UNITED ARAB EMIRATES
MINISTRY OF CLIMATE CHANGE
& ENVIRONMENT

tadweer group

Roland Berger

Waste to Zero

The Global Initiative for Waste Decarbonization


Waste
toZero

The Global Initiative for Waste Decarbonization

Since the launch of the Initiative at COP28, we have made remarkable progress in our mission to decarbonize the waste management value chain. The collaboration between our signatory institutions over the past months has been pivotal in developing innovative use cases that demonstrate how advanced technologies and sustainable practices can reshape the future of waste management. These efforts are not just theoretical; they represent real-world solutions that contribute to the decarbonization of key sectors, turning waste into valuable resources that can be scaled and replicated across locations.

As we look ahead to COP29, the importance of waste management in global climate action is becoming increasingly recognized. The COP29 Presidency has already outlined its "Action Agenda," with key initiatives to enhance ambition and drive action on climate. The COP29 Declaration on Reducing Methane from Organic Waste shows a bold step toward 1.5-aligned waste sector commitments. This initiative is a testament to the growing recognition of waste management as a critical component of reducing emissions, mainly methane, in global waste systems.

COP29 presents a vital opportunity for us to promote and advance the waste decarbonization agenda in front of an engaged global audience. We also aim to expand our network by welcoming additional private and public institutions into the Initiative. Together, we will continue to drive innovation in the waste management sector and contribute meaningfully to the global effort to address climate change.

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Waste to Zero, 2024 activity report

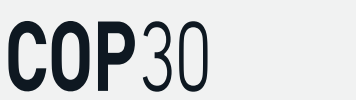
1. December 2023, Launch of Waste to Zero at COP 28

The Waste to Zero initiative was officially launched in December at COP28 in Dubai, marking a pivotal moment in the global effort to decarbonize the waste management sector. The launch ceremony took place within the COP28 Presidency Theatre, where the UAE Ministry of Climate Change and Environment, Her Excellency Mariam bint Mohammed Saeed Hareb Almheiri, officially endorsed the Initiative, demonstrating the UAE's leadership and commitment to climate action.

The event drew a high-profile audience, with the participation of key global leaders from governments, international organizations, waste management companies, and NGOs, all united in support of this critical mission. The Waste to Zero roadmap was unveiled during the launch, outlining clear, actionable steps for decarbonizing the waste sector and addressing its significant contribution to global greenhouse gas (GHG) emissions. In addition, ~50 public and private institutions formally signed the initiative, underscoring the broad, cross-sectoral collaboration required to achieve its ambitious goals.

Following the event, the UAE Cabinet, led by the Prime Minister, officially recognized Waste to Zero as one of the key environmental initiatives supporting the nation's decarbonization roadmap. This endorsement further solidified the initiative's role in driving progress toward the UAE's and global climate goals, aligning with the COP28 implementation pillar focused on prioritizing lives and livelihoods within climate action.

Waste to Zero roadmap



- Announce the Initiative and ambitions
- Reveal the 1st supporting institutions
- Activate the working streams

- Present the 1st annual report
- Introduce the pipeline of bankable & decarbonization projects

- Present the 1st global baselining of the sector's greenhouse gas emissions
- Propose an industry-backed pathway for decarbonization
- Announce 1st projects launch
- Enlarge funding & coalition

2. March 2024, Working streams workshops and development of use-case

As part of the Initiative roadmap for COP29, the signatory institutions were convened in early 2024 to activate the working groups. A series of **five workshops was conducted to present the themes across the working streams.** Following the workshops, the Waste to Zero team invited the institutions to brainstorm and **propose use-cases related to the decarbonization of the waste management** sector according to three criteria: existing technology and concrete application, alignment with the core expertise of the institution, and finally, scalability of the solutions.

We received over 25 propositions of use-cases, went through a review and shortlisting process, and submitted a list of ~15 use-cases for a final vote from the institutions. In the end, we have retained **eight use-cases for development and presentation at COP29 to the broader public.**

Workstream 2: Securing and upgrading WM infrastructure for landfill diversion

- An AI-powered platform supporting the collection and recycling of e-waste (Waste-to-En)
- A decentralized e-waste and battery recycling facility for enhanced waste treatment (Ecyclex)

Workstream 3: Unlocking the potential of new waste management technologies

- A recycling process for unwashed/unsegregated waste through advanced treatment technology (Terrax Environmental Limited)
- A waste collection at the source through advanced data analytic systems supporting the identification of valorization opportunities (AESG)
- A smart chute system and automatic waste sorting system for improvement of community waste collection (Cleantech Hub Grounds)

Workstream 4: Decarbonizing waste operations and logistics

- A valorization system of hard-to-recycle items into multi-purpose raw materials supporting existing recycling infrastructures.
- A construction & demolition waste recycling plant powered by renewable energy sources, i.e., solar (Tadweer Group)

Workstream 5: Enabling and tracking impact through data and digital solutions

- A versatile and scalable tool supporting decision-making through extensive data collection (UN-Habitat)
- An incentive-based deposit system enhancing the collection of recyclables (Recapp Veolia)

