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Guidelines on Public-Private Partnerships for the Sustainable Development Goals in Waste-to-Energy Projects for Non-Recyclable Waste: Pathways towards a Circular Economy

Note by the secretariat

Background

The following document contains a set of guidelines on how Waste-to-Energy (WTE) for non-recyclable waste can, through Public-Private Partnerships (PPPs) for the Sustainable Development Goals (SDGs), can contribute to a transition towards a circular economy (CE).

A first version of this document was submitted to the Working Party on PPPs at its fourth session in 2020 (ECE/CECI/WP/PPP/2020/5). The Working Party proposed its submission to the 69th Commission session in April 2021 and agreed on its further development by the secretariat based on comments from stakeholders.

In 2021, the secretariat conducted a stakeholder consultation through an online survey directed at governments and with the participation of industry and civil society. 138 respondents provided input which was used to prepare a revised version of the guidelines. A review of the revised document was initiated in early 2022 and a peer review process was established.[1] The revision process also benefited from experts' input from two panel discussions on the topic: one held at the fifth session of the Working Party in November 2021, and another at the sixth ECE International PPP Forum in May 2022.

The document was prepared by the secretariat with substantive inputs from A.C. (Thanos) Bourtsalas, and Jiangrong Yu. The secretariat is grateful to the European Commission for its input on the legislative and regulatory framework of WTE in the European Union.

The document was shared with the Bureau in July 2022 and is submitted to the Working Party for its consideration.

[1] A list of experts who contributed to review the document is provided in Annex I.

I. A note on definitions

Waste-to-Energy

WTE is a thermal, biological, or chemical process that uses waste materials to recover energy or fuels. Thermal processes include pyrolysis, gasification, and incineration. Currently, thermal incineration is the dominant technology for processing non-recyclable mixed materials sustainably.[2] Incineration-based processes must operate with stringent pollution standards, such as the EU Industrial Emissions Directive.[3] Sophisticated incineration-based WTE has the capacity to destruct pathogens of environmental concern, and thus, can process materials that contain toxic substances and cannot be recycled. For the purpose of this paper, WTE is defined as a thermal, incineration-based process of energy recovery (See Annex I).

WTE is currently the most sustainable solution for non-recyclable waste as it recovers energy and materials while providing an alternative to highly polluting landfills and waste exports.[4] Energy from WTE plants comes in two forms: electricity and heat, which can be used for district heating/cooling, and/or industrial purposes. To ensure a sustainable transition towards circularity, energy recovery in WTE facilities should only be performed and promoted for non-recyclable waste, that is, waste that cannot be recycled nor composted. The maturity of technologies combined with sound legal and policy frameworks play a key role in ensuring that energy recovery is achieved sustainably through WTE processes, and as such contribute to circularity.

Non-recyclable waste

Recyclable waste comes from materials that have a value in the market, such as metals, paper, glass, and specific types of plastics. Non-recyclable waste (also called "residuals") includes, *inter alia*, polluted waste, degraded waste after several rounds of recycling, and waste made up of composite materials. The share of non-recyclable waste is expected to decline, since technological development and legal and policy frameworks evolve to this end.

However, some waste may simply never be recyclable or recycled, and currently non-recyclable waste remains highly significant around the world. It is estimated that approximately 15% of the waste going to recycling is rejected and ends up in landfills or incineration. For plastics, this percentage can go higher, reaching even 20%.[5] Should the EU Circular Economy regulations for 2035 be met, 30% of the waste materials at the European level would still be considered non-recyclable.[6]

When not processed in WTE facilities to produce energy, non-recyclable waste is landfilled or dumped. It is also incinerated without energy recovery and often without embedded state of-the-art technology designed to ensure that emissions from WTE incineration meet pollution standards.

Circular Economy

The Ellen MacArthur Foundation defines the CE as a system based on three principles, driven by design: (i) eliminate waste and pollution, (ii) circulate products and materials (at their highest value), and (iii) regenerate nature. This essentially means that the CE entails what is commonly referred to as the 6Rs: Reduce, Reuse, Repair, Remanufacture, Recycle, and Recover. WTE for non-recyclable waste belongs to the last category, Recover.

[2] See online: https://doi.org/10.1016/j.wasman.2014.02.003
[3] See online: https://ec.europa.eu/environment/industry/stationary/ied/legislation.htm
[4] See online: https://eswet.eu/can-the-eu-taxonomy-be-truly-sustainable-without-covering-non-recyclable-waste/
[5] See online: https://www2.deloitte.com/content/dam/Deloitte/my/Documents/risk/my-risk-blueprint-plastics-packaging-waste-2017.pdf
[6] See online: https://www.cewep.eu/cewep-capacity-calculations/

Public-Private Partnerships for the Sustainable Development Goals

PPPs for the SDGs refer to PPPs designed to implement the SDGs and thereby to be "fit for purpose". They can be defined as an enhanced approach for PPPs that overcomes some of the weaknesses of the traditional PPP model. PPPs are contract delivery tools for public infrastructure provision involving initial private financing. They include two types: "government-pay PPPs" which are primarily funded by taxpayers and "concessions" which are primarily funded by the users of the infrastructure.[7] PPPs for the SDGs fulfil five desirable outcomes:

(a) Access and Equity;

(b) Economic Effectiveness and Fiscal Sustainability;

(c) Environmental Sustainability and Resilience;

(d) Replicability; and

(e) Stakeholder Engagement.

II. Introduction

Waste, and what to do with it, is one of the central problems of our time. Waste accounts for about 4.5 million tonnes per day worldwide.[8] According to the World Bank, this figure will grow to more than 8 million tonnes per day by 2050.[9] Increasing prohibitions of transferring waste across borders also puts a burden on national governments to find practical solutions themselves.

