FICCI

Accelerating India's Circular Economy Shift

A Half-Trillion USD Opportunity

Future-proofing growth in a resource-scarce world

FICCI
Circular Economy Symposium 2018

accenturestrategy

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अमिताभ कांत
Amitabh Kant
मुख्य कार्यकारी अधिकारी
Chief Executive Officer

भारत सरकार
नीति आयोग, संसद मार्ग,
नई दिल्ली-110 001
Government of India
NATIONAL INSTITUTION FOR TRANSFORMING INDIA
NITI Aayog, Parliament Street,
New Delhi-110001
Tel. : 23096576, 23096574 Fax : 23096575
E-mail : ceo-niti@gov.in, amitabh.kant@nic.in

Foreword

As a rapidly emerging economy, India is expected to grow at over 7% in 2018. This represents an exciting opportunity – however, with this opportunity also comes a responsibility that we need to collectively deliver on. We are all aware that air pollution poses a major threat to a clean and healthy environment. We have also witnessed the challenge of water scarcity which can adversely impact industrial sector and the citizens, alike. Clearly, the resource challenges pose a big risk to our ability to grow in a sustainable manner.

Driving sustainable growth represents a critical priority for the Government of India. This is reflected by the initiatives such as Zero-Effect-Zero-Defect Scheme, Smart Cities Mission, Swacch Bharat, amongst several others. In its capacity, NITI Aayog is committed to help drive clean and efficient growth in India. In line with this commitment, NITI Aayog recently launched a strategy paper on resource efficiency. The paper identified opportunities to drive resource efficiency for materials in selected sectors and outlined its role as a facilitator for driving resource efficiency and circular economy discourse in India.

Given this context, this theme paper on Circular Economy comes at a very opportune time - It represents a unique opportunity to spread awareness about the circular business models in India. I believe this study can be immensely helpful for businesses to understand the diverse circular business models, global best practices, and the size of the prize from adopting circular business models. The study also highlights the key enablers that could help companies accelerate the adoption of circular business models.

I would like to commend FICCI, Accenture Strategy and all participating organizations that have contributed to this critical study. I sincerely hope that this study helps accelerate action on circular economy, thereby making our dream of clean and efficient growth in India a reality!

(Amitabh Kant)
May, 2018

PREFACE FICCI

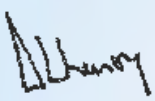
Dilip Chenoy
Secretary General
FICCI

The phrase "Circular Economy" is often used these days in the context of initiatives aimed at driving resource efficiency. The key word here being "Circular", as these business models encourage a shift from linear value chains to circular value chains, thereby enabling more efficient and fuller utilization of resources. This, we believe, is a critical need of the hour to address the acute resource shortage confronting the country.

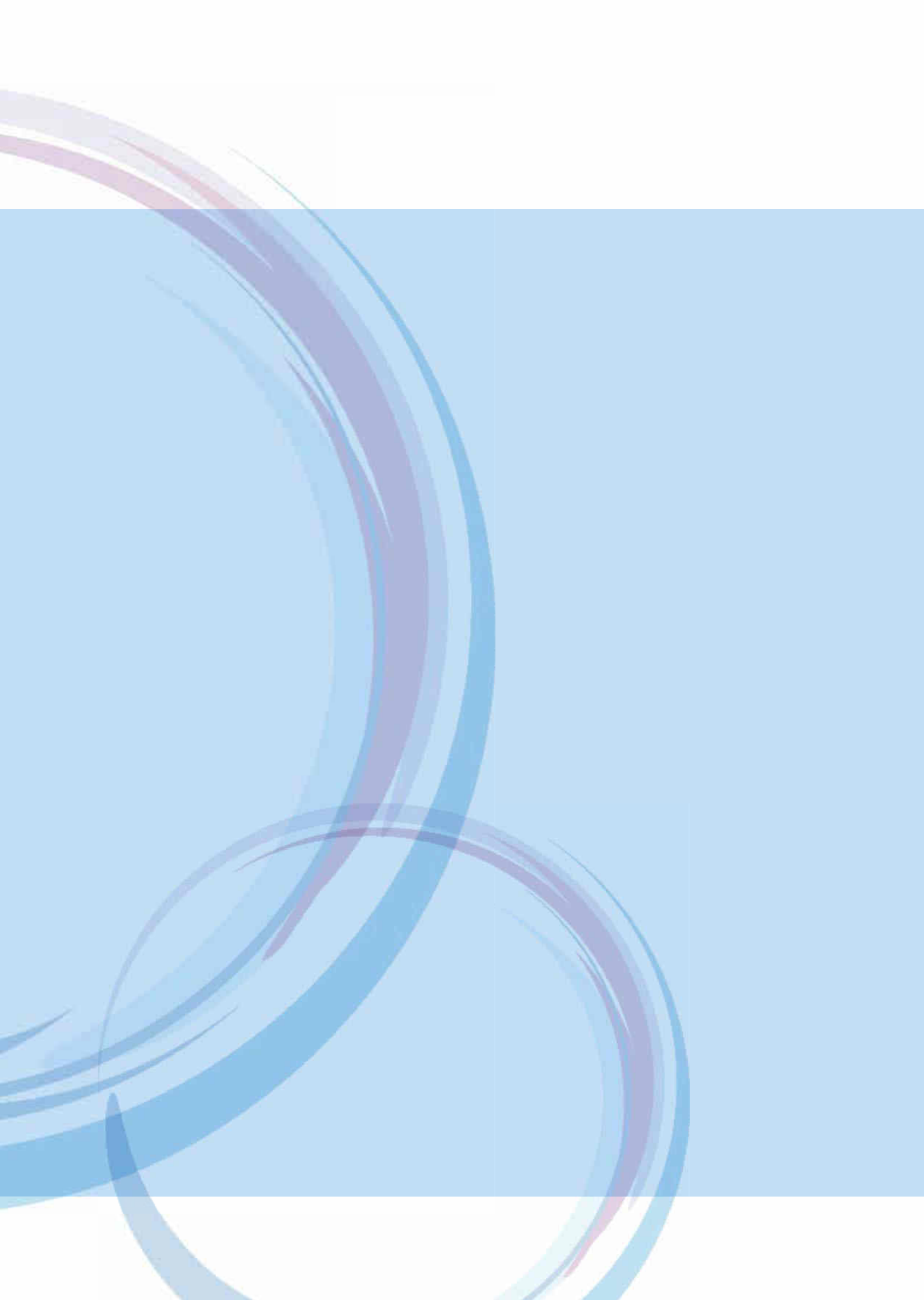
However, despite its immense relevance, the industry today has a somewhat varied (and at times limited) understanding of Cir cular Economy principles. This poses a significant challenge with respect to the adoption of circular business models at scale in India. As the voice of India's industry and business, FICCI is committed to address this challenge – the Circular Economy Symposium 2018 represents our continued efforts in this direction.

We are pleased to share this study of national importance jointly conducted by Accenture Strategy and FICCI. The study seeks to demystify the Circular Economy principles and outlines different business models that organizations and FICCI members ca n adopt to improve their resource efficiency. We are particularly enthused by the 'size of the prize' as indicated by this study – there is almost half-a-trillion-dollar worth of GDP value at stake that can be protected through the adoption of Circular Economy principles in India by 2030. The study also presents several global and local case studies to showcase the good work already happening in this space.

We would like to take this opportunity to thank Accenture Strategy and all the organizations that have contributed to this critical study. We hope their efforts and contributio ns, as captured through this study, will pave way for the much-needed transformation and impact at scale in the coming years.



Dilip Chenoy
Secretary General
FICCI



PREFACE ACCENTURE

Vishvesh Prabhakar
(Managing Director - Communications, Media & Technology, and Sustainability Accenture Strategy, India)

Sundeep Singh
(Senior Principal – Sustainability, Accenture Strategy, India)

The Indian economy today is at a critical stage of its growth journey – a stage that is characterized by rising demand-supply constraints, fast changing consumer preferences and an increasing stakeholder scrutiny. Given the rapidly depleting natural resources and changing stakeholder expectations, business leaders are often confronted with questions about longevity and sustainability of their business models.

This manifests as an interesting business context for organizations to operate – interesting, because it represents a huge challenge and opportunity at the same time. Organizations that are willing to innovate and re-invent themselves may identify new business models and gain competitive advantage over their peers, while organizations that are slow to respond could face challenges with respect to license to grow.

Amidst this exciting business context, Circular Economy presents a window of opportunity to not just address the existing resource constraints, but also drive transformative benefits for businesses and consumers, alike. Our research suggests around half-a-trillion dollars worth of India's GDP value at risk by 2030, which could be protected through the adoption of circular business models in India.

As is often the case, there is no "one size fits all" solution when it comes to embracing circular business models. The nature of opportunities would differ based on the industry context. Through this study, our endeavor is to provide organizations a good reference framework to appreciate the art of possible. We hope that it will help develop a better understanding of the circular business models, global case studies and critical success factors for their adoption in India.

We congratulate FICCI for initiating this position paper as a part of the Circular Economy Symposium 2018. We also express our sincere gratitude to all the participating organizations for their valuable contributions and insights. This study couldn't have been completed without their support.

Last but not the least, we would like to thank Peter Lacy, Accenture's Strategy and Sustainability lead, for his pioneering work on Circular Economy. Peter is a co-author of the book "Waste to Wealth – The Circular Economy Advantage", which explores the enormous opportunity from circular business models globally. Peter's work has served as a huge inspiration for us to dive deeper into the Circular Economy opportunity for India.

Executive Summary

Given the current resource constraints, business-as-usual is not sustainable and there is a need to decouple growth from resource requirements

Our analysis indicates a strong positive correlation between the level of economic development and per capita resource requirements of countries. This trend could have interesting implications for an emerging economy like India. On one hand, there is a need to sustain the industrial growth in our quest to become a fully developed economy; on the other hand, it is critical to identify innovative growth models that do not exacerbate the existing resource constraints in India (for instance, 5% of the population lacks access to drinking water and 20% of the population lacks access to electricity). Circular Economy, through its innovative business models, offers a unique window of opportunity to decouple growth from resource requirements.

At the core of Circular Economy lays a shift towards complete elimination of waste – i.e. waste not in the traditional sense of junk, but any kind of underutilization of assets and resources

Organizations can adopt five distinct models to introduce circular initiatives in their operations:

Message from the Chair of Circular Economy Symposium 2018

India is experiencing environmental degradation in extreme measure. Even the holy river Ganga has not been spared. As the economy struggles with supply – demand issues, with greater urbanization and greater generation of "waste", it is time to consider a new way of dealing with the material cycle. If we look at "waste" as a by-product or even nutrients in a different form, we would probably find a better way to use it instead of disposing it off. Reduce, reuse, recycle and other such ideas would gain ground and Circular Economy practices would become mainstream.

In this context, this theme paper aimed at businesses, talks about the future of Circular Economy models in India and provides economic arguments towards moving the conversation from efficiency within a product lifecycle to maximising efficiency across lifecycles. The need of the hour clearly is for a coherent, focused and systematic framework that can help lay a clear direction and roadmap, spur innovation and encourage private sector participation towards achievement of a Circular Economy. This paper hopes to help that cause!

Anirban Ghosh
Mahindra & Mahindra

Business model	Description	Illustration
Circular Supply Chain 	Provide renewable energy, bio-based-or-fully recyclable input materials to replace single life-cycle inputs	BASF is replacing finite fossil resources with sustainably produced renewable resources through its innovative production Verbund Biomass Balance approach
Recovery & Recycling 	Recover useful resources / energy from disposed products or by-products	Nike reuses and recycles footwear manufacturing scrap and post-consumer shoe wastage, converting it into raw material for other sports equipment manufacturing players
Product Life Extension 	Extend working lifecycle of products and components by repairing, upgrading and reselling	Patagonia launched an online store where customers trade-in their used clothing in return for store credit, thereby extending the life of products
Sharing Platform 	Enable increased utilization rate of products by making possible shared use, access or ownership	Airbnb operates as an online marketplace for people to lease or rent short-term lodging, facilitate tourist experiences or make restaurant reservations
Product as a Service 	Offer product access and retain ownership to internalize benefits of circular resource productivity	Philips offers lighting as a service, wherein users are required to pay for the consumed intensity (rather than for the product)

Our analysis indicates approximately half-a-trillion dollars worth of economic value that can be unlocked through Circular Economy business models in India by 2030

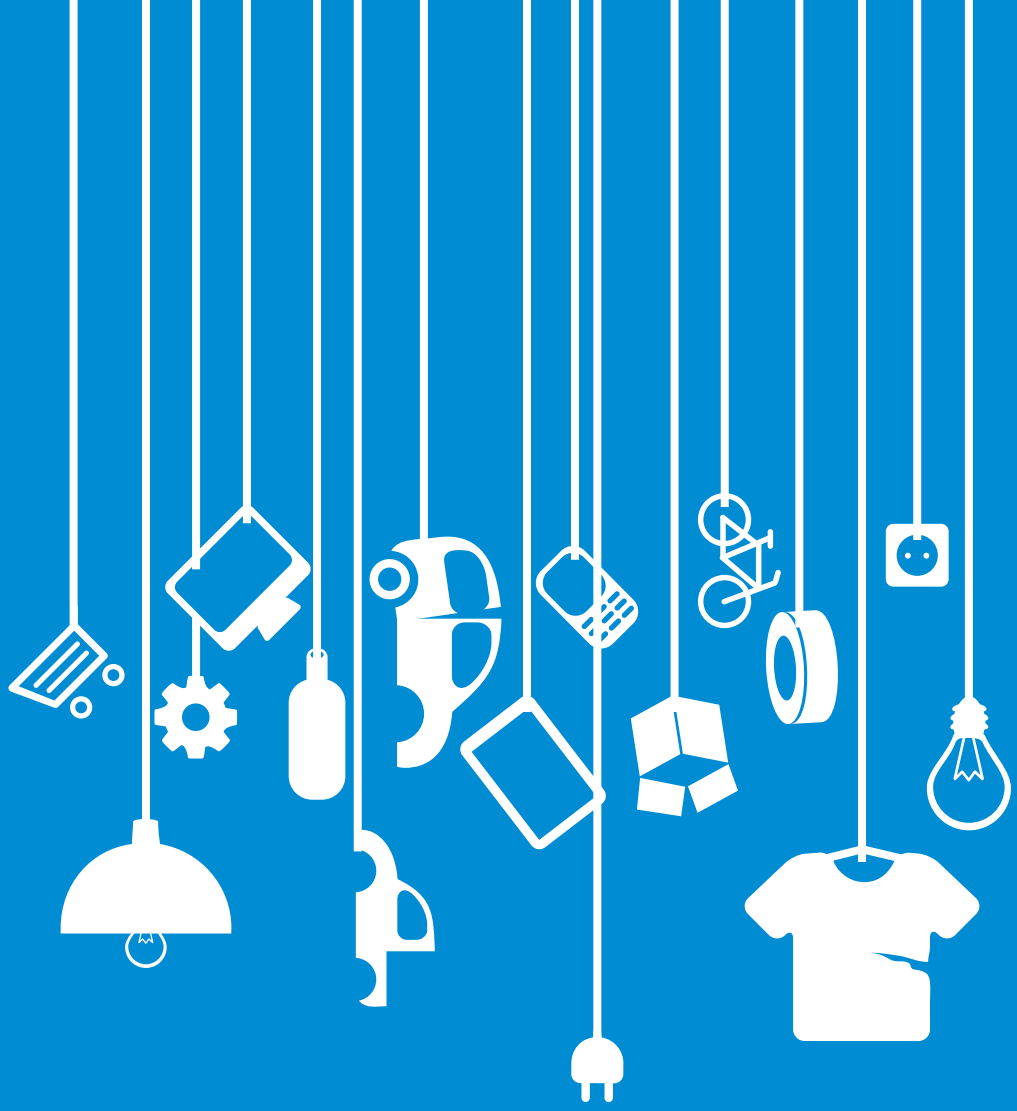
The enormous circular opportunity in India will manifest itself in the form of different resources. From prioritization perspective, resources with significant economic impact and environmental footprint are the natural choices for organizations to focus their CE initiatives. Our research highlights eight such priority resources for India. These are: (i) petrochemicals, (ii) plastics, (iii) food, (iv) gold, (v) iron & steel, (vi) copper, (vii) fibers, and (viii) cement. It is noteworthy that there is no standard model that applies across all industries and the opportunities exist in diverse forms. For instance:

- **Urban mining from e-waste**: There is ~$1bn of value that can be realized from the extraction of gold from e-waste in India.
- **Plastics recycling**: Currently, ~40% of plastic waste in India ends up being uncollected for recycling. Proper management of this waste can create ~14 lakhs jobs and could potentially represent a ~$2bn opportunity.
- **Steel recovery from end of life vehicles**: There is over 8mn tons of steel that can be potentially extracted from end of life vehicles in India in 2025, representing a ~$2.7bn opportunity.

