown earthquake a return period of at least 10,000 years. Moreover, it has to be considered that all four reactor buildings at the Cernavoda site are located in a small area and rely on several common systems located in common buildings. In the same area, all the spent fuel is collected in the fuel bays and there is also the interim storage. Thus, an earthquake for which the plant is not designed could lead to a large disaster."⁴

As construction of all five blocks began in the 1980s, a significant portion of the civil works is almost thirty years old. The Austrian Environment Ministry also sees grave problems herein and states "there are obvious restrictions for the adaption of units to recent safety standards," and points out, that "common mode failure in case of natural disaster or other external events cannot be excluded."

"It's impossible to understand why RWE is intent on investing into a nuclear power plant in a seismic high-risk zone. Especially as the foundation for the project was finalized 30 years ago and it will be impossible to adapt Cernavoda to modern safety requirements," says Jan Haverkamp, Greenpeace nuclear expert for Eastern Europe.

The seismic risks do not only pertain to the structural stability of the plant. In case of a major earthquake, one must expect impacts such as malfunctioning of the electricity and communication systems, fires, floods and other events that will exponentially increase the likelihood of serious operational mistakes and a major accident. "In Germany a project such as Cernavoda would never receive an operating license," states Haverkamp. "After its experiences with Mülheim-Kärlich⁵, RWE is surely aware of this, but safety does not seem to be an important investment criteria for the company," he comments.

4 „Construction of NPP Cernavoda Unit 3&4 Environmental Impact Assessment - Experts Statement,“ Umweltbundesamt Wien, 2007

5 Mülheim-Kärlich is one of RWE's most spectacular misinvestments. The reactor was shut down by German courts after

less than one year of operation due to missing seismic studies.

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An Outdated and Risky Reactor Design

The CANDU 6 reactors envisaged for Cernavoda 3 and 4 are of an outdated design developed in the 1970s. While the nuclear industry is building third generation reactors in countries such as Finland and France, the CANDU 6 model is a second generation design.⁶

CANDU stands for "Canadian Deuterium Uranium Reactor". These are heavy water reactors, whose design and operation are fundamentally different from the pressurized water reactors found in other European countries. A matter of fact many experts consider the CANDU to be a dead-end street in reactor design, because of its fundamental inherent problems.^{7,8} Even WENRA, the Organization of European nuclear regulators cautiously formulates: "The Cernavoda NPP is based on the Canadian CANDU 600 design (...) However, Western European regulators and their technical safety organizations have little experience with this design and no further knowledge regarding this plant. On the basis of the available information, it is, however, obvious that additional studies are needed to confirm design safety margins regarding seismic events and fire protection. Additionally, a validated probabilistic safety analysis must be undertaken."⁹

The core of CANDU reactors is not confined to a pressure vessel. Instead, it consists of many pressure tubes, whereby heavy water is used both as a moderator and a coolant. There are specific risks associated with this design. While modern light water reactors rely on so-called passive safety systems in order to reduce accident risks, CANDU reactors mainly rely on complex active safety systems with a resulting high accident risk, if these malfunction. The main disadvantage of this reactor type is, however, its positive void coefficient of reactivity.¹⁰ This means that the nuclear chain reaction accelerates instead of decelerating if coolant flow to the core is interrupted. The reactor thus experiences a violent power surge, challenging the integrity of the containment if shutdown systems are delayed or ineffective. Such an event occurred in Chernobyl Unit 4 in 1986. Although the RBMK reactors in Chernobyl were moderated by graphite, they share several characteristics with CANDU reactors, including a positive void coefficient. CANDU reactors would therefore not receive an operating license in countries such as Germany, France, Japan or the US as nuclear regulators in these countries only accept reactors with a negative void coefficient and inherent passive safety systems.

