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INTERNATIONAL CLIMATE INITIATIVE

solutionsgateway
Climate, Energy, and Finance Solutions

100% RENEWABLES SOLUTIONS PACKAGE

Energy recovery through co-processing

This solution is part of a package of solutions meant to guide local and regional governments in implementing a local renewable energy transition by providing guidance on mechanisms, applications or technologies that can help accelerate their climate and energy action.

It was produced as part of the 100% Renewables Cities and Regions Roadmap project, which supports nine cities and regions across Argentina, Indonesia and Kenya to develop bankable renewable energy projects and in-depth local strategy and action plans to achieve one hundred percent renewable energy. The 100% Renewables Cities and Regions Roadmap project is implemented by ICLEI – Local Governments for Sustainability and funded through the International Climate Initiative (IKI), which is implemented by the Federal Ministry for Economic Affairs and Climate Action (BMWK) in close cooperation with the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and the Federal Foreign Office (AA).

DISCLAIMER

All cities are unique. The Solutions Gateway has been developed as an advanced knowledge catalogue to provide an overview of possible Low Emissions Development Solutions. The Solutions and Packages it contains provide guidance on general conditions, which may not correspond to the existing conditions in your city or jurisdiction. The consultation and use of the Solutions Gateway does not waive the need for the Local Government to assess the feasibility of a Solution or Package in the local context in its city or jurisdiction, prior to implementation. Please note that the impacts, benefits and co-benefits indicated are generally valid but may not materialize in particular circumstances.

ABOUT SOLUTIONS GATEWAY

Solutions Gateway is an online resource platform for Local Governments where they will be able to find possible Low Emissions Development (LED) Solutions for their cities.

In the context of the Solutions Gateway, Solutions are processes, or groups of actions, which Local Governments can implement to deliver climate change mitigation results and enhance local sustainable development. Taking an integrated approach, and focusing on Local Governments usual responsibilities and roles, Solutions include core actions as well as enabling and multiplying actions essential to maximize their effectiveness and efficiency. These include policy, regulatory, governance, capacity building, awareness raising, stakeholder engagement, etc.

ABOUT ICLEI – LOCAL GOVERNMENTS FOR SUSTAINABILITY

ICLEI – Local Governments for Sustainability is a global network working with more than 2,500 local and regional governments committed to sustainable urban development. Active in 125+ countries, ICLEI influences sustainability policy and drives local action for low emission, nature-based, equitable, resilient and circular development. ICLEI's Members and team of experts work together through peer exchange, partnerships and capacity building to create systemic change for urban sustainability.

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1. INTRODUCTION

Co-processing is a technology for reusing waste as raw material or fuel, mainly in energy intensive industries, where it combines material/energy reuse and the final disposal/destination of solid waste in a single operation. It can contribute to the conservation of natural resources by replacing conventional energy sources (i.e. fossil fuels) and other raw materials with energy and materials recovered from waste, as well as reducing the waste generated in the manufacturing process, and so its overall environmental impact.

This type of treatment produces refuse-derived fuel (RDF) from urban solid waste, using its calorific value in furnaces and thermoelectric power plants. Co-processing often takes advantage of thermal waste-to-energy (WtE) by recovering its energy content. This presents one of the highest potentials for waste use, since the waste is incorporated into the manufacturing process. This solution is intended to encourage the private sector to reconsider ways of obtaining raw materials and energy, while also emphasizing the role of governments in creating enabling public policies.

1.1 RELEVANCE

Co-processing is a technology for reusing waste as raw material or fuel, mainly in energy intensive industries, where it combines material/energy reuse and the final disposal/destination of solid waste in a single operation. It can contribute to the conservation of natural resources by replacing conventional energy sources (i.e. fossil fuels) and other raw materials with energy and materials recovered from waste, as well as reducing the waste generated in the manufacturing process, and so its overall environmental impact.

