A PATHWAY TO CIRCULARITY FOR THE TAVI DELIVERY SYSTEM

Creating change through stakeholder collaboration

How to use this booklet

This booklet was developed as part of the ESCH-R project, which explores how waste in healthcare can be reduced by shifting from linear take-make-waste processes to more circular approaches.

The booklet uses the Transcatheter Aortic Valve Implantation (TAVI) as a case study. It shows the transition of the TAVI delivery system from a linear end-of-life towards a more circular future. The booklets purpose is to help stakeholders understand why this transition is needed, what the long-term direction is, and which actions are required to make it work in practice. In doing so, it connects the broader ambition of reducing waste in healthcare to the practical decisions that actors involved must make. Although this case is specific to TAVI, the approach may also be relevant for other single-use medical products with a similar design.

The booklet is designed to guide readers from problem to action. Chapter 1 explains why change is needed by outlining the current linear system and the reasons for moving to circularity. Chapter 2 presents the transition strategy and the long-term direction. Chapter 3 translates this strategy into concrete actions for each stakeholder.

Transcatheter Aortic Valve Implantation

The delivery system was selected as the focus of this transition because it is the most complex and valuable component of the TAVI procedure.

The TAVI product set consists of three main products delivered by the OEM: the delivery system, the loading system, and the delivery system packaging. The delivery system is used to position the valve in the body. The loading system helps with loading the valve onto the delivery system before use. The packaging protects the product during transport and storage, and also supports the preparation of the valve.

Within this product set, the delivery system was selected as the focus. It contains the most value and is the most technically complex part of the system. At the same time, it is discarded in hazardous waste bins and incinerated after a single use. This makes it the part of the system with the greatest loss of value. Although the packaging and loading system also offer circular opportunities, it is a simpler part of the system and has already been more widely explored in existing OEM initiatives.

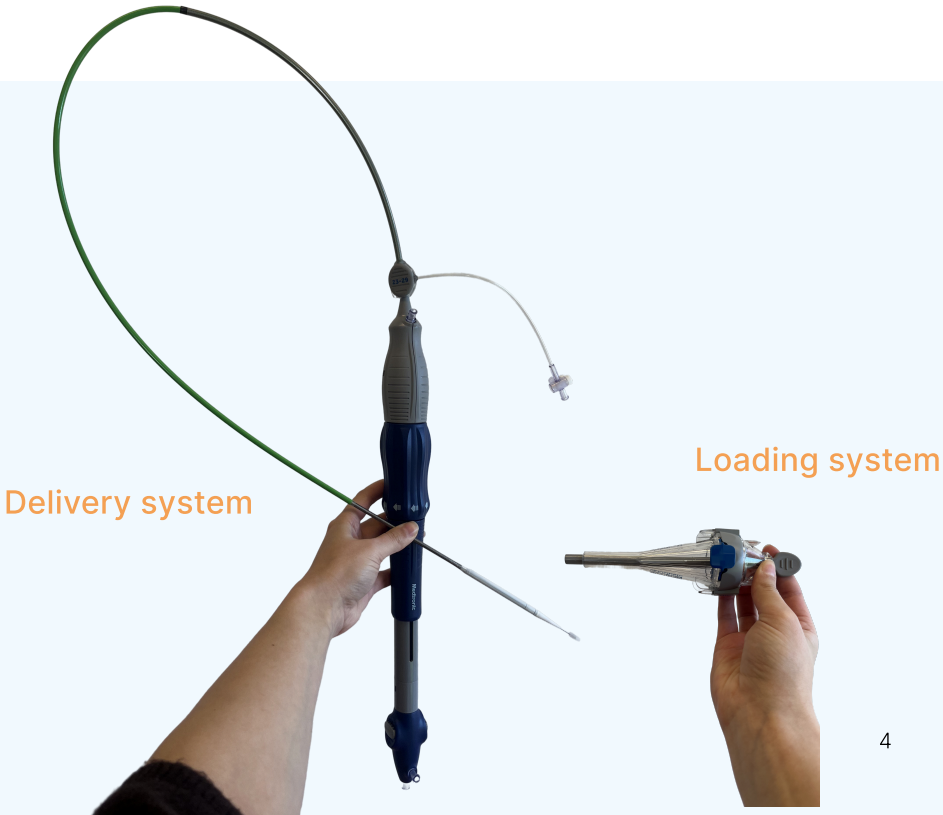
The delivery system is also a Class III medical device, meaning it falls into the highest risk class under the EU medical device framework. This means that changes to the device are subject to strict requirements.

This combination of high value, high complexity, and strict regulatory requirements makes the device system the most relevant part of the TAVI product. If circular strategies can be developed for this part of the system, the underlying principles can also guide future actions in the packaging and loading system.

The delivery system

Understanding the material composition of the delivery system is important for identifying suitable circular strategies. At a general level, the delivery system consists of a handle, a wire with multiple layers, and a tip. The components differ in both function and material composition, which means they do not all offer the same circular opportunities.

The handle is largely made of ABS, a plastic commonly used in medical products. The wires are more complex, combining different materials, which makes them more difficult to separate and process. The tip contains platinum-iridium, a precious metal, and therefore has a relatively high embedded value.



WHY CHANGE IS NEEDED

01

From high-value care to high-value waste

Modern healthcare is highly effective at treating patients, but this success also comes with a high environmental and material cost.

To prioritise safety, sterility, and efficiency, the sector has largely been built around a linear “take-make-waste” model in which single-use devices have become the standard.

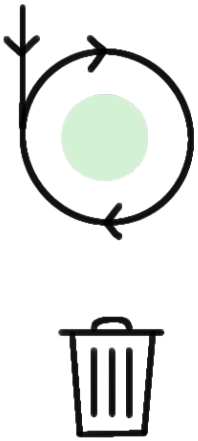
As a result, large volumes of high-quality medical products are discarded after only one use and often end up in hazardous waste streams for incineration.

At a time of rising disposal costs, increasing pressure to reduce healthcare emissions, and growing concern around limited material resources, this linear model is no longer economically or ecologically sustainable.