Waste to Zero

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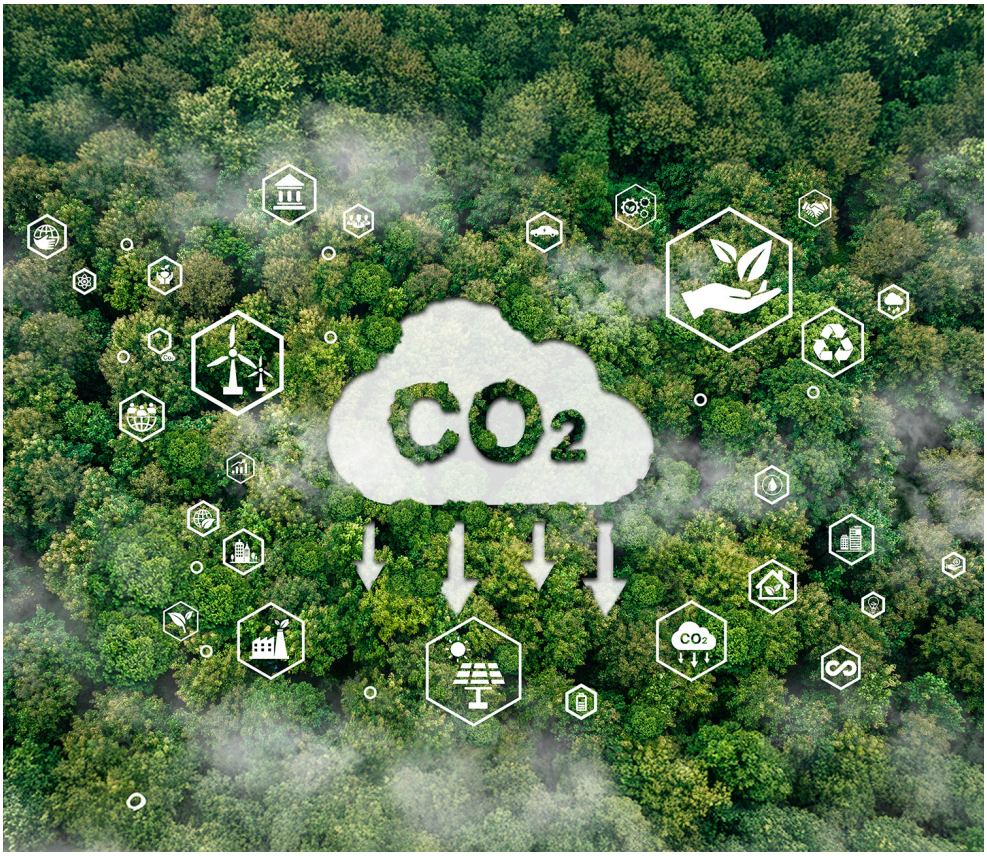
Waste management, a scalable solution for decarbonization

1.Unprecedented waste generation and poor management

Waste generation has reached unprecedented levels globally, with **approximately 2.1 bn tons of municipal solid waste (MSW) produced each year out of a total of ~18 bn tons of solid waste.**[2] This figure is expected to rise by more than 50% by 2050, mainly due to increasing industrialization, urbanization, and population growth. Overall, **almost 50%[3] of the waste is mismanaged,** i.e., sent to open landfills or disposed of through open burning, mainly in emerging or underdeveloped countries.

The inadequacies in global waste management disproportionately affect low- and middle-income countries. In regions such as Sub-Saharan Africa, waste generation is estimated at ~150 kg/person/year, compared to North America's ~850 kg/person/year. In addition to the waste generation figure, country development will also impact the nature of the waste, the magnitude of emissions, and the associated risks. For instance, developing countries tend to generate higher levels of organic waste (40% to 80%), which when poorly managed, exacerbates methane emissions—a potent greenhouse gas.



Therefore, waste management needs to be considered globally, as highlighted by the scope and ambitions of the Waste to Zero Initiative.

2. Sector contribution to greenhouse gas emissions

The role played by the waste management sector in climate change has often been overlooked across governments and international discussions. In **2020, the sector accounted for 1.65 bn tons of CO2 equivalent,[5] representing around 3.5% of global emissions. Methane emissions from waste alone represent 20% of global methane emissions.**[6] By comparison, aviation, which has been traditionally the focus of attention, represents 2.5% of total CO2 emissions.

Organic waste, when left to decompose anaerobically in landfills, produces methane, a greenhouse gas that is 25 times more potent than CO2 over a period of 100 years. Open burning, prevalent in developing regions, releases not only CO2 but also black carbon, further exacerbating global warming.

2 World Economic Forum (2022), This is how cities can reduce emissions with waste-reduction solution
3 World Bank Group (2018), What a waste 2.0 report
4 UNEP (2024), Global Waste Management Outlook- Beyond an age of waste: Turning Rubbish into a Resource
5 OurWorldinData (2020)
6 World Economic Forum (2022), This is how cities can reduce emissions with waste-reduction solution

The waste sector's contribution to GHG emissions might appear modest, but its mitigation potential is significant. Given its relatively low-cost interventions and high-impact solutions, reducing waste-related emissions—primarily methane—can provide significant short-term gains in combating climate change.

Yet the potential for decarbonizing the waste sector is undermined today by the challenges of drawing an accurate baseline for global total solid waste generation.

3. Assessment of GHG emissions and limits

Establishing a robust baseline for GHG emissions in the waste management sector is essential for driving targeted mitigation strategies. **A solid baseline provides the necessary foundation for understanding emission sources and setting reduction targets.** Tracking progress or implementing effective reduction measures becomes difficult without accurate data and assessment models.

Various models are available for assessing GHG emissions, each with advantages and limitations. The most used model for national-level GHG reporting is the IPCC Guidelines for National Greenhouse Gas Inventories (2006). While the IPCC method forms the backbone for national reporting, various other models have been developed for organizational and corporate GHG reporting. Life-cycle assessment (LCA) models such as US EPA WARM are frameworks designed for municipal, corporate, or facility-level assessments. These methods can provide a more granular analysis of GHG emissions across the entire life cycle of products and waste streams, considering emissions from raw material extraction to disposal and recycling.

Even though the accuracy of these assessments is often limited by data availability (especially across all the waste streams/countries), transparency, and standardization, efforts have been conducted to fill the gaps and offer a more accurate and recent overview of the total GHG emissions generated across the waste sector.

The Waste to Zero Initiative strives to collaborate with public and private institutions worldwide to establish a global baseline of the emissions generated across the solid waste value chain.

4. GHG emissions reduction across the waste value chain

Reducing GHG emissions in the waste sector requires a multifaceted approach, addressing emissions across the entire value chain—from waste generation to disposal, resource recovery, and operational decarbonization. Below are the key levers that can be activated to achieve significant emissions reductions.

Reducing waste generation

The most effective way to reduce emissions is to prevent the generation of waste in the first place. Strategies include circular economy practices, i.e. encouraging product design

for durability, reuse, and recyclability, consumer education, and behavioral change, such as raising awareness on practices such as waste minimization, recycling, and composting.

Upgrading basic infrastructure

In multiple regions, waste management systems are either underdeveloped or outdated, leading to significant emissions from open burning, landfills, and inefficient collection systems. Upgrading basic infrastructure is critical to addressing these issues, and best practices include expanding waste collection services, developing engineered landfills, improving recycling and composting facilities to handle organic waste and, divert biodegradable materials from landfills, and reducing methane emissions.