Concurrently, considerable progress was made in the waste management across the globe, in particular regarding the high degree of sophistication with which waste is progressively managed. There is now a growing consensus that the response towards waste must contribute to the CE – a concept that is increasingly driving policy makers to protect the planet by eliminating waste altogether. In this regard, CE approaches are consistent with commitments made by United Nations (UN) Member States in adopting the 2030 Agenda for Sustainable Development and its SDGs, in particular SDGs 6 clean water and sanitation, SDG 7 affordable and clean energy, SDG 11 sustainable cities and communities and SDG 12 addressing responsible consumption and production.

In this context, WTE for non-recyclable waste, as a process that uses heat to recover energy or fuels from non-recyclable waste material has the potential to be a sustainable solution to achieve SDGs 6, 7, 11 and 12, and the CE agenda. While recovering energy and materials, WTE processes also provide an alternative to highly polluting landfills (and waste exports).

To ensure compliance with the CE agenda and the SDGs, non-recyclable waste must be processed in state-of-the-art facilities ensuring control over polluting emissions. Understood and operationalised as such, WTE is considered to complement recycling and reduce the amount of residue deposited in dumps. Existing policy such as EU regulations[10] implemented in WTE plants aim to ensure strict controls of energy-recovery activities to ensure that citizens and the environment are not harmed, thanks to the latest generation of industrial technologies.

The extent of the contribution of WTE processes towards the CE has been debated, and over the years, countries have gradually modified their approach to the WTE industry. The central thesis of these Guidelines is that WTE projects for non-recyclable waste can contribute to a transition towards a CE. However, it is far from automatic. This document discusses and proposes three *sine qua non* to this end: (i) WTE facilities should only

[7] See online: https://unece.org/DAM/ceci/ppp/Standards/ECE_CECI_2019_05-en.pdf
[8] Tonnes is the metric unit of mass equal to 1,000 kilograms according to the International System of Units (SI).
[9] See online https://openknowledge.worldbank.org/handle/10986/30317
[10] See online: https://ec.europa.eu/environment/industry/stationary/ied/legislation.htm

process non-recyclable waste; (ii) state-of-the-art technologies must be embedded in WTE plants to ensure compliance with stringent pollution standards; and, (iii) adopting the five desirable outcomes of PPPs for the SDGs could help governments and the industry adopt better legal and policy frameworks to ensure best governance practices in WTE projects.

WTE can be the final disposal step for non-recyclable materials (which are landfilled, otherwise) to produce a spectrum of marketable products and serve as a transition step to a more circular/sustainable development path, depending on where cities are at the start. WTE could stand as a strong link between the CE and PPPs for the SDGs policy agendas, which present common objectives and areas of intervention.

Purpose

These Guidelines are aimed at policymakers to raise awareness of the potential contribution of the ECE PPPs for the SDGs approach on WTE projects for the transition towards the CE.

Structure

The Guidelines are divided into four parts:

Part 1 examines both the WTE industry and the CE and sets out the potential of WTE for the CE.

Part 2 looks at the project level and how WTE projects could be designed and structured using a PPPs for the SDGs approach.

Part 3 focuses on the policy level response, at local regional and national levels and sets out a possible "road map" for WTE towards the transition to a CE.

Part 4 presents conclusions and proposals for follow-up actions to take the Guidelines forward.

III. Waste-to-Energy for the Circular Economy

This section explores the compatibility of the WTE industry for non-recyclable waste with the CE and the role of WTE in integrated management systems.

A. Background to the debate

1. Linear economy and its consequences

The mantra of today's so-called linear economy can be summarised as follows: take (raw material) – make (products) – use (consume) – dispose (of non-recyclable waste). This has been the economic and social *modus operandi* for many years now. Under this model, waste is the final phase in a society that arguably assumes it has unlimited resources for its consumption and production cycle.

This model has, however, unsustainable consequences. Currently, there are almost eight billion people in the world and the population is growing by roughly 80 million each year.[11] In 1971, energy consumption amounted to 5,519 million tonnes of oil equivalent,[12] with CO2 equivalent (CO2-eq) emissions reaching 15.4 billion tonnes.[13] In 2018 the energy consumption amounted to 14,282 million tonnes of oil equivalent, and CO2-eq emissions reached 36.6 billion tonnes. In other words, in less than 50 years worldwide CO2 emissions more than doubled. Another consequence of the linear economy is that a significant portion of today's Global Municipal Solid Waste (MSW),[14] which accounts for approximately 2.01 billion tonnes of waste per year, is not managed in an

[11] See online https://data.worldbank.org/indicator/SP.POP.TOTL
[12] See online https://www.iea.org/reports/world-energy-balances-overview
[13] See online https://data.worldbank.org/indicator/EN.ATM.CO2E.KT
[14] Municipal waste is defined as waste collected and treated by or for municipalities.

environmentally safe manner. As a result, the waste management sector is the 3rd largest source of anthropogenic methane, a potent greenhouse gas related to global warming and mainly associated with the landfilling of waste materials. Addressing methane emissions is critically important to combating climate change.[15] However, landfill and open dumping are widespread in many developing and transition countries. According to a World Bank analysis, about 70% of the waste produced globally is landfilled, and at least 33% of waste is still openly dumped/burned. Only 4% is disposed of in controlled landfills. [16] The global MSW generation is expected to increase to around 2.2 billion by 2025 and to 3.4 billion tonnes by 2050.[17]

These figures considerably demonstrate that the challenge of dealing with waste is both rather stark and pressing.