Linear economy

Recycling economy

Circular economy

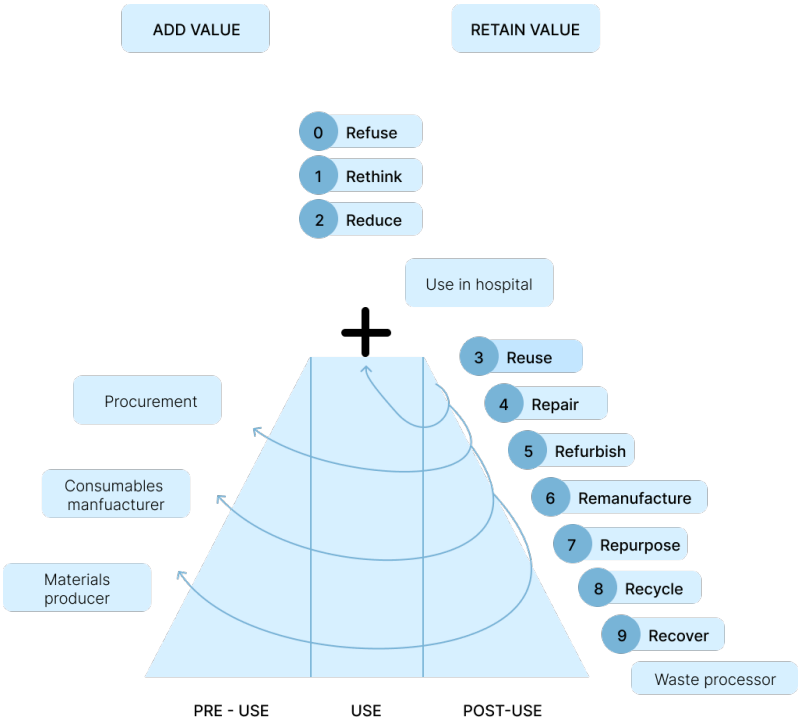


Why reuse matters more than recycle

To retain the most value, recycling alone is not enough, reuse is necessary.

To explain the reasoning behind the chosen circular pathways, the value hill is used. It shows how different circular strategies retain varying amounts of value. As materials are processed and assembled into a medical device, value is added through manufacturing, labour, energy, and knowledge. After use, the value can be either largely lost (refuse) or retained (reuse), depending on the recovery strategy. Using this perspective, different circular strategies were explored for the delivery system. Recycling and reuse emerged as the most relevant options.

In the current linear model, much of the product's value is lost after only one use. Incineration destroys not only the material itself, but also the wider investment embedded in the product. Recycling is therefore an important first step, because it helps recover part of the material value that would otherwise be lost. However, it still breaks the product down into raw material streams. Reuse retains more value than recycling because it preserves more of the product's function, structure, and embedded effort. For that reason, recycling is a necessary short-term step in the transition, while reuse is the higher long-term ambition within a circular model.



Recycle = Process materials to obtain the same (high grade) or lower (low grade) quality (Hoveling et al., 2024).

Reuse = Reuse by another customer (or for another patient in healthcare) of discarded product which is still in good condition and fulfills its orginal function (in healthcare, often after cleaning processes) (Hoveling et al., 2024).

A multi-actor system

A circular healthcare model cannot be organised by a single actor. The delivery system is part of a broader socio-technical system.

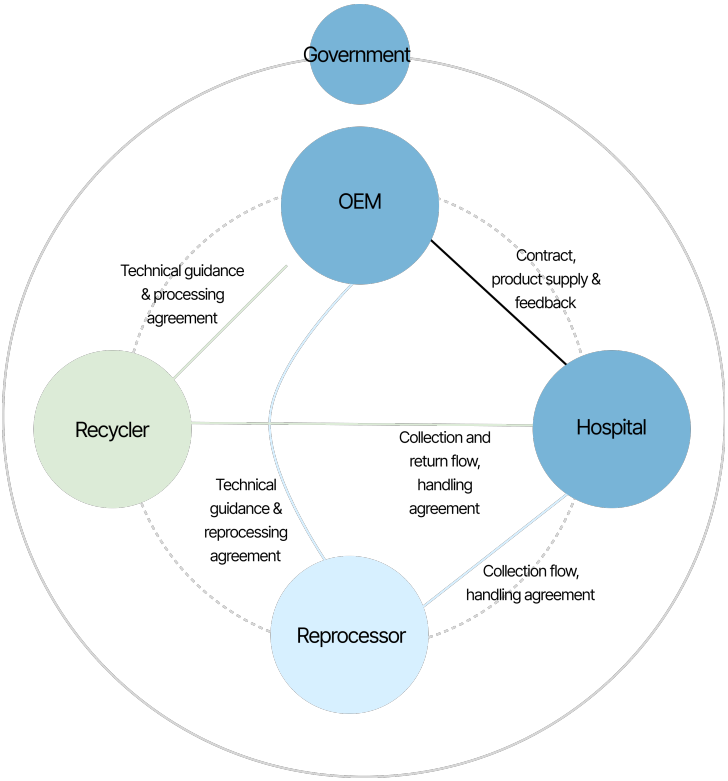
In this system, product design, hospital routines, regulation, infrastructure, and multiple organisations all influence what happens in practice. This means that the challenge is not only to focus on the product itself, but also the wider system around it.

For the delivery system, this means that circularity depends on the alignment of multiple stakeholders. The **OEM** can redesign the product and provide information on materials, handling, and recovery routes, but the hospital plays an equally important role in how the product is handled after use. Within the **hospital**, different stakeholders influence different parts of this process: **nurses** shape post-use handling in the procedure room, **logistics** organises collection, storage, and return flows, **infection prevention** helps define the conditions under which circular routes remain safe and acceptable, **procurement** can include circularity in supplier requirements and tenders, and **management** helps align priorities, responsibilities, and decision-making across the organisations. **Government** must specify the conditions under which these routes are permitted and viable.

The transition towards circularity also introduces new stakeholders into the system. **Recyclers** and **reprocessors** are needed to recover value in practice. Recyclers process materials at the end of their life, while reprocessors clean, inspect, test, and prepare products or components for another use cycle.
If one part of the chain fails, the system falls back to linear disposal.

The figure bellow illustrates the stakeholder network required to transition the delivery system from linear to circular, along with the stakeholders' interdependencies. The inner circle represents the actors directly involved in the operational system around the delivery system, while government forms the outer layer as the broader regulatory and policy context that shape what is possible.

