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# Circular Economy Medical Textiles Road Map for NHS Wales

March 2022



# Report

March 2022

## Prepared by Revolution-ZERO on:

### Circular Economy Medical Textiles Road Map for Wales

Submitted by: Tom Dawson

Signed:

Position: CEO and Medical Director

Date: 31 March 2022

Approved by: William Beharrell

Signed:

Position:

Date:

**Authors** (in alphabetic order): Emma Burlow, Tom Dawson, Peter Hopkinson (Lead)

**Analytics:** Harry Hopkinson

**Graphic Design:** Yannis Tsitsonnis

**Industrial Design:** Ben Manson

**Sponsors (NWSSP):** William Beharrell, Jonathan Irvine, Claire Salisbury

**Core Engagement Team (NHS Wales):** William Beharrell, Fiona Brennan, Laura Burton

## NHS Wales Contributors

### Cardiff & Vale University Health Board

**Jared Torkington** General and Colorectal Surgeon, Associate Medical Director for Innovation

**James Horwood** Lead surgeon, Colorectal Surgical Department

**Matthew Wise** Associate Medical Director for Research and Development

**Jack Parry-Jones** Critical Care Consultant

**Craig Spencer** Critical Care Consultant

**Yvonne Hyde** Head of nursing, infection prevention control

**Lee Barker** Operational Services Manager

**Mark Campbell** Operational decontamination lead

**Ed Hunt** Programme Director for UHW2, Strategy and Planning

**Jonathon Gray** Director for Innovation and Improvement

**Mark Briggs** Assistant Director for Innovation

**Fiona Brennan** Consultant Anaesthetist

**Laura Burton** SpR ENT Surgery, SFERIC scholar

**Stacey Harris** SpR Paediatrics and Sustainability Leadership Fellow

**Jane Boulton** Procurement Business Manager

**Jennie Jenkins** OPD, SFERIC scholar

*\*Presented to the Cardiff & Vale Innovation Multi-Disciplinary Team Meeting (iMDT) on March 3rd*

### NHS Wales Shared Services Partnership

**Neil Frow** Managing Director

**Jonathan Irvine** Director of Procurement

**Claire Salisbury** Deputy Director for Procurement, and Head of Procurement for Cardiff & Vale UHB

**Anthony Hayward** Director of Laundry and Operational FM Services

**Lee Wyatt** Programme Director Key Strategic Projects

**Stephen Pickard** Senior Procurement Lead for Sustainability and Transformation

**Peter White** Head of Greenvale Laundry Services

**Jonathan Ashman** Deputy head of Greenvale Laundry Services

**David Jones** Assistant head of Greenvale Laundry Services

### Hywel Dda University Health Board

**Philip Kloer** Deputy Chief Executive and Medical Director

**Chris Hopkins** Head of Clinical Engineering & Triton Institute

**Leighton Phillips** Director for Research, Innovation and University Partnerships

**Tracey Gauci** Consultant Practitioner in Infection Prevention Control

### Swansea Bay University Health Board

**Lesley Cook** Lead nurse clinical procurement

**Richard Clayfield** Assistant Head of Operational Procurement

**Richard Egan** Consultant Surgeon

**Zoe Li** SpR ENT Surgery

**Elana Owen** Consultant Anaesthetist

**Sarah Hemington-Gorse** Consultant Surgeon

### Betsi Cadwaladr University Health Board

**Carsten Eickmann** Consultant Anaesthetist

### Welsh Value in Health Centre

**Sally Lewis** National Clinical Lead for Value-Based and Prudent Healthcare and Honorary Professor at Swansea School of Medicine

### Bevan Commission

**Helen Howson** Director

# Foreword

**Dr William Beharrell** Clinical Lead for the Circular Economy, NHS Wales Shared Services Partnership

One of the lessons of the last two years has been our reliance on colleagues in procurement to safeguard supplies of essential products and services. As we were learning how to adapt to the consequences of the Covid-19 virus, we found they were several steps ahead, learning how to navigate the vagaries of a rapidly changing world, including the vulnerability of 'just-in-time' supplies chains, a reliance on overseas manufacturers, a lack of storage and haulage, and a 4000% surge in demand. This process of adaptation has been a spur to new and collaborative ways of working, which will be essential if we are to meet our target of cutting our greenhouse gas emissions by 42% by 2032. The report below describes current emissions of over a million tonnes of carbon dioxide equivalent from our buildings and transport alone and over seventy double-decker buses in weight of single use medical textile PPE per year. These examples are illustrative of the planetary harm caused by NHS Wales and representative of the herculean challenge facing our system.

The Welsh Government has responded with the publication of the NHS Wales Strategic Decarbonisation Delivery Plan, which is already twelve months old today. In turn, the NHS Wales Shared Services Partnership has established a Transformation Procurement Unit to work more closely with suppliers to quantify and reduce the carbon in its supply chains. Health Boards across the country have established Sustainability Action Plans and Green Groups of one kind or another, and the Green Health Wales network is emerging as a matrix in which these groups can grow. Anaesthetists have worked hard to minimise the use of harmful agents such as desflurane and nitrous oxide. Our colleagues in facilities and estates are beginning to see the fruit of their investments in renewable energy, such as Morriston's solar farm.

Yet, despite our increasing understanding and use of the term decarbonisation, the report below makes a strong case that any meaningful response to the climate emergency will necessarily involve elimination of waste and pollution, recirculating products and materials (at their highest value) and regenerating natural habitats. This is the circular economy. This is the uncoupling of productivity from consumption and the fostering of an interconnected system in which each partner contributes to prosperity and improved planetary health. It stands in opposition to a linear economy, one characterised by a 'take-make-waste' attitude.

Despite these signs of a new culture emerging, this attitude persists in the fact that our products, practices and processes remain still largely harmful to the planet.

A case in point is the waste generated by our theatres, which typically account for a quarter of all hospital waste according to Rizan et al (Ann Surg 2020) with a single tonsillectomy generating up to a hundred pieces of disposable plastic (J R Soc Med 2020). Such harms are avoidable, and in many cases, there are assured and verifiable solutions readily available (McQuerry et al, Am J Infect Control; 2021). This is why, in a parallel report, we describe our decision to adopt two such products – gowns and drapes – and test them in action using a colorectal tumour excision. We can learn from low-resource settings with, for example, the oft-cited example of cataract surgery in India generating 6kgCO<sub>2</sub> compared to the equivalent in the UK of 182 kgCO<sub>2</sub>. Such lessons are even more pertinent when considering our increasing use of robotic surgery and the associated increases in single-use equipment. In a recent paper, Bhutta (Ann R Coll Surg Engl 2021) states that a robotic hysterectomy generates over 800 kgCO<sub>2</sub> compared to the 280-90 kgCO<sub>2</sub> associated with an abdominal approach, again, largely as a result of single-use equipment.

This Roadmap for the Circular Economy of Medical Textiles was 12 weeks in the making and based on careful analysis, consistent stakeholder engagement, and a clear-sighted appraisal of the resources required to enable us to make this transition in line with our decarbonisation targets. You will find, for example, on page 23, a graphic illustration of the resource and cost savings over 2-3 years from adopting reusable medical textiles. In a sense, this is a transition but it is perhaps more apt to describe this as a revolution. There was a time when we valued the natural world and its gifts and recognised our dependence on them. If, as the writer Malcolm Guite says, quoting the poet Coleridge, "we have moved from the living, sacral view of the cosmos as an interconnected web of human and angelic consciousness to the "modern mechanistic, instrumental view of nature", we can return. This recovery is underway and there isn't a part of our system in which its effects won't be felt. Whether it succeeds or not, will be dependent on you, the reader, and the extent to which you decide this is a revolution worth joining.

