Evaluation Report

Dublin Green Circular Economy Project

For

Leinad Land Developments (Dublin) Pty Ltd, Adelaide

By

Enpro Envirotech Pty Ltd, Adelaide

August 2024

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List of abbreviations

ARENA	Australian Renewable Energy Association
CHP	Combined Heat and Power
CSTR	Completely Stirred Tank Reactor
DGCE	Dublin Green Circular Economy
FOGO	Food Organic Green Organic
GHG	Greenhouse Gas
GISA	Green Industry South Australia
IPCC	Intergovernmental Panel on climate change
K	Potassium
KESAB	Keep South Australia Beautiful
LGC	Large Generation Certificate
MWh	Mega watt hour
M3/tVS	Cubic meter per ton of volatile solids
N	Nitrogen
P	Phosphorous
RDA	Regional Development Australia
SDG	Sustainable Development Goals
T	Tonne
t/y	Tonne/year
VS	Volatile Solids

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Executive Summary

This report has been prepared for Leinad Land Developments (Dublin) Pty Ltd to examine the alignment of the project with circular economy principles and the United Nation's Sustainable Development Goals (SDGs) including collaboration (17), innovation (9), inclusiveness (8), social licencing (9) and scalability benefits.

Bioenergy in the form of biogas, derived from organic waste, presents a promising avenue for addressing energy needs while reducing environmental impact. By implementing bioenergy technology, communities, industries, councils can transform waste into valuable resources, promote renewable energy sources, and mitigate greenhouse gas emissions.

The proposed circular economy aspects of this project encompass diverting waste from landfills to generate electricity and fertiliser, along with repurposing industrial, agricultural and household waste streams for various applications while helping in decarbonisation.

This project has the potential to unlock new market opportunities for the local Council, community, industry and farmers while creating new employment opportunities in the region. Based on preliminary estimates and analysis, this project has the potential to generate the full captive energy demand for the new employment area, with expected extra electricity supply available to provide to the community or into the local electricity grid.

Estimated preliminary input and output for this project is shown in the following Table 1.

Table 1: Estimated annual input and output from Dublin Green Circular Economy Project

Estimated Annual Input, tonnes/year (t/y)	Measure/unit
Chicken Manure	10000
Green Waste	10000
Food organic waste	1000
Grease trap waste	40000
Agricultural waste	10000
Estimated Annual Outputs	
Biogas Produced, m^3	45,372,000
Estimated methane, m^3	29,900,000
Electricity generation, MWh	40,000
Digestate, m^3	250,000
Additional waste treated, t/y	TBA
Overall Annual benefits	
Fossil fuel electricity replacement, MWh	40,000
Carbon dioxide Utilisation m^3	15,200,000
LGCs	40,000
Gate Fees	TBA
Estimated Reduction in GHG emissions, t	400,000
Replacement of chemical fertiliser	TBA

Leinad have secured around 71,000 t of organic waste for this project which mainly includes the poultry, agriculture, grease trap, olive industry waste streams. This helps in reducing greenhouse gas emissions from the waste streams and helps South Australia to reduce overall carbon footprint in the region as well.

In addition, the byproducts generated can be re-used with agricultural uses within the local area.

This project stands out due to several factors, including collaboration with the University, industry, Council, and other organizations. It features innovative implementation of unique technologies that add significant value, offers social licensing, and is scalable. Upon successful completion in Dublin, there will be considerable opportunities to implement similar projects across other parts of regional South Australia.

1. Introduction

Leinad Land Developments (Dublin) Pty Ltd ('Leinad') is developing 'Dublin Park' as a new master planned community and South Australia's first Green Circular Economy Precinct.

Leinad aims to position 'Dublin Park' at the forefront of sustainable residential and industrial development in Australia, through leveraging principles of circular economy and sustainability.

Leinad has prepared an 'Urban Framework Plan' to guide the future development 1,373-hectare land holding as the Dublin Green Circular Economy (DGCE) Precinct comprising:

- An extension of the township for around 1,300 dwelling or 3,250 people;
- 400 hectares of employment land to accommodate a range of commercial and industrial activities integral to a Green Circular Economy;
- A new 224 hectare mine; and
- Around 600 hectares of green open space.

The Minister for Planning has given approval to proceed with the preparation of the 'Dublin Employment Code Amendment'.

In approving the initiation, the Minister has specified that the following matter be addressed in the further investigations to inform the Code Amendment:

> "*Substantiate the concept of the 'Green Circular Economy' including commentary on whether supply chains have been established (including waste to fuel the bioreactor"*.

Leinad has commissioned Enpro Envirotech Pty Ltd to evaluate the circular economy aspects of the project.

This report specifically examines the 'Employment Land' area as part of the Dublin Park project and the alignment of the project with circular economy principles and the UN's Sustainable Development Goals including collaboration, innovation, inclusiveness, social licencing and scalability benefits.

2. The '*Circular Economy'* Concept

The concept of a circular economy revolves around creating sustainable systems where resources are utilised efficiently, products are designed for longevity and reuse, and waste is minimised through resource recovery technologies. Unlike the traditional linear economy, which follows a 'take-make-dispose' model, a circular economy aims to close the loop of resource flows, thereby reducing overall carbon footprint, adverse environmental impact and promoting economic resilience.

One of the major principles of a circular economy is utilising resources at its best.

A circular economy reduces the reliance on finite and fossil fuel-based resources while mitigating the environmental degradation and maximising the value from resources. In achieving circular economy, a closed loop system is practiced where the byproducts are re-used for beneficial purposes (i.e. the resources are transformed to valuable products). Typically, a waste related circular economy involves implementing practices such as composting, anaerobic digestion, and material recovery to ensure that resources remain within the economy's cycle of use.

Overall, the concept of a circular economy embodies a holistic approach to sustainable development, emphasising the interconnectedness between environmental, social, and economic factors. By reimagining the way resources are utilised, products are manufactured, and waste is managed, a circular economy offers a pathway towards achieving long-term prosperity while minimising ecological footprint.

Circular economy addresses a wide range of environmental, social, and economic challenges some of which are as follows

1. **Waste Utilisation**: A circular economy minimises the generation of waste and pollutants while using it in a beneficial way. This is always associated with best practices such as resource recovery, waste to wealth, material recovery, and closed-loop recycling, solutions. Valuable resources are retained within the economy, reducing pressure on landfills and ecosystems.
2. **Climate Change Mitigation**: The transition to a circular economy contributes to climate change mitigation by reducing greenhouse gas emissions associated with resource extraction, manufacturing, and waste disposal. By promoting renewable energy sources, energy efficiency, and carbon sequestration, a circular economy helps decouple economic growth from carbon-intensive activities.
3. **Economic Resilience**: Circular economy principles foster innovation, job creation, and economic diversification by stimulating markets for byproducts

from resource recovery. By transitioning towards circular business models, it is possible to unlock new revenue streams, enhance supply chain resilience, and reduce operational costs.

