WASTE VALORIZATION FOR AFRICAN MUNICIPALITIES: A FRAMEWORK FOR SUSTAINABLE GROWTH

INTRODUCTION

Waste Management presents significant challenges, from public health concerns to environmental degradation and strained municipal budgets. However, within this challenge lies a tangible opportunity for resource recovery, circularity and sustainable economic development. At Nextchem (MAIRE's energy transition technology company), we propose a structured approach to waste valorization, moving beyond disposal to establish reliable systems that convert waste into valuable resources.

Our focus is on establishing a functional "Waste to Revenue" ecosystem that considers the unique context of local urban environments, particularly regarding existing informal waste collection networks and the imperative for consistent feedstock supply.

1. THE WASTE-TO-REVENUE VALUE CHAIN: AN ECOSYSTEM FOR RESOURCE RECOVERY

Establishing a waste-to-revenue ecosystem requires a series of integrated and planned stages, ensuring that waste is treated as the continuous base-feedstock resource supply:

1. **Systematic Collection and Material Recovery Facility (MRF):**
    - **Function:** This initial phase involves systematic waste aggregation from households, marketplaces, commercial entities, and industrial sources. Crucially, it must incorporate and enhance the existing informal collection networks that often recover a significant portion of *Recyclable materials for further recycling and waste valorization processes.* The material recovery facility is essential to the business model positive outcome
    - **Output:** Segregated streams of mixed waste, alongside pre-sorted materials (plastics, metals, paper, glass, organic waste) recovered by informal actors.
2. **Centralized Sorting and Pre-processing:**
    - **Function:** At designated aggregation facilities, collected waste undergoes further sorting to separate different material types. This can involve both manual and automated processes. Pre-processing steps like shredding, baling, and densification are essential to prepare materials for subsequent conversion.
    - **Output:** Differentiated streams of specific waste types, such as clean plastic fractions, metals, paper, organic waste, and residual non-recyclable materials (e.g., Refuse Derived Fuel - RDF).
3. **Consistent Feedstock Delivery for Valorization:**
    - **Function:** This is a critical point. The consistent and specified delivery of waste feedstock to the valorization plants is fundamental for their continuous, efficient operation. Any disruption in supply directly impacts economic viability.
    - **Output:** Reliable, quality-controlled volumes of specific waste streams (e.g., plastic waste with a defined composition, RDF with a consistent calorific value, metals, paper….) suitable for advanced conversion technologies.
4. **Advanced Conversion Technologies, NextChem (MAIRE) core business:**
    - **Function:** Utilizing proven industrial processes to transform the prepared waste streams into new, marketable products. This includes:
        - **Mechanical Upcycling (e.g., NX Replast™):** For creating high-quality upcycled polymers compounds from qualified plastic waste (rigid polyolefin waste).
        - **Chemical Recycling of general waste (e.g., NX Circular Hydrogen™, NX Circular Methanol™):** For converting mixed, low-value, or non-recyclable waste (including plastics, RDF and biomass) into synthesis gas, which is then refined into valuable chemicals or clean fuels.
        - Chemical Recycling of Plastic to produce high value-added monomer via NX Re™. This technology enables the production of recycled monomers (rStyrene and rMMA) from waste polystyrene and waste polymethyl methacrylate.

        - **Biogas conversion into valuable chemical (e.g., NX CPO):** Upgrading of Biogas derived from bio digestion of organic waste to produce Green Hydrogen and Fuels (e.g., Methanol)
        - **Biomass to Energy (NX EnerCircle):** Energy and Steam production from waste or virgin biomass to support local electric infrastructure valorizing available waste.
    - **Output:** Upcycled polymers, Recycled monomers, Recycled fuels (hydrogen, methanol), energy (electricity, heat, biomethane).

5. **Product Off-take and Market Integration:**
    - **Function:** Establishing firm agreements for the purchase of the produced outputs. These off-take agreements ensure a stable market and consistent revenue for the municipality and project operators whilst improving circularity and sustainability.
    - **Output:** Sales of upcycled/recycled materials, chemicals, and energy to industries, agricultural sectors, and energy grids.
6. **Residual Management:**
    - **Function:** Proper, environmentally compliant management of any remaining inert or zero-value/high impact waste, ensuring minimal environmental dispersion, requiring regulatory framework presence.
    - **Output:** Environmentally sound disposal or alternative beneficial use of non-recoverable residues.

