Circular design guideline

Short version

circular FOR zero

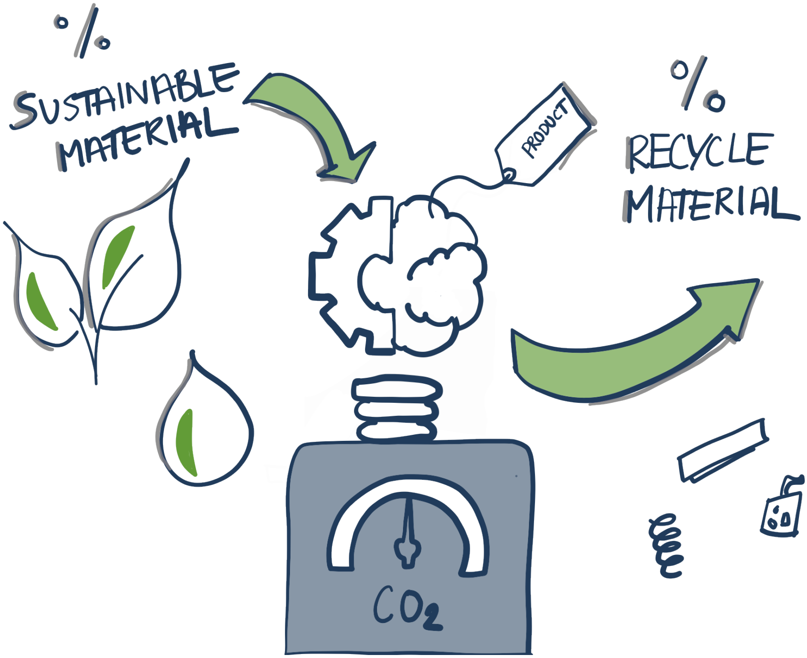
novo nordisk®

Foreword

I dream of a future where we provide sustainable products to our patients, and the Circular for Zero strategy sets a new, bold ambition for Novo Nordisk: To have zero environmental impact. To achieve this, product design must be based on circular principles reducing the use of resources and designing for recycling after use.

Applying circular principles in product design is a new challenge that we must solve together. This guideline is your handbook on circular product design. I want you to dare to set new standards, discover more sustainable solutions and deliver innova-tion to our patients.

Kenneth Strømdahl,
Senior Vice President


%
SUSTAINABLE MATERIAL
PRODUCT
%
RECYCLE MATERIAL
CO_2

Introduction

This Circular design guideline is made as a supporting tool for pipeline projects to inspire new ways to design sustainable products that originates from the thinking behind circular economy.

The new circular approach to products is a part of our new environmental strategy **Circular for Zero** that covers all Novo Nordisk activities.

This guideline covers products such as prefilled devices, durable devices, secondary packaging and electronic devices and modules.

1.

EMBRACING A CIRCULAR MINDSET

To achieve zero impact, we will embrace a circular mindset

Circular supply

Circular company

Circular products

Our new environmental strategy is called Circular for Zero. The ambition is bold and simple: to have zero environmental impact. To get there we are embracing a circular mindset – designing and producing our products so that they can be recovered and re-used, and reshaping our business practices to minimise consumption and eliminate waste by turning it into new resources.

Circular for Zero strategy commits the company to a significant shift towards circular thinking within three focus areas: Circular supply, Circular company and Circular products.

Environmental challenges that require immediate action

Every year at Novo Nordisk we use billions of litres of water and large amounts of energy and resources to manufacture medicines.

Our consumption is increasing, and the majority of what we buy is not sustainable.

We distribute hundreds of millions of vials and injection pens to people who need them – and the demand for our life-saving treatments is growing.

But did you know that over the course of **10 years, billions of our pens and vials** end up in landfill? And that each pen or vial takes over 100 years to decompose?

This puts us at the front line of some of the biggest environmental issues: climate change, water and resource scarcity, pollution and plastic waste.

