ZWAI
ZERO WASTE ALLIANCE IRELAND
Comhaontas Saor Ó Dramhaíl na hÉireann

Submission by Zero Waste Alliance Ireland to the Department of Climate, Energy and the Environment on the Development of Ireland's third Sustainable Development Goals (SDGs) National Implementation Plan

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EEB European Environmental Bureau
CAN Climate Action Network Europe
IEN Irish Environmental Network

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Towards Sustainable Resource Management

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1. INTRODUCTION

Zero Waste Alliance Ireland (ZWAI) welcomes the opportunity to contribute to the development of Ireland's third Sustainable Development Goals (SDGs) National Implementation Plan. Achieving the SDGs in Ireland requires a **strategic shift toward zero waste principles and a fully operational circular economy**, ensuring that resources are used efficiently, pollution is minimised, and environmental sustainability is embedded across all sectors.

Innovative approaches, such as the **integration of hemp into the economy** and the **recovery of nutrients from human urine to produce struvite fertilisers**, demonstrate how sustainable resource management can simultaneously support food security, protect waterways, and reduce reliance on imported and potentially contaminated fertilisers. Aligning national policies and economic strategies more closely with the SDGs will enable Ireland to realise tangible benefits in **climate action, responsible production, clean water, and life on land**, while creating opportunities for green jobs and resilient communities.

By embedding zero waste principles at the core of Ireland's SDG implementation plan, the country can lead by example in demonstrating how **circular, sustainable, and health-protective approaches** are central to meeting global development goals effectively.

2. ZERO WASTE ALLIANCE IRELAND (ZWAI)

At this point we consider that it is appropriate to mention the background to our submission, especially the policy and strategy of ZWAI.

2.1 Origin and Early Activities of ZWAI

Zero Waste Alliance Ireland (ZWAI), established in 1999, is a Non-Government Environmental Organisation (eNGO). ZWAI has prepared and submitted to the Irish Government and to State Agencies many policy documents on waste management, and continues to lobby Government on the issue of using resources more sustainably, and on the implementation of the Circular Economy.

Our principal objectives are:

i) sharing information, ideas and contacts,

ii) finding and recommending environmentally sustainable and practical solutions for domestic, municipal, industrial and agricultural waste management in Ireland;

iii) lobbying Government and local authorities to implement environmentally sustainable waste management practices, including clean production, elimination of toxic substances from products, re-use, recycling, segregation of discarded materials at source, and other beneficial practices;

iv) lobbying Government to follow the best international practice and EU recommendations by introducing fiscal and economic measures designed to penalise the manufacturers of products which cannot be re-used, recycled or composted at the end of their useful lives, and to financially support companies making products which can be re-used, recycled or are made from recycled materials;

v) raising public awareness about the long-term damaging human and animal health and economic consequences of landfilling and of the destruction of potentially recyclable or re-usable materials by incineration; and,

vi) maintaining contact and exchanging information with similar national networks in other countries, and with international zero waste organisations.

2.2 Our Basic Principles

Human communities must behave like natural ones, living comfortably within the natural flow of energy from the sun and plants, producing no wastes which cannot be recycled back into the earth's systems, and guided by new economic values which are in harmony with personal and ecological values.

In nature, the waste products of every living organism serve as raw materials to be transformed by other living creatures, or benefit the planet in other ways. Instead of organising systems that efficiently dispose of or recycle our waste, we need to design systems of production that have little or no waste to begin with.

There are no technical barriers to achieving a "zero waste society", only our habits, our greed as a society, and the current economic structures and policies which have led to the present environmental, social and economic difficulties.

"Zero Waste" is a realistic whole-system approach to addressing the problem of society's unsustainable resource flows – it encompasses waste elimination at source through product design and producer responsibility, together with waste

reduction strategies further down the supply chain, such as cleaner production, product repairing, dismantling, recycling, re-use and composting.

ZWAI strongly believes that Ireland should have a policy of not sending to other countries our discarded materials for further treatment or recycling, particularly to developing countries where local populations are being exposed to dioxins and other very toxic POPs. Relying on other countries' infrastructure to achieve our "recycling" targets is not acceptable from a global ecological and societal perspective.

2.3 What We are Doing

Zero Waste Alliance Ireland has prepared many policy documents on waste management, we continue to lobby the Government of Ireland on the issue of sustainable resource management, and to express our concern at the failure to address Ireland's waste problems at a fundamental level.

In recent decades, as many older landfills were closed or became better managed (primarily as a consequence of the implementation of European Directives, Irish legislation transposing these Directives, the development of a waste licensing regime by the Environmental Protection Agency, and the establishment of the Office of Environmental Enforcement in 2003), concern about the public health effects of landfills decreased considerably.

ZWAI therefore concentrated more on the objectives of ensuring that Ireland's government agencies, local authorities and other organisations will develop and implement environmentally sustainable resources and waste management policies, especially resource efficiency, waste reduction and elimination, the promotion of re-use, repair and recycling, and the development and implementation of the Circular Economy.

As an environmental NGO, and a not-for-profit company with charitable status since 2005, ZWAI also campaigns for the implementation of the UN Sustainable Development Goals, including (but not limited to) Goal 12, Responsible Consumption and Production, and Goal 6, Clean Water and Sanitation (having particular regard to the need to avoid wasting water).

In addition to responding to many public consultations, members of ZWAI have given presentations on how the European Union has addressed the problem of plastic waste (March 2019), on single-use plastic packaging by the food industry (November 2019), and other relevant topics.

It will be clear that ZWAI is primarily concerned with the very serious issue of discarded substances, materials and goods, whether from domestic, commercial or industrial sources, how these become "waste", and how such "waste" may be prevented by re-design along ecological principles. These same ecological principles can be applied to the many ways in which we abstract and use water

as a resource, and to the equivalent volumes of wastewater produced as a consequence of these uses.

ZWAI is represented on the Irish Government's Waste Forum and Water Forum (An Fóram Uisce), is a member of the Irish Environmental Network and the Environmental Pillar, and is funded by the Department of Communications, Climate Action and the Environment through the **Irish Environmental Network**.

In 2019 ZWAI became a full member of the **European Environment Bureau** (EEB); and we participate in the development of European Union policy on waste and the Circular Economy.

3. Challenging Market Led Governance and Re-centering the Public Good

Ireland's approach to implementing the Sustainable Development Goals must move decisively away from neoliberal, market-led policy frameworks that prioritise profit, competition, and commodification over social and ecological well-being. Treating essential systems, such as housing, energy, waste management, health, land, and natural resources, as market commodities has undermined the State's ability to deliver equitable outcomes and protect environmental limits.

Decades of reliance on market mechanisms have contributed to deepening social inequality, escalating housing insecurity, environmental degradation, delayed climate action, and fragmented long-term planning. These outcomes are fundamentally incompatible with the SDGs. Achieving the Goals requires a strong, capable public sector; democratic, accountable governance; and policy decisions grounded in social value, ecological integrity, and intergenerational justice, rather than short-term economic return.

For zero waste principles to be meaningfully embedded across society, Ireland must prioritise prevention, sufficiency, repair, reuse, and circular resource management through robust public policy and regulation. This cannot be delivered through deregulation or voluntary market action alone. Strategic state intervention is essential to redesign systems of production and consumption, ensure resource efficiency, and protect the commons.

Key governance priorities should include:

- **Clear, timely, and accountable decision-making**, with defined statutory timelines and responsibilities
- **Public services explicitly aligned with SDG outcomes**, including waste reduction, emissions reduction, and material circularity
- **Elimination of bureaucratic silos and duplication**, through integrated, whole-of-government approaches

- **Strong accountability mechanisms**, ensuring public bodies are responsible for delivering measurable social and environmental outcomes

To strengthen democratic legitimacy and public trust, Ireland should establish a permanent, open public participation platform for SDG implementation. This portal should enable communities, civil society organisations, workers, and experts to submit proposals and evidence on an ongoing basis. All submissions should be publicly visible, formally assessed, and meaningfully responded to, ensuring SDG policy development remains transparent, inclusive, and grounded in lived experience.