2. NEXTCHEM (MAIRE) ROLE: TECHNICAL PARTNER AND BUSINESS MODEL VALIDATOR

NextChem (MAIRE) role in this value chain is that of a **technology licensor, integrator and project facilitator**. We provide expertise and support across the entire project lifecycle, rather than solely supplying a defined set of process technologies:

1. **Feasibility Assessment:** We conduct thorough assessments of your waste streams, local context, and infrastructure to determine the most suitable and economically viable technologies. This includes detailed analysis of feedstock characteristics and availability.
2. **Technology Provision and Integration:** We offer proven and scalable technologies for various waste streams, including advanced mechanical plastic upcycling, waste-to-chemicals processes (gasification, synthesis), and potentially organic waste conversion. Our role is to integrate these technologies into a coherent and efficient plant design.
3. **Engineering, Procurement, and Construction (EPC) (Via Tecnimont and KT – MAIRE EPC companies):** We undertake the engineering design to the defined specifications, procure necessary equipment, and manage the construction of the entire waste valorization facility, ensuring adherence to international standards and local requirements.
4. **Operational Training and Support:** We provide training programs for local personnel to ensure the safe and efficient operation and maintenance of the installed facilities, fostering local capacity.
5. **Market Linkages Facilitation:** We provide expert support in identifying potential industrial off-takers for the products generated, leveraging our industry knowledge to help secure long-term purchase agreements.
6. **Project Structuring Advisory:** We provide guidance on appropriate project structures, including public-private partnerships, to attract necessary investment and manage project risks effectively.
7. **Financing schemes via MET Development (MAIRE project development company):** We have long-standing relations with financial institutions whether public or private and work with the customer towards obtaining the most appropriate financial package.

3. ESSENTIAL ACTORS: COLLABORATIVE IMPLEMENTATION

Successful implementation of a waste-to-revenue system requires the active engagement and coordination of several key actors:

- **The Municipality/County:** The leadership defines the conducive policy, allocates resources, enforces regulations, and coordinates stakeholders.
- **Citizens, Businesses and Industrial Clusters:** Their active participation in source separation and proper waste disposal directly impacts the quality and quantity of valuable feedstock, under County rules.
- **Formal Waste Collection Entities:** Municipal waste departments or contracted private companies responsible for scheduled and reliable waste collection should merge efforts towards one transformation entity.
- **Informal Waste Pickers/Reclaimers:** This existing active sector is crucial for pre-sorting and recovering high-value materials. Their formalization and integration into the value chain are not just ethical imperatives but practical necessities for maximizing material recovery and ensuring feedstock consistency. The local service provider will offer better than street market fetch prices, in coordination with the County Government.
- **Local Recyclers:** Existing businesses that purchase and process specific waste fractions (paper, metal, some plastics) recovered by informal and formal collectors should interface one transformer.
- **Technology Implementers (Maire Nextchem):** Providing technical solutions, engineering, and project management expertise at value-for-money level.
- **Industrial Off-takers:** Local and regional industries consuming the final products (e.g., plastic manufacturers, chemical industries, power grids, agricultural entities).
- **Financial Institutions:** Banks, development finance institutions, and investment funds providing the necessary capital.
- **Community Representatives/NGOs:** Essential for facilitating dialogue, building trust, and ensuring community buy-in and benefits, especially regarding the integration of informal waste pickers.

4. REGULATORY ENVIRONMENT AND POWER CONSIDERATIONS

A predictable and supportive regulatory framework is essential for attracting investment and ensuring the long-term viability of waste valorization projects.

Key Regulatory Elements:

1. **Clear National or Municipal Waste Management Policy:** A policy that explicitly prioritizes resource recovery, outlines waste flow management, and establishes a clear hierarchy of waste treatment (e.g., reduction, reuse, recycling, energy recovery, safe disposal).
2. **Legal Framework for Waste as a Resource:** Regulations that classify processed waste streams (e.g., recycled plastics, syngas from waste, digestate) as legitimate raw materials or energy sources, facilitating their commercialization.
3. **Transparent and enabling processes:** Efficient and consistent environmental and operational procedures for new waste valorization facilities.
4. **Formalization of the Informal Waste Sector:** Policies that recognize, legitimize, and integrate informal waste pickers through mechanisms like cooperatives, registration, fair pricing schemes, and access to highest H&S standards and basic social services. This secures valuable feedstock and promotes social equity.
5. **Extended Producer Responsibility (EPR) Frameworks (where applicable):** Policies that make producers responsible for the end-of-life management of their products, creating incentives for recycling and demand for recycled content.

