CII MISSION ON WASTE TO WORTH TECHNOLOGIES TO SINGAPORE

19th – 23rd May 2025

Report

Confederation of Indian Industry

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Confederation of Indian Industry

Executive Summary

The Confederation of Indian Industry (CII) led a high-level "Waste to Worth Technologies" Mission to Singapore from 19th to 23rd May 2025. The mission was chaired by Mr. Masood Mallick, Chairman of the CII National Committee on Waste to Worth Technologies and Managing Director & Group CEO of Re Sustainability.

The primary objective of the mission was to foster bilateral collaboration between Indian and Singaporean industries in the waste-to-worth (WTW) sector. The focus areas included joint research, technology transfer, trade, investment, and the signing of MoUs to enhance industrial competitiveness and sustainable development in both countries.

Comprising around 26 delegates from industry, academia, start-ups, and research institutions, the mission provided a valuable platform for networking and collaboration. Participants engaged with top Singaporean corporate leaders, representatives from incineration and recycling facilities, government agencies, and academic experts from renowned institutions.

The delegation commenced its engagements with a visit to the Waste Management & Recycling Association of Singapore (WMRAS), where discussions highlighted investment opportunities in Singapore and potential for technology transfer to India. The delegation also visited advanced facilities such as the Keppel Seghers Tuas Waste-to-Energy (WTE) Plant, the National Environment Agency (NEA), PUB - Singapore's national water agency (Marina Barrage), Nanyang Technological University, and ALBA E-Waste Singapore, gaining insights into cutting-edge waste-to-energy and recycling technologies.

An industry interaction session at the Indian Embassy in Singapore further explored innovative solutions and collaborative opportunities in sustainable waste management. Additionally, on 19th May 2025, the delegation met with the Indian Ambassador in Singapore to discuss expanding partnerships between Indian and Singaporean companies, as well as academic and research institutions.

This mission marked a significant step toward building a cleaner, more resource-efficient future through international collaboration and knowledge exchange in the waste-to-worth domain.

Key Findings:

1. **Technology**: Singapore leads in advanced waste management technologies, using AI, automation, and data analytics for efficient waste segregation and recycling. Facilities like Tuas Nexus combine waste-to-energy and water reclamation, demonstrating a commitment to a circular economy.
2. **Policy & Regulations:** Singapore's waste management is governed by policies like the Zero Waste Masterplan and the Resource Sustainability Act, which

enforce EPR, mandatory waste reporting, and segregation at source. The SG Green Plan 2030 further promotes landfill reduction and recycling growth.

3. **Budget & Financing**: The government allocates significant funds for sustainable infrastructure and green innovation through agencies like NEA and Enterprise Singapore. Grants and incentives support businesses in adopting eco-friendly practices and scaling green technologies.
4. **Social & Cultural Aspects**: Environmental responsibility is deeply ingrained in Singaporean society through programs like Eco-Schools and Clean & Green Singapore. These initiatives foster community engagement and reinforce sustainable habits among citizens.
5. **Waste-to-Energy (WTE)**: WTE is a cornerstone of Singapore's strategy to manage limited land by converting non-recyclable waste into electricity at plants like Keppel Seghers and Tuas Nexus. This reduces landfill use and lowers greenhouse gas emissions.
6. **Leading Companies**: Key players like Keppel Seghers, ALBA E-Waste Singapore, Sembcorp Industries, and Veolia Singapore spearhead innovation in waste treatment, recycling, and renewable energy. These companies drive Singapore's sustainability leadership.
7. **Collaboration with Singaporean Companies**: Singapore encourages cross-border partnerships, with Indian bodies like CII working alongside Singaporean firms on WtE technologies and circular economy projects. Collaboration occurs via trade missions, joint research, and MoUs.
8. **Integrated Infrastructure**: Singapore operates four major WtE plants processing 90% of its waste before final disposal at the Semakau Landfill, which employs sustainable engineering features and is expected to last until 2035. The Integrated Waste Management Facility opening in 2027 will further enhance resource recovery.
9. **Public Engagement & Behavior Change**: Nationwide recycling programs, color-coded bins, and school initiatives promote strong public participation. Policies also aim to shift the public mindset toward reducing waste and increasing recycling rates.
10. **Future Challenges & Innovations**: Despite progress, Singapore faces challenges like limited landfill space and high labor costs. It addresses these through smart technologies like Samsara Optimus, EPR schemes, and upcoming deposit return systems to sustain a circular, tech-driven waste ecosystem.

Key Recommendations:

1. Singapore's WTE plants incinerate unsegregated municipal waste to produce electricity, but turbine efficiency remains around 25%. India can collaborate with the Singapore government, industry, and academia to accelerate innovation in AI-driven waste management and resource recovery solutions.
2. Singapore's WTE plants emit significant CO_2 despite meeting emission norms, highlighting the need for Carbon Capture and Utilization (CCU) technologies. India can support through joint R&D and pilot projects in low-cost CCU,

leveraging its expertise in CO_2-to-value innovations via institutions like CSIR and NTPC.