4. **Social Licence**: A circular economy promotes inclusivity, social cohesion, and equitable access to resources by prioritising community engagement, knowledge sharing, and collaborative decision-making. By empowering marginalised communities, enhancing resource efficiency, and promoting sustainable livelihoods, a circular economy fosters social equity and resilience.

2.1 Strategic & Policy Context

The global imperative to transition towards sustainable energy sources has intensified in recent years due to concerns over climate change, resource depletion, and environmental degradation. In this context, biogas emerges as a viable solution that aligns with the principles of a circular economy by valorising organic waste streams to produce renewable energy and valuable by-products.

The adoption of circular economy principles is integrated and informing long-term decisions of government at all levels, as illustrated below:

Table 2: Circular economy principles adoption at different levels

Intergovernmental Panel on Climate Change (IPCC)	The IPCC is the United Nations Body for assessing the science related to climate change. The objective of the IPCC is to provide governments at all levels with scientific information that they can use to develop climate policies.
UN Sustainable Development Goals	By addressing root causes, the concept of a circular economy, an economy in which waste and pollution do not exist by design, products and materials are kept in use, and natural systems are regenerated provides much promise to accelerate implementation of the 2030 Agenda.
Federal Government, A Future Made in Australia Policy, 2024	A national transition to a circular economy with opportunities for Australia - including a boost to our domestic manufacturing capabilities. This will deliver a future remade in Australia, creating opportunities and demand for goods to be recycled and remanufactured.

<table>
<tr><td>National Waste Policy</td><td>Australia's National Waste Policy has a target of diverting 80 per cent of all waste from landfill by 2030. This strategy aims to boost Australia's capacity to export high-value recycled materials to establish pathways towards a circular economy.</td></tr>
<tr><td>South Australia’s Waste Strategy 2020-2025: Supporting the Circular Economy, Green Industries SA, 2020

</td><td>The circular economy is a prominent focus for Green Industries SA. The Green Industries SA Act 2004 incorporates the concept of circular economy as a guiding principle.

The potential benefits of a circular economy in South Australia have been measured (Green Industries SA, 2017), which describes gains to be achieved in local job creation and reductions in greenhouse gas emissions by 2030. ‘South Australia’s Waste Strategy 2020-2025’ outlines actions that can contribute to the development of a circular economy – that is, an economy that realises the best or full value from products and materials produced, consumed and recovered in South Australia.</td></tr>
<tr><td>Australian Renewable Energy Association (ARENA)</td><td>The Australian Government developed a roadmap to identify the role that the bioenergy sector can play in Australia's energy transition. Released in 2021, the Bioenergy Roadmap aims to help to inform the next series of investment and policy decisions in the bioenergy sector in Australia.</td></tr>
</table>

This project is also able to achieve different Sustainable Development Goals (SDG) including collaboration (17), innovation (9), inclusiveness (8), social licencing (9) and scalability benefits.

3. Dublin Circular Green Economy Project: Overview

Leinad Land Developments (Dublin) Pty Ltd owns and controls 1,373 hectares of land located to the immediate south of the Dublin township which is located approximately 50 kilometres north of the Adelaide CBD.

It is the vision of Leinad to develop 'Dublin Park' as a new master planned community and South Australia's first Green Circular Economy Precinct positioning Dublin Park at the forefront of sustainable residential and industrial development in Australia.

The vision for 'Dublin Park' is an integrated mixed use development comprising future residential development, industry, employment lands and mining opportunities facilitated and supported by sustainable infrastructure, energy, water and wastewater management.

Leinad have prepared an 'Urban Framework Plan' to deliver the Dublin Green Circular Economy Precinct. The Urban Framework Plan includes a high level spatial framework plan that is illustrated in Figure 1 below which includes in the order of 400 hectares of Employment Land.

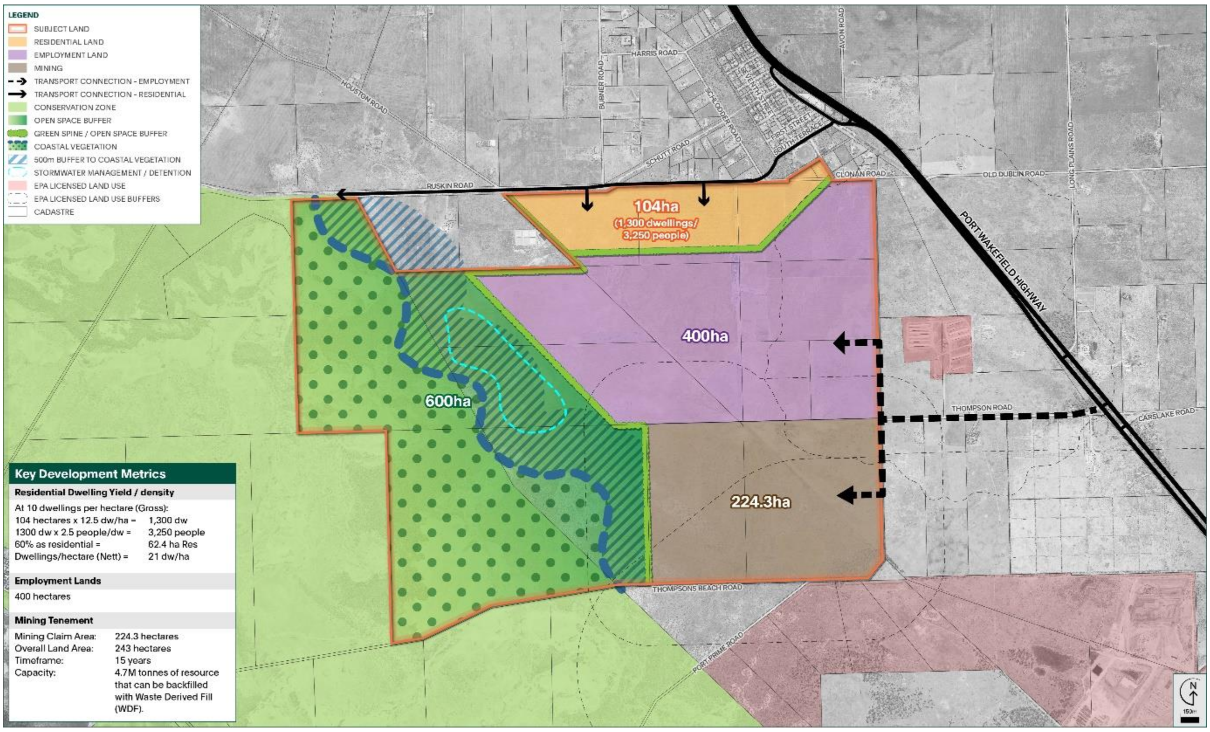

Figure 1: Dublin Master Plan

Preliminary investigations by Leinad have identified the opportunity for the project to utilise bioenergy generation technology to play a crucial role in the transition towards a green economy, renewable energy sources and sustainable resource management. To maximise their effectiveness and sustainability, Leinad have identified that the

