

Sustainable Materials for Engineering Applications

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Outline

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- Mechanical sector
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- Sustainable Advanced Manufacturing Technologies
- Construction sector
- Textile Sector
- Textile sector and Environment
- Textile sector and Sustainability
- Textile sector and Denim industry of Pakistan
- Circularity and Denim industry of Pakistan
- Conclusion

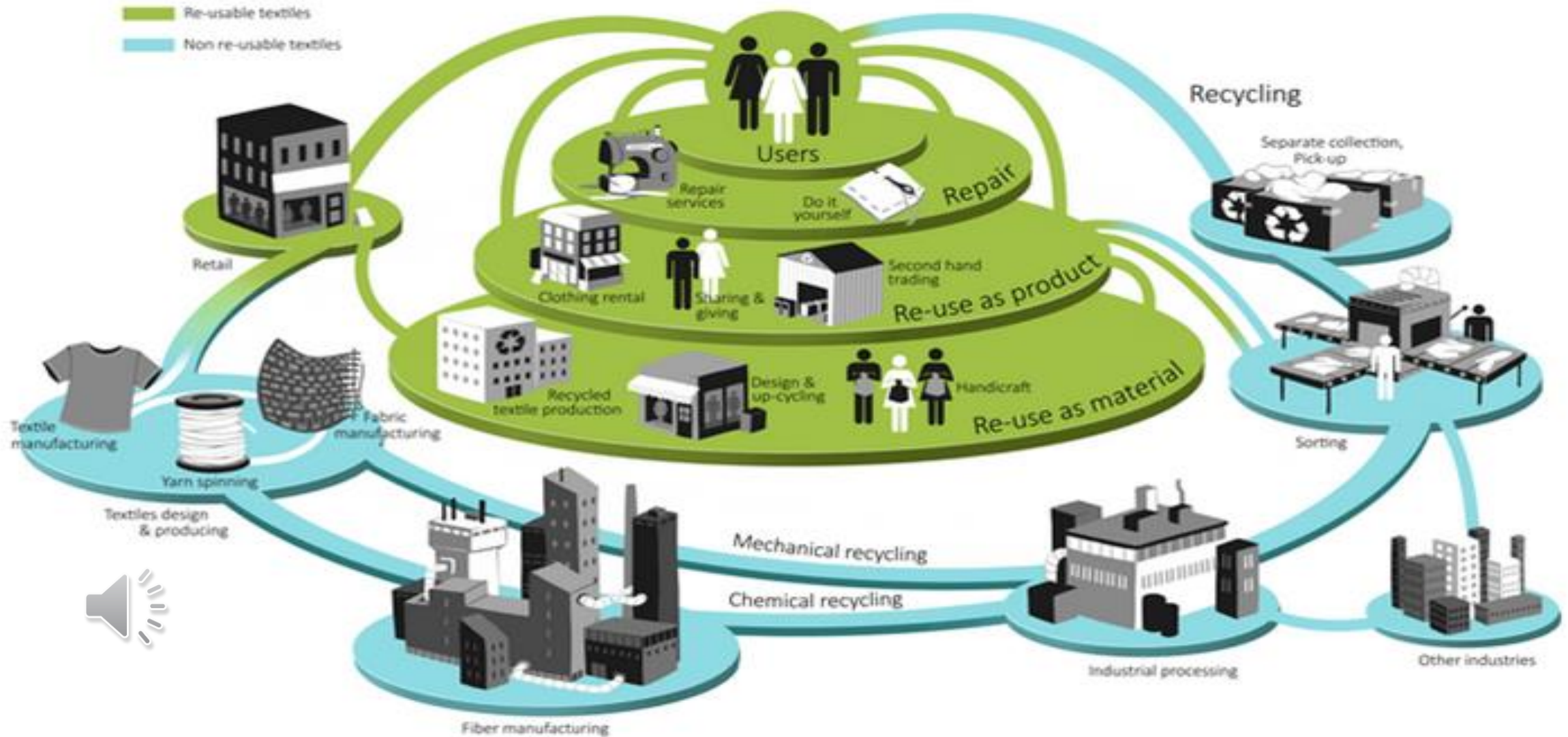


Sustainability / Circular economy

- The United Nations' Commission on environment and Development in 1987
- “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.
- 2030 Agenda for Sustainable Development by United Nations
- Sustainable consumption and production goal
- Need to encourage the sustainable development and safe growth



