Interreg North-West Europe BIOWILL

European Regional Development Fund

EUROPEAN UNION

NEWS

January 2022

Short Recap About the BioWILL Project

- Interreg NWE-funded project aiming to establish a zero-waste bio-refinery by using willow-extracted salicin for bioactive phytopharmaceutical applications
- Residual pulp from the salicin extraction will be transformed into sustainable paper food packaging products
- Remaining residuals will be anaerobically digested into biogas, as well as potentially being used as a

Outline

In this edition of the BioWILL newsletter, you will find:

- Why BioWILL is Necessary
- Meet the Team
- September CWG Meeting
- BioWILL meeting at the End of September in Belfast
- Meeting with Welsh Partners in Brussels
- BioWILL Seminar Hosted by the Welsh Government

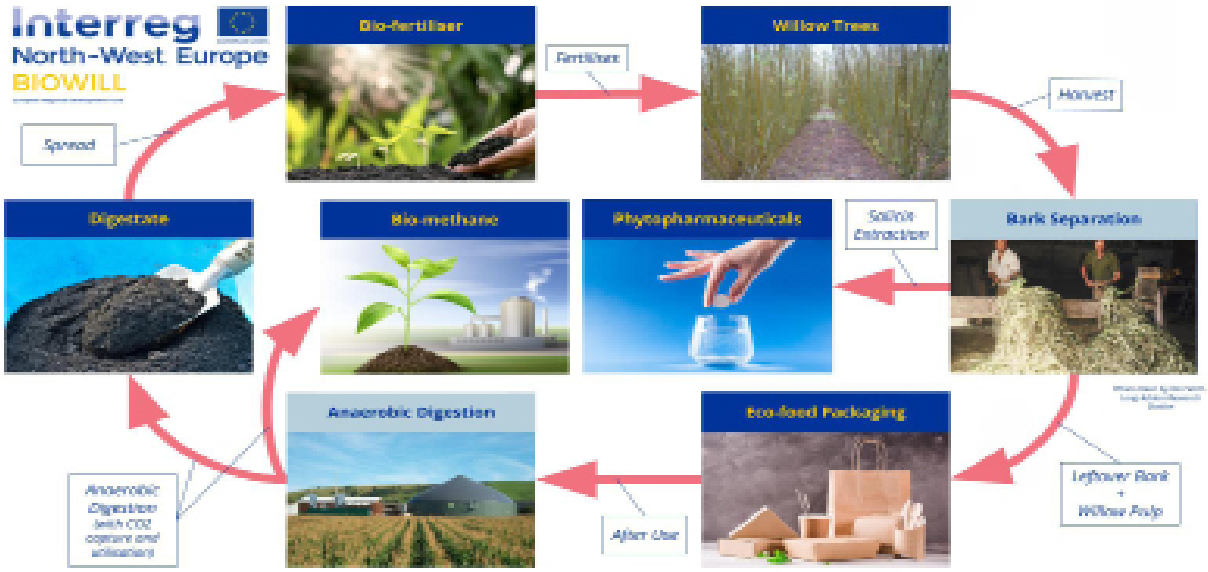
Why Is it Necessary?

- High levels of environmental waste can be caused by current forms of biorefinery technologies that focus on linear production chains containing food waste and forest residue;

- BioWill concentrates on a circular economy and production chain where produced waste leads back into the production chain;

- Presently there is no extractive based cascade biorefinery in the EU: the installation of a refinery such as this can lead to the significant economic potential.

Willow harvest



BioWILL circularity diagramme, focusing on the circular underpinning of the project production cycle

Meet the Team

BioWILL consists of 10 project partners in four countries across North-west Europe (Belgium, France, Ireland and the United Kingdom).

