Comparison of Cotton, Polyester, and Polypropylene: Key Features

1. **Water Absorption**
    - **Cotton:** High absorption (25–30% of its weight); retains moisture, slow drying.
    - **Polyester:** Low absorption (<0.9%), water-resistant, quick drying.
    - **Polypropylene:** Negligible absorption (<0.03%), ideal for humid conditions or sweat management.

	Polypropylene	Polyester	Cotton
Water absorption	0,03%	0,9%	25-30%

2. **Specific Weight**
    - **Cotton:** ~1.54 g/cm³; heavier than synthetics.
    - **Polyester:** ~1.38 g/cm³; moderately lightweight.
    - **Polypropylene:** ~0.91 g/cm³; extremely lightweight, offering better volume with less weight.

	Polypropylene	Polyester	Cotton
weight g/cm³	0,91	1,38	1,54
% plus		+51%	+69%

3. **Thermal Conductivity**
    - **Cotton:** ~0.04 W/mK; loses insulation when wet.
    - **Polyester:** ~0.05 W/mK; stable insulation even in humid conditions.
    - **Polypropylene:** ~0.22 W/mK; excellent insulation due to low conductivity.

4. **Thermal Insulation**
    - **Cotton:** Good insulation, reduced with moisture.
    - **Polyester:** Better insulation than cotton in humid environments.
    - **Polypropylene:** Superior insulation, ideal for extreme climates.

	Polypropylene	Polyestere	Cotton
Thermal dispersion	6,0	7,0	17,5

5. **Thermal and Thermodynamic Properties**
    - **Cotton:** High-temperature tolerance, degrades above 150°C.
    - **Polyester:** Handles up to ~250°C but melts under intense heat.
    - **Polypropylene:** Melts at ~160°C, resistant to heat but less durable under high-temperature stress.

6. **Performance in Extreme Cold**
    - **Cotton:** Becomes stiff and uncomfortable.
    - **Polyester:** Retains flexibility and performance.
    - **Polypropylene:** Excels in cold conditions due to low thermal conductivity.

7. **Flame Behavior**
   - **Cotton:** Highly flammable, burns quickly.
   - **Polyester:** Naturally flame-retardant; melts and resists combustion.
   - **Polypropylene:** Self-extinguishing when removed from flame.

8. **Color Resistance**
   - **Cotton:** Fades over time with sunlight and washing.
   - **Polyester:** Excellent color retention; pigments are integral to fibers.
   - **Polypropylene:** Outstanding color resistance; pigments embedded in the polymer.
   -

Case Study

Project: Replacement of 1000 cotton hospital sweatshirts with innovative polypropylene sweatshirts.

Projections of Energy and pollution Savings

	Specific weight gr/cm3	Weight of 1 sweatshirt (Kg)	Weight for 1000 sweatshirts (Kg)
Polypropylene	0.91	0.320	320
Cotton	1.54 (+69%)	0.540	540

Raw Material Production
Based on the latest data, the energy consumption for producing polypropylene using advanced technologies like Spheripol is approximately:
- Polypropylene: 2.5-3 kWh per kg of polymer produced.

The total energy consumption for producing 1 kg of cotton can vary:
- Cotton: 14-20 kWh of electricity.

Water Consumption for Production

	Weight Total (Kg)	Water per 1 kg (liters)	Total Water for Production (Liters)
Polypropylene	320	0.6	106
Cotton	540	10,000*	5,408,000

*Data source: The World Counts, also, global cotton production requires over 250 billion tons of water annually.

dyeing process

The key solution to drastically reducing water and energy use in the **dyeing process** lies within moving from wet processes to dry processes.

Raw material 1kg	Liters Water
Respectlife	**0**
Polyamide	50
Cotton	150

CO^2 Emission

Raw material 1kg	GWP ($kgCO^2$)	Kg Fabric	($kgCO^2$)
Respectlife	**2,06**	**320**	**659**
Polyamide	8,75	483	4.226

data source: DACOMAT, Damage Controlled Composite Materials from the European Union's Horizon 2020 research and innovation program.