Dublin Circular Green Economy project will transform underutilised site into Green industrial, residential and commercial precinct utilising bioenergy generation technology.

integration of circular economy principles is imperative to success in the project. Leinad have identified that the opportunity for adopting a circular economy approach in a bioenergy project is supported by several key locational factors:

- currently about 1000 t/year of waste from Adelaide Plains Council is transported away. Similarly, the organic waste generated from nearby agriculture farms, livestock industries are currently not suitably treated (being retained on land without treatment) and generating substantial amounts of Greenhouse Gas Emissions (GHG).

  It is possible to achieve resource optimisation by utilising these organic waste streams as feedstock for bioenergy production, thereby enabling circular economy principles of efficient use of resources that would otherwise be discarded or underutilised.

- In addition, the reuse of material will reduce the adverse environmental impact as well as typical dumping into landfill which usually causes issues such as leachate formation, soil contamination, odour generation, flies, and large land requirements.

Traditional waste management practices, such as landfill and incineration, pose significant environmental challenges, including:

- Greenhouse Gas Emissions: Landfills are a major source of methane—a potent greenhouse gas—due to the anaerobic decomposition of organic waste. Methane emissions contribute to global warming and climate change.
- Land and Water Pollution: Landfills and incinerators can contaminate soil, groundwater, and surface water bodies through leachate runoff and air emissions, respectively leading to environmental degradation and public health risks.
- Resource Depletion: Landfilling and incineration result in the loss of valuable resources, such as organic matter, nutrients, and energy (unless captured), which could otherwise be recovered and utilised through waste valorisations processes.
- Waste Accumulation: The unsustainable generation and disposal of waste contribute to the depletion of finite resources, habitat destruction, and

biodiversity loss, exacerbating environmental pressures and ecological imbalances.

Addressing these environmental challenges requires a paradigm shift towards more sustainable and circular approaches to waste management, such as waste valorisation.

3.1 Organic Waste Valorisation

Waste valorisation refers to the process of extracting value from waste streams by converting them into useful products, materials, or energy sources. Rather than viewing waste as a burden to be disposed of, waste valorisation treats it as a valuable resource that can be harnessed for economic, environmental, and social benefits.

Through the Dublin Green Circular Economy (DGCE) Project, Leinad intends to initiate waste valorisation converting waste streams into useful products, materials, and energy sources. Figure 2 shows the waste valorisation generating different byproducts including biogas, electricity, biofertilizer, carbon dioxide, etc.

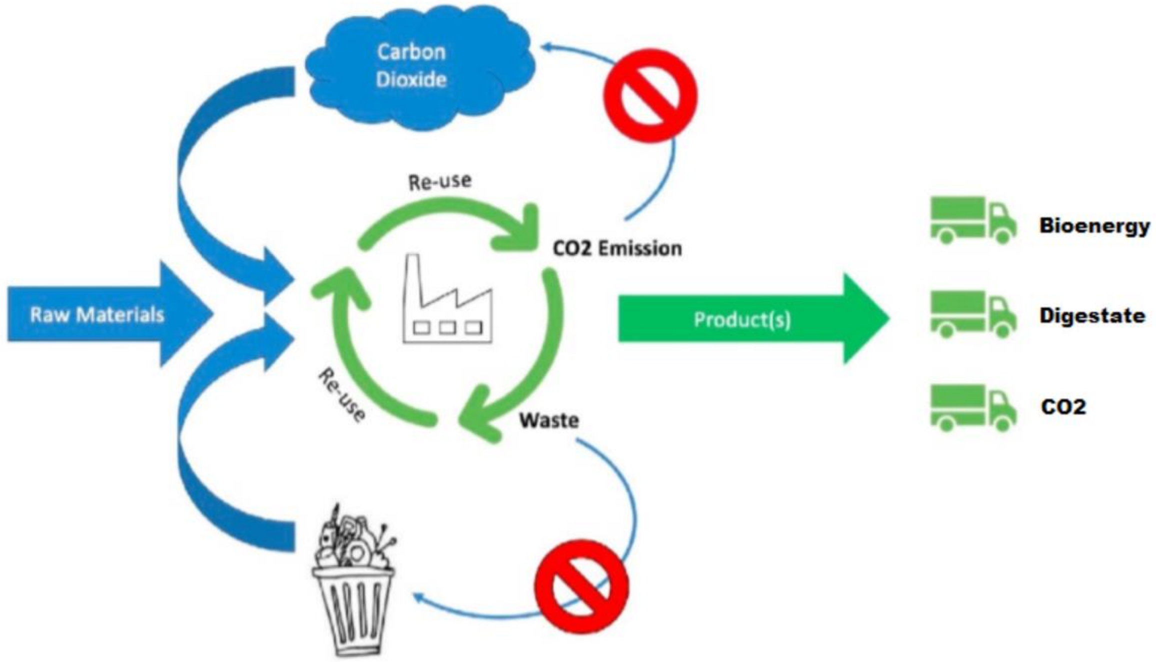

Figure 2: Waste valorisation infographic

Different technologies can be used for waste valorisations depending on the quality and quantity of the organic waste streams. Important waste valorisation technologies and processes include:

- Anaerobic Digestion: Anaerobic digestion converts organic waste into biogas — a mixture of methane and carbon dioxide — through microbial fermentation in the absence of oxygen. Biogas can be used for electricity generation, heat production, or vehicle fuel, while the residual digestate can be utilised as a nutrient-rich fertiliser. It is also possible to utilise carbon dioxide from biogas and utilise for a beneficial purpose. This technology is considered for DGCE project.

- Gasification: Gasification involves thermochemical conversion of organic materials— such as wood chips, agricultural residues, or municipal solid waste—into syngas (synthetic gas) through high-temperature reactions in a controlled environment. Syngas can be used as a fuel for power generation, heating, or chemical synthesis.
- Composting: Composting is a biological process that decomposes organic waste— such as food scraps, green waste, and paper products—into nutrient-rich compost through microbial decomposition. Compost can be used as a soil amendment to improve soil fertility, structure, and water retention. In the composting process, the energy value of the organic waste is not harnessed.

3.2 Project Opportunities

Leinad's Dublin Green Circular Economy project revolves around the circular economy and has the potential to achieve further environmental, economic, and social benefits to the region as well as achieving long term sustainability. These benefits are summarised below.