Circular Economy



Circular Economy / COVID-19

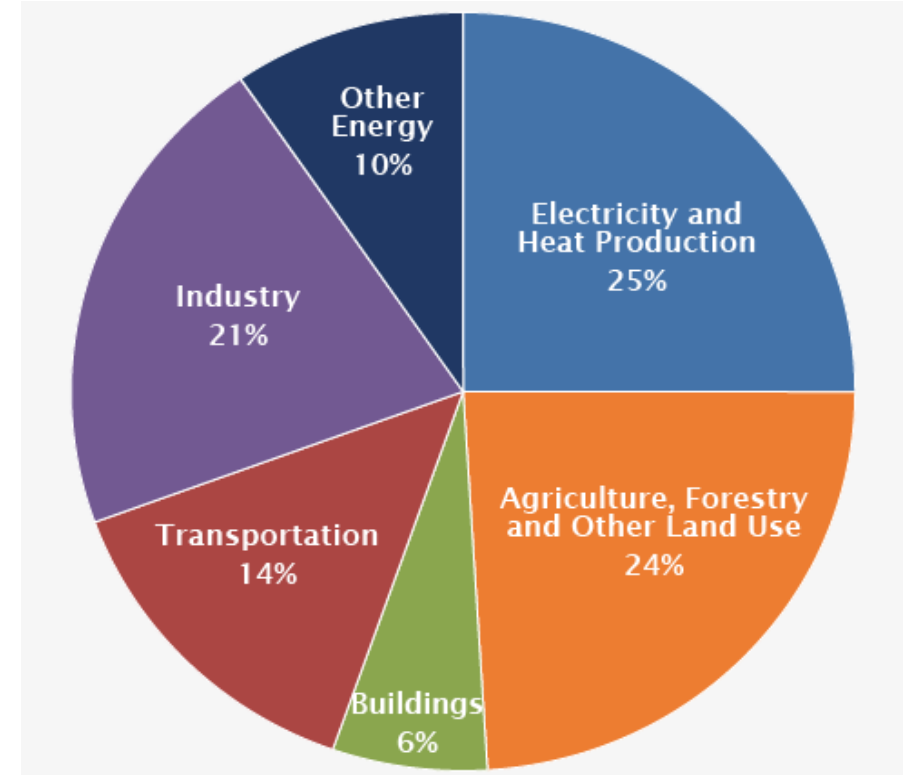
- **COVID-19** causing human suffering, destabilizing the global economy and upending the lives of billions of people around the globe*
- We have to manage the current and future situation in this Covid era without sacrificing circularity
- Our goals must be inline with UN Sustainable Development Goals



*<https://www.un.org/sustainabledevelopment/sdgs-framework-for-covid-19-recovery/>

Mechanical sector

- Machine part designing and manufacturing
- Usage of renewable and recycle materials
- Industries contribution is 21 % Greenhouse gas emissions (US EPA, 2016).
- essential to shift manufacturing industries to sustainable development of product development.



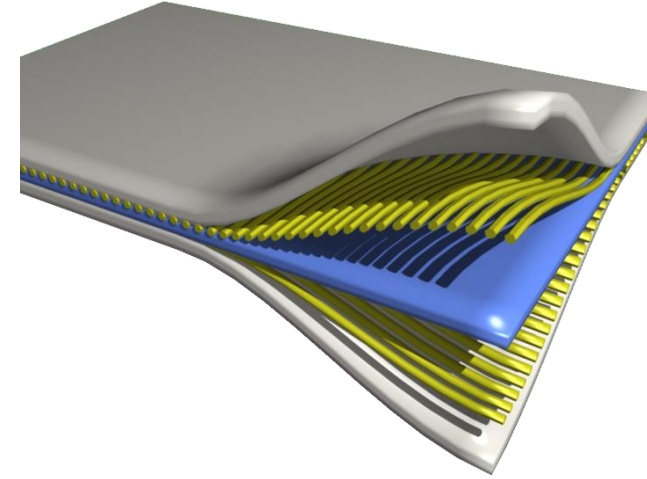
Sustainable Materials

- Innovative sustainable materials for different engineering applications
 - Fiber reinforced polymers such as carbon fibre, glass fibre, aramid and basalt
 - Heat, corrosion and fatigue resistant
 - Much longer lifecycle
 - lightweight
- Potential applications in automotive and aerospace
- Reduction of fuel consumption CO2 emission
- Sustain good environment
- Improve quality of human lives



