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Monitored this issue:

Uranium as an energy source: medium to long term prospects

Uranium is the only metal used as energy source.[1] The extraction of uranium from the Earth's crust involves a complex chain of physical and chemical separation processes and the consumption of large quantities of energy, and of different chemicals.

The energy and chemicals consumed during extraction increase exponentially with decreasing ore grade, accompanied by an exponentially increasing emission of CO_2 . The grades of the available uranium resources decrease with time, because the mining companies mine the richest resources first, and because these offer the highest return of investment. Above phenomena cause the existence of the "energy cliff" and the "CO_2 trap". They thus call into question, for the century to come, the viability of a nuclear based solely on ^{235}U extracted from natural uranium whose geological occurrence couldn't suffice to make it self-evidently an energy resource.

One way to overcome this ^{235}U limitation would be to exploit ^{238}U resources. Nevertheless, this requires the industrial development and worldwide deployment of reactors operating in fast neutron mode (e.g. FNR). However a significant share of the energy produced by such reactors is difficult to envisage at a world level before the end of this century, as we shall see in this article.

Introduction – Purpose of the article[1]

When we talk about the civil use of uranium, we are of course thinking of energy production, and particularly electricity production, which is the almost exclusive application of uranium in this sector. Currently, the fleet of reactors in operation worldwide is based on the fission of ^{235}U. This isotope of uranium represents 0.7% of natural uranium, while the remaining 99.3% is composed of ^{238}U, which is envisaged for energy use in the context of the deployment of future generation IV reactors, known as "fast neutron reactors" (or FNR), as opposed to current reactors which operate in a thermal neutron regime. The main advantage of FNR lies in the energy potential they would allow by exploiting ^{238}U, thus multiplying by a factor of about 100 the amount of energy produced, compared to the exploitation of ^{235}U alone.

In France, the lessons learned from the work carried out in the field of fast reactors are largely due to the feedback from the operation of the Phénix reactor, an industrial demonstrator with an electrical power of 250 MWe, connected to the grid between 1973 and 2010, and whose material balances made it possible to establish a rate of 239Pu overgeneration of 1.16. The practical implementation of fast reactors has thus been demonstrated in France on a pre-industrial scale. More recently, a French programme called ASTRID (FNR-Na reactor) was launched in 2010, one of the objectives of which was to resolve a problem of core instability in case of coolant loss. It was initially intended to lead to a pilot, but the decision was taken in the summer of 2019 to terminate the project.

Outside France, several prototypes or industrial pilots of the FNR type have been built in recent decades. Of particular note are the Russian BN600 and BN800 demonstrators, commissioned in April 1980 and June 2014 respectively, and still in operation. In addition, new generation IV reactors are currently under study in several countries, notably in China and Russia.

1 It should be noted, however, that some metals (e.g. alkali metals) are likely to react with air or water by releasing heat. However, they cannot be considered as a source of energy in the same way as uranium insofar as, in their case, we are in the field of chemical reactions, whereas in the case of uranium, it's nuclear reactions which are involved. The latter are, as we know, far more energetic than the former, where the energy spent on extracting and refining metals must be compensated for by the energy released by the heat-producing chemical reactions, which is hardly the case. Nevertheless, we have to notice that numbers of metals (e.g. copper, cobalt, boron, beryllium, etc.) play a crucial role in energy systems, whether they are renewable or nuclear in nature.

However, what has to be noticed is that after decades of research in seven countries (USA, UK, France among others), along with investments of some 100 billion dollars, the breeder concept didn't go beyond the preindustrial level. Therefore, the global deployment of FNR technology is still not in sight and will most likely not be effective at large scale before the end of this century, as explained below. During this transition period, nuclear electricity production will thus again rely mainly on ^{235}U, and the question of the availability of natural uranium by 2100 is therefore raised.

So, after recalling some available figures on the world's uranium resources, and providing some details on the main techniques for exploiting uranium deposits, this article will analyse the geological factors likely to limit the associated energy yield rates, as well as the expected consequences, for this century, in terms of limiting greenhouse gas emissions. Finally, some considerations on the prospects for the deployment of FNR technology in France, and on a global scale will also be presented.

It should also be noted that this article only deals with physical limits on a global scale, without taking into account the geostrategic stakes of the main countries for access to mineral resources.

About recoverable uranium resources

In terms of natural uranium resources, while the baseline data used in this article is not the most recent, having been established by the IAEA, OECD and NEA in 2008 [22], this has relatively little impact here as the objective of the article is not to establish precisely the current state of uranium resources, but, as said in the introduction, it is more on the limiting factors of its production in the foreseeable future. Nevertheless, the total amount of uranium represented by this diagram, which is 5.469 Tg (1 teragram = 1 million metric tonnes), corresponding with the total resources (RAR + Inferred cost category up to 130 USD/kg U), is quite similar to the 2022 Red Book [23] figures which states 6.078 Tg, partly due to the fact that during the past decades no large new recoverable uranium deposits have been discovered as illustrated below (Figure 1).

Practically, the nuclear industry distinguishes sometimes two categories of uranium resources, based on economic considerations: conventional and unconventional resources. Conventional resources are deposits of the kind now being mined, and, when uranium can

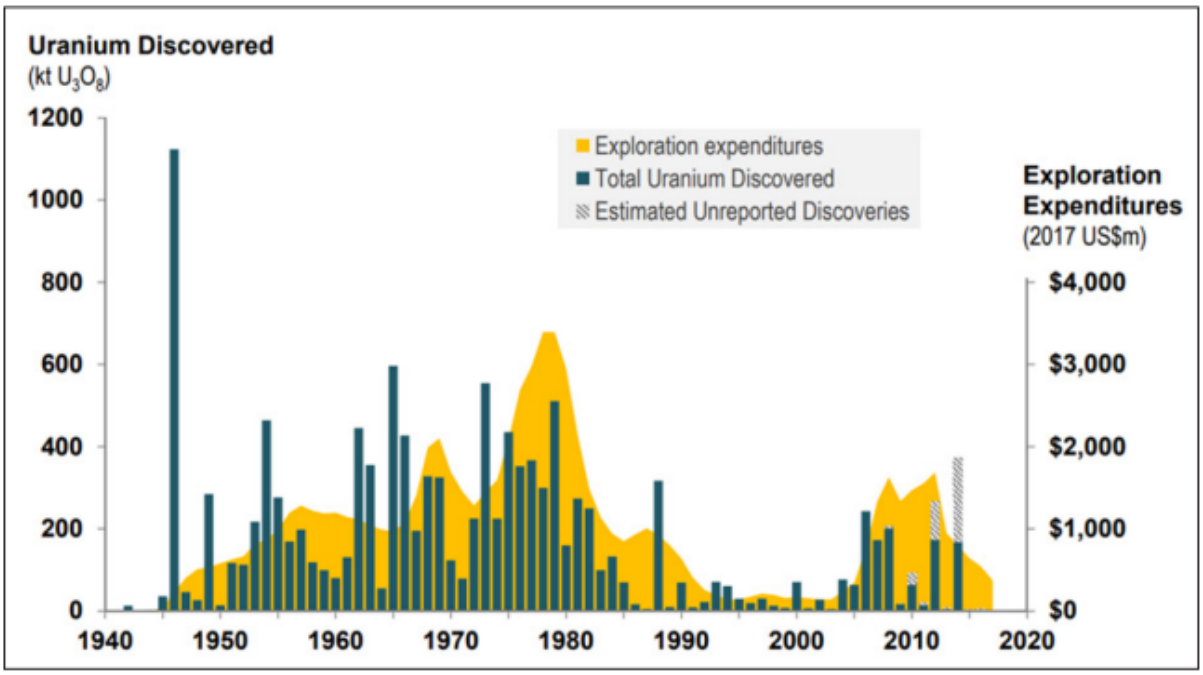


Figure 1. World exploration expenditures, versus uranium discovered (1940-2016).

be extracted in an economic way, the rock containing this uranium is called “ore” which is then an economic notion. As far as unconventional resources are concerned, they

- soft ores, easily mineable and millable, e.g. sandstones and calcretes, with typical grades ranging from more than 10% down to about 0.02% U3 O8 ;
- hard ores, hard to mine and mill, e.g. quartz pebble conglomerates, with grades varying typically from about 0.1% down to the mineralisation limit (see box here-after). Some high-grade vein-type ores are also hard to mill.

Main processing methods currently used

It should be noted that, in addition to the declared resources, the Red Book generally also mentions the processing method envisaged for their uranium extraction. These types of exploitation, of which there are three, are briefly as follows.

Open pit mining
This processing method involves extracting rock or minerals from an open pit. In this respect, it is important to take into account the thickness of the upper layers of waste rock in order to estimate the mining costs, and the economics of the project.

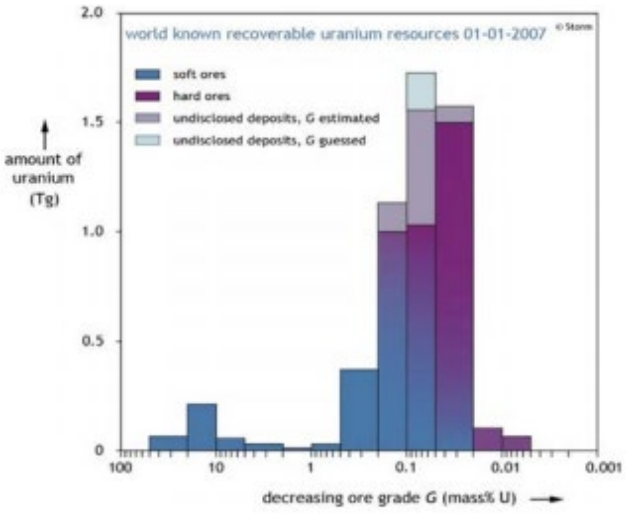


Figure 2. World known recoverable uranium resouces in 2007 (Source: Red Book 2008).

Underground mining
This is a processing method used when any ore body lies a considerable distance below the surface, and especially when the amount of waste that has to be removed in order to uncover the ore through surface mining becomes economically prohibitive.

In Situ Leaching (ISL)
This processing method, also known as in situ recovery (ISR) in North America, involves leaving the ore where it is in the ground, and recovering the minerals from it by dissolving them and pumping the pregnant solution to the surface where the minerals can be recovered.

In general, the extraction of any metal from its ore involves a number of physical transformations and chemical equilibria (Figure 4), all governed by basic physical and chemical laws, which cannot be circumvented by technology. In particular, from the Second Law of thermodynamics, it follows that separation never can be complete, and there always will be losses in the processes.

For this article, the reference uranium mine is the Ranger mine, an open pit mine that may be taken as a world-averaged mine.[2] Underground mining is generally more energy intensive than open pit mining. Differences in specific energy consumption and CO_2 emissions between individual uranium mines are substantial, due to widely varying conditions.

It should also be noted that mines applying the In Situ Leaching (ISL) method have, in some respects, a different flowsheet. Nevertheless, the specific energy consumption and accompanying CO_2 emission of ISL mines may be considered similar to those of open-pit mines, as large numbers of injection and production wells are to be drilled due to clogging, and as large volumes of leaching

2 The Ranger’s mine in Australia, is one of the cheapest operating mines in the world, due to its favourable conditions. The flowsheet presented in Figure 4, representative of Ranger mine’s one, is used as reference in this study. Many open-pit and underground uranium mines in the world operate according a similar flowsheet.

liquids are consumed. In addition, apart from energy consideration, the harmful impact of ISL on the environment can be high [40] and irreversible.

Extraction yield, as a function of the ore grade

Basically, the industrial processes to extract metal from the Earth's crust consume chemicals and energy, and emit CO_2 and other greenhouse gases. For energy, two factors contribute to the specific extraction energy: 1) the dilution factor, 1/G, where G is the grade of the ore, and 2) the extraction yield Y, also called the recovery factor, or recovery yield, which represents the ratio of the mass of metal actually extracted, over the mass of metal present in the treated amount of rock.

In case of an open pit mining, as it is of course for all the other technologies, losses occur at all stages of the extraction process, as illustrated in Figure 3. More specifically, as far as the leaching and subsequent solvent extraction phase, the lower the concentration of uranium in the liquor, the higher the entropy of the uranium and the less complete its separation from the liquor, which means the greater is the fraction lost in the waste streams. However, a low yield may always be improved by application, if any, of more selective separation processes, but at the expense of much higher specific energy requirements.

