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LCA and LCC analysis

Surgical drapes and gowns

Presentation of the results of the comparative life cycle analysis between reusable and disposable fabrics.

Ecomondo 4/11/2025



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Project objectives and methodology

- Carry out a **comparative analysis of the environmental and economic impacts of reusable and disposable surgical drapes and gowns.**
- Compare the purchasing and management services of **single-use solutions (TNT)** with the **rental and laundering services of Reusable Technical Textiles (TTR)**. For both types of textiles, the sterilization phase will also be considered.
- Provide technical information to **companies, suppliers, and healthcare organizations/contracting authorities**, highlighting the benefits and the overall environmental and economic costs of the two solutions being compared, using the Life Cycle Assessment (LCA) approach

METHODOLOGY

- LCA – Life Cycle Assessment in accordance with ISO 14040 and ISO 14044
- Environmental impact assessment: European PEF (Product Environmental Footprint), including the calculation of GWP (Global Warming Potential – climate change) and a single aggregated indicator for other environmental impacts.
- LCCA – Life Cycle Cost Analysis – Conventional LCC methodology (direct and indirect costs) – Environmental LCC (cost savings from resource use) + qualitative analysis of externalities



Functional unit and items under analysis

The functional unit is **one item made of specific textiles that make it suitable for use in the operating room, whether included or not in a dedicated or standard kit, reused 60 times.**

TERM	ARTICLE	AVERAGE ITEM WEIGHT (kg)		ITEM AREA (m ²)
		TNT	TTR	BOTH
Characteristics	Reinforced sterile gown, size L	0.134	0.350	-
	Reinforced sterile gown, size XL	0.142	0.375	-
	Standard sterile gown, size L	0.100	0.300	-
	Standard sterile gown, size XL	0.115	0.325	-
	Main table drape	0.243	0.578	3.96
	Lateral drape	0.050	0.185	0.81
	Pillowcase	0.137	0.323	2.24
	Head drape	0.272	0.663	4.44
	Foot drape	0.221	0.532	3.60

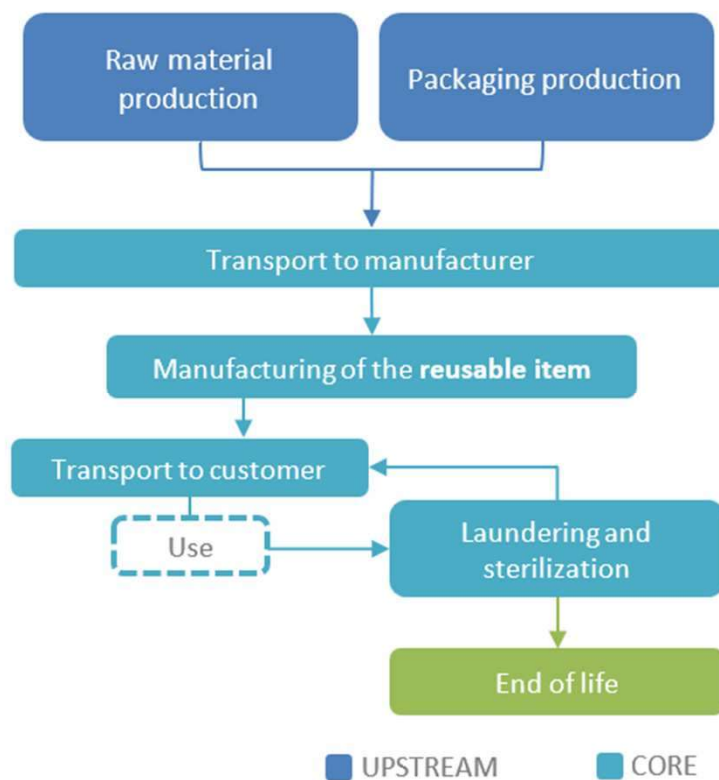
NOTE 1: The area was calculated based on technical data sheets shared by manufacturers and laundries.