Sustainable Advanced Manufacturing Technologies

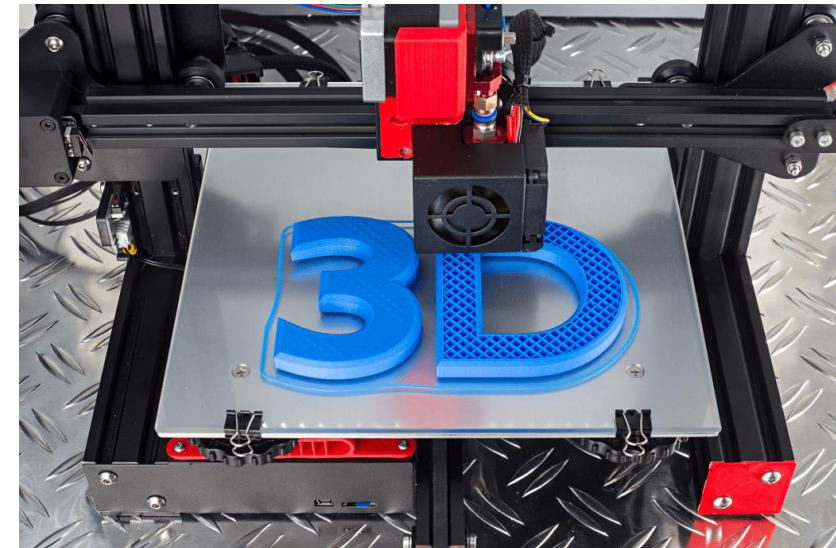
- Additive Manufacturing
- Three-dimensional (3D) printing technology
- Sustainable manufacturing technology
- Production of fully functional machine parts
- Metallic, ceramic, polymers and composites
- Recycled polymers and composite polymers



Composites are formed by combining materials



3D printed composite part



Additive Manufacturing - three-dimensional (3D) printing

Construction sector / Sustainable Materials

- Buildings are the prime energy consumers and greenhouse gas emitters
- Energy intensive materials: Bricks, cement, steel, aluminum, plastic items, paints, polished stone, and ceramic products
- Prevention of global warming and the resultant climate change
- Need of sustainable projects to apply sustainable principles in order to reduce energy, water, and resource consumption
- Sustainable structures/ Buildings



Recycle building materials



Construction sector



Sustainable building

Construction sector

- Plastics and plastic goods
- high-strength one-part alkali-activated blast furnace slag (AAS)
- C&D wastes as the recycled aggregate (RA) Concrete
- Mortar containing Recycled Engineering sediment
- Recycled Brick Powder (RBP)