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1.2 MAIN IMPACTS

LOCAL ECONOMIC IMPACT:

- More certainty and stability in final products prices, since recovered energy avoids the use of conventional fuels sources and decreases costs linked to fuel acquisition
- Opportunities for local job creation
- Increase in recycling rate
- Energy supply stability, due to reduced demand on fossil fuels and a diversification of the energy matrix
- Increase in community awareness of energy use and its localized impacts

ENVIRONMENTAL AND SOCIAL IMPACT:

- Decrease in the amount of waste sent to landfills and improve general well-being
- Reduction of environmental burdens placed on communities by the traditional fossil fuel-based industry e.g. air pollution, and associated health impacts
- Contribution to the reduction of greenhouse gas emissions (GHG) and related climate change impacts
- Decrease in extractive energy industry impacts e.g. mining, by reducing or eliminating fossil fuel energy use and other raw materials
- Decrease in environmental impacts related to waste destination (landfills, dumping, GHG emissions, etc)
- Enabling full recovery/recycling of waste
- Contributes to decreasing the additional waste residue generated
- Separation and treatment of organic waste can help tackle a source of methane emissions (as these materials would otherwise decompose in landfills) [2].

1.3 BENEFITS

- Transformation of the economy from linear to circular by increasing recycling rates and recovered energy
- Contribution to local decarbonization goals by reducing reliance on fossil fuels; RDF is generally lower in emissions
- Direct substitution of primary fossil fuel in the production process (representing a significantly more efficient energy recovery process than other WtE technologies)
- Lessened consumption of fossil fuel for energy generation
- Reduction of fossil fuel consumption as raw material
- Improvement of air quality by controlling the emission of toxic gasses
- Medium term health benefits such as decreasing vector-borne diseases (e.g. from rats and cockroaches in landfills etc.)
- Increased soil and water quality, by reducing heavy metal contamination of groundwater
- More economic competitiveness, job creation and other local economic benefits
- One part of the solution for tackling hard-to-decarbonize energy-intensive sectors e.g. cement production.

1.4 SUGGESTED INDICATORS FOR MONITORING RESULTS

ENVIRONMENTAL PERFORMANCE

- Reduction of fossil fuel consumption (t/year)
- Reduction in energy demand (incl. for the industrial sector) (MWh/year)
- Energy generation via waste-to-energy (kWh/year; % of overall energy generated)
- Reduction in annual greenhouse gas (GHG) emissions (t CO_2e/year)
- Decrease in solid waste disposal sites (number of sites or area in hectares), due to the deviation of solid waste from landfills to industry within energy reuse propurse (tons of materials used in the process, not destined to landfill)

ECONOMIC PERFORMANCE

- Cost reduction in involved industry's production process through energy and raw material exploitation recovery (from waste) (tons. of produced cement from waste recovery * price of buying raw material from the market; unit: USD or local currency)
- Generated jobs (new jobs/year)

1.5 TYPICAL LOCAL GOVERNMENT ROLES

- Policy maker
- Legislator/regulator
- Coordinator
- Consumer and procurement
- Operator of municipal facilities and infra-structures
- Service provider
- Mobilization and stakeholder engagement (particularly being in contact with the industrial sector)

2. INTEGRATED SOLUTION OVERVIEW

	Enabler Actions	Required Actions	Multiplier Actions
Policy	• Check legal frameworks at national/regional level regarding requirements and standards for co-processing, especially mapping the capacity of environmental authorities to monitor and control compliance • Conduct a feasibility study to implement coprocessing within the existing legal national and sub-national framework, considering that co-processing must be in line with other change processes in the waste management structure of a country • Mapping out licensing collection, transport and other waste management aspects • Mapping existing regulatory and enforcement infrastructure to ensure compliance with applicable regulations • Update land use management plans or municipal plans to be according to the site project selections	• Provide a legal framework for co-processing at the municipal level • Integrate co-processing and pre-processing into existing waste management plans • Approve location, technical infrastructure and processing equipment • Create incentives for waste separation at source • Approve the environmental impact assessment and all required national/ local licenses, permits, authorizations and permissions • Provide regulation to the private sector, where site operators or facility managers for hazardous wastes are required to monitor the effects of those activities, ensure stable waste quality and feed rate and report to the public sector its impacts and indicators • Regulate facilities for waste acceptance and feeding control	• Define an ambitious target for recycling • Including waste pickers and other local actors in the process • Charge waste generation and mineral extraction while waste taxation is regulated • Ensuring that the use of hazardous waste in intensive energy industries must add value to the process, while meeting applicable regulations and licensing requirements • Link the regulation and reporting to GHG reduction goals or any local climate action plan • Regulate air pollution control devices, which demands periodic reporting • Regulate alternative energy sources, such as biomass and waste
Stakeholders and Awareness	• Promote dialogue with academia and research institutions • Promote regular dialogue with local community and authorities in order to address possible comments and complains	• Assess alternative disposal routes; environmental, health and safety standards; and the quality of the final product. In countries where there are no stringent requirements for the final product, application of Best Available Techniques (BAT) and best environmental practices (BEP) are considered even more important	• Players involved should be responsible for minimizing risks and striving towards best practices • Establishment of a communication plan for the separation of waste, highlighting the benefits of the project