# Circular Economy for Medical Textiles Road Map for NHS Wales

Authors (in alphabetical order)

**Emma Burlow, Tom Dawson, Peter Hopkinson (Lead)**

## Key Messages

- There are multiple challenges to reach Net Zero targets and early wins are needed
- Circular economy medical textiles have a strong and readily realisable economic, environmental and social business case

## Introduction

NHS Wales emits more than 1,000,000 tonnes of carbon dioxide equivalent (scope 1) Scope 3 emissions from suppliers to NHS Wales form an even bigger carbon footprint, source of and account for over 80% of 2018/2019 emissions and with procured products and services accounting for 62% ( Figure 1 ). NHS Wales is committed to reduce carbon emissions by 16% against the 2025 interim target. It aims to reduce carbon emissions by 34% to 338,300 tCO<sub>2</sub>e by 2030

## Background

Over February 2022 the health service in Wales has used and disposed of 2.3 million single use medical textile PPE products per week (120 million

items per year). This figure is a small proportion of the overall impact of textile products used in healthcare which we estimate to contribute to more than 7% ( derived from Kellera et al., 2021) of NHS Wales total carbon footprint.

To meet net zero targets will require systemic innovation and a shift in mind set from linear to circular. A Circular Medical Textiles System has been demonstrated and evaluated as the foundation for scaling up a roadmap for NHS Wales to implement circular economy models for medical textiles to displace the current carbon intensive procurement of single-use items by 2030 helping the NHS meet its ambitious Net Zero targets

## Method

This study utilised a lean action research approach with close engagement, feedback and iterative development in partnership with key stakeholders based on five Work Packages below.

### WP1: Stakeholder Engagement – Requirements and Service Integration

We engaged with stakeholders both within Wales NHS, NHS England

### WP2: Technical Implementation – Defining the Roadmap

The roadmap was informed by three other concurrent programmes focused on net zero circular medical textiles delivery and stakeholder engagement.

### WP3 Evaluation: Defining methods, key measurements and performance indicators

The key performance indicators were defined by utilising the outputs from WP1 and delivering a total Net Zero focused Circular Economy for Medical Textiles.

### WP4: Business Case

Developed with specific reference to the economic and environmental value propositions around reusable surgical textiles.

### WP5: Communication and Dissemination

Communicated through stakeholder engagement and through communication leads, social media and presentations.

## Results

Stakeholder engagement included: Clinical Teams; Infection Prevention and Control (IPC); Textile Decontamination; Innovation; Sustainability; and Procurement.

There was universal support for moving back to more sustainable models that utilise reuse combined with new initiatives. Single use “hot spots” that were identified by stakeholders included masks, surgical textiles and disposable patient curtains as well as system losses e.g scrubs.

A total system approach that utilised circular models integrating reprocessing, repair, repurposing and ‘recycling as a last resort’ was supported. Integrating tracking, monitoring and operational dashboards into the system was widely welcomed. The benefits to Wales of being an exemplar model of circular economy with more control of supply chain, quality, finances and environmental impact being brought back into the NHS was endorsed. We modelled sterile surgical gowns and drapes as an indicative impact case study.

With a conservative “non-pandemic” forecast of 645,000 gowns and 645,000 surgical drapes alone across the >300,000 annual interventions Wales a transition to reusable circular models equates to: Carbon or CO2 equivalent savings of 955 tonnes; Water savings of 610 tonnes; Waste savings of 302

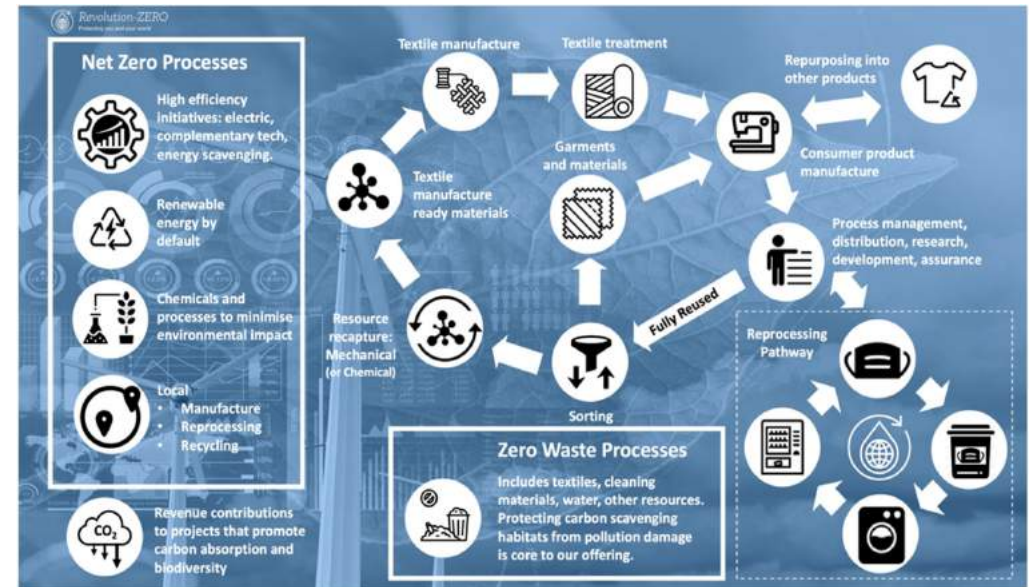
tonnes; Direct cost savings of at least £50,000 annually.

Indirect cost savings of 955 tonnes x £124 (lower end UK government carbon price) + direct cost saving of 302 tonnes x £300 (offensive waste price) = £209,020. Further optimisation of the system will produce higher savings and reductions.

The proposed road map and systems can deliver 65% displacement of single use medical textiles by 2025 and 95% of all medical textiles (regulated and non regulated by 2030). A three phase road map shows the steps, processes, milestones and outcomes to deliver these benefits.

## Discussion

There are clear and widespread advantages of utilising a technical circular economy approach which can also address operational issues such as management of stock items such as scrubs that disappear out of the system. The main barriers to adoption relate to single-use workflows and a lack of comprehensive circular economy logistics infrastructure and capability. There is an opportunity to develop the infrastructure, capability and technologies to enable supply chain resilience and greater control over the environmental and monetary costs of delivering services.



## Conclusion

This road map work has outlined a clear path for NHS Wales and the Welsh Government to adopt and implement a national circular economy medical textiles programme which will aid meeting Net Zero targets. We recommend that it is extended by continuing to work with NHS Wales and other Welsh stakeholders to enable an end-to-end Net Zero solution that will include products, efficient reprocessing, returns, habitat regeneration and materials repurposing and/or recycling (see circular diagram above).

The proposed system will: displace single use medical textiles with more economic and sustainable net zero alternatives; stimulate the economy and job creation; build resilience and autonomy; and allow increased control over service quality, costs and environmental impacts.

***As an integrated health economy with a net zero focus, NHS Wales has a unique position and opportunity to be a global exemplar in circular economy medical textile systems***



# Circular Economy for Medical Textiles Road Map for NHS Wales

**Authors** (in alphabetical order): **Emma Burlow, Tom Dawson, Peter Hopkinson (Lead)**

## Summary

Revolution-ZERO is committed to the displacement of single use medical textiles by more effective, economic, zero carbon, zero waste targeted reusable circular alternatives. Within the healthcare sector single-use items are one of the significant contributors to emissions.

To address healthcare carbon output single-use items and their associated emissions must be addressed.

The focus for this work was the preparation of a realistic and actionable road map with the objective of Wales to be a global circular economy medical textiles leader with a Net Zero focus.

The work involved engagement with stakeholders across NHS Wales including clinical teams, reprocessing services, sustainability specialists and procurement.

This road map work has outlined a clear path for NHS Wales and the Welsh Government to adopt and implement a national circular economy medical textiles programme which will aid meeting Net Zero targets. We recommend that it is extended by continuing work with NHS Wales and other Welsh stakeholders to enable an end-to-end Net Zero solution that will include products, efficient reprocessing, returns, habitat regeneration and materials repurposing and/or recycling (see diagram).