NOTE 2: Values shown in bold are averages.

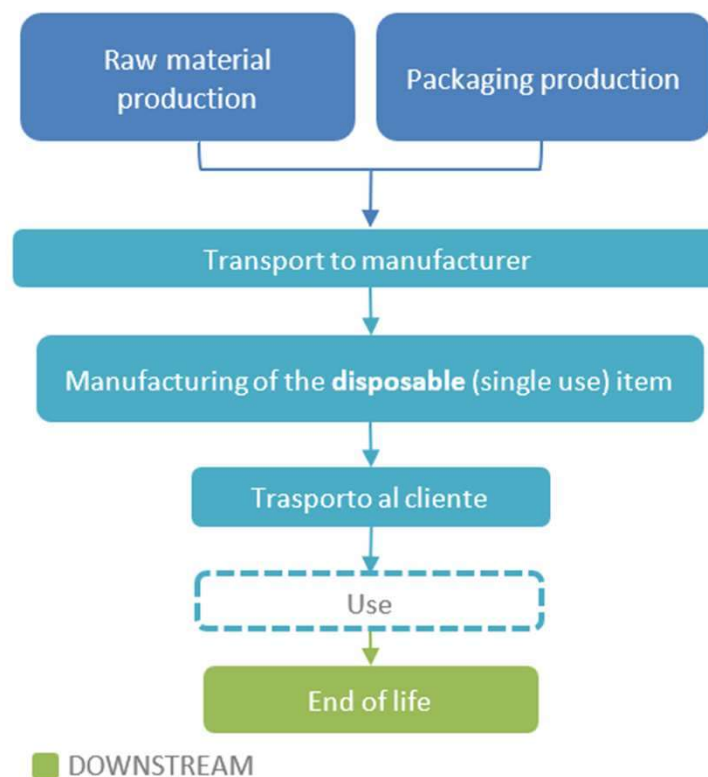


Life cycle boundaries

TTR



TNT





Data and assumption analysis

Data sources: data collection from 4 industrial laundries, 2 healthcare organizations/contracting authorities, checklists and data collection from 2 textile suppliers, literature data, and databases (Ecoinvent). The data refer to 2023.

ITERM	ARTICLE	TNT	TTR	
Materials	Reinforced gown	Bi-layer laminated : PP spunbound + PE film (source: technical datasheets)	Two 85% PES knitted fabrics bonded together with an 8% PTFE membrane, glued with 7% polyurethane adhesive (source: technical datasheets, Creazioni Futura, Vozzola et al.)	Two 78% PES knits sandwiched together with a 15% PU membrane, bonded with 7% polyurethane adhesive (sources: technical data sheets, Creazioni Futura, Vozzola et al.)
	Standard gown	99% PP spunbound (source: technical datasheets) + 1% colour pigment (fonte: Vozzola et al, 2018)	99% microfiber 1% carbon fiber (source: technical data sheets)	
	Drape	Critical area: extruded PP Less critical area: spunbound PP (source: Vozzola et al)	Critical area: PES-PU trilaminate Less critical area: 99% microfiber, 1% carbon fiber (source: technical data sheets)	
Tape (cm): 43.5 Fabric; 2.2 g (calculated by: Vozzola et al.; Creazioni Futura)		Tape (cm): 43.5 Composition: Polyurethane 75% PES 25% (source: Creazioni Futura); 3.8 g (calculated by: Vozzola et al., Creazioni Futura)		



Rental/washing/sterilization – Use phase

Item	AVERAGE Value	MEASUREMENT UNITS REFERRED TO 1 kg OF TREATED FABRIC
Transport of TTR from producers	394.09	km (weighted average)
Chemical products	0.0354	kg
Packaging production	0.0686	kg
Transport of auxiliaries and packaging	138.22	km
Total Water	0.0154	m ³
from well and surface water	0.0152	m ³
from aqueduct	0.0002	m ³
ELECTRICITY	0.3007	kWh
from national grid	0.1825	kWh
from cogeneration	0.0967	kWh
from renewables (certified)	0.0215	kWh
METHANE	0.0012	MWh
Emissions to water	0.0030	kg
Evaporated water	0.0033	m ³
Particulate matter	0.000001	kg
Waste (excluding packaging waste)	0.0040	kg
Collection and delivery ref. 1kg KIT TTR	184.07	km (media pesata)
Waste (rags, screenings, processed textile fibers)	0.68%	sul totale trattato

WASH CYCLES = 60

DISPOSABLE USES = 60

The stages of use consider the transport of products to the user.