Finally, the legal and regulatory framework underpinning SDG delivery must be coherent, accessible, and values-based. Legislation should be:

- **Clearly structured and consistent**, avoiding fragmentation and policy contradiction
- **Ethically grounded**, prioritising long-term social and environmental well-being over private interest
- **Transparent and accessible**, reducing legal uncertainty and discretionary interpretation

A shift away from neoliberal governance toward strong public leadership, rights-based policy, and zero waste systems thinking is essential if Ireland is to move beyond procedural compliance and deliver real, measurable progress on the Sustainable Development Goals.

4. Bureaucratic Reform: Simple, Clear, and Non-Duplicative Governance

4.1 Reducing Bureaucracy While Increasing Transparency

Ireland's bureaucratic system remains overly complex, fragmented, and duplicative, creating a structural barrier to sustainable innovation, timely climate action, and socially beneficial investment. Excessive administrative burden disproportionately affects small and medium enterprises, community-led initiatives, social enterprises, and sustainability-driven projects, undermining Ireland's ability to deliver the SDGs at pace and scale.

Without fundamental bureaucratic reform, climate targets, housing delivery, circular economy initiatives, and just transition policies will continue to be delayed, diluted, or blocked by procedural inefficiencies rather than policy intent**.**

The SDG Implementation Plan must therefore commit to systemic administrative reform, including:

- Simplification and harmonisation of regulatory pathways for sustainable, climate-positive, and socially beneficial projects
- Digitally supported systems with human oversight**,** ensuring clarity, fairness, and accountability in all planning, permitting, and funding decisions.
- Legally binding decision timelines, with automatic escalation and accountability mechanisms where deadlines are exceeded
- Open-access, real-time public data, enabling citizens, researchers, and civil society to monitor decisions, spending, and outcomes
- Integrated blockchain-based registries, ensuring data integrity, traceability, and institutional accountability across agencies

4.2 A Single-Interface "One-Window" or "One Stop Shop" Model: Learning from International Best Practice

Ireland should consider adopting a legally mandated "One-Window Service" model, where citizens, communities, and businesses interact with the State through a single digital interface with defined procedures, fixed deadlines, and clear accountability.

A relevant and proven example is Diia (Дія), Ukraine's national digital governance platform, which integrates public services, identity verification, permits, business registration, social services, and public records into a single, user-centred application. Diia has demonstrated that:

- Complex administrative processes can be centralised without loss of legal robustness
- Digital-first governance can dramatically reduce corruption, delays, and duplication
- Transparency and accessibility can be improved even under conditions of war

Adapting a Diia-style model to Ireland - fully aligned with EU data protection, cybersecurity, and public accountability standards - would significantly enhance administrative efficiency, reduce barriers for sustainability-led sectors, and strengthen public trust in institutions.

4.2 SDG Alignment and Systemic Impact

Transparent, efficient, and digitally enabled governance is foundational to SDG 16 (Peace, Justice, and Strong Institutions) and a critical enabling condition for SDG 13 (Climate Action) and SDG 10 (Reduced Inequalities).

Bureaucratic reform is not merely an administrative upgrade - it is a precondition for credible, timely, and just SDG implementation.

By reducing bureaucracy while strengthening transparency and accountability, Ireland can move from policy ambition toward measurable, outcome-driven, and equitable delivery of the SDGs.

5. The Hemp Economy as a Critical Enabler of the SDGs

The hemp economy is not a niche or experimental solution. It is a strategic, science-based, and scalable enabler of Ireland's Sustainable Development Goals, with the capacity to deliver simultaneous climate, economic, social, and biodiversity benefits across multiple sectors.

Hemp-based systems directly contribute to:

- Climate action, through rapid biomass growth, atmospheric carbon sequestration, and long-term carbon storage in construction materials
- Sustainable and low-carbon construction, reducing reliance on emissions-intensive materials such as concrete and steel
- A circular bioeconomy**,** enabling material reuse, biodegradability, and low-waste production cycles
- Rural development and green employment, supporting farm diversification, regional resilience, and value-added manufacturing

Without the systematic integration of hemp into agriculture, construction, housing, and manufacturing policy, Ireland's climate mitigation, biodiversity restoration, housing delivery, and circular economy targets will be extremely difficult, if not impossible, to achieve. Hemp should therefore be formally recognised as a cross-sectoral strategic resource, not a marginal crop or specialist building material.

5.1 Hemp as a Cross-Cutting SDG Solution

Ireland cannot credibly meet the SDGs - particularly those relating to climate action, biodiversity, housing affordability, and resource efficiency - without embedding hemp-based solutions into national strategies and regulatory frameworks.

The SDG Implementation Plan should explicitly recognise the hemp economy as a cross-cutting enabler, supporting:

- **SDG 9: Industry, Innovation and Infrastructure**
  Through bio-based manufacturing, material innovation, and domestic value chains

- **SDG 11: Sustainable Cities and Communities**
  Via low-carbon, healthy, and affordable construction materials such as hempcrete

- **SDG 12: Responsible Consumption and Production**
  By replacing fossil-based and high-emission materials with renewable, biodegradable alternatives

- **SDG 13: Climate Action**
  Through carbon sequestration, embodied carbon reduction, and climate-resilient building systems

- **SDG 15: Life on Land**
  By improving soil health, supporting biodiversity, and reducing chemical inputs in agriculture

5.2 Removing Barriers and Enabling Scale

Despite its strong alignment with Ireland's climate and sustainability objectives, the hemp sector continues to face regulatory, financial, and institutional barriers. These include restrictive licensing, lack of clear construction standards, limited access to finance, and insufficient cross-departmental coordination.

The SDG Plan must therefore:

- Remove regulatory obstacles to hemp cultivation, processing, and use

- Integrate hemp-based materials into building regulations, public procurement, and retrofit programmes

- Support research, certification, and skills development to enable market confidence and scaling

- Facilitate cross-sector collaboration between agriculture, construction, climate, and enterprise bodies

Recognising and enabling the hemp economy is not optional - it is essential for delivering a low-carbon, resilient, and just transition. Without it, Ireland risks locking in high-emission construction, missing climate targets, and failing to realise the full potential of a domestic circular bioeconomy.

5.4 Hemp as an Answer to Zero Waste Strategy in Ireland

Ireland has set ambitious goals to achieve a circular economy and a zero-waste, emissions-reduction future in line with the Paris Agreement. However, to underline a crucial point: without industrial hemp, these goals cannot be fully realised. Hemp is not just a crop - it has the potential to become a multi-functional, renewable raw material capable of displacing some of the most wasteful and polluting industries of today. Implementing a hemp-based economy

could significantly reduce Ireland's waste while creating green jobs, improving soil health, and positioning Ireland as a European leader in circular innovation.

Drawing on circular economy modelling frameworks and cross-sector substitution potentials identified in recent research,[1] [2] [3] it can be argued that a fully developed hemp-based bioeconomy holds the theoretical capacity to **eliminate up to 95% of Ireland's waste streams**. This estimate represents a conceptual maximum, grounded in the principle that industrial hemp can replace the majority of non-renewable and non-recyclable materials across the construction, agriculture, packaging, textile, and bioenergy sectors.

Such a transformation would align Ireland's production and consumption systems with circular bioeconomy principles, in which biological feedstocks are continually regenerated, waste is designed out of the system, and materials re-enter the economic cycle in restorative loops. While empirical quantification of this potential remains limited, this theoretical scenario underscores the potential and realisable scale of environmental and resource-efficiency gains achievable through comprehensive integration of hemp-based value chains.

The 95% waste reduction estimate is derived from a theoretical aggregation of sectoral substitution potentials achievable under a fully circular hemp-based economy. According to the EPA (2025) and the Irish Green Building Council's circular roadmap, the construction and demolition sector, which generates approximately half of Ireland's material waste, as we have pointed out in section 3.3 above, could achieve up to **50% reduction** through the replacement of conventional concrete, insulation, and plaster materials with hemp-lime and hempcrete composites. Teagasc (2025) identifies large-scale hemp cultivation potential for bio-composite manufacturing, textiles, and bio-packaging, which together could displace an additional **25% of waste** currently arising from synthetic fabrics, plastics, and short-lifecycle packaging. The remaining **20% reduction potential** is attributed to bioenergy recovery, paper substitutes, and agro-industrial applications, where hemp residues can be reintroduced into productive cycles as biomass fuel or soil amendments.

