The background of the entire page is an abstract geometric pattern. It features a series of parallel lines and planes that create a sense of depth and perspective, resembling a modern architectural structure or a complex crystalline form. A large, semi-transparent red rectangle is overlaid on the left side of the image, serving as a backdrop for the main title text.

THE CASE TO ADVANCE REMANUFACTURING IN INDIA

FORGING THE PATH TO
A CIRCULAR ECONOMY

SEPTEMBER 2020



Re:CREATe

Acknowledgements

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We are also deeply grateful to the various practitioners and institutions whose works have enriched this document, and have been duly referenced. And lastly, to all you kindred spirits engaged in co-creating a beautiful, harmonious, and sustainable world, thank you. You inspire us.

Disclaimer

While every effort has been made by Recreate India Research Foundation (Re:CREATe) to ensure that the information contained in this document is correct, no person(s) or entity should place reliance on information derived from this document, where such reliance may result in loss, damage, or injury. This document includes information from, and links to websites operated by organizations other than Re:CREATe. Consequently, Re:CREATe accepts no responsibility for any content on these sites or liability for any loss, damage, or injury caused by accessing these sites.

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"With remanufacturing rapidly growing into a major business opportunity, greater consideration will need to be paid towards the potential reuse of the parts and components used in products.

This report highlights how circularity and sustainability as concepts are gaining traction in India's manufacturing landscape, while also serving as a handbook on reman for the uninitiated."

Anirban Ghosh

Chief Sustainability Officer
Mahindra Group

"India is well tuned into recovering the utility and economic value of discarded and/or dysfunctional manufactured products and components. This has traditionally been driven by need or scarcity, and an acceptance by markets that recovered products will have lower performance.

Remanufacturing de facto industrializes this practice by designing products for multiple lifecycles and ensures equal if not superior performance of recovered components and products compared to new ones. This can make good business sense and help the transition to a circular economy in India."

Dr. René Van Berkel

India Representative
United Nations Industrial Development Organization

"It is inspiring to see Re:CREATe take a leadership role in bringing visibility to the potential and benefits of remanufacturing, and the significant role it can play as part of the circular economy in India.

The information contained within this report is invaluable for stakeholders that would like to to be better informed on these important topics."

Tom Healy

*Chief Executive Officer
CoreCentric Solutions, Inc.*

*"This report **has the power to advance the Indian remanufacturing industry** by pointing out the importance of it."*

Yorien de Ruijter

*Director Remanufacturing Events
Rematec, RAI Amsterdam*

*"I am pleased to see Re:CREATe **bring remanufacturing knowledge to India and look forward to our working together.**"*

David Fitzsimons

*Director
Conseil Européen de Remanufacture*

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FOUNDER'S NOTE

In many ways, the search for a sustainable equilibrium is a search for identity. This deep desire for harmony has felt even more pronounced this year with myriad events that have shifted the course of humanity and the planet - most notably the pandemic - in ways that were unforeseen, except perhaps to the wisest among us.

The events have also laid bare the deep interdependence between humanity and the natural world, in no uncertain terms. And with it perhaps, evoked a leveling realization that nature and the planet don't need us to survive and thrive, and in some cases are better off when shielded from systemic human exploitation.

But this needn't be the end of the story. This moment in time can be viewed as an invitation to evolve, to recognize and give birth to a new story, one in which we return nature and our planet to its rightful place of reverence and become stewards of the many gifts we have been given.

Sustainability isn't just about resource utilization or consumption patterns or

environmental justice or biodiversity or climate change. It is about all of them, and more. Ultimately, sustainability is an invitation for the evolution of human consciousness.

The seeming disconnection from the sense of honor and kinship with our natural world and each other is possibly one of the central causes of human discontent and exploitation. Consumption has perhaps become a weak and addictive substitute for a poverty in spirit.

However, whether we are able to articulate it or not, there is something in us that finds great resonance in honoring things. We find deep meaning in making, building, and passing our creations on as precious and valued personal and cultural heirlooms from one generation to the next. And as with our own transient lives, we may find meaning in giving these so-called utilitarian objects new life and purpose.

If sustainability is about achieving a particular state of inner and outer harmony, then circularity can be seen as the outer

architecture of that state, the architecture of the systems and structures we create that reflect this wisdom. Remanufacturing (or reman) is one such modality of this circular architecture. Repair and reuse have been indelible parts of the culture of consumption in India. However, the nation has not been immune to the growth- and consumption-based model of development that is self-evidently far from perfect.