6 „Drei Generationen von Kernkraftwerken,“ Eike Gelfort, VDI-Gesellschaft für Energietechnik, 2003

7 „Risks of Operating Candu 6 Nuclear Power Plants,“ Dr. Gordon Thompson, Institute for Resource and Security

Studies, published by Greenpeace, November 20088 „Review of ACR-LBD-001, Licensing Basis Document for New Nuclear Power Plants in Canada,“ John Beare, CNSC

file 34-R240-2, March 20059 Nuclear Safety in EU Candidate Countries,“ Western European Nuclear Regulators' Association, 200010

If coolant does not circulate properly in the core, leaving a „positive void“ or space, drastic increases in the rate of the

nuclear chain reaction occur, resulting in a core meltdown if shutdown systems malfunction.

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There are also concerns regarding the security of the CANDU 6 containment. As the spent fuel pool is outside of the reactor building, the fuelling machine has to penetrate the containment in several places, thus undermining the containment's isolation function. It is moreover a question whether the containment can withstand an explosion of the type to be expected if the reactor is subjected to a sudden power excursion. The Austrian Federal Environment Ministry writes: "The large zirconium inventory of the CANDU core reacts exothermically with steam at temperatures which could be reached in a severe accident. This reaction yields hydrogen. Hydrogen gas is a threat for the containment stability, because it reacts explosively with air."¹¹

A massive accident could also occur outside of the containment in the pool for spent fuel. Studies show that the loss of water from a pool would lead to spontaneous ignition of the zirconium alloy cladding of recently discharged fuel assemblies. The resulting fire would be almost impossible to control and would release a large amount of radioactive material to the atmosphere, rendering large areas downwind of the plant unusable for decades.¹²

Another disadvantage of CANDU plants are their high repair costs. Due to constant neutron bombardment, the reactor's pressure tubes become brittle and are subject to breakage, so that CANDU reactors must often be "retubed" after only 15 - 20 years of operation. The resulting costs are often higher than the original capital costs of the reactor.

Because of their many problems, CANDU reactors never achieved great popularity. In spite of intensive marketing campaigns, only nine CANDU 6 reactors were built outside of Canada over the past 35 years (Argentina, China, Romania and South Korea).

¹¹ „Construction of NPP Cernavoda Unit 3 & 4 Environmental Impact Assessment - Experts Statement," Umweltbundesamt, Wien, 2007
¹² „Risks of Operating Candu 6 Nuclear Power Plants," Dr. Gordon Thompson, Institute for Resource and Security Studies, published by Greenpeace, November 2008

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Serious Health Risks

Heavy water reactors such as the CANDU emit extraordinarily high levels of tritium to the environment, much more than other reactor types. Tritium is the radioactive isotope of hydrogen and has a half-life of 12.3 years. The resulting beta particle poses an internal radiation hazard, i.e. it is dangerous when inhaled or ingested via food or water or absorbed through the skin. As the body is not able to differentiate between tritium and hydrogen, it incorporates tritium into tissues and organs where it can lead to genetic and developmental defects, tumors and cancer.

Due to Cernavoda 1, tritium levels in the vicinity of the NPP are already dangerously high. Measurements show that tritium levels in the air are 45 times higher than before the reactor commenced operation, while tritium levels in the water have increased by a factor of 13. The British scientist Dr. Ian Fairlie, one of the world's leading experts on tritium undertook an extensive study of the situation in Cernavoda in 2007. His report recommends that the local population should abstain from eating garden produce or honey harvested within a 5 kilometers radius of the plant. He also recommends that pregnant women and small children should move out of the 10 km zone surrounding the NPP.¹³ The town of Cernavoda with 21,000 inhabitants is situated only 2 kilometers from the NPP.

