Toujeo environmental Life Cycle Assessment (LCA) technical summary report

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Peer-reviewed study by an independent panel, following ISO 14040 and 14044 standards.

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1. References, acronyms, symbols & units

References

ISO 14040/14044	Base standards for LCA conduction & reporting
PEF method	European Commission's methodology for the environmental Life Cycle Assessment (LCA) of products & their environmental footprint communication – based on ISO 14040/14044

Acronyms, symbols & units

ABS	Acrylonitrile butadiene styrene
CFF	Circular Footprint Formula
DP	Drug product
DS	Drug substance
EF	Environmental Footprint
eq.	Equivalent
IU	Insulin unit
kg	Kilogram
LCA	Life cycle assessment
m^3	Cubic meter
MJ	Megajoule
P	Phosphorous
PC	Polycarbonate
POM	Polyoxymethylene
PP	Polypropylene
PEF	Product Environmental Footprint
PTFE	Polytetrafluoroethylene
Sb	Antimony
vs.	Versus

2. Context and objectives

The connection between the health of our planet and that of people is increasingly clear. As a global healthcare leader, our mission at Sanofi extends beyond developing life-changing medicines and vaccines: it encompasses our contribution to the environment and society.

As part of this commitment, we are designing our medicines and vaccines for environmental sustainability through Eco-design. At Sanofi, we have committed to an Eco-design approach for 100% of our new products by 2025 and the 20 top-selling products by 2030.

Sanofi has been working for years to improve its insulin portfolio environmental profile, today used by millions of patients with diabetes worldwide.

Some of the implemented environmental improvement levers for its insulin portfolio are:

- Optimization of the Drug Substance manufacturing process
- PTFE removal from pen composition
- Reduction of the leaflet size
- Development of an injection device containing twice the daily dose

This summary describes the execution and outcomes of the environmental life cycle assessment (LCA) of Sanofi's Toujeo insulin, a top-selling product.

The goals of the LCA study are the following:

- Execute an ISO 14040/14044 compliant LCA of Toujeo full value chain, using primary data on manufacturing stages.
- Identify the major environmental impacts throughout the Toujeo full value chain.
- Compare several scenarios covering implemented Eco-design actions in terms of manufacturing, device and packaging optimization and take-back program to quantify the potential related environmental improvements.
- Identify new specific and robust environmental improvement levers.
- Communicate the results of an Eco-design approach version of Toujeo, resulting from the environmental improvement levers executed between 2017 and today, to support Sanofi's external environmental claims with an LCA reviewed by an independent third party.

3. Scope of the LCA

Aligned with ISO 14040/14044 requirements, environmental impacts of medicines are assessed and compared to each other according to the function they fulfil, which enables fair comparisons.
Given that the administrated amount of insulin (dosage) differs between market and diabetes types, the selected functional unit is:

"Provide one daily dose of insulin appropriate for an average Type 1 or Type 2 diabetic patient, based on standard clinical guidelines in an average market".

Distribution and use in average European market is considered, where the average daily dose is 31.80 insulin units (IU)[*].

The reference impact assessment covers Toujeo full value chain ("cradle-to-grave" approach): Drug Substance (DS) and Drug product (DP) manufacturing, DP filling process into cartridge, and manufacturing of packaging and device, storage and distribution, use phase, packaging and device end-of-life treatments.

Several scenarios are evaluated to compare environmental performance across different product presentations and Eco-design improvement levers executed since 2027:

A. Eco-design improvement levers:

- Optimized manufacturing process, yielding "insulin Glargine 4.0" (vs. former 3.0 generation)
- PTFE removal in SoloStar pen (ahead of regulatory requirements)
- Reduction of the leaflet size (50% weight reduction)
- Take-back program and recycling programs to reduce waste and support responsible disposal practices

B. Environmental performance comparison across product presentation:

- Use of Toujeo SoloStar vs. DoubleStar device (1.5 mL vs. 3 mL cartridges).
- TouStar is a 3-year reusable device commercialized in India market

Environmental impacts are characterized using the Environmental Footprint (EF) 3.0 method from the European Product Environmental Footprint (PEF) method[†]. Multi-criteria results are provided on 16 environmental impact