From implementation perspective, there is a need for an enabling ecosystem – one that fosters the spirit of disruption and innovation

There are five factors that would be critical for the acceleration of Circular Economy models in India:

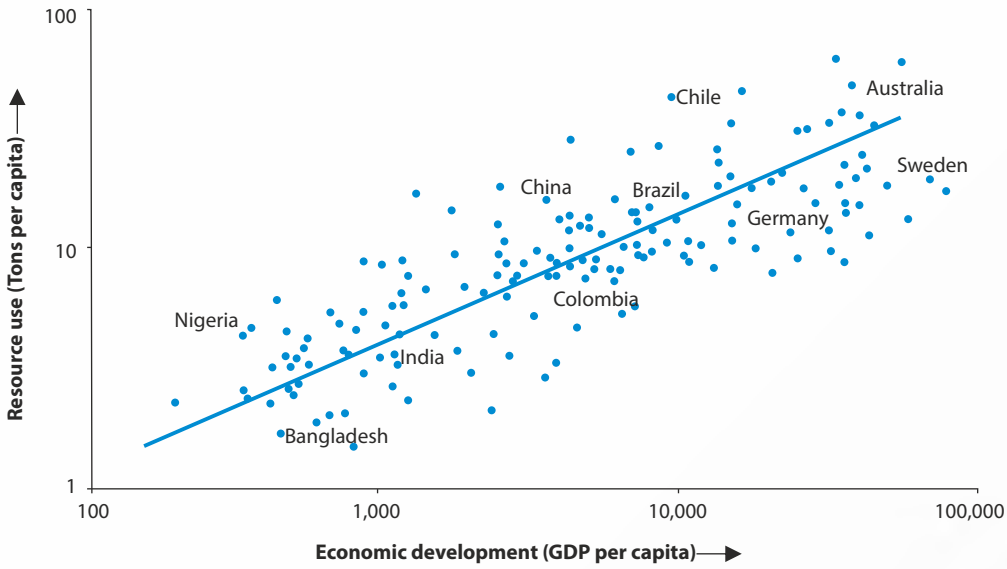
Better awareness	Disruptive technologies	Enabling policy landscape	Innovative funding models	Collaboration and partnerships
■ Better consumer awareness required to drive adoption of new interaction models (between suppliers and consumers) ■ Educating entrepreneurs, designers, engineers, procurement officers, and product managers about the art of possible ■ Intervention in school and university curriculums to influence mindset	■ Emerging technologies can accelerate a shift towards CE models– for example, enabling cleaner resources (bio-materials), enabling extended lifecycles (through predictive maintenance) and enabling shared platforms (through IoT) ■ Three types of technologies would be critical– digital technologies (such as IoT), physical technologies (such as 3D printing) and biological technologies (such as bio-based materials)	■ Favourable policy landscape can help accelerate adoption through elimination of barriers and driving behavioural change ■ Several policy measures already introduced in India – for instance, Zero Defect, Zero Effect, scheme, plastics waste management rules, e-waste rules, BIS standards for CE principles	■ Funds required to drive R&D and capital investments ■ Illustrative examples of best practices – ESG investing (such as green bonds), CE innovation fund introduced by Finnish Government	■ Need for both cross-sector partnerships and partnerships across different players (for example, MSMEs, government, urban local bodies, NGOs and consumers) ■ For instance, MSTC and Mahindra partnering for India's first auto shredding business



Introduction

A close look at the global economies suggests a strong linkage between levels of economic development and resource intensity. Accenture's analysis reveals that the developed countries like Germany, Australia and Sweden have a significantly higher per capita resource consumption as compared to countries like Bangladesh and Nigeria.

Figure 1: Resource use vs. economic development (2014, 166 countries)



The strong positive correlation between resource intensity and economic development has significant implications. It implies that the emerging economies of today may not be able to adopt the traditional growth models as it could strain the finite pool of natural resources. The point becomes clearer when one considers the ability of earth to replenish natural resources - there is a threshold rate at which earth can replenish natural resources. Any consumption beyond this threshold pushes the world into an ecological debt mode, where it starts relying on resources allocated for the future generations. For instance, in 2017 the world exhausted the entire "budget" of natural resources available for the year on 2nd August 2017 (a day referred to as Earth overshoot day). Research indicates that if the global economies continue to operate in the business-as-usual mode, then by 2030 the world would be over utilizing natural resources by a factor of three.

Clearly, the business-as-usual state is not sustainable and there is a critical need to identify innovative models to ensure sustainable growth without straining the finite pool of natural resources. Circular Economy, through its different business models does precisely that. It provides businesses an opportunity to decouple growth from resource requirements – thereby enabling much more efficient and effective utilization of resources.

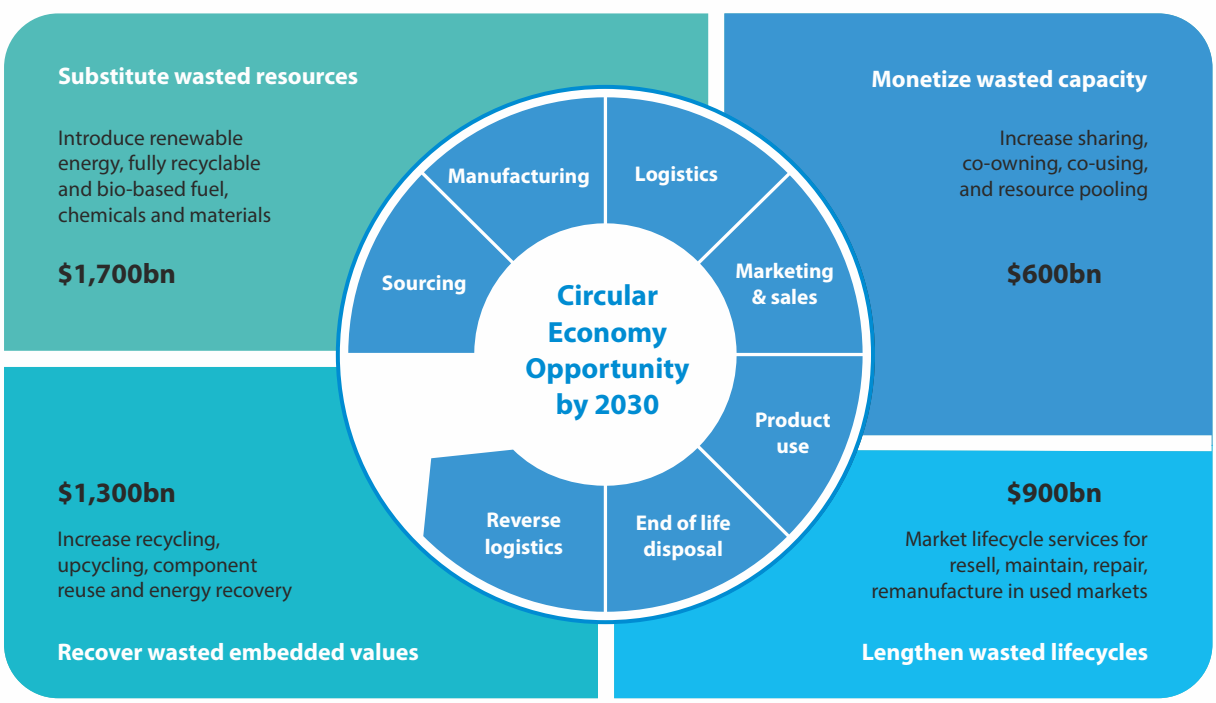
What is Circular Economy?

In simple terms, Circular Economy seeks to eliminate any kind of waste in the market. When viewed from the lens of Circular Economy, waste doesn't refer to the usual connotation of "junk", but it refers to any kind of underutilization of resources or assets. There are four distinct types of waste that circular models seek to eliminate. These are:

- **Wasted resources** - Material and energy that cannot effectively be regenerated over time
- **Wasted capacities** - Products and assets that are not utilized fully
- **Wasted lifecycles** - Products reaching end of life prematurely due to planned obsolescence or lack of second life options
- **Wasted embedded values** - Components, material and energy not recovered from waste streams

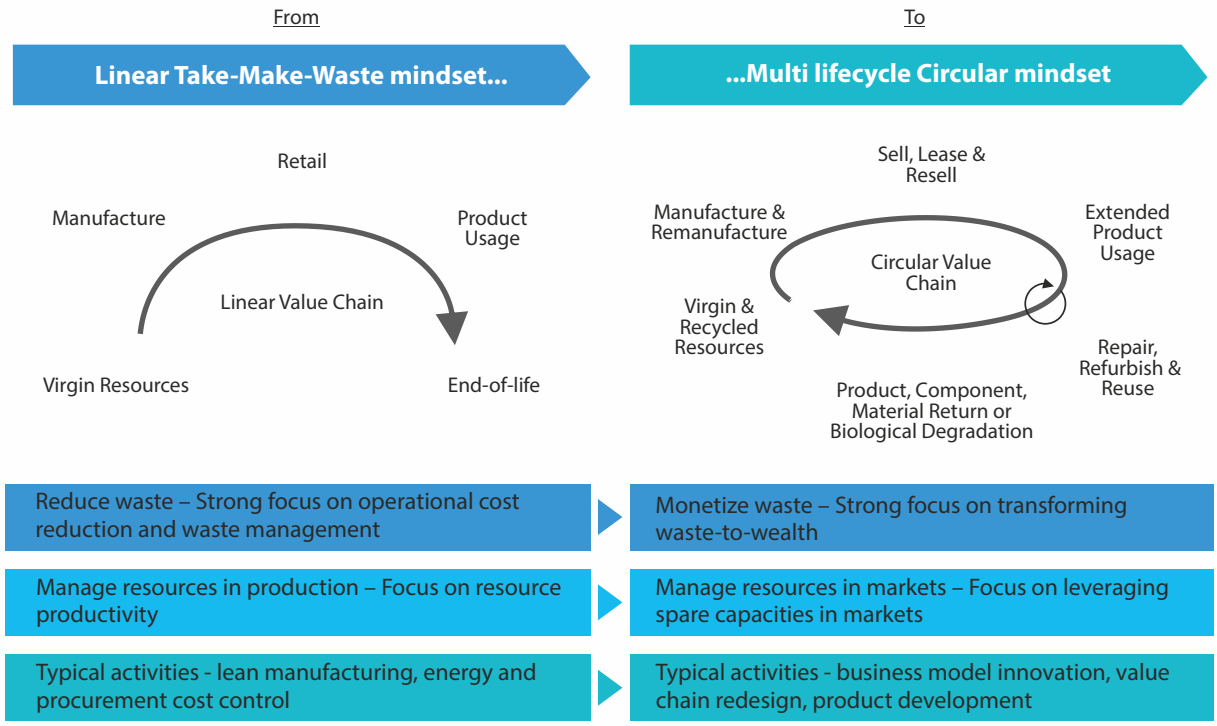
Tremendous value can be potentially realized by eliminating these four types of waste through the adoption of circular business models. Accenture's research estimates the size of this new business opportunity to be around $4.5tn of GDP globally by 2030[1].

Figure 2 : Value realization potential from circular business models by 2030



It is interesting to note that identification and adoption of circular business models requires a shift in approach– a shift from linear "take-make-waste" mindset to a multi-life-cycle "circular" mindset. There is a strong focus on identifying opportunities to continually extract value from resources through business model innovation.

Figure 3 : Adopting circular business models - a shift in mindset



So, what exactly are the circular business models that organizations can adopt? There are five distinct types of Circular Economy business models – (i) Circular Supply Chain, (ii) Recovery and Recycling, (iii) Product Life Extension, (iv) Sharing Platform, and (v) Product as a Service.

Figure 4 : Five business models to mainstream Circular Economy

5 BUSINESS MODELS

Circular Supply Chain	Recovery & Recycling	Product Life Extension	Sharing Platform	Product as a Service
Provide renewable energy, bio-based or fully recyclable input material to replace single-lifecycle inputs	Recover useful resources / energy out of disposed products or by-products	Extend working lifecycle of products and components by repairing, upgrading and reselling	Enable increased utilization rate of products by making possible shared use / access / ownership	Offer product access and retain ownership to internalize benefits of circular resource productivity

Globally, adoption of these five business models has grown substantially in the last decade. This is also reflected in the Global CEO study jointly conducted by Accenture and United Nations Global Compact in 2016. According to this study, one-third of the global CEOs are actively trying to implement Circular Economy models[2] as a part of their core strategy.

The following section provides a detailed overview of each of the five types of CE business models.

Circular Supply Chain

The Circular Supply Chain model introduces fully renewable, recyclable or biodegradable materials that can be used across lifecycles. For instance, replacing a fossil-fuel based energy source with a renewable energy source is a simple illustration. An organization can implement circular supply chain model through its supply chain partners or within its own operations.

BASF is replacing finite fossil resources with sustainably produced renewable resources through its innovative production Verbund Biomass Balance approach. The production Verbund is a set of six BASF sites globally with intelligently networked production facilities, energy flow, logistics and infrastructure. They maintain a closed chain of custody from renewable feedstock to final product. According to a third-party certification, BASF has substituted 100% of fossil fuels with renewable materials in their Verbund production sites.

Carlsberg in partnership with Danish company EcoXpac has developed the world's first fully biodegradable beer bottle made from wood fiber and coated with biologically inert materials like chalk and clay. This bottle will be able to enter a recycling cascade before returning to the source as future raw material. Carlsberg also focuses on end-of-life collection and recycling of their bottles. In fact, ~40% of all bottles they put in the market are made from refillable packaging.

- **Circular supply chain adoption for the supply chain partners:** Companies can develop and market circular supplies like renewable energy and recyclable materials through its upstream or downstream partners. For instance, AkzoNobel, a leading global paints company, is focusing on sourcing bio-based materials from suppliers and supplying customers with recyclable products. Another example is that of Ecovative, an entrepreneurial startup, which provides environmentally responsible, biodegradable and home-compostable mushroom-based alternatives to plastic foam packaging and other synthetic materials.

- **Circular supply chain for own operations**: Companies can also produce circular supplies and use them for their own operations. As an illustration, consider the case of DSM, which embarked on the journey to transition from fossils to renewables, thereby making sustainability an integral element of its business strategy.

The advancements in biological technologies and green chemistry are enabling organizations to identify much more sophisticated circular supply chain initiatives – the use of bio-based raw materials and bio-degradable products is an example. The biological nutrients can replace non-renewable and toxic inputs and safely degrade in the natural environment after use. Some organizations are deploying technical nutrients, which are inputs like metals and minerals that are capable of being reused and recycled infinitely, if they are not contaminated or leaked in the value chain.

Recovery & Recycling

This model enables organizations to capture value from waste stream (end-of-life products, waste products / by-products), thereby eliminating the concept of waste altogether. For instance, consider the following examples:

- **Extracting value from end-of-life products**: Companies can recover value from end-of-life products through recycling, refurbishment and restoration initiatives. For example, Nike is driving circularity at scale through the implementation of a design and manufacturing process that reuses and recycles footwear manufacturing scrap and post-consumer shoe waste, converting it into Nike Grind material. This material is recycled into athletic surfaces such as courts and tracks through partnership with companies like Astroturf (32+ projects so far) as well as footwear (71% of Nike shoes have material made from waste products).
- **Extracting residual value from waste products**: Companies can also disassemble the waste product to unlock the residual value in the form of valuable material. An interesting example is that of medals being planned for the 2020 Olympic games. Japan plans to manufacture gold, silver and bronze medals for the 2020 Olympics games by extracting precious metals from the electronic waste[3].

From execution perspective, the model often requires organizations to establish reverse supply chains to be able to aggregate waste streams at scale. The same is then transformed through initiatives such as recycling, upcycling (converting old products or materials into something more valuable), industrial symbiosis (sharing by-product resources among industries), downcycling (converting products to something of a lesser value) as well as cradle-cradle design (disposed products are reprocessed without any resource loss).

Johnson Controls uses a circular supply chain and reverse logistics network to design, make, transport, recycle and recover vehicle batteries. It has reached 99% recycling rate for conventional batteries in North America, Europe and Brazil, whilst their sold batteries are now made up of 80% recycled materials.

Product Life Extension

Consumers often discard products that they no longer value because the products might be broken, out of fashion or no longer needed. But many of these products still have considerable value, and the Product Life Extension model seeks to recapture this value.

By maintaining and improving products through repairs, upgrades, remanufacturing or remarketing, companies can keep them economically useful for a longer time duration. Hence, there is a shift in the business model from merely volume of sales to longevity of life-cycle and actively keeping them alive and relevant. It also means moving customers from transactions to relationships, incorporating multiple interaction points to facilitate tailoring of upgrades and alterations to specific needs.

Patagonia's Worn Wear program encourages product life extension, through the repair and reuse of Patagonia and non-Patagonia products. In 2017, Patagonia launched an online store where customers trade-in their used clothing in return for store credit and can buy previously-owned Patagonia gear at a lower price point and give it a second life. All second-hand products are covered by their Ironclad guarantee ensuring strict quality standards. The company repaired 30,000 products in the first 18 months after launch of their campaign and sold used clothes worth $1mn in the first six months of the launch of the website.

Caterpillar has been remanufacturing and repairing construction equipment under its Cat Reman business. The model is integrated in the entire value chain with incorporation of modular design principles and setting up of reverse logistics to collect used equipment in return for customer credit. The remanufacturing business employs 4000 people across 17 locations worldwide, refurbishing millions of components, thereby using 93% lesser water, 86% lesser energy and emitting 61% lesser emissions.

There are six distinct activities that can help organizations extract all possible embedded residual value through an extended product life-cycle:

- **Build to last***:* This involves creating high quality durable products charging the customers either a premium or using alternate revenue models like pay per use.
- **Refurbish***:* This model entails restoring products to an almost original state or remanufacturing them in industry-setting.
- **Trade-in***:* Setting up reverse logistics to take back pre-owned goods for trade and reselling.
- **Upgrade***:* This involves adding new features and functionalities, keeping the core product the same.
- **Refill***:* Replacing the functionality that may have depleted/degraded faster than the core product.
- **Repair***:* This is the simplest model, involving fixing broken functions to extend product longevity.

There are different roles a company can play in implementing the Product Life Extension business model. For example:

- Companies can take up the role of an industrial manufacturer which produces these goods with extended life-cycles.
- Companies can also act as intermediary channel players providing a platform to connect buyers and sellers of used goods. OLX and Quickr are good examples of companies playing this role.
- Lastly, companies can play the role of field service company which uses local branches to provide repair, upgrade, refurbishment and maintenance services. This role can be played both by big corporates through their licensed stores or by local actors in the informal sector.

Sharing Platform

Research shows that, in developed economies up to 80% of the things stored in a typical home are used only once a month[4]. This leads to significantly low utilization of assets. The sharing platform model seeks to address this challenge by connecting two or more parties to drive-up the net asset utilization through co-access or co-utilization.

The model typically leverages digital technologies to forge new relationships and business opportunities for consumers, companies and micro-entrepreneurs, who rent, share, swap, lend or barter their idle goods. Hence, this business model provides consumers a new way of making and saving money while offering an asset light business opportunity for the organizations.