Transforming waste into resources

In addition to the basic waste management infrastructure, best-in-class countries in waste management leverage advanced technologies to convert waste into valuable resources and simultaneously drive down GHG emissions. New waste-to-energy technologies such as waste-to-hydrogen, waste-to-SAF, and methane-to-graphene are co-developed and tested as a result of collaboration between technology providers, large waste management companies, and other parties (e.g. an example of the consortium with Tadweer Group, Etihad Airways, Masdar, BP, ADNOC).

Decarbonizing waste management operations
Waste management activities such as transportation and treatment are energy-intensive and often rely on fossil fuels. Decarbonizing these operations can further reduce emissions and play a pivotal role in changing the sector. Key levers include optimizing fuel use (e.g., improving waste collection routes), electrification of fleets, and switching to renewable energies (e.g. solar, wind) to power facilities.

Tracking and monitoring technologies
Accurate tracking and monitoring are essential for quantifying the impact of waste management strategies and ensuring transparency in emissions reporting. Digital waste tracking systems such as smart sensors, IoT, and AI solutions enable real-time monitoring of waste collection, sorting, and treatment while providing valuable data for optimizing operations and emissions reporting.

The Waste to Zero Initiative seeks to comprehensively address the above levers and develop tangible solutions that support the sector's decarbonization.

5. International initiatives and COP Frameworks

The waste sector's increased recognition on the international stage has been driven by high-profile initiatives and milestones from recent COP meetings. T**he 2021 Global Methane Pledge**, introduced at COP26 in Glasgow, was a landmark moment for the sector. With over 111 countries signing the pledge, the goal was to reduce methane emissions by 30% by 2030.

At COP27 in Sharm El Sheikh (Egypt), waste management became a focus through the **Marrakech Partnership for Global Climate Action,** emphasizing the need to reduce and valorize waste, particularly in Africa. T**he 50 by 2050 Initiative**, led by the Ministry of Environment of Egypt, targets bringing the recycling rate from 5% to 50% across the continent by 2050.

COP28 in Dubai (UAE) further highlighted waste management as a key climate action lever with the launch of the **Waste to Zero Initiative**. This COP also featured the first-ever **Waste and Resources Pavilion**, spotlighting sustainable waste management's critical role in achieving climate and SDG targets.

Across the COP editions, waste management has gained momentum and achieved greater recognition from the international community.

Selected use cases for a global impact: The section below covers the use-cases developed by the signatory institutions to the Initiative on the decarbonization of waste management.

Working stream #2: Securing and upgrading WM infrastructure for landfill diversion

Use-case: An AI-powered platform supporting the collection and recycling of e-waste (Waste-to-En)

1. Description:

An AI-based platform has been developed to streamline e-waste collection and recycling by directly connecting consumers with recycling points. The process operates as follows:

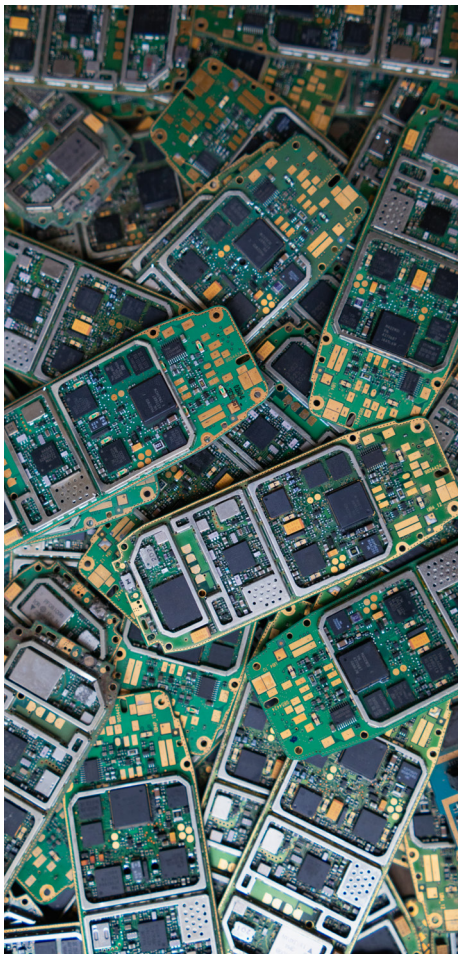
Firstly, users submit photographs of items they intend to recycle, and the platform directs them to the nearest collection point. After the waste is deposited in the appropriate bin, the user is rewarded with a digital incentive, such as discount vouchers, cashback, or credits that can be redeemed for various products and services.

Secondly, the collected e-waste is processed locally using a small-scale gasification unit, which converts the waste into synthesis gas and slag-containing precious metals. The synthesis gas is then used to generate electricity for internal purposes, while the slag is sold to metal refineries for further processing.

2. Impact on the waste management value chain:

This initiative is expected to increase e-waste recycling rates and reduce landfilling. It also improves e-waste data tracking for sustainability metrics. It supports circularity through innovative recycling technology, digital and financial incentives, and robust data collection.

In 2023, the world generated approximately 54 million metric tons of e-waste, a figure expected to rise to 74 million metric tons by 2030. Only 17% of e-waste is formally recycled, leaving the majority improperly disposed of or incinerated, leading to toxic emissions and contamination.



E-waste is challenging to recycle due to the complex mixture of materials, including metals, plastics, and glass, which are often tightly bound together in devices. Traditional recycling methods are inefficient and energy-intensive, requiring significant labor to separate components and recover materials.

Gasification technology helps to process a significant part of e-waste. Gasification is an advanced thermo-chemical process that converts carbon-containing waste into synthesis gas (syngas) and solid residues (slag) through high-temperature reactions. The process involves pyrolysis, cracking of tars, and partial oxidation of the waste material in a controlled environment. The process is self-sustaining, using the energy contained in the waste to power the gasification reactions. Gasification units can be designed to operate on a small scale, allowing for on-site deployment.

Small household electronics (SHE), such as smartphones,

laptops, printers/cartridges, remote controls, routers, and small kitchen appliances are the most suitable e-waste fraction for gasification.

The reasons to focus on this fraction are the following:

- It is possible to collect this waste with an AI-based system: it is abundant (from 4 to 7 kilograms per person per annum in developed countries), easy to recognize, and easy to transport to collection points.
- Difficulty in recycling using conventional methods due to their small size and complex multi-material design.
- They contain many carbon-containing materials, i.e., suitable for gasification: plastics, epoxy resin, textiles in circuit boards, etc.
- Contain a high concentration of precious metals.

