

Pathways Call for Evidence Submission

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Submission to the NSW Net Zero Commission

Decarbonisation Pathways for NSW: Call for Evidence

Sustainable macroalgal biomass from wastewater: a NSW-proven nutrient and carbon sequestration platform, providing cross-sector abatement opportunities for the State's circular economy.

Date: 14th August 2026

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Executive Summary

Pacific Bio operates RegenAqua, a macroalgal bioremediation platform that treats wastewater using native macroalgae, producing a continuous stream of harvestable biomass. The freshwater algae sequester atmospheric CO₂ with dissolved nitrogen and phosphorus, cleaning effluent before discharge; this has two significant decarbonisation impacts. First, capturing nitrogen in biomass before it can be released into waterways limits scope 3 emissions across the wastewater and agricultural sectors. The nitrogen is no longer available to feed algal- and phytoplankton blooms, which produce methane and nitrous oxide, potent greenhouse gases. Second, Pacific Bio leverages this steady supply of sustainable biomass as a feedstock to produce biofuels, and a biostimulant through its Pacific Bio Energy, and PlantJuice operations, aiding abatement efforts beyond the wastewater industry.

Since February 2023 the technology has been under continuous trial at Sydney Water's Picton Water Resources Recovery Facility in NSW. That trial is now the most comprehensively characterised algal bioremediation dataset in Australia, and sits in this State. This submission makes three points.

First, the case for macroalgal bioremediation is proven in NSW and fundable on water quality and cost grounds alone. NSW utilities can deploy this technology now, and the business case does not depend on an emissions or energy policy.

Second, every hectare of RegenAqua treatment produces a sustainable biomass feedstock as an unavoidable by-product. Production is consistent, already funded by nature of the treatment, and occurs within the boundary of the treatment plant. Conversion of algal biomass to useful products is well established, and does not compete for arable land.

Third, water treatment efficiency and biomass yield are determined by nutrient concentration, not wastewater volume. Results demonstrated at Picton operate well below the technology's productivity ceiling, providing greater opportunity further upstream in wastewater treatment, or other nutrient-rich settings.

Utilities make investment decisions across decades, the choice of wastewater infrastructure made today will be a commitment through NSW's 2050 net zero target. The Commission must ensure that industries are able to account for impacts beyond their own decarbonisation pathway, supporting the circular economy and cross-sector opportunities as the one presented in this submission.

Recommendations

1. Embed macroalgal bioremediation as a reference technology in the Waste (wastewater) decarbonisation pathway. The Picton trial provides the best available NSW algal bioremediation dataset; the pathway scenarios should treat tertiary macroalgal treatment as a deployable, commercially-proven option, not an emerging one, so that reference scenarios reflect current readiness.

2. Require resource-recovery and emissions-intensity assessment in utility treatment procurement. Treatment options should be evaluated on energy consumption, emissions intensity and resource-recovery potential, not only capital cost and compliance. This is a near-zero-cost, high-leverage measure available to NSW through its control of Sydney Water and Hunter Water and its regulation of local water utilities.

3. Establish explicit cross-pathway ownership for circular-economy and resource-recovery opportunities. Cross-sector initiatives spanning waste, energy, land and agriculture, and carbon management risk falling outside any sector-specific plan. The absence of an owner should itself be recognised as a structural barrier to the transition.

4. Model scope 3 nutrient-discharge emissions, and treat their omission as a modelling risk. The current NGER/CER framework captures methane and nitrous oxide but not scope 3, which may be material in the water sector via nitrogen discharge driving eutrophication. Pathway modelling that omits downstream impacts of untreated nutrient loads (particularly municipal and agricultural run-off) understates both the problem and the abatement value of tertiary treatment.

5. Facilitate crediting for nutrient removal projects. The State needs an audited, registry-backed scheme to promote nutrient removal efforts; supporting abatement of currently unmodelled emissions in addition to waterway health. The State should consider adapting an established scheme, such as Reef Credits¹, to NSW in order to implement.

6. Act before utilities begin procurement of long-life wastewater assets. Wastewater plants are high-CapEx, long-life assets; technology choices made in the next four years will persist past 2050. Recognising macroalgal bioremediation in NSW treatment standards and procurement frameworks today reduces procurement risk for utilities and councils as they commit to 2050 timelines.