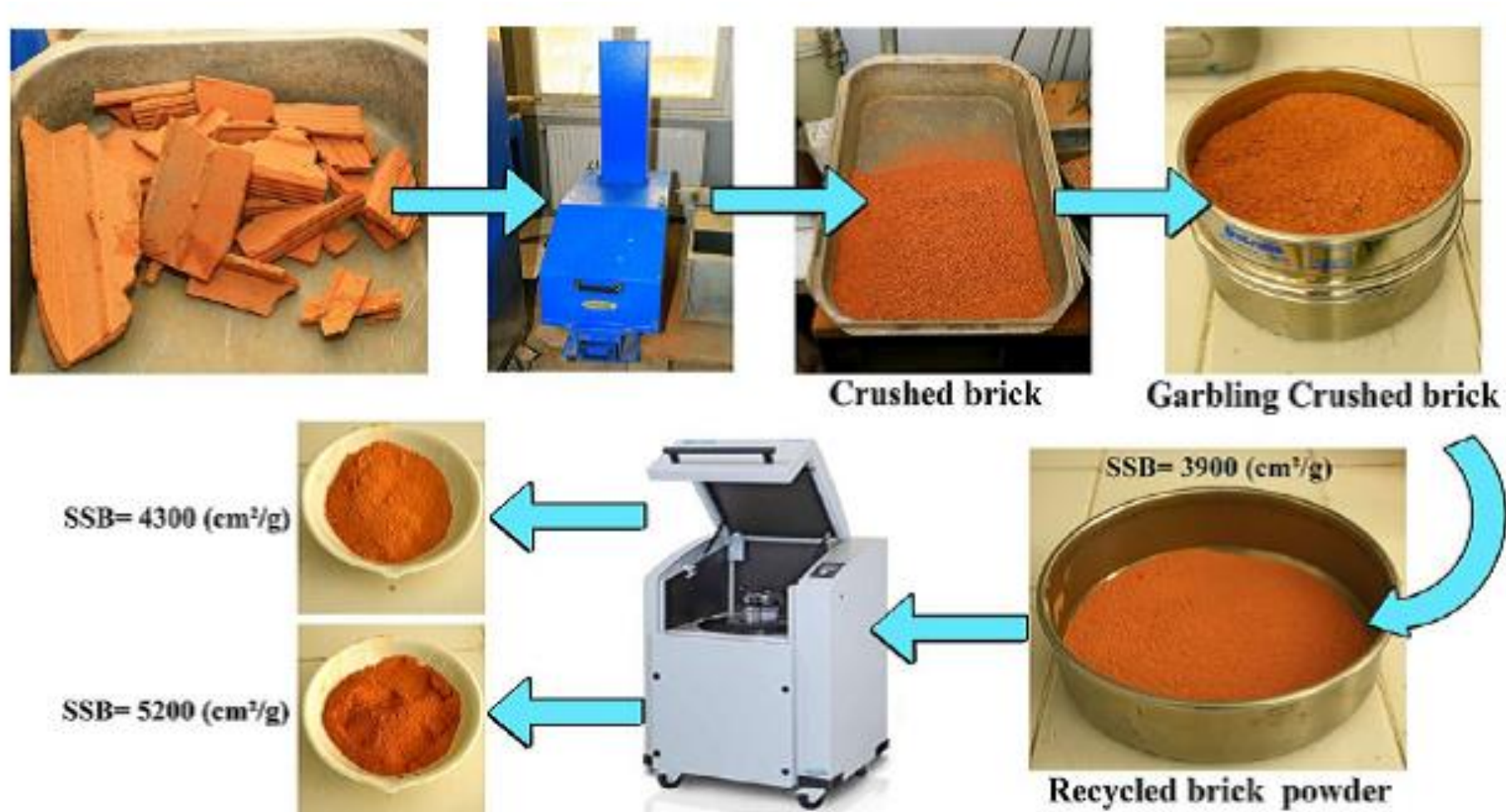


Recycled Aggregate (RA) Concrete



Construction sector

Recycled Brick Powder (RBP)



Textile Sector

- Textile industry is an important sector for economic growth all over the globe
- Main component/raw material is fibre
- Fibres production by:
 - Natural sources
 - Man-made processes
 - combining natural materials with chemicals