2. Circular economy

A CE approach decouples economic activity from the consumption of finite resources,[18] and in line with the PPPs for the SDGs approach, aims to create "value for people" and "value for the planet". [19] In response to the problems of a wasteful linear economy, the CE focuses, by contrast, on maintaining the value of products, materials and resources in circulation for as long as possible, thus minimising waste generation and resource consumption. The transition towards a CE is argued to create new business opportunities and jobs, and will imply innovative, more efficient ways of producing and consuming. It is also presumed that the process towards a CE will save energy and will help avoid irreversible damages to the environment and to society caused by the consumption of resources at a rate that exceeds the earth's capacity to renew them.

CE and zero waste are the policies adopted as a response to the unsustainable use of natural resources. It is argued that the implementation of these concepts in tandem, through a systemic approach including design principles and process integration, would ensure resource efficiency and sustainability.[20]

The general concept of zero waste is an excellent goal to strive toward; leading to a perfect and optimal cycle that allows materials to be forever used once extracted from the environment. Currently, however, this is not possible for many reasons, spanning from limitations of technology to human behaviour. Therefore, until this perfect cycle is achieved in practice, if ever, society has the responsibility to employ all solutions available to sustainably manage materials that become waste. The solutions of waste management should not only be environmentally sustainable, but also cost-efficient and socially acceptable.[21]

3. Waste-to-Energy

WTE for non-recyclable waste has been applied for many decades as a well-established waste management method in many highly environmentally sensitive economies.[22] WTE is an oligopolistic industry dominated by major players from developed countries. Many of them enter into strategic collaborations with local companies or take stakes in the latter when accessing new markets. The global WTE market size was valued at USD 31.0 billion in 2019 and is projected to register a compound annual growth rate of 7.4% until

[15] See online https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2019
[16] See online: https://openknowledge.worldbank.org/handle/10986/30317
[17] See online https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html
[18] See online: https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview
[19] See online: https://unece.org/DAM/ceci/ppp/Standards/ECE_CECI_2019_05-en.pdf
[20] The ECE is also publishing a set of guidelines on promoting CE in PPPs for the SDGs (ECE/CECI/WP/PPP/2022/4).
[21] See online https://ccnyeec.org/wp-content/uploads/2021/05/WTE-REPORT7603.pdf
[22] Also, it has been recognized by the International Energy Association, the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC) report, and others.

2027.[23]In total, in 2019, there were over 1,200 WTE plants in the world, with a total capacity of approximately 310 million tonnes of waste per year. It remains that some WTE plants incinerate recyclable fractions of waste, a practice which must be urgently abandoned if CE objectives are to be achieved.

Of critical importance, regulations must be in place for the design, financing, construction, operation and maintenance of WTE plants, ensuring that laws and regulations concerning emissions are diligently followed. To this end, state-of-art technologies in relation to pollution control must be integrated in WTE plants. There are existing technologies as well as upcoming ones (such as carbon capture)[24] which can lower CO_2 emissions and radically change the WTE industry to ensure it is CE responsive. A lot of emphasis should be placed on the maturity or readiness level of the technologies used for waste management.[25]

4. Waste-to-Energy in the European Union hierarchy

The EU has a very long history of promoting waste reduction and recycling, going back to 1975 with its first Directive - 75/442/EC - on this topic. [26] The European Commission plays a fundamental role within the EU on waste management, including on WTE within the EU waste hierarchy. In its Communication on WTE, the European Commission stated that WTE processes can play a role in the transition towards a CE provided that the EU waste hierarchy is used as a guiding principle and that choices made do not avert higher levels of prevention, reuse and recycling. [27] From the perspective of classifying activities as "environmentally sustainable", the EU taxonomy regulation specifies that any activity that leads to a significant increase in the generation, incineration or disposal of waste, with the exception of the incineration of non-recyclable waste is detrimental to the CE. [28]

Figure 1 shows the current EU waste hierarchy upon which the EU waste policy and legislation is based. Preventing waste is the EU preferred option, then in descending order is "preparing for re-use", "recycling", "other recovery" e.g. energy recovery through WTE for non-recyclable waste, and as a last resort the "disposal" of waste, including incineration without energy recovery and landfilling.

The primary purpose of the hierarchy is to establish an order of priority that minimises adverse environmental effects and negative public health impacts and optimises resource efficiency in waste prevention and management. It is therefore pivotal that going forward this waste management principle remains a key driver in legislative actions and policies touching on waste management.

[23] See online https://www.grandviewresearch.com/industry-analysis/waste-to-energy-technology-industry

[24] See online: https://ieaghg.org/ccs-resources/blog/new-ieaghg-report-2020-06-ccs-on-waste-to-energy

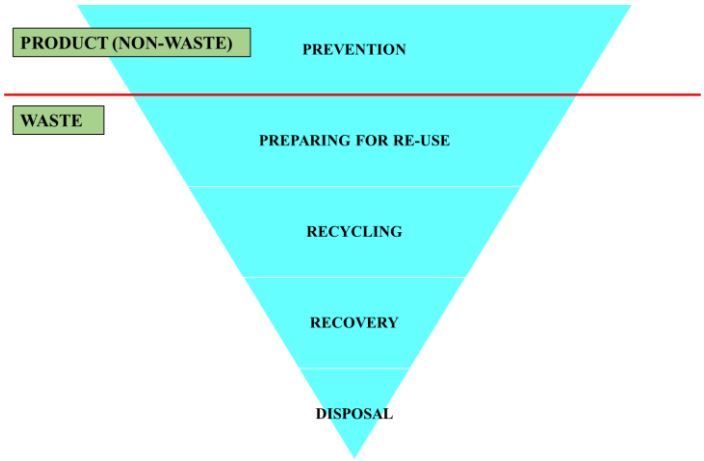
[25] See online: https://www.adb.org/publications/waste-to-energy-age-circular-economy-compendium

[26] See online https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31975L0442

[27] Communication from the Commission on the role of waste-to-energy in the circular economy, COM/2017/034 final https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52017DC0034