Globally, SHE accounts for approximately 22.5 million metric tons of e-waste annually, or **about half of all e-waste produced.**

SHE contains significant quantities of precious metals such as gold, silver, palladium, and copper. The gasification process could extract these metals in the form of enriched slag. This slag can be sold to metal refiners for further processing.

Based on the prevailing market prices, the value of precious metals per ton of e-waste processed via gasification is estimated at $1,420.

One gasification unit can process about 1 ton of e-waste per day, generating about 200 kg of precious metal-containing slag, containing about 100 kilograms of precious metals that could be sold in the market.

3. International examples:

The prototype system is implemented in Dubai, UAE.

Step 1: Users submit a photo of the item they want to recycle through the platform.

Step 2: The system identifies the type of waste and directs the user to the nearest collection point.

Step 3: The user deposits the item in the correct bin at the collection point.

Step 4: The user is rewarded with digital incentives.

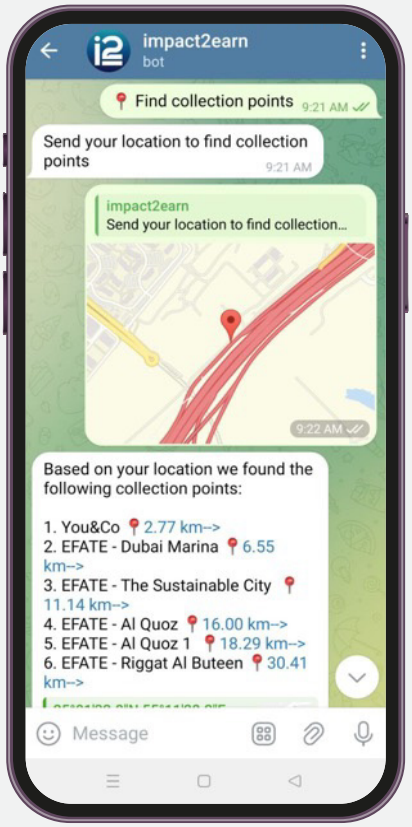
Step 5: Gasification. Waste undergoes thermo-chemical processes (e.g., drying, pyrolysis, cracking, oxidation of carbon) and is transformed into synthesis gas. The gas is then used as fuel in a standard internal combustion engine to generate electricity. No external energy source is required; all processes are powered by the energy contained in the waste itself. The metal-rich slag is later sold to metal refineries for further processing.

4. Key success factors for international expansion:

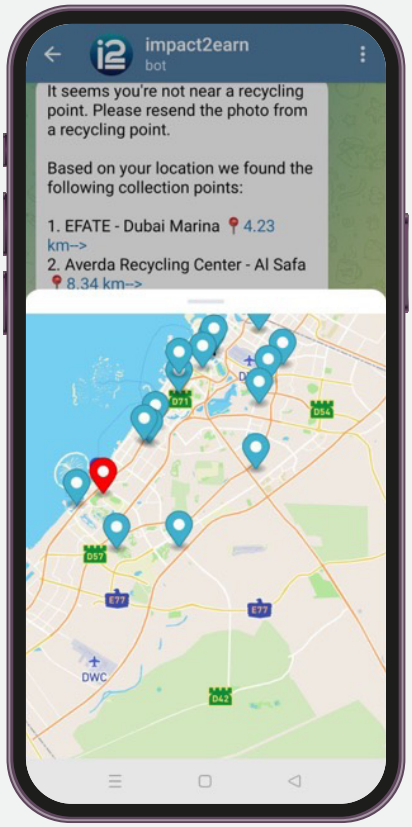
Significant government support is needed to distribute these innovative technologies worldwide, mainly in the form of policies mandating the proper disposal and advanced thermo-chemical recycling of e-waste, with support for innovative recycling technologies.
Other critical success factors are:

- **Public awareness:** Educating consumers and businesses about the benefits of separate e-waste collection and gasification for e-waste recycling.
- **Technological adaptation:** Continuous improvement and adaptation of the e-waste recognition and gasification technology to process different types of e-waste.
- **Scalability:** Developing scalable gasification units that can be adapted to different market sizes and geographic locations.
- **Financing:** Providing financing for research and development in e-waste recognition and gasification.

Visual showcase

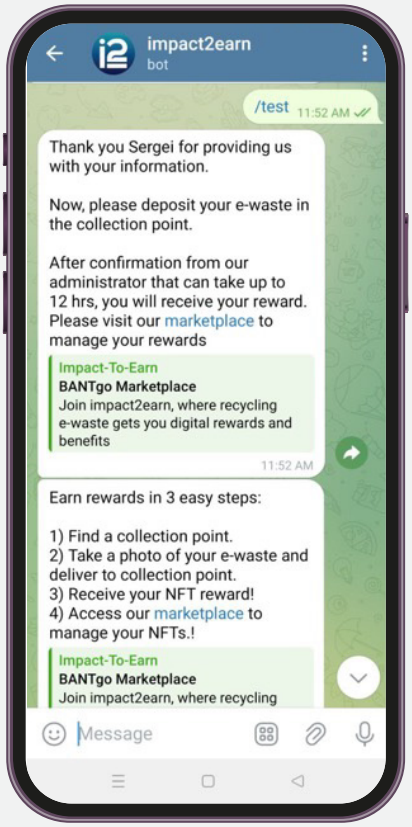


Picture 1:
Provide your location

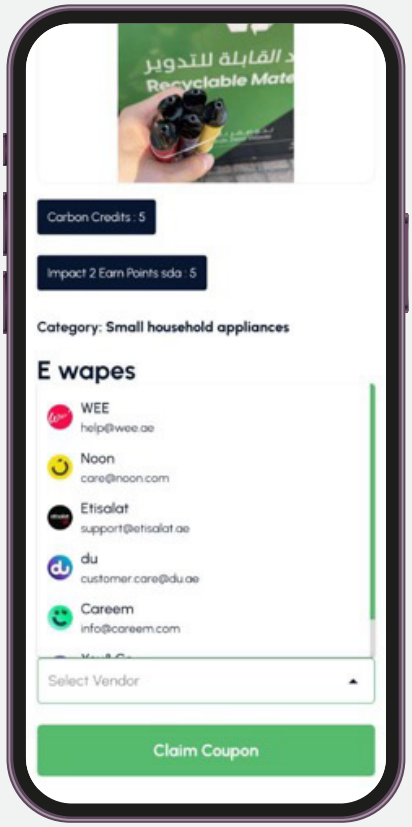


Picture 2:
Select the nearest SHE recycling collection point

Picture 3:
Describe your e-waste item and confirm the act of collection



Picture 4:
Receive collection confirmation



Picture 5:
Obtain a reward

Picture 6:
Gasification unit

Working stream #2: Securing and upgrading WM infrastructure for landfill diversion

Use-case: A decentralized e-waste and battery recycling facility for enhanced waste treatment (Ecyclex)

1. Description:

Decentralized facilities for recycling e-waste & batteries, tackling the challenges faced by large-scale facilities.