Coordinated by the University of Limerick, the consortium comprises of:

BioWILL Partners				
Type	***University***	***Research Institute***	***SME***	***Consultancy***
Partner	University of Limerick Bangor University University College Cork	Agri-Food and Biosciences Institute Institute of Technology Tralee Materia Nova	Cellulac Plc Epitheal Ltd Agriland Helicon	Crops for Energy
Type	***Industry Forum***	***Gas Company***	***Farmers and Landowners Organisation***	
Partner	Renewable Gas Forum of Ireland	Gas Networks Ireland	European Landowners' Organization (ELO)	

September CWG Meeting

On september 6th 2021, the Communication Working Group (CWG) of the BioWILL project got together virtually to discuss the updates on project dissemination, report on current progress, and collectively build a path for future project dissemination. The CWG serves as a focus group for external communication, dissemination, and exploitation activities, and on this day, one representative from every partner organisation was present.

The first topic covered in this meeting was the grounding of what the CWG is tasked to do and what are its expected outcomes. Indeed, the group's work is centered around the project's communication strategy, outlining the direction that project communication, dissemination, and exploitation must take place, in order to provide a communal roadmap for every partner to follow. It is important to point out the living document nature of the strategy, where partners are able to actively provide input on the strategy, as well as serve as both an accountability index amongst the partners and a way from the funding programme to keep up to date on how we are doing. An important takeaway from this part of the meeting was that digital activities are still the norm, therefore online dissemination and communication are still key, and will continue to be in the future.

Afterwards, the majority of dissemination pathways, from newsletters, to social media, to videos, and even the documentary, were discussed.

There is a push for more regular updates on social media, to provide the audience with regular content on project updates, as well as a push to grow the platforms. The project's social media accounts, especially Twitter, have been present at more and more online conferences, informing the project audiences on cutting-edge research in the bio-energy field as well as policy-research conferences, reporting on synergies being created between the two. An extra bonus to this presence at virtual conferences is that there have been times where the speakers in question at these conferences have in fact re-tweeted BioWILL posts, raising the exposure of the project.

In regards to social media and online dissemination as a whole, ELO pushes the partners to send as many informal photos of the partners at the field sites and in their laboratories as possible. This is an ample strategy to keep audiences up-to-date on the everyday aspects of what the BioWILL partners are working on. Once COVID-19 restrictions have been reduced and travel is once again permitted, ELO can travel to the sites and take the photos as well record demonstrations videos.

Concerning project videos, an idea has been pitched to the group to undertake the development of a video that targets the local youth to raise awareness about circular economy, biodiversity, and carbon sequestration, all through the lens of how it relates back to them. It was discussed that this could be made into a short animated video, in contrast to the current video being made which is more of a combined interview and presentation video on the project. On the project documentary, the idea was pushed back to sometime in 2022 and/or 2023, considering that the project extension was approved and that results are waiting to take place/be presented, which will be a major component of the documentary.

Finally, future events were discussed in the meeting, especially the updated meeting in Northern Ireland at the end of September, where partners were able to meet (some partners for the first time) and visit one of the pilot sites. More information on this can be found below. Future events alongside the Welsh government partnership were also discussed, with the talks of a seminar taking place, with more information found below.

BioWILL Meeting at the End of September in Belfast

In late September 2021, a hybrid meeting in Armagh, Northern Ireland and a field visit in Loughgall (also in Northern Ireland) was held.
Through the session, updates were given on each aspect of the project, including salicin extraction results, the prototypes of biodegradable packaging from the biorefinery, and each trial site's progress, including the challenges and future actions needed.

At Loughgall, a wall of willow stood in trial plots

It could be seen how different varieties compared in growth rates, size and, resilience to various factors. One of the most striking visuals of the plot was the results of plant breeding Willow crosses alongside parent Willow plants.

Overall, this event was an excellent opportunity to see the willows in the field and tangibly see the progress that otherwise more recently has been only digitally.

