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ECHA
European Chemicals Agency

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Comments for Annex XV restriction report - Bisphenols with endocrine disrupting properties for the environment and their salts

Green Warriors of Norway/Norges Miljøvernforbund (NMF) acknowledges and welcomes ECHA's heightened concern for environmental exposure of endocrine disrupting bisphenols and the work to propose stronger restrictions. However, we suspect that the proposed derogations undermine the efforts in a large way. The proposed concentration limits may be set too high for some of product specific derogations, which undermine the purpose of stronger restrictions to protect the environment and human health.

As NMF has documented in earlier submitted consultations, one of the main delivery mechanisms for Bisphenols and other highly concerning chemicals and toxins, are within and bound to microplastic particles of various sizes and compounds. While bound to microplastic particles, the bisphenols may be protected from normal degradation in the environment, while they later may be released and activated at particulate conditions like temperature and acidic levels like we find in the digestive system of various organisms. This is what is referred to as the Trojan Horse effect. As the problem of microplastic pollution is environmentally accumulating in all environments and in all corners of the globe, and increasing at an almost exponential factor each year, this problem must be met with strong enough restrictions, and not too loose derogations, which may act as a smokescreen which the industry may be very comfortable under, while the environmental problems continue to rise.

One of the most concerning problems in this regard is linked to the proposed derogation of 65 ppm for the placing on the market of articles manufactured with solid and semi-solid epoxy resins. As we know, some of the applications for solid and semi-solid epoxy resins contribute a high volume of eroded microplastic particles into the environment, especially from Leading Edge Erosion (LEE) from wind turbine wings. This problem is huge and expanding as new sources of this kind of pollution are produced and deployed both on land and in the ocean at an alarming rate. The industry is known for under communicating this problem significantly, which often is noticed through loss of efficiency due to changed aerodynamic properties as the erosion grows. The claim that they have a protective coating that limits the erosion of the underlying epoxy composites is not very comforting, as many of the coating materials contain PFAS and other chemicals of concern.

Studies have shown that solid and semi-solid epoxy resins can release bisphenols through depolymerization in contact with various acids, like what different organisms have in their digestive systems.

As there currently is no proper methods available for large scale recycling of the vast amounts of worn out, damaged and decommissioned wind turbine blades, the industry has amongst others suggested making the solvability of the epoxy resins easier by changing the chemical composition. A too loose derogation level may therefore result in even more problematic chemical compositions that increase the problems and make even more of the bisphenols in solid and hardened epoxy composites available for release into the environment or into the food chain. We remain extremely concerned about the results of the proposed derogation levels and the impact it may get for the environment and human health.

Bisphenols and various types of epoxy compounds are closely linked. For microplastic particles from epoxy resins or other types of plastic, they hardly degrade in the environment, but only are broken into smaller and smaller pieces. This means that the pollution released each year are accumulated and added on top of all previous released microplastic particles pollution from all earlier years combined. This is not only a problem that affect the current population but will remain an environmental hazard for indefinite times forward. Even a total and immediate ban will not remove the problem as there are too many sources for this kind of pollution deployed around Europe and the globe already, but we can't afford to wait.

Bisphenols and other environmentally hazardous chemicals are one of the most important challenges the human race and the environment face today. As we acknowledge the importance regards to the climate emissions and an even bigger biodiversity crisis, bisphenols, and especially bisphenols and other chemicals of concern bound in microplastic particles of different kinds of epoxy compounds and other bisphenol containing plastic materials may be one of the most severe problems we face today and for the indefinite future. While lower carbon emissions may be mitigated by the environment because CO_2 and other greenhouse gases enter the natural cycles, microplastic particles and microplastic particles that contain bisphenols and other environmentally dangerous chemicals, may remain in the environment for several hundreds of years, and in the right conditions even depolymerize and release its hazardous load to the environment, the food chain and to humans.

NMF would therefore propose no or a much stricter derogation standards than the proposed values. We know that there's a lot of pressure from the epoxy industry and from the wind power industry, but a strict regime must be put in place if these problems are not to escalate into a state of no return.

It's not that many decades ago where ozone depleting chemicals like freon and other chlorofluorocarbons and hydrofluorocarbons were wreaking havoc on the ozone layer. The industry complained that it was impossible to make refrigerator systems or spray cans without these gases, and that there wasn't any replacement for them. A necessary and strict ban forced the industry to find good replacements almost overnight, and there was no shortage on either refrigerators or spray cans with more environmentally safe gases. The same must also happen towards the epoxy- and wind turbine industry. A strict restriction and no or very strict derogation levels for epoxy resins and compounds must be forced upon the industry with immediate action. Only that may force the industry to find viable alternatives to the very problematic bisphenol containing epoxy resins and compounds.

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As bisphenols are very troublesome for the environment and for human health, the microplastic particles are a significant environmental problem in itself, with or without containing bisphenols or other chemicals. Accumulation and non-degradation of these substances propose a high risk and indefinite problem of severe concern.

