Interreg North-West Europe Care-Peat

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INTERREG CARE-PEAT

Theoretical business case for using renewable energy sources to fund the restoration of peatlands

REPORT

Theoretical business case for using renewable energy sources to fund the restoration of peatlands

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Table of contents

Glossary of terms

Carbon market:
Marketplaces through which regulated entities obtain and surrender emissions permits (allowances) or offsets in order to meet predetermined regulatory targets.

Carbon sequestration:
The process of capturing and storing atmospheric carbon dioxide.

Carbon sink:
Natural environment viewed in terms of its ability to absorb carbon dioxide from the atmosphere.

Drained:
A conditional category of peatland. Peatland is considered ‘drained’ if it is within 30 metres of an artificial drain or a natural drain formed by the presence of a hagg or gully.

Greenhouse Gases (GHG):
Greenhouse gases are all gases that contribute to the greenhouse effect of the Earth or global warming of the Earth’s atmosphere that is leading to climate change. The Kyoto Protocol recognises 6 said gases: carbon dioxide; methane; hydroflurocarbons; nitrous oxide; perfluorocarbons and sulphur hexafluoride.

Peatland:
Areas of land with a naturally accumulated layer of peat, formed from carbon rich, dead and decaying plant material under waterlogged conditions.

Renewable energy sources:
Come from natural sources of energy or processes that are constantly replenished such as wind power or hydro power.

Restoration:
Achieved by movement of peatland condition to a category with a lower associated emissions factor.

Turbary rights:
the right to cut turf or peat on a common land or on another person's land.

Executive Summary

This report examines new sources of financing for the restoration of degraded peatlands using income from co-located renewable energy sources and provides proposals for the compensation of turbary rights holders. Three renewable energy sources were selected toward this task: wind generation, solar generation and the use of biomass for district heating. These were examined in D1.4 and our conclusions have gone through a validation process by consultation with key stakeholders.

Wind energy

Irish government policy encourages the development of wind energy on degraded peatlands to allow them to meet their greenhouse gas reduction targets. Bord na Móna the semi state organisation in charge of industrial scale peatland exploitation has transformed into a peatland restoration organisation while shifting its primary focus towards wind energy development on its degraded peatlands. It is not always the case that degraded peatlands are used for this kind of development as out of the 39 wind farms of peatlands referenced, 20 are located on relatively intact blanket bogs. Several bog bursts were observed during the development of such wind farms that not only destroy the peatland habitat but also pose a massive risk to drinking water supplies, cause juvenile fish kills and destruction of the aquatic environment. Wind power is already established in Ireland including on drained peatlands. Wind turbines installed on peatlands can supply a good stream of income for both restoration and compensation for the loss of turbary rights. However, future development on near natural peatlands should be discouraged.

Solar energy

Traditionally, Ireland looks in the direction of wind energy for most of its renewable energy production (85% of the total) but with the sharp decline of the price of photovoltaic (PV) panels in the last few years coupled and with their increasing ability to produce electricity from indirect sunlight (ie. during cloudy weather), solar energy is now potentially a viable option for Ireland. Solar PV as a source of electricity generation on peatlands is not well developed in Ireland. Large PV farms on peatlands are not encouraged because they inhibit the growth of *Sphagnum* moss and other peatland species.

Biomass

While biomass is not currently an important contributor of the Irish energy mix, it has the potential to have a much bigger role. For example, biomass generated from wet peatlands combined with the food generated for animal husbandry could be used to create bio-methane in digesters for energy generation. Biomass for district heating schemes could be the best renewable energy option for financing peatland restoration and providing compensation for the loss of turbary rights.

Introduction

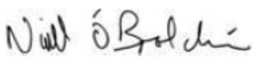
This report validates new sources of financing for the restoration of degraded peatlands from colocated renewable energy and provides proposals for the compensation of turbary rights holders. It is part of a draft toolkit of different socio-economic models and use cases (or business cases) to promote peatland restoration. The overall focus of this toolkit is on ecosystem services and integrated landscape strategies designed to promote the roll-out of developed techniques and methods for peatland restoration. This use case / business case focuses on validating with stakeholders the use of revenues from renewable energy projects to facilitate and fund Peatland Restoration across the EU and particularly in Ireland. While several successful trials have been carried out in Ireland examining the restoration of degraded peatlands for carbon sequestration, project financing either came from research funds or from the landowners themselves. In general, no reference was made of turbary rights. Different avenues to validate the financing of restoration works on degraded peatlands and compensation of turbary rights are reviewed in this document.

The conclusions of this report are clear.

1. Yes, to wind energy co-location but only in cases where peatlands are badly degraded and the revenue from the windfarms is used to fully restore the peatlands.

2. No, to solar farms on peatlands as they inhibit plant growth.

3. Yes, to the use of biomass for district heating schemes collected from restored peatlands, especially when it is used as a replacement for turf cutting and the relinquishment of turbary rights.



Niall Ó Brolcháin

Scope

The aim of this document is to validate the requirements and steps needed to avail of income from renewable energy sources to finance both the restoration of degraded peatlands and the compensation of turbary rights holders. Three renewable energy sources were selected toward this task: wind generation, solar generation and the use of biomass for district heating.

The topics presented and discussed in this document are:

- The present situation of each renewable energy source.
- The advantages and disadvantages of each renewable energy source.
- A use case for each renewable energy source.
- A conclusion for each renewable energy source.
- Validation of each conclusion.
- A list of recommendations.

This report aims to provide the basis for developing socio economic measures to finance the restoration of degraded peatlands and the compensation of turbary rights holders with a focus on Ireland.

This document will not investigate any other sources of financing apart from those stated above.

Context

It is important to understand the significance of peatlands in the context of global GHG emissions to fully appreciate the need for developing socio-economic models to finance their restoration and preservation on a sustainable basis.

According to the MoorFutures® [1] policy document, peatlands account for only 3% (circa 4 million km2) of the total global land area while they contain more than 30% of all global soil carbon weighing in at roughly 500 Gigatonnes (Gt). To put this in context, that is more than 1,000 times the weight of every single human being currently living on planet Earth or 100 billion African bull elephants or twice the total amount of carbon held in the biomass of all the world's forests.

Peat-forming lands are particularly rich in organic matter. Peat accumulates in areas where the decomposition of plants is slowed due to wet conditions, which results in a large store of carbon accumulated over thousands of years. **Fully functional, healthy peatlands are the most space efficient long-term carbon store and sink in our planet's biosphere.** This carbon storing organic matter (peat) is derived from dead and decaying plant material under conditions of permanent water saturation. Peatlands are characterized by an incomplete cycling of matter, resulting in a positive carbon balance.