[*] Insulin posology varies between countries due to differences in healthcare systems, cultural and dietary factors, patient demographics, clinical practices, and access to diabetes care resources.
[†] European Platform on environmental Life Cycle Assessment. Accessed APRIL 2025. https://eplca.jrc.ec.europa.eu/EnvironmentalFootprint.html

indicators. This technical summary report provides deeper analyses only on the 6 most relevant (following the PEF approach for priorization)[‡]: Climate change (kg CO_2.eq), Non-renewable energy resources (MJ, net calorific value), Mineral and metal resource use (kg Sb eq.), Water use (m^3 world eq. deprived), Freshwater eutrophication (kg P eq.) and Particulate matter formation (disease incidence).

Water use and Mineral and metal resource use impact indicators present higher uncertainty due to limitations in localized water scarcity characterization factors (related to locally available water for humans and ecosystems), and uncertain resource depletion potential, respectively.

[‡] Process consisting in identifying top impact categories (i.e. cumulating 80%) contributing to a single score (expressed in Points) resulting from the sum of normalized and weighted results (using PEF factors) in all 16 impact categories.

4. Data and assumptions

Environmental Life Cycle Assessment (LCA) modelling is performed with an internal Sanofi LCA software[§], using ecoinvent v3.8 (cut-off version) as background database.

The figure below illustrates the boundaries of the assessed value chain:

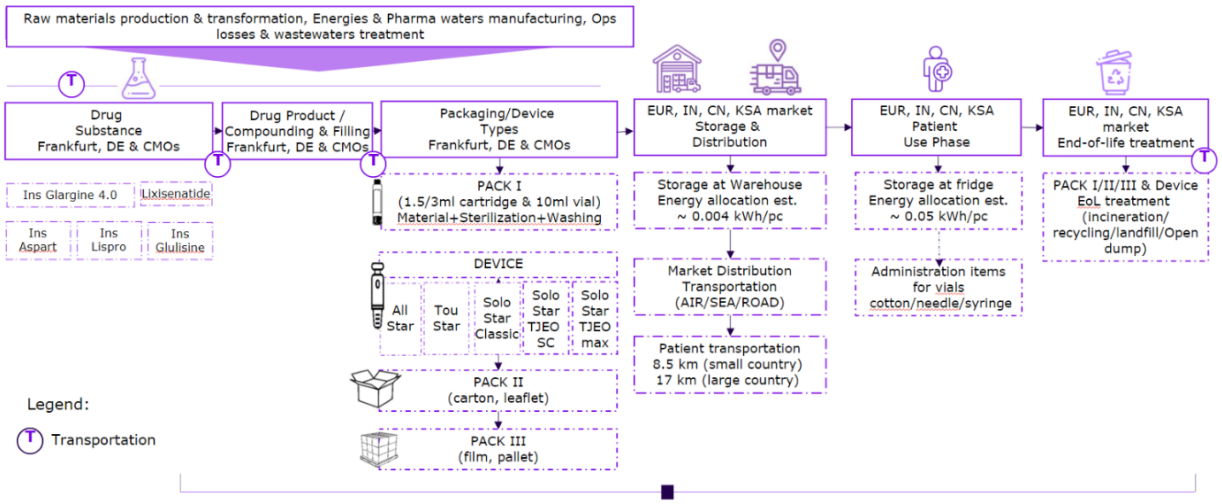

Figure 1 – Toujeo environmental LCA system boundaries

The table below summarizes the key data included in the Toujeo environmental LCA modelling process, depending on primary data obtained and secondary data availability:

LIFE CYCLE PHASE		INCLUDED INPUTS/OUTPUTS
Manufacturing	***Drug Substance***	▪ Raw material production and supply (incl. transport, and packaging of consumables) ▪ Operational losses treatment ▪ Energy consumption (electricity, natural gas) ▪ Waste treatment (wastewater, hazardous waste, consumables) ▪ Formulated DS transportation to DP manufacturing site

[§] Sanofi Eco-design tool, EDDi was certified in 2024 by Bureau Veritas, a world leader independent in certification services, as compliant with ISO 14040 & ISO 14044 standards.