Bisphenols in food is only the tip of the iceberg.

EFSA, the European Food Safety Authority has recently lowered the tolerable daily intake (TDI) to a level that's 20,000 ti,es lower than the TDI set in 2015; [1] [2]

> *Compared to their previous assessment in 2015, EFSA's expert Panel significantly lowered the tolerable daily intake (TDI) for BPA, the amount that can be ingested daily over a lifetime without presenting an appreciable health risk.*
>
> *In 2015, our experts set a temporary TDI due to uncertainties in the evidence, highlighting the need for additional data on the toxicological effects of BPA.*
>
> *This new re-evaluation addressed most of these gaps and remaining uncertainties were taken into account when setting the TDI.*
>
> *EFSA's scientists established a TDI of 0.2 nanograms (0.2 billionths of a gram) per kilogram of body weight per day, replacing the previous temporary level of 4 micrograms (4 millionths of a gram) per kilogram of body weight per day.*
>
> *The newly established TDI is around 20,000 times lower.*

This means that BPA sources directly affecting our food are highlighted for concern, but this isn't the only ways BPA and other bisphenols enter our body. We also get increasing levels of BPA through our environment and through the food chain adding up on the total levels we are exposed to. Microplastic particles from epoxy resins containing bisphenols may become the largest source of these types of chemicals in the near future if we fail to put strong enough restrictions on production and deployment of new sources of such environmental pollution.

[1] https://www.efsa.europa.eu/en/news/bisphenol-food-health-risk

[2] https://ki.se/imm/bisfenoler

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Bisphenols, more problematic than previously known.

As the Annex XV Restriction Report on BPA and bisphenols of similar concern for the environment show that ECHA has taken the concerns around the highly negative environmental and health effects very seriously, we would highlight a few key factors of high concern.

1. Bisphenols are endocrine disrupting compounds (EDCs) that are exogenous substances that can stimulate or suppress endogenous hormone responses and are responsible for interfering with the reproduction and the developmental processes of living organisms.

2. Transgenerational health damage makes the concerns even more grave and serious. Studies of rainbow trout[3] and mice[4] have shown a transgenerational damage. Bisphenol A damages testicular junctional proteins transgenerationally in mice, and *Bisphenol* A in eggs causes development-specific liver molecular reprogramming in two generations of rainbow trout.

3. The cocktail effect where bisphenols act in combination with other endocrine disruptors and toxins way result in higher toxicity levels than each compound inflicts separately. Through both the environment and food we continuously expose us to a cocktail of chemicals that in sum results in increased toxicity levels. This is also true for all organisms throughout the food chain.

4. The ubiquitous occurrence of bisphenol A and its substitutes in the environment and their endocrine activity as well as adverse effects on aquatic organisms is a global concern, especially because many available literature reports show that many substitutes (e.g. bisphenol AF, bisphenol AP, bisphenol B, bisphenol C, bisphenol F, bisphenol G, bisphenol FL, tetrabromobisphenol A) exert adverse effects on aquatic organisms, similar to, or even stronger than bisphenol A.[5]

5. As most of these chemicals are not covalently bound to the polymer, they are susceptible to leaching to the surrounding medium at all stages of the plastics' life- cycle. Such leaching is enhanced at physiological temperature, low pH and in lipid-rich environments. Chemical toxicity following ingestion of microplastics may occur as they can act as vectors to transfer associated chemicals into the body.[6] Many studies show that BPA and its substitutes can migrate from BPs-based materials (polycarbonate and epoxy resins) during diffusion and hydrolysis at elevated temperature and in acidic or alkaline media. Thus, due to the widespread application of bisphenol A and its substitutes in many consumer products, these pollutants enter into the aquatic ecosystems primarily from effluent discharges in plants involved in the production, treatment and processing of BPs and BPs-based products, inefficient removal during wastewater treatments, leachate from landfills and domestic solid waste.[7]

6. Taking into account the negative effects that BPs may have on aquatic organisms, the use and

[3] https://www.researchgate.net/publication/320630432_Bisphenol_A_in_eggs_causes_development-specific_liver_molecular_reprogramming_in_two_generations_of_rainbow_trout/fulltext/59f37f8ca6fdcc075ec349ab/Bisphenol-A-in-eggs-causes-development-specific-liver-molecular-reprogramming-in-two-generations-of-rainbow-trout.pdf?origin=publication_detail

[4] https://www.sciencedirect.com/science/article/abs/pii/S0269749122002810?via%3Dihub

[5] https://www.sciencedirect.com/science/article/abs/pii/S0045653523000292?via%3Dihub

[6] https://microplastics.springeropen.com/articles/10.1186/s43591-021-00022-y#Abs1

[7] https://www.sciencedirect.com/science/article/abs/pii/S0045653523000292?via%3Dihub