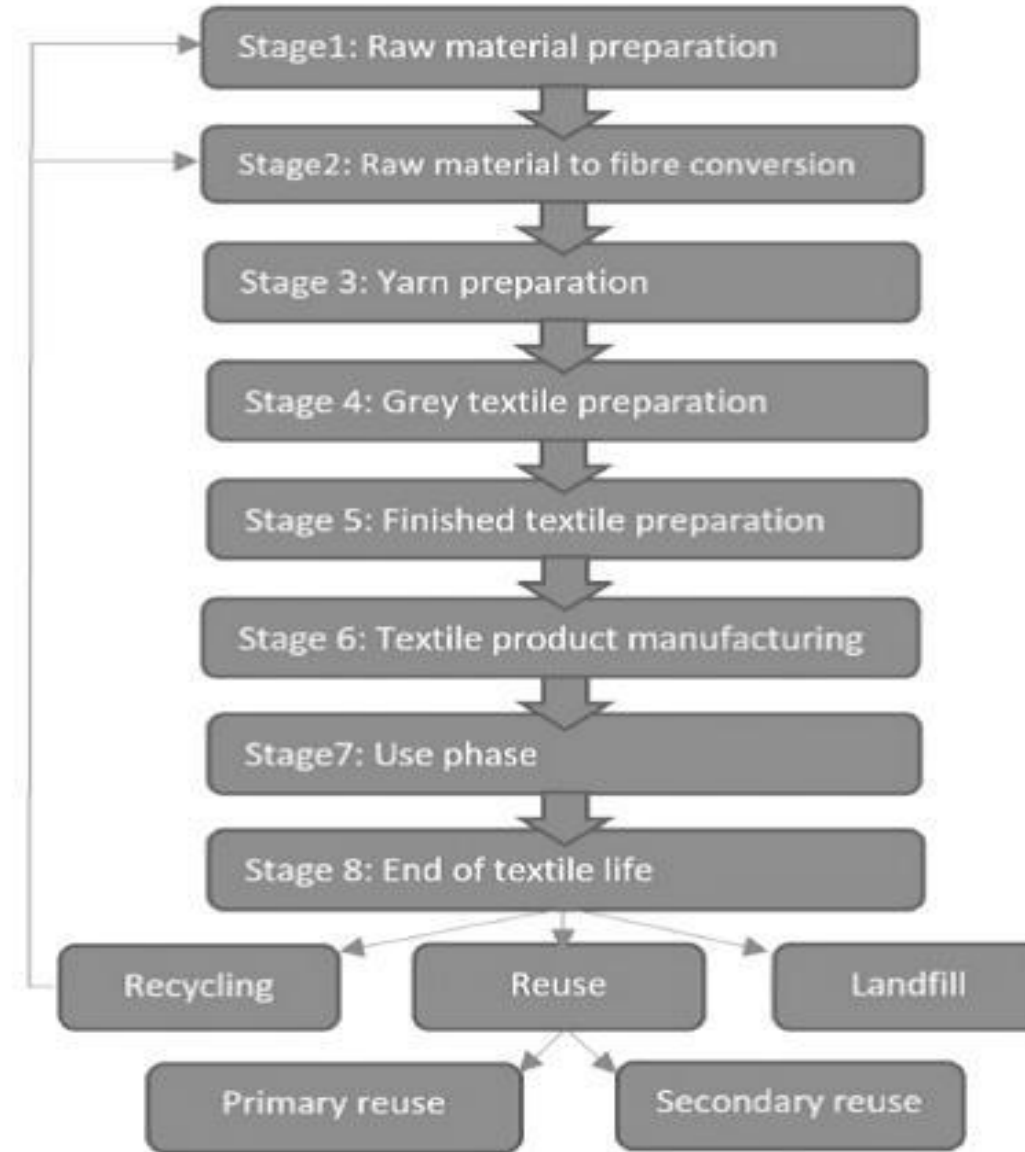
← Cotton Plants



Polyester yarn production →



Textile Sector / Textile product life cycle



Textile Sector and Environment

Conversion of fibre into a useful product consists of:

- variety of complex processes
- huge consumption of water, chemicals and energy
- 5-10% of global greenhouse gases per annum
- generation of waste water
- plastic pollution



Impacts of fast fashion

26.7kg

UK consumption of new clothing per head in 2010 (highest in Europe)

235m items of clothing sent to landfill per year

700,000 fibres released in a single domestic wash

1.2bn tonnes of carbon emissions produced by global fashion industry (2015)

3,781 litres of water used from growing cotton to manufacture and consumer care of a pair of jeans