We are here to drive change to defeat diabetes and other serious chronic diseases, but to do that we must play our part in creating a sustainable, healthy environment for the future.

circular FOR zero

Resources

Our consumption is increasing and the majority of what we buy is not sustainable

CO_2

Our emissions continue to rise

Waste

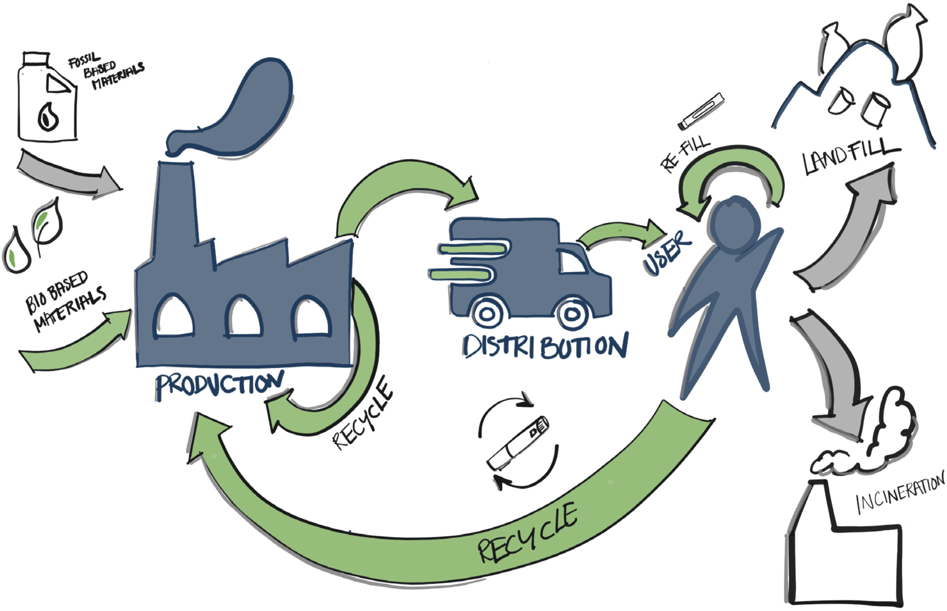
Billion pens and vials are expected to end in landfill over the next 10 years

Introduction to Circular economy

Looking beyond the current take-make-waste extractive industrial model, a circular economy aims to redefine growth by focusing on positive society-wide benefits. It entails gradually decoupling economic activities from the consumption of finite resources, and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles:

- Design out waste and pollution
- Keep products and materials in circulation
- Regenerate natural systems (e.g. by selecting sustainable materials)

