Up2Circ – Boosting the Uptake of Circular Business Model, Product and Process Innovation

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Sectorial catalogue
Health

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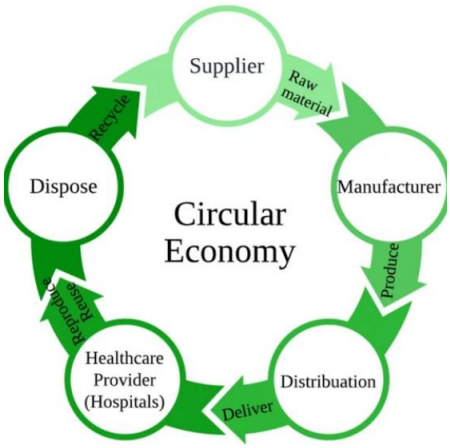
Short introduction to the industrial ecosystem / content focus

Healthcare is one of the fastest growing global industries in recent years. The global population is increasing and is set do so, with an estimate of 8.6 billion by 2030 and 9.8 billion by 2050. With populations aging, and life expectancy increasing, chronic disease spending continues to grow, as well as the cost of having multiple morbid conditions (MMCs).
(source: "Healthcare Waste and Sustainability: Implications for a Circular Economy", Abrar Mahjoob, Yousef Alfadhli,Vincent Omachonu Department of Industrial and Systems Engineering, University of Miami https://www.mdpi.com/2071-1050/15/10/7788)

The potential for transformation is huge. In Europe alone, the healthcare sector employs more than 21 million people and accounts for 10% of GDP. Right now health systems are under increasing strain, as populations age and the impacts of climate change and pandemics grow. In this context, there are the possibilities to deliver the highest quality of care in a way that's sustainable environmentally and financially. The health sector is responsible for 4.6 percent of global greenhouse gas emissions. Environmental pollutants (micro and macro plastic) create a considerable public health burden. The vast majority of health care global greenhouse gas emissions originate in the supply chain, making this the area of highest impact for health care decarbonization. During the past thirty years the health care industry has become increasingly reliant on single-use disposable medical devices, particularly in high-income nations. Medical devices include all equipment used in the provision of medical care that does not primarily function through biological or chemical means. The health care supply chain can be grossly dichotomized into medical devices and pharmaceuticals. Single-use disposables are emblematic of a linear (or "take-make-waste") economy in which products are manufactured, used once, and disposed. A more sustainable framework that has gained traction with industry and policy makers is a circular economy, in which products are maintained in use at the highest-value application for as long as possible without terminating in disposal.
(source: "Transforming The Medical Device Industry: Road Map To A Circular Economy" Andrea J. MacNeill, Harriet Hopf, Aman Khanuja, and others https://www.healthaffairs.org/doi/10.1377/hlthaff.2020.01118

The Circular Economy (CE) in Health can be illustrated in the figure below.



(source: Healthcare Waste and Sustainability: Implications for a Circular Economy https://www.mdpi.com/2071-1050/15/10/7788

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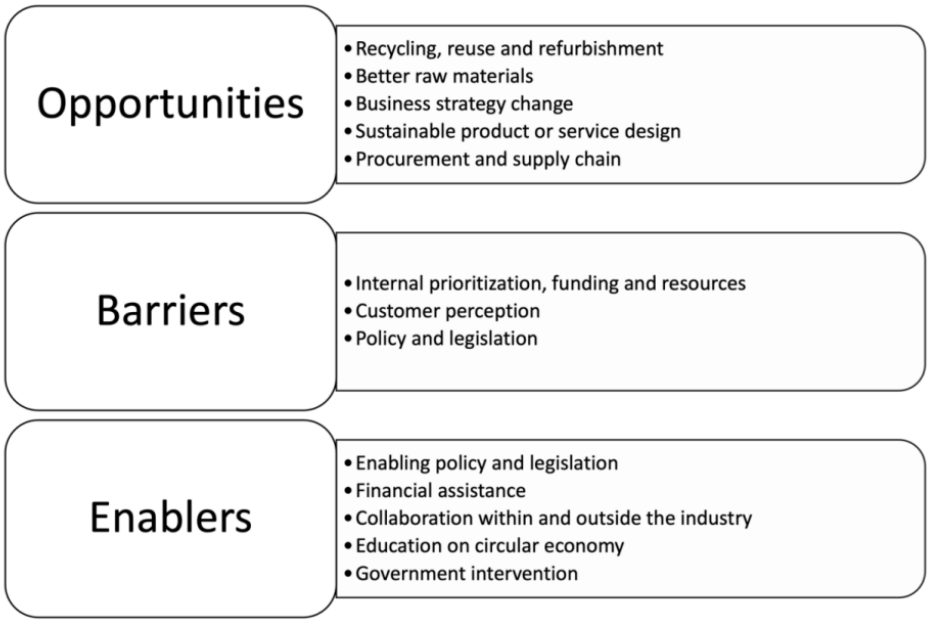
Challenges for the sector with regard to sustainability demands, including a brief overview of relevant regulations