Dependence on large-scale equipment/facilities: The global recycling rate for e-waste and batteries is less than 20%, largely due to the traditional reliance on large-scale recycling facilities. These are **capital and operationally intensive,** requiring tens of millions of USD to establish and demand consistent feedstock volumes of 30,000 tons or more annually.

Evolving nature of material: Another challenge is the **rapid evolution** of e-waste and batteries. Traditional recycling facilities primarily handle IT, telecom, and electrical appliances, but new, **complex materials are being introduced at a fast pace,** including lithium-ion batteries, smart devices, wearable electronics, solar panels, and e-cigarettes/vapes, which standard facilities cannot always process.

Strict movement regulations: Many countries, including China and India, have **banned the importation of e-waste and batteries,** leading to the need for smaller local recycling hubs. Even when transboundary movement is allowed, it must comply with strict environmental regulations under the Basel Convention, which adds time (6-9 months for permits) and cost to the process.

2. Impact on the waste management value chain:

The impact on the waste management value chain is significant, particularly regarding waste reduction and landfill diversion of hazardous e-waste and batteries. These materials often go unnoticed and contribute up to **70% of landfill toxins.** By diverting these streams, environmental harm can be mitigated, and value can also be generated from the waste.

Studies show that in the USA and the UK, around **1,800 fires and explosions occur annually due to improperly discarded e-waste and batteries,** each costing approximately USD 500,000 in damages. Moreover, recycling e-waste and batteries can yield economic benefits, as a ton is estimated to generate around USD 500 in value. This underscores the importance of addressing e-waste as an environmental and economic opportunity.

3. International examples:

- Ecyclex Dubai facility: processing capacity of 12,000 tons annually.
- Ecyclex Abu Dhabi facility: processing capacity of 15,000 tons annually.
- Ecyclex Sharjah facility: processing capacity of 8,000 tons annually.

These facilities adopted the decentralized approach and proved profitable while tackling all the above challenges. Implementing decentralized facilities requires a **CAPEX that can usually be 10-15% that of large-scale facilities**, with the benefits of modularity and access to smaller markets and areas in which e-waste & batteries are still not appropriately tackled.

4. Key success factors for international expansion:

- **Proven business model:** The approach has demonstrated its ability to generate value while addressing the challenges of e-waste recycling.
- **Lean operational model:** Its streamlined processes minimize operational costs and complexity, making it more efficient.
- **Modular recycling machinery:** The equipment's modular nature allows for flexible scaling and customization based on local needs.
- **Compliance with local regulations:** The system can be adapted to meet local regulatory requirements, ensuring smooth and lawful operation.
- **Minimal population requirement:** Unlike large-scale facilities that require a population base of at least 20 million to supply feedstock, this technology can operate effectively in cities with populations as low as 2 million.

Working stream #3: Unlocking the potential of new waste management technologies

Use-case: A recycling process for unwashed and unsegregated waste (e.g., plastics, fibers) through advanced treatment technology (Terrax Environmental Limited)

1. Description:

Terrax is a technology that enables **processing unsegregated and unwashed plastic and organic waste into a unique compound** that can be processed into products to replace virgin materials in the construction, logistics, and events industries.

2. Impact on the waste management value chain:

Landfill Diversion: Recycles traditionally non-recycled waste like multi-layer packaging, composites, and textiles, reducing landfill volumes.

Local Waste Utilization: Uses locally available waste to minimize transportation emissions and reliance on imported resources.

Production of High-Value Products: Converts waste into products like plywood replacement sheets, building materials, and pallets, reducing deforestation.

Water and Resource Conservation: Eliminates the need to wash materials, saving water and preventing contamination.

Circular Economy Contribution: Products made from the Terrax compound can be recycled back into the same compound, promoting sustainability.

3. International examples:

- **Abu Dhabi Project:** Joint venture with the Abu Dhabi National Exhibition Center to develop TerraTile—the world's first 100% recycled and recyclable raised exhibition flooring made from exhibition waste.
- **Partnerships:** Exploring collaborations with companies like BantGo for intelligent waste sorting systems and Waste-to-En for alternative energy solutions.

4. Key success factors for international expansion:

- **Proven technology:** It is already in use at five facilities worldwide, demonstrating its reliability and effectiveness.
- **Profitability:** Offers a viable, cost-effective alternative to traditional waste disposal methods.
- **Versatility:** Capable of handling hard-to-recycle and ordinarily unrecyclable waste streams, filling a critical gap in waste management.

Working stream #4: Decarbonizing waste operations and logistics

Use-case: Utilization of renewable energy (i.e., solar) to power Construction & Demolition Waste recycling plant supporting landfill diversion.

Description:
Tadweer Group's construction and demolition recycling technology, powered by solar renewable energy, enables the recycling of this material to divert it from landfills.

Tadweer Group uses crushing equipment to recycle materials like concrete and asphalt. For example, concrete waste is processed into gravel for roads or repurposed into new concrete, while larger chunks are converted into riprap to protect shorelines.

In 2022, **global power generation from solar PV** surged by 270 TWh, a **26% increase from 2021.** The share of electricity generated from solar energy rose from 0.15% in 2010 to 4.55% in 2022, making solar PV the third-largest renewable electricity technology after hydropower and wind.

Tadweer Groups's Abu Dhabi crushing plant, located in Al Dafra, **integrates solar renewable energy in alignment with the UAE's Green Agenda 2030 and Net Zero Strategy 2050.** With a solar PV generation facility of 752 kWp, **the plant sources 80%- 90% of its energy from solar power. This setup reduces carbon emissions by 6,164 tons of CO2 annually, equivalent to planting 102,733 trees, and conserves 2.3 million litres** of diesel fuel annually.