Many peatlands are degraded and emit rather than store carbon. Global annual GHG emissions from drained organic soils are roughly 1.6 Gigatonnes CO_2eq/year at least twice that emitted directly from aviation. About 15% of the world's peatlands have been drained for agricultural conversion, burning and mining for fuel and **globally the EU is the second largest emitter** of GHG from drained peatlands (0.22 Gt CO_2eq/year or 15% of total global peatland emissions). This is equivalent to circa 5% of the official EU greenhouse gas emissions total of 4.483 Gt CO_2eq/year in 2017. Peatland emissions are reported by EU countries in their National Inventory submissions to UNFCCC but are not yet fully accounted for in the National Inventories [from January 2021, the UK National Inventory does incorporate peatland emissions].

Europe is the continent with the largest peatland losses, where peat has ceased to accumulate in over 50% of former peat areas and few of our peatlands are in a near-natural or rewetted condition. When drained or burned for agriculture, peatlands release centuries of stored carbon into the atmosphere, turning from being a carbon sink to a carbon source. CO_2 emissions from drained and burned peatlands equate to circa 10% of all annual fossil fuel emissions.

The largest peatland emitters in the EU are Germany, Finland, United Kingdom (in the EU pre-Brexit), Poland, Ireland, Romania, Sweden, Latvia, Lithuania, and the Netherlands. In most of these countries, drained peatlands contribute to more than 25% of total emissions from agriculture and agricultural land use while **99% of EU peatland emissions** are caused by **16 of the 28 EU Member States**. These emissions can be significantly reduced by raising water levels near to the surface (e.g. by drain blocking or by stopping pumping), which reduces emissions and protects the remaining peat carbon store.

[1] www.moorfutures.de

Afforestation on drained peatlands is an inappropriate mitigation measure and can result in increased net carbon emissions. In the long term, a complete cessation of peatland drainage and reversal of the effects of existing drainage is unavoidable if we want to reach the core goal of the Paris Agreement - zero net emissions by 2050. The EU and all its Member States have unanimously affirmed this goal.

The negative consequences of this type of land use are becoming increasingly obvious. Drainage allows oxygen to enter the soil, leading to microbial decomposition of the peat and thereby breakdown of the stored carbon leading to emission of substantial amounts of CO_2 and N_2O, both greenhouse gases. Further negative consequences of drainage are a reduction in water quality through the discharge of dissolved and particulate organic carbon to ground and surface water and land subsidence (1-2 cm yearly). This results in increasing drainage costs, higher flooding risks, reduced water quality and - ultimately - loss of productive land. Peatlands occur in almost all EU Member States, with a concentration in North-Western, Nordic and Eastern European countries.

Maintenance and sustainable use of peatlands is of importance for reducing GHG emissions and for climate change mitigation. Beside their role as a natural carbon sink, healthy peatlands provide many additional ecological services including contributions to water depuration, flood prevention and biodiversity conservation. Therefore, by preserving, protecting and restoring peatlands, we can reduce emissions and revive an essential ecosystem with high values for biodiversity conservation, climate regulation and human welfare.

In the EU NWE region emissions amount to 150 Mt CO_2eq/year, which is greater than Belgium's total emissions from all sources. Yet emission estimates from degraded peatlands are inadequate and we currently lack effective strategies and methods to combat degradation and promote recovery. Regional differences in land ownership complicate the situation and limit the replicability and transferability of effective alternative management of peatlands. All relevant EU policies need to reflect this.

Within Care-Peat, nature organisations work together with landowner groups to demonstrate carbon savings potential by using pilots ranging from 10 to 250 ha. Five knowledge institutes from three countries are working together to develop and test new techniques for improved peatland carbon assessment and accounting to highlight the region's natural potential for significant carbon reduction. The project works with innovative companies in the field of restoration and develops partnerships with local and regional stakeholders to increase the impact of pilots and maximize socio-economic benefits. Methods tested and validated will be transferred and replicated to users across the EU to determine the most appropriate management measures. Partners, who manage additional peatlands, will facilitate further restorations after the project ends to benefit both biodiversity and carbon reduction policies. The project will continuously liaise with our partners and continue to build relationships with other projects to maximise exchange, cooperation, and dissemination.

Financing peatland restoration

6.1 Introduction

It is not controversial to say that the restoration of degraded peatlands dramatically reduces the GHG emissions of the rehabilitated sites but also that the restored sites can transform from carbon emission sources to carbon sinks potentially allowing a new source of income from carbon credits through the carbon market. As the EU Green Deal and related policies progress it is likely that paying subsidies through the common agricultural policy for traditional agricultural activities on degraded and drained peatlands will be phased out and it is expected that through legal means peatland restoration will be made mandatory.

Therefore, the restoration of peatlands to farm carbon or to introduce the practice of paludiculture[2] are likely to become more advantageous sources of income for land with organic soils. While this move from conventional farming to new income generating activities that are better for the environment is welcome, it gives rise to two main issues:

- Financing the restoration of degraded peatlands.
- Compensating turbary rights holders for restored sites.

The turbary right is "the right to cut turf or peat on a common land or on another person's land."[3] and is passed from generation to generation in a family. This allows the holders to extract a given amount of peat every year on a specific site for their own use and is seen in Ireland as a cheap source of fuel. However, once a peatland is restored, peat extraction should be discontinued because (1) the peat is too wet and (2) it goes against the purpose of restoration.

Therefore, a compensation system must be put in place to compensate for the loss of those rights (ie: grants to help with the purchase and installation of a new heating system). In this section, we look into three different renewable energy sources (wind, solar and biomass) ability to finance both drained peatlands' restoration and to provide turbary rights holders' with an alternative heating source by analysing the present status of each renewable energy source, its advantages and disadvantages along with the presentation of a use case for each of the sources and a recommendation on the actual suitability of each source and how it can be leveraged.

[2] https://europe.wetlands.org/publications/what-does-paludiculture-mean-a-definition
[3] https://www.dictionary.com/browse/turbary

6.2 Wind energy

6.2.1 Present situation

Ireland
According to Wind Energy Ireland (WEI), there are over 300 wind farms in the Republic Of Ireland (ROI) that represent an installed capacity of 4,309 MW. It is not exactly known to date how many wind farms installed on peatlands, the most recent census from National Parks and Wildlife Service in 2007 shows 39 located on upland peatland. The location of all the wind farms in the ROI can be found in Figure 1 below.