Essential Terms for Connection to the National Grid (for waste-to-energy/chemical projects):

For projects that necessitate power, such as those from syngas or biogas, the following conditions are important for viability:

- **Stable Grid Connection:** Guaranteed access to the national or regional electricity grid with adequate capacity for power resale.
- **Competitive Power Purchase Agreements (PPAs):** Long-term contracts with utilities or industrial consumers that provide a predictable and fair price for the electricity generated. This is critical for financial modelling and securing project finance.
- **Renewable Energy Classification and Incentives:** Where waste-derived energy is classified as renewable (e.g., from biomass fractions), policies that offer preferential tariffs, tax breaks, or other incentives can significantly improve project economics.
- **Local Demand for Baseload Power:** Waste-to-energy facilities provide consistent, non-intermittent power while waste-to-chemicals facilities demand baseload capacity. High local industrial or urban demand for reliable baseload electricity enhances the project's value.
- **Absence of Volatile Fuel Subsidies:** Environments where traditional fossil fuels are heavily subsidized can make renewable energy less competitive. A move towards market-reflective energy pricing improves the attractiveness of waste-derived power.

5. MITIGATING FEEDSTOCK SCAVENGING AND ENSURING CONSTANT SUPPLY

The presence of informal waste pickers is a reality and a valuable resource in many contexts. Instead of viewing them as a threat to feedstock supply, the strategy must be one of **inclusion and partnership.**

Key Mitigation and Integration Measures:

1. **Formalization and Cooperation:**
    - **Cooperative Formation:** Support the formation of official waste picker cooperatives or associations. This provides a structured group to engage with, offers better bargaining power for the pickers, and facilitates training and resource distribution.
    - **Registration and Recognition:** Official recognition by the municipality legitimizes their work and allows for integration into formal waste management plans.
    - **Contractual Agreements:** Establish formal agreements with these cooperatives for the supply of specific, pre-sorted waste materials (plastics, metals, paper) to municipal or privately run sorting centers. These contracts should offer fair and stable pricing, often higher than what informal middlemen offer.
2. **Centralized Sorting and Buy-Back Centers:**
    - **Designated Drop-off Points:** Establish accessible, safe, and well-equipped community-level or municipal buy-back centers where waste pickers can bring their collected materials.
    - **Transparent Pricing:** Implement a clear, transparent, and fair pricing mechanism for different types and qualities of materials, ensuring waste pickers receive maximum value for their efforts. Digital payment systems can improve transparency and financial inclusion.
    - **Incentivizing Quality:** Offer higher prices for cleaner, better-sorted materials to encourage improved practices.
3. **Improved Primary Collection and Source Segregation:**
    - **Public Awareness Campaigns:** Educate citizens on the importance of separating waste at source. This reduces the amount of mixed waste scavengers would typically sift through, allowing them to focus on pre-sorted materials.
    - **Containerization:** Provide appropriate bins for segregated waste at household and community levels.
    - **Scheduled Collection:** Regular and predictable collection services can reduce the time waste sits in public spaces, mitigating the negative effects on the areas affected.
4. **Value Addition at the Waste Picker Level:**
    - **Basic Processing Training:** Train cooperatives on basic processing techniques (e.g., shredding, washing, baling) to further increase the value of materials they collect, allowing them to capture more of the value chain.
    - **Equipment Provision:** Provide access to basic equipment (gloves, safety gear, hand tools, scales) through cooperatives to improve working conditions and efficiency.

5. **Community Engagement and Social Inclusion:**
    - **Health and Safety Programs:** Implement programs addressing the health and safety risks associated with waste picking.
    - **Social Support:** Link waste picker communities to social services, financial literacy training, and micro-financing opportunities.
    - **Addressing Stigma:** Promote public awareness campaigns that highlight the crucial environmental and economic role of waste pickers, countering social stigma.

By implementing these measures, the municipality/county can transform "scavengers" into formal, recognized, and compensated contributors to the waste management system, thereby securing a more stable and higher-quality feedstock for valorization plants while simultaneously improving livelihoods and reducing social inequities.

Nextchem (MAIRE) is prepared to assist your municipality/county in navigating these complexities, developing a tailored plan, and implementing the necessary infrastructure and social programs to transform your waste management system into a sustainable and profitable asset for your community.

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