Collectively, these sectoral transformations would leave an estimated 5% residual waste, principally from non-substitutable materials, hazardous waste, or medical residues, thereby forming the theoretical upper limit of Ireland's transition toward a near-zero waste bioeconomy. Although these figures are conceptual, they illustrate the systemic potential of hemp-based circularity to align national waste flows with the objectives of the EU Green Deal and Ireland's Climate Action

1 Environmental Protection Agency (EPA) (2025) – Hemp Lime Bio-composite as a Building Material in Irish Construction (STRIVE Report 97). Environmental Protection Agency, Ireland. https://www.epa.ie/publications/research/waste/STRIVE_97_BESRAC_Summary_Findings.p df

2 Steyn, L. et al. (2025) – 'A Comprehensive Review of Hempcrete as a Sustainable Building Material', Innovative Infrastructure Solutions, Springer. https://link.springer.com/article/10.1007/s41062-025-01906-1

3 Teagasc (2025) – The Potential of Hemp Cultivation in Ireland: A Farmers' Perspective. Teagasc Rural Economy & Development Programme, Dublin. https://teagasc.ie/wp-content/uploads/media/website/publications/2025/The-Potential-of-Hem p-Cultivation-in-Ireland---A-Farmers-Perspective.pdf

Plan, positioning hemp as a cornerstone of a regenerative and resource-resilient future.

A joint report by the **Irish Fiscal Advisory Council (IFAC)** and the **Climate Change Advisory Council** warns that Ireland could face **€8 billion to €26 billion** in compliance costs by 2030 if it fails to meet its binding emissions reduction obligations under EU law.[4] [5] Under a scenario in which additional mitigation measures are implemented, this cost range could fall to **€3 billion to €12 billion**. Some reports frame these potential costs as "fines," though technically they reflect the need to purchase emissions allowances or compensatory credits under the EU Effort Sharing Regulation[6], rather than direct punitive penalties. According to The Irish Times (2025)[7], in a worst-case scenario, these costs could rise to as much as **€28 billion** if Ireland continues to fall short of its 2030 climate targets.

5.5 Why Hemp is Essential

Industrial hemp grows rapidly, absorbs large quantities of carbon dioxide requires minimal pesticides, and regenerates soils (see Figure 2). It offers a **closed-loop system** where every part of the plant can be used (seeds, stalks, fibres, and hurds) leaving virtually no waste. This makes it uniquely aligned with the principles of zero waste and the circular economy. Moreover, by integrating hemp across sectors, Ireland can significantly reduce its carbon footprint and landfill waste. Hemp therefore represents a practical, scalable solution to help Ireland meet its 2030 climate targets under the Paris Agreement and avoid potential non-compliance fines.

CO_2 absorption comparison between Peatlands, Hemp, and Trees over a 3–4 month period

Criteria	Trees / Wood (per hectare, 3–4 months)	Peatland (per hectare, 3–4 months)	Hemp (per hectare, 3–4 months)

[4] Irish Fiscal Advisory Council & Climate Change Advisory Council (2025) – A Colossal Missed Opportunity: Ireland's Climate Action and the Potential Costs of Missing Targets. Dublin: Irish Fiscal Advisory Council. Available at: https://www.fiscalcouncil.ie/wp-content/uploads/2025/03/Irelands-climate-action-and-the-pote ntial-costs-of-missing-targets.pdf

[5] Reuters (2025) – Ireland may face €26 billion climate bill by 2030, councils warn. 28 May 2025. Available at: https://www.climatecouncil.ie/news/a-colossal-missed-opportunity---irelands-climate-action-a nd-the-potential-costs-of-missing-targets.html

[6] https://climate.ec.europa.eu/eu-action/effort-sharing-member-states-emission-targets/effort-s haring-2021-2030-targets-and-flexibilities_en

[7] The Irish Times (2025) – Ireland could face penalties of €28 bn by 2030 for failing to sufficiently reduce greenhouse-gas emissions. 29 May 2025. Available at: https://www.irishtimes.com/politics/2025/05/29/costs-of-potential-climate-penalties-rise-as-e mission-cuts-fall-leaving-ireland-staring-at-28bn-bill/

CO_2 Absorption	1–2.5 tonnes (varies by species and growth stage)	0.9–1.4 tonnes (extrapolated from annual rates)	8–15 tonnes; also produces 7–12 tonnes of O_2
Growth Rate	Moderate (trees take years to mature)	Extremely slow (forms over millennia)	Fast (harvested within 3–4 months)
Carbon Storage	Long-term (stored in biomass and soil)	Long-term (stored for thousands of years)	Short to medium-term (stored in hempcrete and bio-products)
Environmental Role	Provides oxygen, absorbs CO_2, and supports biodiversity	Acts as a carbon sink preventing CO_2 release	Reduces atmospheric CO_2 through photosynthesis; enhances soil health and circular bioeconomy potential

***Figure 1**: Demonstrates a comparison of CO_2 absorption, growth rate, carbon storage, and environmental roles of hemp, and highlights how it can complement peatlands and forests in delivering both short-term and long-term climate benefits.[8] [9] [10]*

5.6 Hemp Applications Across Sectors

Hemp has a wide range of uses across multiple sectors, including its potential as a sustainable alternative to **conventional plastics** as listed below:

- Hemp bioplastics are fully biodegradable and compostable, unlike conventional plastics which persist for centuries.
- Hemp bioplastics and composites can replace single-use packaging, consumer goods, car parts, and even 3D-printing materials, offering durable, renewable, and biodegradable alternatives to petroleum-based plastics.
- By substituting plastics with hemp-based alternatives, Ireland can drastically cut landfill waste and microplastic pollution.

5.6.1 Energy Storage:Hemp Batteries

- Hemp-based supercapacitors are up to 8 times more powerful than lithium-ion batteries while being cheaper, safer, and non-toxic.
- Hemp-based energy storage reduces reliance on scarce, geopolitically sensitive, and environmentally destructive minerals like lithium and cobalt.

[8] https://teagasc.ie/news--events/daily/the-forest-carbon-tool
[9] https://www.ipcc.ie/a-to-z-peatlands/irelands-peatland-conservation-action-plan/peatland-actionplan/climate-change-and-irish-peatlands
[10] https://agriculture.ec.europa.eu/farming/crop-productions-and-plant-based-products/hemp_en

This is crucial for Ireland's renewable energy transition and energy independence.

Hemp fibres can be converted into graphene-like nanosheets for use in supercapacitors, offering a low-cost, sustainable alternative to lithium-ion and conventional graphene-based batteries. Hemp-based batteries are:

- cheaper to produce;
- faster to charge; and,
- environmentally friendly, with no reliance on rare-earth metals or toxic mining.

As supercapacitors, providing high energy density and long cycle life, making them a promising green solution for future energy storage. In addition, the use of hemp biomass in bioenergy production offers another renewable pathway, reducing dependence on fossil fuels and contributing to a truly circular energy economy.

5.6.2 Metals and Composites Used in Cars, Aircraft, and Other Vehicles

- Hemp fibres can replace metals and synthetic composites in lightweight materials for construction, automotive, and aerospace applications.
- Hemp composites are durable, corrosion-resistant, and lighter, reducing energy use and emissions in transport sectors.

5.6.3 Biofuels: Hemp as Petrol Replacement

- Hemp seeds and stalks can be converted into biodiesel, ethanol, and biogas, offering renewable alternatives to fossil fuels. Research shows hempseed oil can produce high-yield, high-quality biodiesel that meets international fuel standards.
- This reduces Ireland's dependency on imported petroleum and supports decarbonisation of transport and agriculture.