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production of compounds that are detected in high concentrations should be banned or reduced. Phytoplankton is composed of several taxonomic groups, such as e.g. cyanobacteria, diatom and green algae. These photosynthetic microorganisms play a key role in the food web as the primary producers as well as in mediating carbon, nutrient (N and P) and oxygen biogeochemical cycles in the aquatic ecosystems. Therefore, the occurrence of BPA and its substituents in the aquatic environment might affect not only the biodiversity and productivity of phytoplankton communities but might also cause serious adverse effects on other organisms at higher trophic levels. As a result, it might affect the proper functioning of entire aquatic ecosystems.[8]

7. The industry has largely under communicated the amount and severity of such erosion, not at least the large amounts of particles and fragments from wind turbine blade accidents.[9]

8. Two recent scientific reports from Sweden[10] and from the Republic of Korea[11] show that some of the existing scientific knowledge is dominated by publications associated with the industry. This raises concern for the new established TDI of 0.04 ng BPA/kg per day may still being too high. The same principle is the case for the official numbers of micro plastics particles eroded from wind turbine blades into the environment. Most of the data is directly produces by the very same industry which has a financial gain of keeping the numbers as low as possible. It's also a known fact that the total amount released into the environment, in reality is much higher than the natural erosion by itself, due to current methods and procedures of in situ maintenance and repair.

Does the scientific knowledge reflect the chemical diversity of environmental pollution? – A twenty-year perspective
Kristiansson, E., Coria, J., Gunnarsson, L. et al (2021)
Environmental Science and Policy, 126: 90-98 [12]

Environmental policymaking relies heavily on the knowledge of the toxicological properties of chemical pollutants. We also show that university- and corporate-based research exhibit distinct publication patterns and that for some chemicals the scientific knowledge is dominated by publications associated with the industry.

In this study, we investigated the scientific knowledge on environ- mental chemical pollution generated by the research community over the last two decades.
Our results show significant changes in the research agenda with decreasing publication frequency of chemicals used as plant protection products while the publication frequency of pharmaceuticals increased.

We could, furthermore, conclude that the ecotoxicological research community is

[8] https://www.sciencedirect.com/science/article/abs/pii/S0045653523000292?via%3Dihub

[9] https://www.researchgate.net/publication/371599607_The_toxic_wings_-_Damage_and_casualty_of_wind_turbine_blades

[10] https://www.sciencedirect.com/science/article/pii/S1462901121002537?via%3Dihub

[11] https://www.sciencedirect.com/science/article/abs/pii/S0304389421010402?via%3Dihub

[12] http://dx.doi.org/10.1016/j.envsci.2021.09.007

highly focused on a few well-studied chemicals, especially heavy metals, and this raises concerns about our ability to sufficiently cover the large chemical diversity of environmental pollutants.

There is, indeed, a large number of chemicals for which no, or very little, knowledge is available or where the knowledge is, to a large extent, generated through corporate-associated research.

We conclude that a continued expansion and/or a reprioritization of the ecotoxicology research is necessary to meet the challenges associated with the increasing chemical diversity of the expanding chemosphere and to ensure that the need for independent and objective scientific knowledge *– as requested by the society – are properly met.*

Highlights
Environmental Science & Policy
Volume 126, December 2021, Pages 90-98

1. *The ecotoxicological research has been highly focused and as few as 65 chemicals dominates the scientific literature.*
2. *Over the last twenty years, the research interest has increased for pharmaceuticals and decreased for biocides.*
3. *Corporate-associated research has distinct publication patterns and compose large parts of the knowledge for some chemicals.*
4. *A large number of chemicals have little to no scientific knowledge about their toxicity.*
5. *Expansion of the ecotoxicological research field is necessary to catch up with the increasing diversity of the chemosphere.*
6. *"The scientific ecotoxicological knowledge is growing but it is not clear to what extent the research community manages to cover the large chemical diversity of environmental pollution." and*

"We also show that university-and corporate-based research exhibit distinct publication patterns and that for some chemicals the scientific knowledge is dominated by publications associated with the industry.

We conclude that there is a large number of chemicals with little, or no, scientific knowledge and that a continued expansion of the field of ecotoxicology will be necessary to catch up with the constantly increasing diversity of chemicals used within the society."

Environmental Science & Policy
Volume 126, December 2021, Pages 90-98

9. The report on BPA from the Republic of Korea highlights the problem with industry driven research and manipulation even further: [13]

[13] https://www.sciencedirect.com/science/article/abs/pii/S0304389421010402?via%3Dihub

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Drivers of owning more BPA

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4. Suspicious reference doses: do we need more evidence?

Despite the variety of human health effects following exposure to low doses of BPA, in a provisional CLARITY–BPA report, the US FDA stated that the currently approved doses (both TDI and NOAEL) are still safe (FDA, 2018). This statement is factually inaccurate and has been forcefully refuting by many experts (Vandenberg et al., 2019; Vom Saal, 2019).