3. Singapore's incinerators at WTE plants generate large volumes of bottom ash, which are currently landfilled. India can collaborate by offering ash valorisation solutions—such as converting ash into building materials—and share low-cost emission control technologies through its research institutions and startups.
4. Singapore could strengthen EPR frameworks by incorporating a broader range of materials and incentivizing manufacturers to adopt eco-design, drawing lessons from India's evolving EPR policies for diverse waste streams.
5. Leveraging Singapore's experience with platforms like Samsara Optimus, India can implement smart waste management systems to enhance operational efficiency and enable data-driven decision-making.
6. Signing MoUs between Indian industry and Singapore's WMRAS, SEC, NTU and other key organizations can foster collaboration on emerging waste recovery technologies, promoting investment and adaptation of near-commercial innovations suitable for India's waste ecosystem.
7. India can partner with Singapore to establish a regional sustainability network focused on knowledge exchange, joint investments, and harmonizing waste management standards, driving collective progress toward circular economy and climate goals globally.

Confederation of Indian Industry

Detailed Report

I. About CII's Initiatives on Waste to Worth Technologies (ciiwaste2worth.com)

Vision: Strengthening the waste management system in India by identifying and validating innovative technology solutions and models to achieve a zero landfill and zero waste nation.

The Government of India has launched *Mission LiFE (Lifestyle for Environment)* to promote sustainable living by emphasizing the circular economy principles of **Reduce, Reuse, and Recycle**. Prime Minister Narendra Modi has noted that these values are deeply rooted in Indian culture. As a resource-intensive and rapidly growing nation, India is well-positioned to become a global leader in the circular economy, helping reduce waste, conserve resources, and combat climate change—while supporting India's Nationally Determined Contributions (NDCs) and the UN Sustainable Development Goals (UNSDGs).

The Confederation of Indian Industry (CII) is at the forefront of promoting sustainability through its *Waste to Worth Movement*. This initiative encourages the adoption of waste management technologies and circular economy practices across industries. It brings together businesses, government, academia, and startups to develop solutions that reduce environmental impact and enhance resource efficiency.

Waste to Worth technologies play a vital role in addressing India's growing waste challenges. Beyond waste reduction, these technologies also offer opportunities for sustainable energy generation and economic growth. CII's *National Committee on Waste to Worth*—comprising experts from industry, academia, and research—focuses on advancing innovative strategies for sustainable waste management and promoting circularity.

Through these collaborative efforts, CII aims to build a more sustainable, resilient, and inclusive future for India.

Launch of CII W2W Movement: Key Goals of FY 2025-26

CII WOW Waste to Worth Transformation

1. Enhancing National Investment in R&D in W2W enabling Technologies
2. Increase in Industry contribution in R&D investment in W2W
3. Enable a competitive Industry participation in W2W through representations (National Circular Economy Framework and its Implementation)
4. Celebrating best practices of Industry in W2W Ecosystem
5. Global Summit & Missions on W2W leadership

Confederation of Indian Industry

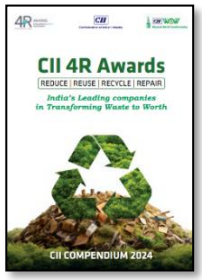
Waste to Worth key initiatives:

Policy Advocacy:

Release of “National Circular Economy Framework (NCEF) Edition 2” and “White Paper on Top issues related to Waste to Worth Sector” which serve as a valuable resource for policymakers, industry leaders, researchers, and other stakeholders committed to advancing sustainable waste management practices in India

CII 4R Awards 2024:

CII introduced the 4th “R” "Repair” into their 3R (Reduce-Reuse-Recycle) Awards to promote refurbishing in India. During conference, 4R awards were conferred to Twenty-one outstanding organizations for their excellent work “CII Compendium 2024” showcasing India’s leading companies transforming waste into worth.



Webinars:

CII hosted the series of webinars that will focus on Waste Management Sector’s Role in Achieving India’s COP Commitments, Management through social inclusion, Efficient Waste Management for FMCG and many more.

CII Annual Conference on Waste to Worth:

An annual conference is also held in November each year that brings together industry leaders, policymakers, and experts to discuss and showcase innovative waste management solutions and technologies

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Annual Oversea Mission:

CII in collaboration with Industries, launched new initiatives to champion the circular economy in India. From August 5th to 9th, CII led a groundbreaking mission to Japan to explore technologies that enable Waste to Worth.

II. About the Mission

Both India and Singapore are addressing the global challenge of waste management through innovative *Waste to Worth* technologies. By fostering sustained innovation, investment, and cooperation, both nations are working toward a cleaner, more sustainable future.

As part of this collaborative effort, the Confederation of Indian Industry (CII) is organized a Mission on Waste to Worth Technologies to Singapore from 19th to 23rd May 2025. This mission aims to enhance India's competitiveness in advanced waste management by facilitating knowledge exchange and promoting strategic partnerships.