¹ The [Reef Credits scheme](#) is a voluntary program for farmers and landholders in Great Barrier Reef regions to measurably improve the quality of water flowing into the Reef. Projects that follow the approved methods provide verifiable reductions in pollutants reaching the Reef; project owners are awarded Reef Credits, which they can sell in markets. The scheme offers an auditable, registry-backed mechanism enabling investment into nutrient reduction practices.

1. NSW-specific evidence: Sydney Water's Picton trial

Located at Sydney Water's Picton Water Resources Recovery Facility (WRRF), the site has nearly two years of continuous operation, being documented jointly with Sydney Water. Pacific Bio can provide the Commission operational data proving efficacy in NSW conditions (James et al., 2025), and at what land costs.

Configuration

The trial commenced in February 2023 at the WRRF which serves five villages, recycling water across 119 ha farmland and discharging excess treated effluent to Stonequarry Creek, approximately 1.3 km upstream of its confluence with the Nepean River. Here the trial-scale RegenAqua facility treats secondary effluent at a nitrogen concentration below 10 mg/L, and phosphorus below 1 mg/L.

Parameter	Raceway 1	Raceway 2	Raceway 3
Exchange rate (% raceway volume per day)	21%	14%	7%
Influent feed (L/min)	2.2	1.5	0.8
Equivalent flow for a 3 ha full-scale system	3 ML/d	2 ML/d	1 ML/d
Implied land intensity	1.0 ha per ML/d	1.5 ha per ML/d	3.0 ha per ML/d

Table 1: Picton raceway configurations.

Three raceways each 2 m x 25 m at 0.3 m depth treat less than 1% of typical plant flow at varying exchange rates to assess efficiency in NSW conditions across different throughput. Note the algal species used (*Oedogonium* sp.) was identified in Stonequarry Creek and the plant's own ponds, eliminating the risk of introducing any non-local strains to surrounding waterways.

Treatment performance

Data gathered over the trial period produced a corresponding performance across each raceway. Results below are at low flow rate (Raceway 3) unless otherwise stated.

Analyte	Reduction	From	To
Ammonia-N	96–100% (all flow rates)	0.2–1.8 mg/L	0.01 mg/L
Oxidised nitrogen (NO _x -N)	92%	4.7 mg/L	median 0.1 mg/L
Total nitrogen	75%	typical 6.7 mg/L	-
Soluble reactive phosphorus	95–98% (all flow rates)	median 0.23 mg/L	0.005–0.008 mg/L
Total phosphorus	88–92%	above 0.5 mg/L	median 0.08 mg/L
Faecal coliforms, <i>E. coli</i> , <i>Enterococcus</i>	above 90%, mostly above 95%	-	-

Table 2: Picton nutrient removal performance.

Dissolved metals were also reduced, with removal improving at longer residence time and at higher influent concentration. Reductions at the 90th percentile included aluminium 50%, copper 46%, cobalt 43%, zinc 50%, chromium 40%, iron 79%, and manganese 66%.

In this trial configuration at the WRRF, RegenAqua is implemented in the final stages of wastewater treatment, where influent has been diluted by prior treatment. Removal efficiency increases at higher nitrogen and phosphorus concentrations, meaning the technology was operating at the hardest end of that range. Consequently, these results should be read as a floor of potential reduction.

Scale-up in NSW

In addition to Picton, Pacific Bio has operated trial sites in Townsville (QLD), and Burdekin Shire (QLD), with the latter leading to a construction of a full-scale 3.3 ha municipal treatment facility,

completed in 2025. The technology has already made the transition from trial to full commercial scale in Australia, that transition is yet to occur in NSW.

2. Cross-sector decarbonisation

Every RegenAqua facility produces sustainable macroalgal biomass as an unavoidable byproduct of ongoing wastewater treatment. The biomass is a stable, predictable feedstock for downstream low-carbon products across the Waste, Energy, Land and Agriculture, and Carbon Management pathways. However, without acknowledging this integrated waste-to-worth model across pathways, the Commission risks overlooking macroalgal biomass as a unique contributor to the State's decarbonisation goals.

Macroalgal biomass as a feedstock

Macroalgal biomass is characteristically a distinct feedstock class, compared to other renewable biomass sources.