Meeting with the Welsh Partners in Brussels

Through the beauty of the internet, the BioWILL project was able to connect with the Welsh Higher Education Brussels (WHEB), the governmental organisation that bridges Welsh universities with the EU as a whole as well as the current policy scene in the capital of Europe.

Project partners from the European Landowners' Organization (ELO), Micaela Cosgrove and Martin Fox, based in Brussels, were able to meet at WHEB at their office in The Wales House to present the project, future dissemination pathways, as well as potential synergies across organisations and other EU-funded projects.

This goes very much hand-in-hand with WHEB's strategy to bridge Welsh Universities with EU-funded projects, as well as create more concrete connections with organisations that work alongside Welsh universities. Both WHEB and ELO have agreed to collaborate on BioWILL events, should there be some in Brussels, as well potentially future projects.

WHEB website: http://www.wheb.ac.uk/en/

BioWILL Seminar Hosted by the Welsh Government

At the end of November 2021, the BioWILL project was invited to take part in a presentation seminar as part of Environment Platform Wales' Green Week.

In this webinar, the project was presented within the context of a novel biorefinery model, as well as the pharmaceutical implications and biogas results further down the production cycle. On top of this, the international nature of the project was presented.

The agenda of the webinar was as follows:

- **An Introduction to the BioWILL Project** – Dr James Leahy, University of Limerick
- **Willow Breeding** – Kevin Lindegaard, Crops4Energy
- **Medical Applications - Salicin from Willow Bark** – Dr John Prendergast, University of Limerick
- **Packaging Applications - Moulded Pulp Products from Willow** - Dr Adam Charlton, Bangor University
- **Energy Production using Anaerobic Digestion** – Dr Chen Deng, University College Cork
- **Life Cycle Assessment of the BioWILL Process** - Laura Yonge, Materia Nova

Ministerial Visit to Welsh BioWILL Partner Site

In early December 2021, the Welsh Minister for Rural Affairs and North Wales, Lesley Griffiths MS, visited Bangor University's (a BioWILL project partner) Biocomposites Centre to gain insight into sustainable rural development projects within the Wales-Ireland partnership.

The Minister was able to highlight the Welsh Government's funding of the following 12 months of the project: BioWILL's Dr. Adam Charlton was there alongside the Minister to provide important insight into the goals of the project, especially the biodegradable nature of the packaging that is an important part of the project results, as a fossil-fuel alternative derived from plastics. The circular nature of the project was also very much emphasised.

The article can be found here: https://www.bangor.ac.uk/news/minister-visits-bangor-universitys-biocomposites-centre-and-m-sparc-science-park-to-learn-more

"This collaborative, multi-disciplinary project further showcases the strength of links between Wales and Ireland, on sustainable innovative solutions which build on our commitments set out in our Shared Statement and Joint Action Plan with the Irish Government."

Minister Lesley Griffiths

"For the BioWILL project, it's all about getting rid of single-use plastic and creating a closed circle of production, with the eco-packaging then going into anaerobic digestion to be transformed into bio-gas for energy production and bio-fertilisers."

Dr. Adam Charlton

Dr Adam Charlton and Dr Rob Elias from the Biocomposites Centre share information about the BIOWILL project with Minister for Rural Affairs and North Wales, Lesley Griffiths and Vice-Chancellor of Bangor University,

Member Spotlight: Chen Deng

Chen, thank you so much for being this edition's Member Spotlight! It's a pleasure to have you here. So let's start at the beginning: what got you interested in the agricultural sector? How did you reach it?

I have been working in bioenergy since I was doing my PhD.

My research primarily focuses on cascading circular bioenergy/biorefinery systems for advanced biofuels/biochemicals production and the development of negative emission bioenergy systems. Agriculture wastes such as forest waste, animal slurries, and grass silage are produced in huge amounts and are promising feedstock resources for bioenergy and biorefinery processes.

Bioenergy, or biofuel, in turn, plays an important role in greening the agriculture sector and that is why I am so interested in the agriculture sector.