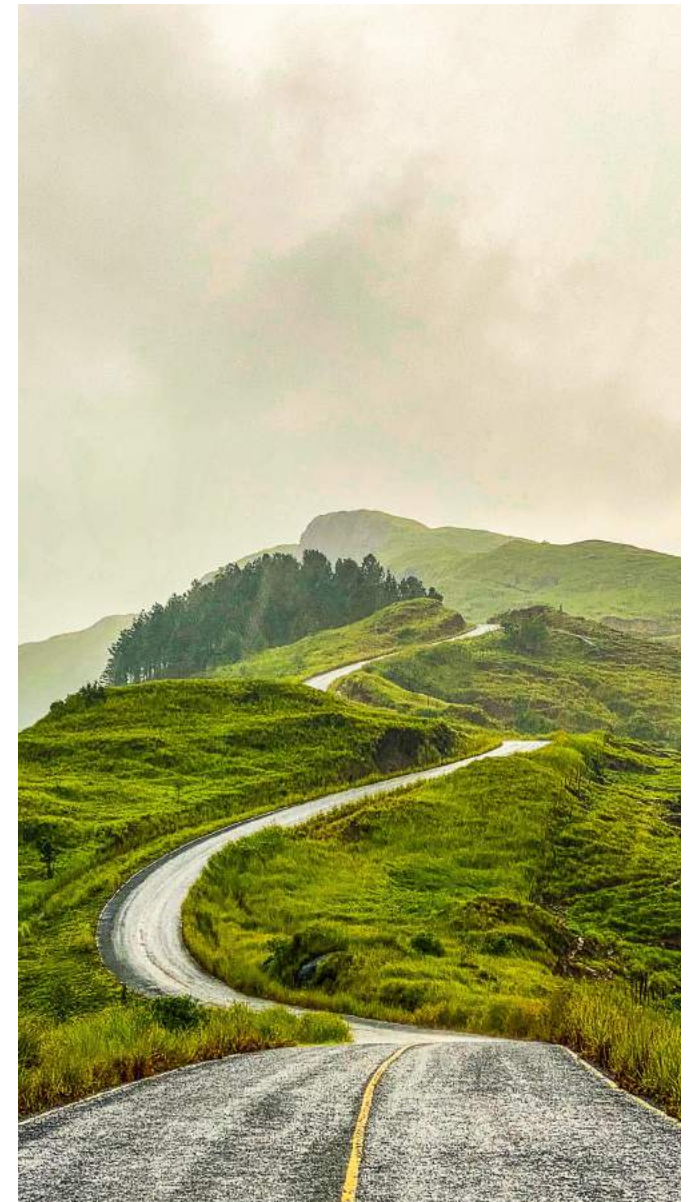
The proposed system will: displace single use medical textiles with more economic and sustainable net zero alternatives; stimulate the economy and job creation; build resilience and autonomy; and allow increased control over service quality, costs and environmental impacts.

## Background

The Welsh health care system comprises the National Health Service, GP services and a private and independent sector offering private care and treatment as well as commissioned services to support NHS Wales. NHS Wales has an annual budget of £7.3bn<sup>1</sup> and employs 78,000 staff and services a population of 3 Million.

In 2021 NHS Wales set its ambitious targets for cutting its greenhouse gas emissions, by 42% reduction by 2032. NHS Wales also recognises that taking preventative action now on emissions and climate will lower and limit damage to the Welsh people in the long term.

***In 2021 NHS Wales set its ambitious targets for cutting its greenhouse gas emissions, by 42% reduction by 2032.***



<sup>1</sup> Available at <https://gov.wales/nhs-expenditure-programme-budgets-april-2019-march-2020>



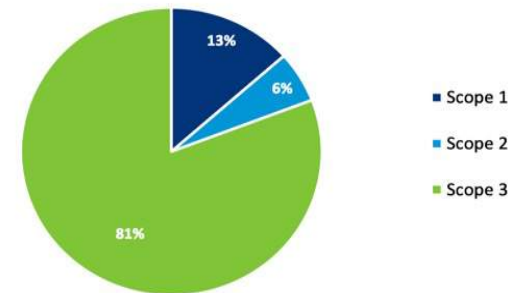
## The Burning Platform

The NHS Wales Decarbonisation Delivery Plan (2021-2030)<sup>2</sup> forms a key contribution to the Welsh Government's commitment for all public services to be net zero by 2030<sup>3</sup>. The scale of this challenge is huge. NHS Wales emits more than 1,000,000 tonnes of carbon dioxide equivalent, just from running its building and transport fleets, approximately 2.6% of Wales total emissions. Scope 3 emissions from suppliers to NHS Wales form an even bigger carbon footprint, source of and account for over 80% of 2018/2019 emissions and with procured products and services accounting for 62% ( Figure 1 ). NHS Wales is committed to reduce carbon emissions by 16% against the 2025 interim target. It aims to reduce carbon emissions by 34% to 338,300 tCO<sub>2</sub>eq by 2030.

Medical supplies is not just a carbon issue. Over the past month the health service in Wales has used and disposed of 2.3 million single use medical textile PPE products per week (120 million items per year). The weight in surgical masks and aprons alone equates to 168,000 kg and 676,000 kg respectively, or 70 double decker buses in weight combined per year. This is just representative of one small subset of the single-use medical textiles waste being generated.

Based on the recent Life Cycle Analysis of 33 Swiss Hospitals<sup>4</sup> we estimate the carbon cost of medical textiles equates to more than 3% of emissions with an additional 2% coming from laundry services and a large proportion of the 4.5% (non-water) carbon impact from waste coming from disposal of contaminated single use textiles. In total the likely overall 2022 impact carbon impact from medical textiles including PPE, surgical textiles, linen, uniforms, bandages and incontinence products is in excess of 7% of a healthcare organisation's carbon footprint.

NHS Wales Carbon Footprint by Scope 2018/19



NHS Wales Carbon Footprint by Category 2018/19

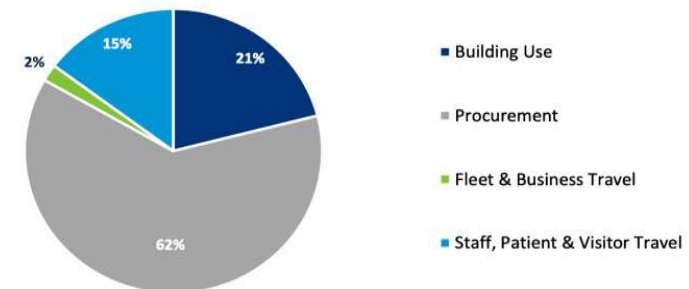


Figure 1: NHS Wales Carbon Footprint by scope and category 2018/19 (source: Carbon Trust 2021) )

<sup>2</sup> Available at: <https://gov.wales/sites/default/files/publications/2021-03/nhs-wales-decarbonisation-strategic-delivery-plan.pdf>

<sup>3</sup> Available at: <https://www.theccc.org.uk/publication/the-path-to-net-zero-and-progress-reducing-emissions-in-wales/>

<sup>4</sup> Available at: <https://www.sciencedirect.com/science/article/pii/S0959652621026901>

To deliver net zero will require annual rates of reduction in supplier carbon reduction performance beyond historic trends and recent upward trends due to Covid 19 (Figure 2). Within this, medical textiles form a significant component of medical equipment and supplies, identified as one of the highest carbon footprint categories (Figure 3)