The black line shows the existing relationship between the hospital and the OEM. The coloured lines show the two circular routes: green for recycling and blue for reuse.



From complexity to transition

The TAVI delivery system shows that circularity cannot be achieved through a single intervention. Because it is embedded in a network of stakeholders, the transition requires changes on product and system level.

This means that the pathway towards circularity must be organised over time, with different actions becoming relevant at different moments. The next chapter, therefore, outlines the transition pathway and shows how the current linear situation can gradually develop towards the desired circular future.

PATHWAY TO CIRCULARITY

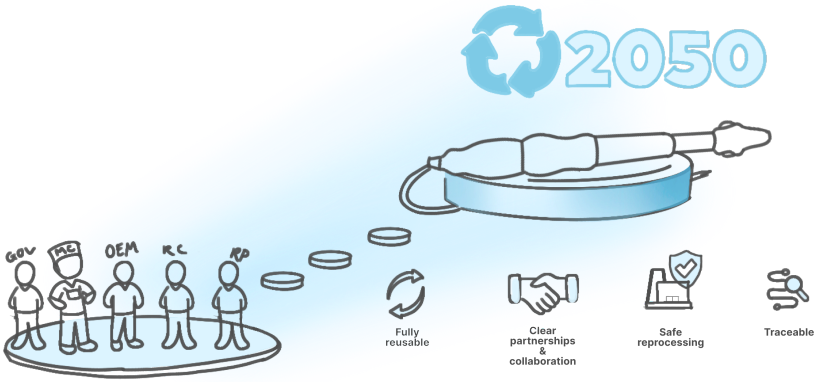
02

Why a gradual transition is needed

Transitioning from a linear to a circular healthcare model cannot happen overnight. The complex system and complex device have developed around a single-use practice over time.

A sudden shift would create friction in clinical practice, resistance in adoption, and uncertainty around responsibilities. To move towards circularity in a realistically and credibly way, the transition must be gradual. This allows the system to build the logistical, organisational, and regulatory conditions needed to support more circular end-of-life routes over time.

Future vision



The long-term vision is a fully reusable TAVI delivery system.

In this future state, worn components are replaced as needed, and materials leave the system only when they have reached their true end of life. At that point, the remaining material value is recovered through recycling.
Several conditions must be achieved for this vision to become reality.

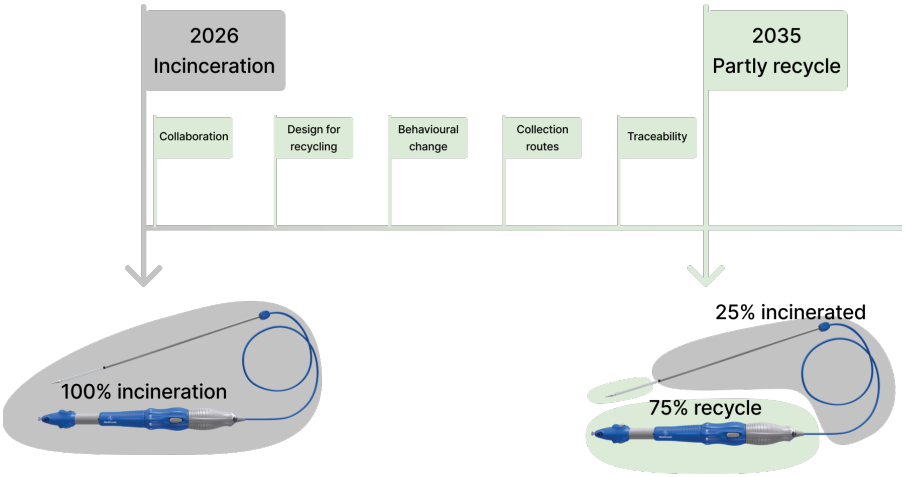
- First, the delivery system needs to be **redesigned for reuse**, allowing components to be safely disassembled, inspected, repaired or replaced, and reassembled.
- Second, successful implementation requires clear **collaboration** and well-defined **responsibilities** among the parties involved, as reuse depends on coordination among the OEM, the hospital, and external processing partners.
- Third, a **specialised reprocessing partner** is essential for cleaning, inspecting, testing, and preparing the system for another use cycle.
- Last, full **traceability** of parts is crucial to monitor how often components have been used, whether repairs or replacements have occurred, and when parts are no longer fit for continued use.

Two parallel pathways to circularity

To make the transition towards circularity realistic, this booklet proposes a two-phase pathway: recycling and reuse.

Immediate reuse is not possible in the current system. It requires additional redesign, validation, testing, and approval. It also requires a change in trust and behaviour within healthcare practice. In a system where single-use is closely associated with safety, reusable products are not automatically accepted. Recycling, therefore, plays an important transitional role: it reduces direct value loss in the short term, while also helping stakeholders become familiar with circular handling and shifting the mindset from disposal towards value retention.

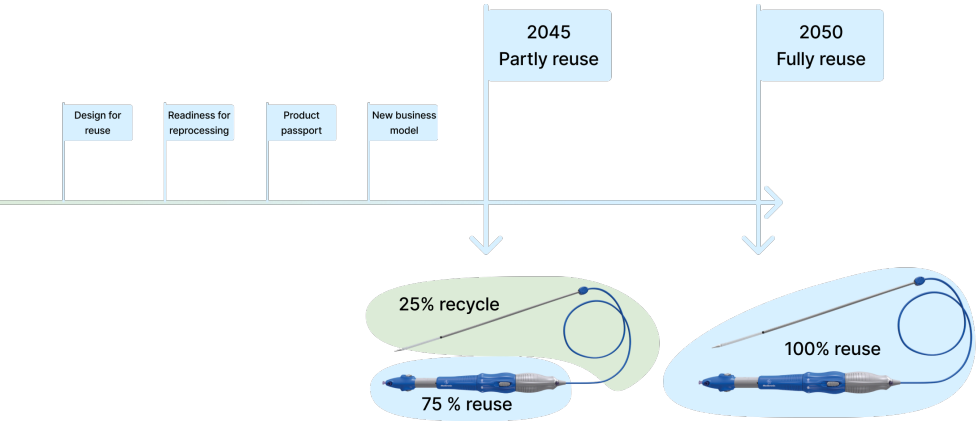
The goal of the first phase is to enable recycling and lay the foundation for further circular steps. This includes design changes that support recovery, shared agreements between stakeholders, collection and return routes, daily routines, training, and traceability of both the product and its route after use.