Cultivation cost is already carried by the treatment service. Unlike purpose-grown biomass, the capital and operating costs of producing and harvesting this feedstock are borne by the treatment provider. The main marginal cost is dewatering (preparing for conversion into downstream products).

Supply is independent of market pressures. Biomass production is tied to nutrient load, in a tertiary treatment setting this is inelastic to consumer behaviour or commodity prices. The Commission may use existing demographic data to model wastewater volumes and biomass yield.

Land use is non-arable, and co-located with treatment. Production requires no arable land, freshwater or fertiliser input, and occurs within the footprint of a treatment plant.

Production is distributed. Biomass is generated wherever wastewater is treated, in NSW this means regional and peri-urban areas. This model supports regional processing, albeit with smaller sites due population size.

Using the Picton trial dataset, the following yield coefficients may be derived for use in the Commission's modelling. Biomass yield derives directly from nitrogen removed per unit of treatment flow, and is provided as dry weight tons per megalitre of treated flow, so the Commission can substitute its own values accordingly.

Parameter	Value	Basis and evidence
Influent total nitrogen	6.7 mg/L	Picton trial data. Typical nitrogen inflows observed.
Reduction in total nitrogen	75%	Picton trial data. As stated in section 1; Raceway 3 nutrient reduction performance.
Assimilation of removed nitrogen to biomass	70%	Assumed macroalgal uptake efficiency of removed nitrogen.*
Nitrogen content of biomass per unit treated flow	3.5 kg per ML/day	Calculated using the above.
Dry weight (DW) biomass nitrogen content	2.5%-5.0%	Estimated range of DW biomass n content. **
Total DW biomass produced per unit treated flow	70-141 kg per ML/day	Calculated.
Annual DW biomass produced per unit treated flow	26-51 t/yr per ML/day	Calculated pa.

Table 3: Biomass production calculated from Picton-specific data.

**biomass yield was not captured as part of the Picton dataset, so assimilation rates have been assumed. If requested by the Commission, equivalent figures could be calculated using the Burdekin, QLD commercial site.*

***as above, biomass data from the Burdekin site could be provided, if requested.*

While there is no consolidated dataset on State-wide primary, secondary, and tertiary wastewater treatment flows, Sydney Water treats 1,300 ML/day across its 30 water resource recovery facilities (Sydney Water, 2026). This is not stated as a commercial target (the Burdekin facility currently treats 2.4 ML/day, production is not volumetrically material to NSW's liquid fuel demand), rather it should illustrate the potential scale for macroalgal bioremediation as an untapped, sustainable feedstock.

Nutrient return and fertiliser displacement – PlantJuice biostimulant

The agricultural industry is under pressure to reduce dependence on synthetic fertilisers. Australia is reliant on imports of synthetic fertilisers, leaving it vulnerable to price fluctuations driven by global energy prices and input costs. More relevant to the Commission, synthetic fertilisers carry a significant GHG footprint in both production and application, which will be modelled in the Land and Agriculture decarbonisation pathway.

PlantJuice is a liquid biostimulant derived from harvested RegenAqua biomass. The first commercial-scale facility has been commissioned at the Burdekin site, and approximately 500,000 litres of product have been sold to date. Biostimulants are a broad category of organic compounds and microorganisms that trigger adaptive responses in plants, such as improved nutrient uptake, crop quality, and abiotic stress tolerance (Arenas Colarte et al., 2025). Algal biostimulants have been shown to increase dry matter yields, and can offset fertiliser requirements (Skapste et al., 2025).

Since commissioning the commercial facility, Pacific Bio is preparing to undertake field trials of its PlantJuice biostimulant to determine optimal dosing across a variety of crops. Results from these field trials will be used to identify high value applications, and quantify potential for fertiliser offset.

Low-carbon fuels – Pacific Bio Energy

The NSW government has identified the need to grow the State's renewable fuel industry. The Renewable Fuel Scheme (RFS) will be expanded to include biomethane from 2028, and further expended to low-carbon liquid fuels (LCLFs), with industry consultation running through 2026.