Born in wartime, remanufacturing involves much more than traditional reuse and repair. It embodies the paradigm of circular design and resource stewardship. The American National Standards Institute (ANSI) defines remanufacturing as "a comprehensive and rigorous industrial process by which a previously sold, leased, used, worn, or non-functional product or part is returned to a "like-new" or "better-than-new" condition, from both a quality and performance perspective, through a controlled, reproducible and sustainable process".

So effective is remanufacturing in achieving environmentally positive outcomes that according to a 2018 report published by the International Resource Panel (IRP), a global science-policy platform established by the United Nations Environment Programme (UNEP):

- A potential reduction of 79-99% can be achieved in greenhouse gases associated with the life of a component when it is remanufactured as opposed to newly manufactured
- An average reduction of 80-98% can be achieved in raw materials usage to remanufacture industrial equipment when compared to producing it new

In addition, a 2018 study by the International Labour Organization (ILO) estimated that by 2030, 24 million new jobs could be created globally if the right policies are established to promote a greener economy. Of those, 6 million jobs could be created by transitioning to a circular economy, which includes activities like recycling, repair, rent, and remanufacture.

But will markets pay for such products and services? Will investors invest? The short answer is yes. The burgeoning growth of sustainable investing and rapidly shifting market preferences towards sustainable products and services is well documented.

Remanufacturing is not a panacea, but perhaps it can play a role in reestablishing a sense of wonder, reverence, and gratitude for our natural world. It is one of the many pathways available for us to be stewards of the resources that we have been endowed with. It has the potential to enable living in alignment with the principle of shared well-being for all life on the planet.

The purpose of this document is two-fold. The first is to offer a clear understanding of what remanufacturing is, what it isn't, as well as its benefits and limits. The second is to present a birds-eye view of the potential of remanufacturing in India's transition to a sustainable and circular economy.

I am confident that this monograph will prove to be a useful primer on remanufacturing and optimistic that the conclusions you arrive at will recognize the powerful role remanufacturing can play in the future of the nations' development.

Sincerely,

Rajiv Ramchandra





THE STORY OF REMANUFACTURING

Introduction

The roots of remanufacturing trace back to the early 20th century according to the the European Remanufacturing Council (CER). The early application of remanufacturing methods and technology was towards military equipment. However, after World War II, it made its way into consumer products like cars.

The significance of its genesis during wartime - in matters of life and death - cannot be overstated. It implies a confidence that remanufactured equipment results in performance and quality that is equivalent to (perhaps better than) new equipment. It concurrently accounts for the scarcity of, and the need for the conservation of natural, human, and financial resources.

This section gives a contemporary snapshot of the state of remanufacturing in the world and covers standardized definitions and methods, an overview of the process of remanufacturing, its benefits, enabling factors, remanufacturing industry categories, sizes of the industry in various nations, and the organizations involved in remanufacturing around the world.

Definition

As defined by the American National Standards Institute (ANSI) standard 'RIC001.1-2016: Specifications for the Process of Remanufacturing':

"Remanufacturing is a comprehensive and rigorous industrial process by which a previously sold, leased, used, worn, or non-functional product or part is returned to a "like-new" or "better-than-new" condition, from both a quality and performance perspective, through a controlled, reproducible and sustainable process."

Remanufacturing is not the same as recycling, reconditioning, refurbishing, reusing or repairing, but can include some or all of these activities.

Remanufacturability Criteria

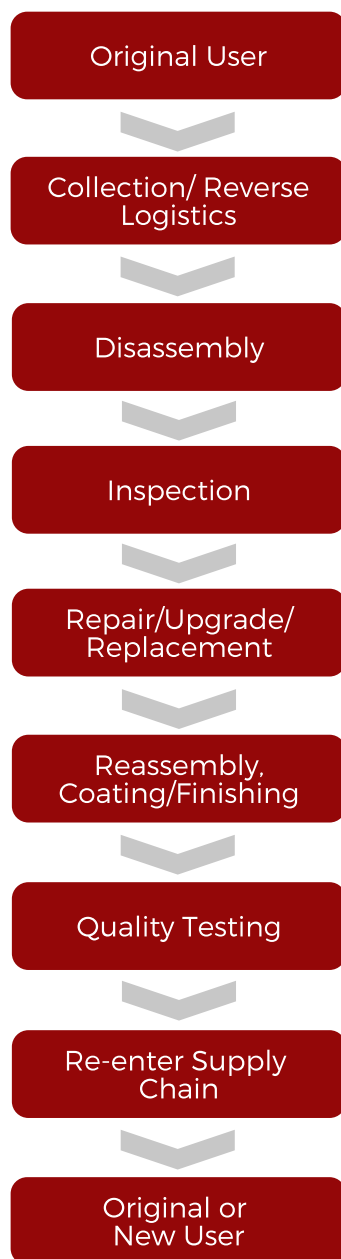
Based on research conducted by Boston University, for a product to be remanufacturable, certain criteria need to be met. These include (but are not limited to):