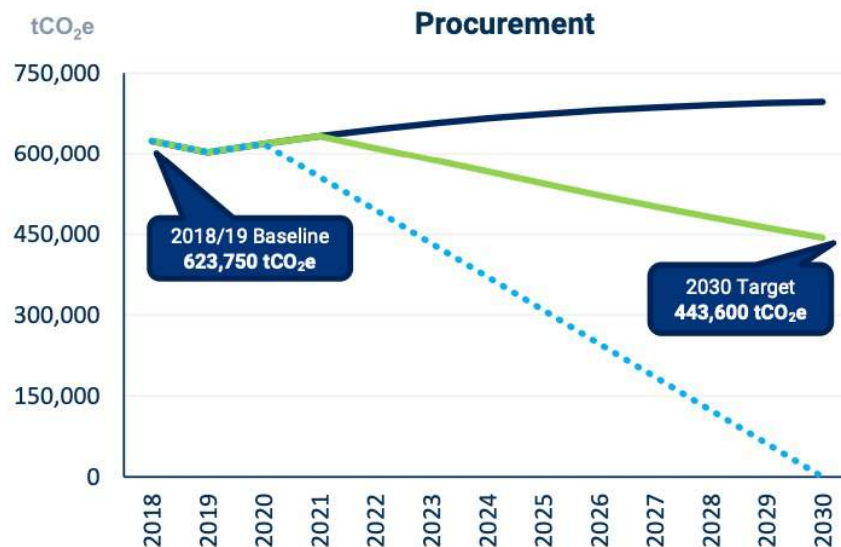


Figure 2: NHS Wales Target Carbon Reduction from Procurement Activity (Source Carbon Trust 2021)

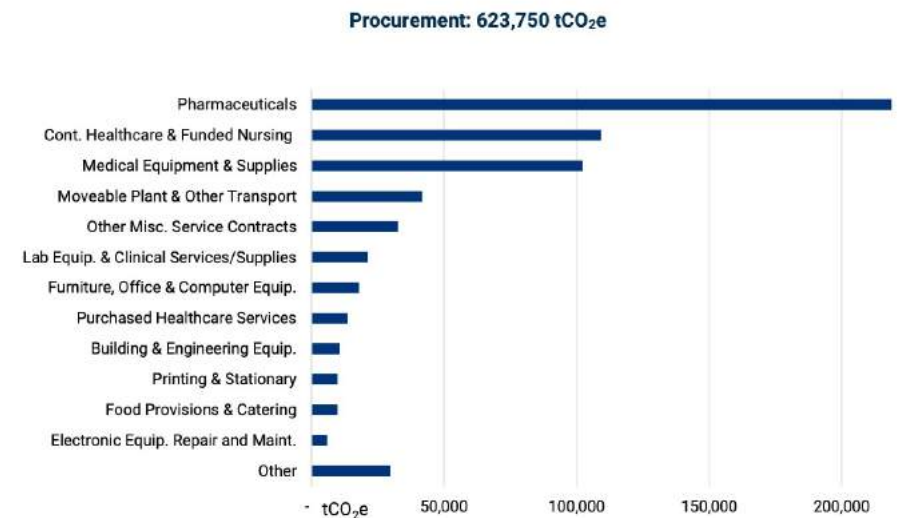


Figure 3: NHS Wales Carbon Target Reduction by Procurement Category (Carbon Trust 2021)

# From linear to circular

Currently, NHS Wales like many other health organisations operates a predominantly take-make-dispose 'linear' system generating high volumes of waste including single use products. To meet net zero targets will require systemic innovation and a shift in mind set from linear to circular.

The majority of medical textiles are single use and reflect a linear economic model where we use and dispose of products and their materials after a single use cycle, and then replace them with new items. This is a waste of product and resources, creates unnecessary cost, and leads to avoidable embodied carbon, environmental and social impacts. NHS Wales and the Welsh Government now has the opportunity to shift away from single use medical textiles to re-use models, adopting the principle of circular economy.

In a circular economy by contrast products are designed to be circulated and recirculated to maintain products, components and materials as long as possible at the highest level of functionality and in-service through repair, remanufacture or refurbishment. The aim of this is to maximize the value of the embedded material, labour, capital cost and retain the embedded upstream emissions-footprint, the right hand side of the CE systems diagram from the Ellen MacArthur Foundation in Figure 4 below .

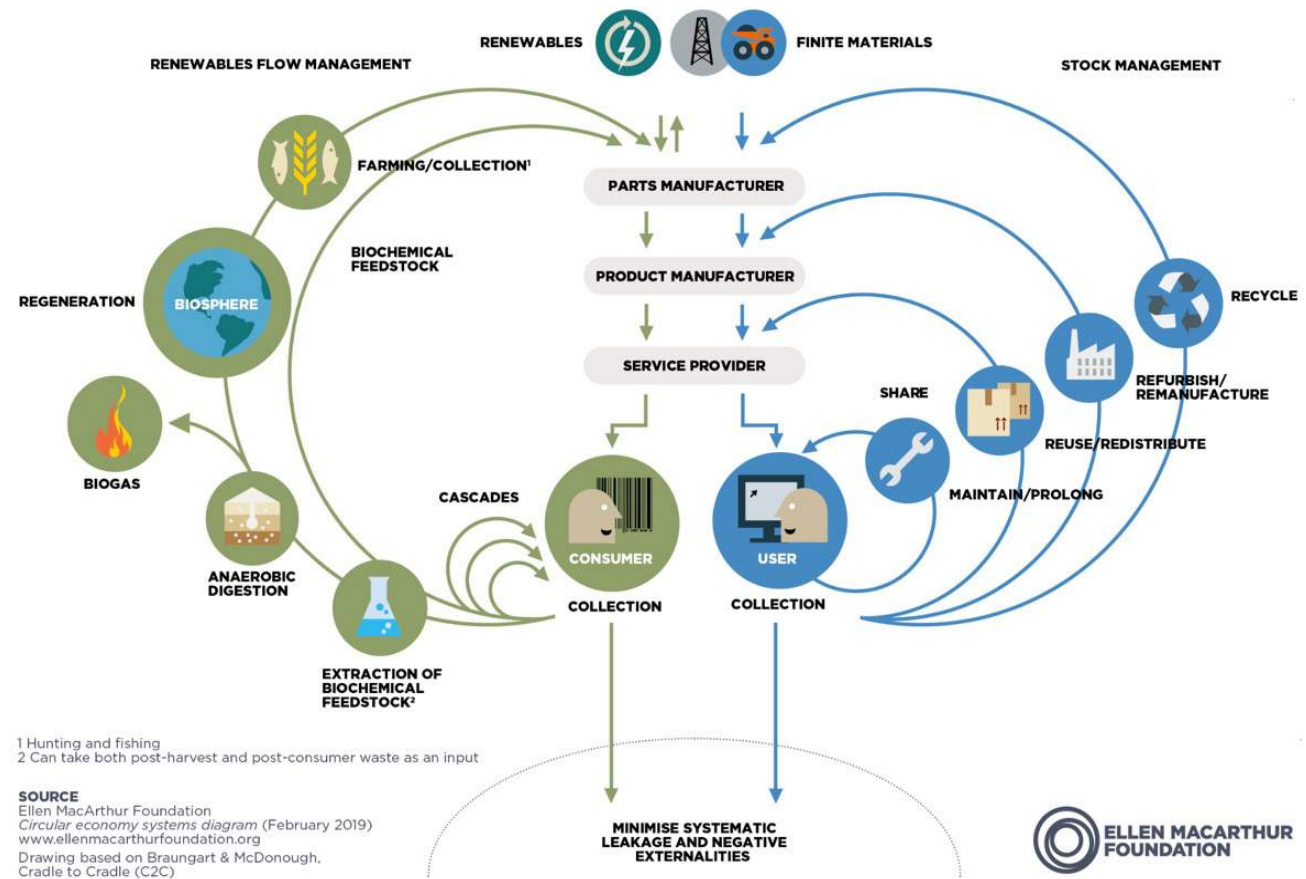


Figure 4: Circular Economy System Diagram (Ellen MacArthur Foundation, 2013)



Many companies and organisations are already benefitting from Circular Economy approaches. They typically succeed by harnessing four core building blocks:

## 1. Design

Work with suppliers that design products and services to promote maintenance, product life extension and eliminate toxic materials that prevent re-use or recirculation.