NSW's renewable fuel ambition ultimately rests on how much sustainable biomass the State can access and mobilise without competing for arable land, food production or waste streams already committed elsewhere. Macroalgal biomass from wastewater treatment is a small but genuinely additional contribution to that supply. It is produced by an activity that will occur regardless, on land that cannot be farmed, using no freshwater and no fertiliser. It displaces no other feedstock in any other pathway. Pacific Bio Energy exists to convert RegenAqua's harvested biomass into low-carbon fuels.

Three routes are under active assessment. They are alternative uses of the same biomass, and the choice at any given site will depend on biomass composition, scale and adjacent infrastructure.

Route	Process	Position
Biomethane	Anaerobic digestion, with co-digestion alongside sewage sludge	Nearest-term. Accepts wet biomass, avoiding the drying energy that undermines most algal energy pathways, and can use digestion capacity that already exists at many treatment plants.
Bioethanol	Pre-treatment, hydrolysis and microbial fermentation	Pre-commercial. A distinct process from digestion, competing for the same substrate; assessed alongside medium-chain fatty acids as a higher-value fermentation product.
Biocrude	Hydrothermal liquefaction, upgraded in conventional refining	Pre-commercial, and the route most relevant to sustainable aviation fuel and renewable diesel. Conversion of <i>Oedogonium</i> sp. to biocrude is characterised in the peer-reviewed literature (Neveux et al., 2016).

Table 4: Low-carbon fuel pathways for macroalgal biomass.

Pacific Bio Energy is pre-commercial and does not present itself otherwise. Work to date has been directed at establishing conversion performance on RegenAqua biomass specifically, rather than on published values for algal feedstocks generally:

- UNSW Sydney is engaged to assess the biomethane, bioethanol and medium-chain fatty acid routes on *Oedogonium* sp. feedstock, including reactor design.
- Queensland University of Technology has re-validated Pacific Bio's earlier biocrude findings at pilot scale using biomass from the operating Burdekin facility, confirming biocrude production and by-product recovery across a range of process conditions.
- Pacific Bio is engaged with industry partners regarding biocrude supply into existing refinery infrastructure.

3. Responses to the guided questions

Policies and market mechanisms

1. What opportunities or barriers could improve the effectiveness of NSW's transition to net zero?

a. What policies or market mechanisms could accelerate emissions reductions in specific sectors or communities? What barriers or opportunities exist for their adoption, including any evidence from businesses, industry and/or comparable jurisdictions?

- **Require resource recovery assessment in utility treatment procurement.** NSW controls Sydney Water and Hunter Water and regulates local water utilities. Requiring that tertiary treatment options also be assessed for energy consumption, emissions intensity and resource recovery potential (not capital cost and compliance alone) would change technology selection at the point where multi-decade procurement decisions are made. This is a high leverage measure available to NSW on the Waste decarbonisation pathway, and has near zero implementation costs.
- **Ensure the NSW Renewable Fuel Scheme accommodates non-conventional feedstocks.** Scheme design that implicitly assumes crop, residue or waste-stream feedstocks may exclude nutrient-derived aquatic biomass by definition.
- **Establish a nutrient-removal crediting pathway.** Nutrient removal has regulatory value in NSW but no market value. Monetising this incentivises further tertiary treatment, reducing nitrogen discharge and therefore indirect scope 3 emissions, for low implementation cost. The State could adapt an established scheme, such as Reef Credits, along with methodologies to expedite implementation.

b. How could the NSW Government better stimulate private finance at the scale and pace needed for the net zero transition?

- **Facilitate crediting pathways for cross-sector, circular economy projects.** Existing crediting methodologies are (with good reason) tightly defined to support audit and credibility. That tight methodology structure increases barriers for circular economy initiatives which are generally cross sector, limiting mobilisation of private finance through crediting.

c. What are the drivers and risks to reaching NSW's interim targets in 2030 and 2035, and net zero by 2050?

- **Driver:** Wastewater treatment is driven by capital cycles and is mandatory; infrastructure investment in the sector will occur. The marginal decision is the type of technology to pursue.
- **Risk: Near-term asset lock-ins.** Wastewater treatment plants are high CapEx, long-life assets. Investment decisions made in the next four years will remain in place past the 2050 targets; it is essential NSW adopts the most promising wastewater technologies.