- Technology exists to restore the product
- The product is made up of standard interchangeable parts

- Cost of the **core** is low relative to the cost savings achieved through core reuse
- The product technology is stable over more than one life cycle
- Sufficient market demand exists to sustain remanufacturing operations/enterprises

Remanufacturing Process

Remanufacturing (or reman) typically follows the following process.



*A **core** is a worn, failed, or end-of-use part, assembly, or product that is retained with the objective of restoring or improving its original functionality through remanufacturing, or for use as a source of parts.*

-ANSI Standard

Benefits of Remanufacturing

According to the Centre for Remanufacturing & Reuse (CRR) in the UK, the benefits of remanufacturing include:

- Job creation (local and skilled)*
- Higher profit margins
- New manufacturing techniques
- Better customer relationships
- Reductions in:
 - Raw material consumption
 - Energy consumption
 - GHG emissions
 - Waste sent to landfill
- Lower prices (by 60-80%)
- Product availability
- Purchasing flexibility

* A 2018 study by the International Labour Organization (ILO) estimated that by 2030, 6 million jobs could be created globally by transitioning to a circular economy, which includes activities like recycling, repair, rent, and **remanufacture**.

Remanufacturing Standards

- ANSI RIC001.1-2016 Specifications for the Process of Remanufacturing
- BS 8887 -2:2009 – Design for manufacture, disassembly and end-of-life processing (MADE) – Part 2: Terms and definitions
- BS 8887 -220:2010 – Design for manufacture, disassembly and end-of-life processing (MADE) – Part 220: The process of remanufacture – Specification
- ISO 10987-2:2017 - Earth-moving machinery – Sustainability – Part 2: Remanufacturing
- ISO 13534:2000 - Petroleum and natural gas industries – Drilling and production equipment – Inspection, maintenance, repair and remanufacture of hoisting equipment

Industry Sizes

The European Remanufacturing Network's (ERN) 'Remanufacturing Market Study' published in 2015 provided the following estimates of the size of the remanufacturing industry in various nations and the EU:

- Japan: €3.8 billion
- Denmark: €300 million
- South Korea: €670 million
- Malaysia: €825 million
- UK: £3 billion
- USA: \$43 billion
- EU: €30 billion

Enabling Factors

- **Life-cycle/Circular Design:** Remanufacturing is significantly easier when factored into product design
- **Market Demand:** Market understanding and perception of remanufacturing must be proactively approached by companies
- **Standards and Legislation:** Commonly accepted definition and standards for remanufactured products in various sectors is a critical enabling factor
- **Up-skilling:** High quality remanufacturing requires technically skilled engineers and technicians
- **Core Supply:** Information sharing, reverse logistics, and supply chain transparency are crucial to recovering products/cores in good condition

*The **circular design** process comprises four stages - understand, define, make, and release - and is informed by approaches such as design thinking and human-centred design.*

-Ellen MacArthur Foundation



Industry Categories

Data from the US Remanufacturing Industry (2012) highlights the sectors and product areas that can be remanufactured:

Sector	Product Areas
Automotive & Other Transport	16
Compressors, Turbines, Valves	5
Electrical/Electronic Apparatus	29
Machinery & Related Equipment	29
Laboratory, Medical, & Surgical	12
Office Furniture/Equipment	3
Tires	1
Toner & Ink Cartridges	2
Other	22
Total	121

Organizations Globally*

- Remanufacturing Industries Council (RIC): www.remancouncil.us
- Center for Remanufacturing and Resource Recovery (C3R): www.rit.edu/gis/remanufacturing
- European Remanufacturing Council (CER): www.remancouncil.eu
- European Remanufacturing Network (ERN): www.remanufacturing.eu
- Centre for Remanufacturing and Reuse (CRR): www.remanufacturing.org.uk
- Scottish Institute for Remanufacture (SIR): www.scot-reman.ac.uk
- Advanced Remanufacturing and Technology Centre (ARTC): www.a-star.edu.sg/artc
- Rematec: www.rematec.com

These represent only a handful of the organizations that are engaged in remanufacturing around the world.



A CONFLUENCE OF CONDITIONS



Introduction

This section provides snapshots of the various stakeholders involved, as well as the factors, and shifts that are resulting in favourable conditions for remanufacturing to meaningfully emerge in India.