¹³ „Cernavoda 3 and 4: Environment Impact Analysis,“ Dr. Ian Fairlie, Consultant on Radiation in the Environment, London, September 2007

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In this context, it must be noted that annual tritium emissions increase over the lifetime of CANDU reactors and that the construction of two further reactors will lead to huge cumulative tritium levels in the area. If blocks 3 and 4 are built, Dr. Fairlie estimates that future total annual tritium releases in Cernavoda will reach levels of 2,400,000,000,000 Bq by 2030. Depending on the wind direction, not only Cernavoda, but towns such as Fetesi (37,000 inhabitants) and Medgidia (46,000 inhabitants) will also be at risk. High tritium levels in the water will also affect towns such as Constanta (310,000 inhabitants), which draw their drinking water from the Danube-Black Sea Canal.

Low Nuclear Safety Standards

The Canadian nuclear expert Dr. Gordon Thompson, who prepared a safety evaluation for the Pickering nuclear power station on behalf of the Canadian Government, comments in regards to the CANDU 6: "Any country willing to buy a CANDU 6 reactor, must also be willing to forgo rigorous safety standards."

The case of Romania illustrates this statement. The country's nuclear regulatory authority is weak and safety standards are significantly lower than in western European countries. While German radiation laws for example limit the effective dose for a design-based accident to 50 millisivert (mSv) per person, Romania accepts a dose, which is five times as high (250 mSv). While the EU limits tritium levels for drinking water to 100 Bq per liter, Romania puts the detection level at 350 Bq/l. Whereas the International Atomic Energy Agency (IAEA) recommends establishing a precautionary zone of 3-5 km around nuclear plants, the Romanian authorities have reduced the precautionary zone to only 1-2 km (presumably to avoid having to include the town of Cernavoda in this zone). At the same time, the intervention standards that define the need to trigger emergency measures lag far behind IAEA standards. The Austrian Federal Environment Ministry therefore concludes: "The evacuation of the town of Cernavoda in case of a serious accident will not be possible under current conditions."

In the same vein, it must be noted that the Environmental Impact Assessment (EIA) for Cernavoda falls short of international standards. Alternatives to the nuclear power plant are not given serious consideration and the possible impacts of a serious accident are fully ignored. The EIA explicitly

states that there can be no trans-boundary emissions - a ludicrous statement if a major accident takes place at the Cernavoda site. The risk of malevolent acts or an airplane crash for the integrity of the NPP and the spent fuel ponds are completely ignored, and an assessment of the health impacts of tritium emissions are missing. The Austrian Environment Ministry therefore concludes

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that the EIA "meets neither European EIA requirements nor the provisions of the Espoo-Convention" on transboundary impacts.

In addition it must be noted that Romania has no serious strategy on dealing with nuclear waste. While the EIA states that there will be interim storage at the reactor site, there are no financial plans for the expansion of existing facilities for low- and medium radioactive waste and the storage of spent fuel. There are also no plans whatsoever for erecting a final storage for radwaste - only the vague intimation that this should happen in 50 years time. There are also no financial arrangements for the decommissioning of the plant. A responsible management strategy would address all of these aspects and make appropriate financial provisions.

Further factors which complicate the situation are sub-standard construction practices and the high level of corruption in Romania's administration and government. In its country ranking 2009, Transparency International lists Romania under the most corrupt EU member countries. Apparently the corruption risks have even increased since Romania joined the EU.

Resume

An objective risk analysis of the Cernavoda project raises serious concerns. There are not only site specific risks, but also grave design-based risks as well as risks resulting from the low level of safety standards and weak administration oversight as well as high corruption risks. All of these risk factors are interdependent and raise the likelihood of mistakes during construction and operation of said reactors, potentially leading to a serious accident with massive nuclear contamination.

RWE investors must also take note of the fact that RWE has no experience whatsoever in regards to CANDU reactors nor in the operation of reactors in areas of high seismic activity. Due to the outlined risks, reactors of the Cernavoda type would not be eligible licensing in Germany. This issue was raised by the Romanian environmentalist Ionut Apostol at the company's AGM in 2009, when he asked RWE's management and Supervisory Board: "Does the safety and health of Romanian citizens not count for RWE? Why do you want to undertake a project in my country, which would never meet the standards you have at home?"

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