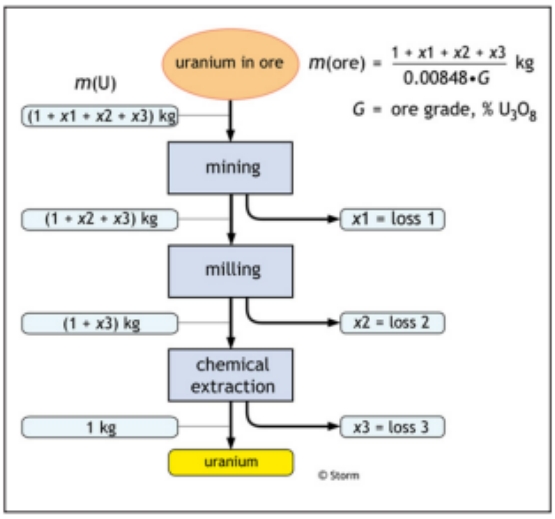


Figure 3. Losses in mining and milling processes in case of an open pit mine.

From the above considerations, it follows that it must exist a relationship between the uranium content of an ore and its recovery rate. In order to approach this relationship, a large number of data from current and past operations have been mobilised for this. This has led to the graph shown Figure 5.

The data used for this graph may seem perhaps outdated, but during the past 4-5 decades the extraction techniques applied in the uranium industry have not changed significantly. The study in [Mudd 2011] shows that the blue curve in Figure 5 can be considered as the upper limit of achievable extraction efficiencies with current extraction technologies.

The grey squares in this figure are also taken from the empirical data in [1], while the red points and bars, which are those used in this study, have been taken from references [2] to [15].

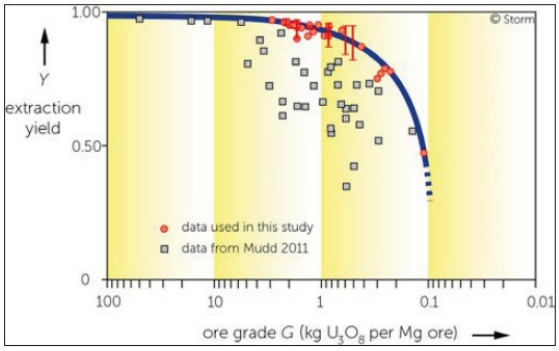


Figure 5. The extraction yield of uranium from ore as a function of the ore grade.

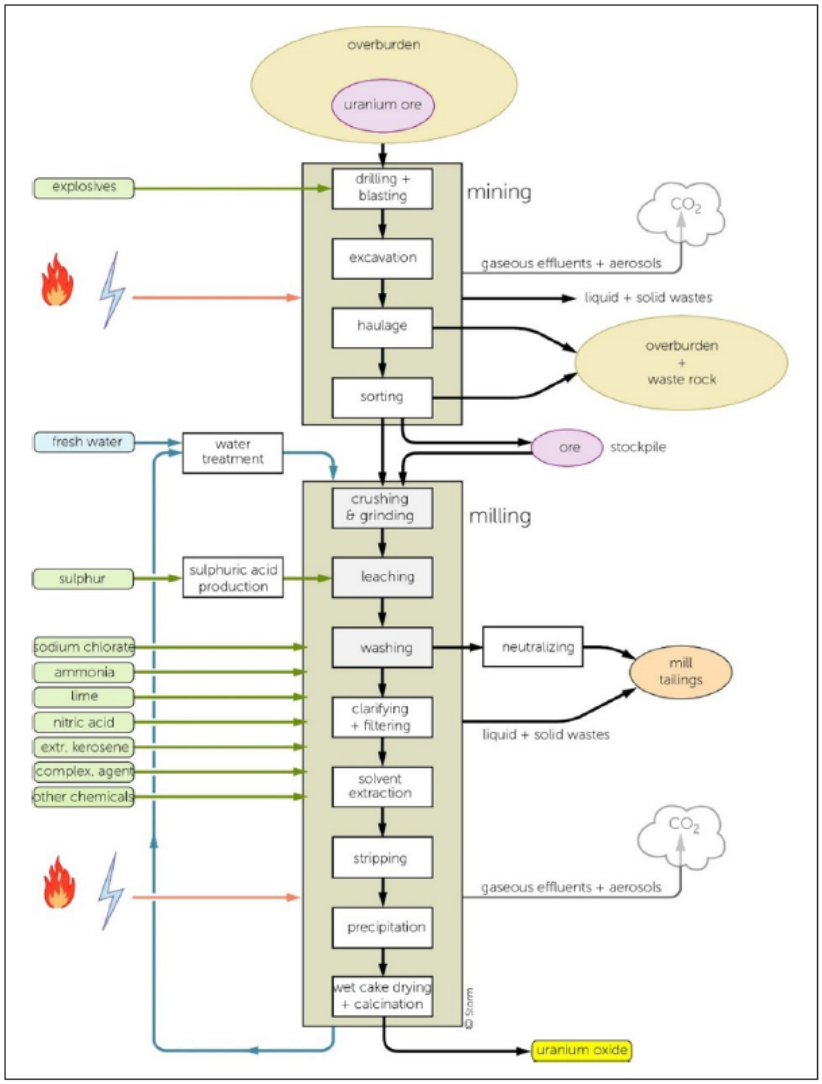


Figure 4. Process of mining and milling in case of an open pit mine.

About the mineralization limit

Mineralization limit is an important notion, quite unknown and very rarely mentioned. This is a notion that is not included, for instance, in the Red Book, even if the indications on the reserves of certain deposits sometimes mention a consideration of extraction yields, but with little consideration on energy expenditures.

For all natural elements, the mineralization limit corresponds to a content below which they cannot exist in mineral form, but are present in the form of separate grains of minerals, and dispersed at atomic scale among the other constituents of the rock. Concerning uranium, this limit corresponds roughly at grades below 0.01% U3O8. Hence, to extract uranium from rock types below the mineralisation limit, the whole rock has to be brought into solution. Conversely, if uranium is present as separate minerals, the lixiviation process starts with selectively dissolving the uranium minerals, and subsequently discarding the other minerals from the processed rocks.

To put it another way, in his book: “Extracted. How the Quest for Mineral Wealth is Plundering the Planet” [42], Ugo Bardy defines the mineralization barrier as the threshold below which the only way to extract an element is to work from the undifferentiated crust, what means a very important extra energetical cost, compared with an extraction from ore.

quantity	unit	soft ores	hard ores
total thermal energy investment mining	GJ/Mg ore	1.237	1.843
total thermal energy investment milling	GJ/Mg ore	1.508	8.67
total thermal energy investment mining + milling	GJ/Mg ore	2.745	10.51
CO_2 emission mining + milling	kg CO_2/Mg ore	206	788

Table 1. Summary of specific energy investment and CO_2 emission of uranium mining + milling at mines with average overburden ratio and hauling distance.

Energy consumption and CO_2 emission of the recovery of uranium

Along with the above definitions, it follows that the specific energy consumption increases exponentially with decreasing ore grade G, and with extraction yield Y. More precisely, the thermal energy requirements of the recovery of one kilogram of uranium leaving the mill, Jm+m(U), as function of the ore grade G, counted in kg uranium per Mg ore, and the recovery yield Y, can be calculated via the following equation:

$$J_{m+m}(U) = \frac{J_{m+m}(ore)}{Y \cdot G}$$

$J_{m+m}(U)$ = specific energy consumption, GJ/kg uranium
$J_{m+m}(ore)$ = specific energy consumption, GJ/Mg ore
Y = extraction yield = fraction of recovered U
G = ore grade, kg U/Mg ore

However, it should be noted here that the specific energy consumption calculated in with this equation excludes the embodied energy of the used chemicals, namely the energy needed to fabricate the chemicals.

As far as the CO_2 emission attached with the mining and milling of the ore, it can be simply derived from the energy Jm+m(ore) in considering that the electricity consumed at uranium mines is generally generated by oil-fuelled generators.[4] This way, all energy inputs of mining and milling may be considered to be provided by fossil fuels.

3 For further details see: https://www.stormsmith.nl/index.html

Moreover, it will be here assumed a thermal-to-electric conversion efficiency of 40% to calculate the all-thermal energy input of mining and milling. Hence, assuming the specific CO_2 emission of the used fossil fuels (diesel oil and fuel oil) is 75 gCO2/MJ, the specific CO_2 emission can be calculated by the following equation:

$$\gamma_{m+m}(U) = 75 \cdot \frac{J_{m+m}(\Sigma th.ore)}{Y \cdot G}$$

$\gamma_{m+m}(U)$ = specific CO_2 emission, kg CO_2 /kg uranium
$J_{m+m}(\Sigma th.ore)$ = specific all-thermal energy consumption, GJ/Mg ore
Y = extraction yield = fraction of recovered U
G = ore grade, kg U/Mg ore

Considering the great diversity of uranium mining conditions around the world (type of deposit, type of operation, logistical chains, access to water and energy, overburden ratios, hauling distances, etc.), the choice made for this article was limited to taking into account an "average" operation, as illustrated by the choice of the Ranger mine taken as a reference. The only distinction made here is that between "soft" and "hard" ores. This has led to the following figures (Table 1) being used for our purpose.

Finally, taking into account all these hypotheses and data, two graphs can be derived which illustrate: 1) the energy consumption related to the recovery of uranium (mining and milling), as function of the ore grade (Figure 6); and 2) the CO_2 emissions related to the recovery of uranium (mining and milling), again as function of the ore grade (Figure 7).

4 In recent years, however, we have seen the gradual introduction of battery-powered construction vehicles. However, there is still a lot to be done in this area, especially as for many mining sites, especially those far from electrical infrastructure, the question of electricity production is difficult to resolve without recourse to fossil resources.

Concerning energy, Figure 6 shows a blue band representing the grades of deposits currently in production around the world. Obviously, because the richest ores are mined first, for these offer the highest return of investments for the mining companies, the remaining resources will contain deposits with lower uranium grades, and the average uranium content of available uranium resources will then decrease with time.

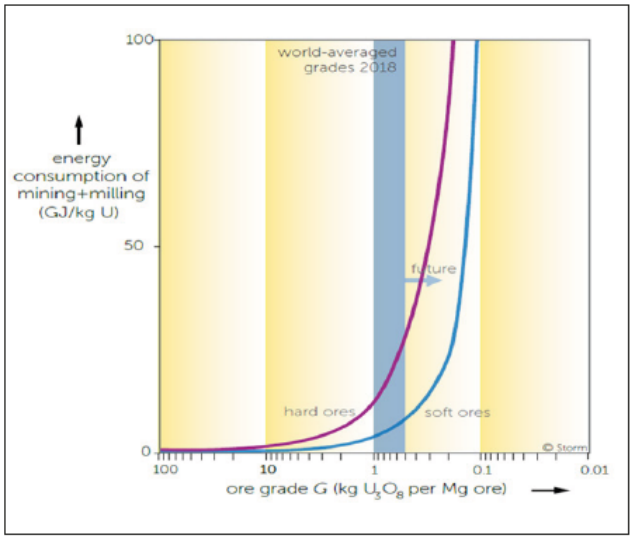


Figure 6. Energy consumption of the recovery of uranium from the earth's crust (mining + milling) as function of the ore grade.

Toward the Energy cliff…

With regard to the energy balance of uranium extracted from ore, there is a threshold below which no net energy production from an uranium deposit is possible. In other words, by falling below this threshold, an uranium ore could no longer be considered as an energy source, because the extraction of, say, one kg of natural uranium would consume more energy (noted "Einvested" hereafter, and which is limited here to the energy expended in the extraction processes alone than the energy (noted "Ereturned" hereafter) than that can be generated from one kg of natural uranium.

This can be illustrated by what is called the Energy Returned Over energy Invested[5] (or EROI, see article from J. Treiner and G. Bonhomme for details). In its basic expression, it is defined as follows:

EROI = Ereturned / Einvested

from which we can easily derive the net energy produced in the extraction process, namely:

Enet = Einvested *(EROI – 1)

So, as to have a net energy positive, EROI must be superior to one, this critical value corresponding to the threshold mentioned above. This conducts to the notion called the "energy cliff", as represented Figure 8, based on ^{235}U technologies, and where the net energy production of nuclear power will fall to zero.

It can therefore be seen that, for U3O8 contents below 100 ppm, and considering the

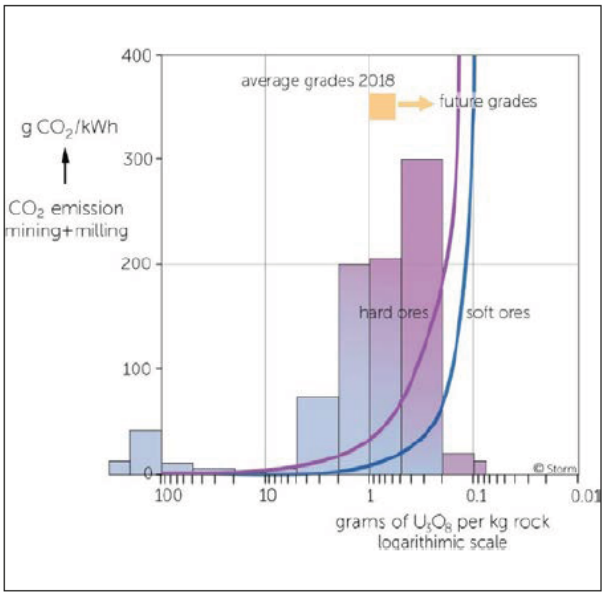


Figure 7. CO_2 emissions of the recovery of uranium from the earth's crust (mining + milling) as function of the ore grade.