	Drug Product	▪ Raw material production and supply (incl. transport) ▪ Energy consumption (electricity, natural gas) ▪ Waste treatment (wastewater, hazardous waste, consumables)
	Packaging Device	▪ Primary (cartridge) to tertiary packaging types: Raw material production and supply (incl. transport) and transformation (e.g. molding material) ▪ Device (pen): Raw material production and supply (incl. transport) + energy for transformation & assembly + operational losses and waste treatment + inter-site transportation (incl. polystyrene trays)
Storage & distribution	***Storage***	▪ Energy consumption for storage in Sanofi warehouses, and at the distribution centers (DCs) and at the pharmacy
	Distribution	▪ Transportation (refrigerated truck) from warehouses to DCs ▪ Transportation (refrigerated truck or plane) within local destination country ▪ Patient travel from home to pharmacy for medicine pick-up
Use	***Use***	▪ Energy consumption for storage in patient's fridge ▪ Consumables production and disposal treatment (for injection: cotton, antiseptic, medical plaster)
End-of-life	***Packaging & Device***	▪ Waste collection & transport (default) ▪ End-of-life treatments of primary, secondary, tertiary packaging types and device components (default European average recycling, incineration and landfilling rates per material type) ▪ Take-back program: 100% polypropylene and steel recycling, 100% efficiency

Table 1 - summary of Toujeo LCA study perimeter

Direct primary data on Sanofi's manufacturing processes was collected, including energy consumption for specific insulin manufacturing, raw materials, consumables, waste generation and treatment. Frankfurt manufacturing site (Germany) uses 100% renewable electricity.

Details on packaging materials and device (injection pen) components were obtained from the suppliers and Sanofi specification documentation. The cartridge is the primary packaging type (in contact with the DP). It is inserted in the device (SoloStar pen), composed of various components sub-assembled in Finland, which site also uses 100% renewable electricity. Intermediary transport of sub-components involves the use of disposable polystyrene trays which are modelled. The final device is then assembled at the Frankfurt manufacturing site (Germany).

Secondary packaging type consists in the carton box (containing either 1 vial or 5 devices) and leaflet. Finally, tertiary transportation packaging includes the cardboard box, the plastic film and a wood pallet considered reused 20 times.

For product distribution default scenarios from the European Product Environmental Footprint (PEF) were used to represent average transport modes and distances used in France, the UK and Italy.

Self-administration at home was exclusively modelled as representative of the main administration mode (vs. in healthcare facility). Default roundtrip distance and modes (e.g. car, public transport, foot…) are assumed for patient personal travel to the pharmacy.

End-of-life disposal of device, primary and secondary packaging is modelled according to European average recycling, incineration and landfilling rates. The PEF's Circular Footprint Formula (CFF)[**] was used to allocate shares of material and energy recovery impacts and benefits (avoided virgin materials or conventional energy sources) to the product.

[**] The Circular Footprint Formula methodology article. Accessed APRIL 2025.https://www.eu4environment.org/news/circular-footprint-formula-or-how-to-calculate-the-emissions-associated-with-the-recycled-content/

5. Environmental impact assessment results

Environmental impact drivers

Figure 2 below details the environmental impact contributions of the different life cycle stages of Toujeo SoloStar with the implemented Eco-design levers - DS 4.0 manufacturing process, PTFE removal in device, reduced leaflet size, take-back program – for three most critical environmental impact indicators. Patient travel is excluded as there is an important uncertainty on the modelisation approach, impacting visibility on the other medicine life cycle stage relative contributions.