Remanufacturing in India

The remanufacturing industry does have a presence in India. However, the full extent of remanufacturing in the nation is not clearly known at this time. According to the European Remanufacturing Network's (ERN) 2015 'Remanufacturing Market Study', the main industries engaged in reman are the **IT industry and the HDOR [heavy-duty and off-road] vehicle industry**.

Most of the remanufactured IT products in India are printer cartridges, but the sector is largely unregulated. Thus, quality varies, and counterfeiting is likely common. In the HDOR sector, **Volvo remanufactures construction equipment for the domestic market and Cummins operates two separate remanufacturing facilities**. One serves the export market and the other serves the

domestic market. In the **electronics remanufacturing industry, CoreCentric Solutions** operates a research facility in India. However, it does not have any commercial remanufacturing operations in the nation.

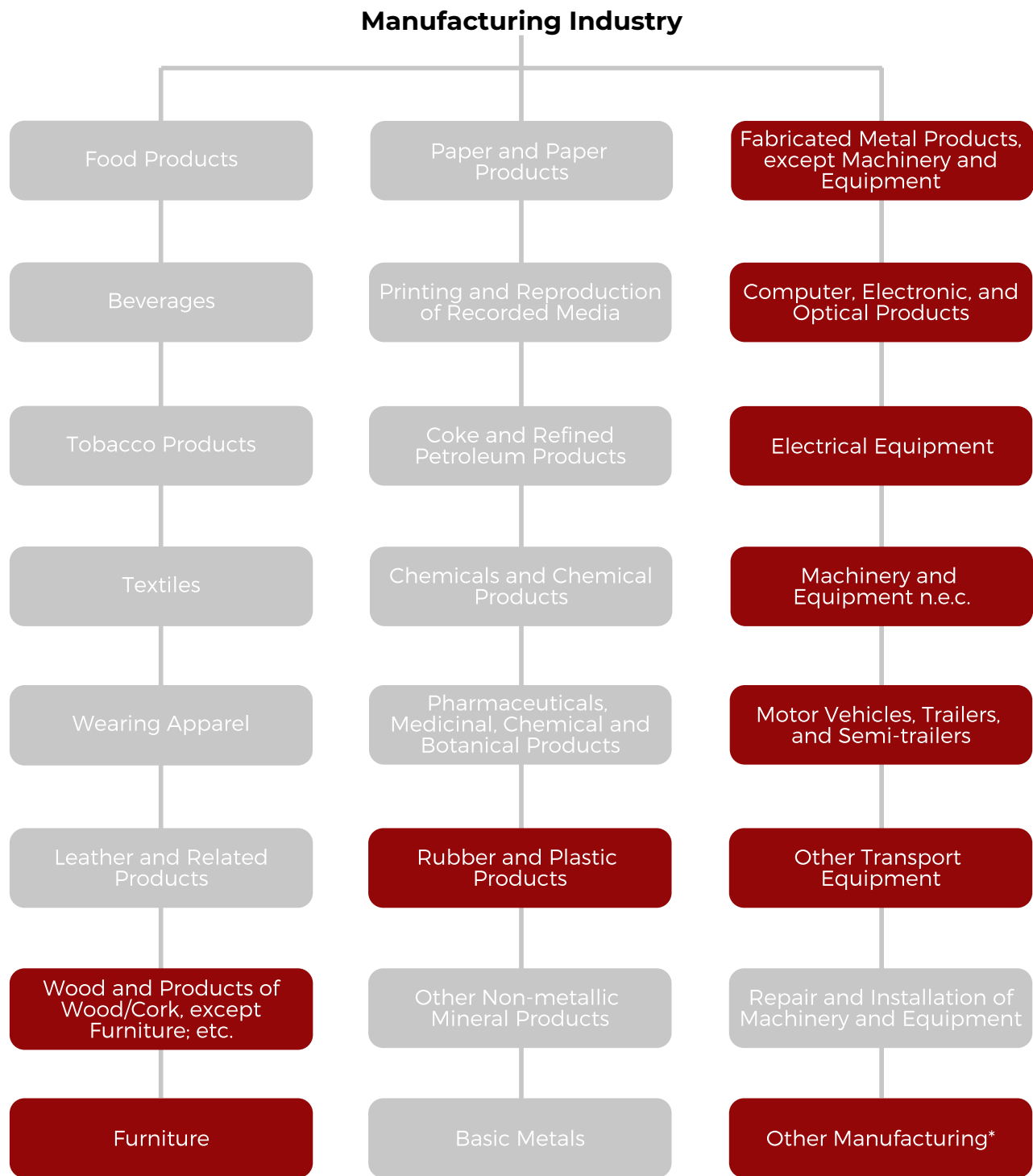
Manufacturing in India

According to the India Brand Equity Foundation (IBEF), the manufacturing industry in India has emerged as one of its high growth sectors, **is the largest private sector employer in the nation, and expected to reach US\$ 1 trillion** by 2025. Despite the pandemic, the outlook and conditions in the Indian manufacturing sector continue to remain positive.