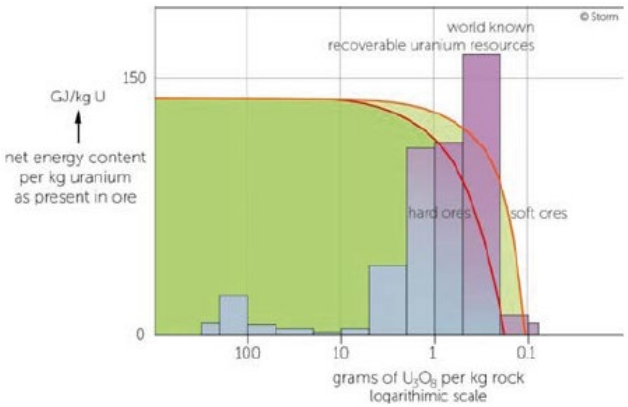


Figure 8. Energy cliff: Net energy content of natural uranium obtained from ^{235}U, and as function of the ore grade.

most favourable case of soft ores, the net energy derived from uranium ore mining takes on negative values. It should also be noted that the variation in net energy, described as a function of the content in grams of U3O8 per kilo obtained from the uranium deposit, is simply the result of a comparison between the data presented in Figure 6, and the energical potential of one kilo of uranium, based solely on the exploitation of ^{235}U.

Moreover, given the presence of a mineralogical barrier below the 100 ppm limit (see box above), the energy used in the uranium extraction process is bound to increase sharply, leading to a sharp deterioration in the energy balance. This is illustrated Figure 9 below where this energy expenditure is then multiplied by a factor of around 100.

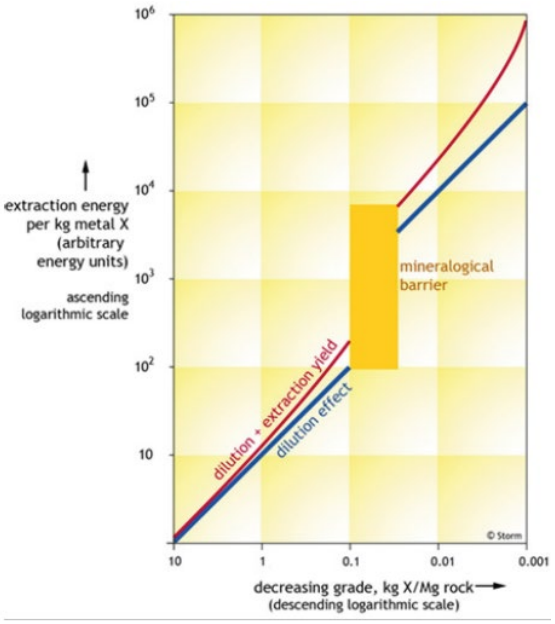
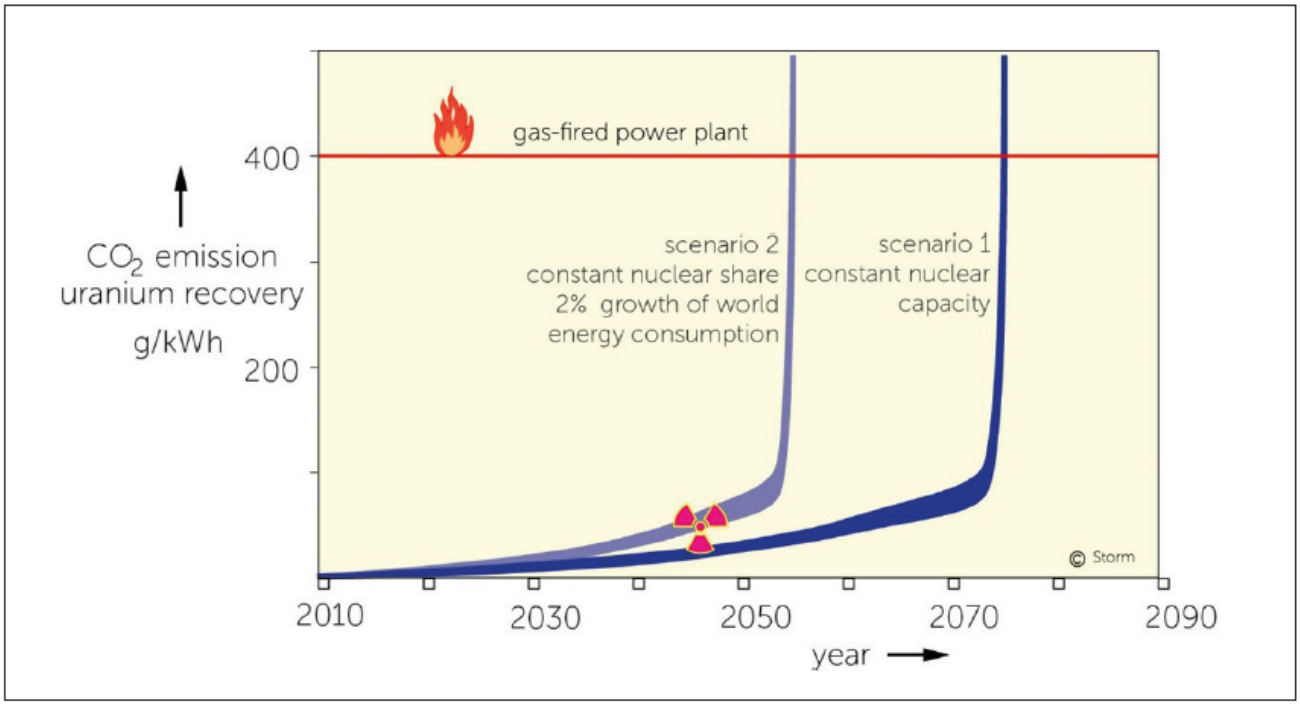


Figure 9. Mineralogical barrier and specific extraction energy of a scarce metal X from the earth's crust.

…and toward the CO_2 trap

As highlighted above, the world average available ore grade of uranium decreases with time. As a result, the specific CO_2 emission of uranium recovery, and consequently of nuclear generated electricity, rises with time, and steeply at low grades. To put it more precisely, Figure 7 shows that at a grade of 130-100 gU/Mg ore, and based on ^{235}U technologies, the specific CO_2 emission of nuclear recovery surpasses that of gas-fired electricity generation, which is of the order of 400 gCO2/kWh: this is called the CO_2 trap.



5 As pointed out above, it should be borne in mind that the energy ratios presented here do not include the energy consumption further down the energy production cycle.

To put these figures into perspective, and assuming that the world nuclear capacity remains at the current level, at about 370 GWe,[6] the specific CO_2 emission of nuclear recovery will grow to values of gas fired power plant within the lifetime of new nuclear build. This is what is illustrated as scenario 1 in Figure 10 below. If, instead of scenario 1, we consider a scenario 2 assuming a constant growth of 2% in the share of nuclear power in world electricity consumption, CO_2 emissions of nuclear recovery will surpass those of gas fired plants about twenty years sooner than in scenario 1, as shown in Figure 10.

About the transition of the French nuclear fleet: from PWR to FNR

As mentioned above, the deployment of reactors based on fast neutron technologies will hardly be possible before the end of this century, as illustrated in Figure 11 for the French nuclear fleet. This roadmap shows one of the scenarios for the deployment of these reactors which was envisaged for the French fleet in the framework of the ASTRID project. It has been defined just before the abandonment of this project, what has thus postponed the date of deployment of such a reactor fleet.

In any case, it can be seen that, although France has the necessary tools for the reprocessing of fuels, as well as for the manufacture of MOX fuels, the deployment of FNR-type reactors is anything but immediate. This is even more true on a global scale, especially since a rapid deployment of FNRs would require a sufficient quantity of 239Pu, of the order of 18 tonnes of Pu per initialized GW, which represents the Pu

Figure 10. CO_2 emissions in a constant share scenario, and in a constant capacity scenario, both based on ^{235}U technologies.

inventory over the entire cycle.7 As an example, France currently has around 360 tonnes of mobilizable Pu, i.e. potentially the possibility of initializing around twenty GW of FNRs.

Conclusions

The main lesson of this article concerns the occurrence, by 2100, of a degradation of the

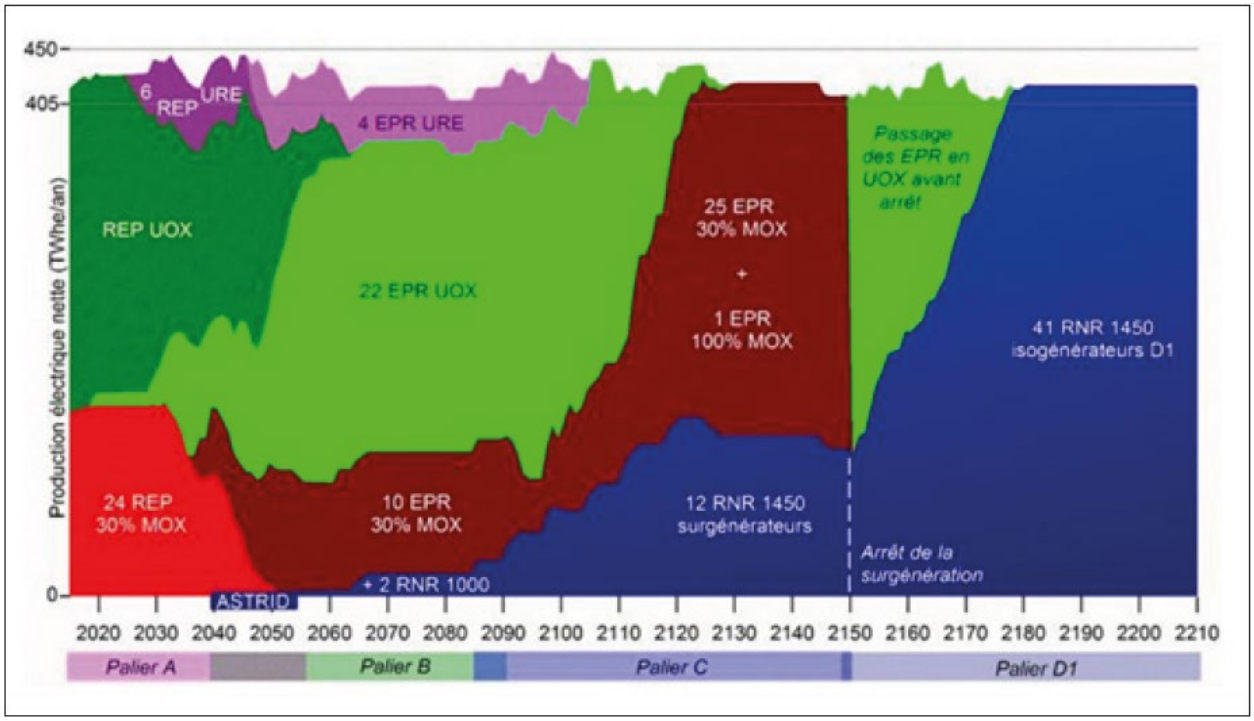


Figure 11. Scenario for the development of the French nuclear fleet leading to a 100% FNR fleet (Source: CEA/DEN/DISN/ACF, 25/10/2018).

6 World nuclear capacity in 2021 (Source: WNA, "*World nuclear performance, 2022*" [28]).

7 Instead of using 239Pu for initialize a FNR, it is also possible to use ^{235}U enriched to about 30%, but this would require sufficient enrichment capacity, and would put further pressure on ^{235}U availability

energy ratios (EROI) attached to the exploitation and use of ^{235}U. If, as pointed out in the article, the data used in this article certainly need updating, this does not detract from the facts that:

- uranium is a metal that has to be extracted from the Earth's crust, whose geological occurrence couldn't suffice to make it self-evidently an energy resource;
- the amount of extraction energy per kg of uranium increases exponentially with decreasing ore grade, so as to lead toward a negative net energy, what has been labelled "energy cliff";
- the same holds true for the coupled CO_2 emission which will finally reach and go through values of natural gas fuelled power plant, what has been labelled "CO_2 trap".

One solution to this problem would be to turn to the use of ^{238}U by the fateful deadline of 2100, but, as mentioned above, this requires taking FNR technology beyond a pre-industrial stage, and thus into the commercial phase, which is still not in sight. However, it is only when FNR technology is deployed that it would be possible to solve both the nuclear energy constraint and the one attached to CO_2 emissions. As we have seen, these constraints are largely attributable to the mining and milling of natural uranium. Thus with the use of ^{238}U, which is already available in the form of hundreds of thousands of tonnes of depleted uranium, these constraints would disappear, with the prospect of energy autonomy over several thousand years and, as the icing on the cake, virtually zero CO_2 emissions per kWh.