The initiative brings together experts from industry, start-ups, academia, and law firms, creating a multidisciplinary delegation. Participants will engage with key stakeholders from the Singaporean government, academic institutions, and leading industry players. The program will include visits to cutting-edge waste management facilities and innovation centers.

By leveraging the strengths and expertise of both countries, the mission aimed to identify scalable solutions, promote circular economy practices, and convert waste into valuable resources—addressing environmental challenges while creating new economic opportunities.

Key Objectives of the Mission

The CII Mission on Technologies Enabling Waste to Wealth Transformation seeks to foster international collaboration, facilitate knowledge exchange, and promote leading practices in waste management and resource recovery.

The key objectives of the mission are as follows:

1. To strengthen the competitiveness of Indian industry by providing exposure to best-in-class waste management technologies practiced in advanced Asian countries such as Singapore.
2. To deepen engagement and dialogue between stakeholders from both India and Singapore on innovative technologies that support the Waste to Wealth transformation.
3. To facilitate the signing of Memoranda of Understanding (MoUs) between Indian industries and their Singaporean counterparts, and to align investment initiatives focused on Waste to Wealth (W2W) technologies.

Expected Takeaways

- Deepened Bilateral Collaboration
- Advancement Through Technology Transfer and Innovation
- Enriched Cultural and People-to-People Engagement
- Exchange of Best Practices and Knowledge
- Forging Strategic Business Partnerships

III. Mission Program

Day 1: 19th May 2025	
1300-1400 Hrs	Waste Management & Recycling Association of Singapore (WMRAS)
1500-1600 Hrs	PUB - Singapore's Water Agency (Marina Barrage)
1700-1800 Hrs	Briefing with Ambassador of India in Singapore, **H.E. Dr. Shilpak Ambule** (With select members)
Day 2: 20th May 2025	
1000-1200 Hrs	Keppel Seghers Tuas WTE Plant
1230-1330 Hrs	Vac-Tech Engineering Pte Ltd (1230-1330 Hrs)
Day 3: 21st May 2025	
1000-1100 Hrs	Singapore Environment Council (Group 1)
1000-1100 Hrs	Singapore Business Federation (Group 2)
1130-1230 Hrs	National Environment Agency (NEA) (Group 1)
1130-1230 Hrs	Visit to India Heritage Centre
1500-1600 Hrs	RVAC Pte Ltd – Re Sustainability Singapore (Cleantech)
Day 4: 22nd May 2025	
1000-1200 Hrs	ALBA E-Waste Singapore – ALBA Group Asia
1430-1600 Hrs	Enterprise Singapore
Day 5: 23rd May 2025	
1000- 1130 Hrs	Nanyang Technological University Singapore,
1330-1430 Hrs	Stewardship Asia Centre
1500- 1600 Hrs	Sembcorp Industries Ltd.

IV. Meetings/Visits

1. Briefing with Ambassador of India in Singapore, H.E. Dr. Shilpak Ambule

HE Indian Ambassador to Singapore, Dr. Shilpak Ambule during the Mission briefing meeting with some senior members of the Mission at High Commision of India, Singapore

Mission commences with the briefing meeting of High Commision of India in Singapore, HE Dr. Shilpak Ambule. The Mission Chair interacted with Ambassador on the meetings/visits and partnership, as well as concrete expected outcome from the visit.

HE Ambassador of India in Singapore emphasizes an overview of the Singapore waste management industry and its importance for a sustainable Nation and 60 years of diplomatic relations between two nations. He further gave emphasis on emerging recycling technologies, and Waste-to-Energy plants highlights significant areas where India and Singapore can collaborate, especially given the complementary strengths of both nations. His Excellency further mentioned the advanced waste management technologies in Singapore, coupled with the global push for sustainability, make this knowledge crucial for future collaborations between India and Singapore. This could lead to innovative solutions that are both environmentally and economically viable, strengthening the partnership between the two nations. The delegation also proposed signing MOU with Waste Management and Recycling Association of Singapore and the High Commissioner advised to include this on the agenda of Working Group.

Suggested key Collaboration areas:

1. India and Singapore can collaborate on advanced waste management technologies, particularly in high-value sectors like semiconductor and rare earth waste recycling.
2. Joint R&D, pilot projects, and setting up eco-parks with global expertise are key components.
3. India can lead in development of biofuels and sustainable aviation fuels (SAF) Singapore's sustainability goals and India's growing clean energy ecosystem can align to create regional hubs for green fuel production and innovation.

4. India can support Singapore through manpower development and shared infrastructure.
5. Long-standing G2G relations and active B2B engagements (e.g., Keppel Seghers and Sembcorp) can be expanded to include joint training programs, policy exchanges, and implementation of zero-waste initiatives.

2. Waste Management & Recycling Association of Singapore (WMRAS)

WMRAS is a non-profit entity dedicated to knowledge transfer within the waste management and recycling industry, with a focus on fostering collaborative relationships between businesses. Their mission is to advance and professionalize the waste management and recycling sector, ensuring it stays modern, efficient, and sustainable. This includes a strong focus on innovation, such as deploying specialized recycling vehicles and adopting modern systems to improve operational effectiveness.