With government-led initiatives like 'Make in India', 'Startup India', 'Skill India' and the 'Modified Electronics Manufacturing Clusters Scheme' (EMC 2.0), the government **aspires to create 100 million new jobs in the manufacturing sector** by 2022. Foreign Direct Investment (FDI) also continues to remain high and the cumulative **FDI in India's manufacturing sector reached US\$ 88.45 billion** from April 2000 to March 2020.

The makeup of the manufacturing industry in India, based on the National Industrial Classification (NIC) - and sourced from IBEF - is outlined below. The sectors that already undertake remanufacturing (with potential room for growth) or have the greatest promise to adopt it are highlighted in red

boxes. It is worth noting that **at present, the NIC does not have an independent industry code or classification** for companies that currently (or want to) undertake remanufacturing. In other words, reman is categorized under traditional manufacturing codes.



* **Other Manufacturing** includes manufacture of: jewellery, bijouterie and related articles, musical instruments, sports goods, games and toys, medical and dental instruments and supplies.

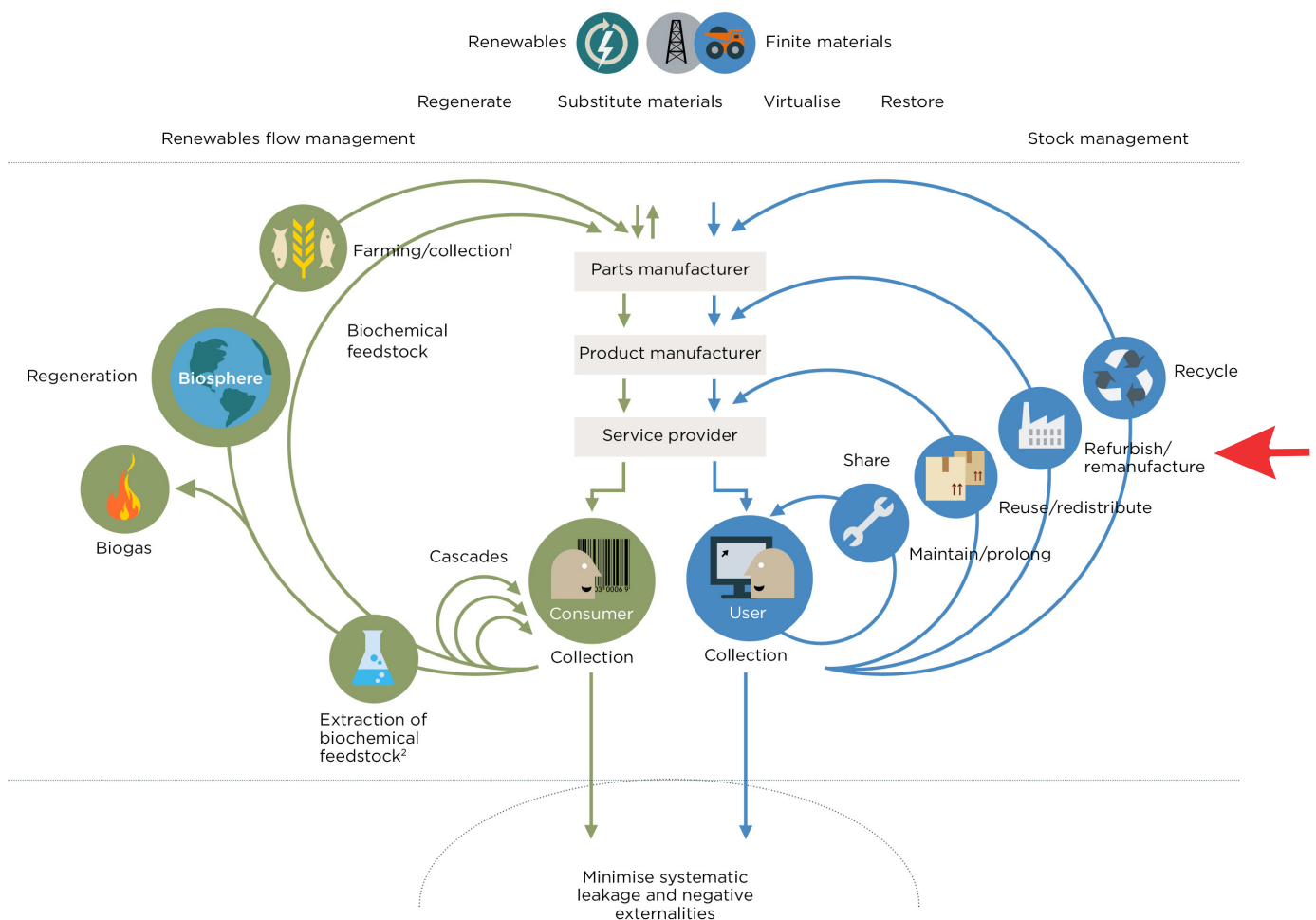
Remanufacturing and the Circular Economy