The Irish government and its associated local authority's policy is to encourage the development of wind energy on degraded peatlands to allow them to meet their greenhouse gas reduction targets. It is not always the case that degraded peatlands are used for this kind of development as out of the 39 wind farms on peatlands referenced earlier, 20 are located on relatively intact blanket bog. Several bog bursts were observed during the development of wind farms that not only destroy the peatland habitat but also pose a massive risk to drinking water supplies, cause juvenile fish kills and destruction of the aquatic environment when the displaced peat enters local water courses4 and are mostly due to poor environmental impact assessment.

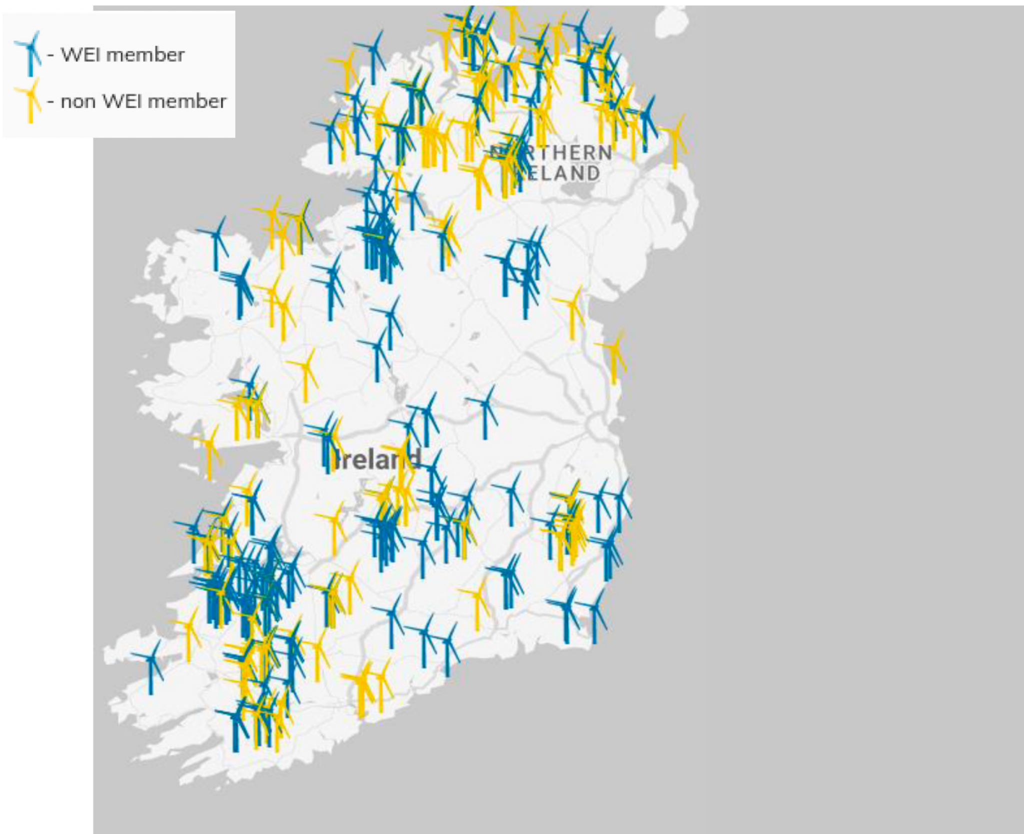


Figure 1: Location of Wind Farms in Ireland - source: WEI website [5]

[4] www.ipcc.ie/a-to-z-peatlands/irelands-peatland-conservation-action-plan/peatland-action-plan/habitat-loss-of-peatlands/#:~:text=Bog%20bursts%20not%20only%20destroy,peat%20enters%20local%20water%20courses.
[5] https://windenergyireland.com/about-wind/interactve-map

6.2.2 Advantages and disadvantages of wind energy

Wind energy has both advantages and disadvantages, some of the already well-known disadvantages in all situations are the intermittency of wind, the impact on wildlife, the noise and visual pollution or the high cost of investment. Further disadvantages arise if it is set up in a peatland: the release of GHG (in particular methane and carbon dioxide) during the construction phase as the peatland needs to be drained and dug out for the base of the wind turbine and for the cable to route the power. Also, the "floating roads" system used to create access to the different turbines can have a long-term hydrologic effect on a site due to the heavy equipment circulating on those roads. Furthermore, wind turbines need to go through a repowering process at the end of their design lifetime to install bigger and more efficient ones. This entails draining again the peatland at least around the turbine base to extract the old base and install a new one, as refurbishing the old imply high financial and carbon costs (GHG emissions) but this can be alleviated by doing the operation extremely quickly.

On the other hand, wind energy is sustainable, cost effective, clean, creates jobs and has a low operating cost. Installing it specifically on peatlands has also further advantages such as cheap purchase price of the lands which facilitates a reduction in the overall cost of the investment. The peat extracted from the wind turbines foundations and other tasks can be used to build dams in the draining trenches allowing the rewetting of the site limiting the amount of peat extraction necessary for the process of restoration. Highland peatlands are particularly desirable as sites for wind farms as they have a great potential for consistent wind. Furthermore, the use of peatlands which are often considered to be marginal lands would leave high value land with mineral soils that could have been used for wind energy, for food production. This would increase the availability of local food supply which we have all been reminded recently is paramount. Also, installing wind energy in peatlands allow further activity on the site such as tourism or paludiculture which when combined would supply a stream of revenue that can be used to compensate the turbary rights owners through grants to replace their peat powered heating system for example.

While well established, the practice of installing wind turbines on peatlands does not have only advantages. Some of those disadvantages can be mitigated like the emission of carbon during installation can be alleviated by installing the turbine in more degraded peatlands that are already drained which would also limit the cost of draining for the installation. Furthermore, the income generated from wind energy can be used to restore the degraded peatland adding a new stream of revenue to the owners through the sale of peatland emissions reduction carbon credits thus, maximising the return on investment. This scenario holds true only for degraded sites, pristine and lightly degraded peatlands should not be concerned as they would more than likely lose some of their capacity to store carbon and it would also lower their capacity to filter water going through them.[6]

[6] Smith et al., "Wind farms on undegraded peatlands are unlikely to reduce future carbon emissions", Energy policy, Vol. 66, pp 585 - 591, 2014.