<u>Environmental Benefits</u>

Reduced Waste: By keeping materials in circulation, the circular economy reduces landfill waste and minimises pollution.

Lower Carbon Footprint: Recycling and reusing materials require less energy compared to extracting and processing raw materials.

Preservation of Ecosystems: Resource extraction often harms ecosystems. A circular approach helps protect natural habitats.

<u>Economic benefits</u>

Job Creation: Circular economy practices create jobs in resource recovery projects utilising different byproducts for different industry sectors.

Cost Savings: Businesses can save costs by reusing materials and reducing waste disposal expenses.

New Business Opportunities: Circular business models (e.g., product-as-a-service, leasing) open up innovative revenue streams.

<u>Social benefits</u>

Improved Livelihoods: Circular practices benefit local communities by providing employment and supporting small-scale enterprises.

Access to byproducts: Typical byproducts from resource recovery plant can be utilised locally to replace fossil fuel energy, chemical fertiliser as well as improving the soil fertility in the region.

Resilience and Security

Less Dependency on fossil fuel and other resources: A circular economy reduces reliance on fossil fuel, fertiliser and other resources and enhancing long-term resilience.

Mitigating Supply Chain Risks: Diversifying material sources and promoting local production reduce vulnerability to supply chain disruptions.

Long-Term Sustainability

Meeting Climate Goals: The circular economy aligns with climate targets by reducing emissions and promoting sustainable practices.

Resource Security: As global demand for resources grows, circular practices ensure resource availability for future generations.

3.2 Potential Benefits of Circular Economy Approaches in Bioenergy Project

Dublin Circular Green Economy project offers numerous opportunities and benefits in attaining circular economy. Figure 34 shows how the Dublin Circular Green Economy works.

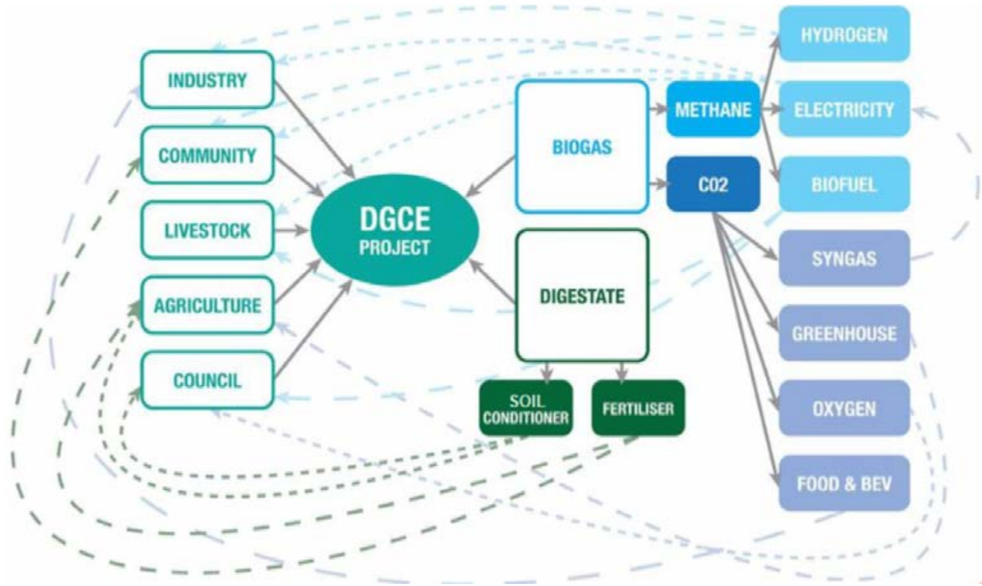

Figure 3: How the Dublin Green Circular Economy Works

The DGCE project has different stakeholders including council, horticulture and agriculture farms, livestock industry, hotel and other industry sectors as well as community. Each of these stakeholders generate waste that is utilised as a feedstock in this project to generate biogas and digestate. The biogas usually contains 60% methane and 40% carbon dioxide, while the digestate will have macro and micronutrients available in the feedstock. The circular economy aspects for this project includes utilising these byproducts by different stakeholders who are supplying their waste.

The community is supplying the FOGO waste while they get back the electricity to potentially offset their fossil fuel based energy. The agriculture and horticulture industry get back carbon dioxide and biofertilizer in the form of digestate while the council utilise digestate for their garden or lawns. Other industries can get the benefits of green energy utilised from such project. Carbon dioxide is utilised in multiple ways including hydrogen generation and it is possible to find out the best suitable pathway that suits to DGCE project and fulfill the local requirements. It is also possible to generate different high value algae by utilising carbon dioxide.

The summarised benefits identified on the site are:

- Resource Efficiency: By valorising organic waste streams as feedstock for bioenergy production, circular economy approaches maximise resource utilisation and minimise waste generation, leading to greater efficiency and sustainability.
- Environmental Protection: Circular bioenergy projects mitigate environmental pollution, greenhouse gas emissions, and resource depletion associated with

traditional waste management practices, thereby reducing environmental impact and promoting ecosystem health.

- Economic Viability: Circular bioenergy projects create economic value through energy generation, by-product utilisation, and cost savings on waste disposal, fostering economic resilience, job creation, and local development.
- Climate Change Mitigation: By displacing fossil fuel consumption and reducing methane emissions from landfills, circular bioenergy projects contribute to mitigating climate change and advancing towards carbon neutrality or negative emissions.
- Community Engagement: Circular bioenergy projects promote community involvement, awareness, and collaboration in waste management and renewable energy production, fostering social cohesion, empowerment, and shared benefits.

4 Dublin Green Circular Economy Project: Particulars

Leinad has identified multiple different organic waste streams that can be utilised for bioenergy generation as part of the DGCE Project. These include poultry manure, green waste, food waste, grease trap waste, olive cake as well as horticulture waste. These waste streams are available in the close vicinity to the project site while there are other potential resources from nearby agricultural and livestock activities that may also be available for increased bioenergy generation.

4.1 Available organic waste streams

Every organic waste has different biomethane potential, which is largely based on the biodegradability, availability of carbonaceous, proteinaceous and fatty material. Current feedstocks selected for bioenergy generation are not treated and thus causing greenhouse gas emissions. By utilising these in the DGCE project, these greenhouse gas emissions will be reduced.

Leinad have provided the following preliminary estimates for potential volumes waste streams that are available for the DGCE Project as shown in following Figure.