Energy Consumption for Heating Water for Industrial Washing Machines

For industrial washing machines with a 200 kg load capacity, energy consumption varies depending on the temperature:

Temperature	Kwh
90°C	7
60°C	4
40°C	2.5
30°C	2
Cold	0

Calculation:

Washing polypropylene sweatshirts instead of cotton ones saves a total of **12 kWh** in electrical energy for water heating under the same conditions.

Calculation of Energy Consumption for Drying Polypropylene vs. Cotton Sweatshirts

This implies that for every kilogram of sweatshirts dried, polypropylene saves **69%** of the energy required for cotton.

End of Use

The environmental and economic cost of disposing of 1000 cotton sweatshirts

Total weight of cotton sweatshirts:

- Total Weight for 1000 sweatshirts: 540 kg

Environmental Cost of cotton:

- **Landfill:** If the garments are sent to a landfill, they decompose over time but will release methane (a greenhouse gas). Transporting garments to a landfill also emits CO_2. On average, it is estimated that textile landfill disposal generates 2-3 kg of CO_2 equivalent per kg of waste.

  For 540 kg of sweatshirts, this could mean **1080-1620 kg of CO_2** released.

- **Incineration:** If the garments are incinerated, the process reduces waste volume but produces CO_2 emissions and other pollutants. On average, incineration can generate about 1-2 kg of CO_2 per kg of fabric.

  For 540 kg of sweatshirts, incineration would produce about **540-1080 kg of CO_2**.

Economic Cost of cotton:

- **Transport and landfill disposal:** Disposal costs vary by country and local policies. In European countries, for example, the average costs for landfill disposal can range between 80 and 150 euros per ton of waste.
- **Incineration:** Incineration can be more expensive, with costs ranging from 100 to 200 euros per ton.

Respectlife's 100% Pure PP Recycling Methods

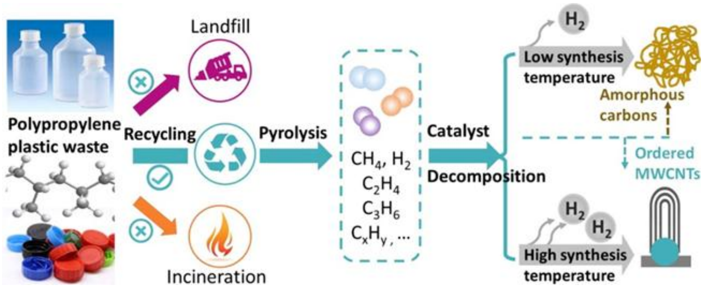
- **Production of New raw material:** The regenerated granules can be used to produce new yarn, pellet and a variety of plastic items, such as containers, packaging, toys, ecc..

"The damage caused by plastic recycling operations is two orders of magnitude lower than that caused by the production of virgin polymer."
Life Cycle Analysis of Possible Plastic Disposal Scenarios (Luca Ferrari)

- **Energy recovery** programs divert plastics from landfills and result in using those materials to generate an added source of energy. The overall sustainability profile of energy recovery is positive.

The U.S. Environmental Protection Agency (EPA) recognizes energy recovery as an advantageous end-of-life approach, stating that it is a "clean, reliable, renewable source of energy" with a lower total environmental impact than most other energy sources.

- **Hydrogen from plastics** waste, these program involves 35 projects in 13 EU countries will receive up to €5.2 billion in public funding, which is expected to attract an additional €7 billion in private investments.