Now, I deal with various agriculture wastes in the laboratory studies, such as the pretreatment of grass silage to facilitate its degradation, pyrolysis of woody wastes to produce biochar, bio-oil, and syngas, and anaerobic digestion of grass silage for biomethane production.

I have participated in several projects related

to the agriculture sector, including both fundamental research projects and industry innovation projects.

Wow! And how were you able to reach a point where you can participate in European-level projects?

I started to work in MaREI (Energy Climate Marine) centre, University College Cork as a post-doc researcher in 2018.

Since then, I have participated in the application and implementation of several national/EU projects, such as the "Sustainable Energy and Fuel Efficiency Spoke" co-funded by the EU and Irish government and the "Marine and Renewable Energy Phase 1 and 2 – Bioenergy" funded by Science Foundation Ireland.

Through participation in these projects, I could improve my skills in research, funding application, project management, collaboration, and interdisciplinary communication.

The MaREI Centre is a national centre that includes over 220 researchers from 13 institutional partners and collaborates with 82 industrial partners. Working in MaREI, I was able to develop networks with academia and industry partners across Ireland and the EU.

These skills and networks enabled me to build collaboration with BioWILL partners and participate in BioWILL.

It is great to hear about your growth! Now, could you please elaborate for us what your task is within the project and how it fits in within the project as a whole?

The role of the CEEES Group from UCC is to develop innovative pretreatment and advanced anaerobic digestion technologies to optimise biomethane production from willow residues and valorise anaerobic digestate to biofertilizer or value-added carbon materials.

The conversion of willow residue to biofuels and biofertilizer will not only improve the energy efficiency of the biorefinery system but also enable high carbon sequestration potential.

From this, what do you see as the next steps for the BioWILL project?

We have investigated several pretreatment technologies for enhancing the anaerobic digestion of willow residues.

The deep eutectic solvent pretreatment has shown encouraging effects on improving biomethane production. We are also looking at producing functional carbon materials such as biochar and activated carbon from willow fractions.

These carbon materials can enhance the anaerobic digestion of willow when added to the digestion and fix carbon in the soil when applied as a soil amendment. We are looking forward to developing a cascading circular bioenergy system based on willow residues through the integration of pretreatment, anaerobic digestion, and pyrolysis technologies.

The integrated bioenergy system will maximize the energy conversion efficiency and carbon sequestration potential of the whole supply chain.

With this in mind, what do you believe to be the most important lessons to be learned from the BioWILL project?

I believe collaboration is a key factor for the success of BioWILL.

We have 12 partners in four countries across Northwest Europe working closely on BioWILL. Each partner has its expertise which is essential for BioWILL.

Collaboration brings us together and will eventually lead to the success of BioWILL.

One last, more general question: moving on to a more overarching and even global perspective, how do you see BioWILL fit into the ever increasing growth of the circular economy approach? Do you see the framework of the BioWILL project having a significant potential impact in other sectors?

BioWILL will develop a zero-waste biorefinery system to produce high-value bioactive extractives for medical applications while using the bark-free pulp to produce food packaging materials. Any waste and residues generated in these processes will be used to produce biogas and biofertilizers.

There is no extractive based cascading biorefinery within the EU, its establishment & replicability will be of significant economic and social benefits.

BioWILL will deliver a biorefinery model which has great potential to be applied in the valorisation of algae, forestry residue, food industry waste.

And that is it for this edition of Member Spotlight! Stay tuned for the next newsletter!

Partner Updates

Bangor University

Bangor University received the first willow samples from the University of Limerick in July 2021. Since then we have looked at pre-treating and pulping this material prior to conversion into moulded pulp packaging for a range of applications. The first sets of food trays were produced in late 2021 and samples of both pre-treated willow and the trays have been sent to University College Cork for evaluation using their Anaerobic Digestion processes.