Data for other stages of the life cycle

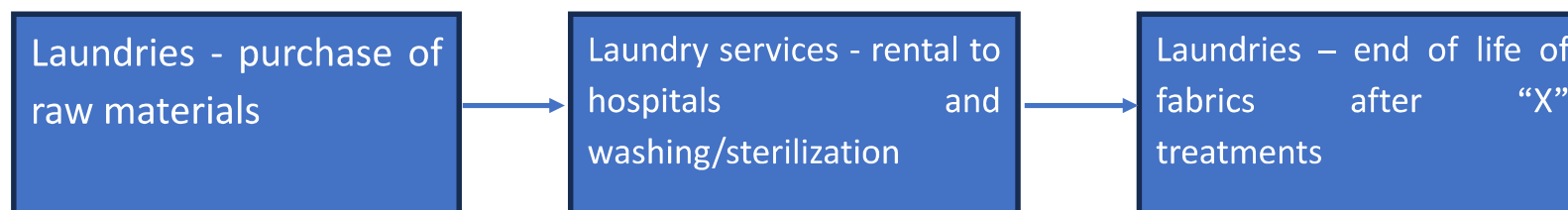
Product distribution transport: the average distance between the manufacturing companies supplying the kits and the industrial laundries considered, or the end users.

End of life – four different scenarios: two recycling scenarios (chemical and mechanical, based on literature data: *Bassi et al., 2022*), incineration, and landfill. For the modelling of this phase, the Circular Footprint Formula as defined in the PEF methodology was applied; the equation is essentially a combination of “material + energy + disposal.”

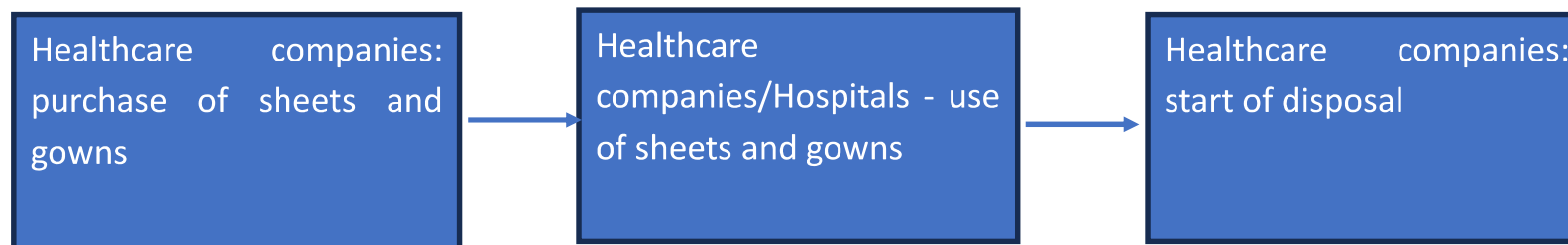


Life Cycle Costing (LCC)

Data collection for LCC assessment of TTR (reusable fabrics)



Data collection for LCC assessment of TNT (non-woven fabric, disposable)



For TTRs (reusable), the economic benefits associated with savings in raw materials needed to produce disposable TNTs (in relation to the number of reuses) were also considered.