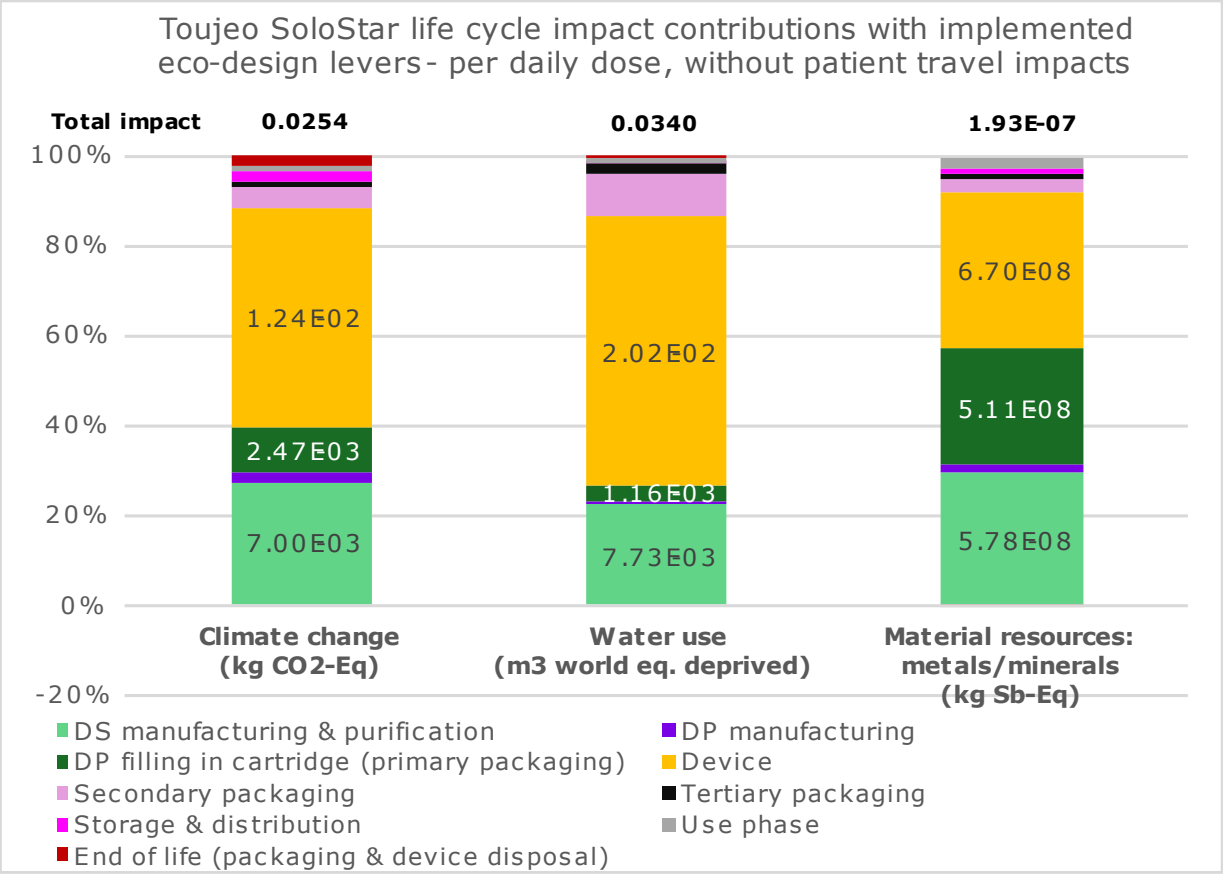

Figure 2 – Toujeo SoloStar full value chain environmental profile for one daily dose for most critical impact indicators excluding patient travel.

- **Drug substance manufacturing** contributes to 29–35% of the total impact in the 3 categories, with natural gas consumption and raw materials (e.g. glucose, water for injection, urea) as key environmental impact drivers. The use of 100% renewable energy use

at the Frankfurt manufacturing site minimizes electricity consumption impacts.

- **Primary packaging** accounts for 3–27% of all impacts due to energy-intensive sterilization and the use of borosilicate glass and aluminum components.
- **SoloStar device production** contributes to 35–60% of each environmental impact. Key environmental impact materials include polypropylene (PP), polycarbonate (PC), and polyoxymethylene (POM).