The second phase focuses on reuse. Its goal is to retain more value by keeping products and components in circulation for longer. This requires redesign for repeated use, readiness for reprocessing, a product passport, contractual changes between actors, and a circular business model that supports multiple use cycles.

The timeline is shaped by Green Deal deadlines and the long development and implementation timelines required for Class III medical devices.

In **2026**, the delivery system is 100% incinerated.
In **2035**, the handle and tip are recycled (75% of the total weight), while the wires (25%) are incinerated because their design is too complex for recycling.
By **2045**, the handle is reused (75%), the tip is recycled, and the wires can also be recycled (25%) as technical recycling capabilities have advanced.
In **2050**, the delivery system is 100% reused.



The roadmap

This map translates the pathways into stakeholder actions. It shows what needs to happen, who needs to take the lead, and how actions across stakeholders connect over time. In this way, the transition is not presented as a single linear process, but as a coordinated effort between multiple actors.

A larger version of the map can be found in the back of this booklet. It is meant to be used alongside the next chapter, so readers can keep the overall overview at hand while reading through the stakeholder actions in more detail.

How to read the map

The map is read from left to right, following the timeline of the transition. On the left side, the stakeholders are listed. Each horizontal line shows the actions of one stakeholder over time.

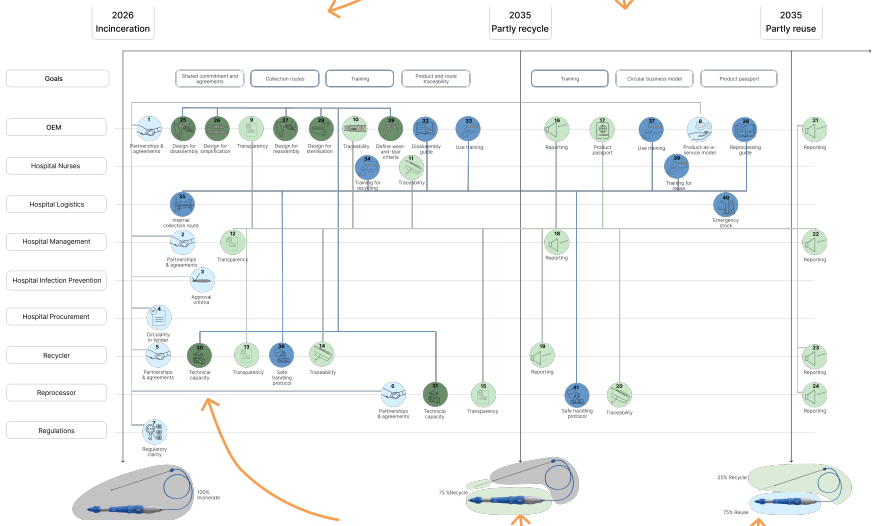
At the top, the broader transition goals are shown. These indicate the main ambitions that the actions contribute to and help connect individual steps back to the overall vision.

Within each stakeholder line, the actions are placed at the moment in time when they become relevant. Connections and numbers between actions show where stakeholders depend on one another, where coordination is needed, and how progress in one lane enables progress in another. A more detailed explanation can be found in the next chapter.

Goals

Time

Stakeholder



Actions

What part of the product is recycled / reused

How the actions connect

The actions in the map are grouped across four levels: system, information, operations, and product.

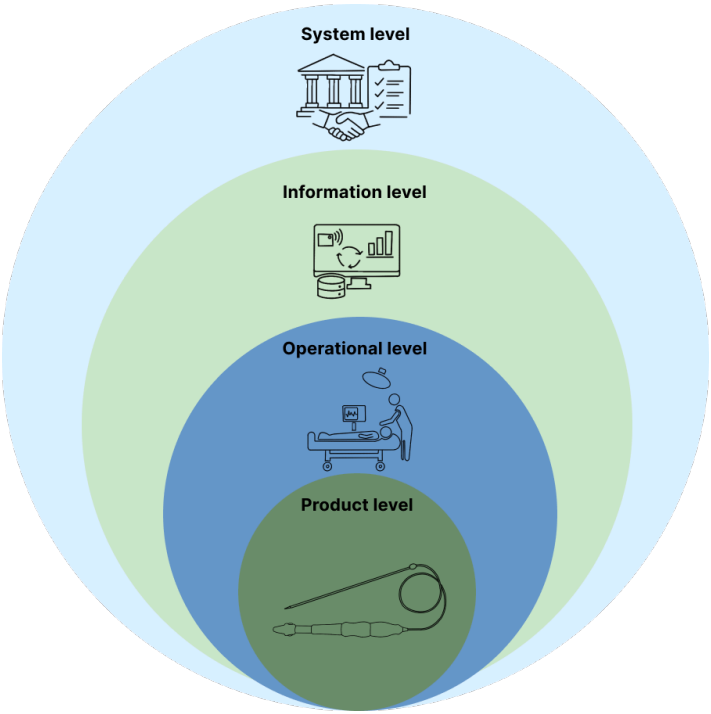
Each level addresses a different part of the transition, but none of them can succeed on its own.

System level creates the conditions for change. These include regulation, procurement, partnerships, and agreements. They define what is allowed, who is responsible, and how stakeholders commit to the transition. Without this level, the actions below have no stable foundation.

Information level makes products, routes and outcomes visible across the chain. Transparency, traceability, and reporting help stakeholders understand what they are working with, what should happen next, and wether the intended impact is actually being achieved. Without this level, actors cannot coordinate effectively.

Operational level actions translate the transition into daily routines and handling. These include training, guides, collection routes, and practical procedures. This is where the transition becomes real in day-to-day practice. However, operational change can only succeed if the product is fit for circular use, if the right information is available, and if the wider system supports it.

Product level actions determine whether the delivery system is technically fit for circularity. These actions shape whether the product can be disassembled, recycled, or reused in practice. Without this level, the circular ambition cannot be translated into a feasible product pathway.



