Position Paper: *Nuclear Energy (legislation on nuclear phase-out)*
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Date: 21/3/2023

Description & situation across the world

The (civil) generation of electricity through nuclear energy was developed in the early '50s and soon found its way in commercial applications in the former USSR (Obninsk, 1954), in France (Marcoule, 1956), in the United Kingdom (Sellafield, 1956) and in the United States (Shippingport, 1957). In 2021, 437 nuclear sites worldwide were connected to the electricity grid. France (69%), Ukraine (55%), Slovakia (52%) and Belgium (51%) were in 2021 the countries with the highest share of nuclear energy in their electricity production. *(Source: International Atomic Energy Agency,* see gc66-4.pdf (iaea.org).

Nuclear energy is the energy that is released by nuclear reaction (fission or fusion), in which the composition of the nuclei of atoms is modified. The heat that is released in these reactions is transformed into electricity, first through steam and next by means of classic turbines/generators. The existing plants all function on the basis of nuclear fission. Heavy elements (usually uranium-235, but also plutonium or even thorium) are bombarded by fast neutrons, thus becoming unstable and losing themselves a certain number of neutrons. This leads to a nuclear chain reaction with release of huge amounts of heat. The material used is recycled for about 95%, the rest is (radioactive) waste. Besides this, nuclear fusion is also studied on an experimental scale, where light nuclei (typically hydrogen isotopes deuterium and tritium) are melted together. The high temperatures at which these reactions take place (about 150 million °C) make it difficult to control this process. The Centre of Cadarache in the south of France currently continues to work on the international project ITER, which should produce about 500 MW of electricity, some 10 times the energy injected to get the process going (see also www.iter.org). China too is intensively investing in the development of nuclear fusion reactors.

Besides the power industry, nuclear reactions are also applied in the medical world (tracers, radiotherapy and diagnosis, sterilisation of instruments…), in industry (detectors, tracers, food preservation, (paper) thickness measuring, humidity measuring, oil refining, radioscopy of containers and paintings, water analysis, measuring of filling levels in cans, improvement of polymers…), in every day's life (fire detectors…), besides military applications (weapons, nuclear propulsion for aircraft carriers, …).

Nuclear energy has been a controversial societal subject since the '70s. The advantages of nuclear energy are:

- The relatively low production cost: the investment cost of the construction of a new plant is the most important cost factor, the exploitation of an existing (*a fortiori* a written off) plant is clearly cheaper than that of classical plants functioning on eg. coal or natural gas. There is, however, a debate going on about the cost of the security of nuclear plants, the insurance cost against all kind of risks, the storage cost of highly radioactive waste and the cost for dismantling plants.
- Nuclear plants are very stable and reliable and are for these reasons extremely fit for the production of base load-necessities of electricity. They do not emit greenhouse gases either, unless during the extracting process of uranium.
- Uranium is extracted in numerous politically stable places in the world, allowing to diversify the supply of primary fuels.

The disadvantages of nuclear energy are:

- Although there are very few incidents with nuclear plants, the potential consequences are enormous (contamination of large territories with radioactive impact, with disastrous consequences for mankind and the environment). Famous examples are Three Mile Island (US, 1979), Chernobyl (Russia, 1986) and Fukushima (Japan, 2011).
- Nuclear plants could therefore be a potential target for terrorist actions. For this reason, it is quite impossible to insure against the cost of a potential incident or assault. Nevertheless, this technology is fundamental when security is concerned, as was demonstrated by the huge difference between the consequences of the incidents of Chernobyl (1986) and of Three Mile Island (1979). The Belgian plants in Doel and Tihange are based on a more safe technology, as is confirmed by experience.
- The technology for the production of nuclear fuels is closely linked to that of the production of nuclear weapons, although the enrichment degree of uranium for weapons must be much higher. Both are often mentioned together though.

- The world reserves of uranium are limited. The *Nuclear Energy Agency* estimates the availability at 100 years at the current consumption rate.
- Nuclear plants produce more or less 1 m^3 highly radioactive waste per year. The dismantling of an old plant also produces lots of medium level radioactive waste. This waste is a danger for thousands of years to come for mankind and environment and needs to be stored in a safe place.
- It is difficult to estimate the global societal cost of nuclear energy (see above).

Nuclear energy continues to be, all over the world, a very controversial topic, where emotional and rational arguments are often mixed up.

After the accident with the plant of Chernobyl in 1986, lots of countries decided not to build any new nuclear plants or even decided to close down earlier their existing plants. In the last years, nuclear technology is again gaining a lot of attention, amongst others because of the following reasons:

- the strong rise or volatility of prices of fossil fuels (coal, petroleum, natural gas);
- climate policy, which aims to reduce heavily CO_2 emissions and other greenhouse gases;
- the slow progress and/or constraints of other technologies, such as wind energy (cost price, intermittency), solar energy (cost price, intermittency), nuclear fusion (slow evolution)…;
- the continuingly rising demand for energy in the world;
- gas and petroleum are raw materials for the production of numerous basic products. It is therefore disadvantageous to burn the limited reserves to produce electricity that can be gained on the basis of uranium, of which the citizen wishes no other applications.