The model manifests itself in two ways currently:

- **C2C**: According to a survey conducted by Nielsen, 68% of global online consumers are willing to offer their personal items to sharing communities in return for payment and 66% are likely to use resources/products from such sharing platform. The items they are willing to share include electronics (ex. Rent-2-Own), bicycles (ex. Mobycy), clothing (ex. Designerex), householditems (ex. KRRB), cars (ex. BlaBlacar), furniture (ex. Furlenco), sports equipment (ex. Sharewood) and homes (ex. AirBnB).

Airbnb is an interesting example of a C2C sharing platform which operates as an online marketplace for people to lease or rent short-term lodging, participate or facilitate tourist experiences or make restaurant reservations. The company has more than 4 million listed lodgings in 65,000 cities, and an annual turnover of $2.6bn.

FLOOW2 is a B2B sharing marketplace that enables companies and institutions to share, rent out, buy or sell equipment, services, and personnel skills. The company positions itself as the World's reset button, matching supply and demand for 25,000 types of assets and services from construction, healthcare, agriculture, real estate and professional services.

- **B2B***:* Although the sharing economy started as a C2C model, it is slowly gaining traction in the B2B space as well. This is especially useful for businesses with expensive assets and low utilization rates.

Product as a Service

Over the last few years, there has been a shift in consumer behavior towards "access-over-ownership" mindset. This model requires the manufacturers and retailers to bear the total cost of product ownership, offering it to customers as a service. The customers become more of users rather than product owners.

Michelin Solutions has adopted product as a service model by offering tire as a service. The company leases sensor enabled tires to fleet customers, effectively selling a service which is monetized per kilometers driven. Customers don't own the tires and therefore don't have the responsibility of maintenance. Extending the lifecycle of tires would save consumption of more than 400 million tires and save 35 million tons of emissions globally.

This model facilitates a shift towards longevity, reliability and reusability as performance and durability take precedence over volume and disposability. It's a win-win situation for the companies and customers - the companies gain a new revenue stream while customers realize significant cost savings, superior performance and quality as well as reduced risk of ownership.

The business model manifests itself in several ways:

- **Pay for use***:* Customers buy a product's output rather than the product and pay based on a metric which measures usage such as miles driven, hours used etc.
- **Leasing***:* Customers buy contractual rights to use a product over an extended period and exclusive access, without transfer of ownership.
- **Rental***:* Customers buy rights to use a product over a short period of time.
- **Performance agreement***:* Customers buy a pre-defined service and quality level with companies guaranteeing achievement of a specific tangible result.

Adoption of the five circular business models has grown substantially in the past decade. A joint study of CEO perspectives conducted by Accenture and United Nations Global Compact in 2016 revealed that one-third of the global CEOs are actively trying to implement Circular Economy models.

The Atlas Copco Group, a Sweden based manufacturer of air and gas compressors provides air as a service through its Contract Air offering. The company provides all necessary equipment and handles installation and maintenance. Under an airLET agreement, customers only need to buy the compressed air they consume (measured by a remote monitoring system). The system guarantees significant cost savings, quality and 50% lesser energy consumption.

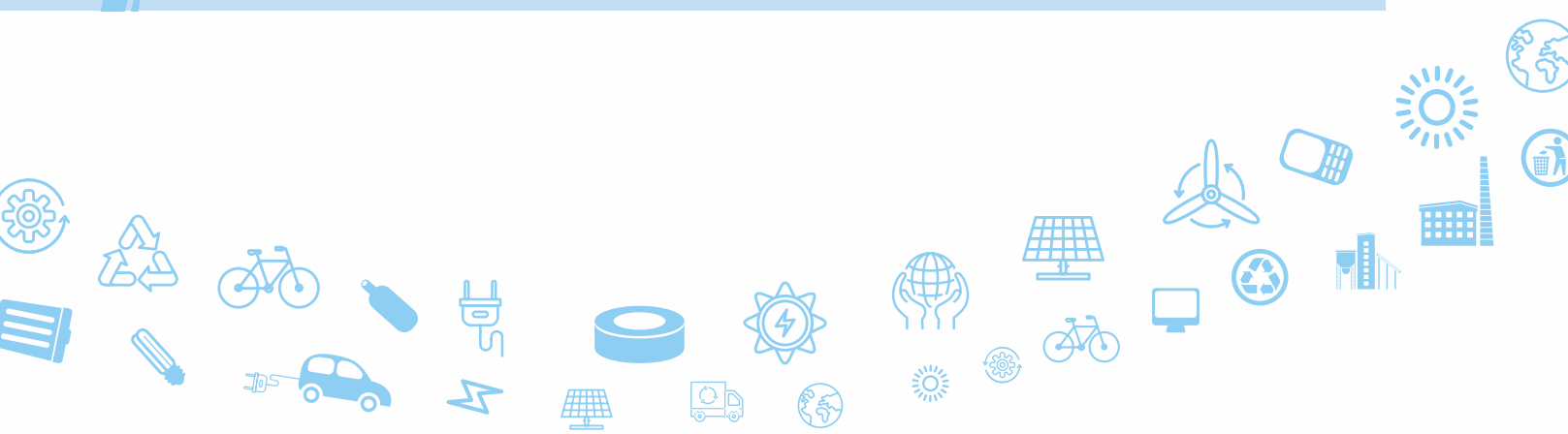
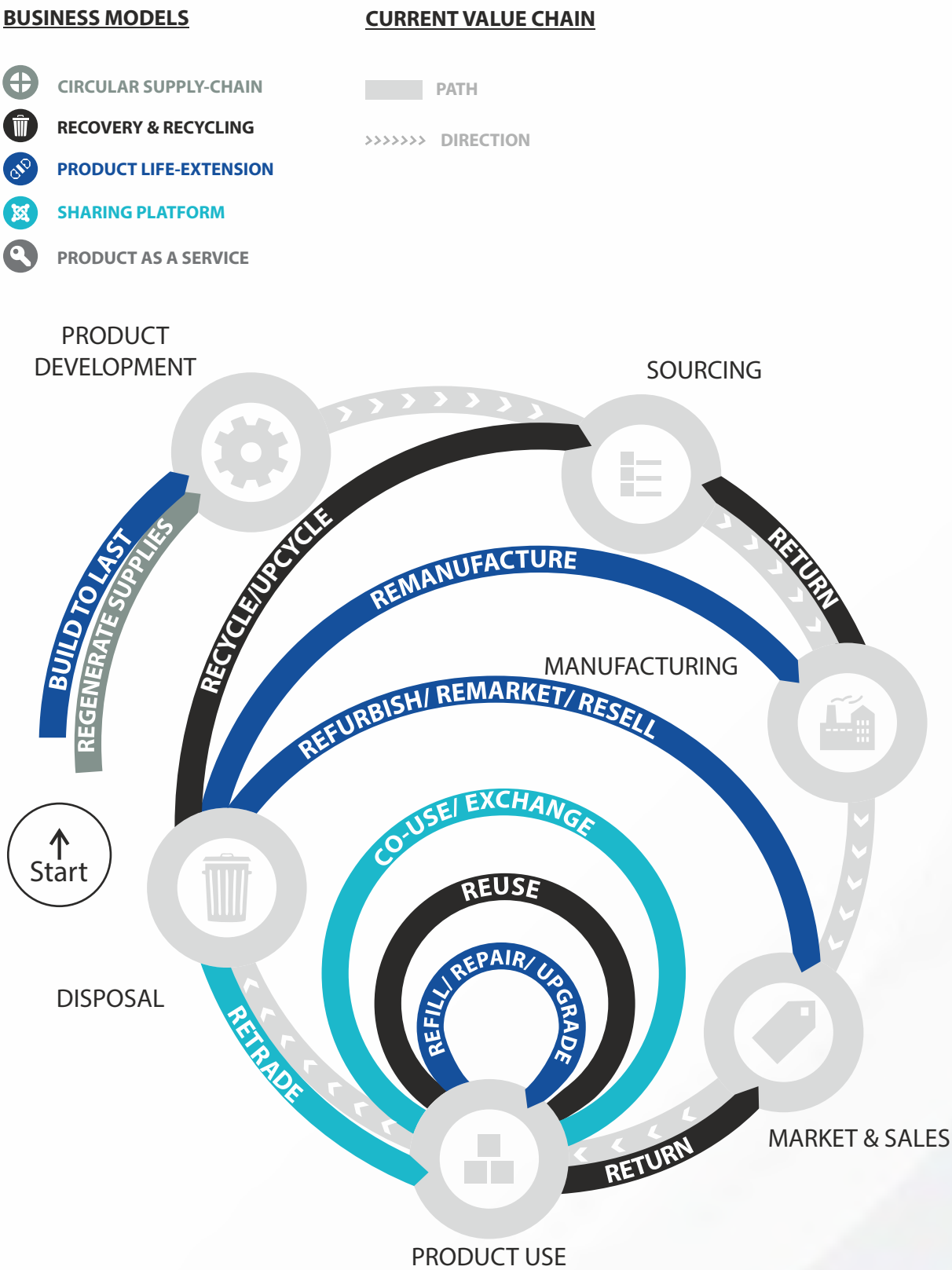


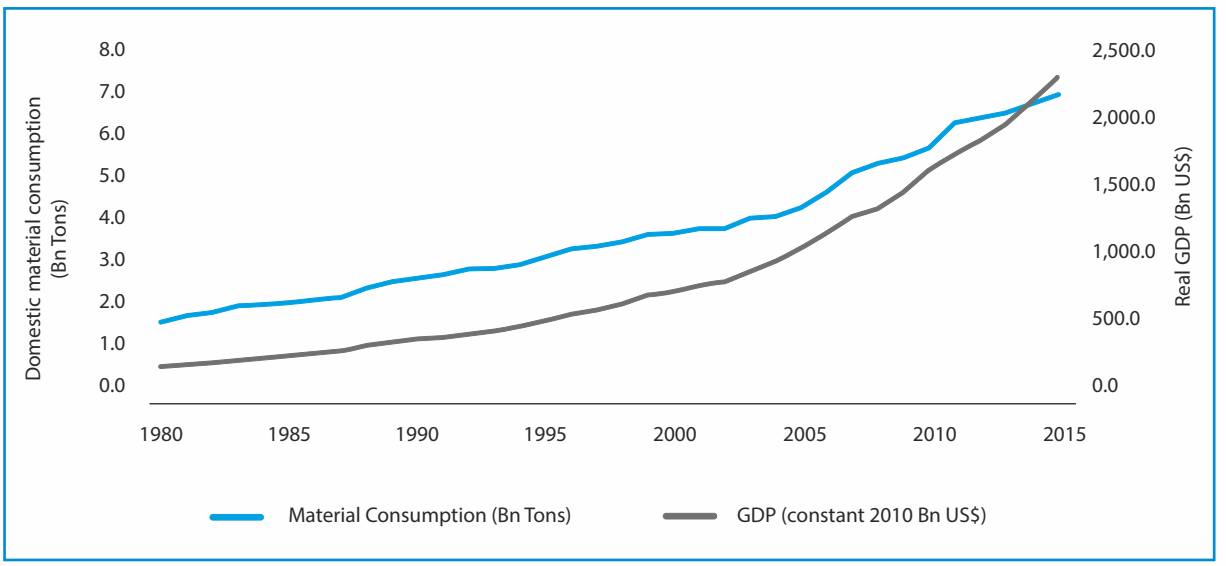
Figure 5 : The Five Circular Business Models



Circular Economy Opportunity in India

Historically, India's economic growth has had a positive correlation with its resource requirements. During 1985-2015, India's real GDP witnessed a growth rate of ~6%, while its resource consumption during the same period increased at a CAGR of ~4%[5]. For an emerging economy like India, this suggests that growth in the coming years could be accompanied by a rise in the demand for resources.

Figure 6 : Rising material use and economic development in India

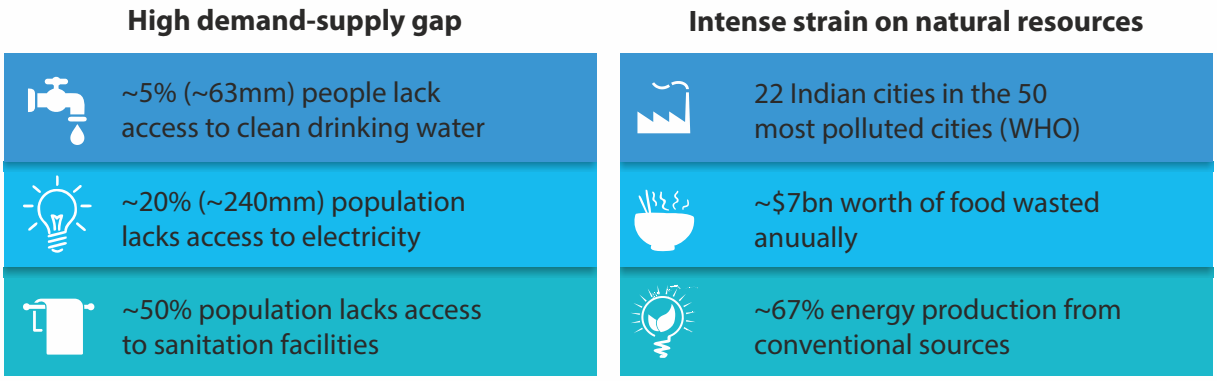


The logical question to ask is – are we well positioned to meet the expected rise in the resource demand? A close look at the current demand-supply scenario for basic utilities reveals that there already is a huge strain on the supply of resources and there is a critical need for improved resource efficiency measures. Given this context, Circular Economy offers a unique window of opportunity for India to continue its growth trajectory without unduly straining the resource supply.

NITI Aayog's strategy paper on Resource Efficiency

Government of India has established the Indian Resource Panel (InRP), an advisory body under the Ministry of Environment, Forest and Climate Change to assess resource-related issues India is facing and advise the government on a comprehensive strategy for resource efficiency. In 2017, NITI Aayog launched a paper on this initiative and strongly advocated the need for an enabling policy framework to mainstream resource efficiency across sectors.

Figure 7 : Current resource constraints in India – an illustration



Circular Economy - Size of the prize in India

Our research indicates around half-a-trillion dollars worth of India's GDP value that could be protected through Circular Economy business models by 2030 in India and $4.5 trillion globally. This would entail eliminating the concept of waste altogether (i.e. eliminating waste not in the traditional sense of rubbish, but any underutilization of natural resources, products and assets).

In calculating the value potential from circular business models in India, we have considered two scenarios:

A. **Business-as-usual scenario**: This scenario assumes that there is no significant change in the external factors such as policy shifts or technological breakthroughs. As such, improvements in material productivity and environmental footprint would be consistent with historical trends. For this scenario, our analysis indicates approximately ~$697bn of India's GDP at risk, which can be safeguarded by the adoption of circular business models by 2030.

B. **Technology-improved scenario**: This scenario assumes that owing to factors such as technological improvements, there would be greater improvements in resource productivity and environmental footprint (compared to what has been achieved in the past). As such, the growth in the coming decade would be characterized by higher resource productivity (i.e. consuming lesser energy to produce same output) and have a lower environmental footprint (for instance, higher renewable energy share in country's energy mix leading to a drop in GHG emissions). These improvements in productivity would partially protect the value at risk (compared with the business-as-usual scenario); however, in this scenario, there would be ~$382bn of GDP value at risk which could be potentially protected through circular business models in India by 2030.

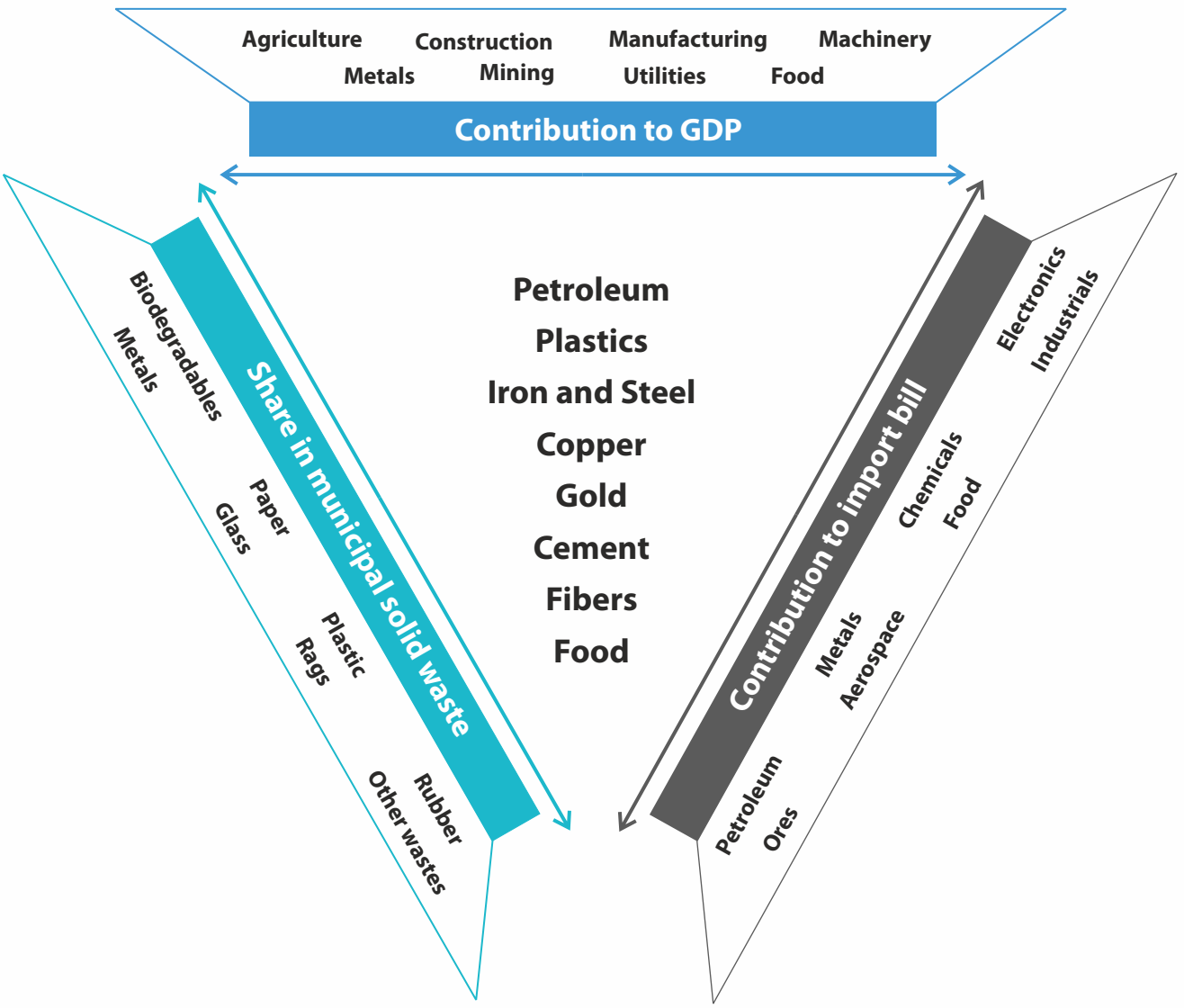
Figure 8 : Reward for adopting circular business models in India (2030)

Growth scenario	Business As-Usual	Technology-Improved
Size of GDP at risk of loss	$697 bn	$382 bn

The size of the reward is the economic output unlocked from Circular Economy initiatives, which would otherwise have been lost to resource demand-supply mismatch. Clearly, there is a huge value at stake when it comes to the adoption of circular models in India. This is the value to be realized by efficient utilization of resources across different industry sectors.

