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Boosting the adoption of Bio-Based Technologies

High-level study of Irish regional dynamics in bio-based technologies and practices

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Article information

Title	High-level study of Irish regional dynamics in bio-based technologies and practices
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Brief summary	This article summarises the outcomes of the high-level study on biomass valorisation technologies and practices in Ireland [1], highlighting the potential for biomass valorisation and bioeconomy development for resources like grass, agricultural residues, livestock manure, dairy and forestry by-products. Despite strong research capabilities and funding, the full potential remains untapped due to logistical and market challenges. The study underscores the need for advanced technologies and collaborative efforts, such as EIP-AGRI Operational Groups, to promote sustainable biomass in the agriculture and forestry sector to expand Ireland's use of bio-based technology and practices for an environmentally sustainable future.
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High-level study of Irish regional dynamics in bio-based technologies and practices

To better understand the Irish research landscape and primary producer ecosystems related to bio-based technologies (BBTs), MTU, with support from Teagasc, conducted a high-level study on biomass valorisation technologies and practices in Ireland [1]. The study examines potentially available biomass for valorisation, related Irish policies, funding mechanisms for bioeconomy initiatives, and the status of EIP-AGRI Operational Groups (OGs) in this sector. This article summarizes the key findings of the study.

Context

A significant portion of Ireland's population, around 37%, lives in rural areas, emphasising the importance of agriculture and rural development in the country's socio-economic landscape [2]. According to the last land utilisation survey from Central Statistics Office (CSO), in 2020, the agricultural sector in Ireland is vital, with 82.1% of farmland dedicated to grassland. Forests cover 11.6% of Ireland's land area, totalling about 808,848 hectares. Small farms tend to generate lower outputs, while larger farms produce more, highlighting the potential of biomass valorisation as an income source [3-5].

In 2020, Ireland produced 2.01 million tonnes of cereals and 300,000 tonnes of potatoes [6]. Specialist Grazing Livestock Production (Dairying and Beef) was the most typical type of farm in 2020 (66.2%), with crop farms comprising nearly 12% of total farms [7]. This emphasis explains why grasslands and croplands made up over 67% of Ireland's terrestrial and transitional ecosystems in 2018, with grasslands providing 21.7 million tonnes of crops, including grazed biomass, by 2022 [8]. Land use trends in Ireland from 1991 to 2020 show grassland as consistently dominant. Additionally, over half of farms in Ireland are specialist beef producers (74,159), followed by specialist sheep (17,435) and dairying farms (15,319) [9]. However, there are around 1.5 million dairy cows and approx. 889,000 suckler beef cows, highlighting the high level of dairy activity in Ireland.

Ireland's forests cover 808,848 hectares, or 11.6% of the total land area, with 70% of trees under 30 years old. The forest estate is composed of 69.4% conifers and 30.6% broadleaves. Additionally, hedgerows and non-forest wooded land cover 375,301 hectares, playing a crucial role in biodiversity. In 2022, private sector forests contributed most of the 4.14 million m^3 roundwood harvest, underscoring private forestry's growing role. Additionally, the forestry sector generates pulpwood, which is essential for paper and paper products, and biomass, which supports renewable energy production, however, high-level valorisation of forest biomass is not well developed yet. The forestry sector is also a significant contributor to carbon sequestration, playing a crucial role in Ireland's climate action efforts by absorbing atmospheric carbon dioxide, removing 1.8 $MtCO_2$ in 2021 [10].

Biomass resources

According to 2022 statistics, the current sources of biomass in Ireland are grass at 18.4 million tonnes, representing over 50% of the total biomass in agriculture, and forage crops at 12.1 million tonnes, followed by cereals and straw [11]. The by-products or residual biomass from these sources can currently be used as animal bedding or feed. However, further potential can be identified for these

biomasses, such as renewable energy production through anaerobic digestion (AD) [12], fertilisers from agricultural residue digestates, pyrolysis of these residues for bioenergy and biochar production for soil restoration, building blocks for construction materials, packaging, etc. [13-16].