Indeed, industrial lobbyists might have been responsible for driving such a decision. ***It has been noticed that industrial lobbyists use different strategies, such as sponsoring industry-friendly researches, limiting access to the information on risks of endocrine-disrupting chemicals (EDCs), launching misleading websites, influencing international trade negotiations, and using financial agreement to defeat BPA banning bills (Janssen, 2010; Erler and Novak, 2010).*** *For example, the NTP panel's review in 2001 indicated credible evidence that low doses of BPA produce harmful effects on specific endpoints' (Gross, 2007). To refute these findings, the American Plastics Council, consisting of all the major BPA producers and their trade groups, commissioned a review from the Harvard Center for Risk Analysis (HCRA). Surprisingly, the HCRA released a report showing that "the weight of the evidence for low-dose effects of BPA is very weak" (Gross, 2007).* ***Besides, the chemical industries have adopted fear tactics claiming that all canned food would disappear from store shelves if BPA bans were passed and have tried to manipulate the legislative process (Janssen, 2010; Erler and Novak, 2010). Moreover, their financial resources and a vast network with legislators made industrial lobbyists an unformidable force opposing the effort to pass more stringent regulations.*** *As such, the regulatory agencies, industrial researchers, and lobbyists' conscious efforts to sustain BPA uses might eventually follow the similar path of sugar overused in everyday food despite its harmful impact on healthy living. Therefore, it is vital to public health that the levels of BPA exposure be redefined according to the prevailing scientific consensus.*

These findings are also in accordance with our experience. One example is Leading edge erosion (LEE) data, where microplastic particles from wind turbine wings are eroded and released into the environment, where a significant amount contains BPA. Media and the industry, in unison, rely unfiltered on undocumented data from the industry and their lobby groups. Any questions, even when documented by scientific findings, are automatically "debunked" by the same undocumented claims.

What they don't tell you..

Most of the information on LEE (Leading edge erosion) is based on natural occurring erosion, as rain, hail, airborne particles from salt and sand and other causes. What the industry never mentions is the other source of microplastic particles to the environment where much also contain BPA, which is the common procedure of in situ reparations. When mechanical open-air sanding is the main part of the operation, the amounts of microplastic particles released into the environment may even exceed the amounts caused by natural erosion. In most cases, where in situ maintenance repair procedures appear, you can easily at least double the industry pollution volume claims. It's not likely, however, that the financial beneficiaries have any interests than to keep their pollution data as low as possible.

No microplastics pollution here..? Image show the commonly used practice of open air mechanical sanding at an in situ repair job. The industry won't tell you this, but this is common practice. Image from: YouTube.

More on LEE (Leading edge erosion) and the common industry practice of in situ maintenance and repair on wind turbine wings further down below.

We see that most of the research on this field are in large extent only focused on the economic side of the effect loss caused by LEE. It is also of concern that there's no industry standard defining Wing Tip Speeds as a parameter.

Most of the offshore wind plants in central and southern parts of Europe are in shallow waters where maintenance operations might be considered relatively easy to conduct. Still, they are conducted on a purely cost based cycle, rather than environmental concerns. When a wind turbine wing starts to erode, the process is rapidly increasing. Too long intervals in a maintenance cycle may therefore pose an unnecessary extra pollution factor, compared to an environmental focused maintenance cycle.

In Norway, most of the proposed offshore wind farms will, due to the added depths mostly be floating constructions far from shore. This is expected to increase the difficulty and costs of maintenance operations significantly, which is no good sign for the environment in regard to the pollution of micro

plastic particles and BPA. Also worth noting is that deep sea offshore wind still has to be constructed and built, and therefore must be considered as potential new sources of this problematic and non-biodegradable pollution.

These findings are also collaborated by another recent report, "A probabilistic rainfall model to estimate the leading-edge lifetime of wind turbine blade coating system" (2021), by Amrit Shankar Verma, Zhiyu Jiangb, Marco Cabonic, Hans Verhoef, et al., that states that:

> **A probabilistic rainfall model to estimate the leading-edge lifetime of wind turbine blade coating system** /2021)
> Amrit Shankar Verm, Zhiyu Jiang, Marco Cabonic, Hans Verhoef, Haraldvan der Mijle Meijer, Saullo G.P.Castroa, Julie J.E.Teuwen
>
> **Abstract**
> ***Rain-induced leading-edge erosion of wind turbine blades is associated with high repair and maintenance costs.*** *For efficient operation and maintenance, erosion models are required that provide estimates of blade coating lifetime at a real scale. In this study, a statistical rainfall model is established that describes probabilistic distributions of rain parameters that are critical for site-specific leading-edge erosion assessment. A new droplet size distribution (DSD) is determined based on two years' onshore rainfall data of an inland site in the Netherlands and the obtained DSD is compared with those from the literature. Joint probability distribution functions of rain intensities and droplet sizes are also established for this site as well as for a coastal site in the Netherlands. Then, the application of the proposed model is presented for a 5 MW wind turbine, where the model is combined with wind statistics along with an analytical surface fatigue model that describes lab-scale coating degradation.*
>
> ***The expected lifetime of the blade coating is found three to four times less for the wind turbine operating at the coastal site than for the inland site - primarily due to rainfall at higher wind speeds.*** *Further, the robustness of the proposed model is found consistent with varying data periods used for the analyses.*
>
> **1.1. Background**
> *The continuous demand in the growth of renewable sources of power production has led to rapid growth in the wind energy sector. Wind turbines, both at onshore and offshore locations, are in high demand and it is expected that by 2050, half of the EU's1 electricity demand will be met by wind energy alone.*
>
> *In order to achieve this goal, the current market trend involves deploying turbines with higher power ratings, along with turbines deployed at locations with larger wind speeds such as near coastal and offshore locations.* ***Such classes of turbines are profitable to the industry, however, this also presents enough challenges to the wind turbine owners and operators, especially from a maintenance perspective. For instance, large size blades rotating at high tip speeds are exposed to harsh environmental conditions such as frequent exposure to rainfall, thereby causing material degradation at the blade's leading-edge - commonly referred to as rain-induced leading-edge erosion (LEE) of WTBs.***
>
> *The impact between rain droplets and the rotating blade at high tip speeds, typically in the range of 70–110 m/s, develops large impact pressure, subsequently leading to a combination of complex damage modes such as pitting, roughening of the leading-edge surface, fatigue failure*

of the blade coating, and eventually structural damage. In Ref., it has been found that LEE increases the drag coefficient of the aerofoil section by more than 314% and decreases the lift coefficient by around 53%, thereby reducing the overall aerodynamic efficiency of the WTB. ***The damage modes associated with LEE and their effects on the turbine's performance can appear in less than two years of the blade's service life,*** *while the blade is expected to last for atleast 15 years continuously.*

As a result, costly repair and maintenance work is imperative to be performed in order to maintain the design power curve of the wind turbine, thereby contributing to the overall increase in the cost of energy. *It has been reported in Refs. that LEE repair and maintenance expenses cost the European offshore wind turbine sector over £56 million annually, and hence LEE of WTBs requires urgent attention.*[14]

The many challenges this report lists as severe obstacles before the wind power industry reaches an acceptable cost/benefit level on maintenance and lifetime of the turbine blades, doesn't seem to be reached anytime soon. Offshore wind will therefore remain a costly and expensive alternative, purely based on economic criteria. Deep sea offshore wind farms will also contribute to even higher costs due to the complexity of the installations itself, and the increased difficulties and costs associated with maintenance and repair operations. The effects of LEE can be triggered in less than 1 to 2 years for some wind turbine sites, whereas it may take several years for others.

[14] https://doi.org/10.1016/j.renene.2021.06.122

Current practice of in situ repair and maintenance adds significant amounts of microplastics erosion to the environment.

While production of wing turbine blades is conducted in closed environments with strict procedures for work environment and filtering, most of the repair jobs are conducted in situ. Whether the operation is conducted by personnel hanging in ropes or by robots, most of the examples we have found are open air solutions where all microplastics and dust is released directly into the environment.

We must also assume that the volume removed mechanically by sanding machines are no less than what has been eroded naturally by LEE (Leading Edge Erosion). The governing authorities must put immediate and strict restrictions on all maintenance operations and ban all open-air procedures.

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Mechanical erosion and the release of microplastic particles directly into the environment, contaminating land, soil, waterways and at the end, the ocean. These practices with in-situ repair without any concern for the environment and pollution must be taken into the consideration regarding the very high (loose) proposed derogation of 65 ppm for the placing on the market of articles manufactured with solid and semi-solid epoxy resins. This industry isn't mature or responsible enough to handle a loose derogation that allow them to continue with this without significant restrictions.

The volume, problems resulting with the release of microplastic particles containing harmful chemicals to the environment through Leading Edge Erosion is bad enough in itself. When much of the collective industry show this kind of negligent attitudes and practices, they must be met with very strict regulations and restrictions.

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Accidents do and will happen.