Key Takeaways: Suggestions for India–Singapore Cooperation

1. Technology validation
2. Exchange of innovative ideas and learnings
3. Market exploration opportunities
4. Capacity building initiatives
5. Strengthened bilateral engagement mechanisms

Key Requests and Action Points

1. Promote collaboration through MoUs between Indian industry and WMRAS to drive tech innovation and investment in India's waste management sector.
2. Share best practices between India and Singapore.
3. Jointly develop professional courses and facilitate cross-country participation in training and education.

Members visited Waste Management & Recycling Association of Singapore (WMRAS)

3. PUB - Singapore's Water Agency (Marina Barrage)

PUB – Singapore Water Agency commencing operations in 2003, its 2-kilometer-long infrastructure, which includes the highly efficient Keppel Marina East Desalination

Plant, plays a critical role in flood prevention and water sustainability. Equipped with the world's largest drainage pumps, it regulates water levels, addresses rising sea levels, and operates continuously to manage rainfall and store water efficiently. They also prioritizes water reuse, recycling 50–70% of wastewater and aiming for net-zero emissions. Advanced technologies purify water to potable standards without extra filtration, while dried sludge and food waste are incinerated to generate energy.

Key Takeaways:

1. Integrated Water Infrastructure: India should develop multi-purpose urban infrastructure—like Singapore's Marina Barrage—that combines flood control, water storage, and public recreation, turning water bodies into both utility assets and community spaces.
2. Energy-Efficient Desalination: Coastal states such as Gujarat and Tamil Nadu can invest in advanced desalination plants modeled after Singapore's Keppel Marina East Plant, focusing on scalable systems that are over 60% more energy-efficient.
3. Climate-Resilient Systems: To prepare for sea-level rise and extreme weather, Indian cities must incorporate smart pumps, floodgates, and 24/7 water monitoring systems, especially in flood-prone areas like Mumbai, Chennai, and Kolkata.
4. Nationwide Recycling Infrastructure: Implement and link standardized, color-coded bin system across the country to simplify recycling, and support it with educational programs in schools and communities to build public awareness and participation.
5. Business Accountability and Sustainable Packaging: Enforce mandatory waste reporting for large businesses, and create a national agreement to promote recyclable, BPA-free packaging, reduce single-use plastics, and encourage eco-friendly product design.

Members visited PUB - Singapore's Water Agency (Marina Barrage)

4. Keppel Seghers Tuas WTE Plant

Keppel Seghers is a leader in delivering integrated power solutions focused on sustainable development and decarbonization. We offer end-to-end services that

include the development, implementation, and operation of advanced energy and waste management systems.

With a global footprint, Keppel Seghers has successfully executed over 100 Waste-to-Energy (WTE) projects and more than 350 water and wastewater projects across 25+ countries. Flagship WTE plants include advanced facilities in Poland, Australia (Kwinana), China (Border AN), and India (Abellon, Jamnagar), showcasing cutting-edge technology, high efficiency, and strong environmental compliance. International highlights also feature key waste management centers in Qatar, Hong Kong, and Singapore. At the core of these operations is the proprietary Sigmatrix™ Waste Combustion System, a scalable, in-house technology designed for high-efficiency waste processing and superior energy recovery. In Singapore, Sigmatrix™ handles 35% of municipal solid waste, demonstrating its impact on national sustainability goals.

Key Takeaways:

1. With a track record of over 100 WTE projects and 350 water projects across 25+ countries, the Keppel Seghers brings deep international experience and credibility.
2. The proprietary Sigmatrix™ combustion system efficiently processes unsorted, non-homogeneous waste including plastics, without pre-sorting, making it ideal for municipal waste streams where energy generation is goal.
3. High Environmental Performance in WTE plant by featuring up to 36% turbine efficiency, <5% ash content, and advanced emission controls (e.g., activated carbon beds, 1000°C combustion), the technology meets stringent environmental standards.
4. Aligned with various initiative that supports decentralized waste management with energy recovery, reducing landfill use and enhancing urban sustainability.

Members visited Keppel Seghers

5. Vac-Tech Engineering Pte Ltd –Blue Planet Environmental Solutions

Vac Tech is a regional leader in integrated waste management, offering sustainable environmental solutions as part of the Blue Planet network. Their services include

manhole cleaning, desludging, high-pressure hydro-jetting, and advanced robotic tank cleaning, first introduced in Singapore in 2019. With successful projects across Singapore and the Philippines, including Horizon Terminal, Vac Tech also provides Squiztech Dewatering Services for oil sludge treatment. Their focus on innovation, safety, and sustainability keeps them at the forefront of the industry.