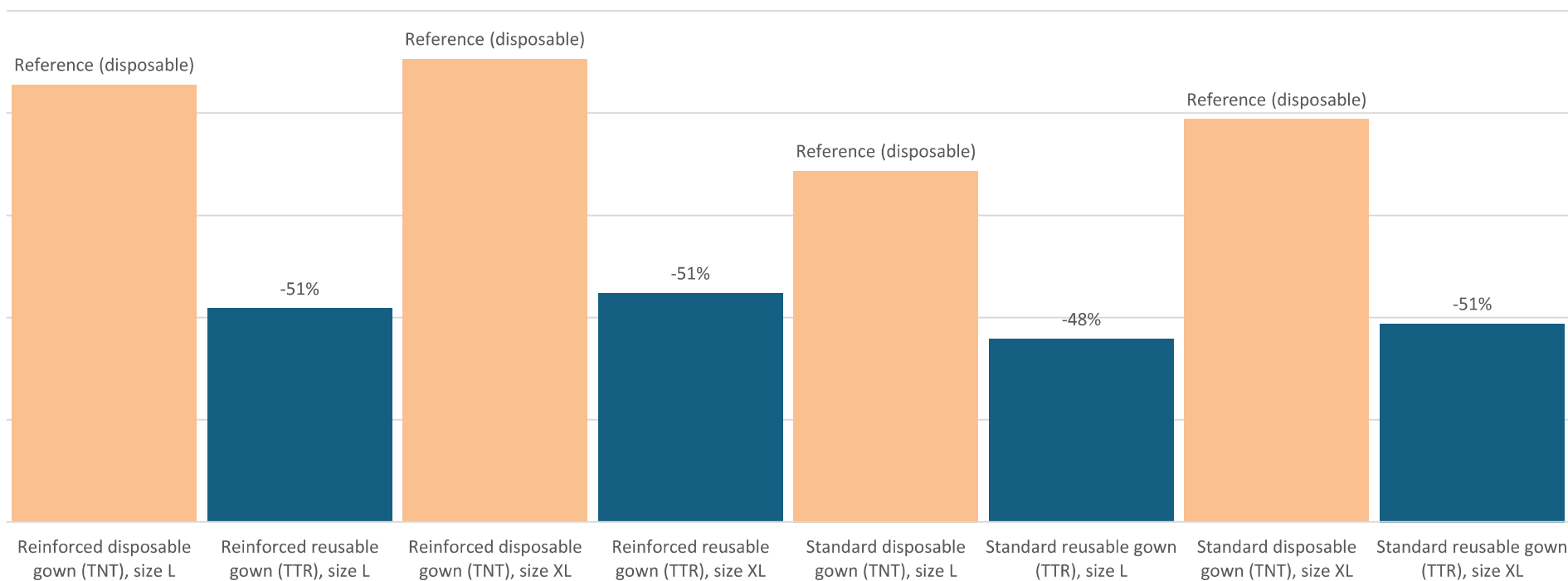


Results



Comparison of items – single indicator Gowns (mPt/piece)