For more information on Circular economy visit www.ellenmacarthurfoundation.org


FOSSIL BASED MATERIALS
BIO BASED MATERIALS
PRODUCTION
RECYCLE
DISTRIBUTION
USER
RE-FILL
LANDFILL
INCINERATION
RECYCLE

Four levers towards circular products: a guideline

Design for expected lifetime

Optimise the design to have the lowest impact during intended lifetime

Design for sustainable materials

Choose renewable, recycled and low impact materials

circular for zero

Design for no waste in production

Avoid scrap and design out waste

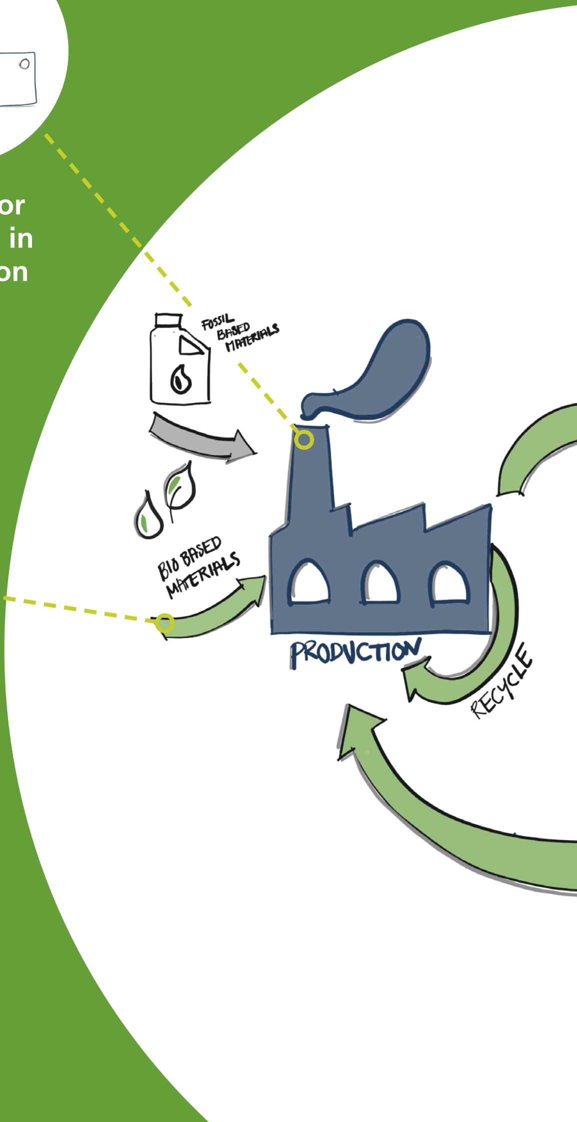
Design for recycling after use

Design products that are ready for recycling into new products

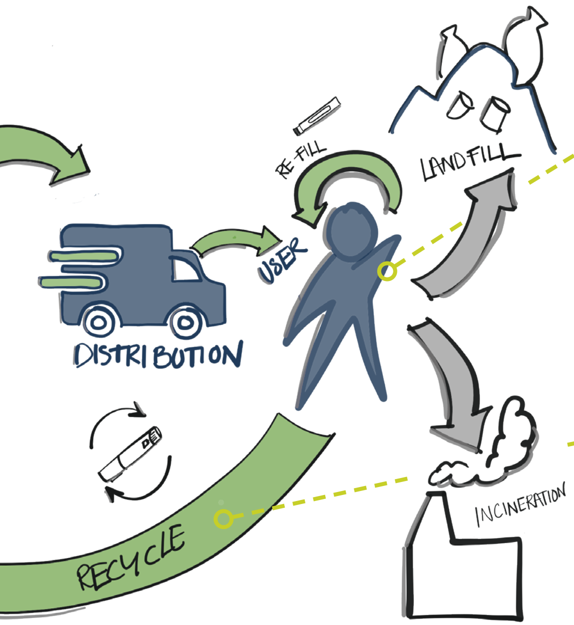
The four levers cover the circular product flow

Design for no waste in production

Design for sustainable materials



circular FOR zero



Design for expected lifetime

Design for recycling after use

2.

DESIGN FOR EXPECTED LIFETIME

WHY

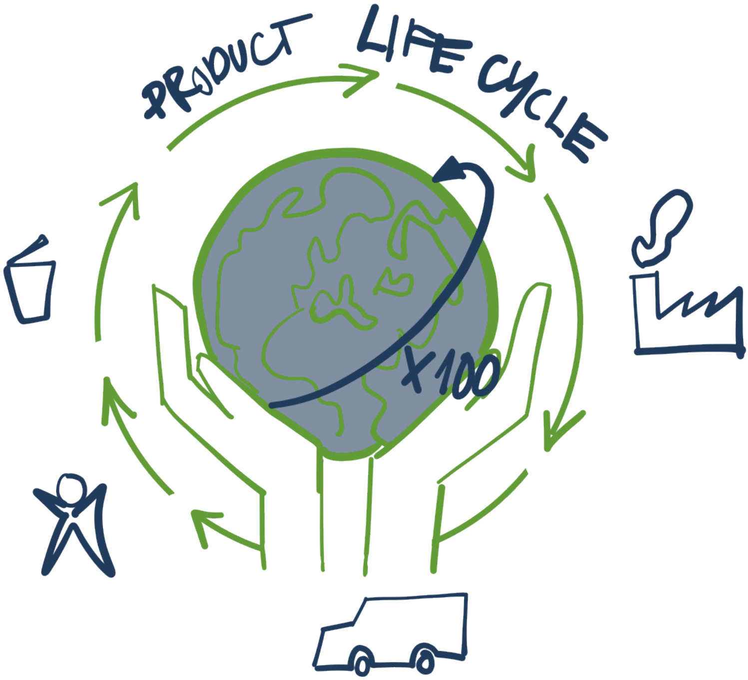
- The product must have the lowest environmental impact over its intended lifetime
- The environmental design strategy is highly dependent on the intended use:
    - A durable device should last as long as possible without loosing functionality.
    - A single use device has a fixed intended use time, and should lower the impact of manufacturing and disposal.

How to improve a products lifetime impact

A. Make a life-cycle assessment (LCA) of the current product or a comparable product and identify the largest contributors to the environmental footprint.

B. Select the design strategies that lower the lifetime impact the most (see examples to the right).

C. Can the intended use case be modified to improve the environmental impact?


PRODUCT LIFE CYCLE
X100

Key definitions

Environmental impact
The product can cause environmental impact in the form of for example water consumption, CO_2 emissions and non-degradable waste on landfills. The Circular for Zero ambition is to have zero environmental impact, which should be seen as a long-term aspiration. We must always strive for a lower environmental impact.