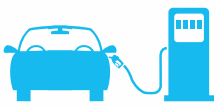
In the next section, we turn our attention to the priority resources that can help tap the huge circular opportunity in India. To keep the analysis focused, we have prioritized resources that have a significant economic and environmental impact by considering the following parameters: (i) resource contribution to economic activity (measured by share in GDP) (ii) resource contribution to India's import bill, (iii) resource impact on environment (measured by share in municipal solid waste).

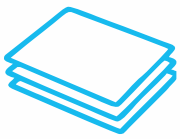
Figure 9 : Exploring circular opportunities in India – prioritization of resources for analysis



The table below provides highlights for each of the shortlisted resources.

Table 1 : Critical resources to tap India's Circular Economy opportunity

Material	Resource criticality	Illustrative ongoing initiatives	Emerging trends / Outlook
 **Petroleum**	• As per a review by BP, global proven oil reserves in 2016 would be sufficient to meet only ~51 years of global production at 2016 levels[6] • With an import bill of ~$120bn[7] India's dependence on imported crude oil has increased from 73% in 2005-06 to 81% in 2015-16[8]	• Niti Aayog has already proposed setting-up methanol economy fund of Rs 4,000-5,000 Cr[9] to explore bio-based fuels • India's largest waste-to-energy plant commissioned in 2017 with a daily capacity to process 2,000 metric tons of waste to generate 24MW of energy[10]	• Push for electric vehicles will further reduce the demand – currently, 70% of diesel, 99.6 % of petrol consumed by transport sector[11] • Innovative benchmarks exist across the world (for example, Veolia collects spent chemicals from refiners and with 95% recovery rates, returns it to them for reuse[12])
 **Plastics**	• India's low per capita plastic consumption of 13 kgs (global average: 32 kgs, USA: 109 kgs) indicates significant growth potential • Plastic consumption in India is expected to grow from the current 17.8mn tons to 20mn tons by 2020 (CAGR: 9%), driven primarily by the packaging and infrastructure sectors[13] • Around 40% of plastic waste generated in India ends up in landfills[14]	• Plastic Waste Management Rules lay down regulations regarding phasing out the usage of multilayer non-recyclable bags, collect back mechanisms and plastic reuse[15] • Corporates in India are also taking up initiatives. For example, Reliance converts 2bn+ PET bottles to polyester yarn annually[16] • Government is also encouraging construction of plastic waste based polymer-bitumen roads. As per a report, Maharashtra Government plans to re-pave 10,000 kms of road using 50,000 tons of plastic waste[17]	• Pockets of innovation evolving in start-up space. For instance, Hyderabad-based Banyan Nation is assisting corporates like Loreal and Tata Motors to convert plastic waste into near-virgin quality recycled granules[18] • Collaboration is critical to overcome the challenges of the fragmented industry. As an illustration - Ramky Group has tied-up with PolyCycl (an Indian start-up with patented technology) to set-up low-grade plastic to high-value petroleum fuels projects in several cities[19]

Material	Resource criticality	Illustrative ongoing initiatives	Emerging trends / Outlook
 **Steel**	• Domestic per capita steel consumption is 63 Kgs (South Korea: 1,130 Kgs, China: 493 Kgs). According to National Steel Policy 2017, this may increase to ~160 kg by 2030[20] • Iron ore production of 142.5mn tons lagged demand of 147.8mn tons in 2015 making India a net importer of iron ore[21] • Iron ore reserves in Goa are expected to exhaust in next 10 years[22]	• 22mn tons of steel scrap is recycled in India annually, 30% of which is imported and remaining 70% comes from domestic scrap[23] • Tata Steel and SAIL have established M-junction, world's largest e-marketplace for used steel and old scrap, having sold 14mn tons till date[24] • Urban mining to recover steel and iron from end of life disposed products has huge value. Recovering steel from end-of life vehicles in India is potentially a $2.7bn industry (2025)	• With cap on iron ore production imposed in Karnataka and Government exploring tightening of imports, recycling of steel and iron could become more important than ever before[25] • The high resilience and recyclability of steel is lending it to product as a service model with applications in infrastructure, especially modular construction. The steel components can simply be disassembled and reused[26]
 **Copper**	• The per capita consumption of copper in India is currently 0.6 kg (China: 5.4 kg, USA: 5.5 kg) and is expected to rise[27] • Demand for copper in India has grown at a CAGR of 5.9% in last 10 years and is expected to grow at 7% till 2030[28] • India currently has a 4% share of global copper demand amounting to ~1.2mn tons. However, it has just 2-3% of the world's copper reserves and mining production is ~0.2% of world production[29]	• Significant recycling already happening globally. Of total global demand, almost 40% is met using recycled material (21% supplied by consumer scrap, 17% sourced from factory scrap and remaining from other sources)[30] • India too has made some progress. According to CPCB, there are 35 licensed units operating nationally for copper scrap collection, with capacity of 0.24mn tons[31]	• Globally, some companies have set benchmarks for state-of-art recovery. Intel, for example, has developed a system to recover reusable solid copper from an aqueous waste stream generated by semiconductor manufacturing. Process has been implemented at Intel's microprocessor manufacturing sites and as a result, more than two-third of waste copper could be recovered[32]

Material	Resource criticality	Illustrative ongoing initiatives	Emerging trends / Outlook
 **Gold**	• India is the world's largest consumer of gold, with demand touching 650 tons in 2017[33] • Domestic production in 2015-16 was 1.5 tons which met only 0.2% of the total demand[34] • The domestic demand-supply gap is compensated through import (in 2016, India's gold import bill was $35bn)[35]	• India is currently fourth largest recycler of gold with 80 tons recycled in 2015, with jewellery scrap contributing to around 90-95% of this[36]	• There is huge potential for gold extraction from 1.8mn tons of e-waste generated annually in India • Accenture research indicates ~$1bn worth of economic opportunity from extracting gold from e-waste[37] • Start-ups like Attero & Green Vortex have set-up reverse logistics and recycling systems to collect end of life electronics and extract gold for recycling[38]
 **Cement**	• With an output of ~280mn tons in 2017, India is the second largest producer of cement in the world. However, consumption is expected to outpace supply over next three years[39] • 30% of cement produced goes unsold or unutilized in India, paving considerable scope for reusing this capacity instead of increasing production or imports[40]	• Indian cement industry has proven to be the most proactive on matters related to resource efficiency, energy and environment • Indian cement plants consume 23% less electricity and 12-15% less thermal energy compared to global average[41] • In 2017, CPCB has also released guidelines on co-processing of hazardous and other wastes in cement kilns[42]	• Wide adoption of best practices such as co-processing of waste in industrial symbiosis, cement recarbonation and innovative low-carbon technologies • For instance, Canada-based CarbonCure captures emissions of local industrial polluters and retrofitted partner concrete plants inject the recycled CO_2 into wet concrete during production to make environmentally friendly concrete[43]

Material	Resource criticality	Illustrative ongoing initiatives	Emerging trends / Outlook
 **Fibres and Textiles**	• From farm to fibre to fabrics, textile industry has a significant water footprint - production of 1 kg of cotton in India consumes 22,500 litres of water as compared to global average of 10,000 litres[44] • During 2000–14, the number of garments purchased each year by the average global consumer has increased by 60%; additionally, consumers today are keeping clothing items for about half as long as they did 15 years ago[45]	• Large amount of clothing is discarded which ends-up in landfills. As per a report by Planning Commission, ~1% municipal solid waste is composed of rags.[46] Collection rates of used clothing remain very low across countries (15% in US, 12% in Japan and 10% in China)[47] • SMEs in Panipat run one of the world's largest used cloth recycling set-up	• New models for organized collection of used garments are being explored - for instance, Fashion e-commerce player Myntra has tied-up with NGO Goonj to launch Myntra Fashion Upgrade Initiative which enables customers to exchange their old clothing which would eventually be repurposed by Goonj for distribution to needy[48]
 **Food**	• Annual value of harvest and post-harvest losses of major agricultural produces in India is estimated at ~$143mn[49] • In India, majority of food loss happens between production to sales stages (~90%) and only 10% occurs at the consumption stage[50] • The wasted food has a carbon footprint of 46.5 megatons and wastes 19.7mn hectares of land[51]	• To address losses in supply-chain, govt. is aggressively pushing for food processing sector as a solution (currently, only 10% of produce is processed[52]) • A bill named Marriages (Compulsory Registration and Prevention of Wasteful Expenditure) Bill 2016 sought to control food wastage in weddings[53] • Start-ups like Feeding India working to connect food surplus with the poor but currently the scale is small.[54]	• At farm level, adoption of precision agriculture rapidly emerging to enable optimized resource usage • Rapid rise of integrated agricultural supply chains enabled by digital technologies – for example, AgriDigital is a start-up creating an integrated platform that would digitize the supply chain and create a post-gate farm system which' will bring traceability[55] • Food sharing platforms like Olio, pay-per-use grocery services like Cirkle and innovative packaging like Tesco are helping extend product life and reduce wastage

From business perspective, Circular Economy opportunity manifests itself in multiple forms depending on the industry context. Based on the priority resources identified above, in the following section we deep-dive into three industrial sectors – (i) Agriculture, Food and Beverage (ii) Metals and Mining, and (iii) Electronics and High Tech. The coverage of industrial sectors for this study may not be exhaustive with respect to the vast circular opportunity in India; however, it does provide a good starting point for businesses to assess the diverse nature of circular opportunities that can be realized through innovative business models.

Circular Economy in
Metals and Mining Sector

Circular Economy in Metals and Mining Sector

Industry context

The per capita consumption of steel (which is often considered as a proxy for the level of development of a country) for India is around 63 kgs in comparison to 1,130 kgs and 493 kgs for South Korea and China respectively[56]. As the Indian economy continues to develop, the demand for metals is likely to increase significantly. This is expected to put significant pressure on the already strained metals supply.

Table 2 : Overview of strained metal supply in India

Metal	Overview of current supply constraint
Rare earths	India is 100% import dependent on China for 7 out of 12 rare earth elements deemed most critical for the economy[57]
Iron Ore	In 2015, India's iron ore production (~142.5mn tons) lagged its total demand (~147.8mn tons), thereby making it a net importer of iron ore[58]
Steel	According to National Steel Policy 2017, the domestic per capita steel consumption may increase to ~160 kg by 2030. To meet the rising demand, the policy aims at increasing crude steel capacity to 300mn tons (from 122mn tons in 2016) through an investment of INR 10 lakh crore[59]
Copper	India currently accounts for ~4% share of global copper demand. However, it accounts for just 2-3% of the world's copper reserves and mining production is ~0.2% of world production[60]
Gold	In 2017, India's annual gold demand was ~727 tons[61] in comparison to its annual production of ~1.5 tons[62]

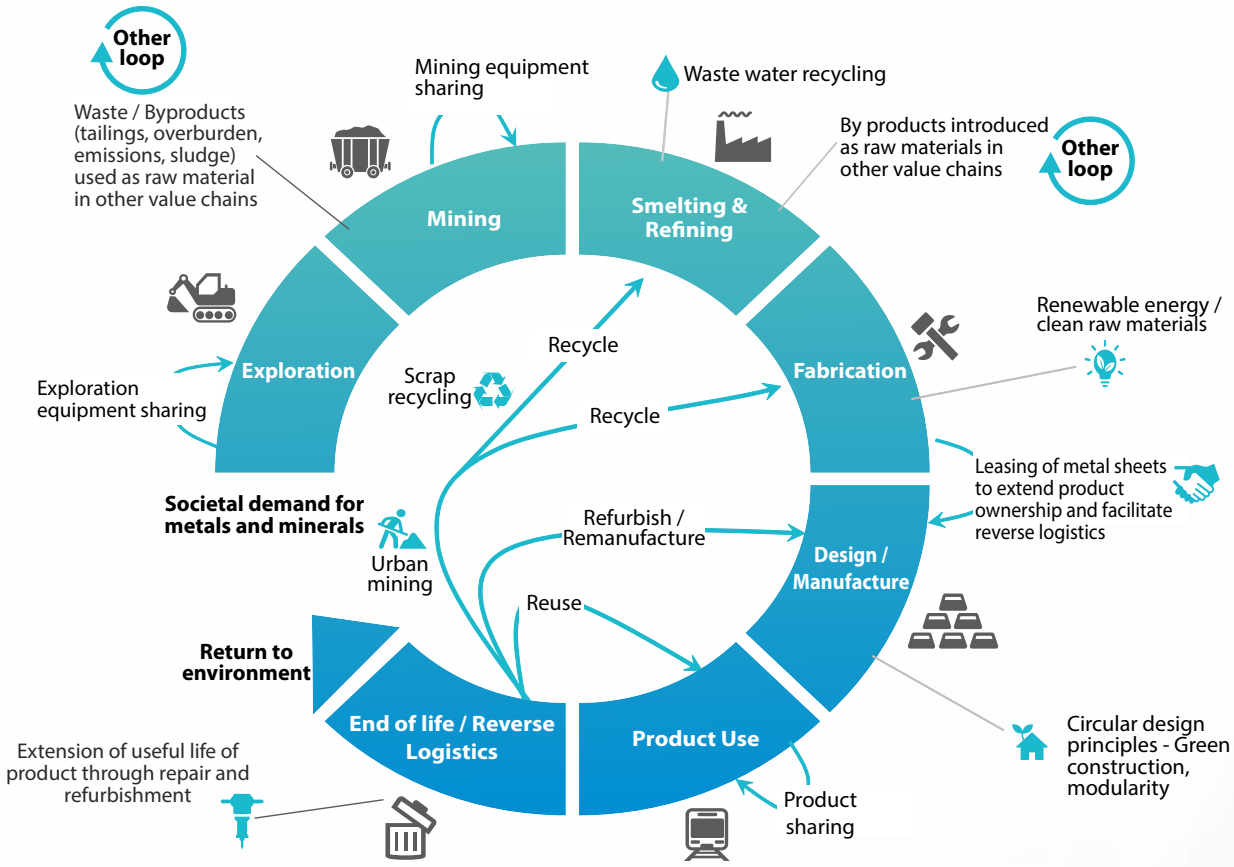
The demand-supply gap is further exacerbated by factors such as depleting reserves and dwindling yields. For instance, Iron ore reserves in Goa are expected to exhaust in the next 10 years[63] and the annual iron ore production in India is expected to fall by 15 percent in 2018 due to lower anticipated production in Orissa and Goa[64]. Furthermore, extraction of virgin metals through mining process poses significant environmental implication and is increasingly subject to regulatory scrutiny – the partial banning of iron ore mining operations in Goa (2012) being a case in point[65].

Given the demand-supply imbalance and growing strain on the finite pool of natural resources, the Indian economy faces a significant supply risk over the medium to long run horizon. These risks can potentially jeopardize business operations and call for a different approach to handling of resources. Leading organizations are already embracing circular business models to mitigate the supply risks while also creating additional revenue generation opportunities.

Circular Economy models in the Metals and Mining industry

The CE models are applicable across the metals value chain in diverse forms. At the upstream stages of the value chain, mining operations create waste (in the form of overburden, slag, waste rock, emissions, tailings etc.), which can be potentially recycled and reused. Compared to this, at the downstream consumption stages there are opportunities to enhance the efficiency of material usage through innovative models such as product life extension shared platforms.

Figure10 : Application of CE models across the Metals and Mining value chain



Upstream CE applications in Metals and Mining industry

The upstream operations during the exploration, mining, smelting and refining stages are typically characterized by generation of waste streams - these waste streams can be recycled and reused either within the factory operations or introduced as a raw material in a different value chain

For instance, at some of ArcelorMittal's steel plants, every cubic meter of water is recycled and reused upto 75 times before it is eventually discharged, an illustration of how circularity can be built within the plant operations to drive efficient use of resources. In another initiative, ArcelorMittal's France-based JV ECOCEM uses slag to manufacture cement, wherein the waste product is recycled and introduced as a raw material in a different value chain (i.e. in the construction industry). Given its impact, the project was recognized and commended during the Circulars Awards, held as a part of World Economic Forum at Davos in 2018.

Recovery and Recycling - ArcelorMittal

ArcelorMittal's France-based JV ECOCEM makes use of secondary slag to manufacture a low-carbon cement which it sells directly to end consumers, thereby creating an additional revenue stream. In France alone, this practice has already reduced the cement industry's CO_2 emissions by nearly 2mn tons, and from 2018 onwards it is projected to further reduce those emissions by a further 1mn tons a year. Selling this by-product generates over Euro 100mn in revenue each year.