[28] Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, OJ L 198, 22.6.2020, p. 13–43 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R0852. See also the Commission's reply to Parliamentary question E-001543/2021, , and https://fead.be/wp-content/uploads/2020/10/FEAD_20200911_Legal_Analysis_Regulation_2020-852_WtETaxonomy_final_EN.pdf

Figure 1. Hierarchy of sustainable waste management



Source: European Union, Directive 2008/98/EC on waste (Waste Framework Directive)

B. The role of Waste-to-Energy in integrated waste management systems for the circular economy

As discussed, the only proven alternative to the landfilling of non-recyclable materials is WTE. The greenhouse gases (GHG) savings of WTE over landfilling have been well reported in the literature and recognized by major stakeholders. In the EU for instance and according to estimates from the European Environmental Agency, in the period between 1995 and 2017, GHG emissions from waste dropped by 42%.[29] This was mostly achieved by diverting materials from landfills towards recycling and composting, as well as toward WTE facilities (1995: approximately 30 million tonnes diverted from landfill; 2017: approximately 70 million tonnes). [30] In addition, WTE plants produce significantly higher amounts of energy as compared to landfills. This energy can further be used to substitute fossil fuels and enhance energy security.

Large quantities of metals can be recovered from WTE plants. Metals can be separated from waste before it is treated or extracted from the residual bottom ash, the incombustible and residual part of the incinerated waste. Important quantities of metals (steel and non-ferrous metals, mainly aluminium) and minerals remain present in these bottom ash residues, and can be recycled, thereby reducing GHG. Bottom ash has been used successfully and sustainably in the construction industry, in particular for roads or as an aggregate for concrete. Its use allows savings on virgin materials like gravel and sand.[31] Hence, bottom ash offers many opportunities for recycling, but also prevents the unnecessary extraction of primary raw materials, [32] and as such further contributes to the transition towards the CE. As to fly ash, the by-product of pollution-control technologies, it requires specific handling, disposal and/or treatment as it is considered hazardous. However, is also contains significant amount of platinum group metals and critical metals. As such it is often referred to as the "ore of the future". [33] Currently, studies are underway to better understand how to sustainably harness fly ash to further and better participate to the CE. [34]

[29] See online: https://www.eea.europa.eu/publications/annual-european-union-greenhouse-gas-inventory-2021
[30] See online: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20200123-1
[31] See online: https://eswet.eu/waste-to-energy-facts/
[32] See online: https://www.cewep.eu/wp-content/uploads/2017/09/FINAL-Bottom-Ash-factsheet.pdf
[33] See Paul Brunel and Helmut Rechberger, Waste to energy – key elements for sustainable waste management', see https://www.sciencedirect.com/science/article/abs/pii/S0956053X14000543?via%3Dihub
[34] For example, the city of Vienna developed material flow analysis in their effort to redirect specific waste flows that contain critical metals to be processed in WTE plants. Both materials must comply

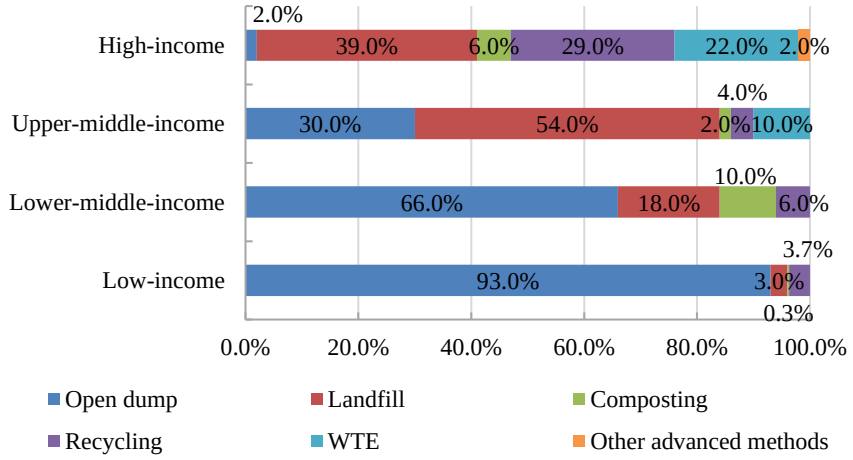
Nevertheless, it is important to note that the approach to waste and what to do with it is considered differently by different cultures and populations. The growing awareness of the value of waste in developed countries may differ elsewhere. The approach to WTE cannot consequently be uniform across all countries and cities; in addition, not all cities can financially support advanced and technologically developed integrated WTE systems.

Whilst these guidelines encourage striving towards this goal, they recognise cultural and financial factors, and suggest that in the absence of sophisticated collection systems, waste management legislations and/or cultural acceptance, the implementation of sanitary landfills equipped with landfill gas capture systems should be a first step to move away from open dumps. Annex III provides an example from the refugee camp of Cox's Bazar in Bangladesh, which transformed an open dump into an engineered landfill to process the camp's waste as a first step towards sustainable waste management and integrating certain aspects of the five desirable outcomes that constitute the ECE PPPs for the SGDs approach.

Box 1. Waste-to-Energy mainly exists in high income countries

WTE is almost non-existent in low- and middle-income countries where open dumpsites are prevalent. In low-income countries, 93% of waste is dumped (or burned) in roads, open land, or waterways, whereas only 2% of waste is dumped in high-income countries (see Chart 1).

Chart 1. Disposal methods by income



Source: What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050, World Bank, 2018.