Benefits of Eco-design levers and specific product presentations

A. Eco-design improvement levers

Sanofi's Eco-design strategy has focused on optimizing life cycle stages from insulin manufacturing to product disposal, thereby reducing material use and enhancing manufacturing efficiency per insulin dose.
Key measures implemented include:

- **DS manufacturing process optimization**: Sanofi DS manufacturing experts have reviewed and optimized the glargine synthesis process ('glargine 4.0' vs. initial 'glargine 3.0'), resulting to an optimization of DS increase of 50% per batch. This environmental optimization leading to 33% impact reductions of the DS manufacturing for all environmental impact categories. Over Toujeo full value, total impact savings range from 10% to 13% across the key impact categories, as shown in Figure 3.

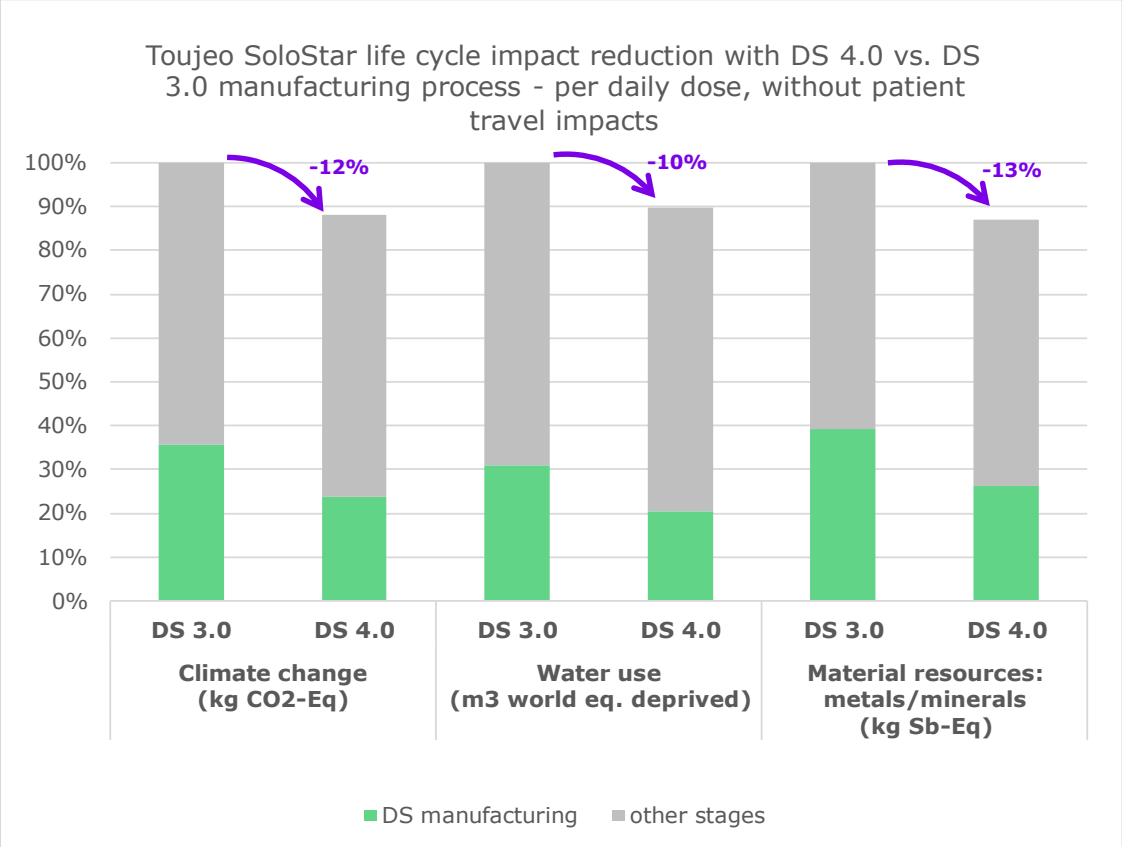

Figure 3 - Toujeo SoloStar impact reductions for one daily dose with DS manufacturing glargine 4.0 process vs. glargine 3.0 (base case), for key indicators (excluding patient travel)

- **PTFE removal in SoloStar**: ahead of European regulatory requirements to ban persistent toxic substances in 2030[††], Sanofi has already redesigned the SoloStar pen to remove PTFE, replaced with the main materials of the concerned pen components (POM, PBT). In addition to the environmental aspects targeted by regulation, this has positive environmental savings in several impact categories as the PTFE-free SoloStar version has 32% less impact on carbon footprint, 10% less impact on water use and finally 13% less impact on mineral and metal resource use. Considering Toujeo full value chain, this relates to 14% lower carbon footprint impact decrease and 13% less material resource use are achieved.