LCA – Life cycle assessment
A life cycle assessment is a method to calculate the environmental impact of a product across the life cycle including raw materials, production, use and waste management. In Novo Nordisk, we often present LCA results as a *product carbon footprint.* The carbon footprint is the sum of emissions contributing to climate change across the product life cycle. We have developed an LCA model that allows for quick assessments of carbon footprint based on a bill of materials.

Intended lifetime
New products often has a set lifetime determined by the use pattern. This can vary from a single-use product that is discarded after one time use to a durable product with a lifetime of several years.

3.

DESIGN FOR SUSTAINABLE MATERIALS

Use renewable, recycled or low impact materials

WHY

- To avoid use of fossil based materials and reduce carbon footprint
- To leverage circular material flow

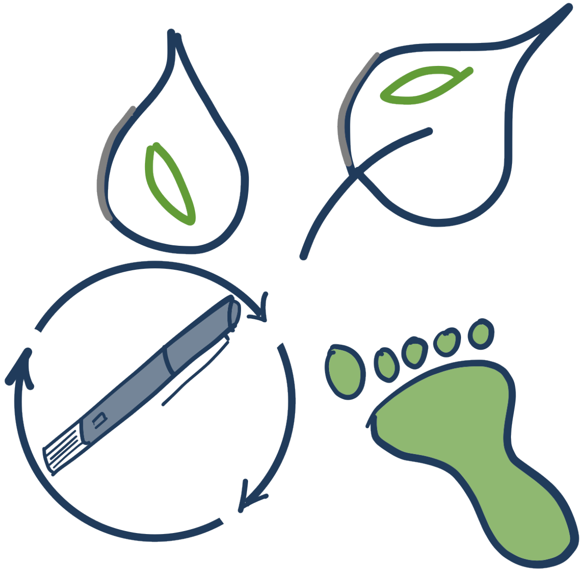
How to select sustainable materials

A. Include carbon footprint and sustainable origin in the material selection in collaboration with your material expert:

  - What material gives the lowest carbon footprint for the application?
  - Is materials with bio-based or recycled content available?
  - Can the material be recycled after use?

B. Consider other factors such as harmful chemicals, heavy metals and manufacture by-products in collaboration with your materials expert.

C. Sourcing, manufacturing and cost could be challenging for some of the new sustainable material alternatives.



Key definitions

Bio-based materials
Materials that can be derived from plant and animal-based sources can be bio-based. Using bio-based materials can lower the environmental impact and create a future demand for sustainable materials enabling the transition to a circular economy. However it is important to consider how the bio-content is sourced to avoid ethical concerns regarding food scarcity and deforestation (ask your materials expert for guidance).

Example: Most cardboard and paper is based on wood. New plastic grades within PE, PP and POM are becomming available with bio-based origin and with similar quality properties.

Recycled content
In a circular economy, used products should become the basis of new products. Use of recycled material in the devices should lower the embodied energy in the product, also when taking sourcing and reprocessing of the materials into account.

Carbon footprint
A carbon footprint is a measure of the environmental impact across the full lifecycle of the product. More than 50% of the carbon footprint of FlexPen® comes from the use of raw materials for components and secondary packaging.

Key questions for Novo Nordisk project archetypes

Prefilled plastic devices

- Several bio-based plastics currently exist: PP, PE and POM. Could these be relevant for your project?
- Could recycled plastic be a possibility (as a result of mechanical recycling or chemical recycling)?
- Consider other factors such as harmful chemicals, heavy metals and manufacturing by-products.

Secondary packaging

- In general, use materials from renewable sources (paper and cardboard rather than plastic).
- Use certifications such as FSC or Cradle2Cradle to ensure sustainable sourcing.
- Inc, varnish and glue should not contain harmful chemicals and heavy metals that may cause a threat to the environment or hinder high quality recycling after use.
- Use less material wherever possible to lower the carbon footprint.

Durable devices

- Durable devices are often made from high performance metals, with a high in-market recycling rate.
- Can special alloys be replaced with more common metals with a higher recycling rate and lower carbon footprint, without compromising durability?
- Can sustainable plastic materials be used to lower the impact of selected components?

Electronic modules and devices

- Electronics have a relatively high environmental footprint due to the energy needed for extraction of raw materials and a high energy consumption in production (clean room conditions).
- Batteries and magnets add to the environmental footprint of a device, but not in the same degree as electronics.
- Currently no sustainable materials have been identified, but use your LCA expert to understand the impact of alternative designs.

4.