In the 1930s, Henry Ford introduced a revolutionary hemp-based car made from plant-derived composites. The vehicle was ten times stronger than steel, 450 kilograms lighter than a standard car - resulting in greater fuel efficiency - and remarkably resistant to dents, as demonstrated when Ford famously struck the car's body with an axe. The material was also fully biodegradable and the car was designed to run on hemp-based biofuel. Ford's pioneering vision demonstrated the potential of hemp to replace metal-intensive manufacturing and reduce reliance on petroleum, presenting an early model of a truly sustainable, circular, and carbon-neutral transport system.

A similar approach can be applied to the aviation industry. Hemp-based materials could be used to manufacture lighter and stronger aircraft, significantly improving fuel efficiency through lightweight hemp fibre composites that reduce fuel consumption and emissions. By replacing conventional composites with hemp-based alternatives, airplanes would require less fuel, lowering both operational

costs and carbon output. Additionally, the use of hemp-derived biofuels and hybrid systems powered by hemp-based batteries could enable zero-emission or carbon-neutral flights, creating a transformative positive impact on the environment and accelerating the transition toward sustainable, next-generation aviation.

5.6.4 Textiles

- Hemp textiles are more durable than cotton, require significantly less water, and are naturally antimicrobial.
- Can replace cotton, polyester, and other synthetic fabrics that currently generate enormous waste and microfibres.
- Hemp-based vegan fur represents a sustainable alternative to animal fur, offering enhanced thermoregulatory performance while eliminating ethical and ecological concerns associated with traditional fur (Ukranian patent).
- Hemp clothing, upholstery, and industrial fabrics are biodegradable, supporting genuine circularity within the textile sector.
- As a sustainable alternative to synthetic fibres used in clothing, footwear, and everyday textiles, hemp provides a non-toxic, breathable, and UV-resistant option. Unlike petroleum-based materials, hemp fabrics are naturally antibacterial and ideal for sensitive skin.
- Hemp cultivation requires less water and land than cotton, grows without pesticides, and even improves soil health, contributing to regenerative agricultural systems.
- Replacing synthetic fibres with hemp can significantly reduce landfill waste, microplastic pollution, and the fashion industry’s overall carbon footprint.
- Additionally, hemp can be used to create biodegradable feminine hygiene products and nappies, which currently account for a large portion of non-recyclable waste and microplastic pollution in landfills. Due to hemp’s natural antimicrobial and antifungal properties, these products are also much healthier than traditional alternatives, which not only harm the environment but can negatively affect human health.

5.6.5 Bulky waste items

Furniture, mattresses, and floor coverings made with hemp-based composites and natural fibres are more sustainable and recyclable than their synthetic counterparts, helping to reduce the volume of bulky waste sent to landfills.

5.6.6 Hemp Paper

Hemp produces significantly more pulp per acre than trees and requires no harsh chemicals for processing. It can be used to make books, packaging, and office paper, providing a renewable alternative that reduces deforestation and paper waste (meanwhile sequestrating massively CO2).

From one hectare of hemp, it is possible to obtain as much paper as from four hectares of trees. Moreover, hemp fibres can be recycled up to eight times, while wood-based paper can only be recycled about three times. This makes hemp paper a cleaner, more efficient, and truly circular solution for the global paper industry.

5.6.7 Hempcrete: Sustainable Building and Retrofit Material

Hempcrete delivers up to 70-90% energy savings in heating and cooling (see figure 3 below). Its natural thermal mass and breathability eliminate the need for dehumidifiers, making it the ultimate passive and healthy building material.

No mould, fungus, pests, or termites can thrive in hempcrete walls, making it the ultimate passive, durable, and healthy building material.

Hempcrete is carbon-negative, breathable, highly insulating, and fire-resistant.

It replaces concrete and insulation materials that generate massive construction waste and emissions.

Hempcrete buildings store carbon over their lifetime, making them essential for decarbonising the built environment.

HEMP BUILD U Value Study	For HEMP BUILD LTD							by Patrick Daly April 2019			
CONSTRUCTION TYPE	EXISTING	IMPROVEMENT MEASURE									
FLOOR	Baseline	Replacement Hemp Lime floo						Upgrade Hemp Lime Floor			
		120mm	% Diff	150mm	% Diff			60mm	% Diff	90mm	% Diff
Floor											
Lime Screed - Earth Floor	0.6	0.4	33	0.34	43						
Uninsulated Concrete Slab	0.64	0.4	38	0.34	47			0.39	39	0.33	48
WALL	Baseline	Upgrade Wall									
		60 mm	% Diff	90 mm	% Diff	120 mm	% Diff	150 mm	% Diff	210 mm	% Diff
Stone											
Limestone Wall 20% Plaster Lath	1.35										
Limestone Wall 40% Lime Earth	1.72										
Limestone Wall 20% Lime Earth	*1.85*	*0.63*	*66*	*0.5*	*73*	*0.42*	*77*	*0.36*	*81*	*0.28*	*85*
Brick											
230mm Brick Wall	*2.12*	*0.65*	*69*	*0.52*	*75*	*0.43*	*80*	*0.37*	*83*	*0.28*	*87*
340mm Brick Wall	1.63										
Concrete Wall											
200mm Conc Wall	*2.59*	*0.69*	*73*	*0.54*	*79*	*0.44*	*83*	*0.36*	*86*	*0.29*	*89*
Masonry Wall											
250mm Hollow Block	*1.93*	*0.68*	*65*	*0.53*	*73*	*0.44*	*77*	*0.38*	*80*	*0.29*	*85*
325 mm Cavity Wall	*1.74*	*0.62*	*64*	*0.49*	*72*	*0.41*	*76*	*0.35*	*80*	*0.28*	*84*

ROOF	Baseline	Upgrade Roof			
		100 mm	% Diff	240 mm	% Diff
Uninsulated Roof	2.5	0.4	84	0.17	93

TGD	New 11	New 18	Exist MA & CoU	
Wall	0.21	0.18	0.35	0.55 cv
Floor	0.21	0.18	0.45	
RoofCl	0.16	0.16	0.16	

Figure 2: *U-value study by Daly (2019) showing that hemp-lime upgrades to floors, walls, and roofs can reduce heat loss by up to 70–90%, bringing traditional constructions close to modern regulatory standards.*[11]

Hempcrete's high thermal mass enables it to store and release heat gradually, while its hygroscopic behaviour regulates indoor humidity levels, reducing the need for mechanical heating, cooling, and ventilation. These qualities contribute to improved comfort, peak-load reduction, and resilience in energy outages - benefits that remain invisible under conventional metrics. Consequently, hempcrete often underperforms in regulatory energy models, leading to its exclusion from building certification schemes, retrofit grants, and policy incentives.

To address this gap, we propose the H-Value – a holistic performance metric for natural building materials. Unlike the U-value, the H-Value integrates:

- Thermal mass capacity (heat storage and release)
- Moisture buffering index (humidity regulation)
- Life-cycle carbon balance (including sequestration and end-of-life impacts)
- Circularity score (potential for reuse, recycling, and biodegradation)

The adoption of the H-Value would align performance assessment with life-cycle thinking and EU climate policy trends, including the Whole Life Carbon Roadmap and the Circular Economy Action Plan. It would enable materials like hempcrete to be evaluated not solely on steady-state energy performance but on their overall contribution to climate resilience, health, and circularity.

Hempcrete's Thermal, Environmental, Health, Acoustic, Protective, and Durability Performance:

1. **Thermal Performance:** Strong thermal inertia; reduces heating and cooling demand by up to 70%.
2. **CO_2 Sequestration:** Hempcrete absorbs and retains substantial amounts of CO_2 through the growth of hemp (photosynthesis) and carbonation of the lime binder, making it carbon-negative over its lifecycle.
3. **Biodegradability:** Fully biodegradable and reusable, supporting circular construction.
4. **Healthy Indoor Environment**: Regulates humidity and improves indoor air quality; eliminates need for dehumidifiers and mechanical ventilation.
5. **Acoustic Performance:** Excellent acoustic insulation; reduces noise transmission and enhances indoor comfort.
6. **Safety and Resilience:** The ability of hempcrete to absorb energy from bullets and explosive blasts can be conceptually linked to findings on porous "soft" materials that dissipate shock waves.