Crops4Energy

Trial survey of Loughgall and Claremorris

A plant is only as good as the soil or climate that it is grown in. You can have specimens that do brilliantly in one location but may struggle to survive let alone thrive on another site.

Such is the case with the willows planted for the BioWill project at Loughgall, County Armagh and Claremorris, County Mayo. In the autumn of 2021 I did a survey of both field trials and the contrast between the two sites couldn't be starker.

The Loughgall site was planted in March 2020 just about the time of the first COVID lockdown. Despite the problems of trying to establish a trial during a pandemic it has grown superbly. It's just about as good a willow trial as I have seen. In order to try and quantify the growth I counted the number of shoulder high shoots amongst the 20 best varieties and near market lines. There were 4,432. In fact, the growth was far better than this indicates as some of the best lines were up to 4.5m tall.

The BioWILL team in front of the Loughgall trial in September 2021

The Claremorris site is at the other end of the spectrum. We knew this site wouldn't be high yielding – that was part of the reason we chose it. It's an organic field that hasn't been fertilised for 40 years. Because of the Lockdown it wasn't planted until May 2020. But for a lay person turning up and seeing this trial after the Loughgall planting, you would probably assume these were completely different crops. Nevertheless, as a result of the painstaking adherence to good husbandry practice (by the AFBI team and in particular Chris McCann) the majority of the plants have survived. This is a major feat in itself but after 18 months of growth many are tiny little waist height withies compared to the giants at Loughgall.

I did a similar count of shoulder high willows at Claremorris and the total from all 31 representatives in the trial was just 411, less than 10% of the number at Loughgall. This really does go to show that even super willows can struggle when they are planted late, have grass competition, and are trying to establish in an infertile soil.

The Claremorris site in November 2021

There were a few specimens that did well at both trials such as LA970253 and LA970243. These are siblings from a cross between a European species S. viminalis (SW880514) and a Chinese species S. miyabeana (Purpurascens).

Endurance and LA970562, which were the best performers at the Loughgall and Claremorris sites respectively, also did reasonably well at the other site. Both of these are also European/Chinese hybrids, the former is the Chinese S. redheriana crossed with the European S. dasyclados and the latter S. viminalis (Romanin) crossed with S. miyabeana (Purpurescens).

The great thing about this result though is that it provides an interesting comparison of sites and is showing up with intriguing results, not least that the concentration of salicin is higher in the Claremorris willows. Could this be because they are under stress? We'll be aiming to find out as the project continues!

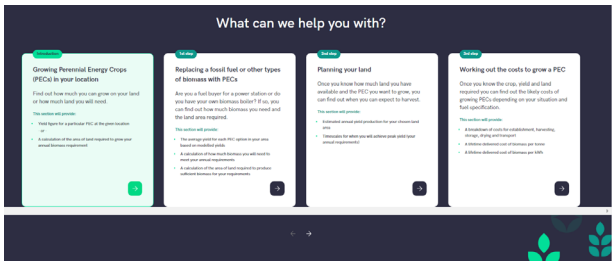
Perennial Energy Crops - Decision Support System

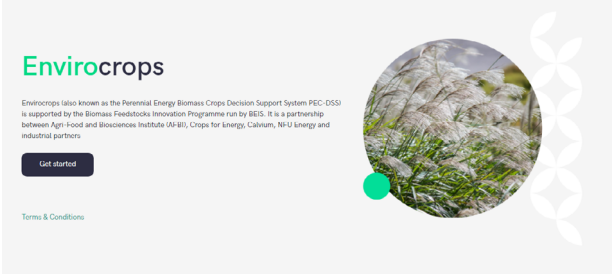
UK Innovation projects could revolutionise SRC willow sector

There is some optimism for the perennial energy crops sector in the UK. In 2021, the UK government Department for Business, Energy and Industrial Strategy (BEIS) launched the Biomass Feedstocks Innovation Competition to identify new technologies and approaches to help upscale the production of home-grown biomass. This is no mean feat as there are currently around 10,000 hectares of willow and miscanthus planted and it is estimated that to meet Net Zero targets will require 23,000 hectares per year to be planted right up to 2050.