Ambuja Cement is providing state-of-the-art sustainable waste management services to other industries and waste generators through cement kiln co-processing under their Geocycle brand. They utilize waste streams like municipal solid waste, biomass, mixed industrial waste, RDF and waste oil as alternative fuels to power their cement plants and have achieved a carbon reduction of ~10.3mn tCO_2 and additional gross value of ~$4.1mn[68]. Another illustration of facilitating greater materials recovery in the upstream mining stages is that of low-carbon smelter technology deployed by Tata Steel. Tata Steel leverages a technology called HIsarna, that eliminates several pre-processing steps and requires less stringent conditions on the quality of the raw materials used. The HIsarna installation produces highly concentrated CO_2, it is ideally suited for carbon capture, without the need for a costly gas separation stage. The technology enables recycling of up to 50% steel scrap; moreover, it could lead to a total CO_2 saving of 80% from the steel production process[69].

Downstream CE applications in Metals and Mining industry

Leading organizations are leveraging Circular Economy models to improve asset utilization as well as extend the ownership of assets which allow easier collection and recovery

At the downstream stages of the value chain, CE models can enable metals and mining organizations to extend the ownership of assets, thereby facilitating efficient collection mechanisms and recyclability. Organizations also have an opportunity to improve efficiency of material usage through CE models such as shared platforms and product life extension.

As an illustration, consider the rental business model introduced by ArcelorMittal for its steel sheet piles. These piles can be used for construction applications such as dams, underground car parks, tunnels and bridges. ArcelorMittal has introduced a rental business model, which allows its customers to rent and reuse the sheet piles thereby reducing their manufacturing costs. Moreover, the business model allows Arcelor Mittal to extend its ownership of assets all the way till the end of the useful product life, thereby facilitating easier collection and recovery. This product-as-a-service model has allowed the organization to implement a closed loop business model with a recovery rate of ~99%[70].

Organizations can also leverage CE models to improve asset utilization and efficient material flow – Tata Steel's mJunction[71] initiative represents a very relevant illustration. The initiative leverages digital platform to connect buyers and sellers of scraps, wastes and idle assets. The initiative illustrates how platforms enabled through digital technologies can help facilitate efficient material flow.

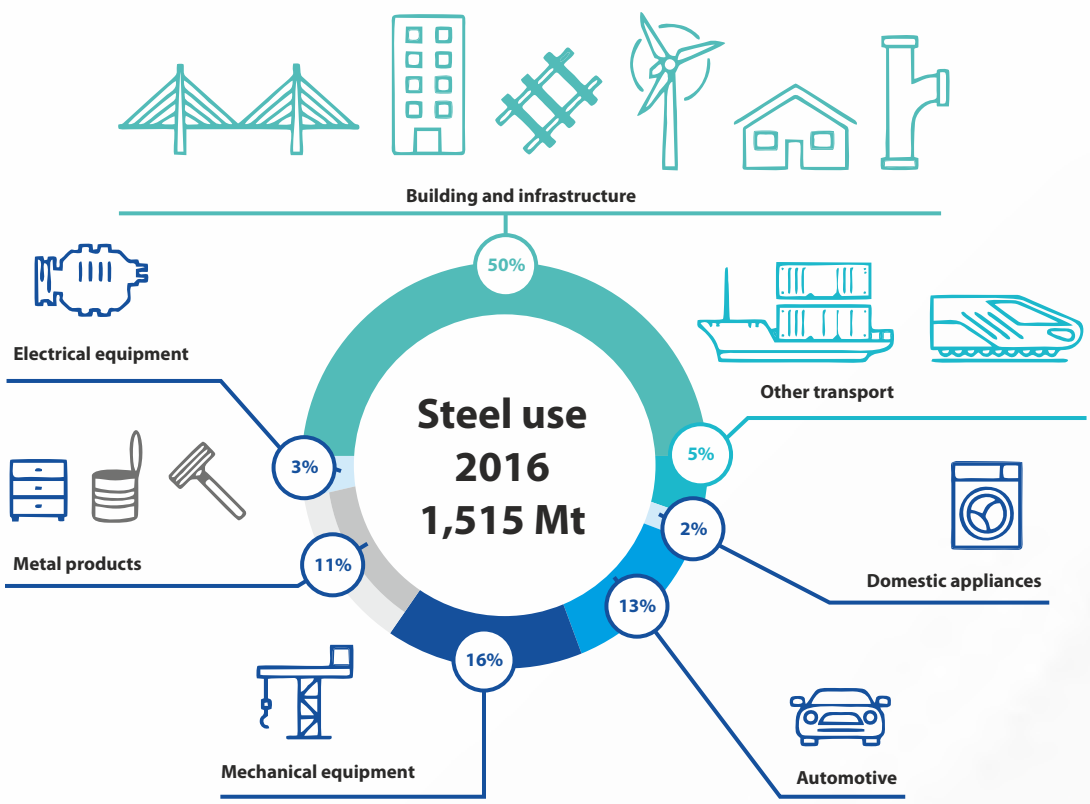
There is considerable value to be derived from recovery and recycling at this stage as well. With an aim to recycle end-of-life vehicles in an environment-friendly way, Mahindra Accelo and MSTC Ltd. have formed a joint venture – Mahindra MSTC Recycling. They have setup their first plant which will shred the end-of-life vehicles using world class equipment and processes and recycle the steel and other materials extracted[72].

Due to the inherent characteristics such as strength and durability, metals can be recycled multiple times. This is particularly relevant at the midstream and downstream (i.e. fabrication, manufacturing, use and disposal) stages of the value chain.

Sharing Platforms - mJunction

In 2001, Tata Steel and SAIL established a joint venture called mJunction services limited, with a mission to create robust and sustainable supply chains and bringing more transparency to stakeholders. Today, it has evolved to become the world's largest e-marketplace for steel. mJunction has increased its business volumes from $13.8mn in 2002 to $20.2bn in 2016. Till date, the company has assisted clients sell 14mn tons of steel, 300mn tons of coal and 6,000 crores worth of idle assets.

Figure 11 : Global steel use by the type of equipment in 2016 – an illustration[73]



One of the key considerations for organizations looking to recycle metal products at the end of their useful life is the product life itself. On one end of the spectrum, there may be products with large life span (such as infrastructure and locomotives). On the other end, there may be equipment with relatively shorter lifespan but somewhat complex reverse logistics value chain from collection perspective. Components at the middle of the spectrum (such as automotive) are most attractive for recycling initiatives as these components have a finite lifespan (thereby becoming recyclable quickly) and relatively organized reverse logistics. Our analysis indicates that recycling of steel from end of life vehicles could potentially represent a $2.7bn opportunity in India in 2025. The challenge for pioneering firms looking to tap this opportunity would be establish robust circular models to aggregate the vehicles reaching end of life at scale and leverage right technologies to dismantle the vehicles and recover metals.

Figure 12 : Recycling of steel from automobiles – a significant CE opportunity in India

Over 8mn tons of steel can be potentially extracted from end of life vehicles in India in 2025

Estimation based on ELVs projection:

Vehicle type	# vehicles reaching obsolescence (2025)	Avg. weight (tons)	Avg. steel content (%)	Embedded steel weight (tons)
Two wheelers	17,723,951	0.10	65	1,186,619
Three wheelers	757,932	0.37	65	182,775
Private cars	2,809,996	1,04	70	2,039,776
Commercial Passenger Vehicles	94,757	5.05	65	311,040
Commercial Goods Vehicles	1,188,833	6.98	65	5,393,735

Embedded steel in Vehicles

~9.1
mn tons

Estimation based on steel usage:

~81.5 **mn tons total steel consumption in India (2015-16)**

10% **Fraction of steel used in automobiles sector**

Embedded steel in vehicles reaching obsolescence in 2025

~8.1
mn tons

Estimated scrap steel
(average of 9.1mn tons and 8.1mn tons)

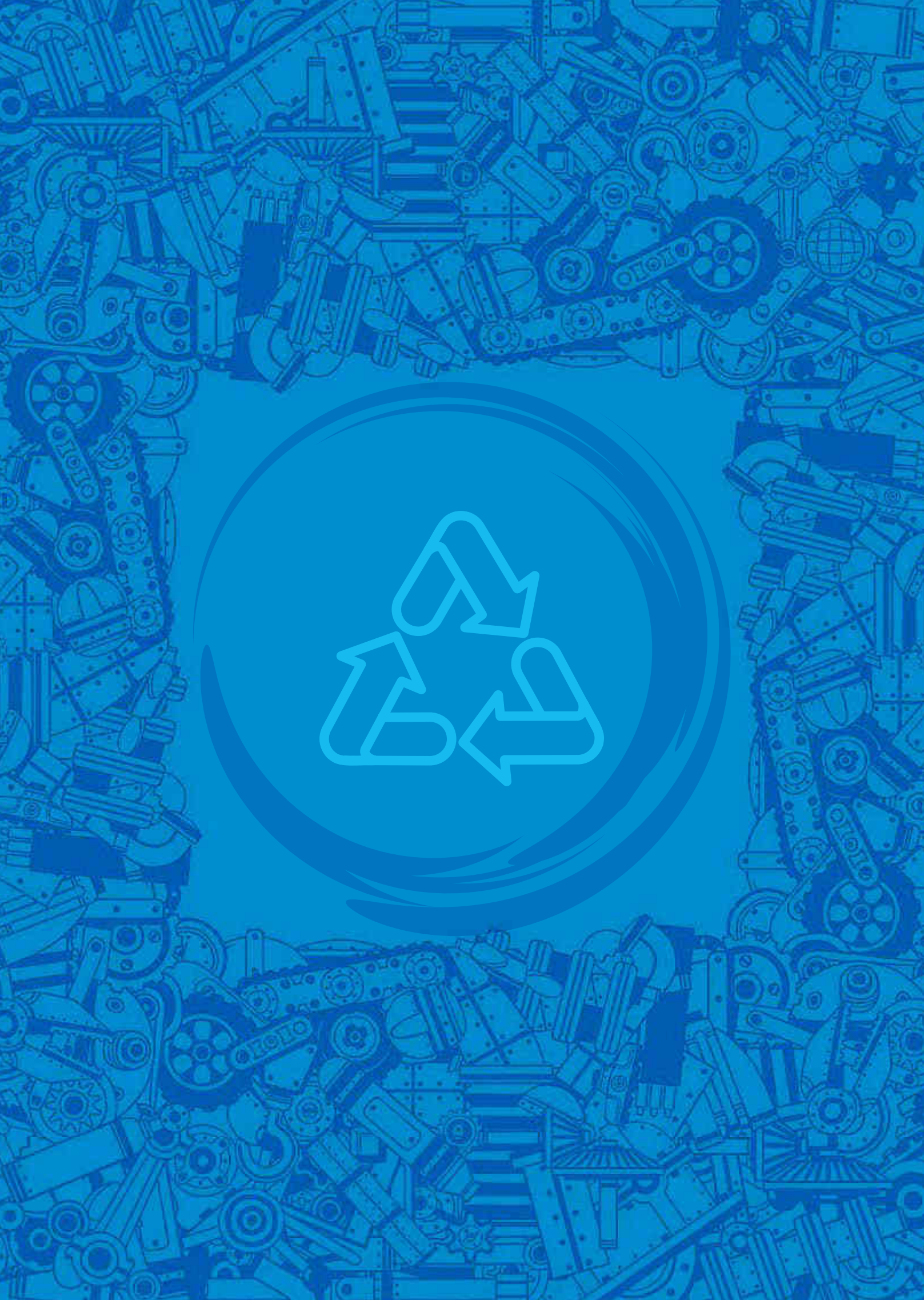
Scrap price = $323 per ton

Sources: CPCB, Metal Recycling Association of India, National Steel Policy of India 2017, Accenture Analysis and Research

CE opportunities in Metals and Mining industry – a snapshot

Table 3 : Key CE opportunities across the Metals and Mining sector

CE Opportunity	Business Model	Status Quo	Potential Improvements
Waste / by-product treatment	Recovery and recycling	Treatment of slags and tailings is common but it is not viewed as a source of revenue stream; scope for utilizing more scrap in production remains untapped	Channelize by-products for commercial applications (like slag being used in concrete and road construction)
Intelligent asset management	Product life extension / sharing platforms	Assets such as mining equipment stay idle for extended period of times; end-of-life assets are disposed-off at salvage value	Use of sensor-based technologies to increase heavy machinery lifecycle and utilization; shift from owned equipment to rented equipment
Marketplace for scrap and idle/ obsolete equipment	Sharing platforms	Challenges with respect to extracting residual value from waste streams; recovery methods mostly localized and fragmented	Buying and selling of waste streams, idle or end-of-life assets among players at scale (enabling higher aggregation and price transparency)
Metal as a service	Product as a service / Product life extension	Ownership of commodity is transferred to downstream partners (for ex., ownership of steel moves to auto manufacturer and then to end-customer)	Technology-based trace and return system to enable metal companies to retain ownership across the cycle through leasing models
Re-designing metallic products	Product life extension	Metal embedded in downstream applications (for instance, building construction has high lock-in period)	Design of reusable steel girders that function like LEGO bricks to plug into new buildings
Downstream urban mining	Recovery and recycling	Vast amount of recyclable metal present in products is leaked to landfills	Reverse logistics for wider range of product categories (consumer electronics, energy applications etc.) to facilitate extraction of recyclable materials at scale



Circular Economy in Electronics and High-Tech Sector

Circular Economy in Electronics and High-Tech Sector

Industry context

Electronics and High-Tech is one of the fastest growing industries in India. It is expected to grow from ~$100bn in 2016 to ~$400bn by 2020, representing a CAGR of 41.4%[74]. This growth is primarily driven by demand for consumer electronics products (i.e. devices like smartphones, tablets and laptops).

From resource utilization perspective, the industry is characterized by following key features:

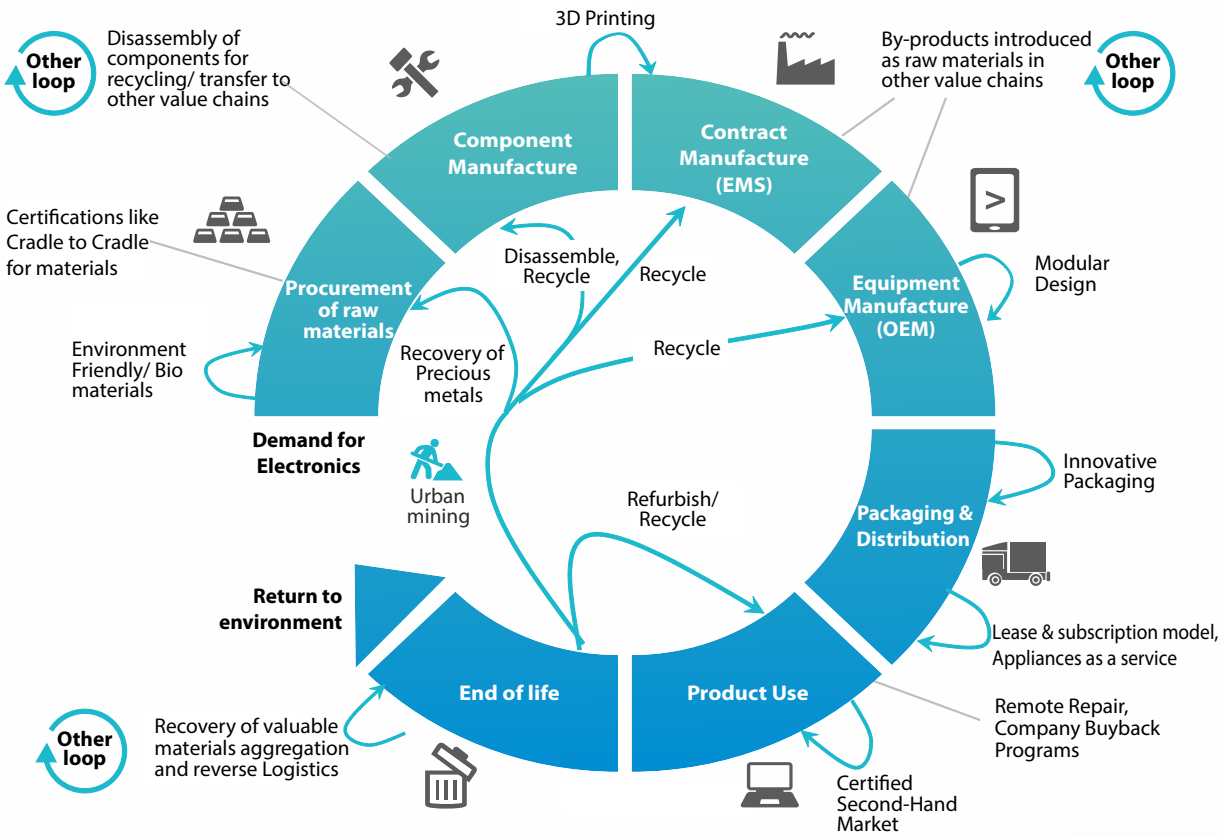
- **Short product lifespan:** For several major brands, the frequency of new product roll-outs has increased by ~66% in the last five years. The short product lifespan is often a result of built-in obsolescence which drives higher sales volumes but in the process, leads to greater resource consumption at manufacturing stage. This stage accounts for ~60-70% of CO_2 emissions over the entire lifespan of product[75].
- **High idle capacity:** There is a high incidence of electronic devices that are not in use due to damage or not in use due to outdated specifications, thereby leading to inefficient resource utilization. For instance, globally, close to $13bn in value is locked in unused old smartphones lying idle[76].
- **High waste generation and low recycling rates:** In 2016, ~44.7mn tons of electronic waste was generated globally, of which India contributed ~ 2mn tons[77]. Only 5% of this e-waste is recycled in India, 35% is refurbished or reused and remaining 60% is locked in warehouses.
- **High trapped value:** e-waste typically contains significant trapped value in the form of precious metals such as gold, platinum and palladium. Concentration of precious metals in e-waste is ~40-50 times more than that in naturally occurring deposits.

Given the hazardous nature of e-waste, there is a growing regulatory scrutiny. For instance, in India, the government introduced e-waste management rules in 2016, which mandates electronic goods manufacturing companies and bulk consumers to collect and channel e-waste from consumers to authorized re-processing units. Another illustration of growing regulatory scrutiny for e-waste is that of China - the government in China has introduced aggressive targets such as sourcing 20% of raw materials for new products from recycled content and 50% recycling target of all e-waste generated by 2025[78].