Several countries have therefore recently reviewed their policy regarding nuclear energy (or are about to do so), and are analysing whether new nuclear plants can be built (e.g. Finland, United Kingdom, Sweden, Czech Republic, Poland, the Netherlands, and many others …).

After the nuclear disaster in Fukushima in Japan, where a nuclear reactor got into trouble in March 2011 after an earth quake, followed by a tsunami, the future of nuclear energy was again strongly subject to debates all over the world. A lot of countries and also the European Union announced that they would in the short term carry out stress tests in their nuclear plants, in order to measure their resistance to natural catastrophes, terroristic attacks and other external chocks. Some countries did not wait for the results of these tests and have in the meantime decided to close their nuclear plants (a.o. Germany), other have confirmed, for the moment, their trust in nuclear energy (eg. the Netherlands, France, United Kingdom). In Japan too, some nuclear plants are in the meantime operational again. The results of the stress tests in Europe lead to the recommendation to do substantial investments in various member states in order to further improve the security and safety of the nuclear plants.

On the other hand, the technology of nuclear fission is progressing as well. New generations of nuclear reactors are much more efficient and thus consume fewer raw materials, and also produce significantly less waste. Their development is however slow, due to the preference of producers for the further exploitation of proven technology and the long delay of development for new concepts. The development of the 3rd generation plant (EPR – European Pressurized Reactor) in the French Flamanville and the Finnish Olkiluoto has thus considerably been delayed. Furthermore, smaller nuclear reactors (Small Modular Reactors or SMRs) are being developed all over the world, which can be produced in mass and which are in principle cheaper than larger reactors. Finally, further research is running in view of future generations of nuclear reactors such as is the case in Mol (MYRRHA project, see https://myrrha.be/).

Nuclear energy in Belgium

In Belgium, there are 7 nuclear plants (4 in Doel, 3 in Tihange) with a total capacity of about 5.800 MW. They produce some 55% of the electricity production in our country. They were built between 1975 and 1985 and are, in the meantime, completely written off.

After years of debate, the "*The law on the progressive phase-out from nuclear energy for industrial electricity production" (Belgian Bulletin 28/02/2003)* was approved in Belgium on 31 January 2003. This law confirmed the moratorium for the construction of new nuclear plants and restricted the lifetime of all existing plants to 40 years. This meant that the plants Doel 1, Doel 2 and Tihange 1 should have stopped their production in 2015, followed by Doel 3 (2022), Tihange 2 (2023), Doel 4 and Tihange 3 (2025)..

On October 13th 2009, the Government Leterme decided to postpone by 10 years the first phase of the nuclear exit plan : "The Government will take the appropriate legal measures to ensure the extension of the exploitation period – and the authorizations linked to it – of the nuclear plants Doel 1, Doel 2 and Tihange 1 from forty to fifty years. But in 2011, the government Di Rupo I announced in its governmental agreement that it would execute the law of 2003 without compromise, and in 2012, the government reached an agreement: the nuclear phase out will irrevocably be settled by means of a slightly modified calendar (http://www.presscenter.org/fr/pressrelease/20120720/nouveau-calendrier-de-sortie-du-nucl%C3%A9aire?setlang=1).

In March 2014, Doel 3 and Tihange 2 were temporarily closed due to continued uncertainty regarding the stability of the reactor's inner side (microbubbles of hydrogen). Moreover, in August 2014, Doel 4 was temporarily closed after a sabotage action. This created great concern about security of supply in our country. Doel 4 was again operational on 19/12/2014 after an accelerated repair. In order to guarantee security of supply, the lifespan extension by 10 years of Tihange 1, Doel 1 and Doel 2 was approved in 2015. After the required approvals and negotiations with the owner, Doel 1 and 2 were operational again in December 2015. Moreover, by the end of 2015 the FANC (Federal Agency for Nuclear Control) gave its approval for relaunching Doel 3 and Tihange 2, meaning that at the beginning of 2016 all 7 Belgian nuclear plants again supplied electricity to the grid.

Right before winter 2018-2019, the unavailability of 6 out of 7 nuclear reactors in October-November 2018 again caused uncertainty regarding security of supply. Plants were unavailable for maintenance, for concrete degradation or refueling. Measures were taken to increase production capacity, to reduce demand and to increase import capacity (see http://www.elia.be/~/media/files/Elia/PressReleases/2018/20181002_Press-release-Winter-outlook-2018-2019.pdf).