Enviro Audit Committee submissions

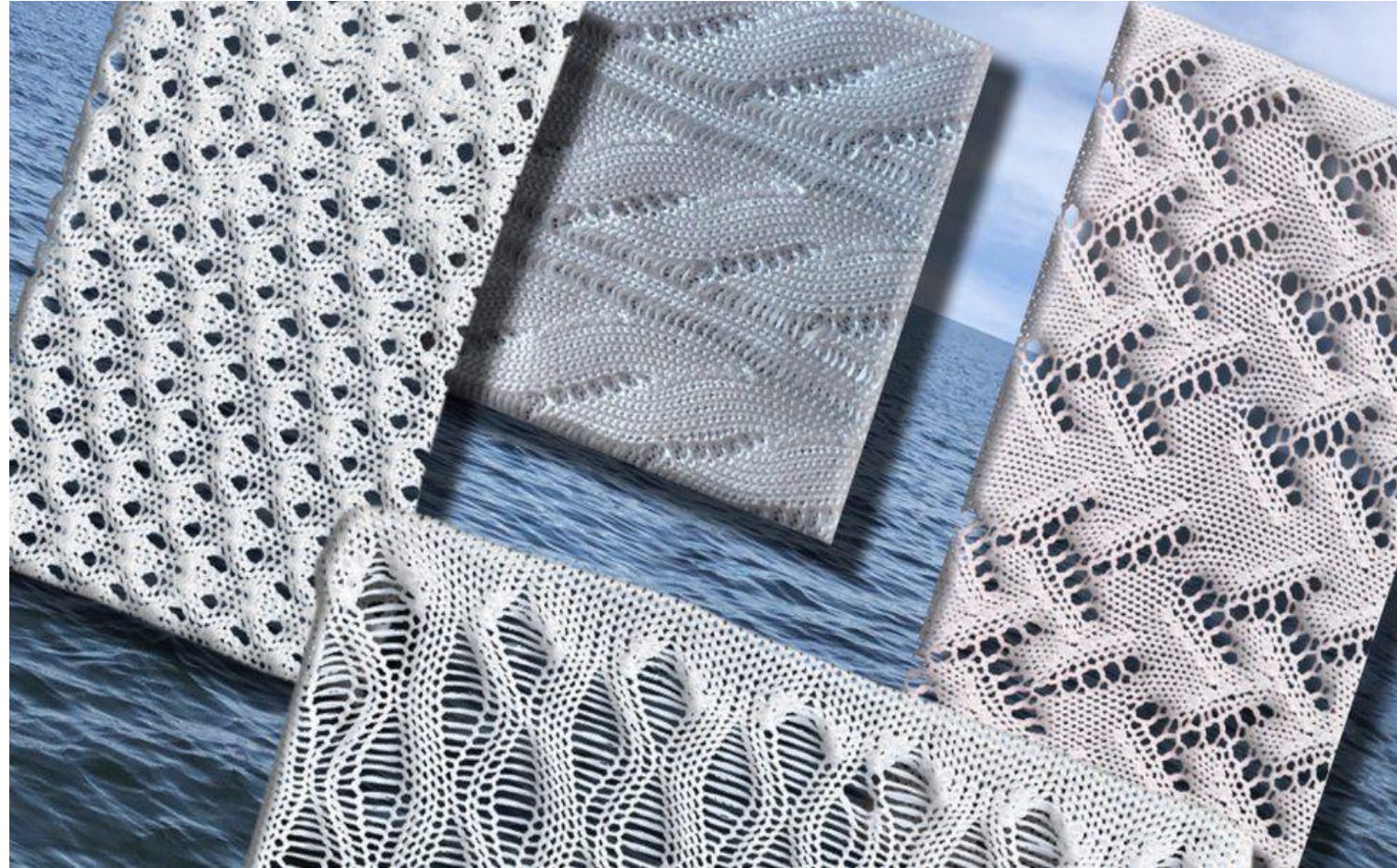


Textile Sector and Sustainability

- Manufacturing of different products using Polythene



Plastic fabrics →



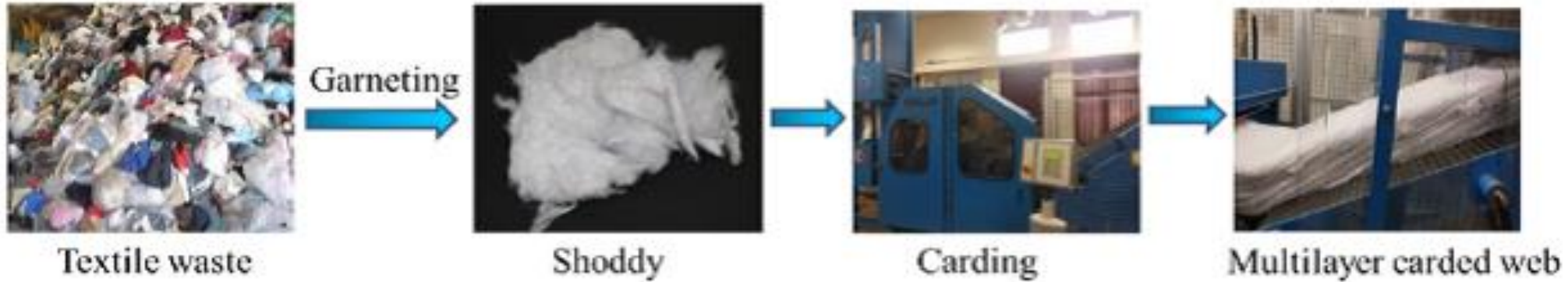
Textile Sector and Sustainability

- Organic cotton
- Bio-based fibres blends
- Engineered Water Nanostructures (EWNSs)
- Textile waste fibre reinforced composites
- Non-wovens from textile waste are new materials
- Ozone finishing
- Cationic pre-treatment of cotton fabric

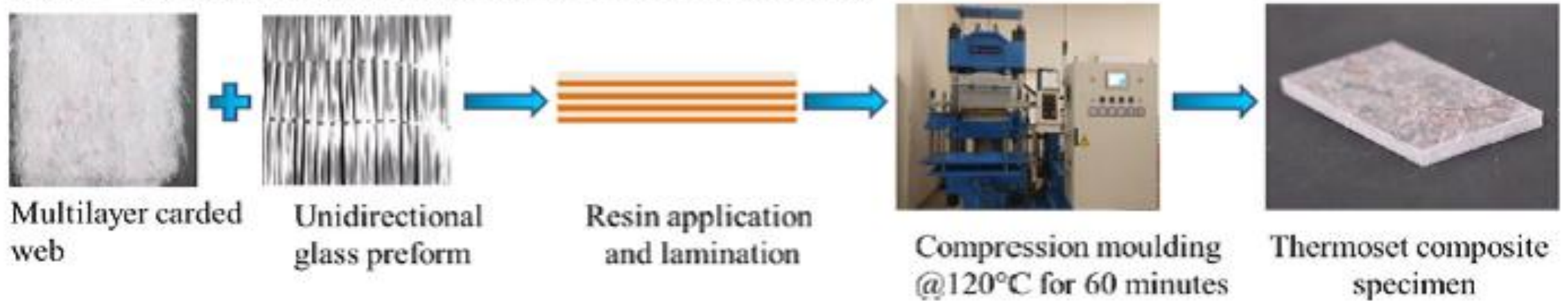


Textile Sector and Sustainability

Stage 1 – Carded web formation from textile waste



Stage 2 – Resin application, lamination and compression moulding



Hybrid composite development process

Textile Sector / Pakistan

- Most vital sector of Pakistan contributes 50% to 60% of the total exports Utilizes 40% of the total workforce
- 8.5 % of the total GDP
- Surge of 12.8% in textile goods for the year ended 2018 on an annual basis.
- Second in Pakistan and ranked eighth in the Asian region for selling textile goods overseas



Textile Sector / Denim Industry

- Key apparel sector
- Total domestic denim garments manufacturing = 15-20 million pieces per month
- Driving force behind the apparel exports of the country
- Denim industries of Pakistan and sustainability

Recyclable denim by Artistic Milliners



Circular Economy / Denim Industry

Measures taken by renown Denim industries of Pakistan:

- Carbon emissions baseline and optimization energy efficiency projects
- Water use and water optimization in dyeing including technology advancements
- Use of renewable energy
- Wastewater recycling to 80%
- Reuse of the materials from the garment
- Reuse of the waste
- Use of sustainable fibers including Organic, recycled, alternate use of fibers including wood based/ PET polyester



Conclusion

- Endeavors in attaining UN Sustainability goals
- Preserving environment
- Development and consumption of the sustainable materials to achieve **circularity / zero waste** manufacturing and processing
- Faculty and researchers collaboration
- More investment in sustainability research for more developments



Thank You

Research interests for potential research students

Additive manufacturing – 3D printing

Advance Engineering Materials

Characterisation of Residual Stresses

<https://www.sunderland.ac.uk/study/postgraduate-research/phd-published-work/>

Existing Published or Creative Work (PhD)

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<https://www.youtube.com/watch?v=GRDdqN19hd8>

Thank You