Circular Economy models in the Electronics and High-Tech industry

At the upstream stages of the electronics value chain, CE models can manifest in the form of efficient design process (for instance, sourcing cleaner bio-materials for component design and introducing modular design for autonomous disassembly). At the downstream stages of the value chain, there are significant opportunities to refurbish or repair components for extended usage as well as recovering precious metals from e-waste.

Figure 13 : Application of CE models across the Electronics and High-Tech value chain



CE opportunities at product design stage

Circular Economy principles help reduce resource consumption during manufacturing and also facilitate easy refurbishment / recycling at later stages

For instance, Fairphone (Amsterdam-based organization) has deployed modular designs to extend the lifespan of smartphones and improve precious metal recovery after usable life. These phones are easy to repair and components are made to last long, which enables replacement of faulty parts instead of entire unit. With respect to phone repair, the company encourages "do-it-yourself" mindset. It sends the owners a replacement module, thereby disintermediating repair centers. The company's circular initiative has increased the useful phone lifecycle to five years and created a market for sustainable electronics products[79].

CE opportunities at product use stage

Adoption of CE models demonstrates clear business benefits in the form of additional revenue streams and improved customer service through service model differentiation

In the traditional model, electronics products are phased out of usage after few years of active lifespan. Most of these products remain idle for significant duration before eventually ending-up in municipal or industrial waste streams. To address this challenge, CE models provide several business opportunities for manufacturers, brand owners and distributors:

- **Refurbishment:** This allows the companies to increase the revenue generated on a product over its lifetime, rather than simply selling it once and providing after-sales services. India, for instance, has market for 70mn refurbished smartphones[80].

- **Product life extension**: Cisco works with its suppliers, customers, employees and communities to implement product return and remanufacture capabilities. The company receives ~12,000 tons of used products each year for remanufacture, reuse or recycling. 90% of Cisco products sent to repair sites are repaired to current product specifications and sent back to the market. If the product has no further useful life, it flows to one of Cisco's audited and approved recyclers. 99% of materials that goes to these recyclers are recovered for re-use[81].
- **Product as a service**: In the context of electronics, the product as a service model serves dual purpose – (i) enables effective capacity utilization (by shifting away from the scenario where product lifecycles are wasted lying idle in households), (ii) enables provision of predictive maintenance to extend the useful life. An interesting illustration is that Philips' lighting-as-service idea, wherein users are required to pay for the consumption-based illumination (pay per lux model). Customers don't need invest in any lighting equipment and the company takes care of the design, consultation, construction, commissioning, operation, maintenance and upgrades, with flexible financing solutions.

Global majors have already realized the benefits of Circular Economy and have made major commitments. In 2018, a group of companies including Philips, Cisco, Dell, HP and Mitsubishi launched a pledge to take full responsibility of their capital assets, encouraging a move towards service based models, smart upgrade paths, or product take-back and remanufacturing programs[82].

Product Life Extension, Recovery and Recycling - Attero

Attero was launched as India's first integrated end-end electronic waste recycling facility. Found in 2007, the Noida-based company has developed patented state-of-the art recycling technology to recycle and extract valuable materials viably, even with smaller e-waste volumes. They also offer refurbishment and reconditioning services to extend the useful life of electronics and a digital portal to enable take back from the end consumers. Company has developed a robust reverse logistics network backed by IT with collection centres in 22 states.

CE opportunities at product's end-of-life

Leading players are working towards formal take-back mechanisms and metal recovery technologies to monetize the embedded value in electronics products while also complying with changing regulatory landscape

The amount of precious metals embedded in electronic equipment represents a huge untapped opportunity. However, e-waste recycling is primarily based on high volume-shredding, which limits the quantity and quality of materials that can be recovered. Leading organizations are taking initiatives to address this challenge:

- Companies like Umicore and Mitsubishi Materials have developed advanced technologies and collection processes for metal extraction from e-waste.
- Liam (Apple's R&D project) leverages a smart disassembly technology to fully automate the process of disassembling iPhones. It uses 29 robots organized in 21 cells and the set-up can disassemble an iPhone into 8 components in 11 seconds. The project is still in the R&D phase but is a critical step in Apple's journey towards a closed loop supply chain.

Figure 14: Extracting gold from e-waste in India – a huge untapped CE opportunity in India

A large share of extractable value from common E-waste is attributable to precious metals

Fraction of extractable value attributable to different metals (%)

E-waste sources	Metals (Copper, Iron, Aluminium)	Plastic	Precious Metals
Washing Machine	57	41	2
Refrigerator	50	45	5
LCD TV	18	12	70
Desktop	14	1	85
Laptop	4	2	94
Mobile phones	2	N/A	98

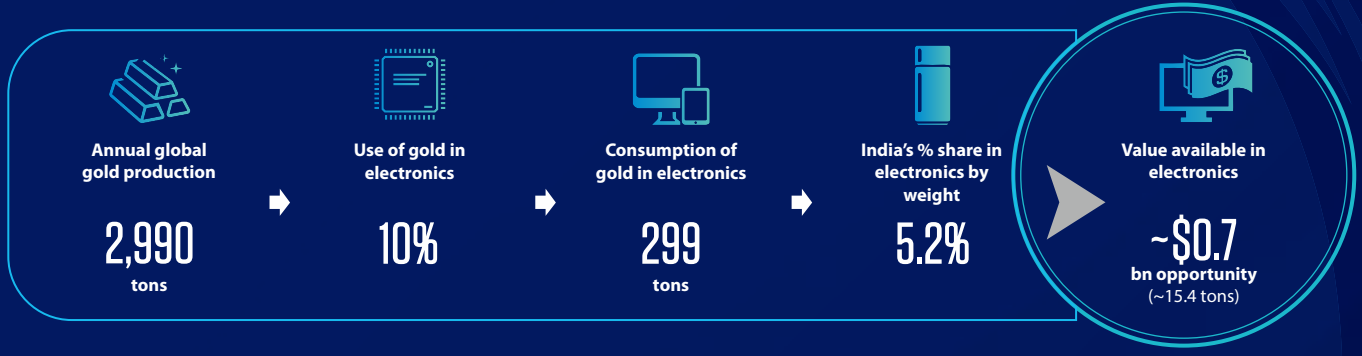
Precious metals included in this analysis are gold, platinum, and palladium

Urban mining opportunity

Our research of the urban gold mining potential suggests a ~$0.7bn to $1bn opportunity in India

Extractable value from e-waste

Extractable gold in electronics

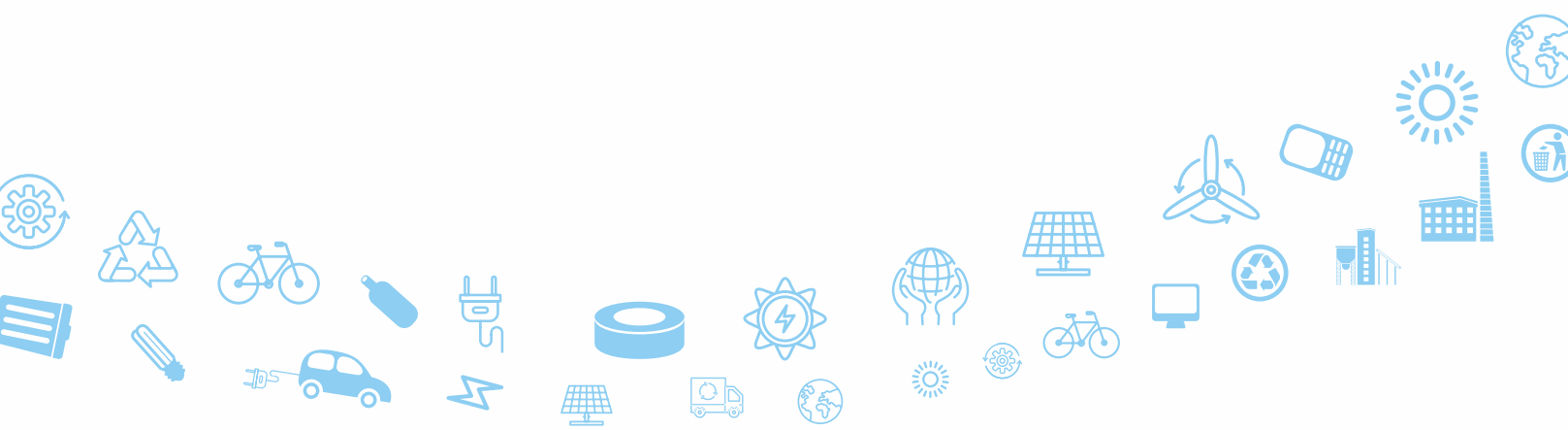


Sources: Accenture Analysis and Research, ASSOCHAM-cKinetics study, Sustainable Electronic Waste Management and Recycling Process, GTZ MAIT E-waste Assessment 2007, Oguchi M., Article in Waste Management (2011), European Round Table of Industrialists, US Geological Survey and USAGold.com

CE opportunities in Electronics and High-Tech industry – a snapshot

Table 4 : Key CE opportunities across the electronics and high-tech sector

CE Opportunity	Business Model	Status quo	Potential improvements
Modular product design	Product life extension	Products rendered as junk even with minor defects; high cost of repair	High reparability through replaceable components which users themselves can do
Appliances as a service	Product as a service	Ownership of consumer appliance gets transferred at the point of sale	Ownership retained by seller/ manufacturers with high data-driven maintenance and provision for customers to pay based on usage
IT-enabled reverse logistics	Recovery and recycling	Traditional collection systems with limited visibility and potential leakages	Highly transparent and efficient collection mechanisms to facilitate efficient take-back programs at scale
Platform- enabled P2P sharing	Sharing platforms	Unused consumer electronic devices and appliances lying idle with businesses and end-users	Hyperlocal sharing of electronic goods among peers (aligned with changing consumer preference for access over ownership)
Autonomous disassembly	Recovery and Recycling	Inefficient and localized sorting and dismantling by humans (mostly in the unorganized sector)	Fast, cost-effective and accurate robotic disassembly of products at scale



Circular Economy in Agriculture, Food and Beverages Sector

Circular Economy in Agriculture, Food and Beverages Sector

Industry context

India currently ranks 100th out of 119 countries in the Global Hunger Index 2017, with ~25% of the world's undernourished people living in India[83]. The challenge of hunger is further exacerbated by high food wastage, with almost 40% of the farm produce in India wasted annually[84]. Unlike developed countries where food wastage is a challenge primarily at consumer and post-consumer stages, food wastage in India is spread across the value-chain. In fact, only 10% of the food loss in India can be attributed to the consumption stages[85].

At the upstream stages of the value chain, the agriculture sector in India faces challenges with respect to resource efficiency. For instance, India's fertilizer intensity (in kgs/hectare of arable land) of ~165 is considerably higher than the global average of ~138[86]. This leads to soil degradation and leakages in the nutrient cycle. The practice of burning crop residues adds to this challenge, leading to a loss of ~1.4mn tons of nutrients from the topsoil layer[87].

The mid-stream stages of the value chain confront challenges with respect to supply security. The last few years have witnessed significant volatility in the prices of raw materials critical to the FMCG industry. For instance, crude palm oil prices increased by 43% in 2016 while prices of materials like tea, coffee and wheat rose by ~20%[88]. Rising prices pose a substantial supply risk for the industry. This stage of the value chain also faces challenges with respect to leakage of micronutrients. For instance, 58% of the iron content in wheat is lost during processing.

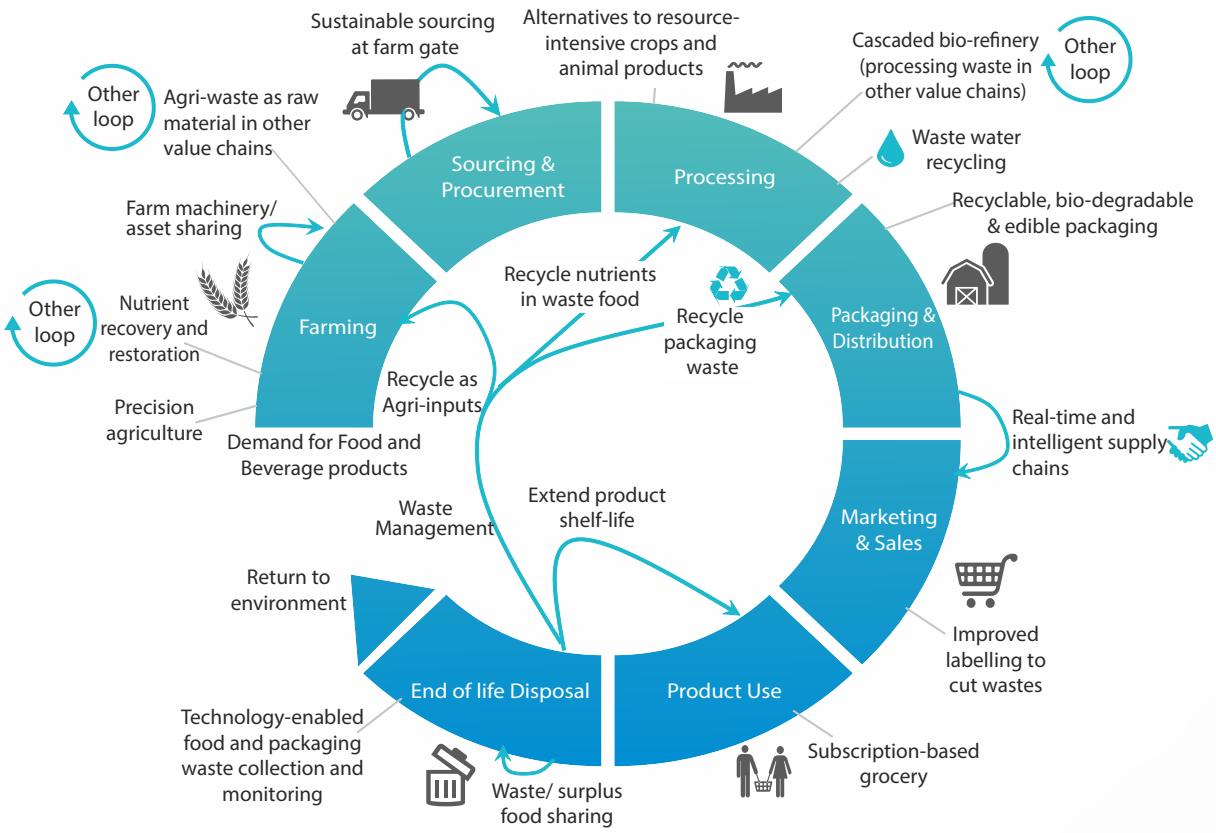
A significant resource challenge faced at the downstream stages of the value chain is that of plastic waste. India's per capita consumption of plastic is currently less than half the global average. However, plastic demand in India is expected to rise at a CAGR of 9% and increase from 17.8mn tons currently to reach ~20mn tons by 2020[89] (driven primarily by demand for packaging). This growth in consumption is likely to be accompanied by a rise in post-consumer plastic waste production. According to the Central Pollution Control Board of India, 5.6mn tons of plastic is disposed of annually, 43% of which is attributable to packaging. Moreover, only ~60% of plastic waste is recycled (mostly in the informal sector) and the remaining 40% ends up in landfills[90].

The magnitude of food and plastic waste coupled with the resource efficiency challenges across the value chain highlight the need to adopt circular business models. In the following section, we explore the application of CE models across the FMCG industry.

Circular Economy models in the FMCG industry

The FMCG value chain in its entirety is susceptible to wastages such as agri-waste, slurry, industrial by-products, food loss and packaging waste. As such, circular models can be deployed across the value chain in diverse forms - for instance, product as a service model can help improve asset utilization at the farming stages, while product recovery and recycling model can be effectively leveraged at the post-consumer stage.

Figure 15 : Application of CE models across the FMCG value chain



CE applications in Agriculture, Food and Beverages sector

There is an opportunity to recover useful resources through recycling of waste streams as well as promoting efficient agriculture through practices like precision farming and sharing platforms

There are multiple instances of agri-players recycling waste streams and using them as inputs within agriculture or introducing them as raw materials into other value chains. For instance, Rallis India has innovated GeoGreen, a bio-fertilizer made from recycled waste from sugar mills and distilleries. It is enriched with nutrient additives and lifegiving microbes and can improve yields per acre by 15-20%[91]. In an illustration of agri-waste being used as input to another loop, Starbucks Japan has tied up with contact lens manufacturer Menicon to pioneer a fermentation technology that converts spent coffee beans into livestock feed[92].

To tackle the increasing prevalence of chemical based fertilizers in agriculture, IFFCO has launched a circular supply chain initiative Sagarika, cultivating red seaweed derivatives to be used as organic solutions for crop enhancement[93]. Similarly, AgriProtein (a South Africa based company) is utilizing a circular nutrient recycling technology to utilize organic waste and turn it into protein for animal feed, organic soil enhancers or biodiesel[94].

Sharing Platforms – Mahindra Trringo

Mahindra's Trringo is India's first of its kind tractor and farm equipment rental and sharing platform, launched to improve asset utilization and address the equipment gap in Indian agriculture. It operates through a dual model, a digital platform based B2B model where tractors are given out to franchisees to set up local hubs and a C2C model where large farmers can rent out underutilized equipment to other farmers. Trringo currently has 1 lakh+ registered users across 5 states in India.

Organizations can also implement circular business models by encouraging sustainable and more localized procurement of agricultural raw materials - the Fruit Circular Economy (FCE) initiative undertaken by Coca-Cola India being an interesting example. Between 2017 and 2022, the initiative will entail an investment of ~$1.7bn, thereby expanding the local procurement of agricultural inputs (such as oranges and mangoes). The initiative builds upon the success of Coca-Cola India's "Project Unnati", which saw it double productivity and raise output and farm incomes (for more details refer to Coca-Cola India's Sustainability Update 2016/17).