According to the Ellen MacArthur Foundation (EMF), in a circular economy, economic activity builds and rebuilds overall system health. It involves gradually decoupling economic activity from the consumption of finite resources, and **designing waste out of the system**.

In a circular economy, technical and biological cycles are viewed distinctly. Consumption happens only in biological cycles, where food and biologically-based materials are designed to feed back into the system through processes like composting

and anaerobic digestion. These cycles regenerate living systems, such as soil, which provide renewable resources for the economy. Technical cycles recover and restore products, components, and materials through **strategies like reuse, repair, remanufacture or recycling**. The diagram below developed by EMF shows the overall architecture of the circular economy system and where remanufacturing fits in.

According to the FICCI-Accenture study published in 2018 titled 'Accelerating India's Circular Economy Shift', approximately **half-a-trillion dollars worth of economic value can be unlocked** through circular economy business models in India by 2030



Source: Ellen MacArthur Foundation

Remanufacturing and the SDGs

The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

These 17 Goals build on the successes of the Millennium Development Goals, while including new areas such as **climate change, economic inequality, innovation, sustainable consumption, peace and justice**, among other priorities.

The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another. Of the 17 goals, remanufacturing impacts:

- Goal 8: Decent work and economic growth
- Goal 9: Industry, innovation and infrastructure
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 17: Partnerships for the goals

Remanufacturing and India's INDCs

Countries across the globe adopted an historic international climate agreement at the U.N. Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP21) in Paris in December 2015. In anticipation of this moment, countries publicly outlined what post-2020 climate actions they intended to take

The 17 SDGs are integrated - that is, they recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.

-United Nations

under the new international agreement, known as their Intended Nationally Determined Contributions (INDCs). The climate actions communicated in these INDCs largely determine whether the world achieves the long-term goals of the Paris Agreement: **to hold the increase in global average temperature to well below 2°C, to pursue efforts to limit the increase to 1.5°C, and to achieve net zero emissions** in the second half of this century.

Of India's eight (8) INDCs, remanufacturing could potentially contribute to the following two (2):

- To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
- To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.

In order to achieve the INDCs, India has identified eight (8) priority areas, of which the following two (2) may encompass remanufacturing activities:

- Promoting energy efficiency in the economy, notably in industry, transportation, buildings and appliances.
- Reducing emissions from waste

Government Alignment

In January 2019, the National Institution for Transforming India (NITI Aayog) in partnership with the European Union Resource Efficiency Initiative (EU-REI) published a status paper titled 'Resource Efficiency & Circular Economy; Current Status and Way Forward'. The four focus areas of the paper included two key abiotic materials (steel and aluminium), and two waste streams (e-waste and construction and demolition (C&D) waste).

A total of 30 recommendations were outlined in the paper in categories ranging from policy interventions to R&D, including the **establishment of an industry body to spur the growth of the remanufacturing industry in India.**

In addition, the International Cooperation Division of the Ministry of Environment, Forest & Climate Change (MoEFCC) published the 'Draft National Resource Efficiency Policy, 2019' in July 2019 which **recognizes remanufacturing as one of the keys to driving resource efficiency.**

It also identifies the need for training in the manufacturing industry to adopt remanufacturing as well as the need for **product certification schemes to provide legitimacy and credibility** to remanufactured products.

International Collaboration

At the EU-India Summit held on July 15, 2020, the EU and India adopted the EU-India Joint Declaration on Resource Efficiency and Circular Economy to scale-up EU-India cooperation in the areas of resource efficiency and circular economy.