Wind turbines are a low carbon electricity producing source. They represent a very powerful tool in the mitigation of climate change. However, they need to be used and placed wisely to prevent unwanted effects, such as emitting more CO_2 than saved or by consuming more energy than produced. At the same time, environmental aspects should be taken into consideration to preserve the integrity of the site of each turbine. The uplands and the west coast of Ireland have the best wind conditions for an installation of windfarms, persistent and continuous wind all year. However, these areas are also the places where most of the peatlands are located. Moreover, blanket bog landscapes offer very suitable conditions for wind turbines, as they are lower than forests and therefore the wind suffers less turbulence. This is the reason why in 2009, there were 73 windfarms in Ireland of which 39 (53%) were located on upland peatland, the first on an industrially cut blanket bog.[7]

Most of the life cycle assessment studies carried out on windfarms represent a significant low-carbon emitting alternative to conventional means of producing energy. For a 20-year expected wind farm lifetime, they range around 10 to 20g CO_2eq per kWh [8] [9] [10] which is 60 to 100 times lower than coal-fired power plants or 30 to 40 times lower than Natural gas-fired power plants.[11] Furthermore, wind turbines are a cost-effective technology as they can provide around 20 to 30 times the energy necessary for their production, construction maintenance and decommission. As well, the time needed to offset the energy put into the production, transportation and construction is generally well under a year, normally from 5 to 10 months. This time can reach up to a year for low wind areas.[12] Windfarms have the benefit of lowering dependence on fossil fuels and preventing further scarcities of electricity.

As wind turbines occupy only 4% of their dedicated area, they can be coupled with beneficial ecological outcomes such as peatland restoration. Windfarms are potentially able to assist in the transition of degraded peatlands into a valuable economic resource by facilitating restoration in place of peat extraction. However, this needs to be factored in at the planning stage. Direct contribution to the local economy can also be mandated via carbon farming, eco-tourism or paludiculture. Restoration of peatlands in parallel with wind energy can provide a sustainable contribution to the local economy and perhaps compensate for the loss of owners' turbary rights. However, this needs to be planned for as it will not automatically happen. It can further be encouraged through the introduction of grants to replace local people’s peat powered heating systems.

[7] Renou-wilson, F., & Farrell, C. A. (2009). Peatland vulnerability to energy-related developments from climate change policy in Ireland: The case of wind farms.link
[8] Ardente, F., Beccali, M., Cellura, M., & Lo Brano, V. (2008). Energy performances and life cycle assessment of an Italian wind farm. Renewable and Sustainable Energy Reviews, 12(1), 200–217. https://doi.org/10.1016/j.rser.2006.05.013
[9] Vélez-Henao, Johan-Andrés, et David Font Vivanco. « Hybrid Life Cycle Assessment of an Onshore Wind Farm IncludingDirect and Indirect Services: A Case Study in Guajira, Colombia ». Journal of Environmental Management 284 (15 avril 2021): 112058. https://doi.org/10.1016/j.jenvman.2021.112058.
[10] Gomaa, Mohamed R., Hegazy Rezk, Ramadan J. Mustafa, et Mujahed Al-Dhaifallah. « Evaluating the Environmental Impacts and Energy Performance of a Wind Farm System Utilizing the Life-Cycle Assessment Method: A Practical Case Study ». Energies 12, no 17 (janvier 2019): 3263. https://doi.org/10.3390/en12173263.
[11] Kumar, Indraneel, Wallace E. Tyner, et Kumares C. Sinha. « Input–Output Life Cycle Environmental Assessment ofGreenhouse Gas Emissions from Utility Scale Wind Energy in the United States ». Energy Policy 89 (1 février 2016): 294-301.https://doi.org/10.1016/j.enpol.2015.12.004.
[12] Lundie, Sven, Thomas Wiedmann, Melanie Welzel, et Timo Busch. « Global Supply Chains Hotspots of a Wind EnergyCompany ». Journal of Cleaner Production 210 (10 février 2019): 1042-50. https://doi.org/10.1016/j.jclepro.2018.10.216.

The location where a windfarm is sited plays a very important role as well, as they can require big infrastructures, foundations and facilities. The construction and use of these facilities can cause harm to the local environment. If roads or buildings interfere with watercourses, natural wet areas can dry out or alternatively this can lead to flooding. As peatlands are very sensitive to the water levels,[13] the consequences of interference can be the destruction of natural habitats, a reduction in local biodiversity, the loss of the peatland's role in carbon sequestration and stock and furthermore bogslides or landslides. The most iconic but yet tragic windfarm related landslide is the Derrybrien bogslide of 2003, where 450,000m3 of peat moved due to the installation of a 60-megawatt wind farm on forested blanket bog and in November 2020, local people were shocked to see whole trees sliding down the hill at the site of the Meenbog windfarm. The fragmentation of the bog can also play a role in its degradation.[14]

During turbine construction, peat needs to be extracted and replaced with concrete to build the foundations and to install the cables to route the power, leading to massive carbon bulk losses, and resulting in enormous greenhouse gas emissions. The amount of carbon emissions during this process causes the time needed to offset the carbon emissions due to the whole windfarm life to increase from around 5 months to nearly 3 years.[15] The location of the windfarm is decisive in determining the efficiency of the windfarm to mitigate against climate change. These effects can be alleviated by using already existing infrastructures, roads, and substations. Moreover, the carbon impact can be lowered with a wise and shrewd management, by placing the wind farm in already degraded peatland and using the incomes of the windfarm to restore them. This is a matter for planning and policy.

Each site has its own characteristics and therefore should be investigated prior to construction. One problem with planning for sustainable development of windfarms comes when their perceived "Green energy" status obscures the significant ecological impact involved in construction. A proper ecological assessment and hydrological analysis of the zone is crucial. Windfarms can also have a significant negative impact on breeding or migrating birds and affect their habitat.[16]

Another drawback of this power generating technology is the lack of control over the primary source of energy used (i.e. the wind). Wind farms must be coupled with non-intermittent sources of energy or energy storage to assure a continuous energy supply. Although wind energy is free to use, it suffers from irregularity, wind turbines need to be stopped when there is too much wind and obviously cannot produce power when there is none. Typically, actual wind farms are coupled with fossil fuel energy to keep the balance between electricity consumption and electricity production, leading to high CO_2 emissions and therefore unsustainability.[17] Furthermore, wind farms are not able to compensate for a high peak demand in electricity consumption, as they cannot produce more in a short time period. When planning for a windfarm every aspect must be considered, from the social and economic impacts to the ecological aspect, along with the noise and visual impacts of these infrastructures.

[13] Bridgham, Scott D., John Pastor, Bradley Dewey, Jake F. Weltzin, et Karen Updegraff. « Rapid Carbon Response of Peatlands to Climate Change ». Ecology 89, no 11 (2008): 3041-48. https://doi.org/10.1890/08-0279.1.