Key Takeaways:

1. Vac-Tech shows Comprehensive environmental solutions across waste handling, treatment, and disposal.
2. Cutting-Edge Robotic Tank Cleaning Technology: First deployed in Singapore's Jurong Island (2019) – 100% automated, mechanical, and safer alternative to manual cleaning.
3. High-Pressure Hydro-Jetting & Desludging Services: Ideal for industrial clusters and refineries in India seeking efficient, high-performance cleaning methods.
4. Successfully executed industrial cleaning and tank dewatering in Singapore and the Philippines, applicable to India's petrochemical and manufacturing sectors.
5. Squiztech Dewatering: Scalable & Sludge-Ready, Commercial dewatering systems designed to handle oil sludge – well-suited for India's growing oil & gas and wastewater treatment demands.

Members visited Vac-Tech Engineering Pte Ltd

6. Singapore Environment Council (SEC)

The Singapore Environment Council (SEC), founded in 1995, is a key non-profit organization championing environmental sustainability in Singapore. As the country's only member of the Global Ecolabelling Network and a UNEP-accredited NGO, SEC supports national efforts like the Zero Waste Masterplan and SG Green Plan 2030. These initiatives focus on building a circular economy through responsible waste

management, producer accountability, and sustainable infrastructure such as the Tuas Nexus facility. Through innovation, policy, and public engagement, Singapore aims to create a resilient, eco-conscious society.

Key Takeaways:

1. Singapore's comprehensive policies, like the Zero Waste Masterplan and the Resource Sustainability Act, demonstrate the effectiveness of a unified legal and policy framework to manage waste and promote sustainability. India could benefit from a similar, centralized approach and streamlines environmental governance across states.
2. Projects like Tuas Nexus showcase how integrating waste treatment and water reclamation in a single facility can maximize resource efficiency. India can prioritize similar infrastructure investments in urban centers, leveraging public-private partnerships to modernize waste management and close the waste loop through innovation and R&D.
3. Promote collaboration through MoUs between Indian industry and WMRAS to drive tech innovation and investment in India's waste management sector.
4. Singapore actively involves its citizens through campaigns, education programs, and citizen workgroups to build a culture of environmental responsibility. India, with its large and diverse population, can amplify the impact of its environmental initiatives by fostering grassroots participation and embedding sustainability into everyday behavior through education and outreach.

Members visited Singapore Environment Council (SEC)

7. Singapore Business Federation

The delegation met with the International Business Division of the Singapore Business Federation (SBF) and gained key insights into its structure and role. Established under the SBF Act (2001), SBF represents over 30,000 companies, including both statutory and associate members. It plays a vital role in supporting overseas business expansion, cross-sector collaboration, and international networking. Notably, SBF

expressed interest in fostering connections between Indian and Singaporean businesses, especially in waste management and sustainability. Once potential collaboration areas are identified, SBF can assist in facilitating partnerships.

Key Takeaways:

1. The visit aimed to strengthen collaboration between Singapore and India, with a focus on helping Singaporean companies expand into overseas markets.
2. Discussions centered around potential cooperation in emerging sectors, including: Waste tyre recycling, Tile and ceramic industry, Cement manufacturing sector
3. There is strong interest in connecting with Singapore-based companies open to consulting or collaboration in waste management.
4. Emphasis was placed on sustainable practices and circular economy models in future partnerships.

Members visited Singapore Business Federation

8. National Environment Agency (NEA)

Delegation visited National Environment Agency (NEA) of Singapore a lead agency responsible for managing waste and promoting environmental sustainability. It oversees policies under the Zero Waste Masterplan, enforces regulations through the Resource Sustainability Act, and manages waste collection via licensed public waste collectors. NEA also operates waste-to-energy plants and the Semakau Landfill, promotes recycling through national campaigns and mandatory reporting, and implements the Extended Producer Responsibility framework for e-waste and packaging. With initiatives like Tuas Nexus and the Singapore Green Plan 2030, NEA aims to reduce landfill use, boost recycling, and transition towards a circular economy.

Key takeaways:

1. The visit highlighted opportunities for collaboration in advanced waste management technologies, including waste-to-energy solutions, recycling

infrastructure, and digital waste tracking systems, which can support India's sustainability goals through technology transfer and capacity building.

2. Observing India's integrated approach to develop environmental policy and industrial operations emphasized how strategic planning, public-private partnerships, and regulatory enforcement can drive effective and scalable waste management systems in Singapore.

Members visited National Environment Agency (NEA)

9. RVAC Pte Ltd – Re Sustainability Singapore (Cleantech)

Re Sustainability Limited, Asia's leading integrated resource management company, operates over 500 projects across 23 states. At Marina One in Singapore has implemented the Pneumatic Waste Collection System (PWCS), a government-mandated, automated solution for buildings with over 100 units. The system uses color-coded bins and a 1.7 km vacuum network to transport waste to incineration plants, supporting Singapore's waste-to-energy strategy. Residents pay $80 annually, while the government pays RESUS $150 per unit for waste processing. The PWCS improves hygiene, aesthetics, and efficiency by eliminating traditional bins and collection trucks.