## 2. Business Models

Work towards business models that focus on the total cost of ownership and innovating product-service offers that incentivize re-use and options to significantly extend product life.

## 3. Reverse Logistics

Design in at the outset an end-of-life reverse loop back to the manufacturer to ensure valuable products, components and materials can be recirculated profitably.

## 4. System enablers

Think in systems and identify enablers that drive systemic innovation including procurement, new forms of collaboration, health service design, digital and software tools, financial and accounting tools. In the longer-term legislation and policy, such as Extended Producer Responsibility (EPR), will influence cost profiles and impact product design, material selection.

# Aims and Objectives

Whereas the benefits of circular economy models to improve efficiencies, local resilience and resource utilisation is well established this work has not been universally applied to the healthcare textiles sector which has transitioned to linear, waste producing single-use models over the last two to three decades.

Therefore, the primary aim for this study was:

To propose a roadmap for NHS Wales to implement circular economy models for medical textiles to displace the current carbon intensive procurement of single-use items by 2030 helping the NHS meet its ambitious Net Zero targets

To realise this, we had the following objectives to:

- 1. Establish through interaction whether the concept of utilising a circular economy approach to medical textiles would be well received by NHS Wales stakeholders**
- 2. Develop a global exemplar roadmap for Wales based on best practice and the domain experience and knowledge of the authors in this space.**
- 3. Develop the evaluation criteria and Key Performance Indicators (KPIs) to benchmark and evaluate success**
- 4. Develop the commercial and environmental business case for the use and rollout of circular economy medical textile models across Wales including identification of the key barriers and opportunities**
- 5. Identify and describe other opportunities outside of the NHS Wales ecosystem related to the development required for national implementation of circular economy models for medical textiles**

## Added Value

As the NHS Wales and Wales as a nation moves towards a more Net Zero economy it is critical to appraise all options for progress utilising structured methodologies which this study has. In the transition from a linear to circular model for Medical Textiles there is a wealth of opportunity related to innovation, new industrial processes, technology development, job creation and generation of research and development opportunities. There is additional value with tracking, stock management, transparent and accountable systems, enhanced resilience, improved quality control and other environmental benefits including enhanced waste and water management.

## Wider Implications

The potential benefits from rolling out circular medical textiles within healthcare environments can be amplified by application of the knowledge, processes and capabilities that need to be implemented for success. There is an urgent need for improved resource management and displacement of single-use items across all of healthcare and into social care environments.

Adopting a Circular Economy mindset will accelerate wider transformational change – not only for net zero but also enhanced health outcomes, reduced costs, improved efficiency and managing workforce challenges

All of these progressions have wider implications for Wales leading to a need for increased reprocessing, repurposing and recycling capability, job creation and opportunities for stimulation of industry in Wales to meet product, logistics, service and technology requirements moving forwards.

# Method

This study utilised a lean action research approach with close engagement, feedback and iterative development in partnership with key stakeholders.

To complete the work, we utilised the following work package structure:

## WP1: Stakeholder Engagement – Requirements and Service Integration

We engaged with stakeholders both within Wales NHS, NHS England and utilising the international experience of our team and wider networks with a focus on the transition from the take - make - waste (and sometimes recycle) towards circular economy approaches with specific reference to textiles used in healthcare settings in Wales.

## WP2: Technical Implementation – Defining the Roadmap

Building on our previous work in the technical implementation of circular economy approaches for medical textiles and wider healthcare work we built up a proposal for a roadmap to Net Zero utilising circular economy methods in concert with the stakeholder engagement work in WP1. This roadmap was informed

by our three other concurrent programmes focused on net zero circular medical textiles delivery.

## WP3 Evaluation: Defining methods, key measurements and performance indicators

We focused on defining the different components required for delivering a total Net Zero focused Circular Economy for Medical Textiles. The key performance indicators were defined by utilising the outputs from engagement with NHS Wales stakeholders along with our previous work and knowledge of what works for Circular Economy Systems .

## WP4: Business Case

Developed with specific reference to the economic and environmental value propositions around reusable surgical textiles which can be extended across all medical textiles.

## WP5: Communication and Dissemination

As well as interaction with stakeholders we communicated this work through communication leads, social media and presentations.



# Results

## 1. Stakeholder engagement

We engaged with stakeholders in the following representative groups:

Clinical Teams; Infection Prevention and Control (IPC); Textile Decontamination; Innovation; Sustainability; and Procurement.

- There was universal support for adopting sustainable models that utilise reuse combined with new initiatives. Stakeholders were concerned about the shift to single-use dependency over the last few years and this is backed up from the findings of our online surveys attached to this report. Where there are more net zero options available that were just as effective and economically feasible there was widespread agreement these needed to be adopted.
- Single use “hot spots” that were identified by stakeholders included masks, surgical textiles and disposable patient curtains. There was also concern over loss in the system of items such as surgical scrubs. Any method where items could be easily and efficiently tracked was welcomed. Some stakeholders mentioned previous technology implementation utilising RFID scanning had not gone so well due to lack of full technical support and engagement with staff.

- o Our proposed total system approach (see below) that utilised circular models integrating reprocessing, repair, repurposing and ‘recycling as a last resort’ was endorsed. Integrating tracking, monitoring and operational dashboards into the system was widely welcomed. The benefits to Wales of being an exemplar model of circular economy with more control of supply chain, quality, finances and environmental impact being brought back into the NHS was given a lot of support. Stakeholders also appreciated the focus on stimulating local economies, job creation along with initiatives that would address socioeconomic inequalities and promote connected communities.

There was also a general education component of the stakeholder interaction relating to the issues relating to materials such as:

- **Cotton:** negative environmental and social impact relating to production, supply and end of life (a) considerable processing to be useful for medical garments and (b) more water and hence energy to process than polyester counterparts (c) Prone to producing particulates and (d) highest relative of microfibre (processed) in sharks off the UK<sup>5</sup>.
- **Polypropylene:** requires energy intensive processes for both recycling and remanufacture. Much more likely to produce particulates than monofibre materials such as polyesters.

- **Mixed fibres such as polycotton:** challenging to efficiently recycle. Like cotton requires more energy to process due to water retention and need to utilise energy to evaporate the water.

As such, it is critical that all material components of a reusable textiles system are interrogated for their full life impact from production to use, reuse, repair, repurposing and recycling. There can be dramatic environmental and monetary cost differences over a lifetime between relatively commonplace materials including cottons, polycottons and polyester fabrics. In adopting a circular approach it is important that these costs are well understood.

## 2. Technical Implementation.

### Proposed Circular System

The circular system is designed around a series of net zero processes and considerations (Figure 5) as below. This system was developed for PPE in response to the issues with supply chain resilience, variable quality, monetary and environmental impact the coronavirus pandemic had highlighted. A locally based and integrated circular economy model allows for increased autonomy, consistency and quality of service. It is equally transferable across all medical textiles and also into sectors and export markets either in separate components or as a whole system. There are multiple areas that are ripe for collaborative innovation and development work.