When identifying the challenges of CE in the health sector, it is necessary to be aware of the current perception by business:

1. **Healthcare has a single-use mindset** – it is safer to throw medical devices away after they have been used. (The perception is that if we throw used devices away, we reduce infection risk: The less we re-use, the safer.)
2. **It is difficult to re-use devices**. (They have to be collected, transported, cleaned, tested, and sometimes sterilized before re-use. It's much easier to throw the device away after a single use and grab another one.)
3. **Many devices are so inexpensive** and the necessary investment to re-use so high that it is financially unsound to engage in re-use.
4. The industry that manufactures devices has discovered that **single-use means the hospital buys more**, so by designing devices for a single use, the manufacturer maximizes its profits.

(source: Healthcare must move toward a circular economy, and single-use device reprocessing offers a template to follow, by Lars Thording https://medcitynews.com/2021/03/healthcare-must-move-toward-a-circular-economy-and-single-use-device-reprocessing-offers-a-template-to-follow/

In the healthcare manufacturing sector following opportunities, barriers & enablers can be identified:



(source: Circular Economy in Single-Use. Medical Device Industry. Barriers, Enablers and Design Tool; Akshat Jain, KTH Royal Institute of Technology; https://kth.diva-portal.org/smash/get/diva2:1648394/FULLTEXT02.pdf

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Key Challenges of CE in the health sector:

1. Supply Chain Management Challenges

A CE supply chain relies on a well-built coordination and exchange of information among all levels of the supply chain . At the foundation of it, there is minimal knowledge on adapting current supply chains to be more circular. There are also clear problems in forecasting, where items are being ordered as required rather than by demand. In addition, the lack of flexibility in implementation is partly due to the lack of infrastructure to adopt CE practices. CE would incur great costs initially with increased transportation and operation costs for recycling or remanufacturing . The lack of infrastructure also makes it challenging to take products to re-use, remanufacture or recycle.

2. Regulations and Policies Challenges

Systemic transformation can rely heavily on the incentives present to do so. Implementation of a CE is considered at two levels. Regulations and incentive policies are powerful tools to encourage business models to adapt CE practices.

3. Industry Challenges

There is clear resistance to transformation due to the cost, time and effort implications. There simply is not any real incentive for consumers to care for the environment.

4. Technology and Operational Challenges

The technological infrastructure currently relies heavily on rudimentary methods of incineration or landfilling to dispose of waste, with a notable lack of environmentally friendly disposal methods. Transforming the technology to follow a CE approach is difficult.

5. Economic/Funding Challenges

The transition from a linear to CE demands a significant initial investment. The costs associated with reprocessing, recycling, or re-using waste makes the option unattractive. In addition, recycling operations can be expensive and inefficient, leading to material loss and cross contamination.

Agreements set out in the European Green Deal on Sustainable Healthcare

Signatories to the Green Deal agree to pursue 5 objectives in addition to their own ambitions and goals:

1. **Promote the health of healthcare consumers and providers through better nutrition and environment and lifestyle interventions**
   To improve people's physical and mental health, health and care organisations and the government have agreed to:
   - promote healthier, more sustainable, plant-based diets for healthcare consumers and providers;
   - apply new insights and experience to ensure a health-promoting environment in health and care facilities and their immediate vicinity.