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More details on the subjects addressed in this article can be found in the following reports on: www.stormsmith.nl [reports]:
m01 Uranium-Plutonium breeder systems
m20 Reprocessing of spent fuel
m24 Thorium for fission power
m26 Uranium mining + milling
m27 Unconventional uranium resources
m28 Uranium from seawater
m29 Uranium for energy resources
m35 Energy cliff and CO_2 trap
m44 Process analysis of the Ranger mine

Diversion from urgent climate action: How the European nuclear lobby undermines the EU's energy future - Part 1: The Netherlands

1. Introduction

This WISE report gives, with research support from the Transnational Institute (TNI), an overview of the role of the Dutch and European nuclear lobby in slowing down urgent climate action.

Nuclear energy is an industry in decline.[1] But if one looks at the whirlwind of debate in the Brussels EU bubble or in the Dutch media, one gets a completely different picture. In the Netherlands, nuclear appears to be back with a vengeance. Until recently, there was hardly any public or political attention paid to nuclear power. Not in the energy debate, which was overshadowed by the earthquakes in the North of the country due to gas extraction. Not in the climate debate, which focused on the low position of the Netherlands in the European climate policy rankings. And not in the industry debate, which was overshadowed by the threat made by Shell to pull out of the country if it could not hold on to its tax advantages. Then, in 2018, one late evening satirical television news show, Zondag met Lubach[2], changed all of that. With 19 minutes of positive spin, nuclear energy was no longer a taboo. The usual political suspects picked up the issue immediately – the conservative liberal party VVD passed a motion in parliament the day after the TV show.[3] It received support from the Christian democratic CDA and from the far right. In the months that followed, Dutch social media were brimming with support for nuclear energy. Progressive liberal newcomer party VOLT picked up the issue in its 2021 election programme.[4] Especially, the support among the younger generation, which had not experienced Chernobyl and for whom Fukushima was something from their childhood or teenage years, increased sharply.[5] What prompted this sudden surge of support for nuclear energy?

Meanwhile in Brussels, several actors noticed that attention for the nuclear disaster in Fukushima, expressed in the call for, and implementation of, the European post-Fukushima nuclear stress tests, was slowly fading. This presented a new opportunity for lobby groups to push nuclear energy as an integral part of climate policy. Nuclear lobby organisations, such as Foratom (now nucleareurope[6]) and the WNA (World Nuclear Association) – as well as a host of astroturf[7] groups around them – focused on the opportunity to have nuclear energy taken up in the Taxonomy for Sustainable Finance, a piece of key-legislation from the EU to motivate the financial sector to move capital to the green transition. The push was turned into motion by traditionally pro-nuclear countries like France, Finland, the Czech Republic and Hungary, with support from the nuclear industry giants Rosatom, Westinghouse and EdF, as well as new Members of the European Parliament (MEPs) that had been voted in in the 2019 elections. Fresh blood seemed to pulse around in the nuclear debate and the European Commission caved in late 2021 by including nuclear in a delegated act under the Taxonomy Regulation.[8]

The Russian invasion of Ukraine, in February 2022, did not diminish the support for nuclear in the Brussels bubble. Initially, there was widespread fear for the fate of the Chernobyl

site during its occupation by Russian troops, and next the Zaporizhzhia nuclear power station, where shelling, occupation, regular loss of off-site power and immense pressure on staff created a sincere and lasting threat of a potential new nuclear catastrophe.[9] Nevertheless, voices calling for learning lessons from this situation, namely a malevolent attack on nuclear installations during war time, were a small minority. The energy crisis resulting from the Kremlin aggression continued to fuel the call for more nuclear in the EU. Forced by fears over security of supply, even anti-nuclear Germany decided to stretch the operation of its last three nuclear power stations for three and a half months past their initial shut-down date. In Sweden, a new right-wing government restarted preparations for new nuclear power stations. Poland pushed forward with agreements for new nuclear. Romania determined a site for small modular reactors. Not even ongoing problems with the newbuild European Pressurised Reactors (EPR) in Olkiluoto in Finland and Flamanville in France, nor the fact that half of the French nuclear fleet was unavailable during a large part of 2022, slowed down these developments.

In the meantime, we see that this nuclear lobby has a direct influence on the speed with which urgent climate action is taken. Our case study of the Netherlands shows how regional energy strategies are delayed because of discussions about nuclear projects that – simply because of unsuitable geography – will never deliver. We see that EUR 5 billion of the government's EUR 35-billion climate fund will not be spent on measures to reduce greenhouse gas emissions, but on facilitating the construction of new nuclear power stations.[10] For this project, there is not even a hint of how construction can be financed. If they ever come on-line, that will be between 2035 and 2040 at the earliest, enabling further use of fossil fuels for many years, and replacing already cheaper and faster delivering low-carbon sources like wind and solar. At the European level, we see the Regulation for a Taxonomy for Sustainable Financing undermined by greenwashing in the form of inclusion of nuclear and gas – leading to a lower level of credibility, which hampers its function of speeding up the energy transition. Discussions about the (niche) use of hydrogen are derailed by proposals to include nuclear into the definition of green hydrogen, and under pressure from the nuclear lobby, the European Commission is looking at ways of enabling increasing sums of money to flow to nuclear projects.

Practically spoken, if all 20 plans, including those that are still quite vague, for new nuclear power stations in the EU are successfully implemented by 2040, given that around 78 of the current 99 nuclear power stations in the EU will have closed down, nuclear will only deliver around 9% of the electricity in that year. This is down from 24% now. Without these new nuclear projects, the nuclear share will decrease to 4.5% of the electricity production. Within the overall energy transition, these numbers are marginal. In order to get this extra 4.5% power from new nuclear projects in 2040, we run the risk that a substantial part of the remaining 91% will not be delivered by low-carbon sources, but still by fossil fuels, severely delaying the urgent climate action we owe to the next generations.
Where did the sudden resurrection of the nuclear sector come from, only a decade after Fukushima?

This report will try to shed some light on the networks behind these developments, and their strategies.

Research questions

- Who are the main actors that pushed nuclear power into the Dutch political debate? What are their interests? Which strategic lines have they set out?
- Who are the main actors that brought nuclear to the forefront of the European Taxonomy debate? What are their interests? Which strategic lines have they set out?
- Is there a European renaissance of the nuclear debate?
- What are the push factors and how do they relate to each other?
- Nuclear lobbying appears to divert attention and capital from urgent

climate action. Which threats and opportunities appear from the used strategies, so that ways can be found to remove this nuclear diversion from the current climate debate?

2. Nuclear lobby in the Netherlands

The Netherlands has been chosen as a case study because the developments in the Netherlands can be seen as a (maybe somewhat exaggerated) model for dynamics also recognisable in other European countries, such as the UK, Finland, Sweden, Belgium, Germany and, to a lesser degree, the Czech Republic, Poland, Italy and Estonia. For two decades, the public debate on nuclear energy in the Netherlands had been on a low level and support and opposition roughly balanced each other out. Powerful actors based in the nuclear industry and nuclear research institutes had, for a long time, been eager to turn the tables on how nuclear energy was perceived in the country, but did not manage to make waves. In came another new group of actors, that wanted to offer an alternative to the "old style" environmental movement, taking inspiration from the Finland and US- born movement of ecomodernists. And with the use of confrontational media and social media communication, they knew to draw attention to themselves. The Dutch nuclear debate turned from non-existent into one of the central political focal points in the climate discussion after one TV show in November 2018. And it has not stopped since.

The run-up to Zondag met Lubach – the Lubach broadcast

Sunday evening 4 November 2018 was a turning point in the nuclear debate in the Netherlands. There were no new developments, no nuclear accidents, no new technologies. Just a satirical news programme on television. During a 19-minute item, host Arjen Lubach[11] posed the claim that there was a taboo to talking about nuclear energy within the framework of climate change, and that problems with nuclear power are overstated. Renewable energy sources, he continued, are not able to deliver. The segment contained factual mistakes and disinformation about the effects of Fukushima and Chernobyl, nuclear technology, the state of the nuclear industry, radioactive waste, reports of the International Panel on Climate Change (IPCC), renewable energy sources and developments in the energy sector[12] Nuclear power criticism was characterised as merely emotional.

Lubach's programme is wildly popular, especially among young people. The broadcast reached 856,000 direct views,[13] which is a very high number in the Netherlands. The YouTube version has been watched, as of March 2023, 2,844,068 times.[14]

The question, then, is why this progressive satirical programme decided to table nuclear power as a taboo that needs to be broken?

Michael Shellenberger

Being pro-nuclear has been an effective way to draw attention to oneself, especially if this position is adopted by someone with green credentials. We have seen this with people like James Lovelock, Mark Lynas and George Monbiot in the UK. Over three decades, industry (including nuclear) lobbyist Patrick Moore positioned himself as a 'former Greenpeace founder' (which he wasn't) who has seen the light.[15] Another personality who built a profile on such a claimed "turn-around" is the US author and publicist Michael Shellenberger. He inspired people like nuclear promoter Kirsty Gogan (UK – see below concerning lobbying in the EU) and prolific pro-nuclear tweeter Zion Lights (US). Shellenberger first gained attention in the US as a climate activist. He co-founded the climate think tank the Breakthrough Institute. After internal problems, he founded the organisation Environmental Progress. With Breakthrough Institute and Environmental Progress, he pushed the ideal of technical progress tackling environmental and climate problems. He built upon a new stream of thinking that emerged from Finland: ecomodernism. From the mid-2010s, Shellenberger started networking with ecomodernists all over the world, was co-author of the Ecomodernist Manifesto[16] and made the propagation of nuclear energy the core of his message. He campaigned in Korea and Taiwan to overturn anti-nuclear policies in those countries and was instrumental in

developing the 'nuclear pride' movement in Europe.
Shellenberger appeared on 31 August 2018 at the DEPTH festival in Amsterdam as a known TEDx speaker. After this, in September 2018, he organised a workshop in Amsterdam to prepare for the first 'Nuclear Pride Fest' in Munich, scheduled for 21 October 2018 by the German pro-nuclear group Nuklearia. On 22 October, Shellenberger spoke at an event at renowned debate centre Pakhuis de Zwijger in Amsterdam. He was joined on stage by nuclear proponent Professor Jan-Leen Kloosterman, from the technical university Delft Reactor Institute, for a discussion on nuclear energy. The Amsterdam workshop was co-organised by people around the emerging Dutch ecomodernist movement, which included, among others, energy engineer Joris van Dorp, Olguita Oudendijk (later director of RePlanet Netherlands), Gijs Zwartsenberg (self-proclaimed energy philosopher, communication expert, chair of the Thorium MSR Foundation and secretary of e-Lise) and journalist Marco Visscher.[17]

Shellenberger described part of his Dutch adventures in a long Twitter thread.[18]

Sometime in mid-2018, Shellenberger was introduced to the editorial team of Lubach. After consultation with, among others, the environmental organisation WISE, the TV team decided not to pursue the issue, but a second contact appears to have changed that point of view[19]. Given the nature of the content in the TV segment, it is likely that the Lubach team has then worked closely with Shellenberger allies like van Dorp, Visscher, Oudendijk and/or Gijs Zwartsenberg, who were also at Shellenberger's workshop. Environmental organisations with opposing views, like WISE, were not further consulted in the run-up to the broadcasted item on 4 November.

A day after Lubach's TV programme was aired, the parliament leader of the conservative VVD party, Klaas Dijkhoff, appeared in the evening news talk show Nieuwsuur, airing plans for new nuclear power stations. This seems like a

Stichting SEK
Board
(former) industry people:
- George Verberg (chair)
- André Versteegh
- Lars Roobol (TSO RIVM head of radiation safety)
- Jacques de Jong (former head of the Energy Department of the Ministry of Economy)
- Tjardus van Citters (former lawyer at Roland Berger)

political party related people:
- Floriske Deutman (secretary – D66 Energy and Climate commission secretary)

Advisors
Industry people:
- Ad Louter (URENCO and former Borssele CEO)
- Carlo Wolters (Borssele CEO)
- Frank Verhagen (PZEM CEO)
- Allard Castelein (Port of Rotterdam CEO)
- Arnoud van de Slot (lawyer at Roland Berger)

Political scene:
- Maria van der Hoeven (CDA – former minister)
- Hans Alders (PvdA – former minister)
- Johan Remkes (VVD – former minister and vice premier)
- Hans Weijers (D66 – former minister)
- Alexander Rinnooy Kan (D66 – former senator, VNO-NCW)
- Marc Calon (PvdA – former provincial deputy)

Academia
- Tim van der Hagen (TU Delft, Rector Magnificus)
- David Smeulders (TU Eindhoven)
- Simon Friedrich (University Groningen, Science Philosophy)

strange coincidence, but may be less so given the close relationship that Shellenberger appears to have with VVD energy speaker in parliament, Dilan Yesilgöz-Zegerius, in the following months.