CE applications at processing stages

Manufacturing of FMCG products generates by-products; significant value can be extracted from this waste stream through recovery and recycling

Tata coffee generates significant amount of coffee waste (with higher calorific value) in its instant coffee manufacturing process, which they've started utilizing as a fuel for their boilers[95].

As another illustration, consider the case of Denmark which is setting up cascading biorefineries to derive value through extraction of valuable ingredients from under-utilized residue, potato peelings, paper pulp and brewer's spent grain produced during processing of FMCG products[96].

CE applications at consumer and post-consumer stages

Circular models such as product life extension, product as a service and recovery & recycling can help address the challenge of food and plastic waste

Innovations in product and packaging are helping in extending the life of food products. Mimica Lab, for instance, has designed a biologically accurate expiry label for food products. The label decays at the same rate as the food, thus providing an accurate indicator of freshness, thereby preventing wastage due to misunderstanding of labels[97]. Another illustration is that of Tesco, which has introduced resealable packaging (with separate compartments to store food for later) to increase the shelf life of packaged food items[98].

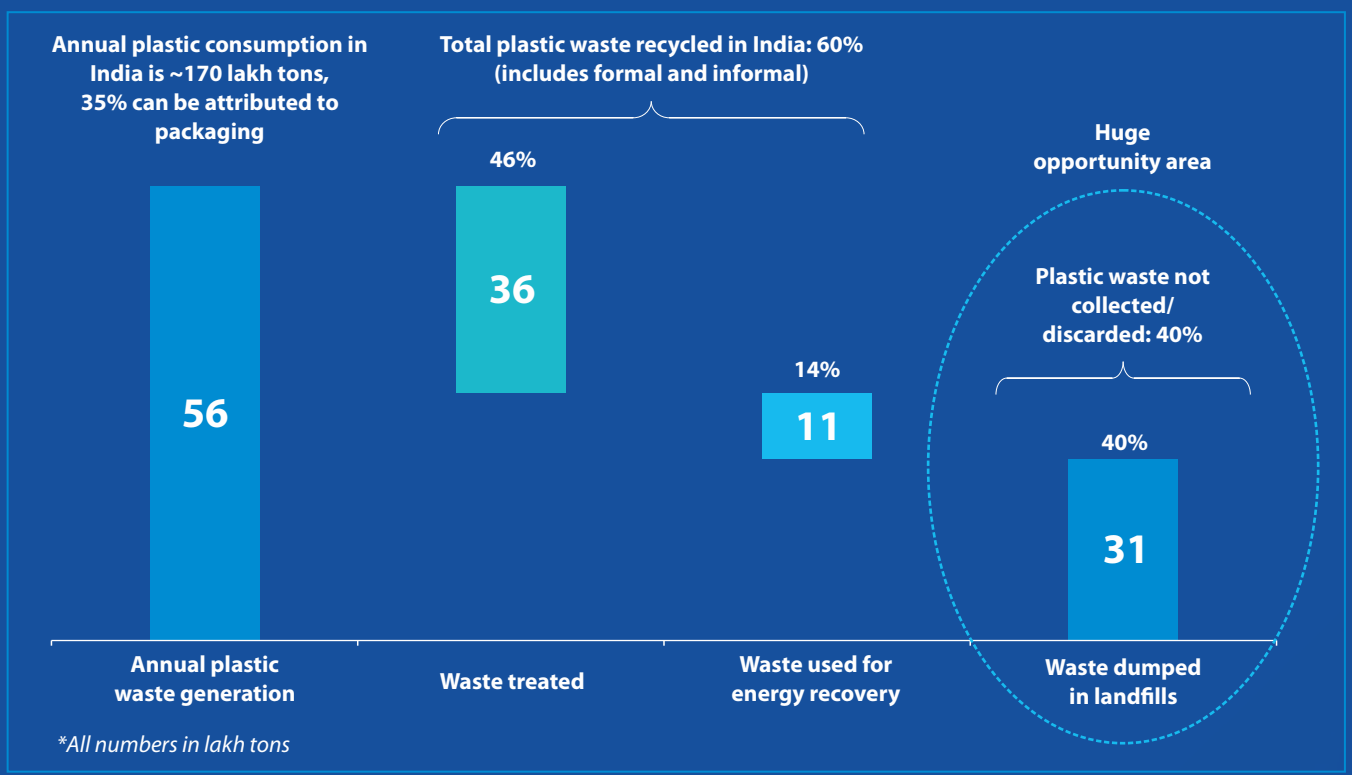
Efficient collection, segregation and recycling of waste is critical to move towards a closed loop production model. As an example, Olio is working towards creating a digital app based aggregation and sharing platform for leftover food. The service connects people with each other and with local establishments so that surplus food and other items can be shared instead of being thrown away.

Product as a Service – Cirkle, Belgium

Cirkle, a food service provider in Belgium is using reverse logistics to combine cost-effective grocery delivery and kitchen waste recycling as a service. They provide fresh and seasonal bio-food and grocery by weight, matching actual consumption with auto replenishment and use the spare capacity of delivery vehicles to collect more than 20 types of household wastes for recycling.

Circular innovations are also happening in the plastic packaging waste space. In 2018, 11 global majors including Unilever, Walmart, L'Oréal, Mars, M&S, PepsiCo, the Coca-Cola Company (collectively, representing over 6mn tons of plastic packaging annually) have made commitments towards using 100% reusable, recyclable or compostable packaging by 2025[99]. The huge volumes of plastic waste generated and disposed in landfills, coupled with informal nature of recycling provides high potential for generating economic and social value in India. It must be noted that the recycling rates, though attributed mostly to unorganized sector, in India are high (~90% for PET), however, littering of plastic waste is wide-spread and calls for urgent intervention.

Figure 16 : Recycling of discarded plastic – a huge CE opportunity in India



Significant value realization potential from the plastic dumped in landfills

Environmental benefits

~31 lakh tons (total plastic waste dumped in landfills) × ~5.6 m^3 (landfill volume saved by recycling 1 ton plastic waste) ÷ ~10 m (Average depth of plastic waste landfills) = ~1.7 km^2 (Potential landfill area that can be saved)

People benefits

~31 lakh tons (total plastic waste dumped in landfills) × ~0.4 jobs/ton (in 2013-14, 1.6mn jobs for 3.6 MT of plastic recycled) = ~13.9 lakh jobs (incremental jobs to recycle dumped plastic waste)

Sources: http://pib.nic.in/newsite/PrintRelease.aspx?relid=138144, Accenture Analysis and Research

CE opportunities in Agriculture, Food and Beverages industry – a snapshot

Table 5 : Key CE opportunities across the Agriculture, Food and Beverages industry

CE Opportunity	Business Model	Status quo	Potential improvements
Nutrient loops	Circular supply chain, Recovery & recycling	Resource intensive agricultural practices; loss of micronutrients due to imbalanced fertilizer use; agri-waste recycled mostly as manure or livestock feed	Use of bio-fertilizers to restore nutrient cycle; Precision farming; Recycling of agri-wastes as input to other value chains
Intelligent supply chains	Sharing platform	Underutilization of logistics assets for transportation & storage	Zero food loss through collaborative supply chains and asset sharing; integration of digital and analytics into logistics
Cascading bio-refineries	Recovery and recycling	Limited treatment of by-products and waste streams; disposal of by-products	Recycling of waste streams; cascading by-products for applications in other industries like chemicals, biofuels, plastics etc.
Circular packaging	Recovery and recycling	Limited segregation and recycling of disposed plastic (mostly by the informal sector)	Tech-based innovations for plastic waste recovery, segregation and recycling; proliferation of bio-degradable plastics
Food Platforms	Product life extension, Product as a service	Stop-gap techniques to address supply chain inefficiencies; localized food waste management initiatives (mostly at small-scale)	Innovative food management platforms such as pay-per use food delivery, product innovations to channelize unsold/leftover food to other uses

Enablers and Success Factors for Adoption of Circular Economy in India

Circular models entail adoption of new business models that can deliver transformative impact. With ~$500bn of India's GDP value at risk (by 2030), clearly the stakes are high. Delivering on this enormous opportunity would require an enabling ecosystem, that encourages identification and adoption of new business models. Our research indicates that five factors would be critical to harness the power of circular business models in India. These are – (I) Better awareness, (ii) Disruptive technologies, (iii) Enabling policy landscape, (iv) Innovative funding models, (v) Collaboration & partnerships

Better Awareness

Circular models have the potential to introduce new ways in which suppliers and customers interact. However, to drive adoption at scale, there is a need to create greater awareness about the benefits of circular models. There are already signs of shift in consumer behaviour towards more sustainable products. For instance:

- According to a research carried out by Assocham and Techsci research, 60-62% of consumers in high income category prefer organic products (especially fresh produce like fruits and vegetables)
- A recent study by GT Nexus (a cloud supply chain platform provider) showed that there is a demand for ethically and sustainably sourced products

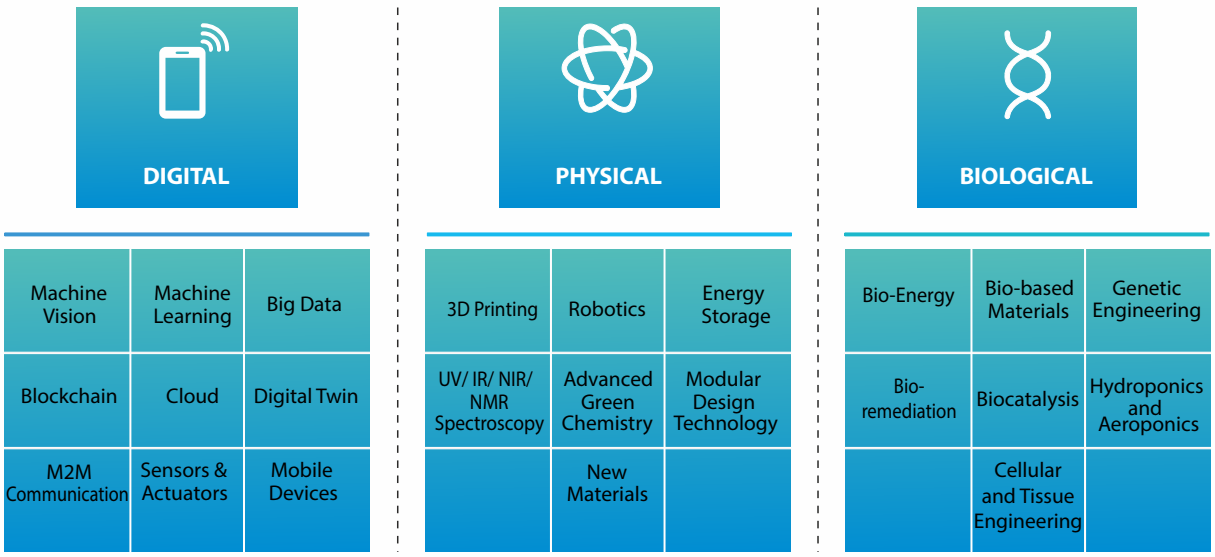
The shift in consumer preferences makes them more receptive to the new circular business models. Organizations in India could leverage this wave of changing customer preferences to create greater awareness about the cleaner and resource efficient options offered by circular models.

There is also a need to educate and prepare entrepreneurs, designers, engineers, procurement officers, and product managers about the art of possible. Creating awareness about new business models through knowledge sharing sessions and workshops could play a critical role in catalysing circular model innovations. From a relatively medium to long term perspective, there is also an opportunity to integrate Circular Economy and systems thinking into school and university curriculums.

Disruptive Technologies

In a recent study, Accenture identifies the emerging digital, physical and biological technologies which are well positioned to catalyze the adoption of CE business models.

Figure17: Key technologies for circular business models

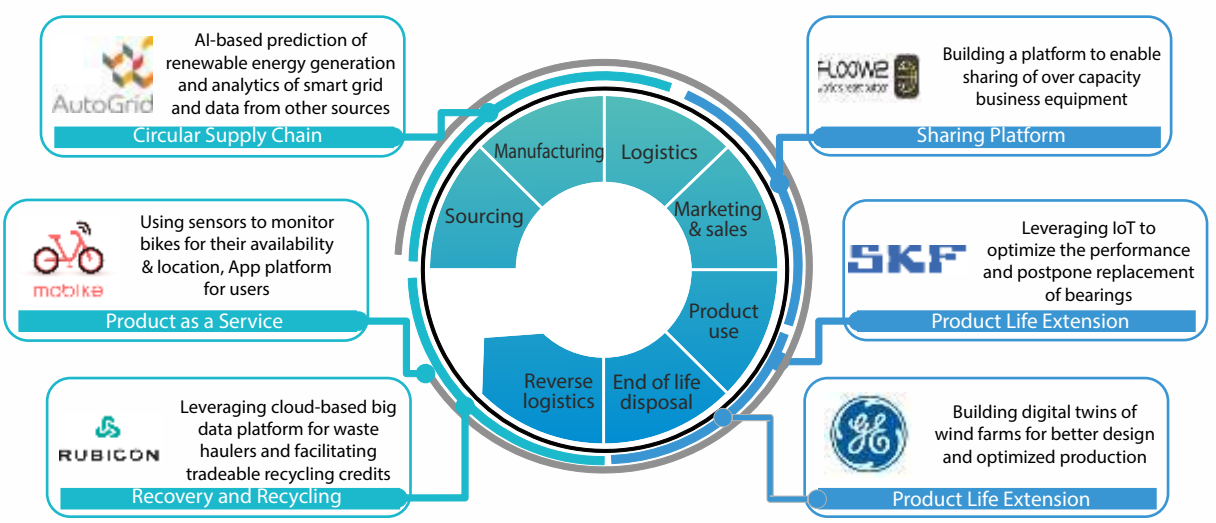


There already are examples of how leading organizations are leveraging these technologies to drive business model innovation.

Digital Technologies

Sensors and actuators coupled with M2M communication (or Internet of Things) make it possible to track resources and assets in newer ways, thereby enabling sharing platform business models. There are illustrations of how machine learning and robotics have helped with waste collection and segregation processes.

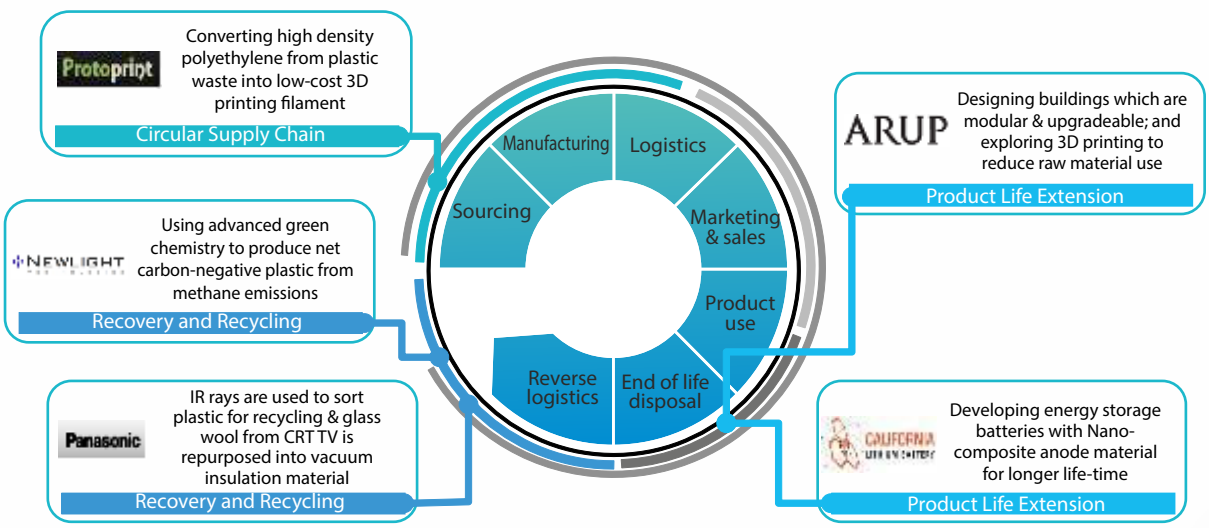
Figure18: Illustration of how digital technologies are enabling CE models



Physical technologies

Physical technologies are based on basic property of materials, energy and forces of nature. For instance, advances in energy storage technologies is enabling deployment of renewable energy solutions. Similarly, additive manufacturing or 3D Printing can help minimize manufacturing waste generated.

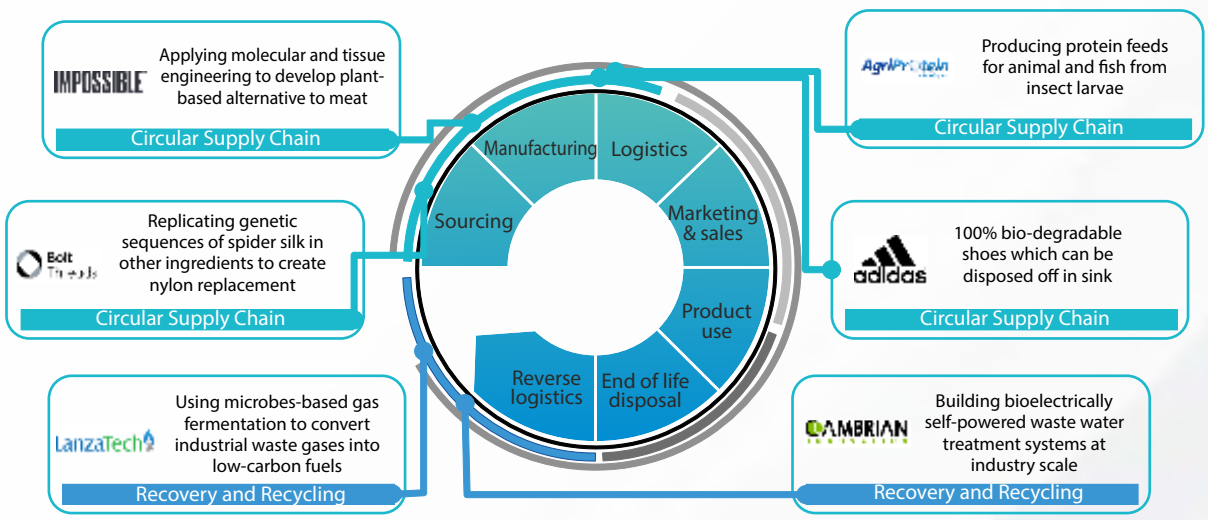
Figure 19: Illustration of how physical technologies are enabling CE models



Biological technologies

These technologies are based on biological systems, living organisms, or derivatives and are still in early stage of maturity as compared to digital and physical technologies. Conversion of bio-waste into energy is well-known example of biological technologies. Another significant development is the advent of bio-based materials (such as bio-plastics are threatening traditional polymers which are petroleum-based). Hydroponics and aeroponics, which refer to growing of plants using nutrient-rich water solvents or mist instead of soil, are other key emerging trends.