- Risk: Pathway modelling that omits downstream impacts of untreated nutrient loads. This risk covers not just municipal waste, but the impact of agricultural run off into NSW's waterways, degrading water quality and releasing GHGs through eutrophication.

d. What are the opportunities or barriers for collaboration across sectors to support the transition?

- **Identify explicit cross-pathway ownership for resource recovery pathways, and treat the absence of such ownership as a structural barrier.** Pacific Bio's circular economy model spans waste, energy, transport, land and agriculture, and carbon management. Cross sector initiatives risk not being included in sector specific decarbonisation plans because wider benefits may be considered out of scope.

Technology and behaviour change

2. What are the opportunities and barriers to technology development, deployment for each sector?
This may include:

a. What technologies are available or emerging in your sector, and what is their current state of readiness?

- Macroalgal bioremediation (RegenAqua) is commercially deployed in Australia, ready for commercial deployment in NSW.
- Macroalgal biomass to biostimulant (PlantJuice) commercial-scale facility undergoing commissioning.
- Macroalgal biomass to low-carbon fuels; biomethane, bioethanol, biocrude (Pacific Bio Energy) pre-commercial.

b. What constraints exist around technology uptake and deployment?

- **Land area.** RegenAqua requires one to three ha per ML/day capacity for municipal tertiary treatment. This is more than energy intensive Membrane Bioreactors, but less than constructed wetlands (while providing superior performance), and is a constraint on metropolitan deployment.
- **Procurement conservatism in the water sector.** Utilities and councils are rightly risk-averse in treatment technology selection, defaulting to established processes. Reference sites and established methods can be more impactful than costs. A two-year Sydney Water trial is a strategically significant asset for NSW.

c. What does the evidence say about current and future costs?

d. What role could the NSW Government play in strengthening technology development and deployment?

- **Recognise macroalgal bioremediation in treatment standards and procurement frameworks** to alleviate procurement risk for utilities and councils.

3. What are the opportunities to foster demand reduction and behaviour change?

- Wastewater volumes and nutrient loads are inelastic to consumer behaviour, scaling with population, agricultural activity, and rainfall. Improving treatment and minimising discharge impacts are more achievable.
- **Institutional behaviour change (utilities and councils) provides the opportunity to support transition.** As noted, reducing perceived risk in procurement by recognising macroalgal bioremediation would aid adoption.

Economic impacts and just transition

4. What are the likely economic effects on NSW of different emissions pathways to net zero, relative to NSW's current level of ambition?
- a. What are the most significant economic or workforce pressures the pathways should account for in your sector or community
5. What are the opportunities and barriers to addressing socio-economic priorities for a just transition, including equitable outcomes for First Nations peoples and rural, regional and remote communities?
- **RegenAqua's cost base is lower than other tertiary treatment methods, allowing for direct ownership by rural and regional communities.**

Evidence and other considerations

6. What evidence can you provide to inform pathway inputs and assumptions? For example, cost curves, deployment rates, or sector-specific data, include commercially sensitive data where relevant.
- Primary NSW trial data: Picton, 2023-2025
 - Deployment rates: delivery timeline across the Burdekin commercial facility.
 - Cost curves: estimated cost base for macroalgal processing into low-carbon fuels and biostimulant.
7. Beyond emissions reduction, what outcomes should be considered? For example, impacts on business, jobs, land-use, water and biodiversity.
- Waterway health. Effects of nutrient discharge into NSW receiving waters have consequences for aquatic biodiversity, recreational amenity and downstream agricultural and tourism activity.
 - Pathogen reduction. Tertiary treatment by macroalgal bioremediation reduces pathogen load without the need for chemical dosing. Note the Picton reduction of 90-95% in Faecal coliforms, E. coli, and Enterococcus. This lowers the reliance on chlorination and disinfection by-products, reducing human health hazard where treated water meets recreational waters.
 - Supply chain resilience. Australia imports the large majority of its synthetic nitrogen fertiliser, leaving growers exposed to price and availability shocks. Recovering nutrient from wastewater and returning it to NSW agriculture converts an imported input into a domestically produced one.
8. Do you have any other comments or information you would like to provide?

Thank you for taking the time to consider Pacific Bio's submission. We would welcome the opportunity to brief the Commission and to provide further data as required.

Sincerely,

Antony Gibson
Chief Development Officer

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