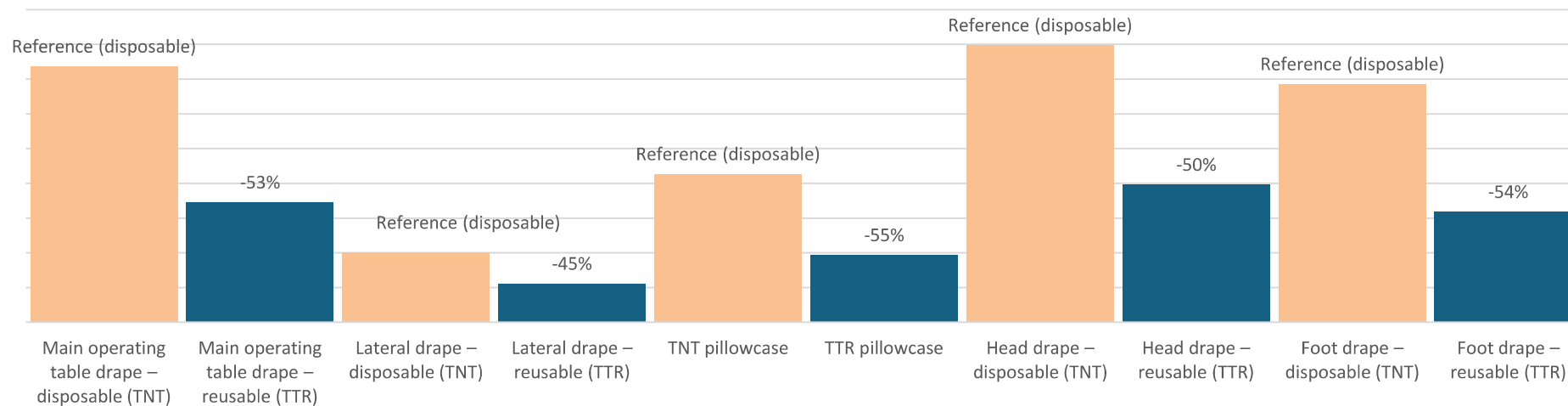
Gowns





Comparison of items - single indicator Drapes (mPt/piece)