	Enabler Actions	Required Actions	Multiplier Actions
Stakeholders and Awareness	• Engage in constructive dialogue with energy intensive industry representatives, others stakeholders, and decision makers regarding the use of conventional and alternative fuels and raw materials in an open, transparent and accountable way • A clear management of the organizational structure must be created, with unambiguous responsibilities, reporting lines and feedback mechanisms.	• Determine criteria to regulated and license based on stakeholder consultation, land rights, and other factors • Open and regular disclosure of performance, as well as compliance verification reports should be produced	
Governance	• Put in place good environmental and safety compliance records • Form a working group including different levels of government and key stakeholders to see how best to implement this technology. The group should support the elaboration of regulation, help define indicators and follow up on the first experience • Adequate record keeping of metrics related to waste and emissions	• Assure compliance with all applicable laws and regulations • Integrate co-processing as a fundamental part of waste management • Establish adequate product quality control routines • Collect data to continuously improve the understanding of the operations' impact, and report regularly on performance • Application of best available techniques (BAT) for air pollution prevention and control, along with continuous emissions monitoring to ensure compliance with regulation and permits (verified through regular monitoring)	• Create adequate documentation and information on safety measures and procedures regarding hazardous waste handling • Create adequate operating procedures and contingency measures • Through openness and transparency, facility management should ensure the workforce is fully informed about health and safety measures and standards • Disseminate results, indicators, lessons learnt with the working group and other existing groups in different levels of government • Maintain good relations with public and other parties involved in local, national and international waste management schemes • Obtain recognition of the initiative, which must be recognized as an attractive alternative in order to build relationships of trust within the community

	Enabler Actions	Required Actions	Multiplier Actions
Capacity Building	• Engage the private sector and other interested stakeholders to generate awareness of the possibilities, in case they are not already aware	• Prepare guidance documents as templates to assist operators in adopting these technologies (technical assistance, funds or grants, administrative procedure and regulations) • Make the technology available at the required scale through enabling policies • Create local capacity, by making sure that all the operational personnel should is trained according to the specific needs and to the nature of the wastes or RDF	• Incorporate the academic sector for continuous improvement (e.g. conducting research on data efficiency and opportunities for improvement) or for training • Including the private sector as well to develop training or apprenticeship programs • Collaborate with other peer cities and networks to learn about best practices in this area
Technical	• Promote waste separation and applying different pre-treatment processes (e.g. pre-processing); not all waste is suitable for co-processing • Standardize air pollution control devices • Analyze if hazardous and non-hazardous waste can be used in co-processing • Install energy efficient equipment	• Elaborate a SWOT analysis concerning specific local/ national aspects including waste streams, costs etc. • Ensure that facilities and infrastructure are in place • Ensure that the product does not have any negative impacts on the environment (for example, through leaching tests) • Guarantee reliable and adequate power and water supplies in the plant • Guarantee reliable and adequate management of wastes and health, safety and environmental issues in the plant management • Guarantee that the exit gas conditioning/cooling are kept at low temperatures (< 200°C) in the air pollution control device, to prevent dioxin formation	• Implementation of an environmental management system (EMS), including a continuous improvement programme • It is recommended that a life-cycle approach of the complete recovery chain of hazardous wastes be used, to assess the available recovery operations

	Enabler Actions	Required Actions	Multiplier Actions
Technical		• Ensure a calorific value of RDF of about 10 - 15 MJ/kg for it to be a viable projefct • Implement of conveyor belts and new technical functions to drive the waste input into the combustion process • Build storage rooms and establish safety measures (e.g. to reduce risk of fire)	
Finance	• Evaluate the potential of uptake market • Get the message across that investing in co-processing can reduce fuel and raw material costs (i.e the higher the price for coal, pet coke, natural gas and raw materials, the cheaper the use of waste as raw material, and more attractive this investment will be) • Explore the potential for alternative financing mechanisms e.g. blended financing or public-private partnerships	• Make use of the Initial investments primarily to include pre-processing, in order to homogenize the feeding waste • Work with affordable gate fees at the facility for the feedstock	• Guarantee the availability of patient finance suitable for innovation – midsize soft loans or guarantees

