Final Project Submission Form

Health Service: Peter MacCallum Cancer Centre	
Title of project: Closing the Loop: A Circular Economy Model for Medical Equipment	**Department:** Biomedical Engineering

Introduction

I am the Chief Biomedical Engineer at Peter MacCallum Cancer Centre, responsible for the governance, safety, and lifecycle management of medical technology assets. My team and I identified a system-level opportunity to address the environmental, financial, and social impacts associated with traditional end-of-life practices for biomedical equipment.

Hospitals generate large volumes of retired and surplus medical equipment, much of which is prematurely landfilled or stored indefinitely due to fragmented governance, unclear reuse pathways, and risk-averse disposal norms. This project was initiated to redesign biomedical asset management using circular economy principles, embedding sustainability directly into standard governance processes rather than relying on ad hoc or downstream recycling approaches.

Since April 2025, this initiative has operated as a **sustained, reproducible system change**, delivering measurable carbon, waste, clinical, social, and financial benefits while maintaining patient safety and regulatory compliance.

What was the problem you tackled?

Retired, used, or surplus biomedical equipment at Peter MacCallum Cancer Centre was historically disposed of inefficiently, either sent to landfill or retained long-term in storage. This occurred despite a significant proportion of equipment remaining functionally serviceable and compliant for reuse.

The lack of a structured recovery system resulted in:

- Avoidable landfill waste generation
- Unnecessary embedded carbon emissions from premature replacement
- Lost financial value from public assets
- Missed opportunities for internal reuse and broader health system benefit

What was your SMART Goal?

To design and implement a **low-capital, reproducible, and governance-led** biomedical equipment recovery system that:

- Achieves sustained **reduction in landfill waste generation**
- Quantifiably avoids carbon emissions through reuse and resale
- Recovers financial value from surplus assets
- Maintains clinical safety, accreditation, and regulatory compliance

What system factors contributed to the problem?

Key system factors highlighted an opportunity to formalise and strengthen collaboration across the organisation:

- Decommissioning and disposal workflows existed but were not integrated into a consistent, formalised pathway
- Limited visibility of reuse, resale, and redistribution options at the point of equipment retirement
- Biomedical engineering, procurement, infrastructure & capital, sustainability teams worked toward common goals, with scope to formalise coordination across asset management processes.
- Environmental metrics were not embedded into asset management processes, limiting evidence-based decision-making

Who were the key stakeholders?

- Biomedical Engineering / Infrastructure & Capital
- Clinical departments
- Procurement and Supply Chain
- Sustainability Team
- Executive sponsors
- Regulated reuse, resale, and recycling vendors

What was the intervention?

A **formalised biomedical asset recovery pathway** was designed and embedded into routine operations. Key components included:

- Auditing stored, retired, and surplus biomedical inventory
- Mapping existing decommissioning processes to identify systemic gaps
- Co-designing solutions with biomedical, clinical, procurement, and sustainability stakeholders
- Benchmarking against health services using circular economy approaches
- Establishing compliant resale, reuse, donation, and recycling partnerships
- Aligning asset disposal policies with sustainability objectives

This intervention transformed asset end-of-life management from an ad hoc practice into a **governed, measurable system**.

What impacts/outcomes were measured? How did you measure them?

Outcomes were systematically tracked using asset registers, inventory audits, and regulated vendor reports:

- **Waste**: Volume of biomedical equipment diverted from landfill
- **Carbon**: Estimated greenhouse gas emissions avoided via reuse and avoided manufacturing
- **Financial**: Resale revenue and avoided disposal costs
- **Clinical**: Safe redeployment of functional equipment
- **Social:** Staff engagement and community benefit from redistribution pathways

Measurement focused on conservative assumptions to ensure defensible reporting**.**

What challenges did you face? What enablers facilitated the change? What were the learning points?

Challenges

The primary challenges were cultural and systemic rather than technical. There was an established risk-averse mindset around biomedical equipment reuse, with concerns relating to patient safety, regulatory compliance, and accountability. Additionally, asset decommissioning processes were fragmented across teams, and environmental benefits were historically not quantified, making it difficult to justify change using evidence.

Another challenge was the absence of an existing, standardised pathway for reuse, resale, or redistribution, requiring new governance, vendor engagement, and policy alignment to be developed from first principles.

Enablers

Key enablers included strong executive support, early engagement with clinical, procurement, and sustainability stakeholders, and the availability of regulated and compliant external vendors. Close collaboration with the Sustainability Team enabled the use of conservative, credible metrics that built confidence and trust across stakeholders.

Embedding the initiative within existing biomedical governance structures, rather than positioning it as a stand-alone sustainability project, was critical to its successful adoption.

Learning points

The key learning was that sustainable change in healthcare is most effective when it is designed as a system-level intervention aligned with core clinical and governance processes. Conservative data assumptions strengthened credibility and uptake. Most importantly, sustainability outcomes improved when clinicians and engineers could clearly see that patient safety and quality of care were not compromised.

What are the next steps with this project?

The next phase of the project will focus on scaling and integration. Planned next steps include expanding the recovery pathway across additional departments, improving data granularity by equipment category, and embedding circular economy considerations earlier in procurement, replacement planning, and capital approval processes.

Further work will also explore opportunities to formalise redistribution pathways that maximise health system and community benefit, and to strengthen reporting so outcomes can be routinely tracked and benchmarked over time.

