A nuclear future for biodiversity conservation?

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Reducing CO_2 emissions progressively moves up on national and international political agendas. For example, US has just rejoined the Paris Agreement towards a climate neutral world (The White House 2021), and the "European Climate Law" aims net zero greenhouse gas (GHG) emissions by 2050 (European Commission 2021), while China's National Energy Administration (NEA) has recently proposed that at least 40 % of the country's energy comes from non-fossil fuel sources (Lo 2021). Hopes for "carbon neutrality" heavily rely on renewable energies, especially wind and solar (van Zalk & Behrens 2018; European Commission 2020; IEA 2021), which will contribute to two-thirds of the 8 % growth expected for renewables in 2021 (IEA 2021). However, actions against climate change are not at zero cost. As recently recognized in a joint report by intergovernmental bodies for climate change (IPCC) and biodiversity (IPBES) (IPBES-IPCC co-sponsored workshop 2021), such actions can exert large negative environmental and social impacts.

Extensive research in the last decades has shown how wind and solar plants impact on ecosystems, from killing hundreds of thousands of birds and bats to habitat destruction and degradation (Cohn 2008; Brook & Bradshaw 2014; Arnett et al. 2016; Gibson et al. 2017). Remarkably, both are highly space-demanding (Brook & Bradshaw 2014; van Zalk & Behrens 2018). Offshore windfarms should occupy up to 76,000 km^2 (i.e. an area larger than Ireland) in the northern seas to meet EU climate-neutral requirements by 2050 (European Commission 2020), and generating 80 % of US electricity with renewables will increase the land footprint of the power sector by 150,000 km^2 (van Zalk & Behrens 2018). Contrasting with the lower impact of installing renewables in urban and degraded areas (e.g. solar panels

above roofs; van Zalk & Behrens 2018), most wind and solar plants are currently planned as land-intensive facilities in rural or mountainous areas, with low human density, but high nature values (Poggi et al. 2018). Actually, their presence is expected to increase up to ~80 % inside protected and wilderness areas (Rehbein et al. 2020). Pressures on natural habitats could further rise if some countries struggle to find the space required for renewables to meet their domestic power demands and international commitments (European Commission 2020; United Nations Economic Commission for Europe 2021).

Despite boosting since 1970s, renewables are still far from satisfying the growing global energy demand, which has already rebounded in 2021 above pre-pandemic levels, further raising CO_2 emissions (IEA 2021). In fact, after the major collapse due to Covid-19, CO_2 reached in 2020 its highest ever average annual concentration in the atmosphere (412.5 parts per million) until now (IEA 2021). The last UN synthesis report of the climate action plans of all 191 countries Parties to the Paris Agreement forecasts an increase of about 16 % in global GHG emissions in 2030 compared to 2010, urging to take actions immediately (United Nations Framework Convention on Climate Change 2021). However, even under ambitious scenarios such as that of the International Renewable Energy Agency (IRENA), which plans to speed up the deployment of wind power up to 6,000 GW in 2050, wind would only cover the 35 % of global electricity needs while representing 27 % of the overall emissions reduction needed to meet Paris climate goals (IRENA 2019), illustrating how such development will still not be enough to satisfy the increasing demand of our electricity-dependent societies. Furthermore, installing such wind power would require between 1.0 and 1.7 million km^2 of land, an area the size of countries like Bolivia or Iran (IRENA 2019).

Paradoxically, wind and solar energy have been proposed as alternatives to reduce the severe environmental impacts caused by the deployment of large dams for hydropower, another renewable low-carbon energy source (Schmitt et al. 2019). With only the 23 per cent of the rivers longer than 1,000 kilometers flowing free to the oceans (Grill et al. 2019), the more than 60,000 large dams existing around the world affect most rivers and watersheds, eroding ecosystem processes such as flood regulation or nutrient retention, drowning hundreds of kilometers of natural habitats and decreasing terrestrial and freshwater species (Grill et al. 2019; Schmitt et al. 2019). Therefore, although dams for hydropower generation contribute to Sustainable Development Goals (SDGs) such as climate action, they conflict with other SDGs, such as maintaining healthy ecosystems, food security in fisheries, and the resilience of cities on coastal plains and deltas (Schmitt et al. 2019). These previously underestimated but far-reaching environmental impacts of river damming worldwide should serve as a warning signal to prevent repeating the same mistakes with other renewable energies. A strategic mix of energy sources and better planning by deploying small facilities to generate electricity where consumed are demanded to mitigate the negative impacts of hydropower on natural ecosystems (Schmitt et al. 2019), offering thus guidance for planning the upcoming surge of wind and solar plants.

The land footprints of wind, solar and hydropower are dozens to hundreds of times larger than other alternatives to fossil fuels, such as nuclear power, with similar or even lower GHG emissions (Brook & Bradshaw 2014; van Zalk & Behrens 2018; United Nations Economic Commission for Europe 2021). However, evidence-based calls to seriously consider nuclear power as part of the energy mix needed to get rid of fossil fuels (e.g. Brook & Bradshaw 2014) seem to be systematically ignored or

rejected, as nuclear energy has been progressively ruled out from the energy transition debate, particularly in most advanced economies (Brook & Bradshaw 2014; United Nations Economic Commission for Europe 2021). Although countries like France (where the 70 % of the electricity comes from nuclear energy; World Nuclear Association 2021) or Finland (which plans to double from 30 to 60 % the contribution of nuclear power to electricity production; United Nations Economic Commission for Europe 2021) offer outstanding examples of the potential role of nuclear power in decarbonization while preventing habitat degradation, the presence of nuclear energy decreases in EU and US, while new reactors come online in India, Russia or China (IEA 2021). Furthermore, the latter considers nuclear energy within the renewable energy mix needed to meet international commitments towards climate neutrality (Lo 2021).

Since first reports on the topic, habitat degradation still ranks as the largest driver of biodiversity loss (e.g. a 68 % decrease in vertebrate populations since 1970), contributing between 4 and 14 times more than climate change (WWF 2020). Climate action is a Sustainable Development Goal that must be addressed without compromising other Agenda 2030 targets, such as preserving biodiversity (IPBES-IPCC co-sponsored workshop 2021). Halting habitat degradation while fighting against climate change will require to seriously re-consider the inclusion of nuclear power into the energy mix for a truly sustainable development, particularly considering that the global energy demand has no signs of slowing down (IEA 2021; United Nations Economic Commission for Europe 2021).

As occurring with renewables (IRENA 2019; IPBES-IPCC co-sponsored workshop 2021), innovation for solving major concerns (e.g. operating risks, long-term wastes,

high costs, use of alternative nuclear fuels) and developing nuclear fusion (van Zalk & Behrens 2018; Gibney 2021; IPBES-IPCC co-sponsored workshop 2021; United Nations Economic Commission for Europe 2021; Mallapaty 2021) should be better integrated in the political agenda to prevent that acting against climate change will contribute to boost habitat degradation and, in turn, biodiversity loss. As President Emmanuel Macron stated in December 2020: "Our energy and ecological future depends on nuclear power". Otherwise, we risk to degrade what is left of our already decimated nature in the name of climate change.

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Conflict of interests

The authors declare no conflict of interests