3. WORKFLOW /PROCESS PHASES

3.1 PREPARATION

- Create a dynamic mechanism and plans that reflect market, economic and political developments
- Run technical and financial feasibility studies, including possible business models
- Obtain commitments from local government to replace fossil fuel and cut carbon dioxide and other emissions
- Identify local stakeholders and start an early engagement process, prioritizing places with more waste-related GHG emissions
- Once key industries are identified, assess the amount of waste , its characteristics and the fraction that can be used for energy recovery
- The implementation of thermal WtE in developing countries has technical challenges, such as waste characteristics, and governance challenges, which include social, financial and legislative aspects. In order to map such aspects, elaborate a SWOT analysis concerning specific local/national aspects
- Assess existing environment policy for promotion of WtE and find out scope of improvement
- Assess the needs of the community and find out the local issues with respect to the socio-economic status, demography, and municipal services and how these can help build a case for WtE
- Assess the financial resources that the government has available to implement or promote WtE
- Communicate the findings and strategy effectively, engaging local key-stakeholders in the process. Transparent process are more likely to be sustainable over the long term
- Pre-evaluation of projects' costs
- Communication campaigns, workshops and training to build capacity and raise awareness among local government's representatives, as well as with the waste and energy sectors and other relevant parties

3.2 APPROVAL

- Ensure that the regulations follow the approval processes of the country's energy regulator if available, and the local or national government
- Ensure all environmental regulations and compliance requirements are accounted for and carefully monitored

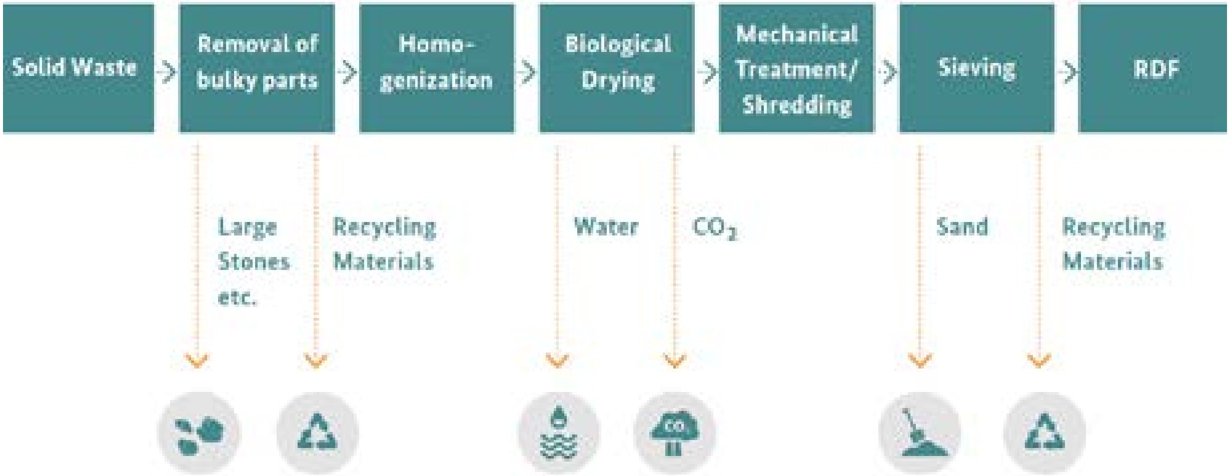
3.3 PROCUREMENT

- Following a transparent procurement process that is aligned with existing guidelines, with clear evaluation criteria for accessing the necessary technologies and expertise
- Acquisition of the necessary technology to enable co-processing
- Mapping of available contractors in the region

3.4 IMPLEMENTATION

- Develop a clear monitoring criteria to ensure the project is proceeding as planned, including appointing independent agents if necessary

- The implementation may be carried out by a single or multiple actors across various stages [2]—typically, the municipality would collect the waste and transport it to a landfill typically operated by a private company. Formal or informal waste workers would work to separate various kinds of waste. A private waste management company would pre-process the light fraction waste for generating alternative fuels (AF). The AF would be co-processed by the energy-intensive company.
- The following steps should be followed to ensure controlled combustion and a quality RDF [2]:



3.5 MONITORING

- Local governments should work with national governments to produce statistics on WtE facilities, their energy output, as well as environmental impacts and employment
- Set a gradual target output, for example, gradually increase the amount of waste used to produce refuse derived fuel used in cement production
- Determine other criteria based on stakeholder consultation, land rights, and other factors
- Develop a GHG inventory of the community to map the waste generation and emissions hotspots, identifying potential opportunities and having a baseline to measure the impact of initiatives
- Report and publish the results obtained from the baseline assessment, to guarantee transparency and clear goals, through validated platforms
- Create a record of the necessary data to monitor the indicators previously suggestested and identify trends, progress and setbacks

4. REALITY-CHECK

- This solution is applicable where the local communities strive for greater self-sufficiency in waste management
- Particularly in developing countries that may have little or no waste management infrastructure, properly controlled co-processing can provide a practical, cost-effective and environmentally preferred option to landfill and incineration
- In general, co-processing can be an important element in a more sustainable system of managing raw materials and energy
- Whenever the local government wants to encourage supply chain redesign and industrial waste reuse and preventions solutions
- Whenever the local government wants to enhance energy supply security, thus reducing the country's dependence on imported fuels
- When there is a clear focus on decarbonizing hard-to-abate sectors

4.1 REQUIRED PRE-CONDITIONS

- Enabling policies and economic incentives supporting waste-to-energy technologies
- Incentives in waste disposal regulation which encourage energy recovery and savings
- Regulations on energy sector which favors renewables and alternatives sources of energy
- Availability of technical skills to create local capacity
- Awareness of the availability and potential of such WtE technologies

4.2 SUCCESS FACTORS

- Technical and human resources with the capability to monitor and implement such projects
- Alignment with other development plans e.g. climate action and waste management
- Bringing on board all relevant stakeholders and their perspectives

4.3 FOLLOW-UP NEEDED AND/OR RECOMMENDED

- Define a robust Monitoring and Evaluation (M&E) mechanism, e.g. continuous measurement of emissions components (SO_2, NOx, VOC)
- Report and verify the emissions and related mitigation measures through verified platforms
- Encourage a more environmental preferable waste management practice in order to avoid increased pollution emissions or failure

4.4 BARRIERS

- Prioritizing other projects that deviate from the the deployment of waste to energy technologies in countries
- Lack of financial sustainability in waste management in developing countries
- Lack of coordination and capacity at the policymaking level/ governance and institutional capacity

- Waste content and its separation, including the lack of experience and local culture and waste recycling
- Social barriers to the application of thermal treatment routes in some countries
- Plant site selection must take into account the transfer and transportation of waste and the final use of the produced product
- If the product final characteristics are different from traditional ones produced without the waste-to-energy process, a capacitation or sensibilization needs to take place so that users get used to it
- An incentive program for waste separation can help to overcome the barrier of it being challenging to separate waste at the source, as is the case in many big cities. Cooperation with community-based-organizations may also be sought in this case

4.5 RISKS

- Health and safety assessments should be undertaken on operations to ensure equipment safety, as well as to minimize risks of endangering people or installations, or damaging the environment
- Only competent and qualified personnel should undertake or oversee such hazard and operating studies, otherwise risky situations may emerge
- Amount and quality of the material to ensure homogenous waste streams must be appropriate