The industrial lobby

The pro-nuclear lobby within the energy industry and nuclear energy–related academia has, in the Netherlands, traditionally focused on direct influence on the pro-nuclear political parties (e.g. VVD and CDA, and to a lesser extent the social democrat PvdA) and on the key ministries of Economy, Finance and Education. The public debate was often seen as being too risky.

In reaction to the Chernobyl catastrophe, the Dutch parliament voted in 1994 for the closure of the Borssele nuclear power station at the end of 2003,[20] a decision accepted by the government of CDA, PvdA and VVD. The nuclear industry in the Netherlands then focused first on breaking this de facto nuclear phase-out decision. Political lobbying managed to extend the operation time of Borssele to 2013. Their breakthrough chance came when the Borssele nuclear power plant was privatised and handed over to the utilities Delta and Essent. The new owners brokered a gentlemen's agreement with the government, under threat of legal action for compensation for 'lost profits', to have the lifetime of Borssele extended to its 60th anniversary in 2033.

In return, they accepted that 2033 would be a hard legal closure date, whereas the operational license of Borssele would remain open-ended. In the meantime, there was a successful lobby, largely outside the public view, to expand nuclear energy, which was halted abruptly by the occurrence of the Fukushima nuclear catastrophe in March 2011. Since then, the nuclear industry and nuclear-related academia remained more or less silent, awaiting new chances. Some voices brought up the issue of nuclear power within the climate discussion, but they received little attention, creating the basis for Lubach's TV show claim in 2018 that nuclear energy had become a taboo subject. When his broadcast broke that taboo, the industry lobby immediately jumped on the band wagon and intensified its contacts with parliamentarian parties that showed a renewed interest, especially VVD, CDA and progressive liberals D66.

The industrial lobby in the Netherlands is made up of the current management from nuclear companies, of retired nuclear managers, workers, policy people and researchers and academics from the field of nuclear science and the social sciences.

On the nuclear managers side, we find people like Carlo Wolters, CEO of Borssele operator EPZ, Ewout Verhoef, CEO of nuclear waste management facility COVRA and Ad Louter, CEO of uranium enrichment company Urenco Netherlands and former director of EPZ.

Among the group of retirees, recurring names are Georg Verberg (former Ministry of Education and Science, Ministry of Economy, CEO of the Gasunie, and Commissioner with Urenco and ECN in Petten) and André Versteegh (former ECN, NRG, Borssele Benchmark Commission). The group of nuclear physicists come mainly from the Technical University in Delft, that works on nuclear issues, like Professor Jan-Leen Kloosterman and the head of the Department of Radiation Protection at the Dutch technical support organisation RIVM Lars Roobol. On the social science side we find people from the universities of Utrecht, Groningen, Leiden and Delft, who are pushing for nuclear extension during fora, conferences, on social media and sporadically on TV or radio talk shows. They work closely with business lobby organisations like the VNO-NCW.

The industry itself is organised via the Netherlands Nuclear Society,[21] the Dutch branch of the nuclear lobby group European Nuclear Society,[22] which brings together researchers, scientists and consultants from the nuclear sector. The society functions like a traditional lobby organisation, with a wide network in the industry and contacts to politicians in The Hague. It is not very visible in the public debate, and does not have an inviting website or high presence on social media, but it is able to function as a central spider in the web of lobbying contacts.

The more visible branch of the nuclear industry lobby is the Initiative Group Nuclear Energy (Initiatiefgroep Kernenergie), which was, in August 2020, renamed to the Foundation for Energy Transition and Nuclear Energy (Stichting Energietransitie en Kernenergie[23] – SEK). On its board, we find former industry people and actors from the political scene. Among its advisors, we find people with a top-level political background, industry background (including the directors of all main nuclear operators) and nuclear-oriented academics.

Ecomodernists and RePlanet in the Netherlands

Around the time of the Lubach broadcast in 2018, the public debate was mostly initiated over social media by ecomodernists. The Dutch ecomodernists initially consisted of a loose grouping around journalists like Marco Visscher, Ralf Bodelier, Hidde Boersma and climate sceptic Marcel Crok, who together published the book Ecomodernism – the new thinking on green and growth in 2017,[24] based on the ecomodernist movement as it was developing in Finland and the US. In early 2018, Visscher, Boersma and the earlier mentioned process moderator Olguita Oudendijk registered the Ecomodernism Foundation (Stichting Ecomodernisme)[25] as a platform for belief in growth, technology and progress. The foundation finds its ideological roots in Michael Shellenberger and Ted Nordhaus's The Death of Environmentalism[26] from 2004 and refers specifically to British climate blogger Mark Lynas and pro-GMO (Genetically Modified Organisms) and pro-nuclear writer Steward Brand.

From the start, the Dutch ecomodernists' strategy has been:

- positioning themselves – following Shellenberger – as environmentalists or former environmental activists;
- attacking the environmental movement as part of the establishment, outdated and anti-technology;
- promoting technopositivism, namely supporting nuclear energy, GMOs, industrial farming and urbanisation as tools to tackle today's environmental crises;
- putting an emphasis on climate change, and that all options to lower emissions need to be considered, including that nuclear power should be embraced as solution.

As described earlier, in September 2018, the ecomodernist group organised a workshop with Michael Shellenberger for European ecomodernists in Amsterdam. One of the new members of the group, Joris van Dorp, co-organised this event. He is a general energy engineer from the TU Delft and one of the most outspoken and aggressive voices of the ecomodernists on Twitter.[27] The workshop was also joined by Gijs Zwartsenberg, a communication advisor, and André Wakker, a former employee of nuclear consultancy NRG and nuclear research centre ECN.

In December 2021, the Ecomodernist Foundation changed its name to RePlanet Nederland – following the European agreement among Ecomodernists to use one brand, while keeping its initial Policy Plan[28] from the Ecomodernism Foundation.

Following Shellenberger's workshop in 2018 and Lubach's broadcast, the ecomodernists joined the first Climate March in Amsterdam in March 2019 with a small contingent of around a dozen pro-nuclear demonstrators. The group remained largely unnoticed. In 2021, the Climate March organisers had explicitly asked the group not to participate, because the pro-nuclear point of view ran against the organisation's vision. It notified the police that it considered the small ecomodernist crew, with music and people dressed in blown-up polar bear suits, as a counter demonstration.[29] The group of, again, around a dozen people simply participated in the march anyway, and caused a bit of controversy by announcing hostility against them from a few other demonstrators to the Telegraaf daily[30] The group did not report the incident to the police. For the 2022 Climate March in Rotterdam, RePlanet announced participation as a 'block'. The organisers rejected this, but did not bar participation. The

group again received little to no attention. In their own report, RePlanet included a photoshopped picture where anti-nuclear WISE participants were turned into RePlanet activists. They restated their position that they stand opposite the mainstream environmental movement, which, in their view, wants less of everything in order to tackle climate change, whereas RePlanet pleads for continued growth on the basis of nuclear power.[31]

Their participation in the Climate March was not under the RePlanet brand, but used kernvoorklimaat.nl (nuclear for climate), an umbrella brand under which they also host the 'nuclear pride coalition', and under which they co-operate with the Nuclear Alliance (Atoomalliantie), an energy provider of nuclear-certified electricity, the Foundation for Energy Transition and Nuclear Energy and the pro-nuclear think-tank e-Lise (which has RePlanet's Olguita Oudendijk and Joris van Dorp as advisors, and Gerrit Zwartsenberg as secretary).

RePlanet also issues a newsletter for kernvoorklimaat.nl.

The newly branded RePlanet brought together the different ecomodernist movements in Europe. RePlanet Netherlands also hosts the European office and its director Olguita Oudendijk is responsible for EU relations for both RePlanet Europe and RePlanet Netherlands.

RePlanet Netherlands received, in 2021 still as Stichting Ecomodernisme, a grant of EUR 900,000 from the foundation of the electronic financial market operator Quadrature.[32]

Political parties

In 2018, at the time of his workshop in Amsterdam and his contacts with the Lubach TV team, Shellenberger also seems to have had contact with Dilan Yeşilgöz-Zegerius, a fast-upcoming VVD politician and energy spokesperson for that party in the Dutch Parliament. Such contacts not only seem to have resulted in the well-timed airing of new nuclear plans by VVD leader Klaas Dijkhoff on the day after the Lubach broadcast, Yeşilgöz-Zegerius and Dijkhoff also organised a Youth Energy Lab (Jongeren Energie Lab) at the TU Delft on 11 February 2019, for the youth organisation of the VVD, featuring Shellenberger.[33]

The conservative liberal VVD, currently the largest party in the Netherlands and the lead party in the last four governments headed by Prime Minister Mark Rutte, has always had a pro-nuclear stance. In the 1980s, it was a strong force behind the attempt to expand the Dutch nuclear fleet, which ended after the Chernobyl catastrophe in 1986, as well as the revival attempts in the 2000s, ending with the 2011 Fukushima catastrophe. Nuclear power remained part of the party programme, under the condition that newbuilds would be privately financed. But the lack of social support initially kept it off the policy agenda of the different cabinets in which the VVD participated and which they later led. The VVD Secretaries of Economic Affairs, Henk Kamp and Eric Wiebes, where widely known for their dislike of nuclear newbuild proposals that involved government funding.

After the Lubach broadcast in November 2018, Yeşilgöz-Zegerius and Dijkhoff received strong support from Agnes Mulder, parliament spokeswoman for energy, climate and sustainability for the Christian Democrat CDA. The CDA had been relatively silent on nuclear energy over the previous years, although it did support the VVD push for new nuclear in the 2000s under the CDA-led cabinets of Prime Minister Peter Balkenende. Since around 2015, a new upcoming voice in the CDA was drawing attention to the need for urgent climate action: the prolifically tweeting physicist Henri Bontenbal, a strategy consultant at the electricity distribution network provider Stedin and junior fellow at the CDA scientific institute. After the parliamentary elections in March 2021, Bontenbal took over the speaker position on energy from Mulder, and took an even stronger pro-nuclear stance. Historically, the CDA has been supportive of nuclear energy, with the exception of its first election programme in 1977.[34] Since then, the party has always hosted some critical voices as well, until, since the Lubach broadcast, the party

moved to a very vocal and strong pro-nuclear position, nationally as well as provincially, and in many municipalities. An exception is the province of Groningen. When Prime Minister Mark Rutte, during an election debate on 28 February 2021, mentioned that he would like to see a nuclear power station in the Eemshaven, a port at the most northern point of the Netherlands, the CDA in Groningen strongly declared that it saw no space for nuclear power in the Eemshaven or in any other part of the province.[35] Mulder, who studied in Groningen and joined the CDA there, supported this stance, but added that the CDA sees a future for nuclear energy in the energy mix and that several other provinces were interested.[36]

With the renewed strong support from VVD and CDA, an unclear position on nuclear energy from the Christian Union, the other Christian party in the government coalition, and a split view in the progressive liberal party D66, nuclear power became a central issue for the current Rutte IV coalition government. In its 2021 Coalition Agreement, it stated:

"Nuclear power can, within the energy mix, be an addition to solar, wind and geothermal energy, and also can be used for the production of hydrogen. Also, it will make us less dependent on the import of natural gas. Therefore, the nuclear power station Borssele will remain open longer, with, of course, an eye on safety. Next to that, this cabinet will take the necessary steps for the construction of 2 new nuclear power stations. This means that we will, among others, facilitate market parties in explorations, support innovations, set out tenders, look at the (financial) contribution from the state, put, where necessary, laws and regulations in order. We will also take care of safe, permanent storage of nuclear waste."[37]

After VVD parliament leader Dijkhoff left politics in 2021 and energy speaker Dilan Yeşilgöz-Zegerius moved to the position of (outgoing) State Secretary, and later Justice Minister, her position in the Chamber was first taken over by Mark Harbers, who then left to become Minister of Infrastructure and Water Management (responsible for nuclear safety). Climate change and energy policy is now handled by Silvio Erkens, a conservative economist and management consultant. Erkens and Christian Democrat Bontenbal are currently the driving parliamentarian political force advocating for nuclear power.