Summary Table

REPLACEMENT OF 1000 COTTON HOSPITAL SWEATSHIRTS

Production		Cotton	Polypropylene
Raw Material Production	kWh	14.000-20.000	**2.500-3.000**
Water Consumption for Production of 1000 Sweatshirts (Liters)	Liters	5.489.100	**106**
Dyeing water	Liters	150.000	**0**
Washing			
Energy Consumption for **Heating Water** for Washing	Kwh	12 kWh per cycle	**0 kWh**
Energy Consumption for Drying	%	+69% compared to polypropylene	
Number of Reuses	n.	100	**200+**
End of life			
End of Life Cotton Sweatshirts in Landfill	(kg of CO_2)	1080/1620	**0**
Incineration of Cotton Sweatshirts (kg of CO_2)	(kg of CO_2)	540/1080	**0**
Recycling			
Recycling PP Sweatshirts in Virgin PP	(Orders of Magnitude)	-	**-2**
Recycling PP in thermos energy	(Orders of Magnitude)	-	**-1**
Recycling PP (C3H6) in Hydrogen	Kg		**44,8**

Production		Polyamide	Polypropylene
Raw Material Production	GWP (kgCO²)	4.226	**659**
Dyeing water	Liters	19.320	**0**

Pavia, 15/10/2024

SDG Report:

Impact of RespectLife Fabric on the Sustainable Development Goals

The RespectLife fabric, developed with antibacterial, super-hydrophobic, and recyclable materials, directly contributes to four United Nations Sustainable Development Goals (SDGs):

- **SDG 3:** Good Health and Well-being
- **SDG 6:** Clean Water and Sanitation
- **SDG 12:** Responsible Consumption and Production
- **SDG 9:** Industry, Innovation, and Infrastructure

This report analyzes the fabric's impact through quantitative and qualitative metrics, highlighting reductions in healthcare costs, water resource savings, and the transition to a circular economy.

Contribution to SDGs

1. SDG 3: Good Health and Well-being

Focus on Target 3.8: Ensure access to safe and affordable healthcare services

Context and Priorities

Target 3.8 of the Sustainable Development Goals (SDG 3) aims to guarantee universal, safe, and accessible healthcare services. One of the major global challenges is reducing **hospital-acquired infections (HAI)** and **antimicrobial resistance (AMR)**, responsible for millions of preventable deaths and unsustainable healthcare costs.

Key Actions to Reduce Hospital-Acquired Infections (HAI)

- **Reducing hospital stays**
  - **ISTAT 2022 data:** 47.7 million hospital stay days per year in Europe.
  - **Objective:** 10% reduction (4.77 million days saved per year).
  - **Economic savings:** €500/day → **€2.385 billion/year** in Europe.

- **Innovative Technology: Biocide-Free Antibacterial Fabrics**
  - **Super-hydrophobicity:** Surfaces repel liquids and prevent bacterial growth, stopping biofilm formation.
  - **Advantages:**
    - Reduces HAI risk without biocides (preventing AMR).
    - Decreases antibiotic dependency, counteracting microbial resistance.

Prevention of Antimicrobial Resistance (AMR)

- **Critical scenario:** AMR is projected to become the leading cause of death by 2050, with **10 million deaths/year** (1 in 5 deaths will involve children under five, often from previously treatable infections).
- **Strategy:**
  - Implement innovative medical materials (e.g., super-hydrophobic fabrics) to reduce infections and antibiotic use.
  - Educate on hygiene protocols and antimicrobial stewardship.

Success Metrics

- **Reduction of infections:** Comparison of HAI rates between traditional and innovative fabrics (% reduction).
- **Hospital efficiency:** Average hospital stay per patient reduced (e.g., from 7 to 6.3 days).
- **Impact on AMR:** Decreased antibiotic use correlated with HAI reduction.

Challenges and Future Prospects

- **Challenges:**
  - Scalability and initial costs of innovative technologies.
  - Inequality in access to advanced tools between high- and low-income countries.
- **Opportunities:**
  - Investment in R&D for sustainable antibacterial materials.
  - Global policies to integrate innovation and healthcare training.