In 2019 under the outgoing government Michel a law was voted to guarantee security of supply after the nuclear phase-out by means of a capacity remuneration mechanism (CRM), and under the impulse of Minister Van der Straeten, the government De Croo I took the necessary measures to realize this. At a record pace, the CRM was elaborated and approved by the European Commission (state aid regime), after which in October 2021, the first auction was organized to guarantee sufficient (production) capacity as from the winter 2025-2026 by means of a subsidy mechanism, a.o. for the development of 2 new gas plants.

With the increasing tensions in Ukraine and the threat of gas shortage in Europe (insufficiently filled storage units, increasing sanctions against Russia), concern regarding security of supply however again increases in 2021. After Russia indeed attacked Ukraine, the government decided on 18 March 2022 to extend the lifespan of Doel 4 and Tihange 3 by 10 years. Negotiations on this issue started with the owner, a.o. on the timing of the required investments, the financing and the costs of nuclear waste storage.

Furthermore, many votes (also from coalition partners in the government) continue to plead in favour of lifespan extension of more nuclear plants. The government too asked Engie, in February 2023, to analyze the possibility to extend the lifespan of other reactors to guarantee security of supply in the winter 2025-2026 and 2026-2027. Meanwhile and according to the law, Doel 3 was taken off the electricity grid on 23/9/2022 and Tihange 2 on 31/1/2023. It is not clear whether these plants still can/will be restarted.

Tax on the nuclear rent

As from 2008 the government decided to introduce a tax on the nuclear rent. Initially, this "repartition contribution" was set at 250 millions of euros (a follow-up committee had to set the amount for 2010-2014, but was never created).

On May 6, 2010 the CREG published its study (F)100506-CDC-968 « *sur la structure de coûts de la production d'électricité par les centrales nucléaires en Belgique* ». It calculated that the nuclear margin in 2007 lay in between 1,75 and 1,95 billion euro. Later on, it estimated that it lay in between 2 and 2,3 billion euro/year (see press release CREG 1/03/2011 «*Rente nucléaire : la CREG analyse les explications d'Electrabel et confirme sa position*»). It suggested to levy a nuclear tax of about 30%, i.e. about 700 million euro. These figures were strongly contested by Electrabel, a.o. during the hearing of the Chamber in February 2011.

In its recommendation ARCG110216-050 of February 16, 2011, «*relatif à l'étude 968 relative à la structure des coûts de la production d'électricité par les centrales nucléaires en Belgique*», the General Council of the CREG notifies to retrieve the illegitimately gained profits coming from the exploitation of nuclear plants, to the consumers.

The “kern” of 26/11/2012 decided moreover that the nuclear rent will be increased to 550 million of euros as from 2012; in 2013 the tax will amount to 475 million of euros (due to the unavailability of Doel 3 and Tihange 2). Finally, the “kern” decided in July 2013 also to cream off the benefits issued from the production of Tihange 1, of which the lifespan has been increased by ten years, and to use them to finance the offshore and to stimulate the construction of gas-fired plants.

In 2015, the nuclear rent was strongly lowered (amongst others after publication of a new study by the CREG, see http://www.creg.info/pdf/Etudes/F1407FR.pdf) to 200 million euros and 130 million euros in 2016.

From 2016 to 2026, the nuclear rent (“repartition contribution”) is ruled by the law of 25 December 2016 *“portant modifications de la loi du 11 avril 2003”*.

As from 2017, the contribution of repartition is determined by means of complicated formulas and will correspond to the highest of the following 2 amounts:

- a minimum level fixed by royal decree; or
- 38% of the profitability margin of the nuclear park.

A degressivity mechanism will still apply to that result.

The CREG has to calculate the revenues, costs and profitability margins each year, actualize every 3 years the parameters required for calculating the fixed and variable costs, and present a minimum level for the contribution of repartition.

Objectives of Febeliec

Security of supply, affordable prices and attention for climate and environment are the three pillars of a balanced energy policy. Given the numerous challenges that these three pillars represent, Febeliec believes that all technological options should be kept open. In the frame of the actual technological development, both fossil fuels and renewable energy sources, but also nuclear plants all have their place in a balanced, efficient and effective energy policy.

Febeliec therefore observes that the closing down of nuclear plants in Belgium on the basis of the law of 2003 would not only lead to a strong increase of the emissions of greenhouse gases in our country, but would also jeopardize security of supply (Belgium already has to import 10 to 15% of its electricity needs from neighbouring countries). Therefore, Febeliec argues for:

- keeping open the existing plants as long as their security is guaranteed and as long as no better technological and economical alternatives are available;
- recalling the moratorium for the construction of new nuclear plants;
- consolidating the Belgian know-how and expertise , amongst others in the field of building nuclear plants, their secure exploitation and the storage of nuclear waste (cfr. Myrrha project). It is therefore necessary to further invest in the development of new generations of nuclear reactors, with increased energy efficiency and decreased waste production.