The key principles of the system which integrate end-user requirements, needs and workflows as core are:

- 1. Design, manufacturing and re-manufacturing:** design and manufacture for reuse and repurposing from Day 1. Manufacture with a focus on zero waste and zero carbon processes utilising efficient manufacturing chains, great working conditions and renewable energy.
- 2. Reprocessing:** Taking traditional laundry facilities to another level with net zero and zero waste focused processes and chemicals driving down energy costs and environmental burden. Utilising state-of-the-art equipment and technologies for the full system control including tracking, monitoring, logistics and operations. Allows for different

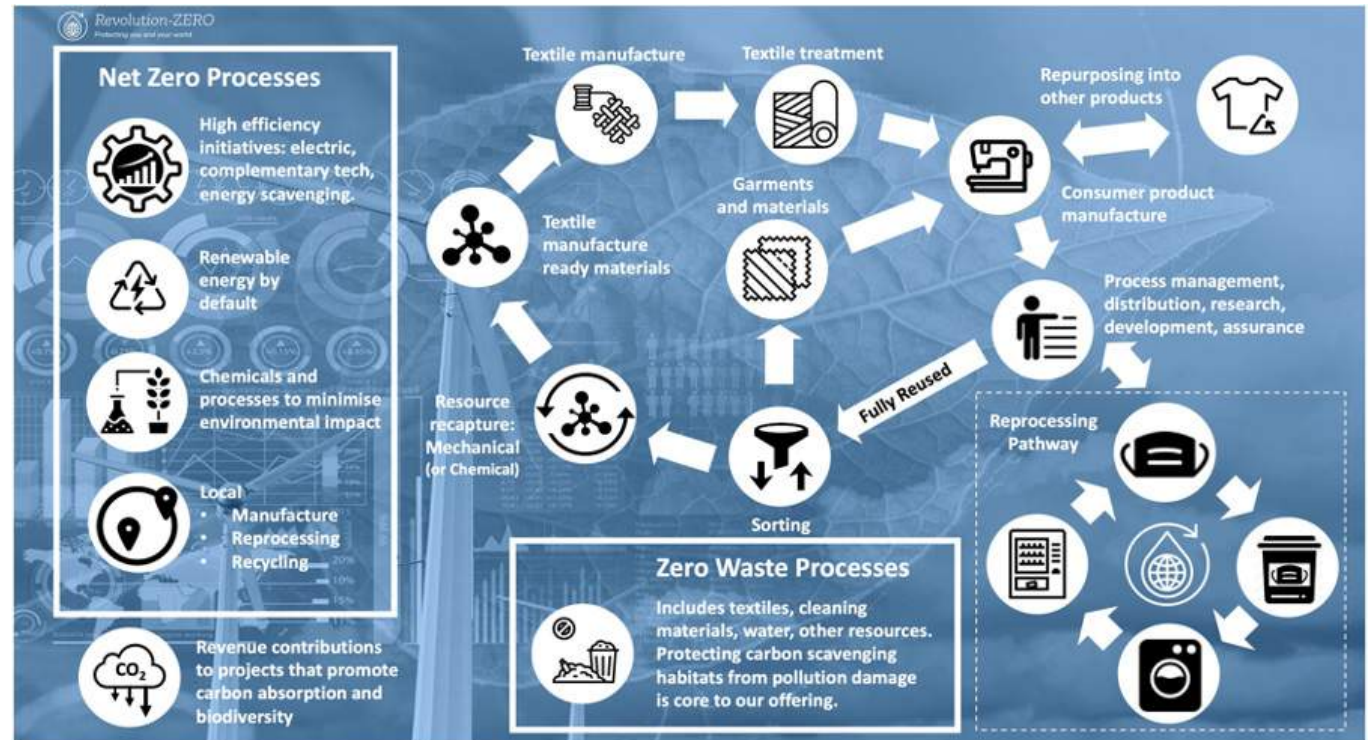


Figure 5: The Revolution-ZERO Circular System

stakeholders to visualise outputs, performance and compliance.

- 3. Repair and repurposing:** Extending the functional life of medical textiles first within healthcare environments and latterly utilising in community resources and people for in- community benefits. For example masks can be quilted within the community to create thermal drapes that can benefit those who suffer from fuel poverty whilst saving home power bills.
- 4. Recycling:** Close horizon implementation of pol-

yester mechanical fibre to fibre recycling plants that have up to 10 times improved efficiency over chemical processes and can create polymer outputs that can be readily utilised in Wales or exported to create yarn and fabrics to complete the cycle. Potential to run recycling plants completely off grid utilising renewable energy sources such as wind and solar.

## Detailed features of the system include:

### Robust research and development processes, reporting and evidencing

- An extensive research, development and assurance process to test, evidence and validate net zero business case
- Live testing, evaluation and validation of performance in surgical and clinical setting

### Manufacture and Design

- Monofibres (polyester) material selection to enable ease of final recycling and repurposing into socially valuable products (curtains, blankets)
- Net zero manufacturing processes (100% renewable energy)
- Product design for durability to support multiple reuse cycles
- User comfort and wearability based on extensive testing and user feedback
- Meeting all safety requirements for medical device regulation and certification

### Re-use pathway

- Modular, expandable and mobile deployment



Figure 6: Revolution-ZERO: Concept ZERO-DECON.net Decontamination facility

of centrally network controlled Net Zero medical textiles reprocessing facilities (Figure 6)

- Co-designed with end-users integrating work-flows, logistics and staff interaction from dispatch to storage to use to returns.
- A re-use pathway designed to minimise use of chemicals, energy and potential longer term to operate on relatively closed loop water cycles.
- Revenues from the system re-invested into local/regional projects to regenerate restore and regenerate biodiversity and carbon sequestering.

### Reverse Logistics

- Local control and oversight, reducing supply chain risks and enabling local manufacturing, repurposing and recycling promoting local economic multipliers
- Business model and material choice designed to support repurposing and mechanical (or potentially chemical) recycling to reduce end of life waste, loss of embodied carbon and maximising social value



## System enablers

- A system based on transparency and open accounting aligning and incentivising stakeholder interests in support of collaboration
- Digital technology (RFID, scanners, Internet of Things) embedded for real time data management for cost and inventory control, operations, governance, assurance, forecasting/planning, supply chain management, environmental impacts and logistics
- New integrated procurement and commissioning frameworks that provide dynamic frameworks to ensure the best value, most effective and innovative solutions are adopted by NHS Wales
- Mechanisms for collaborative partnerships that allow the NHS to work closely with teams and individuals that have specialist capabilities for the benefit of services and society

## Future Opportunities for growing capabilities within Wales includes:

- Manufacture of emerging reusable medical textile technologies including clear front and high protection (P3) masks
- Manufacture of products relating to logistics including inserts, dispensers, returns containers and decontamination accessories
- Development of the medical textiles decontamination and processing industry
- Development and manufacture of automated (ro-

botic) textiles processing equipment

- Development of technology relating to the tracking and monitoring of medical textiles, operations, economics and environmental aspects
- Development of an industry around repurposing of medical textiles and their components
- Development of fibre-to-fibre recycling capability
- Remanufacture of other products from recycling outputs
- Export and transition into other sectors of all of the above developments

## Regulated Medical Textiles

Most of the textiles this report refers to are regulated medical textiles which are registered as Medical Devices. The findings and need for circular approaches can equally be applied to non-regulated textiles such as patient curtains where there has been a trend towards utilising disposable options. In specific reference to regulated textiles there is a need for central governance and assurance functions which have both a collaborative and gatekeeper role.

# The ROAD MAP

The proposed road map (Table 1) sets out a sequence of phased activities over three time period to deliver agreed targets, milestones and outcomes.

## Phase 1 (2022): Gather evidence, implement, evaluate and build the business case

The current demonstration phase will continue through 2022 to implement solutions, gather evidence, evaluate and build the integrated business case on how to optimise carbon, resource and cost savings. This will produce first in kind solutions for re-usable medical textiles. Key activities in this phase include alignment of the Roadmap to NWSSP decarbonisation procurement codes of practice and criteria, creation of a reference committee of sustainability minded infection prevention and control experts for co-creation and governance/assurance functions, formation of a communication and engagement strategy including training and awareness raising, a governance structure including all key stakeholders<sup>6</sup> and a series of workshop and roundtable to add further insight and integration to the Road Map prior to approval.

The outcomes from these activities include a fully evidenced business case and funding mandated into NWSSP procurement and supply chain contracting, an approved of the Road Map to guide long term imple-

mentation and scale up, including milestones and targets, and a highly engaged and committed stakeholder community and decision-makers.

## Phase 2 (2023-2035): Adapt, share and scale up.

The period 2023-2025 will move to scale up implementation and installation of full end to end systems to deliver against a target 60% of medical textiles by 2025. This phase will be underpinned by a fully transparent and documented business case quantified against agreed KPIs (see next section). An expanded service to include non-regulated and non-medical textiles will be tested and evaluated. The communication, awareness and engagement strategy established in Phase 1 will be rolled out to build commitment and generate further opportunity for innovation.