11 Daly, P. (2019). Private report for HempBuild.ie. Unpublished manuscript, available on request.

7. **Fire Resistance**: Hempcrete walls have demonstrated the ability to achieve up to 60 minutes' fire resistance and A1 flame spread classification when appropriately rendered.
8. **Pest Resistance:** Hemp-based insulation exhibits natural pest resistance due to its high alkalinity and lime content, creating an environment inhospitable to termites, rodents, and insects—thus reducing the need for chemical additives.
9. **Waste Management**: Helps address construction and demolition waste; 13–18% of mixed C&D waste still goes to landfill in Ireland.
10. **Policy Relevance**: Recognising hempcrete in waste and retrofit strategies could advance decarbonisation and circularity goals.
11. **Energy Security:** As part of a broader renewable and bio-based materials strategy, hempcrete can contribute to reducing energy demand in buildings and thus support EU goals to end dependency on Russian energy.
12. **Earthquake Resilience**: Hempcrete's low density and ductile nature make it well-suited for seismic-prone contexts, reducing crack propagation and structural damage during ground movement.

5.7 Final Considerations on Hemp Usage

Hempcrete is more than just a building material, it is a holistic solution for decarbonising the built environment. By storing carbon, improving energy efficiency, resisting fire and pests, and preventing construction waste, hempcrete addresses multiple barriers to Ireland's zero waste and climate targets simultaneously.

Experimental research on bio-based phase change materials confirms that optimising thermal mass can improve occupant comfort, reduce reliance on active heating and cooling, and enable better integration of renewable energy sources. Yet, current Irish policy and certification systems do not account for these performance characteristics, leaving hempcrete undervalued and underutilised in both the housing and retrofit sectors.

A strategic shift combining policy reform, investment in processing infrastructure, and updated performance metrics such as the proposed H-Value is essential if Ireland is to unlock the potential of hempcrete as both a climate mitigation tool and a driver of rural economic regeneration.

Ukraine illustrates resilience amid war, with projects like the Ma'rijanni Hemp Industrial Park establishing the capacity to process 14,000 tonnes of stalks annually, with plans to expand alongside cultivation.

Once covering 150,000 hectares, Ukraine's hemp industry is being revived as part of rural economic regeneration, targeting textiles, packaging, and construction materials. Recently, Ukraine opened its largest hemp processing plant and launched the e-Hemp certification system to enhance industry

transparency, traceability, and international competitiveness, marking a major step toward a modern, sustainable hemp economy.

Field studies show hempcrete walls can cut heating and cooling demand by up to 70 - 90%, particularly in temperate climates, with resilience benefits demonstrated in off-grid contexts such as Ukraine during long winter blackouts. However, standard U-value metrics overlook these dynamic behaviours, limiting recognition in certification schemes. To address this, holistic indicators like the proposed H-Value integrate thermal mass, moisture regulation, and life-cycle carbon performance.

Ukraine provides an instructive counterexample with its e-Hemp certification system, which streamlines traceability and quality assurance. This digital approach strengthens domestic market confidence, enhances export potential, and positions hemp for growth in post-war reconstruction.

Implementing hempcrete can be a ‘silver bullet’ for Ireland’s construction sector, simultaneously tackling energy demand, carbon sequestration, waste, health, and resilience. Its potential, however, is held back by regulatory inertia, infrastructure gaps, and policy silos. With holistic metrics like the H-Value, stronger cross-sector collaboration, and investment in supply chains and demonstration projects, hempcrete could move from the margins to the mainstream becoming a cornerstone of Ireland’s path to climate neutrality, healthier homes, and sustainable housing by 2050.

The fact that hemp can be grown vertically in cases of limited land, as well as on traditional farmland, and is one of the fastest-growing crops, taking only 3-4 months to harvest, can be highly beneficial for farmers, allowing them to harvest up to three times a year from the same plot of land, especially in the Irish climate.

6. Advanced and High-Performance Zero Waste Systems

Ireland must urgently move away from landfill-dependent waste management and toward a high-performance, circular, and zero waste system grounded in prevention, reuse, and material recovery. Continued reliance on landfills (even though we have only two landfills remaining) represents a failure of climate governance and resource stewardship, locking in methane emissions, land degradation, pollution risks, and long-term environmental liabilities that directly undermine Ireland’s SDG commitments.

Equally, approaches that prioritise disposal over prevention, whether through landfill or incineration or “energy recovery”, are incompatible with a zero waste future. Both methods destroy material value, discourage upstream waste reduction, and entrench linear consumption patterns.

To meet climate and circular economy objectives, Ireland should adopt advanced zero waste models informed by international best practice, including countries

such as South Korea, where landfill use has been dramatically reduced through strict regulation, high-quality source separation, and robust recycling and reuse systems.

6.1 Strategic Actions Required

The SDG National Implementation Plan should commit to the following system-level reforms:

- Phased further prohibition of landfill disposal, particularly for untreated, recyclable, and organic waste, with clear timelines and escalating regulatory restrictions
- Full and enforceable adherence to the waste hierarchy, prioritising prevention, reduction, reuse, repair, and recycling as binding objectives
- Mandatory and more detailed separation at source, supported by consistent national standards, digital tracking, and effective enforcement
- Expanded and strengthened Extended Producer Responsibility (EPR) schemes, designed to reduce waste generation at source, improve product durability, and eliminate problematic materials
- Investment in reuse, repair, composting, and high-quality recycling infrastructure, ensuring materials remain in productive use and organics are safely returned to the soil

7. Alignment with Circular Economy and Climate Goals

A zero waste approach treats discarded materials not as fuel or liabilities, but as resources to be conserved within closed-loop systems. By prioritising waste prevention and material recovery, Ireland can significantly reduce emissions associated with extraction, manufacturing, and disposal, while protecting ecosystems and public health.

This approach would:

- Eliminate methane emissions associated with landfill
- Preserve material value through repairing, reuse and recycling
- Reduce demand for virgin resource extraction
- **Support SDG 12 (Responsible Consumption and Production)**: through systemic waste reduction and product redesign
- **Contribute to SDG 13 (Climate Action):** by addressing emissions across the full material lifecycle

Moving decisively toward zero waste systems, rather than shifting waste between disposal pathways, will enable Ireland to deliver genuine circular economy outcomes and meet its Sustainable Development Goals with integrity.

8. Governance, Transparency, and Public Trust

To safeguard environmental integrity and maintain public confidence, the transition to advanced zero waste systems must be underpinned by strong governance, transparency, and accountability. This requires:

- **Transparent environmental monitoring**, with real-time, publicly accessible data on material flows, emissions, and environmental impacts
- **Independent and adequately resourced regulatory oversight**, free from industry influence
- **Clear and accessible public communication**, explaining zero waste objectives, the waste hierarchy, and the prioritisation of prevention, reuse, and recycling
- **Full alignment with national climate budgets, biodiversity commitments, and circular economy indicators**, ensuring waste policy supports wider environmental and social goals

Strong governance and openness are essential to ensure waste policy delivers genuine public benefit, protects health and ecosystems, and earns long-term public trust.

9. Strategic Outcome

Without decisive reform, landfill dependence will continue to undermine Ireland's climate targets, waste Ireland's resource potential, and expose communities to long-term environmental risks. By contrast, a modern, circular, and energy-efficient waste management system would transform waste into a strategic asset, reducing emissions, strengthening energy security, and accelerating progress across the SDGs.

Advanced waste management is not a technical upgrade, it is a core infrastructure requirement for a low-carbon, resilient, and resource-efficient Ireland.

10. Plant-Based Transition as a Core Element of Sustainable Consumption and Food Systems

A transition toward plant-based diets - particularly predominantly plant-based and vegan dietary patterns - must be recognised as a central pillar of sustainable consumption and food system reform, rather than a lifestyle choice left to individual behaviour alone. Integrating this transition under sustainable consumption and food systems avoids duplication while strengthening policy coherence across climate, biodiversity, and public health objectives.