Ireland generates over 84 million tonnes of manure annually due to its significant cattle population [17]. Approximately 50% of this manure is applied to land as fertiliser, with 82% stored as liquid and 18% as solid manure [18]. While manure improves soil fertility, it can also pose risks to air, water, and soil quality. In order to prevent pollution of surface water and groundwater from agricultural sources, particularly from land application of manure, and to protect and improve water quality, Ireland has developed a programme called the Nitrate's Action Programme [19]. Besides the current Irish initiative from the Biomethane Strategy to promote renewable energy with slurries through anaerobic digestion (AD) [12], other innovative approaches could be addressed. For instance, the Italian Operational Group "Mountain Carbon" project, a rational management of livestock manure through dewatering, composting and pelleting, allowing better use as a fertiliser, as well as restoring carbon to impoverished mountain soils [20].

In addition, the dairy industry is a major cornerstone of the agri-food sector in Ireland, with annual domestic milk production exceeding 8.4 billion litres in 2023 [21]. Whey is a major by-product of the dairy processing sector, with 80-190 million tonnes of salted and acid whey produced annually in Ireland [22], with the potential to be converted into value-added products such as fertiliser [23] or baby infant formula (Irish Carbery Group, [24]). The Spanish Operational Group “Biosuero” project promoted the production of a plant and soil bio-stimulant through the fermentation of waste whey to promote the reuse of the product, in this case cheese whey, by using it in agricultural production as a biofertiliser [25].

On the other hand, from the forestry sector, wood chips, logs, and residues from forest management activities where the main product is timber logs made of spruce tree stems consisting 60-75% of total tree volume while the remaining 25-40% residues (about 800,000 m^3/year) including branches, stems and deformed trees are not utilized due to lack of large-scale demand in Irish market [26]. In Ireland, forest residues are typically left on the forest floor after wood harvesting, which supports soil fertility and nutrient cycling in forest ecosystems [27]. However, balancing ecological benefits with biomass utilisation is crucial to prevent underutilisation of this resource [26]. A 2018 study by the Society of Irish Foresters found that up to 70% of forest residues could be extracted without significant soil damage or nutrient loss in optimal conditions [26,28]. Innovative projects such as the Italian Operational Group “Clean-ER”, which converts forest residues into energy and biochar, present potential valorisation models for Ireland’s low-value forestry residues, especially in mountainous areas [29].

Bioeconomy sector in Ireland

In 2021, Ireland's bioeconomy achieved a turnover of €10.9 billion, with agriculture contributing €10.29 billion and forestry €200.9 million. These sectors are key employers, particularly in rural and coastal areas, providing jobs for 195,997 people—101,110 in agriculture and 3,180 in forestry. Despite their economic impact, the value-added contributions were modest, with agriculture accounting for 20.5% and forestry only 0.2% of their respective outputs in 2021 [30].

Nevertheless, Ireland has developed several policies, strategies, plans, and laws at both national and regional levels to support the bioeconomy and biomass valorisation [31,32], highlighting the National

Bioeconomy Action Plan 2023-2025, aiming to embed sustainable scientific practices and biobased innovation in various sectors, supporting farmers, foresters, and agri-food companies [31,33]. Ireland hosts several research and development (R&D) groups dedicated to advancing the bioeconomy and biomass valorisation. These groups focus on various aspects of biomass utilisation, including bioenergy, bioproducts, and sustainable practices. This network comprises prominent organisations, centres, clusters, and programs, including the SFI BiOrbic Bioeconomy Research Centre, Enterprise Ireland's Irish Bioeconomy Foundation, the Circular Bioeconomy Cluster South-west, the Circular Bioeconomy Research Group, Shannon ABC, Teagasc, and the Marine Institute. Collectively, these organisations aim to foster engagement, increase awareness of the bioeconomy, and support its progress among a diverse array of stakeholders [34].

Despite all this government and research support, Ireland faces logistical challenges such as transportation, storage, and supply chain coordination. For instance, in the forestry sector there is a lack of significant market, due to the low quality and low density of forest residues, and challenges such as difficulty of extraction and wide geographical distribution, in large-scale mobilisation of such residues to CHP units, etc. [26]. There is also need for more AD plants, slurry separation technology and harvesting equipment. Regional funding for shared technologies could help overcome these challenges and make processes more circular [35].