The position of the other large coalition partner, D66, a progressive liberal party, is less clear. In 2020, the party was still critical about nuclear energy, which was voiced, among others, by then parliament leader, now Minister for Climate, Rob Jetten and energy spokesperson Matthijs Sienot. It accepted nuclear energy as low-carbon, but saw nuclear as too expensive and too slow, and was critical about its drawbacks, such as radioactive waste, accident risk and proliferation. The official position before the 2021 elections was that D66 'was open to nuclear energy, if that can be done in a sustainable, reliable and financeable way'.[38] After the 2021 elections, this position started sliding when D66 joined the coalition with the VVD and CDA, and Climate Minister Rob Jetten can now regularly be heard supporting the cabinet position. Matthijs Sienot left politics after these elections. There are a few very active party members trying to move it to a pro-nuclear point of view. One of the most visible is Floriske Deutman-Bodisco Massink, secretary of the aforementioned Stichting Energietransitie & Kernenergie. She is a management consultant and owner of Dutch Sino Business Promotions.[39] Within D66, she is secretary of the working group Energy and Climate and active in the theme group Economy. She filed several (failed) motions in the D66 party congress to have nuclear power taken up in a more positive sense in the party programme for the 2021 elections.[40] She also signed the Manifesto stichting Energietransitie en Kernenergie (SEK). Her pressure on the party grew when three prominent party elders also signed the manifesto: former ministers Jan Terlouw, Hans Weijers and Alexander Rinnooy Kan. Jan Terlouw has been instrumental in convincing climate minister Rob Jetten to change his opinion on nuclear power in a favourable direction.[41]

Within the opposition parties, the right wing is in favour of nuclear energy and the left wing opposed, with the exception of VOLT.

VOLT is a relative newcomer in the wide and fractioned Dutch political spectrum. It is a pan-European party, which, in contrast to its German and EU wing, chose to promote itself, in an attempt to attract the young electorate that watches the Lubach broadcasts, by actively embracing nuclear. This also sets it apart from its main competitor in that market, D66. One member of parliament split off from the VOLT faction in early 2022, Nilüfer Gündoğan. Since then, as a party-independent parliamentarian, she presents herself as representative of RePlanet and the ecomodernist movement.[42]

On the extreme right wing, it is the new party, JA21, that is the most outspoken. In 2020, JA21 split off from another far-right party, the Forum voor Democratie (FvD). Several members from FvD in the European Parliament moved to JA21 in December 2020 and joined the far-right conservative ECR group. Also, seven FvD senators (members of the First Chamber of Dutch Parliament) moved to JA21, as well as members of the provincial parliaments in Drenthe, Utrecht, Noord-Brabant and Friesland. In the 2021 parliamentarian elections, JA21 achieved three seats in Parliament. There, faction leader Joost Eerdmans and energy speaker Derk Jan Eppink are the most outspoken supporters of nuclear power. In the European Parliament, MEP Rob Roos published a report from two EU lobbyists/lawyers[43] on the cost of nuclear power, in an attempt to prove that nuclear power is cheaper than renewable energy sources.[44]

Other than the parliamentary far-right parties PVV, FvD and JA21, the conservative Christian party SGP, the one-person factions Van Haga, Omzigt and de Haan, and the farmers protest party BBB are all strongly in favour of nuclear energy. BBB became the largest party in the 2023 provincial elections, and it will create the largest faction in the First Chamber of Dutch national parliament, which is indirectly chosen by the provincial parliaments.

The support for nuclear energy is driven by the pro-nuclear parties not only at the national level, but since the Lubach broadcast also at the provincial level, where coalitions of VVD, CDA and JA21 have organised seminars for provincial parliamentarians (at least in ZuidHolland, Noord-Holland, Limburg, Utrecht, Gelderland, Friesland, Zeeland, Overijssel and Noord-Brabant, which represent 9 out of 12 provinces). The Lubach broadcast even spurred initiatives from local chapters of these parties, in many municipalities, together with independent local issue political parties, where nuclear was pushed into the discussions for Regional Energy Strategies (RES).[45] These RES need to lead to municipal and regional plans to fulfil the 2030 renewable energy targets set by the national government in 2019. The introduction of the issue of nuclear power at this level is often used to prevent or slow down development of renewable energy sources in a NIMBY (not in my back yard) atmosphere. That can be seen, as some examples among many others, in three municipalities that would never be able to host a nuclear power station, because they do not fulfil basic infrastructural criteria: the municipalities of Woerden,[46] Bunschoten,[47] Castricum.[48]

What is important to note when assessing the positions and activities of these political parties in the Dutch nuclear debate is that they are mainly ideologically techno-optimist, or have an ideological position counter to the centre and progressive/left-wing narrative. Within the far right (right of VVD and CDA), positions on nuclear energy are virtually always also linked to climate-sceptic opinions.

We do, however, see indirect influence from the nuclear industry, in the form of communication from industry-related party members or the participation of industry people in party seminars and events throughout the moderate party landscape, from CDA and VVD to D66. This includes the use of controversial reports that are promoted by the “old” industrial lobby, like the ENCO report,[49] the report from e-Lise,[50] the 2021 UNEP report initiated by the World Nuclear Association (WNA)[51] and others (see under).

Within the more extreme right-wing parties, rather than with industry, exchanges take place with people from the astroturf and genuine pro-nuclear popular activism that emerged after Lubach's broadcast, for example, in the form of the use of a report from a JA21 Member of the European Parliament.[52]

Interaction between the three groups

The surge in attention regarding nuclear energy in the Netherlands is a result of synergic interaction between the three aforementioned groups. But they each have a different background, and they only marginally mix organisationally. We have observed close cooperation between Shellenberger and the VVD, but no open cooperation between RePlanet and political parties.

RePlanet is cooperating closely with the industry branch in the lobby domain. Olguita Oudendijk, Gijs Zwartsenberg and Joris van Dorp are part of e-Lise,[53] a pro-nuclear consultancy including a physicist, a journalist, several communication specialists, a data specialist, a military radiation expert and an economist, which produced a report in February 2021 to support the political debate for nuclear power.[54] It is interesting to see how e-Lise's budget plans[55] imply a turnover of over half a million euro, whereas its last annual report (2021)[56] indicates one of less than EUR 2,300. This budget proposal indicates that they do aspire to get a lot of income from the nuclear industry, as well as from government sources.

There is, traditionally, close cooperation between the nuclear energy sector and political parties. Since the Lubach broadcast in 2018, political parties have organised a wave of seminars on different governance levels – the parliament, provinces (e.g. Utrecht, Zuid and Noord Holland, Overijssel, Gelderland, Limburg, Brabant, Zeeland and Friesland) and municipalities (e.g. Rotterdam and others) – where they tend to invite lobbyists from the industry sector. Sometimes this is with the participation of one critical voice (e.g. the province of Utrecht or Rotterdam), which is then put into a difficult minority position, or more (e.g. parliament), where different parties seem to listen only to invitees supporting their own position, which in the current political landscape gives prominence to people from both the industry and ecomodernist sides.

At a more structural level, we see the activities of the Foundation Energy Transition and Climate, where former politicians actively participate under the lead of people from the industry lobby, pushing for nuclear to their prominent party members that are still active.[57]

A more problematic level of cooperation between the industrial lobby and politics appears in the production of reports for the government. Under the former Rutte III cabinet, economy minister Eric Wiebes, from the pro-nuclear VVD, commissioned, on request of a 2019 parliament motion from Yeşilgöz (VVD) and Mulder (CDA), a report on the cost of introducing nuclear energy within the proposed scenarios to arrive at decarbonisation of the Dutch energy system in 2050. This report, published in March 2020 by a cooperation between the consultancy Berenschot and research bureau Kalavasta,[58] came to the conclusion that the costs of introducing nuclear energy would always be higher, unless nuclear reactors could be built on time, built within budget, the state would carry all the financial risk and they would be able to operate 24/7 ('must go' preference on the grid). Only in that case, cost levels could be comparable to a fully efficient and renewable energy mix. This did not land well with the political right and the nuclear lobby (all three segments), and Wiebes was pressed to commission another report to the Viennese research bureau ENCO.[59] This report was published in September 2020, and came to completely opposite conclusions. Although the report did not mention authors, investigative journalists found that it was written by ENCO director Bojan Tomic and former Borssele nuclear power station director Mario van der Borst.[60] Bojan Tomic is a former International Atomic Energy Agency (IAEA) staff member and generally seen as a pro-nuclear consultant, as well as member of the so-called benchmark commission that was established in 2006 in the Covenant between

the Dutch government and (privatised) Borssele operators RWE and Delta to establish and monitor whether Borssele "belongs […] to the 25% safest nuclear power stations of comparable types in Europe, the USA and Canada."[61] Tomic was proposed for that position by Borssele license holder EPZ (owned at the time by RWE and Delta). The other author, Mario van der Borst, is a former EPZ director and the current president of the Netherlands Nuclear Society[62], the Dutch branch of the nuclear lobby group European Nuclear Society[63], which brings together researchers, scientists and consultants from the nuclear sector. The report was received extremely critically. Research bureau Kalavasta even took the unprecedented step to write a counter-expertise in reaction, because they noticed the ENCO report was used to push their earlier report to the side[64]. In its rebuttal, Kalavasta concluded that the ENCO report used for 2040 higher investment costs for solar and wind than the investment costs already existing in 2020 – noting that renewable costs tend to decrease. It noticed that ENCO did not take the Dutch market into account, for instance where "must run" obligations for nuclear power stations are not a given. They observed further that ENCO uses for 2050 a lower penetration (50%) of wind and solar energy in the Dutch grid than the legally fixed target of 70% in 2030. And, although ENCO argues that system costs are crucial for establishing cost comparisons, its report does not include system costs in its calculations, but introduces them from outside the system, not adapting them to the Dutch situation. They also conclude that the ENCO study was not peer reviewed, whereas the Kalavsta study was reviewed by the Dutch Planning Office for the Living Environment (PBL) and the OECD-NEA (the Nuclear Energy Agency of the Organisation of Economic Co-operation and Development).[65]

Since this controversy, the Ministry of Economic Affairs has become more careful with its choice of consultants on the nuclear portfolio, using consultancy KPMG for a market consultation,[66] and Consultancy Wittenveen+Bos and eRisk Group for a scenario study.[67] It has to be noted, however, that the co-author of this last study, Laetitia Ouillet from eRisk, also functions as a member of the Borssele benchmarking group for EPZ, and Ruut Schalij from eRisk represents the Canadian company General Fusion in the Netherlands, which works on a nuclear fusion reactor concept.

Lobby platforms of the ecomodernist groups – strengths and weaknesses

We have already seen that the ecomodernist groups functioned as the engine behind the renewed attention for nuclear energy in the Netherlands. Their activities were instrumental in causing the wave of attention around the Lubach broadcast in November 2018. Since then, they have been active on several platforms.

The first wave of attention for their message in the mainstream media stems from the 2017 publication of their book Ecomodernisme and their ecomodernist manifesto. The counter-positioning towards the environmental movement won them a large following on social media from other, one could call them, counter-culture groups – groups of people pushing back on what they see as "the elite", often circling around the extreme wings of political thought. But by keeping to their own profile of highly environmentally motivated people that have developed a new perspective ("seen the light"), they were able to draw the attention from mainstream news media – dailies, talk shows, etc. – for a while and increase attention for their message. Because the message itself is relatively extreme,[68] the media slowly turned away from them. Still, they are regularly invited to create a "balanced" situation opposing critical experts from the environmental movement.

They appropriated some of the tactics of the environmental movement. They have participated in the Climate Marches with positive messaging in the form of live music and eye-catching, cuddly, blow-up polar bear suits called 'Melty' (!), while in the meantime causing controversy. This has increased attention, mainly among right wing and some extreme left-wing supporters.

The ecomodernist movement used the vacuum in nuclear information that had appeared after almost a decade of silence on the issue in the media very well. They plugged easy digestible chunks of perceived advantages of nuclear energy: it would be cheap, fast to implement and safe ('Nobody died at Fukushima'); there is no waste, only resources; thorium; we can still grow; it is "and, and" (implying nuclear energy is needed next to renewable energy); we follow the science; anti-nuclear sentiment is a historical ideology; and anti-nuclear sentiment is emotional. And they linked their cause to climate change. At the same time, they played the card of nuclear being a long-time victim: nuclear energy is a taboo, and the evil environmental movement wants to take economic growth away from people. This mixture caught the attention of many people who previously had no solid opinion on nuclear power. That includes the political party VOLT, and some within D66 and the socialist SP. But it definitely rang a bell on the right side of the political spectrum, where the style and message were eagerly taken over by the VVD, CDA, PVV, JA21 and BBB. Politically, ecomodernists targeted, above all, those who were on the front line of the debate in the party landscape: D66. There, they were able to create a split opinion – extremely strategically, as D66 is the second largest parliamentary and government party after the VVD.[69]

On social media, especially on Twitter, ecomodernists are not a steady presence. Their attention is not continuous, but rather comes in waves – often around their own activities (the climate marches, a petition to urge for lifetime extension of German nuclear power plants, etc.). Some are prolific tweeters, like Joris van Dorp, and have created a bubble of fans around them.[70]

Members from these groups increasingly turn up on larger nuclear debates (including officially organised ones) and sometimes are invited in order to show different sides of the discussion. The media also contact them, with journalists eager to show a discussion with two sides, for example, quotes from RePlanet members featuring next to critical quotes on nuclear energy. This does, however, create a 'false balance': simplified, rather fringe arguments (radioactive waste does not exist, Fukushima caused no casualties, we cannot do without nuclear power, etc.) are featured alongside more sophisticated, more complex argumentation around cost, development of energy mix, risks and so on, and thus gain more acceptance. These arguments (including references to mainly grey literature supporting them, like the life-cycle analysis (LCA) report published under the name of the United Nations Economic Commission on Europe (UNECE), the JRC report for the European Taxonomy, the ENCO report and the e-Lise white-paper on the role of the Dutch state in the business case for nuclear energy) are then moving further in the social media sphere – often in simplified forms. This has created a larger bubble of more or less fanatical followers that spread this information in reaction to any public outing concerning energy, nuclear or otherwise. Gerard Brinkman, from the anti-nuclear organisation WISE, put it this way: 'If you tweet about any issue related to climate, it is just a matter of time before someone raises the issue of thorium reactors'.[71]

The simplicity of their messaging delivers them space – nuclear critics are pushed into the defence, having to explain backgrounds that are not so easy to pass on because of their complexity. And very importantly, although most exponents from this movement are in their forties and fifties or older, they know how to charm a younger audience.