International best-practice examples, such as Amsterdam's city-wide plant-based transition strategy, demonstrate that dietary change can be effectively supported through public policy, procurement, education, and urban food planning.

10.1 Climate, Environmental, and Resource Benefits

A shift toward plant-based diets delivers substantial environmental benefits, including:

- Significant reductions in greenhouse gas emissions, particularly methane and nitrous oxide associated with animal agriculture
- Lower land and water use, reducing pressure on ecosystems, deforestation, and soil degradation
- Improved biodiversity outcomes, by decreasing intensive livestock production and feed-crop monocultures

Dietary transition (for example a healthy diet for a healthy planet as proposed by the EAT-Lancet commission and supported by Zero Waste Alliance Ireland) is therefore a high-impact, low-cost climate action, directly supporting SDG 13 (Climate Action), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land).

10.2 Public Health and Social Benefits: Emphasising the Vegetarian/Vegan Shift

Beyond environmental benefits, predominantly plant-based and well-planned vegetarian or vegan diets are increasingly recognised as health-promoting and disease-preventative. Evidence-based plant-based dietary patterns are associated with:

- Lower rates of cardiovascular disease, obesity, and type-2 diabetes
- Reduced healthcare costs linked to diet-related chronic illness
- Improved overall population health and wellbeing

Positioning the plant-based transition as a public health strategy aligns food policy with SDG 3 (Good Health and Well-Being), reducing long-term strain on health systems while improving quality of life.

Importantly, a vegetarian/vegan shift, when supported through education, access, and nutrition guidance, can deliver complete, affordable, and culturally adaptable nutrition, particularly when combined with fortified foods and public health standards.

10.3 Policy Integration and Systemic Change

The SDG Implementation Plan should therefore:

- Integrate plant-based transition targets into national climate, food, and health strategies
- Expand plant-based and vegan options in public procurement, including schools, hospitals, universities, and public institutions
- Support public education and nutritional guidance, ensuring plant-based diets are accessible, balanced, and inclusive
- Align food policy with circular bioeconomy principles, promoting plant-based proteins, legumes, grains, and locally sourced crops

- Encourage innovation in plant-based food systems, supporting sustainable agriculture and food enterprises

10.4 Strategic Outcome

A plant-based transition is not about restriction, it is about optimising health, resource efficiency, and climate outcomes simultaneously. By embedding plant-based and vegan dietary shifts into sustainable consumption policy, Ireland can deliver immediate emissions reductions, improve public health, protect biodiversity, and strengthen food system resilience.

Dietary transition is one of the most effective and underutilised levers for achieving the SDGs. Treating it as a core policy instrument, rather than a voluntary behavioural change, will significantly accelerate Ireland's progress toward a low-carbon, healthy, and sustainable future.

11. Restricting the Import of Low-Quality, Non-Circular Goods

Ireland's transition to a circular economy is at serious risk of being undermined if domestic markets continue to be flooded with low-cost, low-quality, and non-durable imported goods, many of which are designed for short lifespans, single use, or limited repairability. A significant proportion of these products originate from high-volume manufacturing countries, including China, where production costs are often minimised by externalising environmental, waste, and lifecycle impacts.

While such goods may appear economically attractive at the point of sale, they are "cheap but costly" in reality - generating disproportionate volumes of waste, increasing pressure on recycling and landfill systems, and shifting long-term environmental and financial burdens onto Irish local authorities, communities, and taxpayers.

12. Measures Required to Protect Ireland's Circular Economy

The SDG Implementation Plan should introduce strong, enforceable market-entry standards to prevent Ireland from becoming an end-of-life destination for poorly designed products. These measures should include:

- Minimum durability, quality, and repairability standards for all imported goods, aligned with EU Ecodesign and Right-to-Repair principles
- Bans or strict restrictions on products that cannot be reused, repaired, refurbished, or recycled within Ireland's existing waste management and material recovery infrastructure
- Mandatory availability of repair information, spare parts, and material transparency for imported products
- Differentiated levies or compliance requirements reflecting the true environmental and waste-management costs of low-quality imports.

13. Supporting Irish and EU Circular Industries

Restricting non-circular imports would:

- Protect Irish and EU-based circular manufacturers, repair businesses, and refurbishment industries from unfair competition with disposable goods
- Strengthen domestic value chains, local employment, and skills development
- Reduce dependency on long, high-emission global supply chains, particularly those associated with weak environmental enforcement

This approach is fully consistent with EU Circular Economy policy, SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 8 (Decent Work and Economic Growth).

14. Strategic Outcome

Restricting low-quality, non-circular imports is not protectionism, it is environmental responsibility and economic prudence. Ireland should not serve as a dumping ground for products designed elsewhere to fail quickly. By enforcing durability, repairability, and circularity standards at the point of market entry, Ireland can reduce waste generation, cut emissions, and support high-quality, circular production within Ireland and the EU.

A circular economy cannot succeed if it competes against imports designed for disposability. Strong import standards are therefore essential infrastructure for sustainable consumption, climate action, and long-term resource security.

15. Integrated Approaches to SDG 6 (Clean Water and Sanitation) and SDG 2 (Zero Hunger)

Ireland continues to face significant challenges in providing adequate wastewater treatment infrastructure for many small urban areas. Numerous villages and towns are already operating at or beyond their sewage treatment capacity, directly constraining the delivery of new housing for young families. As a result, smaller settlements are experiencing gradual decline, with younger generations forced to relocate and communities increasingly composed of older residents. This situation is regularly highlighted in national media, for example: *"Louth County Council rejects another housing development due to lack of sewerage capacity[12]."*

At the same time, the Environmental Protection Agency (EPA) has reported that improvements in the quality of Ireland's surface waters are not occurring at a sufficient pace. Delays in housing development caused by inadequate wastewater infrastructure are not unique to Ireland but represent a growing global challenge, with implications for sustainable communities and regional development under the SDGs.

[12] https://www.independent.ie/regionals/louth/dundalk-news/louth-county-council-rejects-another-housing-development-due-to-lack-of-sewerage-capacity/a1642329954.html

15.1 Pharmaceutical Pollution in Wastewater and Antibiotic Resistance

Ireland has yet to introduce effective measures to prevent pharmaceutical pollution in rivers and lakes. Across the European Union, Member States are now being required to implement advanced (quaternary) wastewater treatment to remove pharmaceuticals and antibiotics from surface waters, reflecting the scale and urgency of this issue worldwide.

Urine is a significant pathway through which antibiotics and pharmaceutical residues enter aquatic environments. In Ireland, the presence of pharmaceuticals in rivers has been documented for many years, yet meaningful action to address this source of pollution remains limited. As highlighted in *The Irish Times* article *"The undiluted truth about chemicals in our waters*[13]*"*, the issue is well recognised but insufficiently addressed, undermining progress toward SDG 6 (Clean Water and Sanitation).

15.2 A Zero Waste and Circular Economy Approach to Nutrients in Wastewater

Current wastewater treatment challenges cannot be resolved using the same approaches that created them. An increasing number of scientists and practitioners now argue that concentrating all domestic wastewater streams into a single pipe for centralised treatment is neither sustainable nor resilient.

In response, Zero Waste Alliance Ireland (ZWAI) proposes a paradigm shift in wastewater management[14]. To achieve optimal treatment outcomes and align with the SDGs, particularly SDGs 6, 12, and 2, ZWAI recommends that Ireland and the European Union permit and actively support urine separation and targeted treatment. The EU should mandate the recovery and recycling of nitrogen and phosphorus from human excreta, particularly through urine treatment systems and the use of composting toilets where appropriate.

15.2 Refocusing Wastewater Treatment to Deliver Circular Economy Goals

Historically, household waste was disposed of through a single collection stream, typically destined for landfill or incineration. Today, European countries widely separate materials such as paper, glass, plastics, metals, batteries, cardboard, and food waste, recognising that material separation is essential for effective recycling and sustainability.