According to this brief overview, a few and important pre-conditions seem to emerge for WTE to contribute to CE principles and practices:

1. Landfills are a major health and environmental problem and need to be scaled down. Even in the most developed countries, they are too prominent and WTE is a means of ultimately eliminating them.
2. WTE facilities cannot compete with recyclable and compostable products and should only process non-recyclable waste.
3. The design, financing, construction, operation and maintenance of WTE plants must ensure that laws and regulations concerning emissions are diligently followed. To this end, state-of-art technologies in relation to pollution control must be integrated in WTE plants.

with stringent standards to be beneficially used or safely disposed in landfills. As such, their utilisation and safe disposal can further participate to the transition towards the CE.

4. Stakeholders must be duly informed of WTE projects and stakeholder engagement made a priority, in particular as cultural factors can play a significant role in local communities' approval of WTE facilities.

Developing countries and transition economies should first work towards an integrated waste management system prior to develop and finance WTE facilities for non-recyclable waste. Developed economies should emphasize on efficient collection and sorting of materials, so that as little recyclable waste as possible goes to WTE plants. The following sections outline how a PPPs for the SDGs approach with its five outcomes, designed to ensure value for people and the planet for infrastructure projects can significantly contribute to reaching these objectives and guide governments and the industry to adopt legal and policy approaches that ensure best governance and practices in WTE projects.

IV. A Public-Private Partnerships for the Sustainable Development Goals approach to Waste-to-Energy projects in the Circular Economy

This section explores selected individual best-practice WTE projects to assess their actual and potential impact on CE practices. It consists of two parts: the first looks at traditional PPPs and why better and more expansive models, such as the PPPs for the SDGs approach advocated by ECE, are needed if the SDGs and the transition to a CE are to be achieved. The second part discusses the problems that WTE projects will have to overcome in order to contribute to this transition. To this end it showcases WTE projects, which succeeded (or could have succeeded) in contributing to the CE objectives by meeting one or more PPP for the SDGs outcomes.

A. Traditional Public-Private Partnerships and Public-Private Partnerships for the Sustainable Development Goals approach: main challenges to overcome.

PPPs are a favoured development strategy in countries for several industries, including WTE facilities. In a typical PPP structure for WTE projects, the developer undertakes the development of the project under the Design-Build-Own-Operate (DBOO) model. In the DBOO model, the developer secures its own financing and builds, owns, maintains and operates the WTE facility to create the energy capacity over the life span of the facility, which is about 25 to 30 years.

WTE facilities require significant upfront investments. Developers and their financiers require assurances from the Government agency commissioning the project, ensuring that satisfactory returns from the investment will be recovered over time.[35]Along with Government incentives, WTE projects are based mainly on two sources of revenue. The first source is a "gate fee" charged when municipalities, businesses or other organisations deliver their waste to the facility for disposal. The second source is the generation of energy, electricity and/or heat, that is sold to local power grids. Some end products coming out of WTE incineration like bottom ash, represent a third, smaller source of revenue.

Whether traditional PPP models are fit for purpose for the SDGs is a matter of debate. The complexity in the design and management of long-term public-private arrangements presents some limitations and challenges. In order to realise their social value beyond their economic value, PPPs need to be "fit for purpose". Hence, the ECE has advocated the need for a more expansive and broader developmental model, arguing that such "PPPs for the SDGs" should place sustainable development at its core and the "people" as the main beneficiaries.

[35] See online: https://home.kpmg/xx/en/home/insights/2019/10/waste-to-energy-green-solutions-for-emerging-markets.html

PPPs for the SDGs are to be evaluated according to a set of criteria for "quality infrastructure" investments. Overall, such PPPs for the SDGs should give meaning to "value to people" and "value to the planet" through achieving and complying with its five desirable outcomes (See Annex V).

B. Achieving Public-Private Partnerships for the Sustainable Development Goals in Waste-to-Energy projects

Combining "high quality" investments and achieving PPPs for the SDGs outcomes is challenging the WTE industry. The section takes each of the five outcomes in turn and outlines the opportunities of a PPPs for the SDGs approach for the WTE industry to be aligned with the SDGs and CE principles It showcases how some projects have successfully addressed one or several outcomes, [36] paving the way for current and future WTE projects to fit the PPPs for the SDG model. The projects referred to are set out in Annex VI .[37]

5. Increase access and promote equity

This outcome refers to whether as a result of the project, access to critical services, such as energy are achieved, especially for those who were previously unserved or served by a much lower quality of service.

Opportunity: Ensure the affordability of WTE projects to consumers in low- and middle-income communities.

A critical outlook at WTE advances that the industry does not, in fact, significantly contribute to the national grid and the energy supply of the country. It is also claimed that WTE facilities do not provide cheaper energy than other sources. From this perspective, WTE can be hardly presented as making energy more accessible to vulnerable groups, usually unserved or underserved in energy provision. However, WTE is a waste management method for non-recyclable materials, which in addition to safe disposal, produces energy from materials, which otherwise are landfilled. As such, WTE can offer significant direct, e.g. landfill diversion, and indirect benefits, e.g. substitution of fossil fuels, to the local population, if the service is designed properly, by considering low and middle-income communities.

For instance, the city of Glasgow, United Kingdom, used to send 72% of its waste to landfills. As the landfill tax continues to rise alongside ambitious Scottish Government zero waste to landfills targets, the government planned for change by focusing on waste reduction, re-use, enhanced recycling rates, and recovering renewable energy from residual waste. The WTE plant in Glasgow diverts 90% of materials away from landfills, saves about 20,000m^2 of land per year, and 90,000 tonnes CO_2 equivalent per year. In addition, it also recovers about 10,000 tonnes of metals and minerals. In sum, this WTE plant increased the provision of electricity to 26,500 households and provided heat to 8,000 homes, all of which by substituting fossil fuels and enhancing the energy security of Glasgow.

For its part, the WTE project in Maardu, Estonia contributed to approximately 20% to the heating demand of the local communities, at one-fourth of the price provided by the conventional fossil fuels, and generated enough electricity to meet the demands of small cities in proximity to the facility.