This phase will deliver significant carbon, waste and cost savings for NHS Wales and be a first of its kind globally leading to reputational and export revenue benefits. A continuous monitoring and evaluation programme will deliver and validate the business case, and fully evidence impact outcomes against agreed targets. These findings will used to continuously adapt the CE system to optimise social, environmental and economic benefits.

## Phase 3 (2026-2030) Amplify, export and refine.

Phase 3 covers the period 2026-2030 in line with NHS Wales and Welsh Government Net Zero commitments and targets (by for 2030 to cover 95% of medical and non-medical textiles). Phase 1 and 2 will have scaled and Phase 3 will involve further amplification in volume and system efficiencies with the opportunity to scale up export of the solutions globally. A number of technology innovations and future opportunities (see above) under current review such as fibre to fibre recycling will be market-proven by 2026 and offer additional opportunity for increasing the value of end-of-life materials. The Road Map will track and map other technical and social innovations and market developments to maximise overall system effectiveness and ROI.

By 2030 circular medical textiles will be the new Business As Usual (BAU) resulting in all NHS Wales and Welsh Government net zero and other impact targets achieved.

<sup>6</sup> These include amongst others; Welsh Government: Public Sector Decarbonisation, Net Zero Delivery, Economic Development; NHS Wales: Shared Services Partnership (procurement, Estates, Environment), Capital Estates and Facilities; Carbon Trust; NHS Wales Trusts; Representative NHS staff across all functions; Lead Social innovation Bodies

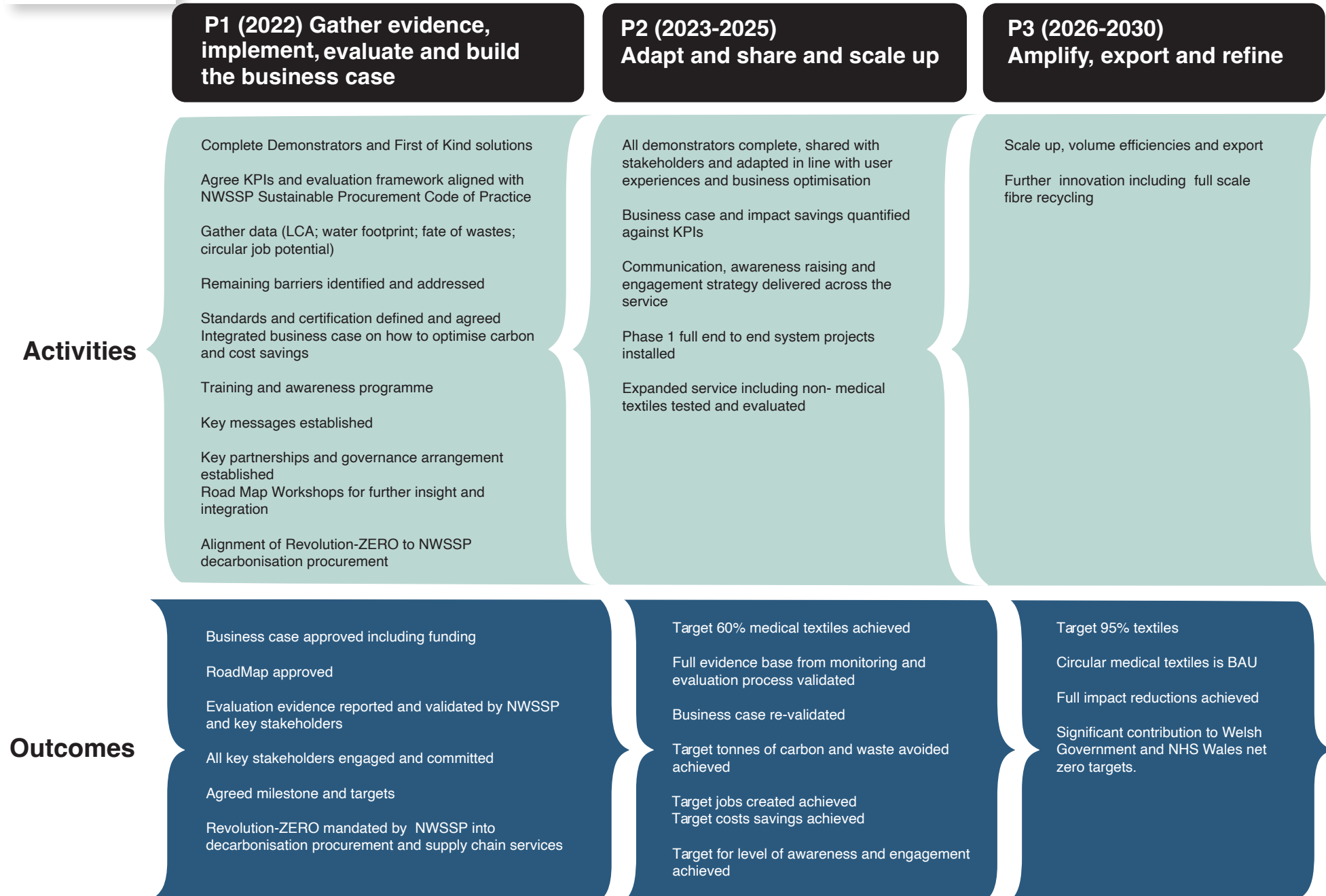


Table 1: Road Map for Circular Medical textiles 2022-2030



### 3. The evaluation criteria and Key Performance Indicators (KPIs) to benchmark and evaluate success

Related to our stakeholder engagement in work Package 1 we asked various stakeholders what KPIs might be useful.

These broke down into five main categories with sub-categories ranked from high to low:

**Environmental:** Carbon - Waste - Water

**Economy:** Employment - Welsh Industry – Export

**Commercial:** Cost Effective – Savings – Investment – CAPEX – OPEX - RoI

**Functional/Operational:** Applicability (consider diversity) – Workstream integration

**Risk Management:** Negative consequences – hazard logs - mitigation plans – testing and assurances

### 4. Develop the commercial and environmental business case for the use and rollout of reusable medical textiles across Wales

- Enablers – stakeholders desire for meeting KPIs above; Net Zero agenda; expert community; strong manufacturing, clinical, sustainability and technical community within Wales. Changing procurement, commissioning and partnership models between the NHS and specialist system supply organisations. Development of dynamic procurement and commissioning systems to accelerate the progressive change that is needed. The creation of sustainability minded governance structures such as a Infection, Prevention and Control reference group that can function in a collaborative and gatekeeper role.
- Barriers – lack of current infrastructure and labour base to support widespread adoption of reusables including process management and distribution. Segregated system and sub-communities that need to be fully joined up to realise optimum outcomes. Loss of items during use-reuse cycles (common for the textiles industry). Staff education on reusables. Need to develop technologies such as robotics and information technology to optimise operations, monitoring and accountability.

## The commercial and environmental business case (continued)

Table 2: Comparative carbon, water, waste and cost saving per product versus a 1000 single items as below based on reference life cycle analysis studies (source column)

Product	*CO2 saving /1000 items	*Water saving /1000 items	*Waste saving/1000 items	Source
Drape	402 kg	35 kg	246.9 kg	Vozzola et al., 2018
Mask	23.7 kg	-65.7 kg	3.1 kg	UCL Plastic Waste Innovation Hub, 2021
Gown	1079 kg	912 kg*	221.6 kg	Vozzola et al., 2020

\*all figures need testing/confirmation as relate to multiple and adaptable factors such as blue water recovery from theatres and balance of environmental savings/financial costs.