However, this principle is not yet fully applied to wastewater management, particularly regarding the recovery of non-toxic phosphorus from smaller wastewater treatment systems. ZWAI proposes that Ireland and the EU should prioritise the recovery of nutrients, free from toxic metals and organic pollutants, across all wastewater sectors.

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[13] https://www.irishtimes.com/news/science/the-undiluted-truth-about-chemicals-in-our-waters-1.439674

[14] https://pubs.rsc.org/en/content/articlehtml/2021/ew/d0ew01064b

As an initial step, waterless urinals could be used to separate and store urine, similar to current practices for sludge management in domestic septic tanks. Urine could be stored in dedicated plastic tanks for later collection and treatment, enabling the efficient recycling of phosphorus while removing pharmaceutical residues at source.

15.3 Preventing Phosphorus from Entering Surface Waters

The most effective means of preventing phosphorus pollution in lakes and estuaries is to address it at its source. This can be achieved through the installation of urine-separating toilets and dedicated storage tanks for the collection and subsequent treatment of urine at community level.

To support this transition, pilot and demonstration projects should be implemented in new housing developments within villages and small towns. Ireland must make substantial progress in preventing phosphorus pollution, moving beyond research conducted in German and Swiss universities, where phosphorus recovery from urine has already been technically proven[15].

ZWAI proposes that Ireland now scale up and deploy these proven technologies in large buildings and new housing developments without delay, supporting cleaner waters, nutrient security, and progress toward the Sustainable Development Goals.

15.4 Case Study: Phosphorus Removal from Urine at Domestic Scale (Ireland)

At the domestic household scale, one example of phosphorus recovery in Ireland is a pilot system operated by Herr Ltd. This case study is presented for illustrative and learning purposes only, to demonstrate the practical feasibility of urine-based nutrient recovery, rather than as a commercial endorsement.

The system involves the controlled addition of a magnesium-rich salt to separated urine, followed by filtration and drying of the resulting precipitate. The process is non-hazardous and produces a solid by-product known as struvite (magnesium ammonium phosphate). Struvite is a slow-release, phosphorus-rich fertiliser, comparable in function to diammonium phosphate, and is suitable for use in agricultural or community horticulture settings when appropriately managed.

This pilot system was supported through project funding provided by Zero Waste Alliance Ireland and the Irish Environmental Network. To independently assess performance, urine samples were analysed by Oldcastle Laboratories, Co. Westmeath. Testing measured phosphorus concentrations in untreated urine and quantified the proportion of phosphorus removed following struvite precipitation. The results are outlined below:

	Before adding magnesium to	**After magnesium has been added -**	**Measured by**

[15] https://www.youtube.com/watch?v=1B0evlD_vGE .

	the raw urine	Producing struvite	Oldcastle Labs
Sample 1	286 mg/l	26mg/l (91% lower)	Total Phosphorus
	137 mg/l	5 mg/l (94% lower)	Ortho Phosphorus
Sample 2	198 mg/l	9 mg/l (95% lower)	Total Phosphorus
	155mg/l	1 mg/l (99% lower)	Ortho Phosphorus

Urine is the largest single source of nitrogen, phosphorus and pharmaceutical pollution from domestic wastewater that ends up in our groundwater and rivers.

Analysis of various pollutants in domestic wastewater **Ref: Academic studies** *NB. These are only approximate figures*	**Grey Water**	**Kitchen Solids**	**Faeces**	**Urine**	**Faeces & Urine together**
Nitrogen N	**7%**	**8%**	**15%**	**70%**	**85%**
Phosphorous P	**12%**	**14%**	**26%**	**50%**	**76%**
Potassium K	**10%**	**15%**	**25%**	**50%**	**75%**
Faecal bacteria & faecal viruses			**100%**		**100%**
Excreted medicines & hormones			**30%**	**70%**	**100%**

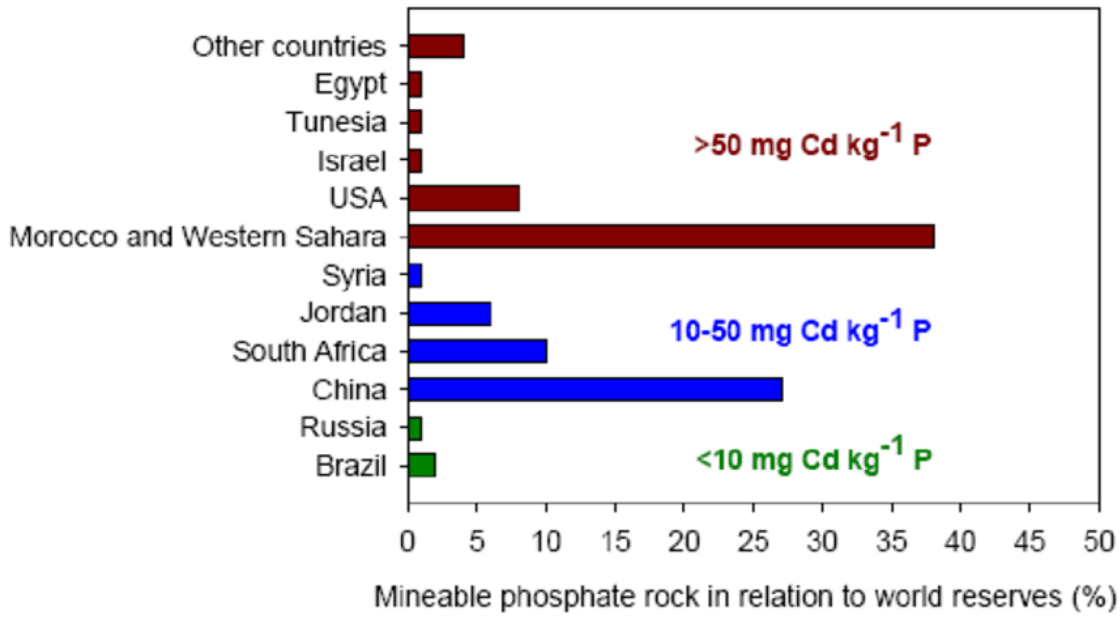
The test results shown below what was achieved by the Herr Ltd system. These figures confirm the purity, the “almost undetectable” levels of “toxic metals” in the struvite fertiliser, that can be produced from urine. The two struvite samples were sent by Herr Ltd to the Eurofins Laboratory in Germany to test for the presence of a range of toxic metals.

Struvite, from urine. Testing by Eurofins Labs	**Levels of Metals in Struvite Sample 1**	**Levels of Metals in Struvite Sample 2**	UD = Almost Undetectable measurement	
Arsenic	<0.8 mg /kg dw	<0.8 mg /kg dw	UD	

Lead	<2 mg/kg dw	<2 mg/kg dw	UD	
Copper	2 mg/kg dw	2 mg/kg dw		
Nickel	<1 mg/kg dw	<1 mg/kg dw	UD	
Mercury	<0.07 mg/kg dw	<0.07 mg/kg dw	UD	
Cobalt	<1 mg /kg dw	<1 mg /kg dw	UD	
Zinc	32 mg/kg dw	21 mg/kg dw		Safe for humans
Iron	108 mg/kg dw	149 mg / kg dw		
Cadmium	< 0.2 mg/kg dw	< 0.2 mg/kg dw	UD	

Zinc and iron levels were measured in the results, but they are not toxic and only to be expected, since they are important trace elements for healthy human metabolism. Like the phosphorus, they are naturally absorbed in food and excreted afterwards in the urine.

Of particular concern, for CE certification, the EU wants cadmium limits in phosphorus fertiliser to be less than 60 mg/kg dry weight. The urine derived phosphorus in this urine derived sample has a cadmium level that has as little as 0.3% of the 60mg/kg EU target. Struvite in large quantities, from separated urine will therefore be in demand by farmers with the lowest toxic levels and the cheapest cost, in comparison to internationally mined phosphorus rock.