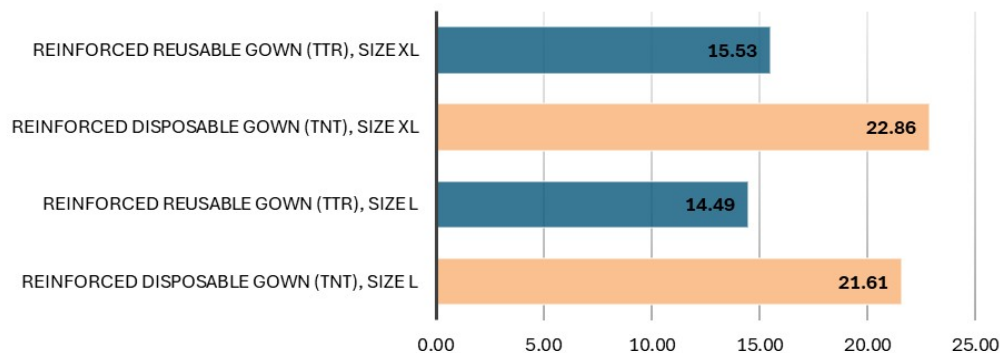
Drapes



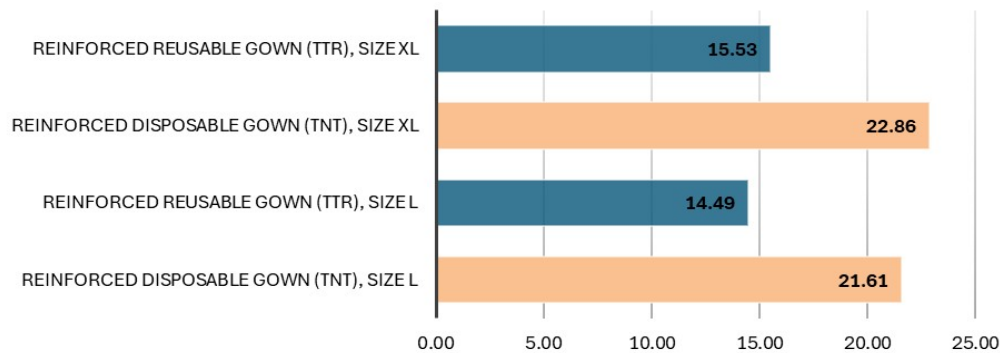


Articles compared – Climate change

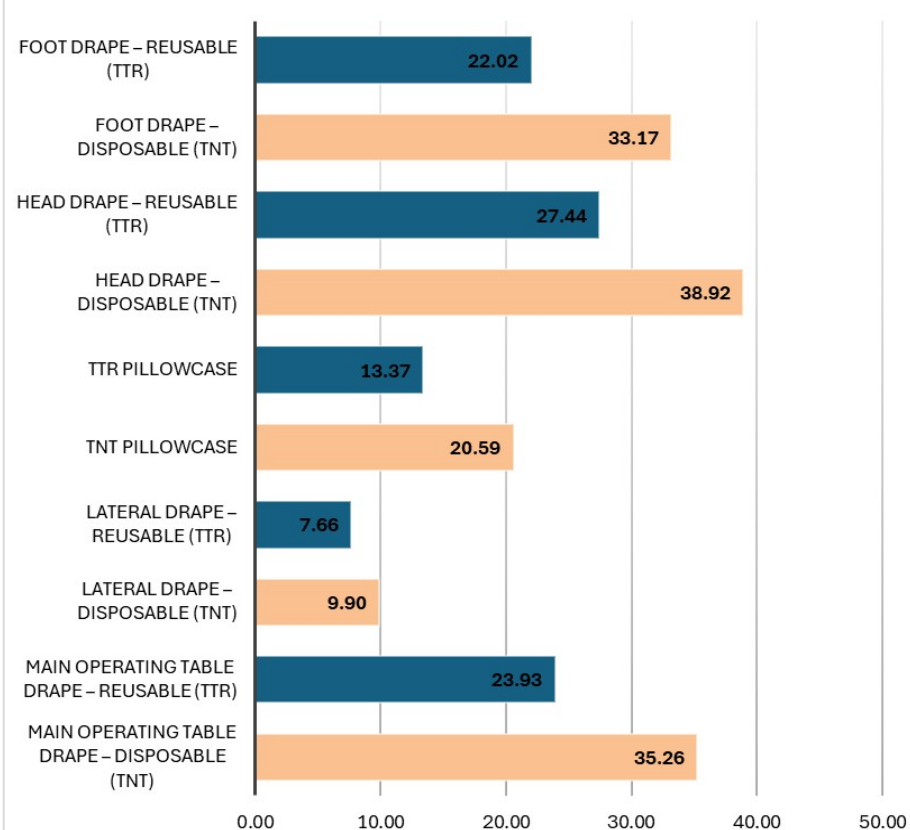
Reinforced surgical gown (kg CO₂ eq./piece)



Reinforced surgical gown (kg CO₂ eq./piece)



Drapes (kg CO₂ eq./piece)