Overall, the societal benefits of WTE plants cannot be assessed solely from the perspective of energy production. WTE plants' primary mission is the treatment of residual waste that would otherwise be landfilled, while it also provides supplementary benefits mentioned above.

[36] Whilst projects are presented for their contribution to one particular outcome, some projects could also fit under some or all of the five outcomes.

[37] These projects are drawn from jurisdictions that have placed emphasis on the promotion of efficient separate collection of waste and instituted stringent regulations for WTE operations.

6. Improve projects' economic effectiveness and fiscal sustainability

This outcome refers to the project's contribution to, inter alia, good quality jobs, technology and innovation including the project's ability to utilise sufficiently all economic assets, including the empowerment of women and the profitability of the project.

Opportunity: Design and operate WTE projects that guarantee local economic impact.

Do WTE projects provide well paid jobs, transfer knowledge to local people and benefits to the community as a whole? And at the base of the pyramid, do WTE projects materially improve the livelihoods of the low-income and marginalised groups?

WTE plants can indeed negatively affect the livelihood of communities if they do not adequately consider the interests of local people during the construction and operation of the project. Particularly, a major concern relates to low-income families relying on informal recycling activities for their income as well as other vulnerable and impacted populations.

When adequately designed and governed, WTE projects can provide a viable support for these groups and provide high quality jobs and transfer knowledge to the local community in addition to other monetary benefits. For example, the WTE project in Dublin, Ireland, provided about 100 jobs to local people for the operation of the plant, and more than 50 jobs during construction that also included extensive training, and transfer of know how. In addition, more than €10 million has been allocated for the community to date, paid for out of the revenues generated by the project. Similarly, the WTE project in Baku, Azerbaijan, provided 900 jobs during the construction, and 90 jobs during the operation of the plant.

WTE projects typically do not advocate gender quality and women's empowerment, which is something they should put emphasis on, in order to fully comply with that specific outcome. A dedicated body should ensure that women and vulnerable groups are getting high-quality jobs as a result of WTE projects.

7. Improve environmental sustainability and resilience

Environmental sustainability refers to the protection and preservation of the planet and is a basic requirement of sustainability. [38] *Mitigating the impacts of climate change is integral to the successful implementation of the SDGs.*

Opportunity: Embed latest technologies within WTE plants to ensure compliance with stringent pollution standards

There is a significant concern that WTE relates to emissions that harm the environment, but also, if not designed properly, WTE can reduce recycling in communities. However, when designed for non-recyclable waste only and to divert materials from landfills, WTE projects produce significant environmental benefits for communities and enhance recycling with the recovery of metals and minerals from the bottom ash fraction. In addition, if WTE plants comply with stringent standards, such as the EU Directive, then they produce insignificant amounts of toxic compounds, and thus do not affect public health. [39] Highly developed and environmentally sensible economies use integrated waste management systems, which include recycling/composting facilities and WTE plants for the residual waste, to divert materials from landfills. Some cities, such as Vienna, Paris, Osaka, and Brescia built WTE plants that became landmarks and tourist attractions. The most recent addition is the new WTE plant of Copenhagen that has a roof used as a ski slope. WTE plants are often built in the middle of residential or industrial sites. This is so as to minimize travel distance from the point of generation to WTE facilities, as well as to facilitate the use of the by-product low-pressure steam of the turbine generator for

[38] Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment: https://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf

[39] See online: https://www.cewep.eu/dioxins-wte-state-of-the-art/

district or industrial heating or cooling. For example, Denmark provides around 30% of the heating demand by WTE, and South Korea around 15%.

In Belgrade, Serbia, a PPP contract was set up for the construction and operation of the WTE plant, the construction of a landfill and a recycling facility, all aiming to close a non-sanitary landfill which had been operating for 40 years, and on which Roma families lived. The PPP project's sponsors are responsible for the closure and remediation of the non-sanitary landfill, and the municipality aided Roma families living on the old landfill to find employment and accommodation. The project thus contributed to environmental sustainability and resilience.

For its part, the WTE plant in Barcelona, Spain saves 19,000 tonnes CO_2 equivalent per year, reduces fossil fuel consumption by 58%, improves the energy performance of the buildings that are using heat from the plant, and recovers about 15,000 tonnes of metals and minerals. The plant integrates the latest technologies to ensure compliance with EU stringent pollution standards and improve environmental sustainability and resilience.

These aforementioned cases demonstrate excellence in circularity, by reducing, or even eliminating the use of landfills, as well as by maximising the resource and energy efficiency of the waste management systems. In addition to harnessing technological developments to ensure compliance with polluting emission limits, these developments put emphasis on industrial symbiosis, in which several industrial entities develop mutually beneficial relationships.[40] Such systems increase resilience and economic gains, while reducing the environmental impact and costs. [41]

8. Replicability

Replicability refers to the project's emphasis on the replicability and scalability of the technologies and programmes, for these to be developed elsewhere. For this, the governmental, industrial, and communal capacities should be enhanced, by providing training opportunities for the local communities, and cultivating specific skills of the local stakeholders.

Opportunity: Train local staff in to guarantee skills transfer for projects to be reproduced at local levels

In terms of skills transfer, WTE companies do frequently provide training opportunities to local dwellers, who can become employed as professional plant operators. For instance, In Doel, Belgium, the WTE plant enhanced the communal capacities by organising training programmes for local stakeholders. The project was associated with the decommissioning of the gas-fired boilers that resulted in savings of 200,000 tonnes CO_2 equivalent per year, but also the process recovers about 20,000 tonnes of metals, and minerals that are used in construction.