System level	Regulatory, contractual and procurement actions that create the conditions for transition.
Information level	Actions that make products, routes and outcomes visible and traceable across the chain.
Operational level	Actions that translate the transition into routines, training and operational handling.
Product level	Design and technical actions that make recycling or reuse possible.

FROM PATHWAY TO ACTIONS TO CIRCULARITY

03

Reading guide

This chapter presents the proposed actions. Actions are grouped by stakeholder and follow the timeline as in the transition map.

The action number corresponds to the number on the map. The numbers are grouped per level (system, information, product, or operational). Each action explains what the action involves, what change it aims to create, and why it is important.

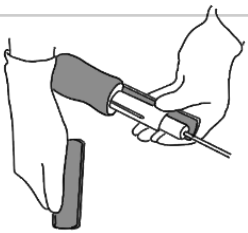
Number of action on the transition map

Icon of the action

This shows if the action is important for recycle, reuse or both.

1 Title of action

Explanation of action



Recycle | Reuse

Eplanation of what the action is and why it has to change

- The impact of the action

OEM

The OEM is both the enabler and the leader of this transition. They have a central role in redesigning the delivery system, but also in shaping the wider conditions needed for circularity to work in practice. This includes setting up partnerships, ensuring quality and compliance, and creating the contractual and organisational foundations for recycling and reuse.

Because many other stakeholders depend on the choices made by the OEM, it plays a leading role in moving the system away from a linear model to a circular one.

1 Partnership and agreements

Establish clear agreements with the stakeholders involved in the transition of the product.

Recycle | Reuse

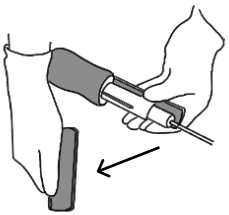
Circularity cannot be realised by the OEM alone. Even with a redesign, the system will fail if hospitals, recyclers, and reprocessors do not know their role or what is expected from them.

This action creates clear responsibilities, aligns expectations, and supports coordination across the chain.

- Clarifies roles across stakeholders.
- Strengthens coordination across the chain.
- Creates a stronger basis for recycling and reuse.

25 Design for disassembly

Redesign the delivery system so that valuable parts and materials can be separated more easily after use.



Recycle | Reuse

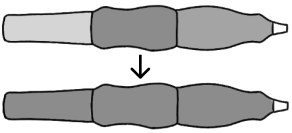
The current design makes it difficult to separate components and materials after use, which limits recovery options and reinforces incineration. This action shifts the product from a single-use design towards one that also considers end-of-life separation.

It includes reconsidering joining methods, component connections, and material composition so that parts can be taken apart more easily.

- Makes material recovery more feasible.
- Reduces incineration of valuable parts.
- Supports higher-value recovery routes.

26 Design for simplicity

Redesign parts of the delivery system towards simplicity to improve circularity and material recovery



Recycle

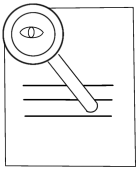
Reuse

Mixed material combinations make recycling more difficult and reduce the quality of recycled materials. This action reduces unnecessary material complexity by moving towards mono-material design, using mono-colours, avoiding multi-layer constructions, and selecting compatible polymers for components that cannot be separated. This action makes it possible to sort, separate, and recycle parts easier.

- Clarifies roles across stakeholders.
- Strengthens coordination across the chain.
- Creates a stronger basis for recycling and reuse.

9 Transparency

Provide clear information on the material composition, component structure and end-of-life possibilities.



Recycle

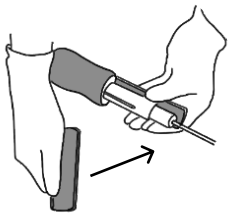
Reuse

Important product information is not always visible to the actors who need it after use. This action makes relevant information more accessible across the chain, helping stakeholders understand what can be recovered, how the product should be handled, and which recovery route is possible.

- Improves decision-making across the chain.
- Supports correct handling after use.
- Creates a stronger foundation for collaboration.

27 Design for reassembly

Redesign the delivery system so that the handle can be reassembled safely and consistently after disassembly and reprocessing.



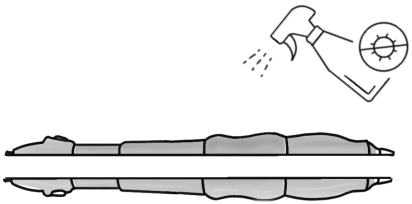
Recycle | Reuse

To enable reuse, the product must not only come apart easily (design for disassembly) but also be put back together in a safe and reliable way. This actions shifts the product from a one-time assembly logic towards a design that also supports repeated reprocessing and reassembly.

- Creates a technical basis for reuse.
- Supports safer reprocessing.
- Helps retain more functional value.

28 Design for sterilisation

Redesign the handle so that it can be cleaned and sterilised safely for reuse.



Recycle | Reuse

This action adapts material choices, surfaces, and part interfaces so that the handle can be cleaned and sterilised. This is important for reuse and recycling, as cleaner components are easier and safer to recover. It includes removing unnecessary edges, gaps, and, hard-to-reach features so that clinical fluids can be wiped off, rinsed away or sterilised more easily.

- Supports reliable reprocessing.
- Creates a technical foundation for safe reuse.

10 Traceability

Adapt the design so that the delivery system, or selected components, can be identified and traced through its life cycle

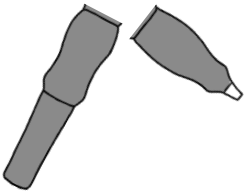
Recycle | Reuse

A circular system requires to remain clear what has happened to a product and which route it has followed. This action adds traceable design features that make products easier to identify, follow and, link to relevant product information.

- Improves visibility across the chain.
- Supports monitoring of recycling and reuse routes.
- Strengthens the basis for safe and credible reuse.

29 Define wear-and-tear criteria

Define wear-and-tear criteria for the handle that is reused.



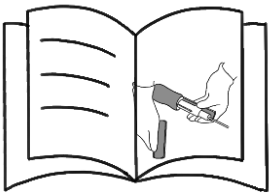
Recycle | Reuse

Reuse is only possible if it is clear when a component is still suitable and when it should be recycled. This action creates a more structured basis for assessing component condition after use, based on safety, quality, and performance.

- Supports safe reuse decisions.
- Makes reuse more reliable.

32 Disassembly guide

Develop a clear guide that explains how the delivery system should be taken apart after use for recycling and reuse.