2. Impact on the waste management value chain:

The Abu Dhabi crushing plant is vital in minimizing landfill waste and advancing **Tadweer Groups's goal of diverting 80% of landfill waste by 2030.**
Environmental Benefits

Utilizing **solar energy** at the Abu Dhabi crushing plant has significantly **reduced reliance on non-renewable sources,** decreasing the environmental footprint and air pollution by replacing diesel-operated machinery with cleaner energy.

Economic Benefits:
The plant's transition to solar power has led to substantial reductions in operational and maintenance costs, moving away from **annual expenses equivalent to 2.3 million litres of diesel fuel,** resulting in significant savings.

Social and Community Benefits
Adopting renewable energy has created job opportunities and increased awareness of clean energy practices in the community. The shift to solar power enhances employment in installation and maintenance and fosters an understanding of sustainability, contributing to a cleaner, healthier environment.

Considerations and Challenges
Integrating renewable energy into waste management facilities involves considerations such as initial investments and space requirements. Upfront installation costs can be significant, and securing adequate space for solar panels can be challenging, especially in densely populated facilities. Addressing these factors is crucial for a successful transition to cleaner energy solutions.

3. International examples:

Oman: Solar-Powered Waste Management and Recycling Facilities

Project Lead Institution: Oman Environmental Services Holding Company (Be'ah)

Highlights:

- **Installed Capacity:** Solar panels have been installed at Be'ah's waste management facilities across Oman, supporting the country's goals of increas-

- ing renewable energy use.
- **Solar Impact:** The use of solar energy helps reduce operational costs and the environmental footprint of waste management activities. It supports Oman's National Energy Strategy 2040, which aims to achieve 30% renewable energy.
- **Sustainability Goals:** Advances Oman's efforts to incorporate renewable energy into essential services, improving waste management practices and reducing greenhouse gas emissions.

Main Outcome(s): Supports efficient waste management through renewable energy, reduces reliance on fossil fuels, and aligns with national sustainability and energy diversification goals.

Potential Challenges: High initial investment costs, ongoing maintenance requirements, and integration with existing waste processing systems.

India: Solar Energy for Circular Economy in Waste Management

Project Lead Institution: Council on Energy, Environment & Water (CEEW)

Highlights:

- Installed Capacity: India's installed solar capacity of 66.7 gigawatts (GW) as of FY23 has generated about 100 k tons of cumulative waste, projected to increase to 340 k tons by 2030.

- Around 67% of this waste will be generated in Rajasthan, Gujarat, Karnataka (50% of waste generation by 2030), Tamil Nadu, and Andhra Pradesh.
- By 2030, India will generate around 600 kt of cumulative waste from existing and new capacities. This volume is expected to increase 32 times by 2050, resulting in about 19,000 kt of cumulative waste.

Main Outcome(s): Promotes the use of solar energy to power waste management systems, thereby improving efficiency and reducing the carbon footprint of waste disposal. Supports India's transition towards a circular economy.

Potential Challenges: Implementation costs, infrastructure development, and integrating solar energy into existing waste management systems.

United Arab Emirates (UAE): Be'ah Waste Management Complex

Project Lead Institution: Be'ah

Highlights: Be'ah operates a cutting-edge construction and demolition (C&D) waste recycling facility. This facility includes a solar-powered crushing plant that processes C&D waste into recycled aggregates.

Main Outcome(s): The facility reduces landfill use and conserves natural resources by turning C&D waste into usable aggregates for new construction projects. It supports the UAE's sustainability and circular economy goals.

Potential Challenges: Ensuring consistent solar energy supply and maintaining efficient processing operations.

4. Key success factors for international expansion:

Proven Technology

Reliability and Efficiency: Ensure the solar technology used is proven to be reliable and efficient in various environmental conditions. This includes demonstrating successful deployment in different climates and operational contexts.

Certification and Standards: Adhere to international standards and obtain relevant certifications (e.g., ISO, CE) to build trust and credibility in new markets.

Track Record: Showcase a solid track record of successful projects and deployments in existing markets. This includes case studies, testimonials, and performance data.

High Scalability and Adaptation

- **Modular Design:** Develop scalable solutions that can easily adapt to different sizes and types of C&D waste operations. This helps in addressing varying market demands and operational scales.
- **Local Adaptation:** Adapt the technology to local conditions, including weather, waste types, and regulatory requirements. Customization may be necessary to fit local needs and improve adoption rates.
- **Integration Capabilities:** Ensure the system can integrate seamlessly with existing waste management infrastructure and processes.

Investor Attractiveness

Financial Viability: Present a clear and compelling business model that demonstrates strong financial returns and long-term sustainability. This includes cost-benefit analyses, projected ROI, and risk assessments.
Market Potential: Provide detailed market research and analysis showing the potential for growth and profitability in target international markets. Highlight any existing demand for solar-powered waste management solutions.

Regulatory Compliance and Policy Alignment

Local Regulations: Understand and comply with local regulations related to waste management, solar energy, and environmental impact. Navigate permitting processes and adhere to legal requirements in each market.

Government Incentives: Explore and leverage government incentives and subsidies for renewable energy projects. These can provide financial support and enhance the attractiveness of your solutions.

Working stream #5: Enabling and tracking impact through data and digital solutions

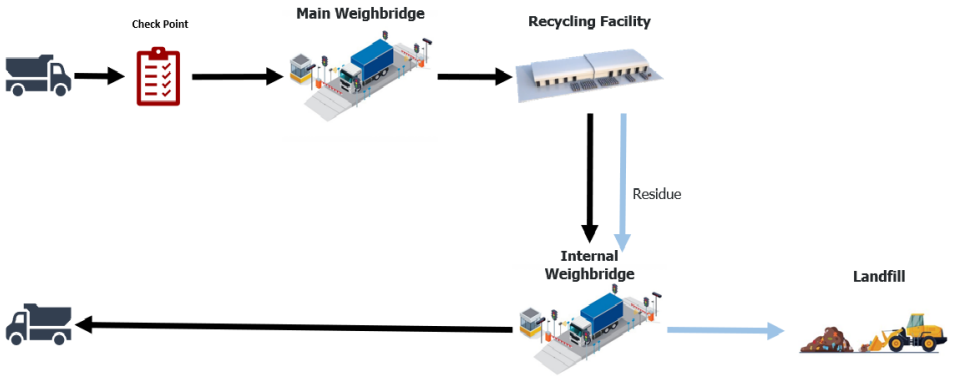
Use-case: Versatile and scalable tool supporting decision-making through extensive data collection (UN-Habitat/Bee'ah)

1. Description:

Recycling BI is a new digital solution for smarter waste management and recycling. Harnessing the power of data at every stage of the waste management recycling value chain. Enabling better business decisions for the recycling industry while increasing material recovery and accelerating the circular economy. Capturing data as trucks collect waste and reach the weighbridge. Tracking data with custom parameters on what types of waste enter your facility. Enhancing visibility on material recovery rates to identify new efficiencies and additional revenue streams. Consolidating insights across business through automated reporting, giving high-level overviews and detailed insights to help optimize operations.