On the technology side, the wrong selection of the WTE technology can lead to significant losses for the community as well as the project sponsors. For example, in the case of the Tees valley project in the United Kingdom, where a plant was to be built, the project resulted in the loss of 700 jobs and reported a loss of about USD 1 billion because of the failure of the technology involved.

9. Stakeholder engagement

PPPs for the SDGs encourage the project developers to engage all the people and stakeholders who may be affected by the project. Effective engagement requires good quality and understandable data – provided by the project sponsors to all stakeholders – by which to evaluate the performance of the plant.

[40] Industrial symbiosis systems are a key component of CE. They are based on collaboration and the synergistic possibilities offered by geographic proximity, where the industries find ways to use the waste from one process as raw materials for another.

[41] See online: https://publications.iadb.org/en/increasing-infrastructure-resilience-with-nature-based-solutions-nbs

Opportunity: Harness stakeholder engagement to improve project designs, knowledge transfer to communities and offset risks of community backlash

WTE projects can create strong opposition from local stakeholders which may, in some instances, be due to information asymmetries. In addition, there can be a lack of trust between the authorities and/or the project sponsors responsible for the construction and operation of the project and local stakeholders. Strong opposition can delay or even cancel the construction of the plant, such as in Araucania, Chile, where a WTE project for non-recyclable waste was eventually abandoned. The opposition was partly caused by a lack of communication, but also and especially as an important concern over the livelihood of vulnerable groups was not adequately nor sufficiently addressed.

The level of stakeholder engagement is strongly associated with the capital investment required for WTE projects. On average, WTE plants cost between $600 and 800/ton, although differences may exist between nations. For instance, although the WTE plant in Dublin, Ireland was commissioned in the late 1990s, it only opened in 2018 due to strong public opposition. The final capital investment required was around $1,200/ton, as compared to $600/ton, as initially estimated. Project failures due to a lack of stakeholder engagement can be prevented if the project design integrates the following points:

- the project engages all stakeholders, including and in particular vulnerable groups, in the planning, construction, and operation of the plant;
- the project provides high quality and understandable data to affected communities to ensure a zero-tolerance approach to corruption and transparency.

In Trimmis, Switzerland, local groups organised effectively to change the policy of a company involved in a WTE project and were given opportunities to have their views heard. Stakeholders were fully consulted in drawing up plans, in the setting up of the facilities, in the tendering process, etc. Assurances about health and wellbeing were given to the populations by project's experts, for instance concerning the monitoring of emissions and the project contributed not only to the development of the local infrastructure but to the overall economy.. Including stakeholder in the design phase of a WTE PPP project can help ensure project benefits to affected communities.

The above-mentioned PPP projects demonstrate that using the ECE PPPs for the SDGs approach at the outset and across the five outcomes and throughout the project can assist in achieving significant social and environmental objectives, and be ultimately consistent with CE principles. However, to scale up these examples, governments and other stakeholders need to play a key role in moving the WTE industry onto another level.

V. Embracing the Circular Economy: Seven recommendations for Public-Private Partnerships Waste-to-Energy projects to be fit for the Sustainable Development Goals

WTE is evolving due to several factors, such as government policy and actions against climate change and supporting CE processes, new technological developments and corporate strategies. PPPs for the SDGs have the potential to overcome key problems and barriers to the CE. This part tentatively elaborates seven best practice recommendations for transforming WTE PPPs into projects that follow the five desirable outcomes critical to PPPs for the SDGs to ensure that they fit the circular approach.

1. Vision

Challenge

Historically, waste has been perceived as undesirable. This "throwaway" mentality is at odds with CE principles and processes. A high percentage of waste still goes to highly polluting landfills. Most of the world is still overwhelmed by waste and cannot manage it as a resource. Europe and Central Asia together are expected to generate 490 million tonnes per year by 2050, roughly 100 million tonnes more than the amount generated in 2016.[42]

Recommendation 1: Embed circular economy visions and principles into Government policies.

WTE projects delivered through PPPs for the SDGs can contribute to turning non-recyclable waste into a resource and operating the enterprise as a purpose-oriented business (with purpose before profit), a client-oriented focus and generating new business and service opportunities. Governments and local authorities need to encourage the WTE industry to operate with contributing to the CE as a core objective.

Specific recommendations

1.1 Valuing waste: projects should prioritise efficient collection and pre-processing systems, which can prevent the loss of potentially valuable waste, and should aim at avoiding the use of land for throwing waste away. To promote WTE for non-recyclable waste, it is therefore necessary to highlight the importance of preventing waste, reusing waste products and recycling as much as possible.

1.2 Encouraging new WTE technologies and processes where WTE is not common: such a programme should particularly focus on low- and middle-income countries where WTE projects are relatively rare. These are the countries where WTE for non-recyclable waste could, under the right regulations, gradually replace landfills which are cheaper but dangerous for the public health and the environment.

1.3 Developing countries and transition economies are first encouraged to develop solid regulatory frameworks that guides waste management along the five desirable outcomes that are core to PPPs for the SDGs before financing WTE facilities for non-recyclable waste. The ECE secretariat can offer assistance to ECE member States seeking to engage in this process.

2. Scope and scale

Challenge

Waste is set to grow exponentially in the coming years and the size of WTE plants is predicted to grow in commensurate fashion, creating mega plants dealing with enormous quantities of waste. But in the CE, there should be a focus on smaller scale and decentralised operations serving specific purposes in decentralised systems. The waste hierarchy, which is a standard, needs to reflect the CE challenges. CE focuses on decentralized systems, but also, on materials design, and the extension of products lifetime.