Their largest strength appears to be that the simplicity of their message has created space within the member base of political parties for easily arguable support for nuclear energy.

However, the simplicity of argumentation is also one of the movement's weaknesses. The interest of the media appears, at the moment, to be slowing down in comparison with one or two years ago, and the amount of space that ecomodernists get in serious media outlets seems to be decreasing.

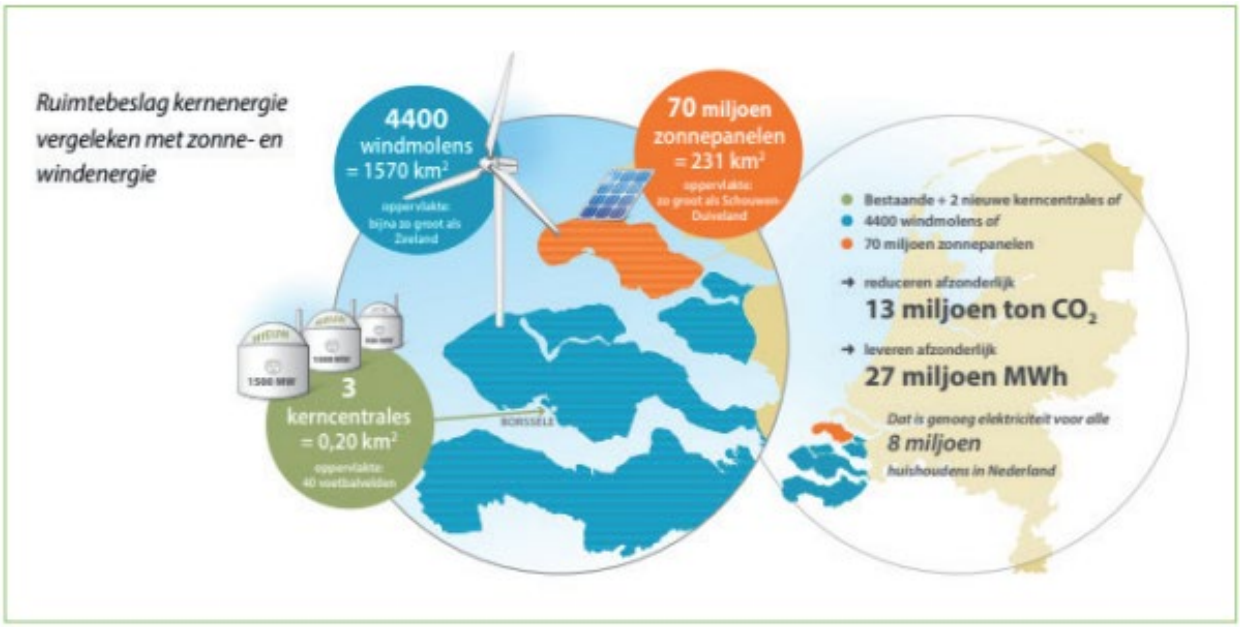

Figure 1 Space need of different power options according to Borssele operator EPZ (source: EPZ (2020))

Lobby platforms for the industrial lobby – strengths and weaknesses

The industrial lobby continues to focus on the traditional media platforms. The Stichting Kernvisie (Nuclear Vision Foundation – with a board from the nuclear industry under chair Andre Versteegh, formerly of TU Delft and nuclear research group NRG), which aims to increase the support for nuclear technology and all its implementations, issues its own magazine, namely Kernvisie. [72] We see exponents of the lobby regularly publishing in specialised media, such as Energeia,[73] daily media and weeklies. In particular, the weekly EW Magazine (formerly Elsevier's Weekblad) and the right-wing daily Telegraaf eagerly give space to nuclear industry spokespeople.[74] This lobby branch is less prominent on audio-visual media and social media, with the exception of some prolific tweeters (e.g. TSO RIVM's radiation safety head Lars Roobol and Thorium Foundation's Gijs Zwartsenberg). On LinkedIn, there is an active pro-nuclear community.

The strength of the industrial lobby lies in its direct contacts to the political sphere, not in its media presence.

In the meantime, industry has focussed more on getting its foot in the door in political discussions around climate. During 2021 and 2022, it argued that the Netherlands should support the European Commission proposal to include nuclear energy in the Taxonomy for Sustainable Finance and generated quite some attention with that. It spread simplified messages on perceived strengths, such as use of space (see Figure 21),[75] and Dutch and Finnish progress in dealing with radioactive waste, and also tried to position nuclear energy next to renewables as necessary low-carbon technologies, including the notion that 'only wind and solar will not be sufficient'. In expert meetings for government bodies or government advisory bodies,[76] it tries to undermine the picture of the high costs and long construction times of nuclear power stations, and the lack of progress in the development of solutions to radioactive waste. Some also stress the claim that nuclear energy would be the safest form of energy.

In economic terms, the Dutch nuclear industry pushes the claim developed by the OECD-NEA that when including so-called 'system costs' (e.g. necessary grid adaptations), inclusion of more nuclear energy in a decarbonised energy mix would be profitable [77] – in spite of these costs being an integral part of scenario studies carried out for the government, including those of TNO[78] and Berenschot/Kalavasta.[79] One of the ways in which they were able to push this was, as mentioned earlier, by getting the

government to commission the controversial ENCO study.

Another line of argumentation hangs strongly on the promise of so-called Small Modular Reactors (SMRs), especially thorium molten salt reactors. Because there is a line of research looking into this option at the Technical University in Delft, the lobby for a more active Dutch role in the development of this reactor type has been riding high on the wave of the new attention for nuclear. Not only on social media, but in many political debates, the word 'thorium' suddenly pops up whenever climate issues are discussed, and a vocal group around the research group of Jan-Leen Kloosterman of the Technical University Delft, the research group at NRG in Petten and Gijs Zwartsenberg's Thorium Foundation feeds such debates whenever there is an opportunity. They have been especially effective at inserting the potential of thorium reactors into provincial and municipal debates on regional energy strategies, even though these strategies only deal with investments until 2030 and SMRs therefore cannot play any role.[80]

Because many in the nuclear lobby have either studied nuclear physics, or hold (or have previously held) positions in the nuclear industry, they have the advantage of an aura of expertise. This gives them a strong position in the social and political debate – even when, for example, a nuclear scientist is talking about the economics of nuclear energy, that is, outside his or her sphere of expertise. This enables the industry, for instance, to easily override strong economic argumentation with a low-quality report, as could be seen in the case of the Berenschot-Kalavasta report versus the ENCO report.

However, this strength of a perceived monopoly on expertise may also become a weakness of the lobby. In the Netherlands, there exists a culture of looking at problems from different angles. And when the lobby does not accept that, it also may lose influence. For instance, during the deliberations of the Council of the Living Environment and Infrastructure for its advice on nuclear power,[81] an advisor from the nuclear industry ended his involvement in the process, because he felt his input was not recognised to a sufficient degree in the much broader setting of the discussion on the basis of values, even though all other sides had carefully listened and taken his views into account.[82]

Lobby platforms for political parties – strengths and weaknesses

The debate on nuclear power from the side of political parties is riding high on social media, especially Twitter. People like VVD energy spokesperson Silvio Erkens and CDA energy speaker Henri Bontenbal use this platform to create a wide support base for nuclear issues. Where Bontenbal appears to do this from a position of conviction, Erkens mainly seems to focus on nuclear for electoral reasons. Interestingly enough, political parties do not proactively use the printed and audio-visual media a lot to draw attention to nuclear. For these media, it remains a side-issue with a specific audience. The nuclear lobby's targeted audience seems to be better serviced with social media, which they mainly connect to via their personal Twitter accounts.

Within political parties, the issue of ideology is a strength for the nuclear lobby. Parties like the VVD are ideologically in favour of nuclear power; there is no internal debate and lobby arguments are accepted without much critical reflection, whereas critical issues are not taken seriously. In parties on the far right, however, nuclear power is not as ideological, but rather the counter-position to what is seen as 'left wing anti-nuclear sentiment' and the 'climate hoax'. The nuclear industry is capable of influencing the conservative VVD, the conservative Christian democrat CDA and, to a certain extent, the progressive liberal D66. The extreme right-wing parties BBB, PVV, JA21 and FvD, as well as the one-person factions, are more influenced by the argumentation from the ecomodernist wave – simple one-liners that can be easily used as a fast counter of nuclear critical points of view.

Where public opinion in the Netherlands has always been overshadowed by the group that is 'undecided', lately the part of the population being critical has decreased, while the part

being in favour of nuclear has sharply increased in the years since the Lubach broadcast. Taking courage from this shift in public opinion, the nuclear lobby within political parties has become increasingly self-confident. Critical voices on nuclear are now countered by pro-nuclear political actors with argumentation like 'you are going against the stream [with criticism on nuclear] – the race is over'.[83]

The fundamental weakness and strength of the Dutch debate

Because of realities on the ground, it remains highly unlikely that new nuclear power stations will be added to the grid in the Netherlands. These realities include the issue of cost and financing, the issue of necessary long-term political stability, and a small but vocal hard core of opposition to nuclear energy in society and politics that will make it difficult to sweep challenges completely under the carpet.[84] Long preparation and construction times, as well as cost increases, especially for SMR projects like current NuScale and Rolls Royce, are also not a supportive case for fast delivery. A long-time horizon may make nuclear an easy tool now for kicking the can of urgent climate action down the road. But it could also make it difficult to maintain the strong support and attention needed. At least, long enough to overcome the enormous cliff of financing, especially in comparison with the fast roll-out of other technologies.

The populist, bullet point argumentation from the ecomodernist lobby stream seems to be petering out a little in its influence because of this complexity. The industrial lobby does not seem to have any other answer than diversion of attention – steadily introducing other factors that would make nuclear energy more attractive: system costs, the use of nuclear for the production of hydrogen, load-following[85] and the use of nuclear reactors for the production of medical isotopes. All of these are not, or insufficiently, relevant for the financing question looming over the future of nuclear energy, but sufficient to keep the issue of nuclear power in the debate. The political lobby, driven by the VVD and CDA, tries to overcome this question by speeding up investments in preparation and urging for easing procedures. That latter point will be very difficult, because these procedures are largely fixed by internationally agreed directives (EU) and conventions (Aarhus, Espoo, Convention on Nuclear Safety (CNS)). When the relevant Climate Minister Rob Jetten has to respond to motions of this kind in parliament, these ambitions will hit the wall of realism.

The chances of the Netherlands actually pushing operation of its only nuclear power station Borssele beyond the current maximum foreseen lifetime of 60 years, as well as construction of new nuclear power in the country, remain for these reasons very low. However, the amount of attention, space and, indeed, money that the surrounding debate consumes, practically diverts necessary capacity from urgent climate policy. And this on all levels of governance, from the local to the national.

The nuclear lobby in the media

Although we see in the Netherlands an unprecedented move towards support for nuclear energy, the amount of attention in the traditional media remains limited. Journalists are careful to give voice to different sides of the debate, and the media are careful to balance the overall attention. Nevertheless, the ecomodernist journalist Marco Visscher knew how to generate a wave of pro-nuclear attention around the Lubach broadcast in late 2018. The fact that he did not 'out' himself as one of the early ecomodernists in the Netherlands backfired a bit,[86] and he has lost his media platform for journalistic nuclear stories to some extent.[87]

Social media is the main transporter of the nuclear debate, whereby the dynamics support an ever-deepening polarisation between those in favour and those in opposition. The important actors in this come from all three lobby streams, though the political party–affiliated lobbyists seem to create the most traffic, with some dedicated people from industry, such as Roobol and Zwartsenberg, a clear second. The attention for nuclear on social media is further helped by the communication background of people like

Floriske Deutman, who uses social media to support her networking position for nuclear within D66.