- **Leaflet size reduction**: By halving the leaflet weight by 50% compared to initial production, Sanofi has decreased both the resource intensity and disposal impacts of its secondary packaging. This translates into reduced secondary packaging impacts around 8-9% in carbon footprint, water use and mineral & metal resource use categories.

[††]The EU's chemicals strategy for sustainability towards a toxic-free environment. Accessed APRIL 2025. https://environment.ec.europa.eu/strategy/chemicals-strategy_en

- **Take-back program and recycling programs :** In partnership with Novo Nordisk, Eli Lilly and Merck KGaA, Sanofi has launched a pilot take-back program and recycling programs 3 countries in Europe (UK, France, Denmark). This LCA study considers the reverse logistics of device program, including drop-off containers, recycling bags, and transport of the pens to the recycling infrastructure as well as recycling burdens and benefits following the CFF methodological approach[‡‡].

Overall, recycling polypropylene and steel components leads to a reduction of 3-4% for Toujeo full value chain carbon footprint, emissions water and material resource use. Further scaling could enhance material circularity across markets.

B. Environmental performance comparison across product presentations

The positive environmental repercussions of switching from SoloStar single dose medical device to DoubleStar, a device that is used for two injections, have been quantified. Doublestar is recommended for people using at least 20 units of insulin (IU) per day.

The DoubleStar device, that contains twice as much insulin units as SoloStar, cuts all device manufacturing-related impacts by approximately half (41% less water user to 49% less material use) per daily dose compared to SoloStar device. Over Toujeo full value chain, considering also the repercussions on the other environmental improvement levers (e.g. packaging amounts per dose, distribution, end of life), the environmental reduction on carbon footprint is reduced by 35% as per Figure 4. Indeed, though the device components differ in weight and material composition, PC-ABS, PC and POM remain the most impactful materials but do not intensify much the DoubleStar unitary impact. For material resource use environmental impact indicator this translates into 24% reduction, and up to 42% for water use.

[‡‡] The Circular Footprint Formula methodology article. Accessed APRIL 2025. https://www.eu4environment.org/news/circular-footprint-formula-or-how-to-calculate-the-emissions-associated-with-the-recycled-content/