[14] Renou-wilson, F., & Farrell, C. A. (2009). Peatland vulnerability to energy-related developments from climate change policy in Ireland: The case of wind farms.link

[15] Mitchell, J, John Grace, et Gareth Harrison. « CO 2 payback time for a wind farm on afforested peatland in the UK ». Mires and Peat 4 (1 mai 2010). link

[16] Renou-wilson, F., & Farrell, C. A. (2009). Peatland vulnerability to energy-related developments from climate change policy in Ireland: The case of wind farms.link

[17] Emblemsvåg, Jan. « Wind Energy Is Not Sustainable When Balanced by Fossil Energy ». Applied Energy 305 (1 janvier 2022): 117748. https://doi.org/10.1016/j.apenergy.2021.117748.

6.2.3 Best Practice Guidelines

Good Practice approach to development on peat and carbon savings – a summary of recommendations developed by the Scottish Government[18]

- Conduct a detailed peat survey
- Position site infrastructure in areas of shallower peat or design an appropriateengineering solution to avoid and/or minimise excavation of peat (for examplefloating roads and piling solutions).
- Minimise the detriment to peat if excavation cannot be fully avoided.
- Avoid or reduce peat displacement from the development of excavations.
- Excavations should be prevented from drying out or desiccating as far aspossible. Consideration should also be given to spraying with water (althoughthis may not be feasible in the long term).
- If stockpiling peat assess the potential loading effects for peat slide risk.
- The peat should be restored as soon as possible after disturbance.
- Consider cable trenching operations and timings.
- Floating roads should be used in areas of deeper peat.
- Minimise plant movements and haul distances in relation to any earthworksactivities including peat management.
- Developers should take all opportunities to identify habitat enhancementopportunities, where appropriate.

One of the key aims of wind farm development is to reduce carbon emissions.[19] Wind farm developments, through the materials used, the construction processes employed and the potential emissions from disturbed soils and habitats, do result in carbon emissions. Guidance from the Scottish Government provides a methodology to explore potential carbon emission savings and losses associated with a wind farm development in forestry or on peatland.

The report recognises that in some circumstances the payback of wind farm development could be significantly affected by the construction methods used and the degree of restoration of the site. This guidance seeks to ensure that good practice is adopted to reduce the carbon emissions associated with wind farm development.

[18] https://www.nature.scot/doc/guidance-good-practice-during-wind-farm-construction

[19] https://www.gov.scot/publications/carbon-calculator-for-wind-farms-on-scottish-peatlands-factsheet/

6.2.4 Use case

For mitigation of climate change and restoration of former over-exploited industrial cutaway peatlands, the Irish government agreed to fund a €108M project for Bórd na Móna, a former peat cutting energy provider. The project aims to restore 33,000ha of cutaway peatland that has been degraded by the company activities. This 4-year programme (2021-2025) is partly funded by the company, up to €18M and will create an opportunity for 310 jobs. The investment is followed by another €1.6 billion for renewable sources of energy with the objective of supplying one third of all Irish homes in 2030.[20] This objective is very ambitious as in 2020 renewable energy represented only 13.3% of the national energy mix.[21] The company has made a dramatic shift, driven by the lack of sustainability of their former activities (peat cutting), the global climate change mitigation effort and a very profitable conversion opportunity. This programme will reportedly help to enhance the lost biodiversity of the bogs, allow the sequestration of 3.2M tonnes of greenhouse gases and protect the existing and already vanishing carbon store (109M tonnes).[22] With 14 projects of renewable energy sources in 2020, Bord na Móna is investing a lot in the transition to other more durable energy sources, as they need to offset their decreasing peat cutting activity which is likely to be reduced to zero by the year 2030.[23]

Figure 2: Mount Lucas Wind Farm Co. Offaly,© Kenneth Gallery Smyth[24]

[20] http://www.ipcc.ie/wp/wp-content/uploads/2021/04/Peatlands-Climate-Change-Action-Plan-2030-pages-26-34.pdf Irish Peatland Conservation Council : Peatlands Climate Change Action Plan 2030
[21] https://www.seai.ie/data-and-insights/seai-statistics/key-statistics/energy-use-overview/ Statistics on energy
[22] Peatlands Climate Change Action Plan 2030
[23] Peatlands Climate Change Action Plan 2030
[24] https://www.geograph.ie/photo/4784063

Figure 3: Mount Lucas Wind Farm Co. Offaly, Google Earth

The Galway wind park (Figure 4) is a good example of the complexity that can occur in dealing with sensitive environmental conditions during the installation of a wind park. Indeed, this 174MW infrastructure is located in an afforested peatland. Composed of 58 turbines of each 3MW, it is the largest wind farm on the island of Ireland. Fully in operation from 2017, the installation of the wind farm was made possible due to the already degraded state of the peatland. The monoculture of coniferous plants completely dried out the peat soil causing it to decompose. The EU Life “MULTI-PEAT” project aims to restore some of this peatland by removing the trees and rewetting dried out areas restoring part of the wintering habitat for flocks of white fronted geese. This will make it possible to combine energy generation, an improvement in biodiversity and carbon sequestration.

Figure 4: Galway Wind Park Co. Galway, Photo : Vincent LEBON

The first ever Irish windfarm built on cutaway peatland in the Midlands was completed in 2014 in Mount Lucas, Co. Offaly. This windfarm represents an 84MW electricity power production, providing electricity for 45,000 homes.[25] According the "Cutaway Bog Decommissioning and Rehabilitation Plan 2021",[26] peat industrial extraction stopped on site in 2019 and all peat extraction stopped in 2020.

According to the "Peatlands & Climate Change Action Plan 2030", the transition from peat extraction to a sustainable source of energy should be made easy for the people depending on it.[27] For instance, the Mount Lucas wind farm contributes to fund public facilities, sporting clubs and charity programmes.

This covers up to €1,000/MW per installed capacity per year for the entire lifetime of the wind farm.[28] Bord na Móna's "Cutaway Bog Decommissioning and Rehabilitation Plan 2021" [29] is a Peatland restoration plan, including both short-term and long-term actions. In a 0-2 years scale, they planned to do hydrological management, drain blocking and peat field reprofiling: in other words, rewetting as well as the acceleration of re-vegetation which has already started since the end of the peat extraction. They also planned to colonise the area with target species to underpin the restoration of a former industrial restored bog. These efforts are in line with long term monitoring objectives to assess the success of the short-term actions. These proposed schemes will provide some employment for more than 1 year. Bord na Móna, also created public amenity walking routes through the windfarm, encouraging visitors to discover the site and the flora and fauna present.

25 https://www.bordnamona.ie/bord-na-mona-launches-mount-lucas-wind-farm/
26 Cutaway Bog Decommissioning and Rehabilitation Plan 2021
27 Peatlands Climate Change Action Plan 2030
28 https://www.mountlucaswindfarm.ie/community-benefits/
29 Cutaway Bog Decommissioning and Rehabilitation Plan 2021

6.2.5 Recommendation

For a long time in Ireland, wind farms have been built on peatlands (mostly degraded and exploited sites). Concerning these types of sites, the financing of both the restoration of the sites where they are located and the financing of the compensation schemes for turbary rights holders could come from the income generated by the wind turbines already present.