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2. **Increase knowledge and awareness of the sector's environmental and climate-related impact**
   It's important that care workers understand the relationship between human activity, climate change, the environment and health. To this end:
   - the health and care sector will actively participate in the social debate on climate change and pollution;
   - sustainable healthcare and planetary health will be integrated into medical and healthcare training;
   - health and care organisations and insurers will address prevention and sustainable healthcare in their strategic documents (such as procurement policy).

3. To be carbon-neutral by 2050
In order to be carbon-neutral by 2050:
- health and care organisations will strive for energy-efficient buildings, transport and procurement, and aim to use renewable energy;
- from 1 July 2023, large health and care organisations must have roadmaps that show how they are working to reduce their carbon emissions through local and other measures. One way is by reducing the energy consumption of hospitals and long-term care facilities

4. Reduce use of materials and resources as well as residual waste
The health and care sector uses a lot of raw materials and products such as medical devices and personal protective equipment (PPEs). The sector will take steps to reuse more materials and reduce the use of new materials and resources where possible. By 2030, the volume of unsorted residual waste should be no more than 25% of the sector's total waste produced. In addition, the volume of unsorted waste in 2026 should be 25% lower than in 2018. To achieve this the sector will:
- incorporate sustainable and circular principles into their procurement policies, such as purchasing reusable products where possible;
- reduce the use of diapers and incontinence pads.

5. Reduce the environmental burden of pharmaceuticals
Pharmaceutical residues in surface and groundwater are an inevitable consequence of using medicines. The manufacture of medicines also has environmental and climate-related effects. To reduce the environmental impact of medicines, the sector and the government will:
- prescribe and issue medicines economically, that is, not more than the number of doses required;
- reduce discharges of radiographic contrast media into wastewater;
- continue implementing the chain approach to reducing pharmaceutical residues in water.

(source: More sustainability in the health and care sector; Government of Netherland
https://www.government.nl/topics/sustainable-healthcare/more-sustainability-in-the-care-sector

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CE opportunities for the sector, including best practices

Starting with identification of opportunities of CE in medical device industry, following Circular Business Models (CBM) can be applied:

CBM	Description	Industry Example
CBM1: Full-care equipment as a service	Renting or leasing equipment on a contract basis, including lifecycle services	Medigo: Renting of defibrillators
CBM2: In-hospital lifecycle care services	Maintenance services are provided on a contract basis at various service levels	Steris: Customizable service contracts for equipment
CBM3: Support for hospital-based reprocessing	Provision of hospital-based cleaning, disinfection, and sterilisation equipment and consumables	Medivators Renatron: Provision of products to facilitate dialyzer reprocessing;
CBM4: Mobile solutions	Mobile medical units provide short-term access to equipment	Shared Medical Solutions: Rent of imaging equipment for a defined time enabled by trailers or modular buildings
CBM5: Platform for devices circulation	Using a third-party platform, healthcare organizations can share, rent, or sell medical gadgets	Floow2Healthcare: Platform for sharing medical devices
CBM6. Refurbished system	Purchase of turn-key reconditioned and updated equipment with the same guarantee as new	Siemens Ecoline: Provision of refurbished imaging system by OEM
CBM7. Full-provision of reprocessed devices	Collection, reprocessing, and distribution of high-risk medical devices	Sterilmed: Collection, reprocessing and provision of single-use medical devices
CBM8. End-of-life (EOL) equipment collection	Medical equipment collection, parts harvesting, and certified recycling made easier	Advanced Technology Recycling: Certified recycling of medical equipment
CBM9. Continued collection of disposables	Disposable device take-back programs	BD ecoFinity Life Cycle Solution: Facilitated collection and recycling of sharps

(source: Circular Economy in Single-Use. Medical Device Industry. Barriers, Enablers and Design Tool; Akshat Jain, KTH Royal Institute of Technology *https://kth.diva-portal.org/smash/get/diva2:1648394/FULLTEXT02.pdf*

Circular Design for Medical Devices

One of the examples of basic principles of circular economy for mitigating and disposing of the hospital waste can be following design practices:

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Key Desirable Design Practices	Key Less Desirable Design Practices
• Using mono-material whenever possible • Using easy to separate or jointly processable plastics when multiple materials are required • Minimizing use of paper components by replacing them with breathable plastics • Using water-based adhesives • Allowing for easy cleaning & drainage of products before disposal • Reducing the use of pigments	• Using incompatible plastics in one product • Permanently joining two components of unlike plastics • Using plastic film with paper in package design • Using metal with plastic • Using lead & PVC

(source: Circular economy of medical waste: novel intelligent medical waste management framework based on extension linear Diophantine fuzzy FDOSM and neural network *approach;* XinYing Chew, Khai Wah Khaw, Alhamzah Alnoor, Marcos Ferasso, Hussam Al Halbusi & Yousif Raad Muhsen; Environmental Science and Pollution Research *(https://link.springer.com/article/10.1007/s11356-023-26677-z)*

Examples of Circular Economy (CE) Applications in Health Care:

1) Reducing products needed

• Virtual health where possible, reducing emissions from transportation, volume of cleaning, and PPE due to fewer in-person appointments

• Reducing the number of gloves used in situations where evidence does not support their use for safety and sterility purposes, such as the NHS' 'Gloves Are Off' campaign (NHS, retrieved 2021)

• Eliminating unnecessary magazine subscriptions (CCGHC case study)

• Sizing cancer medication vials to eliminate wasted drugs (CBC, 2020)

• Optimizing surgical kits to eliminate unnecessary waste (Ahmadi, 2019)

2) Substitution

• Substituting Sevoflurane for Desflurane in anesthesiology

• Substituting oxygen for nitrous oxide as carrier gas in anesthesiology

3) Onsite Reuse of Products

• Reuse of patient-specific anesthetic gas during surgery

• Onsite reprocessing of medical devices

• Reusable linens (drapes and gowns) and onsite laundry

• Onsite distillation of solvents used in laboratories

• Use of onsite generated aqueous ozone for cleaning instead of cleaning chemicals which must be regularly shipped to the site (CCGHC case study)

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4) Offsite Reuse of Products

• Reprocessing of medical devices

• Reusable linens (drapes and gowns) and offsite laundry

• Offsite distillation of solvents used in laboratories

5) Reuse, repairability, recyclability and refurbished products

• 3D printing of parts to improve repairability

• Amcor pledge to develop all packaging to be reusable or recyclable by 2025 (Amcor, retrieved 2021)

• Philips' Diamond Select refurbished systems program, which provides refurbished imaging systems that have the same quality and performance as new equipment at a lower cost (Philips, retrieved 2021a)

• Philips' pledge of 2018 to take back and repurpose all the large medical systems equipment that its customers are prepared to return to it by 2020. Including equipment such as MRI, CT, Ultrasound and interventional and diagnostic X-ray systems (Philips, 2019)

• GE Healthcare GoldSeal program, which refurbishes and recycles old imaging equipment (GE, retrieved 2021)

(source: CIRCULAR ECONOMY IN HEALTH CARE Communicating to non-experts, Elizabeth Samuels, UBC Sustainability Scholar, 2021 https://sustain.ubc.ca/sites/default/files/2021-006_Circular%20Economy%20in%20Healthcare_Samuels.pdf

Other examples of CE application in Health Sector:

- **Single-use device reprocessing**
  Single-use device reprocessing is arguably the most successful and widespread example of a circular healthcare economy: Medical devices labeled "single-use" by the manufacturer are collected after procedures or other use and stored. The medical device reprocessing company's representative picks up the devices and ships them to the reprocessing plant. Here, they are traced and registered, cleaned, tested, and sterilized. At this point, the hospital can purchase the reprocessed devices for a fraction of the price paid for a new device. After re-use, devices are collected, and parts are recycled.

(source: Healthcare must move toward a circular economy, and single-use device reprocessing offers a template to follow, by Lars Thording https://medcitynews.com/2021/03/healthcare-must-move-toward-a-circular-economy-and-single-use-device-reprocessing-offers-a-template-to-follow/

- **Sustainable biochip technologies**

The microarray technology allows the detection of multiple biological targets simultaneously on a single chip. This makes a faster and more efficient sample analysis possible. The latest technical advances aim to reduce the environmental impact of the automatons used.