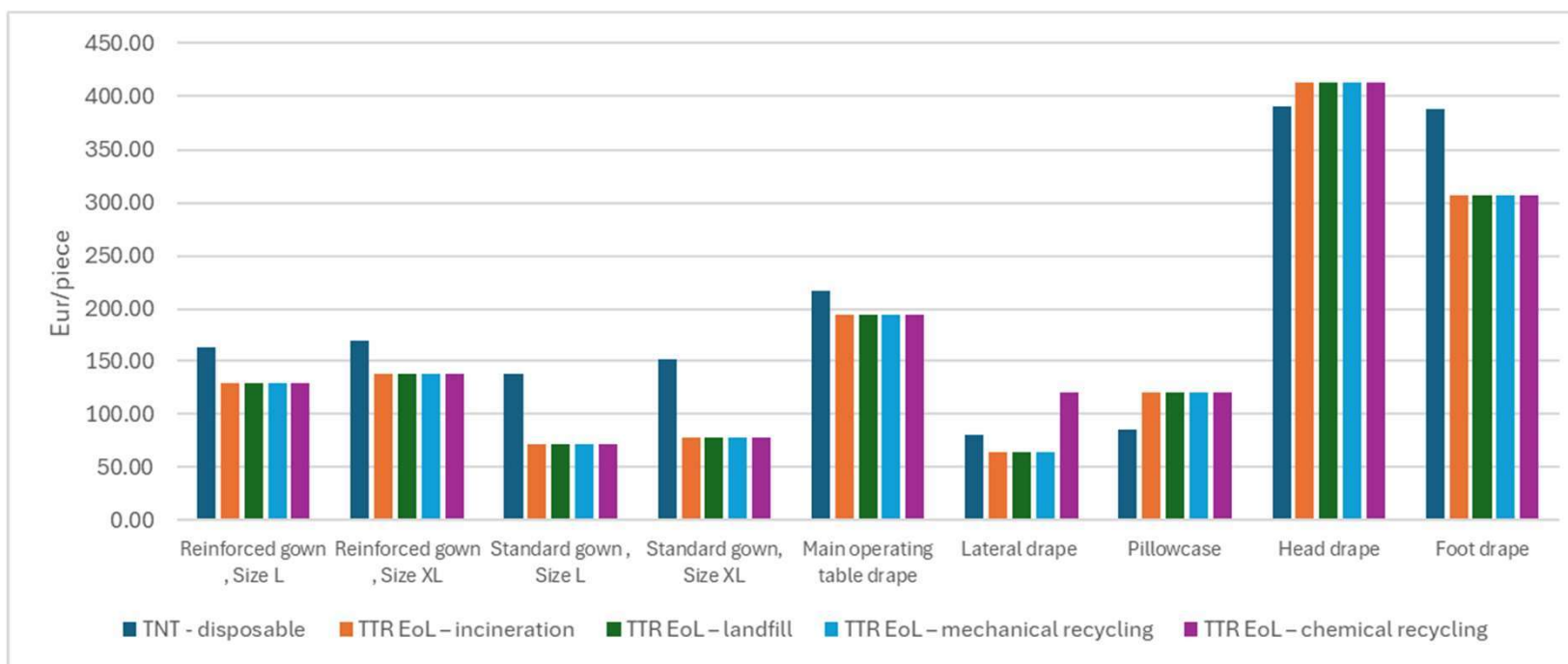


Comparison of items – Life cycle costs Euro/piece

Item	TNT	TTR – 1 pz reused for 60 times			
	Disposable 60 pc	TTR E-o-L mechanical recycling	TTR E-o-L chemical recycling	TTR E-o-L incineration	TTR E-o-L landfill
Reinforced gown – LL size	162.91	128.64	128.61	128.49	128.68
Reinforced gown – XL size	168.69	137.94	137.90	137.78	137.98
Standard gown – LL size	137.64	72.05	72.02	71.92	72.08
Standard gown – XL size	151.17	77.59	77.56	77.45	77.63
Main operating table drape	217.21	195.34	195.29	195.09	195.41
Lateral drape (surgical drape)	80.13	63.66	63.64	63.58	120.16
Pillowcase (surgical drape)	85.83	120.13	120.10	119.99	120.16
Head drape	391.13	413.09	413.03	412.80	413.16
Foot drape	387.79	307.34	307.29	307.11	307.40



Comparing items – Life cycle costs



The results show life cycle cost differentials in favor of TTRs ranging from a **minimum of 18–20% up to 48–50%** (with the exception of pillowcases and drapes, due to the greater fabric weight, which affects the final value).



Externalities – Social costs

Assessment using the eco-costs method

Standard gown, size XL

Differential greenhouse gas emissions (TNT/TTR): 14.51 kgCO₂eq / per item

Cost indicator used (proxy for repair costs): min €0.06/kg CO₂eq – max €0.09/kg CO₂eq

Eco-cost of TNT: min €0.87 per item – max €1.30 per item

Social costs over the life cycle

Costs attributable to personnel services for the end-of-life management of TNT

Estimated cost: €0.33 per patient-day (based on studies and case experiences in the USA, Canada, and Mexico – Gurtler Industries; value updated to 2023)



Interpretation analysis - LCA

Three sensitivity analyses were carried out to assess variations in environmental impacts as a function of the characteristics of the textiles under analysis:

- > Contribution of the PU or PTFE membrane in reinforced gowns: **variations of 0.02% in the climate change indicator**
- > Consideration of potential recycled content: **variation of 0.27% in the single aggregated indicator**
- > Variation in service life 20 times: **reduction of 2–3% for 100 cycles; increase of less than 1%**



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