DESIGN FOR NO WASTE IN PRODUCTION

WHY

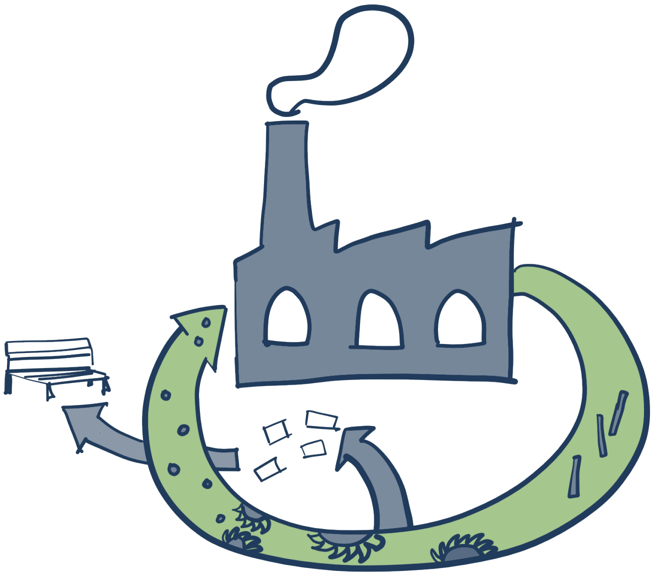
- The largest impact on processes selection and waste generation during production can be made in the design phase.
- We need to show the good example on circular production and lead the way with both existing and future devices.
- The highest recycling value can be obtained with small recycling loops and a short supply chain from waste to new product.

How to design for no waste in production

A. Design out waste by eliminating scrap from component manufacturing, ensuring long shelf life of modules and optimizing the volume utilization of packaging.

B. Select the processes with the lowest energy and material consumption per delivered unit.

C. Design for internal recycling by selecting materials that can be recycled and enable efficient separation of material types.



Key definitions

Production waste
Any use of materials or energy that does not add value to the finished product is characterized as production waste. In a circular design perspective, new solutions can become relevant e.g. to avoid the loss of material quality.

Example: When a label is used for a carton or a device, waste is generated in the form of discarded release liner that carries the label to the application.

Example: Sometimes poor volume utilization of secondary packaging & poor pallet utilization leads to few devices per palled in the warehouse and thereby waste of space in the factory and supply chain.

Downcycling
Downcycling is to reuse a material for a new product of lower value than the original product. It is often a result of a reduction in material quality during the recycling process due to mixing with other materials and a lack of traceability.

Example: An example is the combined fractions with different plastic grades mixed in the same recycling container, thereby making it hard to specify material and process characteristics for the next use.

Key questions for Novo Nordisk project archetypes

Prefilled plastic devices

- Can we design out scrap in moulding and assembly?
    - Molding of very small parts (~0.1 g) will often lead to material scrap from cold-runners which should be avoided.
    - Rubber components leads to large amounts of scrap due to the material cut away after moulding.
- Consider the shelf life of sub assemblies. As an example could heavily spring loaded motor modules lead to scrap due to a reduction in allowed storage time.
- Is new manufacturing processes that allow for more efficient & less energy consuming manufacturing with the same end result available?
- Design for internal recycling:
    - Consider how the expected scrap of assembled pens can be disassembled or crushed locally, and sorted into valuable material fractions.
    - Novo blue plastic has a lower recycling value than lighter colours as the possibilities for re-colouring is limited.

Secondary packaging

- Can we reduce the weight and volume of secondary packaging to save space and optimize transport?
- Is the pallet utilization during transport and storage > 80%?
- Standardize to reduce pages in leaflets and print on cartons. Limit the number of variants
- Is new manufacturing processes and equipment available that allow for more efficient and less energy consuming manufacturing?
- Can we avoid scrap from small batches e.g. by inline printing instead of pre-printed labels.

5.

DESIGN FOR RECYCLING AFTER USE

WHY

- Currently many products end up at landfills, which is a waste of resources and may be a cause of pollution.
- We take responsibility for the end-of-life of our products
- Think of it as: We design waste. We have the possibility to design the products so it is easy to recycle useful materials at their end-of-life.