Irish Operational Groups in Bio-based technologies

The latest data shows that 3,400 EIP-AGRI Operational Groups (OGs) were funded between 2014 and 2023, with 6,600 projects planned for 2023-2027 across the EU. In Ireland, 57 OGs were funded, primarily focusing on biodiversity, farm management, and conservation under the Rural Development Program 2014-2020 [36]. Only three projects have worked on biomass valorisation, producing biochar, biogas, and biomaterials such as proteins and fructo-oligosaccharides. These included the "Small Biogas Demonstration Programme," "Biomass to Biochar for Farm Bioeconomy," and "Biorefinery Glas," collectively advancing BBTs applications. All three OGs identified have developed technologies for processing agricultural biomass, with outputs being biochar, biogas, and biomaterials such as protein, and fructo-oligosaccharides [36,37]. Table 1 summarises details on the three BBT-focused OGs in Ireland.

Table 1: OGs focused on BBT development in Ireland (EIP-AGRI Operational Group Projects - Ireland).

OG project	Technology description	Biomass target	Output(s)
Biomass to Biochar for Farm Bioeconomy (2018-2021)	Mobile Pyrolysis Unit (chemical)	Rushes, gorse, bracken, hazel, and forest residues	Biochar
Small Biogas Demonstration Programme (2019-2022)	Farm-scale biogas (AD) plant (microbial)	Farming waste (including livestock manure)	Biogas

OG project	Technology description	Biomass target	Output(s)
Biorefinery Glas (Small-scale Farmer-led Green Biorefineries) (2019-2020)	Small-scale mobile grass biorefinery (physical-chemical)	Grass	Cattle fibre feed, Protein concentrate feed for monogastric, High value prebiotic sugars, grass whey (fertiliser/bioenergy).

Discussion

Ireland has significant potential to use agricultural and forestry biomass, supported by strong research capabilities and funding programs at national and EU levels. Government action plans, such as the National Bioeconomy Action Plan 2023-2025 and the National Biomethane Strategy, highlight the importance of developing technologies to use biomass sustainably.

Ireland has significant potential to harness its diverse biomass resources, including grass, agricultural residues, livestock manure, dairy by-products, and forestry materials like branches and deformed trees. Grass, mainly used for feed, shows promise in biorefinery applications. Agricultural residues can be converted into biochar, fertilisers, renewable energy via anaerobic digestion, and materials for construction and packaging. Livestock manure and slurry offer potential for biofertilisers and energy, while dairy by-products like whey can become plant and soil bio-stimulants. Forestry residues can support green energy and soil restoration through pyrolysis and biochar production.

With strong research support and funding available, Ireland is well-positioned to advance bio-based technologies, though this capacity remains underutilized. Most Operational Group (OG) projects have focused on biodiversity and land conservation, these strategies emphasize the need for innovation to fully leverage Ireland's biomass resources for a sustainable and prosperous bioeconomy.