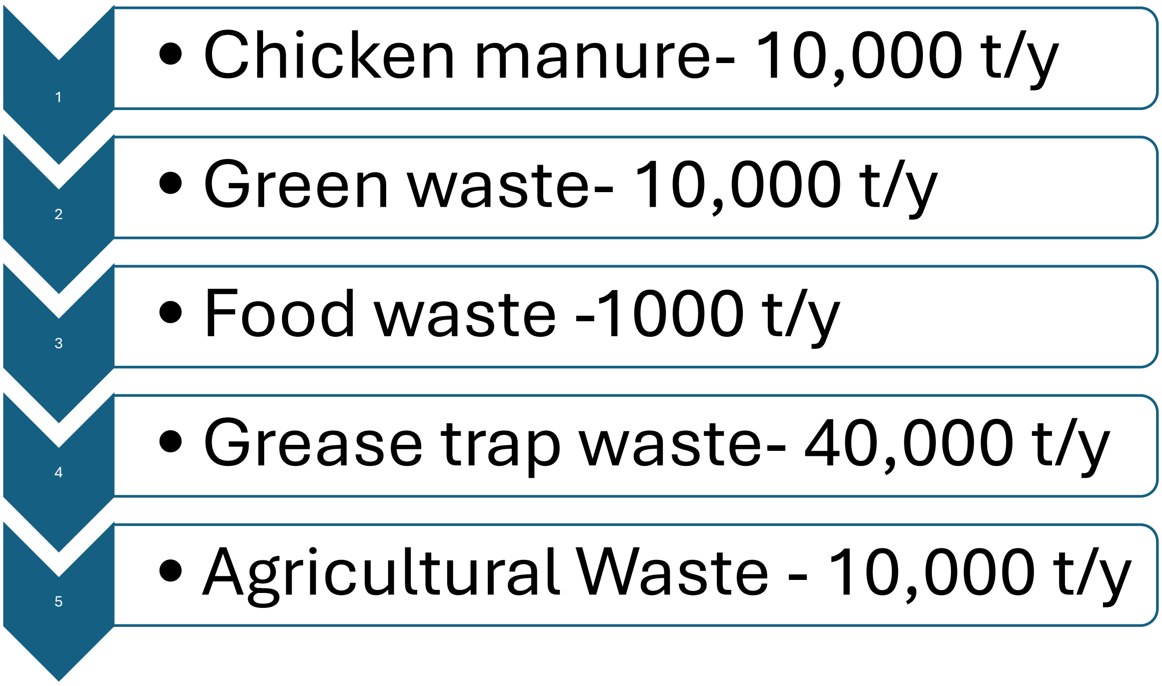

Figure 4: Estimated organic waste streams for DGCE Project

In addition to the organic waste streams identified above, Leinad advised that there are further potential waste streams available in the nearby region including sewage biosolids, horticulture waste and potential for additional volumes of the organic waste streams.

4.2 Estimated potential bioenergy generation

Theoretical data for biomethane potential is available for most of the organic waste streams. However, due to the process and raw materials variation, the biomethane potential may vary. Hence, it is always advisable to analyse the organic waste streams samples for its total and volatile solids contents as well as biomethane potential testing.

Theoretical biomethane potential testing for the waste streams identified by Leinad as potential material sources is shown in the following Table.

Table 3: Theoretical biomethane potential for different organic waste streams

Organic waste streams	Total solids, %	Volatile solids, %	Theoretical biomethane potential, m^3/tVS
Chicken Manure	52	88	260
Green Waste	60	80	210
Food organic waste	20	95	500
Grease trap waste	95	92	740
Agricultural Waste	79	70	460

With this theoretical biomethane potential, it is possible to generate about 40,000 MWh electricity in a year and 46,000 MWh heat energy with a typical Combined Heat and Power (CHP) engines.

Bioenergy is a versatile as different organic feedstocks can be used for generation of energy.

Part of the electricity and heat is utilised for the anaerobic digester operations while the remainder can be utilised to meet the energy needs for the commercial and industrial land uses within this development with excess available to be provided to surrounding land. Subject to the final type and density of uses within the proposed employment area, it is expected that a generation of 40,000MWh/year would be sufficient to supply the entire employment area with spare capacity to serve surrounding land uses.

This bioenergy can be integrated into existing energy infrastructure and used for different applications including electricity generation, heating, and transportation. Another important aspect of bioenergy is flexibility and storage. Unlike solar and wind energy, which is dependent on nature, bioenergy can be generated with available organic waste streams and can be stored for later use providing flexibility in energy production. Organic waste resources are often available locally, reducing dependence on imported fossil fuels and enhancing energy security.

4.3 Potential use of Byproducts

Different byproducts are generated from the bioenergy plant which includes digestate, biogas, carbon dioxide, hydrogen sulfide, etc.

The digestate is digested material coming out from the anaerobic digester tanks, which contains inherent nutritional properties depending on the available Nitrogen (N), Phosphorous (P) and Potassium (K) with other micronutrients. The digestate can potentially be utilised in the nearby farms to replace the use of chemical fertilisers.

Biogas contents mainly include methane and carbon dioxide. Carbon dioxide is usually in the range of 30-45% and can be separated with available technologies and used for multiple purposes. Depending on the hydrogen sulphide contents in the biogas, it is possible to extract elemental sulphur with the help of special bacteria which can then be used as fertiliser in the nearby agriculture farms.

Biogas can be used for generation of electricity and heat, or after separating the methane, can be used for transportation purposes (replacing the use of fossil fuels).

Based on our experience, Enpro would anticipate that there will be sufficient market opportunities to utilise all byproducts, thereby not generating any new waste streams and achieving circular economy with resource recovery.

5. Dublin Green Circular Economy Project: Strategy for Implementation

Through project liaison with Leinad, the following potential strategies have been identified to assist with achieving and realising the vision and aspirations of a circular economy.

Enpro provides the following commentary on strategies that revolve around community engagement, innovative technological solutions as well as demand for the use of byproducts in the local market.

5.1 Waste Collection, Segregation and Community

Leinad plans to collect food organics and green organics (FOGO) waste from local townships. In most of the locations, there is a low level of community awareness that organic waste can end up in landfill. Through early discussions, Keep South Australia Beautiful (KESAB) has provided verbal support to be part of this project and assist with community education to achieve the aims of the project. Successful community education will allow waste collected by the Adelaide Plains Council to be segregated upon the collection and this will be used to maximise recycling. Leinad's strategy for waste collection and segregation is shown in the following figure.

Figure 5: Potential Strategy for waste management for DGCE Project

Enpro recommends a clear and concise methodology is developed relating to waste management and collection.

5.2 Technology Evaluation

Based on the quantity and quality of available organic waste, there are different technologies available in the market to generate biogas and biofertilizer in the form of digestate as main byproducts.