Points will be awarded in the following categories:

Environmental sustainability: What were the carbon savings from your project? (Please include your raw data and calculations)

Project period assessed 2025–

2026

Raw data

- Biomedical equipment diverted from landfill: **40.34 m³**
- Resale value enabling reuse (excl. GST): $**202,252.50 AUD**

A conservative lifecycle assessment (LCA) approach was applied to estimate greenhouse gas emissions avoided through this initiative. The approach is consistent with Australian Government greenhouse accounting guidance and published healthcare LCA literature, and was deliberately designed to avoid over-claiming (Australian Government, 2024; Drew et al., 2023).

Two emissions pathways were assessed:

1. Avoided landfill emissions resulting from the diversion of biomedical equipment from disposal

2. Avoided manufacturing emissions resulting from reuse and resale of medical equipment, thereby displacing the production of new devices

This dual-pathway method aligns with recognised approaches for estimating environmental benefits of circular economy interventions in healthcare (McGain et al., 2017; Drew et al., 2023).

Avoided landfill emissions

Diverted equipment consisted of mixed biomedical assets, primarily metals, plastics, and electronic components. Given the heterogeneous and partially inert nature of this waste stream, a **conservative landfill emissions proxy of 0.45 t CO,e per cubic metre** was applied. This value sits at the lower end of Australian landfill emissions estimates and is consistent with National Greenhouse Accounts guidance when conservative assumptions are required (Australian Government, 2024).

Calculation:
40.34 m^3 × 0.45 t CO,e/m^3
= **18.15 t CO,e avoided**

Avoided manufacturing emissions (primary benefit)

The primary emissions benefit arises from **avoided manufacturing**, as reused and resold equipment directly displaces the need to manufacture new medical devices. Manufacturing impacts are well established as the dominant contributor to medical equipment carbon footprints, particularly for capital and electronic devices (McGain et al., 2017; Drew et al., 2023).

A **conservative embodied carbon intensity factor of 0.9 kg CO,e per AUD $** was applied. This factor aligns with economic-input LCA estimates for healthcare goods and is lower than many reported values for complex medical devices, ensuring credibility and conservatism.

Calculation:
$202,252.50 × 0.9 kg CO,e/AUD

= **182.0 t CO,e avoided**

Total estimated emissions reduction (2025–2026)

Emissions source	**CO,e avoided**
Avoided landfill emissions	~18.2tCO,e
Avoided manufacturing emissions	~182.0tCO,e
Total emissions avoided	**≈200tCO,e**

Assumptions and integrity

- Conservative emission factors were deliberately chosen
- Transport, refurbishment, and secondary handling emissions were excluded
- Estimates therefore represent a **minimum, defensible emissions reduction**, consistent with good practice in sustainability reporting and award submissions (Australian Government, 2024)

References

Australian Government Department of Climate Change, Energy, the Environment and Water. (2024). National Greenhouse Accounts factors 2024. Commonwealth of Australia. https://www.dcceew.gov.au/climate-change/publications/national-greenhouse-accounts-factors-2024

Drew, J., Henstock, M., Irving, J., & McGain, F. (2023). Healthcare LCA: A database of environmental impacts of healthcare activities. Centre for Planetary Health & Sustainable Care. https://healthcarelca.com

McGain, F., Burnham, J. P., Lau, R., et al. (2017). The carbon footprint of healthcare: A systematic review and applications in Australia. Critical Care and Resuscitation, 19(1), 37–44.

Environmental sustainability: What were the waste reductions? (If possible, please specify what waste stream – reduced clinical waste by diverting to recycling, reduced clinical waste by using reusable equipment etc.)

This initiative achieved a **sustained reduction in waste generated**, not merely improved recycling.

Approximately **40.34 m³ of biomedical equipment** was prevented from entering landfill through upstream intervention — prioritising reuse and resale at the point of decommissioning rather than downstream waste processing.

This represents a **system-level shift away from waste generation**, aligned with circular economy principles.

Clinical outcomes: How did your project improve patient care? (include outcome data if available)

Functional biomedical equipment was safely redeployed internally or redistributed externally through regulated pathways. This maintained continuity of patient care preserved access to clinically appropriate technology, and upheld safety, infection control, and regulatory standards.

By extending equipment life, the project reduced disruption associated with premature replacement and strengthened resilience in equipment availability, delivering clear patient-centred benefit without clinical compromise.

Financial sustainability: Have there been any financial savings? (please include your calculations)

The initiative generated **$202,252.50 AUD (excl. GST)** in quantifiable resale revenue while avoiding disposal and storage costs.

These savings were achieved **without capital investment**, demonstrating operational relevance, strong value for money, and reproducible financial benefit.

Social sustainability: How did your project socially benefit patients, staff, or wider community?

The project fostered strong staff engagement by empowering biomedical and clinical teams to participate in sustainability outcomes aligned with patient care values.

External redistribution pathways enabled surplus equipment to deliver benefit beyond the originating service, contributing to broader health system and community value. The initiative strengthened sustainability culture, professional pride, and workforce morale by demonstrating responsible stewardship of public assets.

Generalisability: Could this project be replicated in other areas of the hospital?
This model is **easily scalable and transferable** across departments and health services. It leverages existing governance structures, standard asset registers, and compliant vendor partnerships. Key steps are clearly defined, enabling adoption with minimal adaptation in other healthcare settings.

Please attach some photos.

Photographs of various types of equipment waiting to be picked up from the loading dock.


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