Members visited RVAC Pte Ltd

Key takeaways:

1. The Pneumatic Waste Collection System (PWCS) offers a scalable, automated solution ideal for high-density urban developments in India, especially in growing cities with increasing waste management challenges.
2. The Singapore model shows how government mandates, coupled with private sector implementation, can create an efficient and sustainable waste management ecosystem.
3. By eliminating open garbage bins and manual collection, PWCS significantly enhances cleanliness, reduces pest issues, and improves the visual appeal of residential and commercial spaces.
4. The system reduces the need for large bin storage areas and minimizes waste truck movement, freeing up valuable urban space and easing traffic congestion—both critical issues in Indian cities.
5. With waste transported to incineration plants for energy generation, India can explore waste-to-energy models to reduce landfill dependency and enhance sustainability in waste processing.

10. Enterprise Singapore

Members visited Enterprise Singapore

Enterprise Singapore is fostering deeper bilateral collaboration with India by leveraging innovation, technology, and sustainability to address shared urban challenges. With a focus on areas such as waste management, water treatment, and smart city solutions, Enterprise Singapore supports both the internationalisation of Singaporean companies and the facilitation of Indian companies entering Singapore's innovation ecosystem.

Key takeaways:

1. India has strong policy frameworks for sustainability, but there are notable gaps in on-ground implementation—especially in areas like waste segregation,

recycling infrastructure, and public-private coordination. Learning from Singapore's efficient systems can help strengthen India's circular economy practices.

2. With recyclable collection efficiency around 60–70%, India has room to improve through technology-enabled tracking, smart sorting systems, and digitized waste supply chains. Collaboration with Singaporean firms can introduce scalable innovations to improve recycling outcomes.
3. India can benefit from structured carbon credit mechanisms and climate financing models that Singapore enterprises have experience with. These can incentivize sustainable practices and create new economic opportunities for Indian industries.
4. India's vast agricultural sector can gain from Singapore's expertise in precision farming, vertical agriculture, and food tech. Joint pilot programs can help boost productivity, reduce environmental impact, and enhance farmer incomes across different regions in India.
5. Platforms like SWITCH and SLINGSHOT, supported by Enterprise Singapore, offer Indian startups and innovators access to global networks, funding, and R&D collaboration. Tapping into these can accelerate India's sustainable technology development and market access.

11. ALBA E-Waste Singapore – ALBA Group Asia

Members visited ALBA E-Waste Singapore

ALBA, a German company established in 1956, operates in Singapore as the appointed Producer Responsibility Scheme (PRS) Operator for e-waste under the Resource Sustainability Act (RSA). In partnership with Wah & Hua Pte Ltd, ALBA collects and processes about 12,000 tons of e-waste annually through public bins, smart bins, collection drives, and doorstep pickup for large appliances. Services are free for the public, while producers bear recycling costs under the Extended Producer Responsibility (EPR) framework. Collected e-waste is sorted and processed locally, with hazardous components reported to authorities, such as gas extractors, to the NEA.

The company's fee structure is approved by the government, with producers bearing the recycling and disposal costs—particularly for "negative items" like refrigerators,

which are expensive to recycle. Unlike the informal “Resource Value” sector, which is profit-driven, ALBA operates within the formal sector, prioritizing compliance, environmental safety, and regulated recycling. While Singapore’s EPR framework continues to evolve, it is often compared to India's more advanced system in terms of regulatory maturity. Through its services, including doorstep collection for large appliances, ALBA plays a vital role in supporting Singapore’s circular economy and reducing environmental impact.

Key takeaways:

1. The transparency of ALBA’s process—from consumer collection to recycling by licensed facilities—ensures accountability and traceability. India can explore implementing similar systems at the city or district level with local adaptations.
2. ALBA’s public campaigns and educational efforts effectively promote responsible disposal habits. India can benefit from similar large-scale awareness initiatives to boost citizen participation in formal e-waste channels.
3. The use of smart bins with sensors and data-driven collection routes enhances operational efficiency. Integrating such technology in urban Indian areas could streamline logistics and reduce costs.
4. Obligating producers to finance recycling and retailers to accept returns, without incentives from the operator, creates a clear chain of responsibility. India’s EPR enforcement could be strengthened by applying similar non-negotiable roles.
5. ALBA’s free doorstep collection service for large appliances ensures proper handling and recycling. This approach could be piloted in Indian metros to improve collection rates for items often mishandled in the informal sector.

12. Environmental Resource Institutes (NTU)

Members visited Nanyang Technological University (NTU)

Nanyang Technological University (NTU) Singapore is a leading public research university known for its interdisciplinary innovation in areas like Energy Systems, Multi-Energy Systems, and Urban Solutions. The ERI@N team has made significant progress with projects such as Solid-State Transformers (SST) and autonomous

vehicles. A standout initiative, the Renewable Energy Integration Demonstrator – Singapore (REIDS), includes the Low Voltage Microgrid Cluster at Semakau Landfill, which supports energy transition for off-grid and urban areas.