AFBI and Crops for Energy (C4E) have been awarded funding to scope out several innovations

AFBI are leading a project to develop a Perennial Energy Crops Decision Support System (PEC-DSS) which aims to produce an app (called EnviroCrops) which will enable users to do a mini feasibility study on whether growing and using PECs is viable from a logistical and economic perspective. This encompasses all the work AFBI have done over many decades in creating best practice guidance





combined with C4E's know-how on energy crops consultancy.
Both partners are also involved in looking at the feasibility of setting up a multi-site and online biomass platform to demonstrate new innovations and disseminate information. The BioFIND project is led by the UK Centre for Ecology and Hydrology and has also been awarded funding.

This project involves several other research bodies with vast experience with miscanthus and willow. The intention is to create a network of 8 hub sites in all four countries of the UK and 30-40 spoke sites showcasing individual crops, best practice and to test new innovations in planting and harvesting. It also plans to create a central website for knowledge exchange and training.

C4E are also lending support to a funded project led by Willow Energy who are a leading planting and harvesting contractor in the UK. The Net Zero Willow project (Full title: Upscaling UK SRC Willow Planting and Harvesting Capacity) is looking at initial designs for machinery to multiply, plant and harvest willow that is specifically suited to the UK climate with wet winters and moist, muddy soils.

The three innovations being considered could potentially increase the window of opportunity for all field-based activities, increase productivity, reduce soil damage, reduce lifecycle carbon emissions, reduce waste products and reduce costs for the contractor and the grower.

All three projects are completing their initial Phase 1 studies in January 2022 and will be looking to secure follow up Phase 2 funding this spring, to make these projects a reality over the next three years.
The full list of 25 Biomass Feedstock Innovations (BFI)-funded projects can be seen here.

Materia Nova - BioWILL as a Life Cycle Assessment Case Study

BioWILL has proved to be an excellent case study for explaining the application of life cycle assessment for agricultural processes.

Back in November 2021 Materia Nova had the pleasure of presenting and sharing it's Life Cycle Assessment (LCA) knowledge to a group of dynamic students who are following an environmental management course as part of their Master of Science in Industrial Engineering (Agronomy) degree from Haute Ecole Provinciale de Hainaut - Condorcet, Belgium. Willow culture from the BioWILL project was used as an ideal example of how to model agricultural processes and assess the corresponding environmental impacts.

LCA Progress

The BioWILL environmental LCA model is advancing steadily forward with the intention of identifying environmental impacts linked to the different process steps and to highlight environmental improvement opportunities.

LCA is an iterative approach, where data and models are continuously re-evaluated and updated as processes advance and new data becomes available. After the production of the initial willow culture model the key steps in the process chain, such as willow harvesting and debarking, have been reviewed and revised. In addition to the input from project partners the advice and data from Hegan Biomass Ltd, Northern Ireland and De Vos Salix, Belgium for willow stem harvesting and willow debarking respectively have been invaluable to this study.

Model for Producing Willow Bark

BioWILL is investigating the optimum harvest cycle for salicin production. Harvest cycles of 1, 2, and 3 years are being considered in this study.

As mentioned in the previous newsletter, when the impacts of producing 1 kg dry matter (DM) of willow for the 3 harvest cycles are compared, it seems less advantageous, from an environmental point of view, to harvest willow stems each year (see Fig 1). The increased impacts associated with a 1-year harvest cycle are due to an elevated number of harvesting processes in comparison to 2- or 3-year harvest cycles. The willow crop is indeed cut down and collected 24, 12, and 8 times for harvest cycles of 1, 2, and 3 years respectively for a plantation lifetime of 25 years.