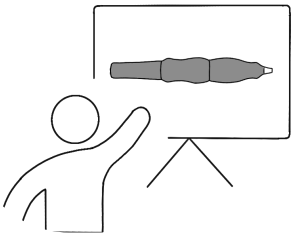
Recycle | Reuse

Without clear guidance, parts may be damaged, mixed or, discarded incorrectly, which reduces recycling quality and reuse, and can push the product back towards incineration. The guide makes clear which parts should be separated, in what order, and for which recovery route.

- Improves the consistency of disassembly.
- Supports higher-quality recycling.
- Makes circular routes more workable in practice.

33 + 37 Use training

Provide hospital staff with training on how to use and how to handle and collect the delivery system after use.



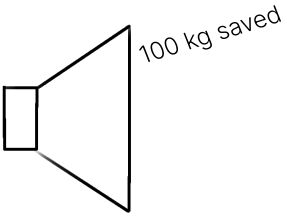
Recycle | Reuse

If staff continue to treat the product as hazardous waste, valuable parts and materials will still be lost through incineration. Training is needed to support new routines in practice.

- Improves correct handling after use.
- Reduces unnecessary incineration.
- Builds awareness around circular practice.

16 + 21 Reporting

Set up reporting on what happens to the delivery system after use.



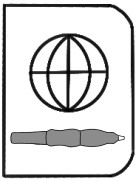
Recycle | Reuse

Set up reporting on what happens to the delivery system after use, including return flows, recovery routes, and the value retained through recycling or reuse. Share what is recycled, what is reused, and what is saved through these efforts to create transparency, track progress, and motivate continued engagement.

- Supports learning and accountability.
- Improves insight into system performance.
- Helps track progress towards circular goals.

17 Product passport

Develop a product passport that stores and shares key information about the product.



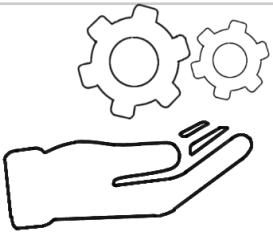
Recycle | Reuse

A circular pathway requires actors to know what a product is made of, how it should be handled after use, which recovery route is suitable for each part, how many use cycles it has had, and whether it has been repaired. Without that information, products are harder to sort, process, and trace, which increases the chance that value is lost through incorrect handling or disposal.

- Improves transparency across the chain.
- Supports better recycling and reuse decisions.

8 Product-as-a-service mode

Explore a product-as-a-service model in which the OEM keeps ownership of the product.



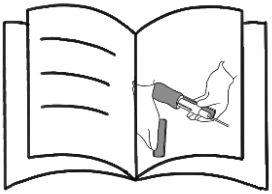
Recycle | Reuse

In a linear model, responsibility for the product largely ends at the point of sale. This action shifts the business model towards bigger lifecycle responsibility, creating stronger incentives for return, reprocessing, and long-term value retention.

- Aligns the business model with circularity.
- Strengthens incentives for reuse and reprocessing.
- Supports long-term lifecycle responsibility.

38 Reprocessing guide

Develop a clear guide for how the components should be inspected, cleaned, tested and prepared for reuse.



Recycle | Reuse

Clear guidance is needed on how components should be handled after use, assessed for suitability for another cycle, repaired where needed, and reassembled into the device.

- Supports safe reprocessing.
- Makes reuse more reliable.
- Strengthens the basis for functional value retention.

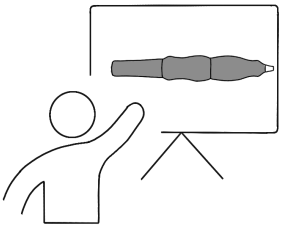
Hospital

The hospital is a group of internal stakeholders who each shape a different part of the transition. **Nurses** influence how the product is handled after use. **Logistics** organises collection, storage, and return. **Infection prevention** helps define the conditions under which circular routes remain safe and acceptable. **Procurement** can embed circularity in tenders and supplier requirements. **Management** helps align priorities, responsibilities, and decision-making across the organisation.

Together, these actors determine whether the delivery system continues to follow a linear disposal route or can move towards a more circular pathway.

34 Training for recycling

Train clinical staff on how to dispose of and route the delivery system correctly after use.



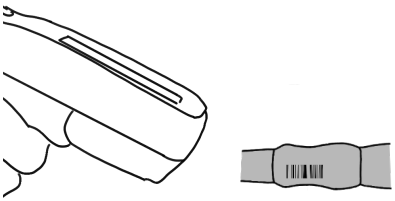
Recycle

If staff continue to treat the product as ordinary waste, valuable parts and materials will still be lost through incineration. This action introduces new routines around separation, handling, and return, helping staff recognise that the product still holds value after use.

- Improves correct handling after use.
- Reduces unnecessary incineration.
- Builds awareness around circular practices.

11 Traceability

Ensure the delivery system can be identified and followed through the entire life cycle of recycling or reuse.



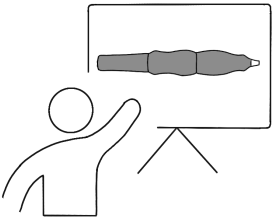
Recycle Reuse

A circular pathway requires it to remain clear what has been used, returned, and transferred to the next actor. This action creates a clearer basis for linking products to the right route for recycling or reuse.

- Improves visibility of return flows.
- Supports safer handover and documentation.
- Strengthens the basis for future reuse.

39 Training for reuse

Train hospital staff on how to work safely and confidently with reused components in practice.



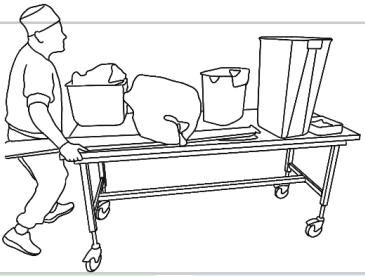
Recycle | Reuse

Clinical staff need to understand how reused components fit into clinical routines, what checks are required before use, how it can be collected, and why reuse can still be safe and reliable.

- Builds confidence in reuse.
- Supports safe and consistent use.
- Helps embed reuse in daily practice.

35 Internal collection route

Set up a clear internal route for the collection, storage, and handover of the delivery system after use.