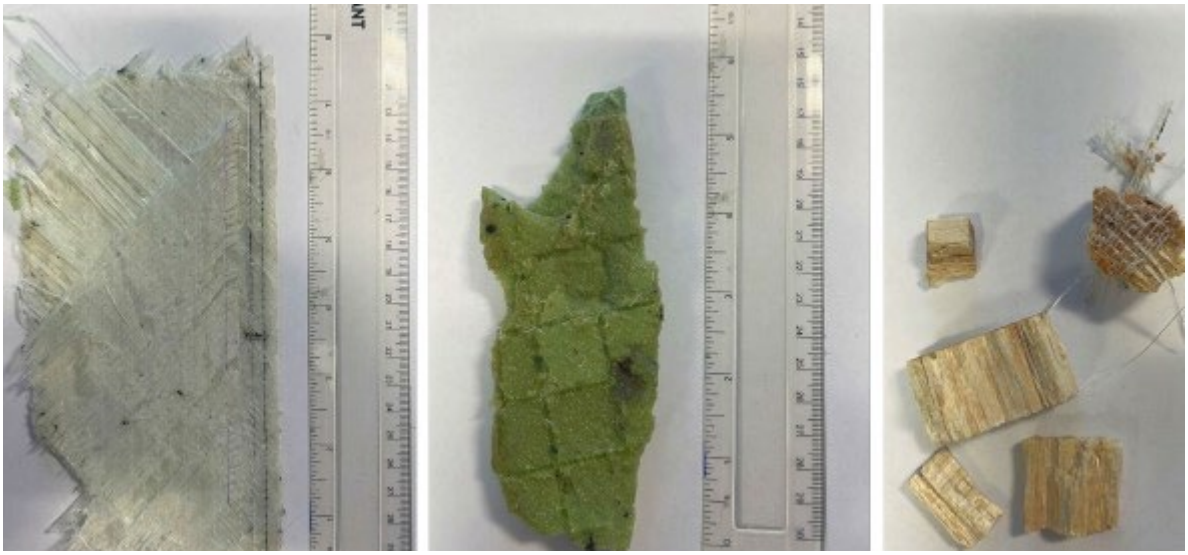
One thing never changes, and that is the fact that accidents do and will happen.

Here is a compilation of some of the many accidents regarding wind turbines around the world.[15]

Offshore wind power plants also pose a heightened risk of collision with ships and other sea born vessels. Operations on the offshore turbines is also a posed risk factor that must be considered.

Just as recently as late October this year 21.10.2021, three 61-metre blades fell into the sea during a major component exchange at Ormonde offshore wind farm in the UK.

> *A hub, three 61-metre blades, and blade clamping tool have fallen into the sea during major component exchange at the Ormonde offshore wind farm in the UK, with majority of the parts and tools now resting on the seabed and debris from one broken blade reported to be on the sea surface.*
>
> *The MPI Adventure jack-up vessel was positioned alongside the wind turbine B01 when the parts fell into the water, adjacent to the vessel and in proximity to the B01 turbine.*
>
> *Along with the three turbine blades weighing 126 tonnes and blade clamping tool weighing around 3 tonnes, a hub containing three pitch motors, batteries, four electrical cabinets, grease pumps and other components was also dropped.*



Debris has fractured off from one of the blades and will likely reach the shore.[16] [17]

Video:
https://www.youtube.com/watch?v=HF5w2eWcKjI

[15] http://www.caithnesswindfarms.co.uk/fullaccidents.pdf

[16] https://www.offshorewind.biz/2021/10/21/turbine-parts-dropped-into-sea-at-ormonde-offshore-wind-farm/?fbclid=IwAR3zF9FM6IUWtYdNy_bJDHJ7UUpoYsx9FIR9X91gOv38bBql12MVI0Q-iLE

[17] https://www.offshorewind.biz/2021/10/25/update-video-rotor-hub-and-blades-fall-into-sea-at-ormonde-owf-coastal-debris-could-be-widespread/

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Actual accident data or statistics are hard to come over, as the industry obviously have a vested interest in downplaying any problems regarding wind turbine blade leading erosion (LEE), maintenance cycles and accidents. Some information on the subject comes however to the surface from time to time, but it is scarce and far between. As stated in their latest May 2023 report *"The toxic wings - Damage and casualty of wind turbine blades"*, Solberg, Rimereit and Weinbach states the following;

> *We have to go to Scotland against spin's website to find Mishnaevsky's (2022) sources for the extent of damage in the report "Root Causes and Mechanisms of Failure of Wind Turbine Blades: Overview"[18], there we can read:*
>
> > *"In June 2015, the wind industry's own publication "WindPower Monthly" published an article confirming that*
> >
> > *"Annual blade failures estimated at around 3,800", based on Gcube information.*
> >
> > *"Wind turbine rotor blades are failing at a rate of around 3,800 a year, 0.54% of the 700,000 or so blades that are in operation worldwide."[19]*
>
> *This is almost verbatim what Mishnaevsky (2022) writes in his report, but without disclosing the source or informing that these are figures published by the wind turbine industry and not figures from neutral sources.*
>
> *With our knowledge and familiarity with developments in the wind turbine industry, it is reasonable to believe that the extent of damage and accidents has not decreased since 2015. We base this on the fact that wind turbine wings have doubled in size since 2015 and we are approaching what is physically possible with today's plastic materials (glass fiber reinforced epoxy plastic/carbon fiber reinforced epoxy plastic).*
>
> *Furthermore, we see that wind turbines are increasingly being deployed in tougher climatic conditions.*
>
> *If we combine this knowledge with the extensive scope of research into how to prevent injuries and accidents, it gives a clear impression that the problem is increasing.*
>
> *"All potential causes of damage to wind turbine blades strongly depend on the surrounding environment and climate conditions. Consequently, the selection of an installation site with favourable conditions is the most effective measure to minimize the possibility of blade damage."[20]*

[18] https://doi.org/10.3390/ma15092959

[19] https://www.windpowermonthly.com/article/1347145/annual-blade-failures-estimated-around-3800

[20] Katsaprakakis, D.A.; Papadakis, N.; Ntintakis, I. A Comprehensive Analysis of Wind Turbine Blade Damage. Energies 2021, 14, 5974.