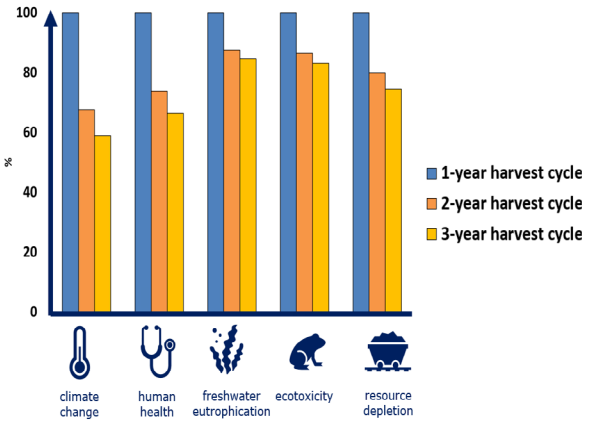


Fig 1. Comparing environmental impacts for 1 kg DM willow for different harvest cycles.

With the current model, using assumptions based on the debarking process used by De Vos Salix in Belgium, the impacts relating to removing bark from willow for the different harvest cycles have been calculated (Fig 2).

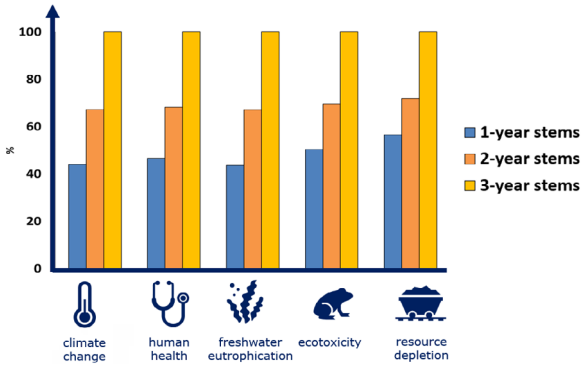


Fig 2. Comparing environmental impacts for debarking 1kg DM willow stems for different harvest cycles

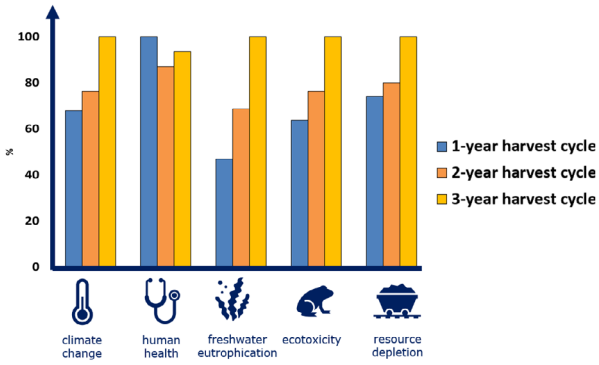


Fig 3. Comparing environmental impacts for 1 kg DM willow bark for different harvest cycles.

In this instance the reverse trend is observed. The debarking process is limited to the size and weight of stems that can be debarked at any one time by the equipment. Therefore, the debarking rate, and thus the electricity demand, to remove bark from the willow stems is impacted by the mass of the stems. For this reason, more 1-year-old stems can be debarked per hour in comparison to three-year-old stems. As the BioWILL project is based on the extraction of bioactive molecules such as salicin from willow bark the environment impacts relating to the production of bark has been determined by taking into account the impacts for producing and debarking willow stems. For the impact categories shown in graph 3, harvesting every year appears to be the more advantageous option overall.

However, these are still intermediate results, since some important factors are missing in the in-progress model, such as the ratio of bark to wood for willow harvested at different times (here considered constant), the bark salicin content and the efficiency of the extraction process, that may all vary depending on harvest frequency. In the coming year, refined data about these issues will be available, and the model and results will evolve accordingly.