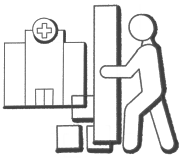
Recycle | Reuse

Without a structured internal route, products are likely to fall back into the default waste stream, and recovery options are lost. This action turns post-use handling from disposal into an organised return flow inside the hospital.

- Supports correct collection after use.
- Reduces loss into ordinary waste streams.
- Creates the operational basis for circular handling.

40 Emergency stock

Maintain an emergency stock of delivery systems to safeguard availability during urgent or unexpected situations.



Recycle | Reuse

Circular opportunities should never compromise treatment continuity. This action adds a safety buffer to the system, reducing dependence on return and recovery flows when immediate care takes priority.

- Protects continuity of care
- Reduces resistance to circular implementation.
- Makes the transition more reliable in practice.

2 Partnership and agreements

Establish clear agreements with the stakeholders involved in the recycling and reuse of the product.

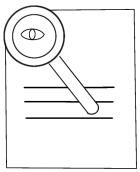
Recycle | Reuse

The hospital cannot realise circularity alone. This action clarifies roles, aligns expectations, and supports coordination with the OEM, recyclers, and reprocessors.

- Clarifies responsibilities
- Improves coordination across stakeholders.
- Strengthens the basis for recycling and reuse.

12 Transparency

Make hospital handling, requirements and practical constraints visible to the stakeholders involved in the circular pathway.



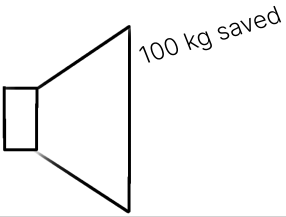
Recycle | Reuse

A circular system works better when actors understand what is realistic in hospital practice. This action makes routines, handling conditions, and implementation needs clearer across the chain.

- Improves alignment with other stakeholders.
- Supports more realistic circular design and planning.
- Helps connect product design to hospital practice.

18 + 22 Reporting

Report on collection, return flows, and practical outcomes within the hospital circular pathway.



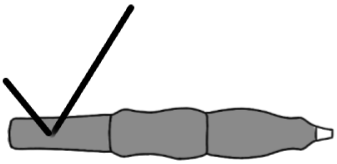
Recycle | Reuse

Without reporting, it is difficult to see whether circular routines are working in practice or where value is still being lost. This action makes hospital performance within the circular system more visible over time and can help to motivate.

- Supports learning and accountability.
- Improves insight into operational performance.
- Helps track progress towards circular goals.

3 Approval criteria

Define clear approval criteria for circular handling and future reuse within the hospital.



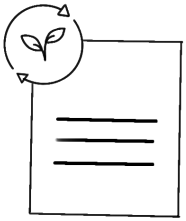
Recycle | Reuse

Circularity will only be accepted if it is clear under which conditions it remains safe and workable. This action sets clearer boundaries for what is acceptable in relation to recycling and reuse.

- Reduces uncertainty around circular implementation.
- Supports safer and more credible adoption.
- Helps prepare the pathway towards reuse.

4 Circularity in tender

Include circularity requirements in procurement and tender processes.



Recycle | Reuse

If circularity is not reflected in tenders, OEMs remain incentivised to continue offering linear solutions. This action shifts procurement from a conventional purchasing logic towards one that also values recycling and reuse.

- Embeds circularity in procurement decisions.
- Creates stronger incentives for suppliers.
- Support long-term system change.

Recycler

The recycler plays a key role in retaining material value within the transition pathway. Its role is to process returned products safely and recover valuable materials of sufficient quality. To do this, the recycler needs the right technical capacity, handling protocols, and information of the product. It also depends on clear agreements and coordination with the OEM, the hospital, and other partners in the chain. Together, these conditions determine whether valuable materials can be recovered in practice or are still lost through incineration.

5 Partnership and agreements

Establish clear agreements with the stakeholders involved in the collection and recycling of the product.

Recycle | Reuse

The recycler cannot recover value in isolation. This action clarifies roles, aligns expectations and supports coordination with the OEM, hospital and other partner across the chain.

- Clarifies responsibilities.
- Improves coordination across stakeholders.
- Strengthens the basis for reliable recycling.

30 Technical capacity

Develop the technical capacity needed to separaate, process and recover valuable material streams from the delivery system.

Recycle | Reuse

Even if products are returned correctly, recycling remains limited without the right equipment, processes, and expertise. This action strengthens the recyclers ability to safely and properly clean the device, handle more complex product compositions, and recover materials of sufficient quality.

- Increases recovery feasibility.
- Improves the quality of recycled materials.
- Reduces dependance on incineration.

13 Transparency

Provide clear information on what material can be recycled, under which conditions, and with what limitations.

Recycle

Reuse

Other stakeholders need to understand what the recycler can and cannot do in practice. This action makes the recycler's capabilities, requirements, and limitations more visible across the chain.

- Improves alignment across stakeholders.
- Supports more realistic product and system decisions.
- Helps match design to recycling practice.

36 Safe handling protocol

Develop a clear protocol for the safe handling of returned products during receipt, storage, and processing.

Recycle

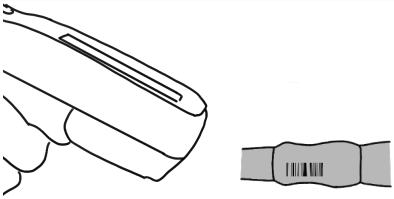
Reuse

Returned medical products require careful handling to protect staff safety, material quality, and process consistency. This action creates clearer procedures for how products enter the facility and move safely through the recovery process.

- Improves safety in handling.
- Supports more consistent recycling.
- Builds trust in the recycling route.

14 Traceability

Set up traceability for collected streams so it remains clear what has been received and recycled.



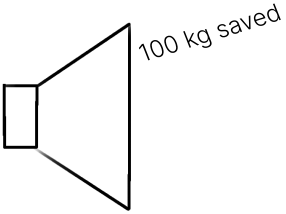
Recycle | Reuse

A circular pathway requires visibility into what happens after products leave the hospital. This action creates a clearer record of material flows through the recycling process and connects returned products to recovery outcomes.

- Improves visibility of recovery flows.
- Supports accountability across the chain.
- Strengthens trust in the recycling route.