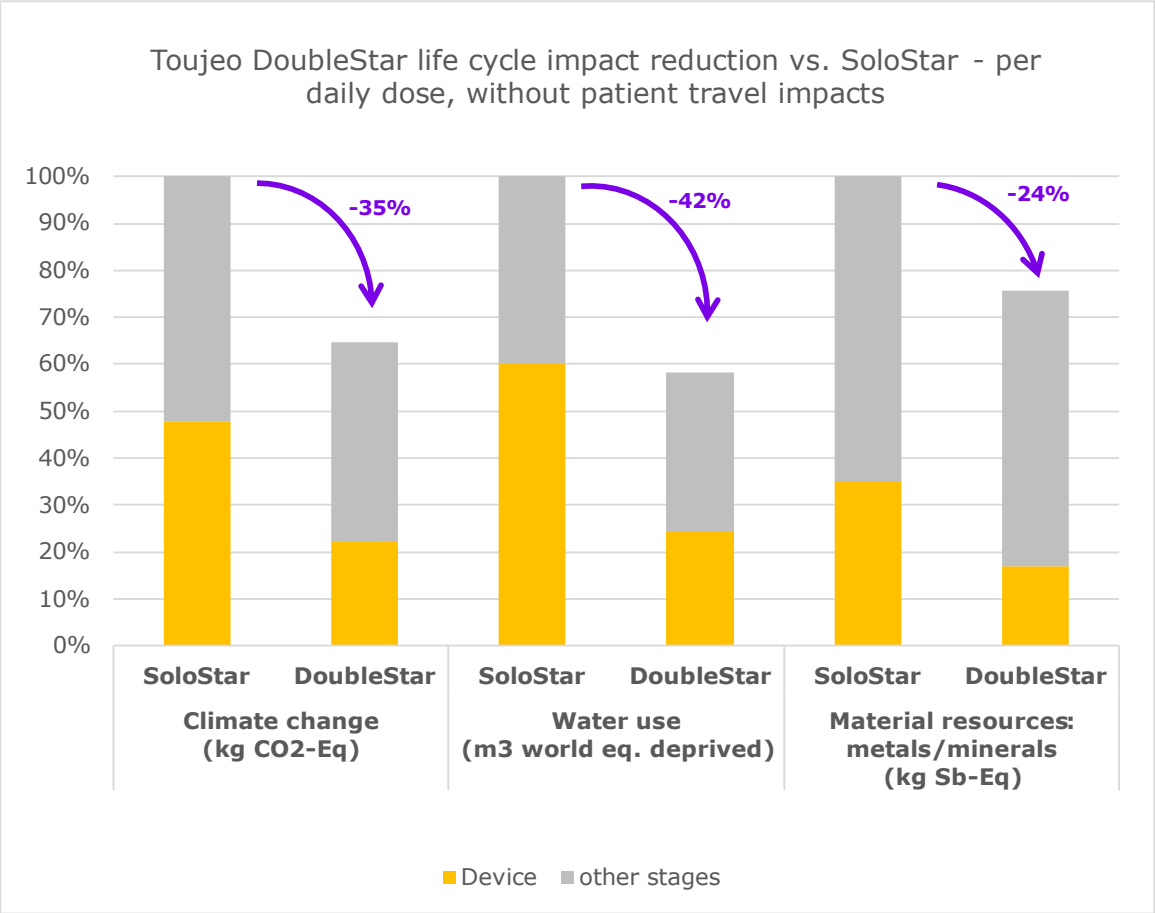

Figure 4 - Toujeo DoubleStar vs. SoloStar for one daily dose, for key indicators (excluding patient travel)

The TouStar device is a 3-year reusable device which uses insulin cartridges with cartridge holder replaced by the patient, instead of replacing the insulin device as with Toujeo SoloStar. As a result, using a TouStar device for a patient in India allows to reduce climate change impacts by 47% on the whole life cycle of the product.

		Disposable device	Reusable device	Device Percentage Reduction (%)	Medicine Percentage Reduction (%)
Climate change	**kg CO2eq.**	0,024	0,013	-97%	-47%
Resource use, fossils	**MJ**	0,348	0,194	-98%	-44%
Resource use, minerals and metals	**kg Sbeq.**	1,42E-07	1,07E-07	-97%	-25%
Water use	**m3 depriv.**	2,46E-02	9,53E-03	-99%	-61%
Eutrophication, freshwater	**kg P eq.**	3,44E-06	1,99E-06	-97%	-42%
Particulate matter	**disease inc.**	1,05E-09	4,24E-10	-99%	-60%

Table 2 – environmental comparison - Toujeo TouStar and Toujeo SoloStar (IN)

6. Conclusions

Sanofi has been working for years to improve Toujeo environmental profile by optimizing each step of its entire lifecycle.
Our implemented Eco-design approach has positive environmental impacts: over the years, **per day and for millions of patients worldwide, Sanofi Toujeo SoloStar product offers reduced environmental impacts from 11% to 27%** as presented the Figure below.