And what about Arjen Lubach? After the late 2018 broadcast, he has returned to the nuclear issue several times, but mostly in one sentence. Having taken a strong position in Zondag met Lubach, he seems to have walked into – in what he defined in another of his broadcasts dedicated to social media as a 'fables trap' – an information bubble from which it is hard to escape. With that he has cemented himself into a nuclear position based on the ecomodernist bullet points; a position that is not easy to step back from. The continued popularity of his show to this day supports the lobby in favour of nuclear power.

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[42] https://replanet.nl/een-ecomodernist-in-de-nederlandse-politiek-nilufer-gundogan-welkom-in-het-antropoceen-24/
[43] Katinka Brouwer is legal consultant for Interlex N.V., which is not registered in the EU Transparency Register. Lucas Bergkamp is former head of the Brussels office of Hunton & Williams, and also not registered in the EU Transparency Register.
[44] https://nucleairerenaissance.nl/Energy_Study_Full.pdf – the authors of the study claim to have worked with a team of further anonymous experts and peer reviewers.
[45] https://regionale-energiestrategie.nl/default.aspx
[46] https://www.ad.nl/woerden/drie-woerdense-partijen-willen-kernenergie-we-moeten-wel~aa83bada/ https://www.ad.nl/woerden/woerden-wil-uitzoeken-of-plaatsen-van-een-mini-kernreactor-mogelijkis~ac7e8519/
[47] https://bunschoten.vvd.nl/nieuws/40948/vvd-bunschoten-kritisch-maar-ook-realistisch-over-regionale-energie-strategie-res
[48] https://www.noordhollandsdagblad.nl/cnt/dmf20200923_52674747
[49] https://open.overheid.nl/repository/ronl-f29c1eb8-af04-4e8c-bc95-812be06991be/1/pdf/POSSIBLE%20ROLE%20OF%20NUCLEAR%20IN%20THE%20DUTCH%20ENERGY%20 MIX%20IN%20THE%20FUTURE.pdf
[50] https://en.e-lise.nl/_files/ugd/faaaa7_3d652f47dcda47dd9d118fe7ecfcbde1.pdf
[51] https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf
[52] https://ecrgroup.eu/article/ecr_co_commissioned_climate_study_advises_eu_to_embark_on_a_nuclear_renaiss; see also footnote 43.
[53] https://en.e-lise.nl/
[54] Beckers, Mathijs & Gijs Zwartsenberg, The role of the Dutch State in the business case for nuclear energy – Recommendations and background information, Utrecht (2021) E-Lise: https://en.e-lise.nl/_files/ugd/faaaa7_3d652f47dcda47dd9d118fe7ecfcbde1.pdf
[55] https://www.e-lise.nl/_files/ugd/faaaa7_837490458b67484d946a63f34b104ca3.pdf
[56] https://www.e-lise.nl/_files/ugd/faaaa7_2eb4d1b7c6f74348aac0c339042117bb.pdf
[57] The Energy Transition and Nuclear Energy Manifesto (Manifest Energietransitie en Kernenergie), from 30 March 2021, called immediately after the parliamentary elections on the parties to form a new government to look for a serious role for nuclear energy for the post-2030 period, and was signed by political dignitaries: Hans Alders and Marc Calon (both PvdA); Floriske Deutman, Hans Wijers, Alexander Rinnooy Kan and Jan Terlouw (all D66); Maria van der Hoeven (CDA); and Johan Remkes and Lars Roobol (both VVD). See: https://www.nucleairnederland.nl/nieuws/manifest-roept-op-om-kernenergie-in-de-energiemix-vanaf-2030/
[58] https://www.rijksoverheid.nl/documenten/rapporten/2020/03/09/systeemeffecten-van-nucleaire-centrales-in-klimaatneutrale-energiescenarios-2050
[59] https://www.rijksoverheid.nl/documenten/rapporten/2020/09/22/possible-role-of-nuclear-in-the-dutchenergy-mix-in-the-future https://www.enco.eu/_files/ugd/083d85_6093f463583f4e968533777678bc20eb.pdf
[60] https://www.volkskrant.nl/nieuws-achtergrond/onafhankelijk-onderzoek-pro-kernenergie-blijkt-van-oud-directeur-borssele~bc4cbaec/
[61] https://zoek.officielebekendmakingen.nl/kst-25422-119.pdf (author's translation)
[62] https://kerntechniek.nl/
[63] The European Nuclear Society can be found at: https://www.euronuclear.org/. It is registered in the EU transparency register under: https://ec.europa.eu/transparencyregister/public/consultation/displaylobbyist.do?id=083308125409-83
[64] https://www.nvde.nl/wp-content/uploads/2020/09/Vergelijking_rapporten_nucleair_ezk-_.pdf
[65] This controversy was widely discussed in the media. The cartoon in Figure 1 can be found at: https://www.trouw.nl/cartoons/de-wereld-van-anton-dingeman~b7e8c8e1/
[66] https://www.rijksoverheid.nl/documenten/rapporten/2021/07/07/kpmg-marktconsultatie-kernenergie
[67] https://www.rijksoverheid.nl/documenten/rapporten/2022/09/07/scenariostudie-kernenergie
[68] An example is https://www.nporadio1.nl/nieuws/achtergrond/5ee7333b-5a0f-4a39-a811- 5f1d346ee124/moet-nederland-vol-inzetten-op-kernenergie, where ecomodernist Joris van Dorp compares the effects of a nuclear disaster with life in a mega-city; or https://pointer.kro-ncrv.nl/kernenergie-is-geen-taboe-meer-maar-de-discussie-is-nog-lang-niet-voorbij where he states that 'so-called "green energy" is a lie that only will damage our environment and economy when we would try to run 100% on it.' (author's translation)
[69] https://twitter.com/fdeutman/status/1594005019413594112
[70] On Twitter, RePlanet currently has 2,419 followers, and its director Olguita Oudendijk 1,070, but its most prolific tweeter, Joris van Dorp, has almost 11,000. Consulted 11/10/2022.
[71] Personal interview, 5 October 2022.
[72] https://www.kernvisie.com/
[73] https://energeia.nl/
[74] The weekly EW Magazine featured 36 articles about nuclear energy in 2022: https://www.ewmagazine.nl/onderwerp/kernenergie/. De Telegraaf featured 100 articles in 2022, of which 14 dealt with the situation of nuclear power stations in Ukraine after the Russian invasion. The others were mainly propagating nuclear energy: https://www.telegraaf.nl/tag/kernenergie
[75] Vision of Borssele owner EPZ on nuclear energy in the Netherlands after 2033, Figure 2, claims that three nuclear power stations (Borssele and 2 EPR reactors) would claim only 0.2 km2 (200 ha) of space for the production of 27 TWh electricity, whereas for the same amount of energy, it claims 4,400 wind turbines would be necessary, needing 1,570 km2 of space or almost the surface of the entire province of Zeeland. However, 4,400 wind turbines of 4 MW capacity would deliver around 70 TWh in the Zeeland situation (4 MW capacity per turbine, 45% load factor), and with a need of around 1 ha per turbine, would not cover more than 44 km2 of space; the province of Zeeland has a surface of 2,934 km2 . Still, this picture is used time and

again, sometimes adapted to different provinces. EPZ, Visie EPZ op kernenergie in Nederland na 2033, Borssele (2020): https://www.epz.nl/app/uploads/2021/04/Visie-EPZ-op-kernenergie-in-Nederland-na-2033.pdf

[76] This includes, among other,s a Round Table discussion in the Commission for Economic Affairs and Climate in the Second Chamber of Parliament, the ongoing advisory research of the Rathenau Institute to disposal of radioactive waste and the advise of the Council for Living Environment (RLI) and Infrastructure on nuclear energy.

[77] OECD-NEA, The Costs of Decarbonisation – System Costs with High Shares of Nuclear and Renewables, Paris (2019): https://www.oecd-nea.org/jcms/pl_15000/the-costs-of-decarbonisation-system-costs-with-high-shares-of-nuclear-and-renewables

[78] https://repository.tno.nl/islandora/object/uuid%3A5c7f19fb-9e6d-4830-9ad6-1e83d1355ece

[79] https://kalavasta.com/pages/projects/infra_scenarios_nuclear.html

[80] Jan-Leen Kloosterman lists the following provincial authorities he gave presentations to on thorium reactors: Parliament Zuid Holland (13 May 2020), National meeting of Provincial Parliaments (21 October 2020), Parliament Noord Holland (22 October 2020), Parliament Limburg (29 January 2021), Provincial Executive Utrecht (3 February 2021), Parliament Gelderland (12 January 2022), Parliament Friesland (19 January 2022) and Parliament Zeeland (17 June 2022); as well as to several municipal councils and political party seminars. http://www.janleenkloosterman.nl/presentations.php

[81] RLI, Splijtstof – Besluiten over Kernenergie vanuit Waarden, Den Haag (2022): https://www.rli.nl/publicaties/2022/advies/splijtstof

[82] https://www.rli.nl/nieuws/2022/ad-louter-trekt-zich-terug-als-externe-adviseur

[83] Remarks made to anti-nuclear activists handing out leaflets before the D66 party conference on 19 November 2022 – oral information from Gerard Brinkman, WISE.

[84] This can, for instance, be observed in the Province of Zeeland. The government announced in 2022 that Borssele would be the preferred location for new nuclear reactors, on the basis of the argumentation that there was a large support in the province. This resulted in the resurrection of a strong anti-nuclear movement that since has overtaken attention in the regional media.

[85] Following a variable demand by ramping up and down capacity very fast. This is currently done by gas power stations. Normally, nuclear power stations are, for technical and economic reasons, seen as base-load power stations that continuously have to deliver 24/7 power. However, adaptations in design make it also possible for nuclear power stations to ramp up and down faster, so they could be more easily incorporated in a highly variable grid-system on the basis of variable input from wind and solar. But this goes against a severe economic loss.

[86] An example where this happened was his interview with Science Philosopher Behnam Taebi in TROUW on 16 March 2019, which led to a heated discussion between the anti-nuclear organisation WISE and the TROUW ombudsman because of the fact that the strongly pro-nuclear-biased introduction of the interview did not cover the more neutral position in the interview with Taebi, and it was not revealed clearly in the article that Visscher, in his position as author of Ecomodernisme, had taken a strongly pro-nuclear advocacy position. https://www.trouw.nl/duurzaamheid-economie/kerncentrales-sluiten-is-je-kop-in-het-zand-steken~b4f740e7/

[87] The frequency of publishing of articles from Visscher peaks in 2020: https://www.marcovisscher.nl/mijn-artikelen/, with his home platform, de Volkskrant, only listing one article in 2022: https://www.volkskrant.nl/auteur/marco-visscher

World Nuclear Power Status

Number of Reactors
(as of May 2023)

Source: https://www.worldnuclearreport.org/

World major banks don't see nuclear as green

Euractiv reports: None of the world's 30 major banks have explicitly included nuclear energy in their criteria for issuing green or sustainability-linked bonds, researchers said on Thursday (6 July), despite an EU decision last year to label it as sustainable.

The European Union decided last year to include nuclear power plants in its list of investments that can be labelled and marketed as green. The move aimed to guide investors towards climate-friendly technologies, but split EU countries who disagree on atomic energy's green credentials.

So far, banks have not followed the EU's lead in their own green bond rules, according to an analysis by Columbia University's Center on Global Energy Policy. The study looked at the 30 banks deemed systemically important by the Financial Stability Board.

Of those banks, 17 had explicitly excluded nuclear energy from their green financing frameworks, while 12 had frameworks that were silent on nuclear, and one had no such framework, the researchers said.

The EU's own green bond standard includes nuclear power. But exclusion from banks' frameworks could restrict the sector's access to a fast-growing pool of sustainable capital.

Green bond issuance hit a record high globally in both the first and second quarters of 2023, Refinitiv data showed.

Research co-author Matt Bowen said he was surprised nuclear energy was so often excluded from banks' green finance guidelines, given its potential contribution to fighting climate change.

Nuclear energy does not produce climate-damaging CO_2 emissions in the same way that fossil fuels such as oil and gas do, but it does produce radioactive waste.

Countries including Germany and Austria oppose the energy source and lobbied against the EU's decision to label it as green, citing concerns including waste disposal, the potential risk of accidents and long delays to recent nuclear projects.

The International Energy Agency has said global nuclear capacity would need to roughly double by 2050, if the world is to achieve net zero emissions by 2050.

Source:
https://www.euractiv.com/section/energy-environment/news/major-banks-yet-to-match-eu-with-nuclear-green-label-study-finds/