Concerning the highly contentious subject of the installation of new wind farms on existing peatlands, the evidence would suggest that this should happen only highly to moderately degraded sites as installing them on pristine and slightly degraded peatlands would negatively affect their ability to store carbon. Concerning highly degraded peatlands, wind farm installations could perhaps be considered if they fully finance site restoration and turbary rights compensation. Any installation should include those two elements at the planning stage of the project.

Another source of income for site restoration and turbary rights compensation could come from wind farms that are already installed or which are planned to be installed near peatlands. If the owner of a wind farm also owns peatlands that need restoration or turbary rights that need compensation, the financing could come from revenue generated by the wind farm(s). The extent of turbary rights compensation & site restoration should be decided during the planning process on a case-by-case basis. Integrated land use policies are essential.

6.3 Solar energy

6.3.1 Present situation

Traditionally, Ireland looks in the direction of wind energy for renewable energy production (85% of the total) but with the sharp decline of the price of photovoltaic (PV) panels in the last few years coupled with their ability to produce electricity with indirect sunlight (ie. during cloudy weather), solar energy is now potentially a viable option. Ireland has 70% of the sunshine that Madrid gets but 75% of it occurs between May and September which means its winter reliability is highly doubtful due to the short daytime and bad weather conditions of the season. Even during high availability periods, any lack of effective energy storage capacity makes the efficient use of such a resource challenging.

To alleviate the energy storage problem, the renewable electricity support scheme offers subsidies for the development of renewable energies in Ireland and when PV is concerned, insists on the installation into existing structures (ie: roof building). The production is used to power the said structure, the excess is sent to the grid. Farms of PV panels are not considered a high priority, if such a project should be developed, it should be strategically placed to avoid sensitive areas and minimise negative impacts on biodiversity and the functional use of land beneath panels should be promoted.

Figure 5: A solar farm covering large areas of land

6.3.2 Present situation

PV panels produce clean and natural electricity in abundance if there is daylight. They are well suited for distributed power generation (next generation power network structure). The cost of PV panels is continuously diminishing for installation and PV panels have low cost of both operation and maintenance which coupled with governments financial incentive make it very attractive. PV panels are silentious, suited to a lot of locations including urban and residential areas and their maximum output generally comes at the highest demand for cooling. They are easy to install on a rooftop or on the ground. As previously stated, the Irish government does not necessarily promote the development of PV farms but if developed on peatlands, it would have the advantages of a low purchase cost of the site, limit water evaporation from the site (if restored or pristine) slightly limiting climate change in the process. If the panels are elevated, crops could grow under the panels and a technique called Agri-PVs (a smart combination of agricultural infrastructure with a solar PV installation) could be employed, a case could be made for paludiculture even though no use case could be found on this subject.

Like any renewable energy, PV suffers from intermittency issues due to the fact that it can only work during daytime and its output varies widely as a function of the weather. PV panels produce direct electricity (DC) which is great for housing as all the appliances use DC current but for a PV farm that connects to the power network which uses Alternating Current (AC), inverters are required to transform the current to AC form. Another heavy investment associated with PV panels is the storage batteries that are necessary to store energy not necessarily needed at the time of production but that can be sold later. Furthermore, PV farms need a large surface area to be committed for the deployment of the panels which have a poor efficiency (10% to 25%), creating a need for insurance as the panels are fragile. The need for a long commitment in terms of time of exploitation (minimum lifetime: 15-20 years) can be off putting. When pertaining to peatlands, the setup of PVfarms has the disadvantages of requiring foundation and to dig trenches for the cables which liberate GHGs and, furthermore, if installed in wet peatland, it would require special foundations whose impact cannot be measured right now. Also, if the batteries get damaged, they have the potential to release highly toxic chemicals in the water which would destroy the peatland ecosystem. PV farms have also been found to have a high impact on a site's biodiversity and the cover provided by the panels can slow down the carbon sequestration process as the ground does not get as much energy from sunlight to stimulate it.

Deep shades have a significant negative impact over the biomass accumulation of *Sphagnum* mosses,[30] which are the crucial peatland vegetation for carbon storage, via the reduction of photosynthesis. For *Sphagnum* dominated bogs, it is not recommended to install solar panels that obscure the *Sphagnum*. *Sphagnum* mosses play a major role in the ecological state of the bog, as they are the main indicator of the bog's degradation state.[31]

[30] Bonnett, Samuel Alexander Festing, Nick Ostle, et Chris Freeman. « Short-Term Effect of Deep Shade and Enhanced Nitrogen Supply on *Sphagnum* Capillifolium Morphophysiology ». Plant Ecology 207, no 2 (1 avril 2010): 347-58. https://doi.org/10.1007/s11258-009-9678-0.
[31] Lucchese, M., J. M. Waddington, M. Poulin, R. Pouliot, L. Rochefort, et M. Strack. « Organic Matter Accumulation in a Restored Peatland: Evaluating Restoration Success ». Ecological Engineering 36, no 4 (1 avril 2010): 482-88. https://doi.org/10.1016/j.ecoleng.2009.11.017.

6.3.3 Use case

Blackwater solar power farm is a project launched in 2017 by ESB and Bord na Móna. The co-development consists in creating solar power for 150,000 homes on formerly cutaway peatlands. According to the "Cutaway Bog Decommissioning and Rehabilitation Plan 2020", the Blackwater site is a former industrial drained bog, whose industrial cutting activity stopped in 2019. But the site is still affected by domestic turf cutting.[32] This can be explained because local people have access to this source of energy with no other available alternative.

According to the "Peatlands & Climate Change Action Plan 2030",[33] the transition from peat extraction to a sustainable source of energy should be made easy for the people depending on it. By furnishing sustainable energy, the project aims to encourage people to stop cutting peat and make the transition to cleaner sources of energy, contributing to supply of electricity to the Midlands region.

The Blackwater solar farm will contribute to funds for the local community, for instance public facilities, sporting clubs and charity programmes. At the same time, it will provide jobs either for the construction of the site or longer-term jobs in security, operation, or maintenance.[34]

6.3.4 Recommendation

Solar energy is not as developed as wind energy in Ireland, policies and grants are oriented toward installation of existing structures and the construction of PV farms are not promoted. There are a lot of downsides associated with solar farms on peatlands. It is important to say that no use case with a long history on a peatland could be sourced and therefore it is possible that the impact of such a project on such a site may not be fully understood yet and may need more study. A case can also be made concerning Agri PV coupled with paludiculture in the future provided that the impact of a PV farm on a peatland can be fully understood and is not deemed negative.