The declaration establishes an India-EU Resource Efficiency and Circular Economy Partnership bringing together representatives of relevant stakeholders from both sides, including governments, businesses (including start-ups), academia and research institutes.

Financial Capital Flows

The Reserve Bank of India's (RBI) 2019 'Report on Trend and Progress of Banking in India', **green bond issuances totaled about US\$ 7.7 billion** during the 2012-2018 period. The report also recognizes that more needs to be done at the policy level "to establish an enabling framework that promotes the green finance eco-system in India".

An example of the growth in sustainable finance in India is the Green Growth Equity Fund (GGEF) managed by EverSource Capital. It was established with **anchor investment from India's National Investment and Infrastructure Fund (NIIF) and the Department for International Development (DFID), Government of UK** in 2018. The fund invests in scalable operating companies and platforms ranging from renewable energy and e-mobility, to resource conservation and associated value chains.

As recently as July 2020, UK-based BP committed to investing US\$ 70 million into the fund.

Remanufacturing and Industry 4.0

Industry 4.0 refers to the fourth stage of industrialization, aiming for a high level of automation in the manufacturing industry through the adoption of ubiquitous information and communication technologies (ICTs).

In simple terms, electronic and mechanical components are linked through sensors in a network, which provides a smart platform for data flow and data analytics called cyber-physical production systems (CPPSs).

An early form of this technology is the implementation of radio frequency identification (RFID) sensors, which have been in wide use since the year 1999. The opportunities that Industry 4.0 bring to remanufacturing are in the following three areas:

- **Smart Life Cycle Data for Design for Remanufacturing and EOL Management**

Ineffectiveness of data circulation has reduced the efficiency of product life-cycle management and the quality of service provided. This could be enabled through sensors, embedded systems, and connected devices ("Internet of Things"), as well as a comprehensive data management platform.

- **Smart Factory for cost-effective and green remanufacturing operations**

"Smart factories" are essentially at the core of Industry 4.0. "Smartness" is achieved using

electronic hardware/software, as well as networking of production resources.

Compared with traditional manufacturing, more ancillary hardware and software, like RFID tags, barcodes, laser markers, sensors, as well as communication infrastructure, will be embedded into the factory to enable machines to collaborate with each other using intelligent analytics.

- **Smart Services for a successful remanufacturing business model**

In this emerging and disruptive business model, ownership of the product is usually retained by the OEMs or retailers and only the service or usage is offered to customers (e.g., selling "flying hours of the engine" instead of selling "engines").

Hence, it creates a mandate for manufacturers or retailers to monitor their product's performance during its runtime and to forecast remanufacturing operations on the cores returned based on the predicted remaining life of the product.

On the other hand, from the consumers' perspective, as they pay for the service rather than the ownership of the product, market acceptance for remanufactured goods will likely be increased, leading to a successful remanufacturing model.

Source: All the information above has been sourced directly from the paper 'Opportunities for Industry 4.0 to Support Remanufacturing' published in the Applied Sciences journal and available at <http://dx.doi.org/10.3390/app8071177>





FORGING THE FUTURE

The economy is a child of the biosphere, not the other way round. In 2018, the UN's International Resource Panel (IRP) published a comprehensive report titled 'Re-defining Value – The Manufacturing Revolution. Remanufacturing, Refurbishment, Repair and Direct Reuse in the Circular Economy'. The report highlights that:

"One of the objectives of a circular economy is the adoption of practices that seek to decouple the rate [of] economic growth from the rate of growth of environmental impact."

Many circular economy practices seek to retain value within the economic system (value-retention processes, or VRPs), and these processes include: arranging direct reuse, repair, refurbishment or comprehensive refurbishment, and remanufacturing."

Designing products and systems for durability, longevity, recoverability, and disassembly is paramount not just to remanufacturing, but to circular economies. It invites innovation, creativity, and wisdom in product, process, business-model, and system design.

Remanufacturing is undoubtedly a critical piece of the circular economy. It is also just one element of the tapestry of the future of how we make things (i.e. manufacture) and how we use them. Additional elements include:

- Greater consumer awareness
- Wise material selection
- Higher workforce skill-levels
- Circular/life-cycle design
- Closed-loop supply chains
- Additive manufacturing
- Automation and robotics
- Artificial intelligence
- Industry 4.0

The deeper question is what we choose to make and why. Unless the answers to the 'what' and 'why' are imbued with a desire for the well-being of all life, we will unfortunately, always be off the mark in creating a sustainable world.

This monograph is an invitation to stakeholders across the board to give deep consideration to the potential of, and role that remanufacturing can play in co-creating a beautiful, circular, and sustainable India.