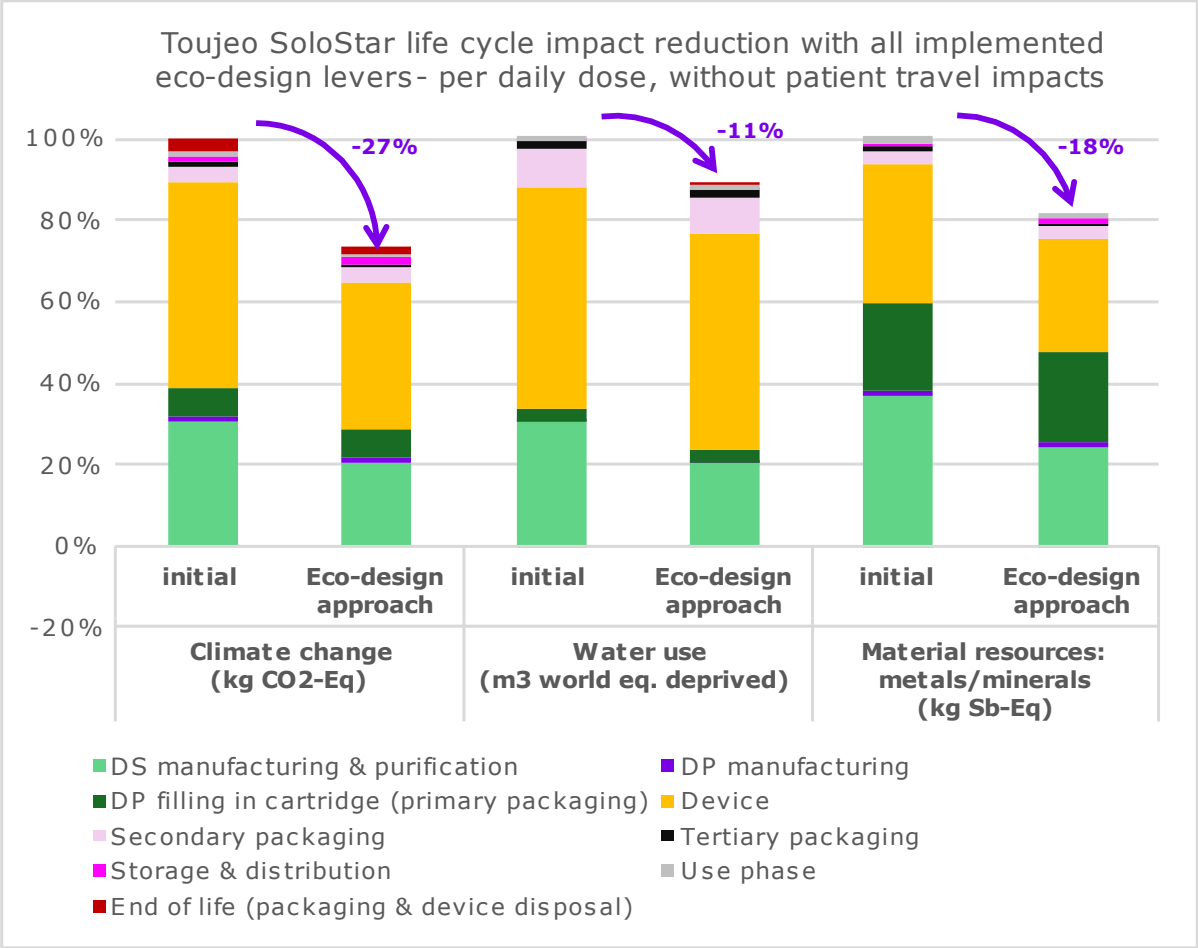

Figure 5 - Toujeo SoloStar with all executed Eco-design levers, for one daily dose, for key environmental indicators (excluding patient travel)

Our implemented Eco-design approach has positive impact for millions of patients worldwide, Toujeo offers a reduced environmental profile. Considering the treatment of 1,000 patients over 5 years, cumulated impact environmental reductions are equivalent to:

- 45 500 km driven by car[§§]
- 365,850 water bottles[***]
- Metal and mineral use to produce 368 Li-ion batteries[†††].

Sanofi's commitment to conduct an Eco-design approach is evident in the significant reductions achieved through initiatives like optimized manufacturing process, reusable delivery devices, and improved packaging composition. These efforts align with global sustainability goals in the pharmaceutical industry.

Committed to our contribution to environment and society, we will continue to improve [TOUJEO]'s and Sanofi's environmental footprint.

Learn more about Sanofi's commitment to the environment [hyperlink]

§§ Source: Ecoinvent 3.10, based on a medium-sized petrol car (EURO5), considering tailpipe emissions only.
*** Source: Ecoinvent 3.10, assuming average 0.5-L water bottles and European tap water scarcity impact.
††† Source: Ecoinvent 3.10, considering average 90 g smartphone batteries.