Concerning financing peatland restoration and/or for subsidies to compensate turbary rights from PV panels installed outside a peatland, it seems doubtful that it would work in Ireland given that the installation of small units for self-consumption are promoted and that no single units would provide a sufficient income stream for a restoration project or on a limited surface only, and/or to compensate turbary rights.

It is not thought at that time that PV panels are a suitable source of income for peatland restoration and/or to provide income for people to renounce their turbary rights.

[32] Cutaway Bog Decommissioning and Rehabilitation Plan 2020
[33] Peatlands Climate Change Action Plan 2030
[34] https://www.blackwatersolarfarm.ie/community-benefits/

6.4 Biomass

6.4.1 Present situation

The International Energy Agency (IEA) country report on Ireland[35] states that 13% of the energy consumed is from renewable and that a third of it is sourced from biomass. While biomass is not an important contributor of the Irish energy mix, it has the potential to have a much bigger role. For example, the food generated for animal husbandry could be used to create bio-methane in digesters for energy generation if the Irish people heed the call of climate specialists and health specialists that strongly advise a reduction in meat consumption due to its large environmental and climate impact. Also, 11% of Irish land is afforested (19% is protected) and can produce biomass for both heating and energy generation. The Irish government provides grants to set up biomass burners through the support scheme for Renewable Heat but for heat generation only, they also raised the fuel obligation rate from 10% to 11% as of the 1 January 2020.[36]

6.4.2 Advantages and disadvantages of biomass

Biomass energy has several disadvantages, first is the pollution it generates from its combustion mostly if it burns in an inefficient and traditional way (IE: stove) can generate as much pollution as coal which is a double curse as biomass is noticeably less efficient than fossil fuels. Slurry used to generate bio-methane can release a copious amount of methane into the atmosphere if it is not treated and/or stored properly. The smells associated with biomass can be unpleasant, can attract unwanted pests and spread both bacteria and infection. If the demand for biomass becomes too great, it may lead to deforestation and to cope with demand, large areas of land can be diverted from food production to produce the biomass required. The price to pay is also a problem, of course there is a fiducial price but here we are talking of the environmental price with emissions from production and transport, the destruction of habitats for both fauna and flora, and the occupation of arable land earmarked for biomass production may lead to food deficiencies. Pristine, slightly degraded and restored peatlands could use paudiculture to produce biomass, but this would mean investing in specialised equipment and building to cure the biomass, also any site used this way would see its ability of sequestering carbon dramatically diminished.

One of the main advantages of biomass is the fact that it is renewable and widely available which allows a lower dependency on fossil fuels and because it is carbon neutral, it contributes to the fight against climate change. Biomass comes in several different forms, the main factor is that it has to be organic matter which means organic matter that would ordinarily be going to the landfill can also be used as biomass to produce methane gas, biodiesel and other biofuels. Another advantage of biomass is the level of investment for production compared to fossil fuels that is generally recouped on the selling price. If paludiculture is used in pristine, slightly degraded, or restored peatland, it would produce a non-negligible amount of biomass supplying a stream of revenue (estimated at €10,000/ha/annum) for the owner to compensate any possible turbary rights and/or restore further degraded peatlands.

[35] https://www.ieabioenergy.com/wp-content/uploads/2021/11/CountryReport2021_Ireland_final.pdf
[36] https://www.iea.org/policies/6487-ireland-11-biofuel-obligation-for-2020?country=Ireland

6.4.3 Use case

The Irish Environmental Protection Agency (EPA) has stated that paludiculture is one of the best climate change mitigation tools to consider CO_2 emissions reduction for both social and economic matters, in the context of peatland preservation.[37] This methodology will allow farmers to make a living by producing *Sphagnum* for horticulture or medicinal products, typha for building materials, energy crops for biomass fuels for district heating schemes or growing food in wetlands while simultaneously stocking carbon. This sustainable way of farming is already promoted in Ireland by cooperatives including Claremorris and Western District Energy Co-Operative, Galway Energy Co-Operative and Green Restoration Ireland (GRI), which has launched a European innovation partnership for agriculture project called “Farm Carbon”.[38]

Farmers can apply independently to the latter project if they have valuable lands relating to environmental protection. They can be paid out of EU funds for keeping good environmental conditions on their land. This for instance includes organic soils restoration, thus rewetting, or protection of water resources and creating wetlands.

One of the main interests of the project is to improve the standard of living for farmers by paying them for maintaining good environmental conditions such as better water quality, rich biodiversity and of course reduction of greenhouse gas emissions. This science-supported agriculture will give them new farming methods and help them to transition from conventional types of agriculture.

[37] https://www.epa.ie/publications/research/land-use-soils-and-transport/STRIVE_75_web_SC.pdf
[38] https://farmcarbon.ie/about/

6.4.4 Biomass to fuel District Heating Schemes

Figure 6: Biomass for district heating schemes

District heating schemes utilizing biomass from paludiculture involve the use of wetland biomass, as a renewable energy source for heating purposes in a local district or community.

Biomass Production: Wetland plants, such as reeds, cattails, or other suitable species, are cultivated in specially designed wetland areas or peatlands. These plants are chosen for their high biomass production and their ability to thrive in wetland conditions.

Harvesting and Processing: Once the wetland plants have reached maturity, they are harvested and processed to extract the biomass. The biomass can include the stems, leaves, and other plant components, depending on the specific plant species and cultivation methods used.

Biomass Conversion: The harvested biomass is then converted into a usable form of energy, typically through combustion. In this process, the biomass is burned in a controlled environment, such as a biomass boiler or furnace, to generate heat.

Heat Distribution: The heat generated from biomass combustion is used to produce hot water or steam. This heat is then distributed through a network of insulated pipes, known as a district heating network, to supply heat to various buildings and facilities within the local district or community.

Heat Utilization: The hot water or steam from the district heating network is used for space heating, water heating, and other heating applications in residential, commercial, and industrial buildings. The heat can be utilized through radiators, underfloor heating systems, or other heat transfer mechanisms, depending on the building's infrastructure.

Environmental Benefits: Biomass from paludiculture is considered a renewable energy source because wetland plants can be sustainably harvested and regrown. Additionally, the use of biomass as an alternative to fossil fuels reduces greenhouse gas emissions and contributes to mitigating climate change.