NTU also leads major projects like the Power Offshore Island and sustainable technologies such as Cool Paint. Globally, NTU collaborates with countries like China, achieving breakthroughs like 90% methane-to-carbon conversion. In sustainability, NTU partners with SCARCE to turn e-waste into resources, including innovative methods like using fruit waste to treat batteries and advanced PCB recovery through visual and X-ray technologies. These initiatives contribute significantly to global sustainability challenges.

Key takeaways:

Expand the NTU's food-waste-to-battery-material project in India, which includes the possibility of setting up a local battery production facility. The initiative also aims to explore and develop recycling and upcycling infrastructure in the country, promoting sustainable waste management and clean energy solutions.

NTU-SCARCE Lab

Members visited NTU-SCARCE Lab

The Singapore CEA Alliance for Research in Circular Economy (SCARCE) is a collaborative lab between NTU and the French CEA, focusing on recycling technologies for lithium-ion batteries, solar panels, and printed circuit boards (PCBs). SCARCE has developed advanced sorting tools using AI and X-ray technology to enhance material recovery. Their solar panel recycling prototype achieves high-purity outputs of glass, silver, silicon, and solder through a delamination process. The lab also explores mechanical, chemical, biological, and electrochemical methods to recover valuable metals like lithium, cobalt, and nickel for reuse in batteries. These innovations offer promising solutions for global sustainability challenges, with opportunities for industry partnerships to scale up. Additionally, NTU's Energy Research Institute (ERIAN) supports clean energy initiatives including electric transport and power grid integration, advancing sustainable transport and energy technologies.

Key takeaways:

1. SCARCE's innovations in recycling lithium-ion batteries, solar panels, and e-waste offer India a model for establishing advanced recycling infrastructure. Adopting similar technologies can support India's growing clean energy and electronics sectors while reducing environmental impact.
2. The partnership between NTU and CEA highlights the value of collaboration. India can foster similar alliances between academic institutions, government bodies, and global partners to accelerate research and commercialization of circular economy solutions.
3. Techniques like using fruit waste to treat battery waste showcase creative, low-cost solutions that are highly relevant for India. These can be adapted to local conditions, supporting both sustainability goals and the development of green jobs.

13. Stewardship Asia Centre

Members visited Stewardship Asia Centre

The Stewardship Asia Centre (SAC), a non-profit founded by Temasek in Singapore, promotes values-based leadership through its concept of "Steward Leadership," which balances societal, stakeholder, generational, and environmental responsibilities. SAC's emphasis on the 21st-century challenge of "doing well by doing good" perfectly encapsulates the "Waste to Worth" philosophy. It demonstrates that financial success and positive societal/environmental impact are not mutually exclusive.

SAC offers executive education, research, and advisory services, and recently launched Stewardship Commons, a global digital platform for collaboration on ESG and sustainability. Its work includes youth programs, regional partnerships, and research into the role of corporate boards in driving sustainable change across the Asia-Pacific.

Key takeaways:

1. Steward Leadership: SAC champions leadership that creates long-term value by integrating societal and environmental responsibilities into decision-making.

2. Collaboration and Innovation: Through initiatives like Stewardship Commons, SAC fosters global knowledge-sharing on ESG, governance, and sustainability.
3. Focus on the Future: SAC invests in next-gen leadership development and board-level research to shape a more responsible, sustainable future across Asia-Pacific.

14. Sembcorp Industries Ltd.

Members visited Sembcorp Industries Ltd.

A visit to SembWaste, one of the three Public Waste Collectors (PWCs) appointed by National Environmental Agency (NEA) to collect waste from City Punggol and Clementi-Bukit Merah. Singapore is overhauling its waste management system through a multifaceted approach that addresses high labor costs, promotes recycling over incineration, and emphasizes integrated, tech-driven solutions.

Waste collection is a major trade, with operations running daily and heavily reliant on costly human capital. Despite current reliance on incineration, national efforts aim to shift public behavior and build capacity to reduce landfill use. Strategic partnerships, including cross-border collaborations and platforms like Samsara Optimus, support this transition alongside advanced infrastructure like Mona Lisa facilities. The country is also advancing Extended Producer Responsibility (EPR) schemes for e-waste, food waste, and PET bottles, with a bottle return system launching in April 2025. National goals and packaging regulations further reinforce circular economy practices. Regionally, Singapore collaborates with Malaysian companies and entities like SembWaste, whose Closed-Loop Partners Network (CLPN) fosters innovation through tools such as MONA and LISA to reduce waste and enhance recycling.

Key takeways:

1. Visiting Sembcorp provided a comprehensive understanding of how Singapore needs to expand recycling infrastructure to enhance waste diversion rates and support its circular economy goals.
2. Semakau landfill is projected to reach full capacity by around 2035. Efforts are underway to extend its lifespan through waste reduction, recycling, and exploring alternative uses for incineration bottom ash.

3. Beverage Container Return Scheme (BCRS) run by the consortium including Coca-Cola, Pokka, and F&N Foods. Singapore's decision to license a single, industry-led, not-for-profit company (BCRS Ltd.) to operate the scheme on behalf of all producers provides a clear and accountable framework.
4. The visit opened up discussions on potential collaborations, particularly in areas related to technology transfer, sustainability initiatives, and process optimization.