References

1. Giambiaggi Dall'Orso, P.; Rosa Álvarez, P.; Chavrier, N.; Ureña, M. D2.4 - High-level study of regional dynamics for the use of Bio-based Technologies (BBTs) - Draft. *BBioNets - Creation and promotion of Forest and Agriculture Networks to boost Bio- Based Technologies adoption and Value Chain development* **2024**, doi:10.5281/zenodo.13768986.
2. Population and migration estimates. Available online: https://www.cso.ie/en/releasesandpublications/ep/p-pme/populationandmigrationestimatesapril2023/ (accessed on June 1).
3. Department of Agriculture, F.a.t.M. Fact Sheet on Irish Agriculture. **2024**.
4. Coford. *Forests and wood products, and their importance in climate change mitigation: A Series of COFORD Statements*; Dublin, 2022.
5. CSO. Census of Agriculture 2020 - Preliminary Results - Land Utilisation. Available online: https://www.cso.ie/en/releasesandpublications/ep/p-coa/censusofagriculture2020-preliminaryresults/landutilisation/ (accessed on
6. Area, Yield and Production of Crops 2020. Available online: https://www.cso.ie/en/releasesandpublications/er/aypc/areayieldandproductionofcrops2020/ (accessed on
7. CSO. Census of Agriculture 2020 - Preliminary Results - Introduction and Overview of Results. Available online: https://www.cso.ie/en/releasesandpublications/ep/p-coa/censusofagriculture2020-preliminaryresults/kf/ (accessed on
8. Central Statistics Office. Ecosystem Accounts – Grasslands and Croplands 2000-2022. Available online: https://www.cso.ie/en/releasesandpublications/fp/fp-eagac/ecosystemaccountsgrasslandsandcroplands2000-2022/ (accessed on June 12).
9. Central Statistics Office. Crops and Livestock Survey Final Results June 2023. Available online: https://www.cso.ie/en/releasesandpublications/ep/p-clsjf/cropsandlivestocksurveyfinalresultsjune2023/ (accessed on June 12).
10. Forest Statistics - Ireland 2023. **2023**.
11. Material Flow Accounts 2022: Key findings. Available online: https://www.cso.ie/en/releasesandpublications/ep/p-mfa/materialflowaccounts2022/keyfindings/ (accessed on
12. Annual Review and Outlook for Agriculture, Food and the Marine 2023. Available online: https://www.gov.ie/en/publication/91e7e-annual-review-and-outlook-for-agriculture-food-and-the-marine-2020/.
13. Verma, M.; Singh, P.; Dhanorkar, M. Sustainability in residue management: a review with special reference to Indian agriculture. *Paddy and Water Environment* **2024**, *22*, 1-15, doi:10.1007/s10333-023-00952-8.
14. Allohverdi, T.; Mohanty, A.K.; Roy, P.; Misra, M. A Review on Current Status of Biochar Uses in Agriculture. *Molecules* **2021**, *26*, 5584.
15. Alburquerque, J.A.; de la Fuente, C.; Ferrer-Costa, A.; Carrasco, L.; Cegarra, J.; Abad, M.; Bernal, M.P. Assessment of the fertiliser potential of digestates from farm and agroindustrial residues. *Biomass and Bioenergy* **2012**, *40*, 181-189, doi:https://doi.org/10.1016/j.biombioe.2012.02.018.

16. Gontard, N.; Sonesson, U.; Birkved, M.; Majone, M.; Bolzonella, D.; Celli, A.; Angellier-Coussy, H.; Jang, G.-W.; Verniquet, A.; Broeze, J.; et al. A research challenge vision regarding management of agricultural waste in a circular bio-based economy. *Critical Reviews in Environmental Science and Technology* **2018**, *48*, 614-654, doi:10.1080/10643389.2018.1471957.

17. Köninger, J., Lugato, E., Panagos, P., Kochupillai, M., Orgiazzi, A., Briones, M. J. . Manure management and soil biodiversity: Towards more sustainable food systems in the EU. *Agricultural Systems* **2021**, *194*, doi:https://doi.org/10.1016/j.agsy.2021.103251.

18. Buckley, C., Moran, B., & Donnellan, T. . *Teagasc National Farm Survey: A Report on Bovine Manure Management, Application and Storage Practices in Ireland 2017 to 2021*; Agricultural Economics & Farm Surveys Department, Rural Economy and Development Programme. Teagasc: 2023.

19. Department of Housing, L.G.a.H. Nitrates Directive. Available online: https://www.gov.ie/en/publication/b87ad-nitrates-directive/#:~:text=Ireland's%20Nitrates%20Action%20Programme%20is%20designed%20to%20prevent%20pollution%20of,protect%20and%20improve%20water%20quality (accessed on July 7).

20. Centro Ricerche Produzioni Animali (CRPA). GOI Carbonio di montagna (OG Mountain Carbon). Available online: https://carboniodimontagna.crpa.it/nqcontent.cfm?a_id=16496.

21. Central Statistics Office. Milk statistics April 2024. Available online: https://www.cso.ie/en/releasesandpublications/ep/p-ms/milkstatisticsapril2024/ (accessed on June 24).

22. Teagasc. Paving the whey - Transforming dairy waste. Available online: https://www.teagasc.ie/news--events/daily/dairy/paving-the-whey---transforming-dairy-waste.php (accessed on June 24).