Economic and Social Benefits: District heating schemes utilizing biomass from paludiculture can have positive economic and social impacts. They create local employment opportunities in biomass production, harvesting, and processing. Moreover, they enhance energy independence, reduce dependence on imported fossil fuels, and contribute to the development of a local, sustainable energy infrastructure.

6.4.5 Recommendation

Biomass offers a lot of possibilities; it is easy to grow and requires little investment. The income from biomass produced on peatlands is sustainable and can be used to finance the process of restoration. Biomass is generally used for district heating schemes which can heat houses and obviate the need for turf cutting. District heating schemes work best in town or villages where houses are close together. It should be particularly encouraged as a replacement for heating from the burning of peat at a community level and can be put in place to encourage the relinquishment of existing turbary rights. Integrated land use policies are essential.

6.5 Validation

This document aims to validate the conclusions relating to the use of renewable energy sources (wind, solar and biomass) to finance restoration of damaged peatland and to provide compensation for the loss of turbary rights. The updated conclusions can be found in section 6.6 of this report.

Validation took place using the quadruple helix method. This involves consultations with stakeholders involved in government, business, academia and civil society (including NGOs). It should be noted that consultations also took place with landowners.

Consultations also took place with decision-makers and advisors in the Irish parliament in Dublin[39] and in the European parliament in Brussels.[40] These consultations involved various policy discussions including the co-location of renewables and restored peatlands.

[39] https://data.oireachtas.ie/ie/oireachtas/committee/dail/33/joint_committee_on_environment_and_climate_action/submissions/2022/2022-11-15_opening-statement-niall-o-brolchain-research-assistant-university-of-galway_en.pdf

[40] https://www.youtube.com/watch?v=_1xKa4wK3pY

6.6 Conclusions and recommendations

The following are conclusions validated by stakeholder feedback as described in section 6.5.

Wind power is already established in Ireland including on drained peatlands. Wind turbines installed on peatlands can supply a stream of income for both restoration and compensation for the loss of turbary rights. However, future development on near natural peatlands should be discouraged as the overall ecological gains from switching to renewable energy are balanced out by potential carbon loss from damage caused to the peatlands.

Solar PV as a source of electricity generation on peatlands is not well developed in Ireland.[41] Large PV farms on peatlands are not encouraged. It is unlikely that PV farms could generate sufficient revenue to fund co-located peatland restoration or to generate enough energy to compensate local communities for any loss of their turbary rights.

Biomass for district heating schemes could be the best renewable energy option for financing peatland restoration and providing compensation for the loss of turbary rights. Funding for such schemes could be provided in areas where significant turf cutting is currently taking place to assist in a Just Transition process.

[41] https://www.google.com/maps/@53.2930662,-9.0892579,14z GGHGHGJ DAKSJDHKAS

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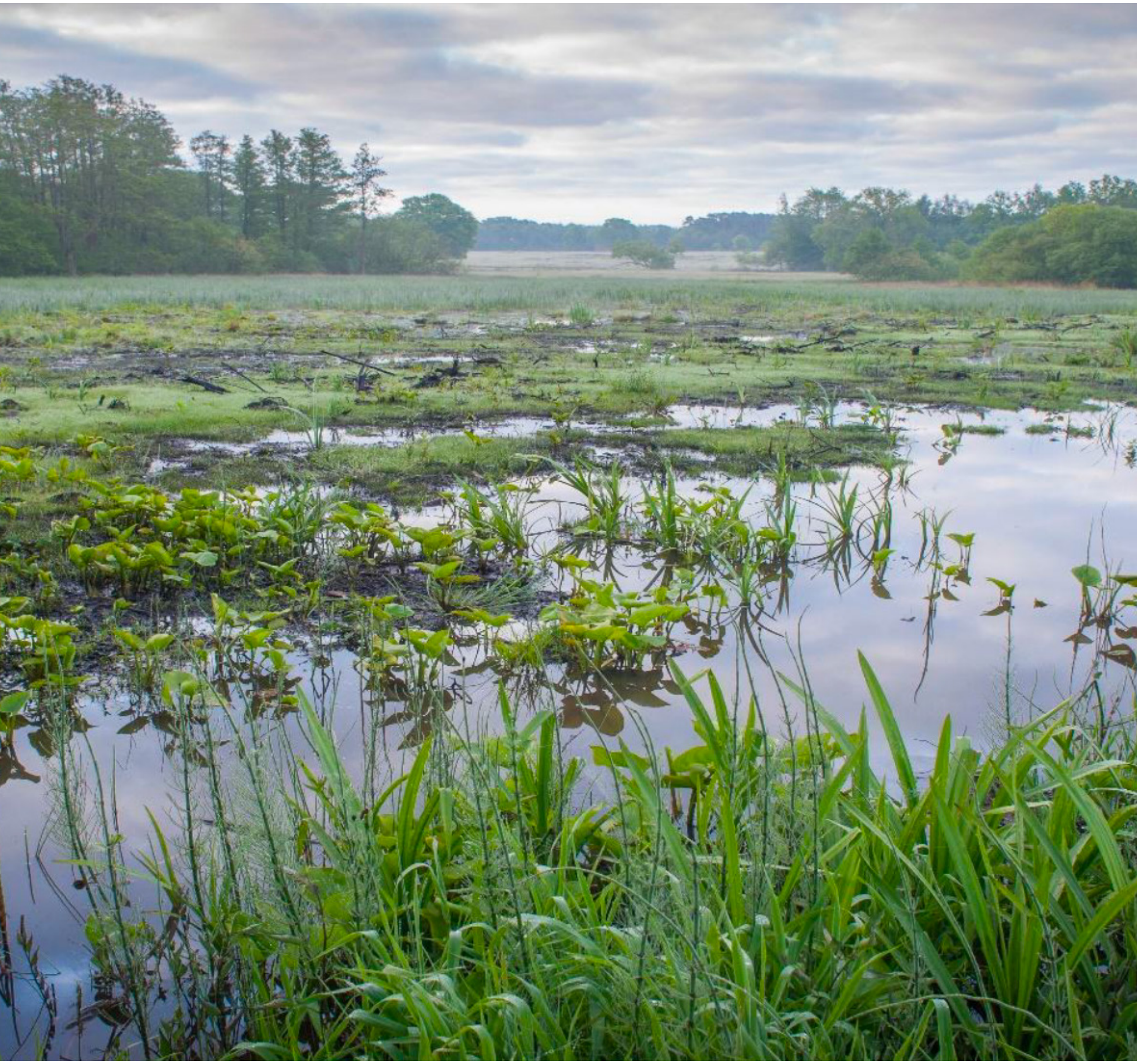
North-West Europe
Care-Peat
European Regional Development Fund

EUROPEAN UNION



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