**With a conservative “non-pandemic” forecast of 645,000 gowns and 645,000 surgical drapes alone across the >300,000 annual interventions Wales the above figures equate to:**

- Carbon or CO2 equivalent savings of 955 tonnes
- Water savings of 610 tonnes
- Waste savings of 302 tonnes

- Direct cost savings of at least £150,000<sup>3</sup> annually
- Indirect cost savings of 955 tonnes x £124-373/tonne<sup>1</sup> (UK government carbon price) + 302 tonnes x £300<sup>2</sup> (offensive waste price) = >£209,020/year

The above environmental savings figures are for non-optimised decontamination and sterilisation programmes.

1. <https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation#annex-1-carbon-values-in-2020-prices-per-tonne-of-co2>

2. Depending on how the waste is defined the figure could be higher. Average figure for offensive taken from: Royal College of Nursing (2018) Freedom of Information Follow up Report on Management of Waste in the NHS Available at: <https://www.rcn.org.uk/-/media/royal-college-of-nursing/documents/publications/2018/february/pdf-006683.pdf?la=en>

3. Derived from work contained within the ZERO.DECON.net report based on 10 modules across Wales saving £18,950 each for £189,500 savings to the nation

The above figures are for non-optimised decontamination and sterilisation programmes. Figures 7 and 8 demonstrate the impact of near term and 2-3 year optimisation plans utilising Revolution-ZERO methods and technologies.

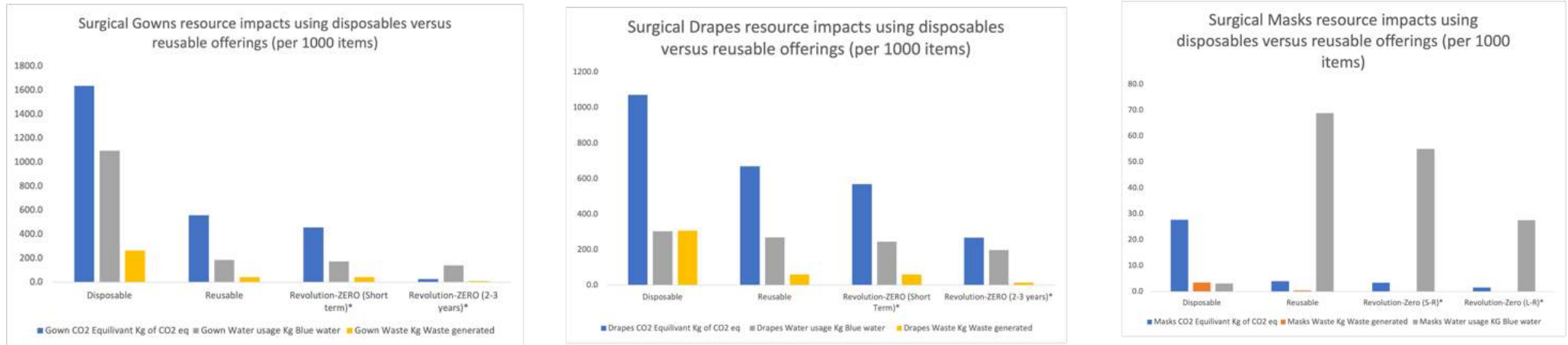


Figure 7: The resource impacts with transition from disposables to more efficient reusable systems

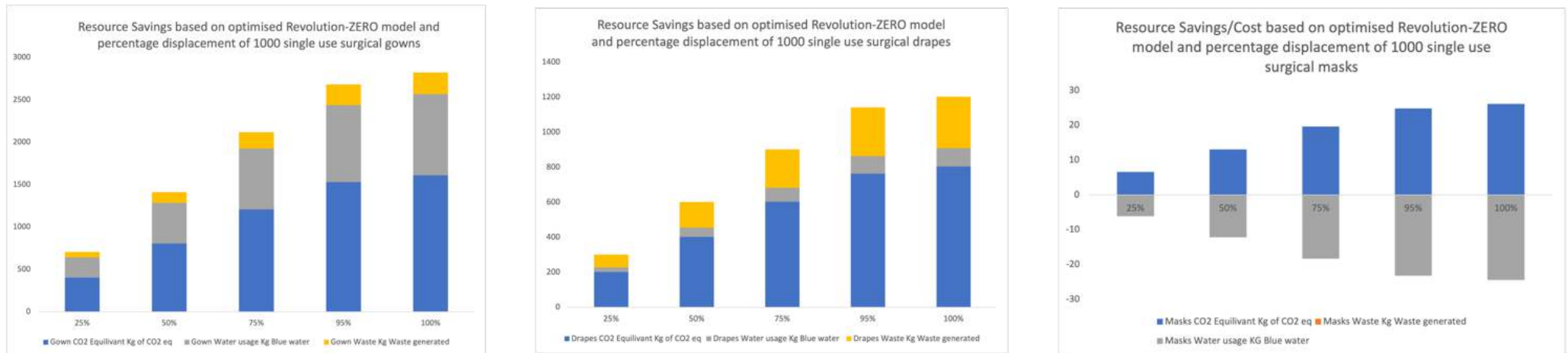


Figure 8: The resource savings from displacing single-use textile with highly efficient reusable systems

If we apply the 100% transfer for the forecasted fully optimised Revolution-ZERO system with the conservative “non-pandemic” forecast of 645,000 gowns and 645,000 surgical drapes alone across the >300,000 annual interventions across Wales then the savings from would equate to:

- **Carbon or CO2 equivalent savings of 1,556 tonnes (>90%)**
- **Water savings of 685 tonnes**
- **Waste savings of 353 tonnes**
- **Cost savings of >£150,000 per year (reference ZERO-DECON.net report)**
- **30 direct jobs created for decontamination alone with multiple others for the full circular system**
- **Variable cost/environmental savings depending on relative weight of financial versus environmental gains**

## 5. Identify and describe other opportunities outside of the NHS Wales ecosystem related to reusable surgical textiles

There is a clear appetite for switching to sustainable textiles across healthcare that also extends beyond surgical textiles into curtains and better management of garments such as scrubs which are more typically mixed fibre which has issues around both decontamination and end-of-life recycling.

Outside NHS Wales and within the social care and private medical verticals there is also a strong desire and need for reusables. They face the same barriers. Made in Wales solutions could be readily exported to other regions within the UK and also further afield to maximise the impact of this work.



## 5. Discussion

The primary aim of this project was to define a roadmap for NHS Wales to implement circular economy models for medical textiles to displace the current carbon intensive procurement of single-use items by 2030

We have demonstrated that there is a widespread stakeholder appetite for solutions which can be readily integrated into existing workflows. There are clear and widespread advantages of utilising a technical circular economy approach which can also address current operational issues such as management of stock items including uniforms such as scrubs that disappear out of the system.

Reusable surgical textiles such as gowns and drapes have a strong financial case which combined with the environmental benefits makes them strong candidates to transition through to business as usual as quickly as is feasible.

For items such as reusable masks which currently cost more financially<sup>7</sup> than single-use items the environmental benefits may be considered to outweigh the cost required to make the change.

For all items the main barriers to adoption relate to a lack decontamination and logistics infrastructure and capability. There is an opportunity to develop this infrastructure and capability to enable supply chain resilience and greater control over environmental and monetary costs of delivering services. Suggested

developments for the specialist decontamination and sterilisation capabilities are considered in a parallel report.

There are further opportunities to develop design, manufacturing and mechanical recycling capabilities within Wales which would again enhance scalability and resilience whilst stimulating Welsh industry and employment. Once developed there are cross health vertical and region export opportunities for the solutions.

All of the above requires investment into infrastructure, process and human resource. The potential return on investment for Wales and the Welsh economy is considerable.

## Conclusion

**To address the barriers associated with implementation requires investment into infrastructure and people. The benefits from investment include increased resilience of the NHS, decreased environmental impact, short to medium term cost savings and stimulation of the Welsh economy and job market.**

<sup>7</sup> If mask costs return to pre-pandemic level then it will be cost neutral or saving to transition to reusable masks.

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