The conventional technology for biogas generation is Completely Stirred Tank Reactor (CSTR). The waste streams are fed from the top through a pipe that goes to the bottom of the tank. All the contents are mixed with either agitators or with a gas/liquid mix system. The digester tank is covered with double layer dome whereby biogas is collected in the inner membrane dome while the outer cover is inflated with air. The digester is fitted with pH and temperature indicators, pressure gauges, and safety devices such as pressure and vacuum relief valves.

The mixing system may vary and more recently a centralised agitator or gas mixed circulation systems are also implemented in a commercial scale biogas digester. It is important to assess total waste quantity generated per day with biomethane potential to properly design the CSTR system. These tanks can be constructed in either concrete or glass fused steel tanks and are well insulated.

Typical conventional CSTR system is shown in the following figure.

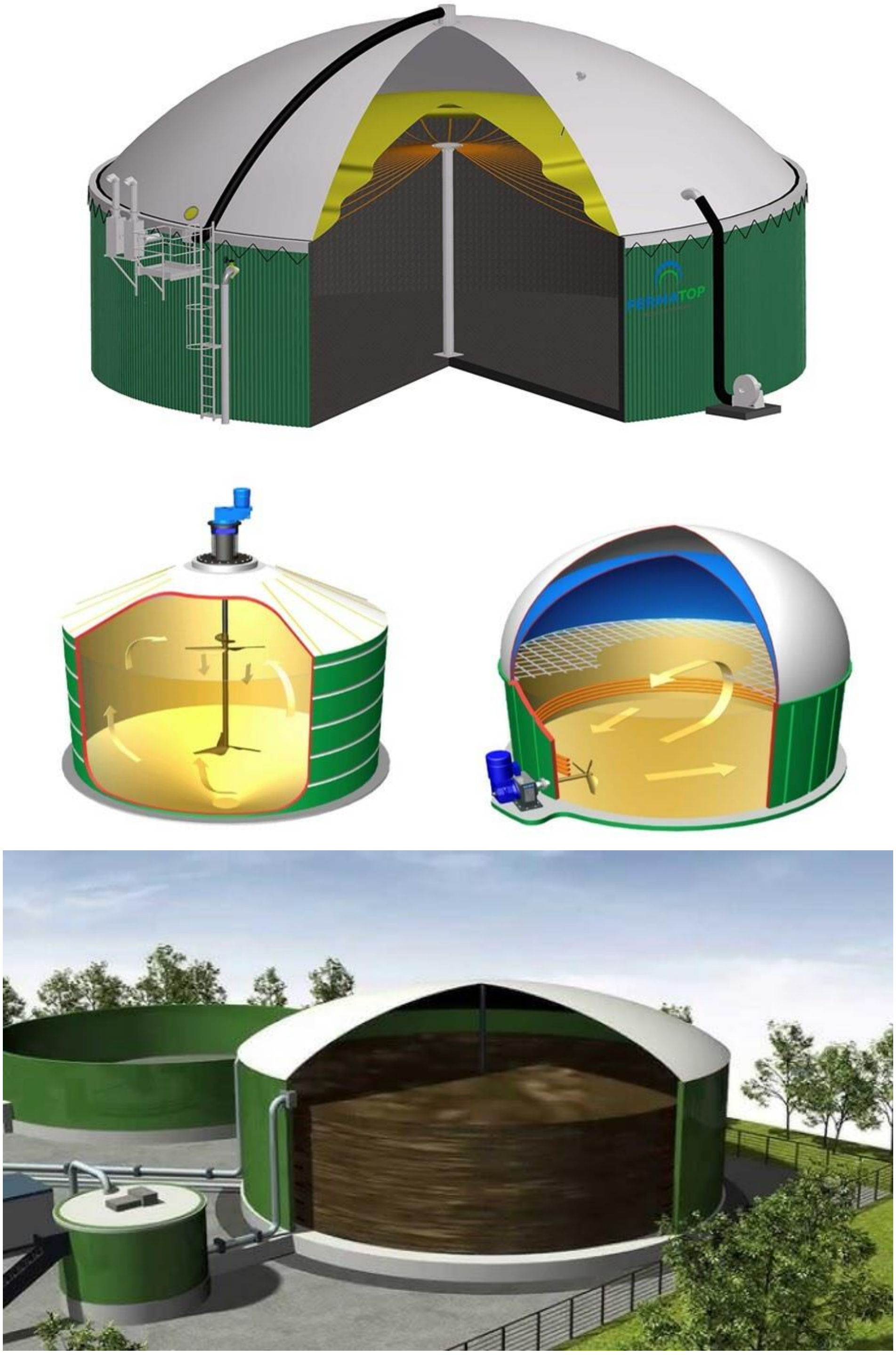

Figure 6: Typical Completely Stirred Tank Reactors (CSTR)

Another available technology for biogas generation is dry digestion technology. In this method, organic wastes are received in the receiving shed and further screened suitably to remove the inorganics and contaminants including plastics. With the loader, the waste is added into the garage type digesters and the leachate is recycled to keep the bacteria active.

This technology enables flexible use of various feedstocks due to robustness against impurities. Anaerobic digestion takes place with low mechanical intervention as compared to CSTR technology while the water and energy requirement is also low. The details of dry digestion technology are show in the following Figure 7.

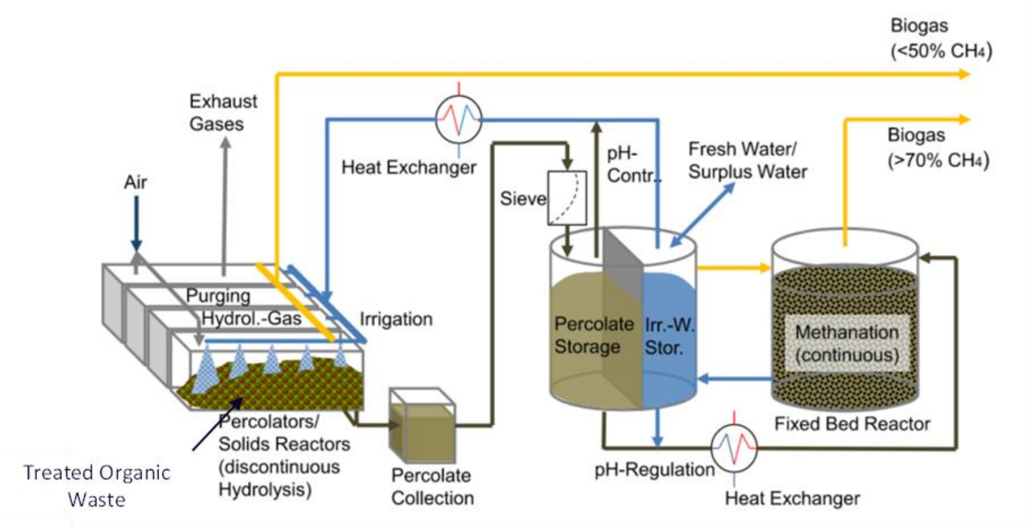

Figure 7: Typical Dry Digestion Technology for bioenergy generation

5.3 Byproduct utilisation

Major byproducts from a bioenergy plant include biogas and digestate.