Way Forward

1. Singapore's WTE plants have ~25% turbine efficiency, India can collaborate on AI-driven waste and resource recovery innovations.

2. Significant CO_2 emissions from WTE plants call for CCU tech, India can co-develop low-cost CCU solutions with Singapore.

3. Large bottom ash volumes from incineration require valorisation; India can share tech to convert ash into building materials.

4. Singapore can expand EPR by including more materials and promoting eco-design, learning from India's evolving policies.

5. India can adopt smart waste management platforms like Samsara Optimus to boost efficiency and data use.

6. MoUs with NTU and Singaporean organizations can accelerate adoption of TRL 6–7 waste recovery tech in India.

7. India and Singapore can build a regional sustainability network for knowledge sharing, investments, and aligned standards.

Confederation of Indian Industry

Annexure 1

List of Mission Members- Member and Company Profiles

S. No	*Name and Details*
1	Mr Masood Mallick Chairman of the CII National Committee on Waste to Worth Technologies and MD & CEO Re-Sustainability Ltd
2	Mr Prashant Singh Vice-Chairman of the CII National Committee on Waste to Worth and Co-Founder & Chief Executive Officer Blue Planet Environmental Solutions India Pvt. Ltd
3	Mr Uma Kanth Sanghishetty Narasimhulu Head -Waste to Worth ITC Limited
4	Mr Thota Krishna Rao Senior Vice President Re-Sustainability Ltd
5	Mr Saket Dave Chief Executive Officer Wastelink
6	Mr Ramakant Burman Chairman & Managing Director Greentech Environ Management Pvt Ltd
7	Mr Subrata Bhattacharya Director Indiahub E-Governance
8	Mr Chavda Kiritkumar Kantilal HOD of design department including R&D and new product development Fornnax Technology Pvt Ltd

9	Prof Pankaj Pathak Professor SRM University AP
10	Mr Mohit Taneja Consultant Gardget Guru
11	Mr Subash Chowdary Koduri General Manager – Sustainability Re-Sustainability Ltd
12	Ms Sangeetha Sundararajan Director GeeKay Residency
13	Mr Santhosh Gandhi Director GeeKay Residency
14	Mr Amit Shirish Saste General Manager- Environment & Safety M/s City Corporation Limited
15	Mr Harsh DineshKumar Nayak Manager – Design Fornnax Technology Pvt Ltd
16	Mr Raval Nirav Chimanbhai Manager – Design Fornnax Technology Pvt Ltd
17	Dr Loganath Radhakrishnan Environmental Engineer GeeKay Residency
18	Mr Nitin Subhashchandra Jain Sales Manager Fornnax Technology Pvt Ltd
19	Mr. Rakesh Kumar Ghanshyambhai Dharajiya Team Leader – Design Fornnax Technology Pvt Ltd
20	Mr Vinay Chandrakant Shinde Solid Waste Consultant M/s Prakrriti Enterprises

21	Mr Avnish Patnaik Chief Representative and Head - Singapore Confederation of Indian Industry
22	Ms Nabanita Mukherjee Director- IPR and Waste-to-Worth Technologies Confederation of Indian Industry
23	Ms Sowjanya Adusumilli Head - GreenCo Forum and Govt relationships CII - Godrej Green Business Centre (GBC)
24	Mr Vadala Ravi Kumar Counsellor CII - Godrej Green Business Centre (GBC)
25	Ms Gargi Sharma Executive Officer- Waste to Worth Policy Initiatives Confederation of Indian Industry
26	Ms Shivani Gupta Engineer and System Expert Confederation of Indian Industry

Confederation of Indian Industry

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society, through advisory and consultative processes.

CII is a non-government, not-for-profit, industry-led and industry-managed organization, with around 9,000 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 365,000 enterprises from 294 national and regional sectoral industry bodies.

For more than 125 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. CII charts change by working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness, and business opportunities for industry through a range of specialized services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Through its dedicated Centres of Excellence and Industry competitiveness initiatives, promotion of innovation and technology adoption, and partnerships for sustainability, CII plays a transformative part in shaping the future of the nation. Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes across diverse domains including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

For 2024-25, CII has identified "Globally Competitive India: Partnerships for Sustainable and Inclusive Growth" as its Theme, prioritizing 5 key pillars. During the year, it would align its initiatives and activities to facilitate strategic actions for driving India's global competitiveness and growth through a robust and resilient Indian industry.

With 70 offices, including 12 Centres of Excellence, in India, and 8 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with about 300 counterpart organizations in almost 100 countries, CII serves as a reference point for Indian industry and the international business community.

Confederation of Indian Industry
The Mantosh Sondhi Centre
23, Institutional Area, Lodi Road, New Delhi - 110 003 (India)
T: 91 11 45771000
E: info@cii.in * **W**: www.cii.in

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Reach us via CII Membership Helpline Number: 1800-103-1244