2. Impact on the waste management value chain:

In the waste management industry, valuable data lies at every stage of the value chain, from the point of waste generation to recycling and disposal. This data was developed, tried, and tested at Beah's award-winning waste management complex.
Recycling BI is flexible in terms of scalability. It can be implemented for a single project, a full complex, or a whole city, and it can also be implemented on a national scale.
Recycling BI can be tailored to be implemented to achieve the following benefits:



Waste Data Classification - Consultation to classify waste types, set targets, and identify parameters:

- Help achieve organizational targets & vision.
- Study & analyze different waste types to build a waste data structure.
- Identify data fields required for digital tracking.
- Develop a waste database.

Turnkey weighbridge solutions Capture and record all waste generation or disposal data, to track progress against targets:

- Deploy weighing systems, sensors, & tools.
- Commission weighbridge system.
- Develop standard operating procedures.
- Provide operation and maintenance services.

Reporting and Automation - Get real-time insights and generate reports automatically on the parameters that matter:

- Create an automated custom report.
- Enable live data reporting and analysis.
- Build live dashboards to monitor identified KPIs.
- Support on requirements to develop new reporting features.

3. International examples:

Recycling BI is being increasingly adopted worldwide, with organizations leveraging data to improve their waste management and recycling practices, optimize operations, reduce costs, and enhance sustainability.

Below are some international examples of Recycling BI:

1. Beeah (UAE)

- **BI Application:** Beeah uses real-time data from sensors, smart bins, a weighbridge network, and GPS-enabled waste collection trucks to optimize operations, reduce fuel consumption, and improve material recovery.
- **Outcome:** BEEAH has achieved 90% landfill waste diversion in Sharjah, the highest in the region, thanks to having Recycling BI among the technological innovations used. This is hoping to accelerate the circular economy and contribute to the city's goal of zero waste to landfill by 2025.

2. Recology (United States)

- **Overview:** Recology, a San Francisco-based waste management company, uses BI tools to manage recycling and waste collection in the city and surrounding areas. Their system helps track waste generation, collection routes, recycling rates, and resource recovery efficiency.
- **BI Application:** They use data analytics to monitor waste diversion from landfills and optimize the recycling processes. The system also provides insights into the types of waste being generated, helping to design public awareness campaigns and inform policy decisions.

Outcome: San Francisco has one of the highest recycling rates in the United States, with over 80% of its waste being diverted from landfills. Recology's data-driven approach has been instrumental in achieving this milestone.

3. Waste and Resources Action Programme (WRAP) (UK)

- **Overview:** WRAP is a UK-based non-profit that uses BI tools to provide data-driven insights into waste management, recycling, and sustainability initiatives.
- **BI Application:** WRAP collects and analyzes data on material flows, recycling rates, and the environmental impact of waste management processes.
- The insights are used to develop national recycling strategies and support businesses in improving their waste management practices.
- **Outcome:** WRAP's BI system has helped the UK significantly reduce waste sent to landfills and improve recycling rates, particularly for materials like plastic and food waste.

4. Key success factors for international expansion:

Local Partnerships: Establishing solid collaborations with local stakeholders is essential for effective implementation and community acceptance. Partnerships enhance market entry and operational success.

- **Regulatory Compliance:** Ensuring adherence to local regulations is critical to mitigate risks and maintain operational integrity. This includes navigating diverse regulatory frameworks across different regions.
- **Financial and Environmental Benefits:** Demonstrating clear financial advantages and positive environmental outcomes is vital for gaining support from municipalities and investors. Case studies from successful implementations, such as Beeah in the UAE and Recology in the U.S., strongly endorse these benefits.
- **Scalability and Flexibility:** The ability to scale operations and adapt to various market conditions enhances Recycling BI's

- attractiveness. The technology is designed to integrate seamlessly with existing waste management systems, including fleet management and recycling facility software.
- **Advanced Data Analytics:** Recycling BI leverages real-time data analytics capabilities to optimize waste management operations, track waste flows, and improve recycling rates. Tools like sensor networks, IoT integration, and cloud-based systems contribute to operational efficiency and reliability.
- **Proven Track Record:** A history of measurable outcomes, such as increased recycling rates and reduced landfill use, enhances Recycling BI's appeal to investors focused on sustainable technologies.

- **Alignment with Global Sustainability Trends:** The technology's adaptability to diverse markets, coupled with its alignment with global sustainability goals, positions Recycling BI as a compelling investment opportunity, particularly for investors targeting green technologies and scalable business models.

Working stream #5: Enabling and tracking impact through data and digital solutions

Use-case: Incentive-based deposit system enhancing collection of recyclables (Recapp Veolia)

1. **Description:**

Implementation of **Smart Recycling Stations** providing deposit solutions of mixed recyclables through a digital application enabling the tracking of users, users' waste consumption, tonnage collected, and usage frequency, rewarding households and consumers with a cash system and diverting waste from landfills while promoting more awareness on the importance of segregation at source to improve the collection rate of recyclables in a country significantly.

The Recapp Digital App already has more than 30,000 households, and 100,000+ users are registered who can either request a collection of their packaging at home or use one of the drop-off machines such as RVMs or Smart Machines. Smart boxes provide digital rewards with more than 20 reward retail partners and Smart Recycling Stations with a cash reward through Careem Pay app.