Biogas contains methane, carbon dioxide, hydrogen sulfide (depending on sulfate content of feedstock) while the digestate can be used as a biofertiliser as it contains considerable N, P, K and micronutrients.

Various technologies are used for cleaning biogas thereby separating methane, carbon dioxide and hydrogen sulfide. The separated methane is used to burn in the boiler to generate steam, generate electricity through engines or used as vehicular fuel. Typically, biogas is burned into a Combined Heat and Power (CHP) engine to generate electricity and heat. About 35-42% electrical efficiency is achieved with such engines. We understand that Leinad is assessing innovative ways to increase the electrical efficiency by utilising Fuel Cell Technology where about 60% electricity efficiency is achieved with much less maintenance costs as compared to CHP engines.

It is envisaged to potentially utilise the purified biogas as a vehicular fuel. Leinad is also exploring hydrogen generation from purified methane, which would be a value-add to this project.

The global environment is changing rapidly. Supply chains are under pressure, with increasing fragmentation and intensifying global competition. New opportunities in clean energy industries are also emerging that will shape the future of the global economy over the next decade and beyond. https://budget.gov.au/content/factsheets/download/factsheet-fmia.pdf

Carbon dioxide has multiple applications such as food and beverage production, Urea/Fertiliser production, Fuel and Chemical production, Enhanced oil recovery in upstream Oil and Gas Process, Greenhouse to enhance vegetable production, Industrial process like Refrigeration, requirements for heat transfer fluids and growing specific high value algae. Out of these multiple applications, Leinad is assessing the best suitable alternative considering the location of the DGCE project.

Digestate with a high level of nutrients can be used for replacing chemical fertilisers. The value of digestate is increased further by separating solid and liquid phase while further adding suitable soil rejuvenator in the liquid phase to increase the yield by 15 to 30% for vegetables, broadacre, fruits etc.

Thus, Leinad is planning to 'value add' the byproducts generated from DGCE project that help the community, industries and agriculture farms with other stakeholders.

6. Dublin Green Circular Economy: What Sets It Apart

The Dublin Green Circular Economy Initiative Project provides a significant opportunity to demonstrate how public, private, and community stakeholders can work together to create sustainable solutions.

The scale of the project provides opportunity to not only be a demonstration for adoption of sustainable solutions, but also potential to deliver significant on-ground benefits. Moreover, its versatile approach not only creates the potential to address local needs but also offers a scalable model with the potential for implementation in other locations in South Australia, demonstrating the transformative power of a well-coordinated circular economy.

In our experience, such type of project must consider the best practices in the market where stakeholders engagement, site selection, feedstock availability, technology and product utilisation are important factors. It was informed by Leinad that they already have initiated the collaboration with various stakeholders and made arrangements for regular supply of feedstocks. While this is in place, the energy produced from bioenergy plant is planned to utilise for the community as well as industries around the site.

Collaboration with various organisations, innovation with inclusiveness and social licencing as well as scalability sets this DGCE project apart. The innovation forms a major part of this project where different solutions are integrated in such a way that it helps in achieving circular economy. The potential innovative solutions include but not limited to community involvement for food organics collection, utilisation of biogas as vehicular fuel, value addition of digestate, high value algae production, hydrogen production etc.

Through innovative technological solutions and a commitment to environmental stewardship, the initiative creates an opportunity to foster a culture of inclusiveness, with social, environmental and economic benefits.

6.1 Collaboration

This is a snapshot of Dublin Green Circular Economy stakeholder group.

Figure 8: Dublin Green Circular Economy Project Stakeholders

By collaborating across sectors, stakeholders can leverage their respective expertise, resources, and networks to develop integrated Green Circular Economy system that is economically viable, environmentally sustainable, and socially beneficial. This collaboration fosters innovation, drives potential policy change, and accelerates the transition towards a circular economy powered by renewable energy.

6.1.1 University

Leinad has received a letter of support from the Griffith University for evaluating the opportunities associated with resource recovery and identifying further value add propositions (Appendix 1). Specifically, Griffith University have identified an opportunity to partner on the assessments of sustainable technologies that focus on the integration of growing high value algae species utilising the byproduct from bioenergy production.

Apart from algae generation, Griffith University have also identified an opportunity to collaborate on different technological solutions that they are currently developing which will further value add to the DGCE Project.

The university can also facilitate the transfer of knowledge and technology between academia and industry, helping to commercialise research findings and promote innovation. A suitable manpower development program can also be developed with the University which will be helpful for circular economy related projects jobs.

6.1.2 Government Bodies

Government bodies play a crucial role in this project by setting policies and regulations that support the development of Green Circular Economy projects, including waste management policies, renewable energy targets, and incentives for bioenergy production (as summarised in section 2 of this report). The Adelaide Plains Council as well as Regional Development Australia (RDA) – Barossa, Gawler, Light & Adelaide Plains (RDA) have and continue to support this project.

Furthermore, it was informed by Leinad that the Council has already consented to be part of this DGCE project where they supply the food organics as well as other available organic waste streams through a MOU. Similarly, RDA is extending their help for this project by fostering public and industry support. Both the entities can provide support for raising awareness among community about importance of waste management, renewable energy and circular economy principles.

Apart from these government bodies, it is intended to discuss this project with Green Industries South Australia (GISA) who is one of the important organisations supporting development of the circular economy through diverse collaborations and partnerships which improve productivity, resilience, resource efficiency and the environment. It helps businesses to implement sustainable resource efficiency measures and increase productivity by funding innovations which will create new jobs in the waste and recycling sector. GISA's current strategic plan outlines how South Australia can ensure a sustainable future while maintaining a thriving economy and one of the strategies focus on Circular resource recovery, Circular sectors, and Circular capacity where Dublin Green Circular Economy project fits well.

6.1.3 Industries

Regular supply of organic waste is the key to DGCE project.

Various industries have been approached who are ready to supply the organic waste for this project. This includes business operators who are ready to supply the grease trap waste to this project. Typically grease trap waste has very high biomethane potential and thus will be immensely useful to maximise the bioenergy generation.

In addition, a poultry farm adjacent to the site creates chicken manure which is a potential feedstock to this project. As an example of agricultural waste, the olive oil producing industry generates olive cake which is also a feedstock for the bioenergy project. There are other industries around with whom we are advised Leinad is in discussions. A wide variety of waste streams creates opportunities to procure the best possible mix for optimising bioenergy generation.

