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Does Nuclear Power comply with the DNSH Criteria of the EU Taxonomy for Sustainable Activities? A Literature Review

The 'Taxonomy Regulation' refers to three criteria, which have to be met so that an economic activity can be classified as contributing to sustainable development: (1) a 'substantial' contribution to at least one of the six environmental objectives (or at least enabling others), (2) does not significantly harm any of the environmental objectives, and (3) is carried out in compliance with the international social standards listed in the Taxonomy.

This literature review examines to what extent nuclear power corresponds to the criteria laid out in the Taxonomy Regulation.

Criterion 1: Nuclear power is recognised as an energy source with low greenhouse gas emissions compared to fossil fuels, and thus basically meets the criterion regarding the reduction or stabilisation of greenhouse gases. However, there is controversial discussion whether this technology should be included in a future sustainable energy mix with significant CO_2 reductions. It is questioned whether nuclear power corresponds to the 'best-in-class approach' in the energy sector (and can thereby be classified as 'transition activity'), and it is argued that there are alternative energy sources with even lower greenhouse gas emissions which do not compromise the relatively good climate protection performance by comparatively high risks.

Criterion 2: Based on this literature study, meeting the criterion "Do No Significant Harm" for all environmental objectives[1] can be summarised as follows.

Although the risks of nuclear accidents can be reduced, they can never be excluded. The resilience of nuclear power production is further challenged by increasing costs for construction and operation of nuclear power plants to protect against the impacts of climate change. Nuclear power plants require concentrated, large amounts of blue water. Increased water temperatures and reduced river flows have already led to reductions or even interruptions of electricity generation in recent years. For this reason, new cooling technologies are being developed, resulting again in higher costs. Forzieri et al. (2018) estimate that drought and heat damage in Europe will account for 67% and 27% of all hazard consequences for the energy sector by the end of this century (currently 31% and 9% respectively).

The literature has sufficiently documented the negative consequences of high-dose ionising radiation on human health. However, whether low-dose radiation has a negative effect on human health is controversial, as it is unclear at what exposure level negative consequences occur.

Uranium mining generates considerable quantities of waste materials and process water containing low-level radioactive substances, metals and acids. Although the link between the provision of nuclear power and biodiversity and ecosystems has not yet been sufficiently studied, recent findings suggest that uranium mining has negative impacts, especially on freshwater ecosystems.

[1] The six environmental criteria cover climate change mitigation (already mentioned in criterion one), climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, protection and restoration of biodiversity and ecosystems.

After 40-50 years of development of the nuclear sector, the issue of high-level nuclear waste storage, with its very long-term consequences, is still heavily under discussion, mainly because of uncertainties due to unforeseen geological movements and radioactive leakage into groundwater. High-level radioactive waste is still stored temporarily, thus posing another threat for which no far-reaching solutions exist. High-cost options are under consideration occasionally and under implementation in one case in Finland. Further, uranium mine remediation is still an unresolved topic, with thousands of banned uranium mines left in various parts of the globe.

Criterion 3: Uranium mining and milling has been struggling with human rights and safety issues throughout its history in different parts of the globe. This concerns workers in the mines as well as the human right to access to resources, e.g. clean water and used land, which might impact neighbouring communities.

Cross-cutting issues: Beyond the environmental objectives of the Taxonomy, governance aspects are relevant. The IPCC (2018) concluded that the political, economic, social and technical feasibility of solar energy, wind energy and electricity storage technologies has improved dramatically in recent years, while nuclear energy and carbon capture and storage in the electricity sector have not seen similar improvements.

In addition, nuclear power struggles with social acceptance in wider parts of society and with long development times (in democratic societies 10-19 years per plant). A major shift to nuclear power would imply that many of the current fossil-fuelled power plants would stay in operation for that period and thus delay their decommissioning, making it impossible to achieve the climate targets.

From an economic point of view, it has been noted that the business case for nuclear energy has weakened in recent decades. Based on a full cost accounting for Europe, this is partly due to the recent success of renewables, where the cost of PV modules has fallen by 80% within 10 years and that of wind turbines by 30%. In this way, renewable energy systems are not only feasible, but already economically viable and cheaper every year.

The risks of nuclear accidents will continue to exist. Further barriers to and risks associated with an increasing use of nuclear energy include operational risks and the associated safety concerns, uranium mining risks, financial and regulatory risks, unresolved waste management issues, nuclear weapons proliferation concerns, and adverse public opinion. The complex issue of highly radioactive waste will remain. We already live in a world with more than a quarter of a million tonnes of highly radioactive waste from nuclear power production, all in interim storage including potential leakage, which could increase to more than one million tonnes worldwide by 2100.

According to the literature, nuclear power can also not be seen as a **transition or bridging technology** because it misses to be the ‘best-in-class‘ in the sector concerning its climate mitigation potential. Moreover, it would lead to a lock-in of carbon-intensive coal plants for up to 10-20 years until the new built nuclear plants to replace them would become operational. It even can be seen to hamper the deployment of other low-carbon alternatives due to its high capital intensity, which could be devoted to the scale-up of alternative energy sources like solar, wind and water.