University College Cork (UCC)

1. The UCC team developed a green and effective pretreatment of willow residue for renewable biogas production. Deep eutectic solvents (DESs), consisting of quaternary ammonium salts (hydrogen bond acceptor) and hydrogen donors, present similar properties to room temperature ionic liquid but have the advantages of being easy to synthesize and low cost.

Three different DESs systems, including choline chloride and acetic acid, choline chloride and propionic acid, and choline chloride and lactic acid were facilely synthesized and applied to willow pretreatment at varied reaction temperatures (120, 140, and 160 °C) and time (15, 30, and 45 min).

Results showed that the DESs pretreatment effectively removed lignin and increased the subsequent biomethane production from willow. This study demonstrated that DESs pretreatment could be a promising method for the optimal conversion of willow into renewable biofuels.

2. High-quality biochar and activated carbon were produced from the lignin extracted from willow and applied in the digestion of lignin derivatives and willow residue. Extracted lignin was pyrolyzed to produce biochar.

Biochar was then activated with potassium hydroxide to produce activated carbon. As a consequence of the activation process, the carbon content of activated carbon was much higher than the carbon content of biochar, which indicated that a high-quality activated carbon was produced from lignin.

With the optimal addition of biochar and activated carbon, the biomethane yield from both syringaldehyde (lignin monomer) and willow residue was increased by 20 – 40%. Simultaneously, the lag-phase time of the digestion process was significantly reduced. This study demonstrated that both biochar and activated carbon could significantly enhance the anaerobic digestion of lignin derivatives and willow.

The integration of the DESs pretreatment and the application of lignin-derived biochar (or activated carbon) in the anaerobic digestion offers a promising method to improve the overall energy efficiency of the cascading circular bioenergy system.

Agri-Food and Biosciences Institute (AFBI)

Together with our partner Kevin Lindegaard of Crops for Energy Ltd, AFBI has been maintaining and assessing the willow plantations at the AFBI site at Loughgall Co Armagh and the University of Limerick site which has been established near Claremorris in Co Mayo.

Due to ongoing maintenance of these plantations (planting 2020 and cutback Feb/March 2021) these plantations represent near 100% establishment success.

2021 was a challenging year due not only to further COVID restrictions but also the unpredictable weather conditions we experienced at the start of the year.

Although Best practice does recommend cutback during the winter following establishment in order to encourage strong multi-stem regrowth, there are risks associated with late frosts post cutback. 2021 experienced frosts not only in February but also several frosts through March and April which all served to “knock back” some of the more vulnerable early regrowth.
With some encouragement and physical weed control however, any overall stool death was kept to an absolute minimum.

Furthermore, in October 2021, Chris Johnston was invited by the Irish Bioenergy Association (irbea) to present during its "National Bioenergy Conference Webinar Special 2: COP26 Goal 2".

Specifically with respect to *Adapt to protect communities and natural habitats*. In this Chris expanded not only on the wider applications of biomass crops for environmental protection and waste management but also on indigenous production of biomaterials and high value chemicals which forms the concept of the University of Limerick led Interreg NWE Biowill project.

Sustainable Agriculture in the 21st Century

In mid-February 2022, funded by the Welsh Government, the 2 day "Sustainable Agriculture for the 21st Century" will be taking place online.

The event will showcase the excellent research that is currently taking place in Wales to deliver agricultural systems fit for the 21st century that fit within the vision of an agricultural sector that sustains communities as well as local economies whilst contributing to mitigating, at the same time, both the climate and nature crises currently taking place.

The aim of the event is to build bridges and synergies between prospective industry partners, researchers, and any other potential stakeholders. The event will bring participants from all over Europe with the goal to co-create future research directions that can fall under Horizon Europe's upcoming calls in Climate, Energy and Mobility (Cluster 5) as well as Food, Bioeconomy, Natural Resources, Agriculture and Environment (Cluster 6).

The event will take place on February 15 and 16 2022, and more information as well as the online sign-up form can be found here: https://sustainable-agriculture.b2match.io/