Based on the results presented above, the measured concentrations of toxic metals in struvite derived from urine are consistent with findings reported in the academic literature. These studies confirm that contaminant levels are extremely

low, resulting in a fertiliser product that is close to chemically pure (see, for example, peer-reviewed research published in *Water Research*).

This outcome is unsurprising, as the food consumed by the general population contains minimal levels of toxic metals. Consequently, only trace quantities are excreted in urine, making urine-derived struvite a comparatively clean and safe source of phosphorus for reuse in agriculture or community growing contexts.

Urine accounts for approximately **50% of the phosphorus** and **around 70% of pharmaceutical residues** present in domestic wastewater. As a result, urine has a disproportionate biological impact on surface water pollution in rivers and lakes globally. Addressing this source at origin therefore represents a highly effective intervention for improving water quality and advancing SDG 6 (Clean Water and Sanitation).

To achieve meaningful reductions in river pollution, both the European Union and the Irish State must formally recognise urine as a primary pathway for nutrient and pharmaceutical loading and take appropriate, evidence-based action. Despite the well-documented data, current policy and regulatory frameworks in Ireland have yet to acknowledge urine as a significant and recoverable resource for sustainable phosphorus and nitrogen management.

Recognising and addressing this gap would support progress toward SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Consumption and Production), and SDG 2 (Zero Hunger), while reducing pollution pressures on freshwater ecosystems.

15.4 Case Study: Ringsend Sewage Treatment Works: Phosphorus Recovery from Separated Urine

At Ringsend Sewage Treatment Works, approximately 14 tonnes of struvite are produced per day. This substantial amount of phosphorus would otherwise have ended up in Dublin Bay, so well done to Úisce Éireann. However, Zero Waste Alliance Ireland (ZWAI) believes that the European Union and the Irish Government should support the replication of struvite/phosphorus recycling initiatives in other major Irish cities.

Compared to treated sewage sludge, this method of nutrient recovery from wastewater contains fewer toxic metals and no organic pollutants. The Irish Government should adopt the same struvite production approach in other large urban areas in Ireland. Currently, there have been no announcements from Úisce Éireann or the Government regarding plans to expand this sustainable nutrient recovery initiative.

15.5 Cadmium in Imported Commercial Mineral-Based Phosphorus

The European Union is increasingly concerned about cadmium levels in soils and in mineral-based phosphorus fertilisers imported from Morocco. The EU’s current limit for cadmium in imported phosphorus is 60 mg/kg (dry weight). Morocco

supplies the largest phosphorus resource in the world, but it also contains the highest levels of cadmium contamination.

Research by Ballabio et al. highlights that cadmium pollution in topsoil poses a significant health concern, particularly in countries such as Ireland and Poland. While the mean cadmium content of fertilisers in the EU is 36 mg/kg, levels can reach up to 200 mg/kg.

15.6 Toxic Cadmium in Phosphorus Fertilisers

Cadmium present in conventional phosphorus fertilisers can be gradually absorbed by food crops, leading to accumulation in humans over decades. The European Union is currently negotiating with member states to reduce cadmium levels in fertilisers to below 20 mg/kg (dry weight). By comparison, phosphorus recovered as struvite from urine contains less than 0.2 mg/kg cadmium—approximately 0.003 times lower than the EU target. Protecting European soils from cadmium contamination is therefore urgent, and recycling phosphorus through struvite production from urine represents the most reliable method to prevent long-term accumulation of heavy metals in topsoil. This approach supports SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land).

15.7 Pharmaceutical Levels in Recovered Struvite from Separated Urine

The struvite recovered from separated urine is virtually free of pharmaceutical residues. During filtration, less than 2% of pharmaceuticals and organic pollutants remain in the captured phosphorus, allowing urine-derived struvite to safely fertilise food crops without the contamination risks associated with sewage sludge.

15.8 Removal of Pharmaceuticals with Biochar

Separately treating urine with biochar, a low-cost, community-scale solution using wood-derived charcoal, offers an efficient method to remove pharmaceuticals and antibiotics from wastewater before they enter rivers, lakes, and groundwater. This treatment is critical for protecting drinking water sources near septic systems and reducing environmental exposure to pharmaceutical residues. Between 2020 and 2022, Dublin City University detected 16 commonly prescribed pharmaceuticals in surface waters of the Nore, Suir, Annalee (Co. Cavan), and Liffey (Dublin) rivers, highlighting the widespread presence of these compounds. Residual antibiotics in treated and untreated wastewater contribute to the global rise of antibiotic resistance.

The World Health Organization projects 10 million premature deaths annually by 2050 due to antibiotic-resistant infections, with at least 700,000 deaths currently occurring each year. Urine separation combined with biochar treatment is a cost-effective approach to remove pharmaceuticals at scale, as urine accounts for approximately 70% of excreted pharmaceuticals while representing only a small fraction of domestic wastewater, requiring 100 times less biochar than municipal wastewater treatment. This strategy contributes to SDG 3 (Good Health and Well-

being), SDG 6 (Clean Water and Sanitation), and SDG 12 (Responsible Consumption and Production).

15.9 Sulphuric Acid Shortages Leading to Phosphorus Fertiliser Shortages

Sulphuric acid, a key industrial chemical, is largely produced as a by-product of flue gas scrubbing during fossil fuel combustion. Approximately 50% of global sulphuric acid is used for phosphorus fertiliser production. Growing demand for metals, minerals, and fertilisers, driven by the expanding green economy, is creating potential supply shortages and rising costs. Without strategic planning, these shortages could reduce fertiliser availability, threaten agricultural productivity, and compromise food security, highlighting the importance of phosphorus recovery and recycling in Ireland and Europe. This issue intersects with SDG 2 (Zero Hunger), SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action).

15.10 Nitrogen Recycling from Wastewater

Conventional municipal wastewater does not recover nitrogen, as mixing of urine, faeces, and greywater dilutes nutrient concentrations. Implementing urine separation allows recovery of nitrogen for fertiliser production, such as ammonium sulphate, or for renewable hydrogen generation through ammonia splitting. Early adoption of urine separation aligns with EU climate targets and the Paris Agreement, ensuring sustainable nutrient recovery while reducing reliance on fossil fuels. This approach also captures more nutrients and organic pollutants than conventional septic tank sludge treatment, addressing current contributions to groundwater pollution and supporting SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action).

In conclusion, urine separation and struvite recovery present a cost-effective, scalable, and environmentally sustainable strategy to address multiple challenges simultaneously: cadmium contamination, pharmaceutical pollution, phosphorus and nitrogen scarcity, and nutrient-driven environmental degradation. These measures advance Ireland’s compliance with EU directives, protect public health, enhance food security, and contribute to multiple SDGs. The government and EU policymakers should prioritise funding, regulation, and implementation of urine separation, biochar treatment, and struvite recovery as a central component of sustainable urban wastewater management.

16. Conclusion

Zero Waste Alliance Ireland (ZWAI) strongly urges that Ireland’s third SDG National Implementation Plan adopts a robust approach grounded in **zero waste principles** and the **circular economy**, if the country is to meaningfully achieve the Sustainable Development Goals. Incorporating materials such as **hemp into the economy** offers a sustainable, renewable resource that supports climate action, responsible production, and job creation, while reducing reliance on fossil-based materials.

More broadly, Ireland must integrate **circular economy strategies** across all sectors, ensuring that resource recovery and pollution prevention become standard practice. Practical solutions, such as the **recovery of nutrients from human urine to produce struvite fertilisers**, demonstrate how waste can be transformed into valuable resources, while simultaneously **protecting our waterways from pharmaceutical and heavy metal contamination**.

Aligning national policy and industry practices with the SDGs in this way will not only help Ireland meet its environmental targets but also strengthen food security, public health, and sustainable economic growth. By embedding **zero waste and circular economy principles** throughout the SDG implementation plan, Ireland can become a global leader in sustainable development and demonstrate tangible, science-based pathways for a more resilient and resource-efficient future.

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This submission was written by Olena Larionova and Ollan Herr on Behalf of Zero Waste Alliance Ireland, with editing by Órla Coutin Fitzsimons.