23. Caballero, P.; Rodríguez-Morgado, B.; Macías, S.; Tejada, M.; Parrado, J. Obtaining Plant and Soil Biostimulants by Waste Whey Fermentation. *Waste and Biomass Valorization* **2020**, *11*, 3281-3292, doi:10.1007/s12649-019-00660-7.

24. Carbery Group. Infant Nutrition. Available online: https://www.carbery.com/nutrition/market-focus/infant-nutrition/ (accessed on

25. BIOSUERO. BIOSUERO - Revalorización del suero quesero para su uso como biofertilizante - bioestimulante (Revalorisation of cheese whey for use as biofertiliser - biostimulant). Available online: https://biosuero.com/ (accessed on

26. Rai, A., Monaghan, R. . *High value sustainable renewable fuels and bio-products from forest residues in Ireland*; Ryan Institute & School of Engineering, University of Galway, MaREI, the SFI Centre for Energy, Climate and Marine Research: 2023.

27. Titus, B.D.; Brown, K.; Helmisaari, H.-S.; Vanguelova, E.; Stupak, I.; Evans, A.; Clarke, N.; Guidi, C.; Bruckman, V.J.; Varnagiryte-Kabasinskiene, I.; et al. Sustainable forest biomass: a review of current residue harvesting guidelines. *Energy, Sustainability and Society 2021 11:1* **2021-04-14**, *11*, doi:10.1186/s13705-021-00281-w.

28. Ardao Riveraa, E.; Nieuwenhuis, M. A GIS-based site suitability assessment of harvest residue procurement during integrated first thinning operations in southern and eastern Ireland. *Irish Forestry* **2018**, *75*.

29. Clean-ER. Clean-ER. Available online: https://marcoerrani.wixsite.com/website-1/clean-er.

30. Knowledge Centre for Bioeconomy. Available online: https://knowledge4policy.ec.europa.eu/bioeconomy/monitoring_en.

31. Bioeconomy policy. Available online: https://www.gov.ie/en/publication/a1bb6-bioeconomy-policy/.

32. Ministers McConalogue and Ryan publish first National Bioeconomy Action Plan. Available online: https://www.gov.ie/en/press-release/595e3-ministers-mcconalogue-and-ryan-publish-first-national-bioeconomy-action-plan/.

33. Bioeconomy Action Plan 2023-2025. Available online: https://www.gov.ie/en/publication/a1bb6-bioeconomy-policy/.

34. Department of Agriculture, F.a.t.M. Stakeholder Coordination & Consultative Groups. Available online: https://www.gov.ie/ga/foilsiuchan/046ce-stakeholder-coordination-consultative-groups/#irish-bioeconomy-network (accessed on June 26).

35. McCarthy, T. BBioNets and the Circular Bioeconomy: Identifying Key Regional Primary Resources and Needs Across Europe. *BBioNets Website* **2024**.

36. EIP-AGRI Operational Group Projects - Ireland.

37. EU CAP Network. EIP-AGRI Project Database. **2024**, *2024*.

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Coordinator	Munster Technological University Ms. Carmen Girón Domínguez (carmen.dominguez@mtu.ie)
Project overview	**BBioNets** will constitute a thematic network that will rely on, promote, and further advance the work carried out by EIP AGRI Operational Groups (OGs) with respect to **management and/or processing of agricultural and forest biomass with Bio-Based Technologies (BBTs).** The project will set up 6 regional Forest and Agriculture Networks - FANs (IE, ES, IT, GR, PL, CZ) that will identify local needs, prioritise specific BBTs and share BBT knowledge ready for practice to farmers and foresters, boosting the (re)definition of value chains, stimulating cross-fertilisation beyond borders, and bringing Europe to the forefront of farming, forestry, and bioeconomy with economically viable and sustainable practices.
Consortium	MTU Ollscoil Teicneolaíochta na Mumhan Munster Technological University cagasc IUNG Institute of Soil Science and Plant Cultivation State Research Institute TEPRO Consultores Agrícolas, S.L. CTA crea American Farm School Thessaloniki - Greece FOCUS BIO EAST

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