5. CLIMATE CHANGE MITIGATION POTENTIAL

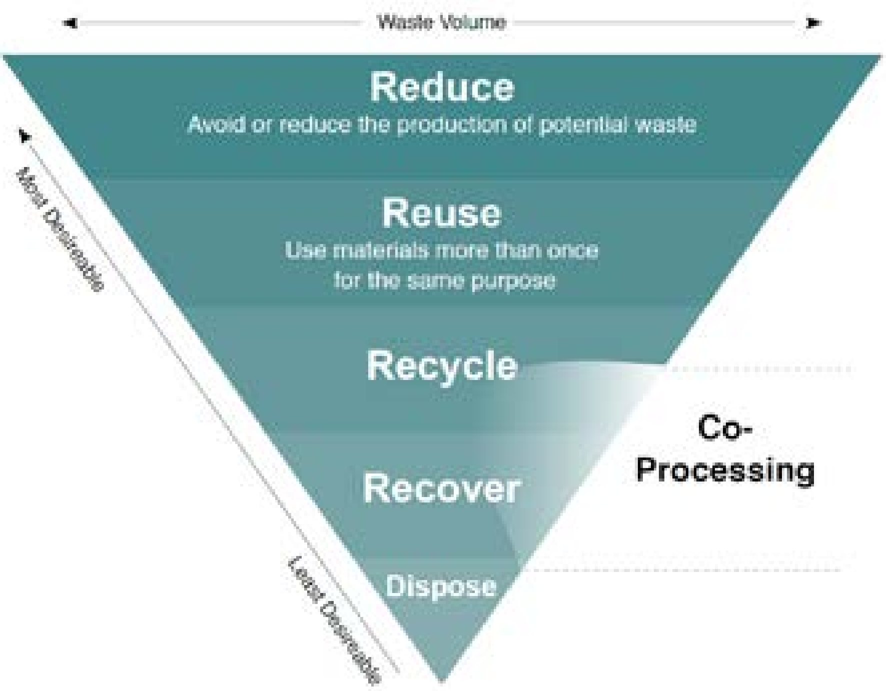
Energy intensive industries are highly pollutant. Only the Cement Industry, for instance, is responsible for about 7-8% of CO_2 emissions worldwide (IEA). Developing countries are partially responsible for this, and thus the production in those countries must start on the right (zero-carbon-compatible) track. The current Solution Package aims to promote the co-processing of energy intensive plants, aiming to reduce greenhouse gas (GHG) emissions by diverting waste from landfills and open burning, thus replacing fossil fuels and providing incentives for the achievement of the developing countries' climate goals. The direct substitution of the production process' primary fuel by waste might represent a significantly more efficient energy recovery than other WtE technologies, typically achieving 85-95% efficiency depending on waste characteristics.

WtE initiatives, supply chain redesign, and industrial waste reuse and prevention are solutions that are applicable to several emitting sectors, such as: materials extraction, production processes, consumption patterns and waste management activities. Major sources of emissions in these areas include fossil fuel combustion for energy, emissions generated in extraction, production and waste management processes. The potential for mitigation include less energy-intensive processes, use of waste (secondary feedstock), avoid biodegradation in disposal sites by diverting waste from landfilling to WtE treatment and replacing fossil fuel with waste as an alternative source of energy.

6. FURTHER SCIENTIFIC AND TECHNOLOGICAL INSIGHTS

The following section expands on the specifics of waste management practices [2]:

Figure 1: Waste management hierarchy. *Source: GIZ [2]*



The figure above shows at what stage co-processing can be useful; often it is one step after other materials such as glass and metals have already been recovered [2].

Figure 2: Integrating co-processing into waste management practices. *Source: GIZ [2]*