Figure 20: Illustration of how biological technologies are enabling CE models



Enabling Policy Landscape

A favorable regulatory framework can play an important role in enabling Circular Economy across industries. The Government has already introduced several measures to drive sustainable consumption of resources:

- The Zero Defect, Zero Effect scheme aims to improve the quality of Indian manufacturing while minimizing the negative externalities[100]
- The Ministry of Environment, Forest and Climate Change established the Indian Resource Panel to partner with other governmental ministries and private / public organizations to facilitate the use of recycled materials, act as a hub for resource efficiency, and bring policymakers the right policy and technology support[101]
- A national action plan on climate change (comprising of National Solar Mission, National Mission for Enhanced Energy Efficiency, National Water Mission and others) aims to reduce the environmental footprint of the economy

In addition to these macro-initiatives, the Government has also introduced several sector-specific rules that can help catalyze circular business models.

Table 6 : Circular Economy related regulations in India

Regulation	Key highlights
Plastic Waste Management Rules, 2016[102] and Plastic Waste Management (Amendment) Rules, 2018[103]	• The rules mandate producers and brand owners to introduce collect back systems as per extended producer responsibility • Minimum thickness of plastic bags increased to reduce free distribution by retailers and facilitate collection and recycling • The rules also ban the manufacture of multi-layer plastic (non-recyclable or non-energy recoverable or with no alternate use) packaging and lay down penalties on their manufacture or use by retailers • Introduction of plastic waste management fee through pre-registration of the producers, importers and vendors
E-Waste Management Rules, 2016[104]	• The rules lay the responsibility of collection and recycling of e-waste generated during manufacture of any electrical/electronic equipment on the manufacturer • The responsibility of producers is extended through an EPR to collect end-of life E-waste and properly store, transport and treat it before recycling or disposal • Consumers need to properly segregate and dispose the e-waste generated by them
Construction & Demolition Waste Management Rules 2016[105]	• Require local bodies to utilize 10-20% material from construction and demolition waste in municipal and government contracts
Upcoming Metals Recycling Policy	• The government has proposed setting up of 5 scrap-based steel plants with an investment of 500 crores in the coming year[106]

There is also a need for clear verifiable standards or criteria to identify circular goods and services such as the one launched by the BIS. These standards can help bring consistency and transparency with respect to the implementation of circular business models in India.

BS 8001 - World's first standard for Circular Economy principles

BIS has launched BS 8001, the world's first practical framework and guidance of its kind, for organizations to implement the principles of the Circular Economy. It provides practical ways to help organizations secure smaller 'quick-wins' by helping them re-think holistically how their resources are managed to enhance financial, environmental and social benefits.

CE Innovation Fund by Finnish Government

SITRA is the Finnish Government's innovation fund with an endowment worth $771mn. It aims to explore CE opportunities such as regenerative agriculture, tackling post-consumer food and plastic waste and end-of-life electronic waste and recycling of waste streams.

Innovative Funding Models

Organizations need access to financing to fund capital investment and R&D in their move towards a circular business model. The government and private sector are well positioned to drive innovative funding models.

The government could consider budgetary allocations to finance the Circular Economy initiatives as well as provide the necessary financial support and subsidies to the private sector. The Circular Economy innovation fund launched by Finnish Government is an interesting illustration of the role Government can play in mobilizing CE funds.

Businesses in their part could take a lead by allocating appropriate capital funds for CE innovation. For instance, Coca-Cola India (along with its fruit suppliers and processors) will contribute more than $1.7bn to foster circularity in India's agri ecosystem over the next five years[107]. Private equity funds and venture capitalists are also well positioned to channelize funding into CE initiatives, thereby realizing lucrative returns. For instance, Circularity Capital (a specialist PE firm that invests in SMEs and their circular economy initiatives in Europe) plans to invest between $1.2mn to $6.2mn in transformers (companies reusing old materials and reducing waste) and enablers (companies supporting circular practices in other companies)[108].

Collaboration & Partnerships

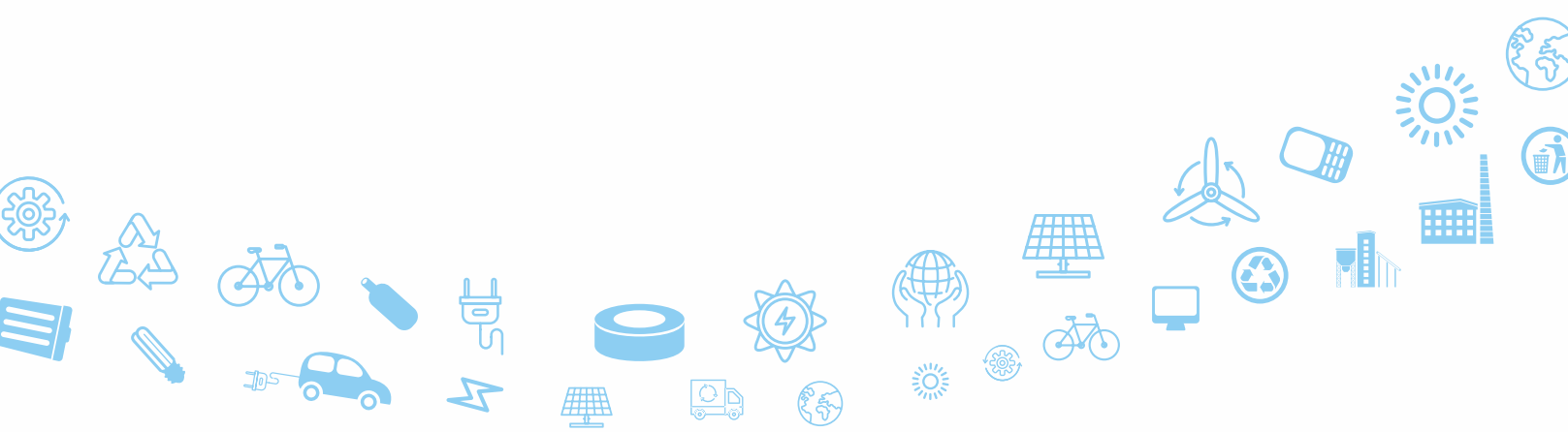
For companies looking to implement Circular Economy business models, partnership with other players in the value-chain is a key enabler. Beyond value-chain collaborations within industry, collaboration with government authorities such as urban local bodies, NGOs and even, consumers will ease the transition.

Within industry, companies can partner with upstream suppliers and downstream customers, to design new products, services and processes which reduce leakages and close the material flow loops. In automotive sector for instance, Tata's Jaguar and Land Rover sells the waste aluminium from vehicles back to the supplier (Novelis). The initiative has made possible recovery of over 50,000 tons of aluminium in one year and has also helped Novelis reduce its GHG emissions by 13%[109]. A need also exists to develop mechanisms which leverage the capabilities of unorganized and informal sector while providing them an occupational identity. Bangalore-based NGO Hasiru Dala aims to integrate marginalized waste pickers with city's solid waste management system and today, provides services to more than 22,000 households and has created 800 jobs[110].

With government, companies could collaborate to advance the discourse and support a conducive policy framing. PSUs can also take a lead in identifying right strategic resource priorities for country, building domestic capacities in association with private sector players and set standards in the form of successful proof-of-concepts with industry. Industry can also play a strong role in capacity building of state govt. and urban local bodies through technical assistance.

MSTC and Mahindra partner for India's first auto shredding business

MSTC (A mini-ratna PSU) and Mahindra Accelo have entered a JV for shredding of end-of-life vehicles and recovery of valuable metallic and non-metallic products. With an estimated cost of Rs 120 Cr., the first phase of the project is expected to be commisioned in 2018 and includes collecting and dismantling of vehicles.



Call for Action

Transition towards Circular Economy requires a systematic and well-thought implementation roadmap – one that can only be designed and implemented through collaboration across diverse stakeholders. Given their scale and influence, government and private sector are uniquely positioned to shape this journey. It is imperative to view this transition as a National project with clearly defined priorities and milestones. There are several initiatives which could help shape a systematic transition to a Circular Economy.

Table 7 : Transition to Circular Economy – Call for action

Focus Areas		
National initiatives to set-up a conducive ecosystem	**Material-level and sector-level action plan**	**Proof-of-concepts, pilots and scale-up**
Potential Measures		
• National policy with guiding principles and legislative framework • Integration of existing rules / regulations into a comprehensive national CE policy framework • Fiscal measures such as incentivization for private sector and taxes on non-optimal resource consumption • Monitoring and evaluation framework • Educational curriculum-level intervention	• Adoption of Circular Economy as a CEO agenda • Material-wise and sector-wise baseline assessments and identification of risks and opportunities • Prioritization of materials and sectors for short-term, medium-term and long-term action-plan	• Dedicated capacity building programs (ex. trainings for skill development) • Platforms for dissemination of best practices • Cross-sector idea generation workshops / R&D investments • Partnerships with start-ups, technology providers and other players • Innovation showcase platforms

Appendix A - Illustrative Circular Economy Initiatives in India

Organization	CE initiative	Brief Description
Ambuja Cement	Alternative fuel and raw materials (Geocycle)	■ Provide state-of-the-art sustainable waste management services to other industries & waste generators, using municipal, agri and mixed industrial waste as alternative fuel for their cement kiln
Mahindra Sanyo	Multiple Initiatives	■ Recover and reuse metal waste like slag, rejections and forging flashes in furnace for production ■ Collaboration with other players for transfer of by-products to other loops- refractive bricks sent for recycling, slag waste used in construction, flue dust used in pig iron manufacture
SABIC	Renewable chemicals	■ Purification and utilization of waste CO_2 from one plant as feedstock in others to produce urea and methanol coupled with purified-CO_2 sales to F&B players and production of polymers from renewable feedstock
JSW	Recovery and recycling at steel plant	■ Recovery and recycling of iron from processing sludge and fine dust through processes like micro-palletization and briquetting ■ Installation of ZLD facilities to recycle wastewater and using waste generated in processing for energy production for heating
Mahindra Group	Mahindra Accelo's car shredding business, Bio-CNG plant	■ Utilizing world class processes to shred end-of-life automobiles and recycling recovered steel and materials ■ Setting up of Bio-CNG plant in Mahindra world city which utilizes the city's food and kitchen waste to generate biogas, CNG and fertilizers
Saahas Zero Waste	Reverse supply chain solutions	■ Offers decentralized waste management solution for bulk waste generators across cities in South India, utilizing the wet waste for composting, food waste to generate biogas and dry waste is sorted for valuable materials which are sold
India Glycols Ltd.	Sugarcane molasses based derivatives, Waste as energy	■ Utilize waste from sugar plants e.g. sugarcane molasses as raw material to produce Bio-Mono Ethylene Glycol (Bio-MEG) and Ethylene Oxide (EO) derivatives ■ Also use waste from Ethanol plants as fuel for steam and power generation

Organization	CE initiative	Brief Description
Safe Water Network	Small-scale community water purification plants	■ Recycling of water purification system components and water cans at end of life, reusing waste water in toilets and farms, use of analytics and digital to extend life of their iJal stations, renting of delivery vehicles and borewells ■ Provision of water as a service through water ATMs and RFID smart cards for pay per use
Green Vortex	Refurbishment & remarketing of IT hardware products	■ Involved in the collection, segregation, storage, handling and recycling of electronic/ electrical waste products ■ Launched a complimentary business line of refurbishment & remarketing of IT hardware products
Tata Steel	Junction	■ Established to create robust and sustainable supply chains for Steel and bringing more transparency to stakeholders ■ Today, it has evolved to become the world's largest e-marketplace for steel and steel scrap
Tata Steel	Upcycling waste into fertilizers	■ Innovated GeoGreen, a bio-fertilizer made from recycled waste such as effluents and molasses from sugar mills and distilleries ■ Enriched with nutrient additives and lifegiving microbes, it can improve yields per acre by 15-20%
Tata Steel	Alternative fuels at Tata Coffee	■ Utilizing waste produced in instant coffee manufacturing (with very high calorific value) as alternative fuel for boilers
IFFCO	Fly ash based bricks, CO_2 recovery	■ Recovery of fly ash which is produced as a waste stream in coal power plants and selling it to cement plants which use it as a raw material, instead of dumping it in lakes ■ Recovery and utilization of CO_2 which is produced as a byproduct in Ammonia production and using it as a raw material for urea production
IFFCO	Seaweed-based plant growth promoter	■ Producing red seaweed derivatives-based crop enhancement product ■ Providing livelihoods to more than 1500 fishermen families in Tamil Nadu who are partners in cultivation
Coca-Cola India	Fruit Circular Economy	■ Circular supply chain initiative, which promotes localized procurement of agricultural inputs, thereby increasing farm productivity and incomes

Appendix B – Methodology to compute GDP at Risk

A top-down approach has been followed which compares a resource-constrained growth scenario with an unconstrained scenario (post Circular Economy adoption) to estimate economic output at stake. Overview on the key steps, assumptions and approach along with key findings are provided below:

Step A – Projecting Material Demand

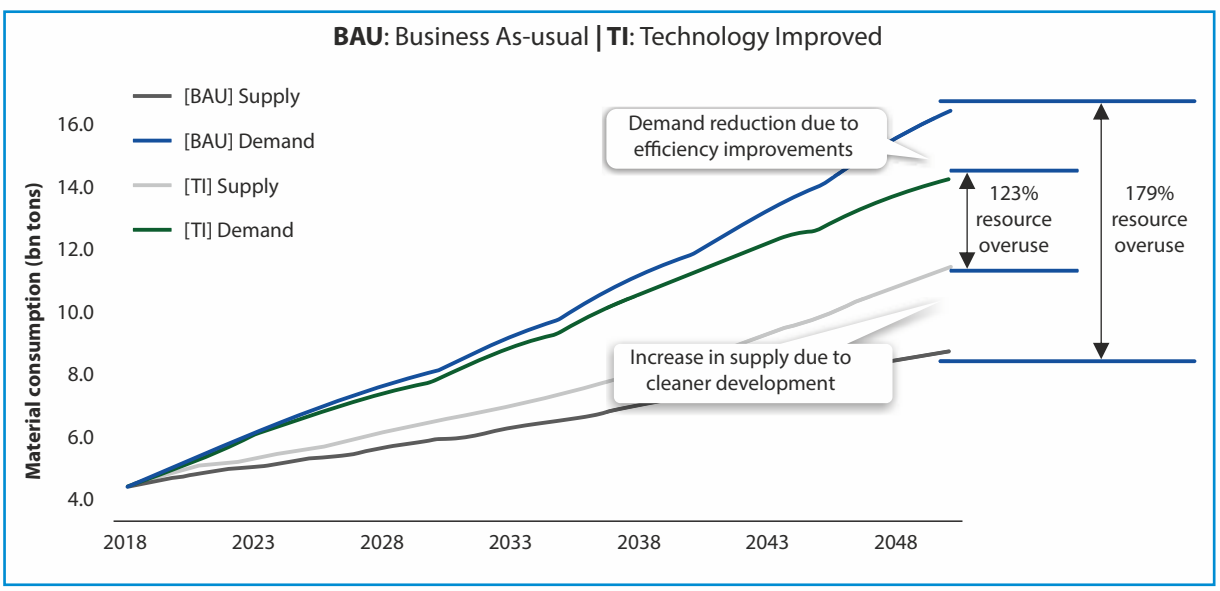
To project the future resource demand for the material resources (biomass, fossil fuels, metal ores and non-metallic minerals) in the period 2018-2050, population and GDP growth were used. In, technology-improved scenario, adjustments were made to consider material intensity improvements.

Step B – Projecting Material Supply

Resource supply limits were computed using ecological footprint and several other adjustments assuming a conservative stabilization path with sustainable resource use not met before 2070. For the purpose of modelling, a boundary condition that biological deficit reduces to zero in 2070 was assumed.

Step C – Resource Imbalance Pathway

A resource imbalance pathway is computed by comparing the demand with supply of resources. The figure below depicts the resource imbalance pathway (demand-supply gap) for two scenarios.



Finally, economic impact due to this imbalance has been calculated using elasticities of growth (i.e. percentage reduction in growth for each percentage shortage of resources). Value computed is India's GDP at risk which could be lost in a non-circular economic growth model, characterized by high resource scarcity.

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Study Leads

Dilip Chenoy
Secretary General
FICCI

Anirban Ghosh
Chair
Circular Economy Symposium 2018

Lead Authors

Sanjay Jain
Managing Director
Accenture Strategy & Sustainability

Vishvesh Prabhakar
Managing Director
Accenture Strategy & Sustainability

Sundeep Singh
Senior Principal
Accenture Strategy & Sustainability

Jay Thakkar
Manager
Accenture Strategy & Sustainability

Arpit Srivastava
Analyst
Accenture Strategy & Sustainability

Palash Gupta
Analyst
Accenture Strategy & Sustainability

Core Working Group

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Mr Anirban Ghosh
Mahindra & Mahindra

Dr Ashok Menon
SABIC Technology Centre

Dr Nimish Shah
Unilever

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UN Environment, Asia Pacific Office

Prof Surya Chandak
Birla Institute of Management Technology

Dr Rachna Arora
GIZ

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Key Contacts

Vishvesh Prabhakar
vishvesh.prabhakar@accenture.com
Mobile: +91-9910452524

Sundeep Singh
sundeep.singh@accenture.com
Mobile: +91-9818119794

Archana Datta
archana.datta@ficci.com
Mobile: +91-9891049511

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