- **Recyclable materials and eco-design of in-vitro diagnostic medical devices (main trends)**

  1. use of biobased and biodegradable materials, such as corn starch, polylactic acid, cellulose and chitosan, aims to reduce the environmental impact of plastic waste.

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2. microfabrication processes such as deep immersion lithography and 4D printing are used to reduce energy consumption in the production of IVD devices.
3. the development of portable and rechargeable diagnostic systems reduces the amount of waste generated by disposable consumables.

- **New partnership model in the in vitro diagnostic industry**

- **New technologies such as artificial intelligence (AI), quantum computing and supercomputing could help deliver safer and more sustainable chemicals and materials by design.**

Other useful smart and green lab techniques

- **Spectroscopy** uses light to identify molecules in a sample. It can be used for non-destructive analysis of biological samples, and therefore for multi-sample analysis.

- **Digital PCR** can detect and quantify DNA with extreme accuracy in infectious diseases.

- **Microfluidics** allows the manipulation of liquid biological samples at the micrometre scale. This technology offers dramatic developments for biological analysis processes and five significant advantages: fewer samples and reagents (volume reduced to the nanolitre), real-time analysis

- **Digitizing diagnostic data** reduces the amount of paper and plastic needed to store test results. This reduces waste and energy consumption: a 30-50% reduction in paper consumption and a reduction of up to 30% in energy consumption associated with medical data storage and management.

Overview of tech-savvy SMEs that develop/offer solutions to increase circularity in the sector

TESALYS SAS

French company with an international presence that develops, manufactures, and markets on-site solutions for the pre-treatment by sterilisation of waste from healthcare activities with infectious risks (HCW).

http://www.tesalys.fr

Bertin Medical Waste

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A brand of Bertin Technologies, offers innovative solutions for the on-site treatment of biomedical waste thanks to a patented 100% electric technology combining shredding and sterilization by microwaves in one single vessel.

https://www.bertin-medical-waste.com/

Geochanvreis (Biodegradable face masks using hemp)

The French company Geochanvreis producing face masks mad out of hemp. The hemp masks as a way to reduce plastic waste during the coronavirus pandemic.

https://www.geochanvre.fr/

Links to sector specific online contents, including sector specific funding opportunities

EIT Health

EIT Health - Community funded by UE which one the of the goals is contributing to a sustainable health economy in Europe.

https://eithealth.eu

Health Care Without Harm Europe

Network of thousands of hospitals, healthcare leaders and healthcare professionals, with members across Europe and partners across the globe pushing for sustainable practices, sharing insights, inspiration and innovation – and transforming how healthcare systems work.

https://noharm-europe.org/

KLIK green

German Association for the Conservation of Environment and Nature, the Hospital Association of North Rhine-Westphalia and the Jena University Hospital that actively supports climate protection and resource-conversation efforts in hospitals.

https://www.klik-krankenhaus.de/project-description

“CirculAid – Circular Economy in Healthcare”

German Ministry of Health funding initiative to reduce the consumption of resources in the healthcare sector

https://www.dbu.de/en/topics/funding-initiatives/circulaid/

FLOOW2 Healthcare

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Sharing platforms that allow healthcare organizations to optimize usage of already available capacity (equipment, surplus stock, facilities, services and knowledge of staff) internally between departments, as well as externally between organizations.

https://www.floow2.com/en.html

Eurocluster DESIRE

Direct funding for innovation and internationalisation of e-health SMEs. It will address the challenges that SMEs face when accessing the European eHealth and Digital Health Market in order to build resilience and facilitate green and digital transition.
https://desire-development-of-e-health.b2match.io

https://desire.grantplatform.com

European Partnership for the Assessment of Risks from Chemicals (PARC)

Project funding by the European Union's Horizon Europe coordinated by ANSES, seeking to develop next-generation chemical risk assessment in order to protect health and the environment.
https://www.eu-parc.eu/

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- “The challenge of "greening" medical technologies Report: Bernard Banga: https://healthcare-in-europe.com/en/news/challenge-greening-medical-technologies.html

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