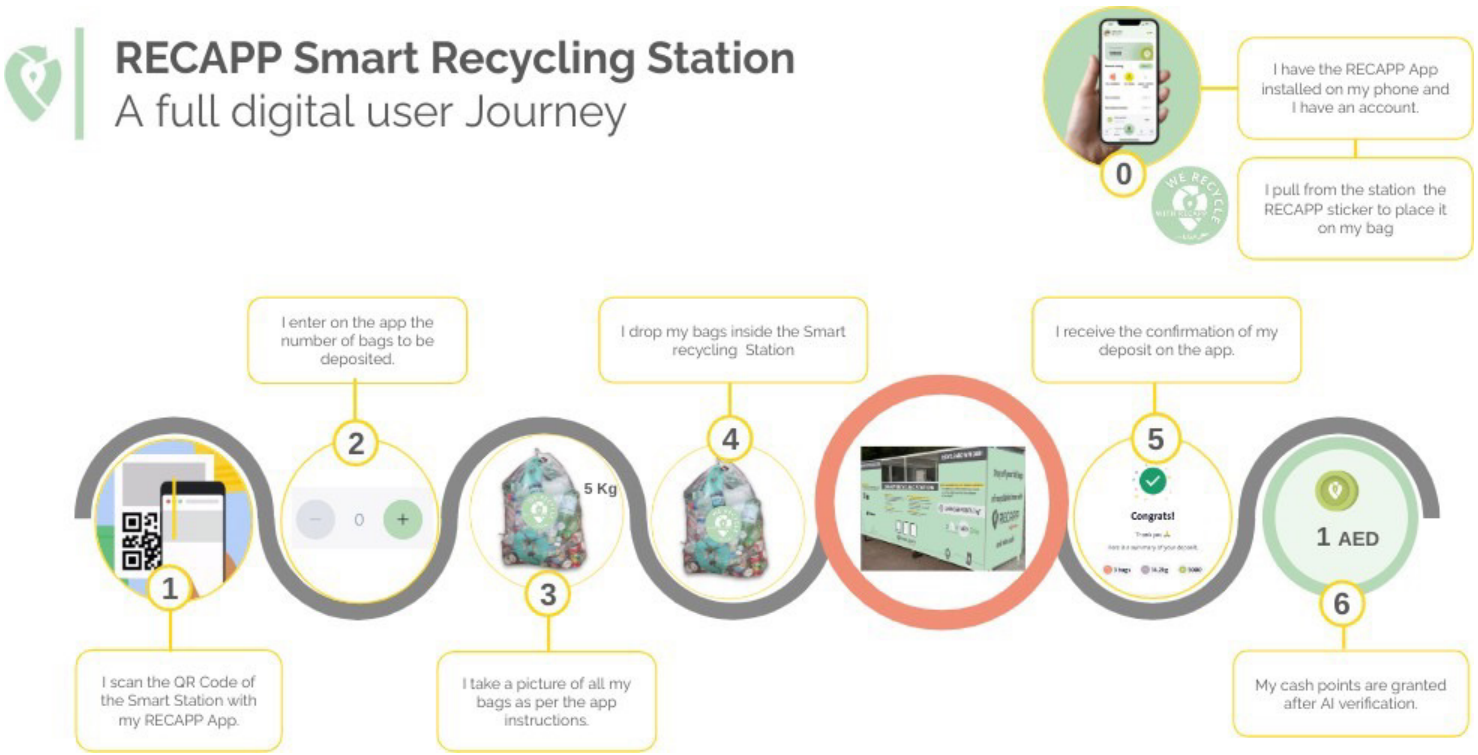
2. Impact on the waste management value chain:

By sorting and baling collected recyclables and selling them to organizations that recover the materials, RECAPP actively closes plastic loops and supports the local circular economy. This approach promotes sustainability and demonstrates an interesting twist in generating revenue by selling recyclable materials.

The RECAPP app allows users to track and measure how their recycling efforts positively impact the environment. Users are provided with an interactive and valuable perspective of how much waste they have recycled over time and can compare it with the amount of CO2 reduced in the environment.

The initiative has successfully collected more than 2,500 tons of recyclables. RECAPP has established partnerships with 22 reward partners, and users have been rewarded with 1250,000 vouchers. Moreover, the initiative has contributed to reducing 4,000 tons of CO2 emissions.

RECAPP solutions have demonstrated the importance of awareness with the impressive commitment of



the UAE communities who have made significant efforts in their environmental behaviors, such as starting to provide only 1.7 Kg of recyclables per session in 2021 to 6.3 Kg in 2024, segregating their packaging as new learners with 17% of mistakes to less than 4% of rejection recognized in their waste bags.

3. International examples:

The service has been successfully implemented in the UAE, specifically in the emirates of **Abu Dhabi and Dubai.**

RECAPP is endorsed by **the Ministry of Climate Change and Environment (MOCCAE) and the Environment Agency of Abu Dhabi (EAD),** alongside significant food and beverage industry players, including **Al Ain Water, Rainbow, and Nestlé.** Additionally, RECAPP received support from prominent local **industrial entities such as Emirates Global Aluminium and Borouge.**

However, RECAPP encountered challenges in implementing these recycling stations in public areas, as obtaining permits from municipalities can be a slow and cumbersome process.

Steps to Dispose of Your Bags in the Smart Recycling Station:

- Scan the QR Code
- Affix the sticker with the 6-digit code to your bags
- Indicate the number of bags you will be dropping off
- Take a photo of all your bags together
- Drop your bags into the station
- Receive cash points as a reward (0.20 AED/kg).

4. Key success factors for international expansion:

- **Lower Capital Expenditure:** The Smart Recycling Station requires significantly less initial investment than alternative technologies, making it a more financially viable option.
- **Cost Efficiency:** It operates

- at five to ten times lower cost than traditional solutions, maximizing budget efficiency for waste management operations.
- **No Electricity Required:** Unlike many existing solutions, the Smart Recycling Station operates without electricity, reducing operational constraints and costs.
- **Scalability:** The Smart Recycling Station's design allows for straightforward scaling, enabling expansion as waste management needs to grow.
- Fully Digitalized Ecosystem: The station operates within an utterly digital ecosystem, enhancing operational efficiency and data management.
- **Traceability**: It provides comprehensive tracking of waste collection and recycling activities, ensuring accountability and transparency in waste management processes.
- **Incentivization through Cash Rewards:** Users are incentivized to recycle through cash rewards (0.20 AED/kg), encouraging higher participation rates and fostering a culture of recycling within the community.

Waste to Zero

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