19 + 23 Reporting

Report on recycling outcomes, recovered materials, and value losses within the recycling route.



Recycle | Reuse

Without reporting, it is difficult to see whether recovery is actually retaining value in practice. This action makes recycling performance visible and measurable over time.

- Supports learning and accountability.
- Improves insight into recovery performance.
- Helps track progress towards circular goals.

Reprocessor

The reprocessor plays a key role in moving the system beyond recycling towards reuse. Its role is to inspect, clean, sterilise, test, and prepare selected components for safe reuse. This requires not only technical capacity but also clear approval conditions, traceability, and alignment with the OEM and the hospital.

Together, these conditions determine whether reuse can become a safe, credible, and workable route in practice.

6 Partnership and agreements

Establish clear agreements with the stakeholders involved in the return, approval, and reuse of the product.

Recycle | Reuse

The reprocessor cannot enable reuse in isolation. This action clarifies roles, aligns expectations, and supports coordination with the OEM, hospital, and other partners across the chain.

- Clarifies responsibilities.
- Improves coordination across stakeholders
- Strengthens the basis for reliable reuse.

31 Technical capacity

Develop the technical capacity needed to inspect, clean, sterilise, test, and prepare selected components for reuse.

Recycle | Reuse

Even if products are returned correctly, reuse remains limited without the right equipment, processes, and expertise. This action strengthens the reprocessor's ability to handle complex components in a controlled and reliable way.

- Increases reuse feasibility.
- Supports safe preparation of components.
- Helps retain more functional value.

15 Transparency

Provide clear information on reprocessing capabilities, conditions, and limitations for reused components.

Recycle | Reuse

Other stakeholders need to understand what the reprocessor can and cannot do in practice. This action makes the reprocessor's capabilities, requirements, and limitations more visible across the chain.

- Improves alignment across stakeholders.
- Supports more realistic product and system decisions.
- Helps match design to reuse practice.

41 Safe handling protocol

Develop a clear protocol for the safe handling of returned components during receipt, storage, inspection, and reprocessing.

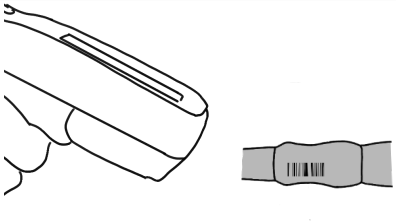
Recycle | Reuse

Returned medical components require careful handling to protect safety, quality, and reuse potential. This action creates clearer procedures for how products enter the facility and move safely through the reprocessing route.

- Improves safety in handling.
- Supports more consistent reprocessing.
- Builds trust in the reuse route.

20 Traceability

Set up traceability for returned components so it remains clear what has been received, processed, tested and released for reuse.



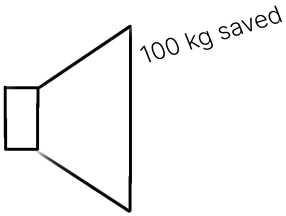
Recycle | Reuse

A reuse pathway requires clear visibility on what happens after products leave the hospital. This action creates a clearer record of how components move through inspection, cleaning, testing, and release.

- Improves visibility of reuse flows.
- Supports accountability across the chain.
- Strengthens trust in the reuse route.

24 Reporting

Report on reprocessing outcomes, release decisions, and rejected components over time.



Recycle | Reuse

Without reporting, it is difficult to see whether reuse is actually retaining value in practice. This action makes reprocessing performance visible and measurable over time.

- Supports learning and accountability.
- Improves insight into reuse performance.
- Helps track progress towards circular goals.

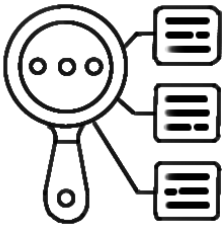
Government

Government plays a key role in creating the regulatory clarity needed for circularity to move beyond ambition. Even if products are redesigned, and stakeholders are willing to collaborate, the transition will remain difficult if responsibilities, approval routes and legal conditions for return, recycling, and reuse remain unclear.

By clarifying these conditions, the government helps create the framework within which other stakeholders can act with greater confidence.

7 Regulatory clarity

Provide clearer guidance on the conditions under which medical devices and their components can be returned, recycled, and reused.



Recycle | Reuse

Circular pathways remain difficult to implement when legal boundaries, responsibilities, and approval routes are unclear. This action creates a clearer framework for how recycling and reuse can be developed safely and responsibly.

- Reduces uncertainty across the chain.
- Supports more confident decision-making.
- Strengthens the basis for circular implementation.

CALL TO ACTION

04

Why is this transition worth pursuing?

This transition towards a more circular TAVI delivery system is worth pursuing from clinical, environmental, and economic perspectives.

This booklet shows that a phased pathway makes this transition more realistic in a complex clinical setting, because it allows confidence, routines, and collaboration to develop over time rather than requiring a full change all at once. In the shorter term, recycling can reduce waste and prevent the loss of valuable materials through incineration. In the longer term, reuse creates opportunities for higher value retention and new circular business models. Although not every step is immediately feasible, the findings show that circularity becomes more achievable when the transition is approached gradually and in a structured way.

A starting point for collaboration

The booklet should not be seen as an endpoint, but as a starting point for the transition.

For each stakeholder, it is important to understand not only their own role, but also how their actions connect to those of others. The roadmap and stakeholder actions in this booklet are therefore not meant to be read in isolation, but as part of one shared transition. Only when these efforts align can the system move from linear disposal towards more circular end-of-life strategies.

The next step is to bring the right stakeholders together and begin moving from ambition to action. A useful first step would be to form a small cross-stakeholder working group and use this booklet as a shared discussion document. From there, stakeholders can begin to align on both short-term and long-term ambitions, while identifying which actions can start now and which still require preparation.

This conversation can begin with a few questions:

- What actions can realistically start now?
- What conditions are still missing?
- What needs to be prepared today to make reuse possible later?
- Who depends on whom to move forward?
- What could be a realistic first pilot?

This booklet was developed to support that shared understanding. It aims to help stakeholders see where the transition is heading, what is needed to get there, and how different actions can contribute over time. In that way, it offers both a direction for the future and a starting point for action in the present.

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Creating change through stakeholder collaboration.

Eleonore van Hees

esch-r creating circular hospitals together

TU Delft

Erasmus MC