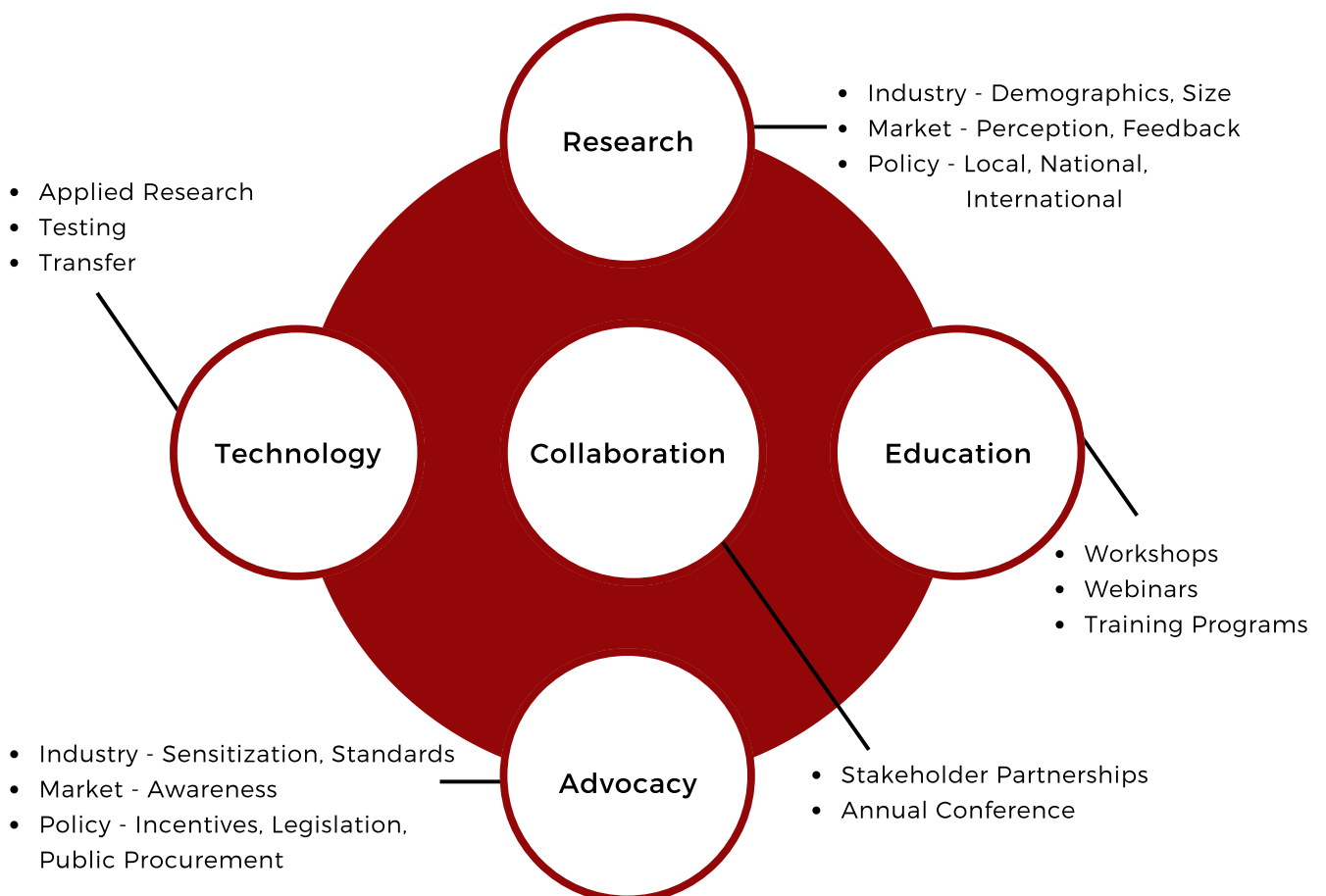
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ABOUT Re:CREATe

Recreate India Research Foundation (Re:CREATe) is a Section-8 Nonprofit Company established to catalyze, advance, and co-create a thriving remanufacturing industry in India.

The four pillars of Re:CREATe are **R**esearch, **E**ducation, **A**dvocacy, and **T**echnology resting on a foundation of national and international **C**ollaboration. Re:CREATe's activities and aspirations are shown below.



Recreate India Research Foundation (Re:CREATe) is a Section-8 Nonprofit Company that aims to advance the remanufacturing industry in India. Re:CREATe is incorporated under the Companies Act, 2013 in India.

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Registration #: 330013



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