The insurance industry (Gcube) published the following notes on wind turbine failures in 2018:[21]

> *1. Failure of operators to carry out sufficient due diligence through maintenance checks is of increasing concern, and;*
>
> *2. Operating wind farms outside of design parameters has been cited as a significant contributor to fires.*

Given what we know from research and our material knowledge of today's wind turbine blades, it is more likely to expect an increase in damage and breakdowns. How much is difficult to say, but if the extent is 1%, or more, it will not surprise us. We must bear in mind that what we know of damages and breakdowns probably constitutes the ***"tip of the iceberg".***[22]

Further concluding the obvious lack of clear and up-to-date information from the industry, Solberg, Rimereit and Weinbach provides this observation;

> *That recognition is so disturbing that we have felt obliged to share research that shows that operating and maintenance costs increased in line with the size of the wind turbines, and that they increased in particular for marine turbines. This at least gives an argument to decisionmakers who are worried about the consequences of the release of plastic – a lot more plastic - and contamination of the food chain.*
>
> *The entire western world has enumerated and adopted gigantic development targets with this unproven technology, and that without having a scientific basis for the overall scope of consequences for HSE (health, safety and environment). It is almost unbelievable, and we know of no other industry that have been allowed such "Wild West" conditions ever.*[23]

More microplastic particles containing bisphenols and other troublesome chemicals are released into the environment than ever before. The problem of erosion (LEE) is much greater than the industry will admit. A newly released DNV report[24] states that.

> *While operational expenditures have always been notable for wind projects, the decrease in predictability around blade reliability, multiplied by potentially high repair costs, very high replacement costs, and lost revenue due to turbine downtime, has the potential to add financial uncertainty and thus increase the cost of capital to build new wind projects. DNV perceives blade durability as a major challenge the wind industry must address.*
>
> *DNV has been engaged in supporting activities around blades through their life cycle since the industry's inception. In recent years, DNV has observed significant challenges and costs related*

[21] https://scotlandagainstspin.org/turbine-accident-statistics/

[22] https://www.researchgate.net/publication/371599607_The_toxic_wings_-_Damage_and_casualty_of_wind_turbine_blades/link/648b900dc41fb852dd094a5c/download

[23] https://www.researchgate.net/publication/371599607_The_toxic_wings_-_Damage_and_casualty_of_wind_turbine_blades/link/648b900dc41fb852dd094a5c/download

[24] https://www.dnv.com/Publications/the-challenges-of-wind-turbine-blade-durability-243601

to blade damage at operational projects globally. Sources for DNV's observations include comprehensive surveys of damage rates as well as accumulation of deep experience in specific blade failures and root causes.

The rate of critical damage well exceeds that which would be expected based on targets in design standards. While the observed rate of damage is not clearly increasing, it is also not decreasing, as one would expect given advancements in materials, processes, and tools available in recent years, as well as decades of experience within the leading original equipment manufacturers (OEMs), both turbine OEMs and blade OEMs.

Further, even with a steady rate of damage, the scale of the problem has grown as blades have become larger, more expensive, greater in quantity, and more complex to field repair. Further, when larger blades fail, the safety and environmental risks are greater.

Specific trends that DNV has observed are:

- *Higher uncertainty in blade maintenance costs for new blade models.*
- ***Significant blade problems affecting the industry, including top tier turbine and blade manufacturers, requiring large, time-consuming inspection campaigns.***
- *Significant numbers of turbine collapses due to blade failure.*
- *An increase in severe lightning damage, particularly on blades with carbon components.*
- *Structural blade damage initiating from relatively minor features that would not have been expected to have propagated in the past, for example, at conventional details such as core ramps.*
- ***Higher incidence of severe leading-edge erosion early in operating life.***

While operational expenditures have always been notable for wind projects, the decrease in predictability around blade reliability, multiplied by potentially high repair costs, very high replacement costs, and lost revenue due to turbine downtime, has the potential to add financial uncertainty and thus increase the cost of capital to build new wind projects. DNV perceives blade durability as a major challenge the wind industry must address.

All this contributes to severe microplastic erosion from the wind turbine blades, where the particles can contain chemicals like PFAS, bisphenols and other troublesome chemicals to the environment. Additionally moist absorption from sea- and freshwater into epoxy compounds can degrade the materials faster through osmosis.[25] Combined with damages from hitting airborne particles in high speed (wing tip can reach 300 km/h or more) and pitting erosion, osmosis can accelerate the degradation of wind turbine blades on an increasingly rapid rate. The amounts of such microplastics released into the environment are not insignificant, contributing to an accumulative pollution problem.