6.1.4 Agriculture

The Adelaide Plains region has a focus for food & vegetable production with most of the green waste is disposed of outside. This green biomass can serve as a feedstock for bioenergy production, including crop residues, wasted vegetables/fruits and energy crops grown specifically for energy purposes. This can be managed along with the Northern Food Cluster.

The DCGE Project creates an opportunity to work with local food producers for the digestate generated from this bioenergy production to be supplied back to farmers to adopt sustainable agricultural practices that maximise the yield while minimising environmental impacts, contributing to the overall sustainability of bioenergy projects.

6.2 Innovation

Different new innovative technological solutions are investigated for this project. This includes but not limited to

- Optimisation of bioenergy generation with better concoction of waste
- Community involvement for source segregation and collection of waste
- Utilisation of carbon dioxide for greenhouse, food packaging, winery, or generating syngas and oxygen
- Utilisation of biogas to generate BioCNG for vehicular fuel
- Value addition to digestate by utilising Soil Rejuvenator solution
- Demonstration of hydrogen generation from biomethane
- High value algae generation from carbon dioxide
- Fuel cell technology for higher electrical efficiency (>60%)

Leinad intends to choose optimum pathways for implementing these innovative technologies in a stagewise manner to maximise the benefits to the region as well as community.

Innovation is the backbone of this project that improves the community and industry wellbeing in the region.

6.3 Inclusiveness and Social Licencing

Inclusiveness and social licence are critical for the success and sustainability of Dublin Green Circular Economy project. By fostering genuine community engagement, sharing benefits equitably, and maintaining high standards of transparency and accountability, this circular economy project can gain the necessary social support and operate successfully within the host communities.

Inclusiveness for this project is achieved by suitable community engagement and participation, involving all relevant stakeholders including communities, indigenous groups, government agencies, NGOs and private sector. For DGCE project, Leinad is in discussions with KESAB to provide education and further collection of food organics that is used as a feedstock for bioenergy project. It is recommended to have a transparent and accessible consultation to gather input and address concerns from the community. This leads to inclusive decision-making process for DGCE project. A suitable feedback mechanism is established to improve on the project performance and progress.

This project provides various social and economic benefits including job creation, regional development, sharing the benefits (byproducts of DGCE project) locally, access to clean and green energy.

Social Licence to Operate is developed by conducting open forums, building trust and legitimacy, maintain transparency in all operations, financial dealings, and environmental impacts. From time to time, it helps to provide clear and regular updates to the relevant stakeholders. The project planning and implementation involve acknowledging and respecting the cultural heritage and traditions of local communities by suitably integrating them into the project.

Leinad is willing to adapt project plans based on community feedback and demonstrating flexibility can build trust and acceptance for this circular economy project. Ethical standards in all project dealings, avoiding exploitation and ensuring fair treatment for all stakeholders are followed in the project.

6.4 Scalability advantage

Successfully completing the Dublin Green Circular Economy project can lay a strong foundation for expanding similar initiatives across other regions of the state.

The scalability of such a project pivot on several key factors including proven model and best practices, availability of detailed blueprint including technical specifications, project management strategies, stakeholder engagement etc.

By building on the successes and lessons of this project, the State can effectively scale up bioenergy initiatives, promoting sustainable energy solutions, economic growth, and environmental stewardship across multiple regions.

Different organic streams are generated in different regions of South Australia and predominantly includes horticulture, broadacre, agriculture, livestock, food processing, beverage industries etc. The byproducts from such project are immensely useful for potentially reducing reliance on fossil fuel electricity, chemical fertilisers while further improving the soil quality and achieving various Sustainable Development Goals (SDG) developed by the United Nations (UN) as mentioned in section 2.1.

A successful project helps in developing a robust supply chain for biomass, equipment, and services. This established network can be leveraged to support new projects, ensuring consistency and quality.

Most importantly such a project will initiate capacity building in the region and make the State more advanced in the BIOENERGY sector. Training and developing local expertise during the first project create a pool of skilled professionals who can lead and support new projects, ensuring knowledge transfer and sustainability even interstate.

7. Conclusion

In our opinion, Leinad’s proposed model and approach to developing a circular economy as part of the Dublin Project can address opportunities of sustainable waste management to provide energy, environmental and socioeconomic benefits in the region.

The innovative approach of converting organic waste into biogas and biofertiliser is a significant step towards achieving a circular economy where waste is not merely discarded but valorised to valuable resources. A closed loop system is created where waste is recycled back into the economy. This project aligns well with the UN Sustainable Development Goals.

Leinad has strategic partnerships in place and is also working on developing suitable collaborative arrangements with different stakeholders involved in the project. They also are well aware of the different byproducts generation and utilisation and finding off-takers for these valuable byproducts. This project may set a benchmark for circular economy practices and inspire further innovations in waste management and renewable energy.

Enpro finds various sustainable opportunities to achieve circular economy and resource recovery in the region and supports the proposed DGCE project in the region.

Annexure 1 Support letter from Griffith University

Prof. Prasad Kaparaju

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Date: 8th May 2024

To
Daniel Palumbo
Leinad Land Developments Dublin Pty Ltd
55 Stanbell Rd, Salisbury Plains, South Australia
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Dear Mr Palumbo

Thank you for the discussion and providing the framework plan to for the Dublin Green Circular Economy Precinct.

We have reviewed the information sent by Dr Jayant Keskar and noted that our interests and subsequent excitement about the opportunity this presents to Griffith University, a recognised worldwide leader for their commitment to sustainable development.

Griffith University is aligned with Sustainable Development Goals and is committed to advancing sustainable development through comprehensive initiatives that promote economic prosperity, social inclusion, and environmental sustainability.

The university are content to collaborate with your team members to further review the 'Green Circular Economy Project' with emphasis on various circular economy initiatives. Specifically, we are interested in partnering with your team to conduct assessments on sustainable technologies, focusing on the integration of growing high value algal species utilising the byproduct from bioenergy project. Apart from algae generation, we can also collaborate on different technological solutions that we are currently developing which will further value add to your circular economy project.

Grifith University will be happy to support your project in various ways including technology assessment, research collaboration, laboratory trials etc. We have necessary facilities, expertise, and resources to support your project which will be a perfect example of industry-university nexus.

We believe that by combining our expertise, resources, and networks, we can make significant strides towards advancing sustainable technologies and accelerating the transition to a circular economy model. Moreover, we are confident that this collaboration will not only generate valuable insights and outcomes but also foster long-term partnerships between us. We certainly aim to achieve the shared goals for this project.

Thank you for considering this collaboration opportunity. We look forward to the possibility of working together and making a positive impact on circular economy through our collective efforts.

Yours sincerely

Professor Prasad Kaparaju
Team Leader, Environmental Biotechnology and Bioprocess Engineering
Griffith University