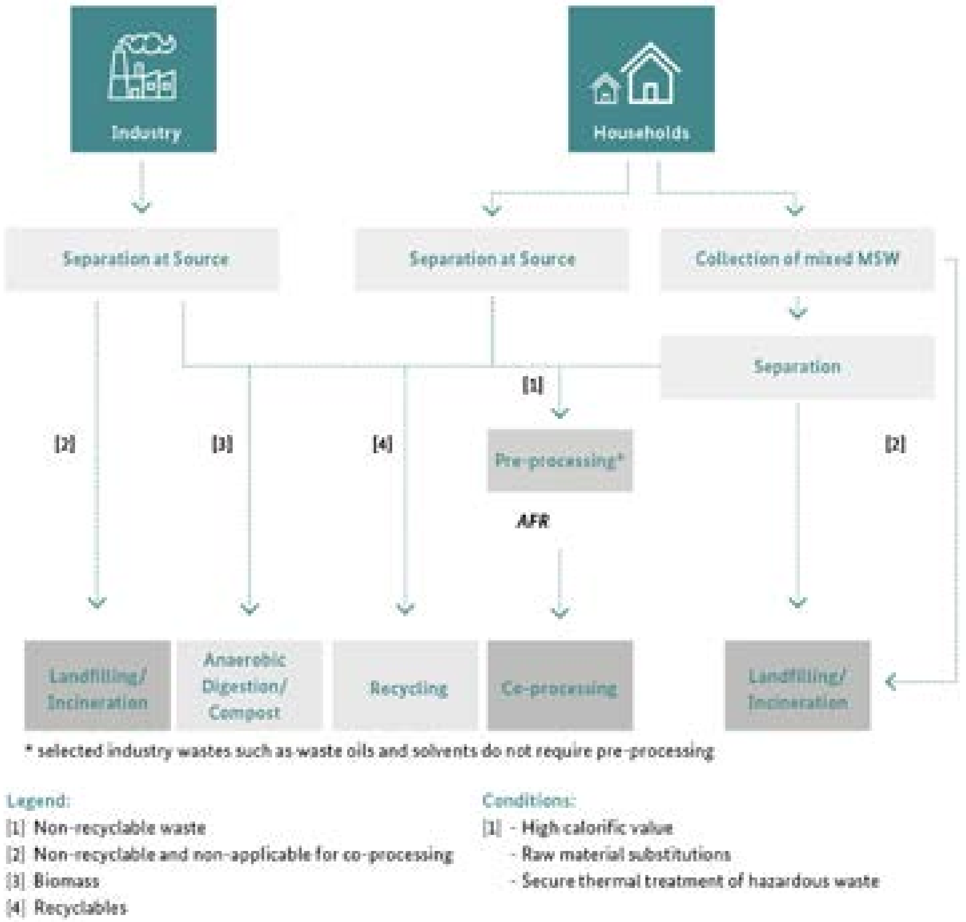


Figure 2 shows the different pathways for waste management based on the source of the waste, and how pre- and co-processing can be integrated into it [2].

Figure 3: Types of waste suited for co-processing. *Source: GIZ [2]*

Figure 3 shows the types of waste that are best suited for co-processing [2].

7. NATIONAL – SUBNATIONAL INTEGRATION IN THE CONTEXT OF THIS SOLUTION

This section shows how the national-subnational integration can facilitate the implementation of this solution, focusing on the benefits that such integration can bring to the different levels of government.

7.1 BENEFITS TO LOCAL GOVERNMENT

- Through the benefits of reduced reliance on fossil fuels and natural resources, local government action in this space can help meet national climate action goals while bringing in numerous local-level benefits
- Local governments can act as pioneers and connect with other peer cities to share experiences; they can collectively advocate for more enabling policies at the national level

7.2 BENEFITS TO OTHER LEVELS OF GOVERNMENT

- Reduced demand for fossil fuel and natural resources can help reduce the need for fossil fuel and resource imports
- Local action spurs the achievement of national level climate goals and helps meet international climate commitments
- Reduced environmental impacts can also lead to improved health outcomes and align with national development plans

8. RESOURCES/SUPPORT

8.1 CASE STUDIES

CO-PROCESSING INDUSTRIAL WASTE: HONGSHUIHE PLANT PROJECT CHINA [3]

China Resources Cement (CRC) saw an opportunity to integrate urban and industrial waste into its cement production processes at its 3,200 t/day Hongshuihe plant. A deal with FLSmidth was signed with CRC in order to take municipal and industrial waste from the city of Binyang in Guangxi. The main objective was to integrate raw urban and industrial waste into cement production using a co-processing facility. The co-processing had a positive environmental impact on Binyang by helping to **scale back the waste** by an estimated equivalent of **0.75 hectares per year** and by a **reduction in methane emissions by 8.76 million cubic metres a year**. This project is a successful example of the implementation of innovative technologies in order to solve solid waste challenges and contribute to waste reduction.

VOTORANTIM CIMENTOS CO-PROCESSING PLANT IN SALTO DE PIRAPORA IN BRAZIL 2019 [4]

Votorantim Cimentos, a company located in Salto de Pirapora, in the state of São Paulo, Brazil, recognized RDF co-processing as an alternative to reduce the volume of garbage sent to landfills and transforming part of this waste into energy for cement production. During the testing period for licensing, the company reached a **5.3% reduction rate** in petroleum coke in 2018, by using **17,900 tons of RDF.**

GEOCYCLE - INCREASING AWARENESS ON RECYCLING IN COLOMBIA [2]

With the objective of promoting WtE co-processing technology and respecting the waste hierarchy while, at the same time, promoting recycling, company Geocycle (a Holcim subsidiary company based in Boyacá, Colombia) launched a campaign entitled *'Reciclando y Coprocesado el ambiente estamos cuidando'*. The campaign aimed to promote environmental education to strengthen the commitment of people at different levels of the waste value chain, such as households, schools and other private and public institutions. The focus of the campaign was to raise environmental awareness of recycling and co-processing in the community. The municipalities of Boyacá benefitted around 18,000 people by recognizing the work of those people taking part of the recycling business, while **creating formal recycling jobs**. The sustainable report of 2020 indicates **33,038 tonnes of waste was used in co-processing**, which equals to a **19.1% thermal replacement rate**.

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