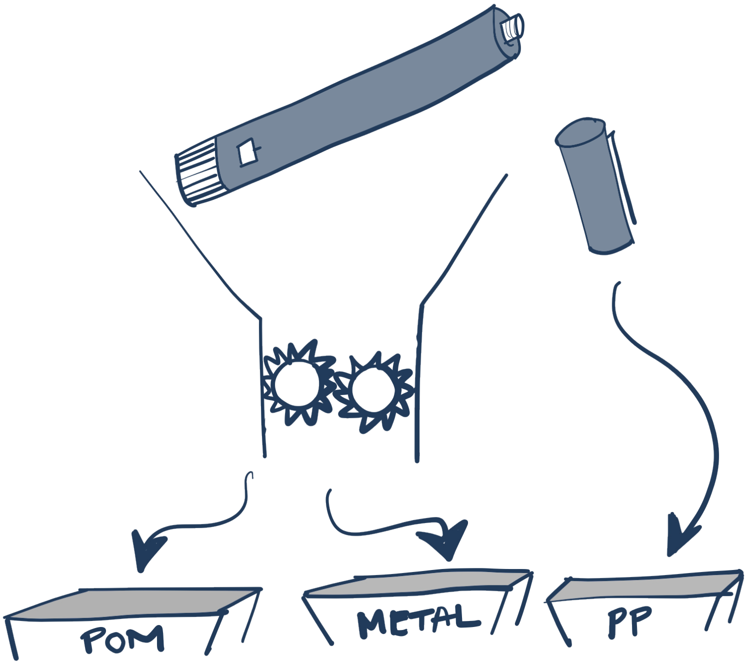
How to design for recycling

A. Which materials do the device consist of and how can they be recycled for use in new products? (Ask your materials expert for guidance)

B. Map in which markets the products will be disposed

  - What are the recycling options and legislation in those markets now and in the future?
  - What could a potential future recycling scenario look like?

C. Design the product for recycling in the target markets.


POM
METAL
PP

Key definitions

Recyclable
A recyclable product can be collected and disassembled in clean material fractions for reprocessing or remanufacturing.

Design for recycling
Design for recycling ensures that materials, components or modules can be easily separated after the intended use of a product. It can be applied to increase the future rates of material and component reuse and recycling. Products can be designed for manual or automatic separation or crushing depending on the product type, recycling value and market.

Clean material fractions
A clean material fraction consists of only one material type and therefore has a higher recycling value, as it is easier to use in new products. It is easier to obtain clean fractions when you use few materials and they are not glued together.

Example: PET drinking bottles, aluminum cans, glass bottles and cardboard is easy to sort and therefore have a high recycling rate.

Key questions for Novo Nordisk project archetypes

Prefilled plastic devices

- Map the recyclability of each material used in the devices: Can it be used in new products without losing material quality?
- Design for disassembly or crushing: Consider where the product will be disposed and the availability of recycling options in that country?
- Use as few material types as possible, as plastic fractions need to have a high purity to represent a recycling value.

Secondary packaging

- Select as few different materials as possible and make them easy to separate in clean fractions after use.
- Consider not mixing materials, e.g. plastic label on carton.
- Is it possible to facilitate proper recycling by nudging, labelling and graphics?
- Consider where the product will be disposed and the future recycling options in that country?

Durable devices

- With relatively low volumes and high material value a take back system could be an efficient way to handle waste
- Consider if sub-modules or components could be given a new life in new products? E.g. by functional testing or sterilisation?
- Can we communicate how the device should be recycled and the content of valuable materials?

Electronic modules and devices

- Can partnerships increase the likelihood of circular material flow?
- Is it possible to facilitate proper recycling by digital user input?
- Devices with both electronics and medicine will be difficult to handle from a waste perspective: Always make the electronic module easy to separate from drug delivery devices.

Text and internal review:
Mattias Ingerslev (MIIG), Device Manufacturing Development

Linn Heiden (LHID), Device Research & Development

Nanja Hedal Kløverpris (NNHK), Corporate Environmental Strategy

Jesper Bøgelund (JSBQ), Device Research & Development

Camilla Liisborg (CLZZ), Device Research & Development

This work was carried out with external review from MATChE:
Nicklas Christian Funk, Research assistant, DTU Mechanical Engineering,
Section of Engineering Design and Product Development, MATChE

Mathias Malmkvist Bahrenscheer, Research assistant, DTU Mechanical Engineering,
Section of Engineering Design and Product Development, MATChE

Daniela C.A. Pigosso, Associate professor, DTU Mechanical Engineering,
Section of Engineering Design and Product Development, MATChE

Supported by Industriens Fond

Layout:
Julie Plovgaard (JLPV), Device Research & Development

Illustrations:
Linn Heiden (LHID), Device Research & Development