[25] https://www.researchgate.net/publication/270230151_Environmental_Effects_on_Mechanical_Properties_of_Glass-Epoxy_Composites

Not addressing the problem with strong enough restrictions may also violate EU's Water Framework Directive

The continued and growing problem of microplastics pollutions from epoxy resin and other plastic compounds, with or without the presence of bisphenols, from deployment of new sources of pollution and the failure to mitigate existing ones may even be in clear violations of the 2000/60/EF Water Framework Directive (WFD) amongst other appropriate directives and regulations. Even at the current annual amount of pollution of this kind released to the aquatic environment, the degradation of the water bodies and aquatic and marine life may reach a level where the breach is reaching a point of no return. Once the microplastic particles, with or without bisphenols or other hazardous chemicals, from epoxy resins and other plastic compounds are released into the environment we can never get them out again. As many, if not most, of the European wind turbines are situated close to wetlands, waterways and the ocean, the 2000/60/EF WFD applies to all parts of this industry. Even microplastics and microplastics containing PFAS, bisphenols and other chemicals will reach different kind of terrain and soil, and over time be washed out into the waterways and all the way out to the ocean. The water bodies can therefore be exposed to this kind of pollution in two main ways: direct impact on the water bodies, and indirect via soil and ground. In the end, almost everything ends up in the waterways or the ocean.

> *The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:*
>
> > *(a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;*
> >
> > *(b) promotes sustainable water use based on a long-term protection of available water resources;*
> >
> > *(c) aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;*
> >
> > *(d) ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and*
> >
> > *(e) contributes to mitigating the effects of floods and droughts and thereby contributes to:*
> >
> > > *- the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use,*
> > >
> > > *- a significant reduction in pollution of groundwater,*
> > >
> > > *- the protection of territorial and marine waters, and*
> > >
> > > *- achieving the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment, by Community Page 4 of 15 action under Article 16 (3) to cease or phase out discharges, emissions and losses of priority hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.* [26]

Given the high volume of deployed wind turbines across Europe, Scandinavia and the world, pollution of microplastics from erosion, containing bisphenols, PFAS and other highly disruptive and toxic chemicals are clearly conflicting and in violations with 2000/60/EF Water Framework Directive (WFD).

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[26] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02000L0060-20141120&qid=1485938661229&from=EN#page=9

Conclusion and call for stricter derogations.

NMF acknowledges ECHA's heightened concern for environmental exposure of endocrine disrupting bisphenols and the work to propose stronger restrictions. However, we suspect that the proposed derogations undermine the efforts in a large way. The proposed concentration limits may be set too high for some of product specific derogations, which undermine the purpose of stronger restrictions to protect the environment and human health.

One of the most concerning problems in this regard is linked to the proposed derogation of 65 ppm for the placing on the market of articles manufactured with solid and semi-solid epoxy resins. This problem is largely connected to the high amount of wind turbines across Europe and rest of the world, not the least of which the level and amount of microplastic particles from epoxy composites and other plastic materials are significantly higher than the industry will acknowledge. These particles serve as a delivery mechanism that in a high degree protect the chemicals from normal degradation, while depolymerization can happen in acid environments like the digestive system of various organisms. In this way, the chemicals may be released into the food chain in a higher amount than normally can be found in solid and semi-solid epoxy resins. Due to this we need much stronger restrictions for those applications and on the epoxy industry at large than the slack derogation limits proposed in the ECHA Annex XV restriction report.

The industry has reacted and managed big changes before when forced by restrictions, ie. the use of freon gas and other CFCs regarding the problem with the alarmingly expanding ozone hole that peaked a couple of decades ago. The industry managed the transition well despite early complaints of impossibility. This show that the industry will manage a transition to safer methods and materials once they are forced through strict restrictions.

NMF will therefore present a call for a much stronger restriction on the epoxy industry than what is proposed in the derogation limits as suggested in the Annex XV restriction report. If not, the problem will escalate beyond what's tolerable for both the environment and to human health. Remember that microplastic particles mostly does not degrade normally in the environment. It only is broken up in smaller and smaller pieces. Each year's pollution is accumulated and added on top of all earlier years pollution. We therefore call for immediate action in this regard.

NMF will also call for ECHA to check any and all proposed derogations for compliance with 2000/60/EF Water Framework Directive (WFD). From our wiewpoint, and given the obvious lack of responsible attitude, environmental concern, and practices from the epoxy/wind power industry, the proposed derogation of 65 ppm for the placing on the market of articles manufactured with solid and semi-solid epoxy resins seems to be set way too high (loose) and may also be non-compliant and also in direct conflict with the provisions and intent of the 2000/60/EF Water Framework Directive.

With green regards,
Green Warriors of Norway
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