Conclusion

Fighting HAI and AMR requires an integrated approach combining technology, governance, and equity. Reducing hospital stays and promoting innovative materials not only saves lives but also eases healthcare systems, bringing the world closer to achieving Target 3.8 and SDG 3.

Call to Action:

Support funding for the adoption of advanced antibacterial technologies.

Strengthen international collaborations to combat AMR.

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2. SDG 6: Clean Water and Sanitation

Focus on Target 6.4: Increase water efficiency and reduce chemical pollution

Introduction

The textile sector is one of the most impactful globally in terms of water consumption and chemical pollution, particularly in dyeing processes. Adopting innovative technologies, such as **dry-dyeing processes**, is a key solution to align with SDG 6, drastically reducing water use and the release of toxic substances into water ecosystems.

Key Results

- **Water Savings in Production**
  - Comparison between materials:

Material	Liters of Water/kg
Cotton	10,000
Polyamide	50
RespectLife®	**0** (dry dyeing)

- **99.9% reduction** in water consumption for innovative cotton compared to traditional cotton.
- **Reduction of Chemical Pollution**
  - **Elimination of toxic substances:** Innovative productions (e.g., RespectLife®) eliminate heavy metals, chlorinated solvents, and azo dyes, which contaminate groundwater and harm aquatic life.
  - **Metric: 100% reduction** of harmful chemicals in dry-dyeing processes.

Challenges and Opportunities

- **Challenges:**
  - Scalability of dry technologies, especially for cotton.
  - High initial costs for plant conversion.
- **Opportunities:**
  - Long-term savings on water and energy (-50% energy in dry processes).
  - Access to premium markets (sustainable fashion) and compliance with EU chemical regulations (e.g., REACH).

Conclusions and Recommendations

Adopting dry-dyeing processes and innovative materials (e.g., low-water-consumption cotton) not only achieves Target 6.4 objectives but also reduces water pollution from dyes. To accelerate progress:

- **Government incentives** for technological transition.
- **Collaboration between brands and suppliers** for shared standards.
- **Transparent monitoring** of metrics (liters saved/kg, % chemical reduction).

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3. SDG 12: Responsible Consumption and Production

Target 12.5: Reduce waste generation

Circular Economy of Polypropylene (PP)

Polypropylene (PP) is a **100% recyclable** material capable of enduring **over 200 washing cycles** without losing structural integrity. This drastically reduces the need for virgin plastic production and minimizes premature disposal.

Innovative Recycling Methods for RespectLife (100% Pure PP)

- **Material regeneration:** Recycled pellets are used to produce new fibers, plastic containers, packaging, and toys.
- **Energy recovery:** Recognized by the U.S. EPA as a **clean and renewable energy source** with superior sustainability compared to fossil alternatives.
- **Hydrogen production from plastic waste:** EU-funded projects (€5.2 billion in public funds, €7 billion in private investments).

Conclusions and Benefits

- **Waste reduction:** Recycled PP prevents landfill accumulation and methane/CO_2 emissions.
- **Economic efficiency:** Recycling cuts disposal costs (up to 50% vs. incineration) and creates new value chains.
- **Alignment with SDGs:** Energy recovery and hydrogen technologies support the transition to a low-emission economy.

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4. SDG 9: Industry, Innovation, and Infrastructure

Target 9.4: Modernize infrastructure for sustainability

Technological Innovation

- **Super-hydrophobic fabrics** with **Global Recycled Standard (GRS) certifications**.
- **Low CO_2 emission production processes** (-40% vs. standard synthetic materials).

Key Metrics

- CO_2 emissions reduction (kg/ton of fabric).
- Number of active partnerships for the circular economy.

Impact Measurement Methodology

- **Data collection:** Pilot studies in hospitals comparing infection rates before/after fabric use.
- **Analysis:** ROI calculation for hospitals and insurers (€2,000-4,000/day savings).
- **Communication:** Annual ESG reports and infographics for stakeholders.

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