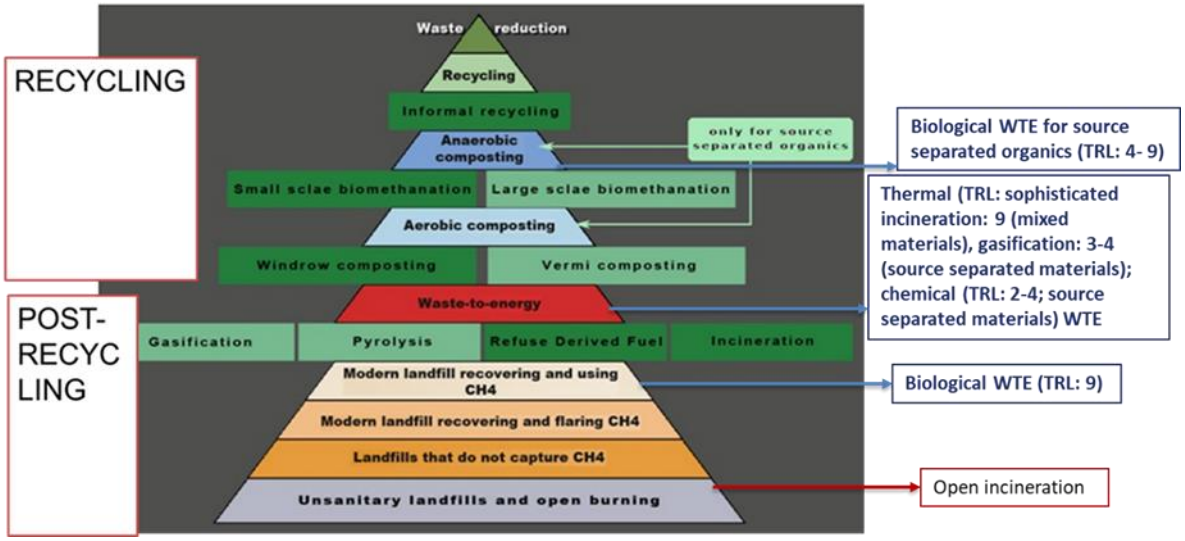
Recommendation 2: Internalise externalities, gain social acceptance and mobilise investments.

The waste hierarchy should encapsulate the CE activities as presented in Figure 2. In this context, emphasis should be given on two separate activities: resource management, and waste management. The first requires advocacy of innovations, and strong regulatory environment to enhance the smarter product use and manufacture, as well as to extend the lifespan of product cycles. Waste management should be related to sophisticated collection systems, outreach programmes to enhance public participation, and maximum

[42] See online https://openknowledge.worldbank.org/handle/10986/30317

resource and energy recovery; certainly not landfilling or incineration of waste without energy recovery. Also, PPPs for the SDGs should focus on marginalised and vulnerable groups such as refugees, indigenous peoples and other vulnerable communities.

Figure 2. Hierarchy of sustainable resource and waste management



Source: Themelis, Diaz Barriga and Estevez and Velasco, "WTE Guidebook 2013 for the Application of WTE Technologies in Latin America and the Caribbean".

Specific recommendations

WTE PPPs for the SDGs projects for non-recyclable waste should focus on specific areas and purposes that are "circular" for better waste resource management. WTE PPPs for the SDGs should:

2.1 Advocate the implementation of industrial symbiosis solutions, that aim at maximum recycling/composting of resources, and maximum energy recovery from the residual fraction, by using the waste from one process as raw materials for another.

2.2 Address non-recyclable waste which is waste of poor quality. This prevents the recycling cycle from being contaminated with polluted products.

2.3 Create energy out of the biodegradable fraction of waste in the WTE process.

2.4 Ensure that the bottom ashes from incineration are turned into real valuable products with the recovery of metals as well as for construction purposes, roads and bridges etc, and in line with existing stringent pollution standards. Fly ashes from incineration should be disposed of in a sustainable and safe manner.

3. Technology and capacity building

Challenge

Many projects in the WTE industry are often outdated and utilise technologies that are polluting and cancer inducing. Combustion technologies can lead to a dangerous level of toxic emissions, if not monitored constantly and properly. Accordingly, the challenge is to encourage the use of more appropriate and advanced technologies that are both expensive and require skills that are not available in many countries.

Recommendation 3: Select suitable technologies that are innovative and less polluting, and ensuring their affordability and financing in transition economies.

WTE PPPs for the SDGs should adopt the right CE- enhancing technologies including "cleaning" the circular process by removing dangerous harmful substances and helping the local economy with skills development to utilise these technologies.

Specific options

3.1 WTE PPPs for the SDGs should operate with sophisticated air pollution control systems, and their emissions must be lower than strict emission standards, such as the EU Directive.

3.2 A system to monitor emissions from WTE plants needs to be put in place with centralised registers controlled by the appropriate public environmental agencies.

3.3 Such data and information need to be publicly available.

4. Fiscal incentives

Challenge

Tax incentives and subsidies are being used to encourage WTE plants that are environmentally harmful - for example by support being given to projects claiming to produce renewable energy when in fact they do not.

Recommendation 4: Provide economic incentives and price support to WTE projects that adopt CE processes.

WTE PPPs for the SDGs should benefit from fiscal incentives that encourage such projects to adopt CE processes and move upwards in the waste hierarchy.

Specific recommendations

4.1 Governments should consider increasing the landfill tax and consider a credit for WTE for energy production, e.g. feed in tariffs or the issuance of tradable green certificate with a guaranteed minimum market value for capacity installed.

4.2 Access to public funding should be granted on a science-based and technology-neutral approach in line with the waste hierarchy, e.g. the WTE project replaces an existing landfill, and its capacity matches local needs for residual waste treatment.

4.3 Results-based financing, e.g. environmental impact bonds, should be considered to address the construction, operation, and counterparty risks in WTE investments for non-recyclable waste facilities. Governments should support cities to bring order to their financing and accounting practices and help them become creditworthy.[43]

5. Partnering and partnerships

Challenge

Partnership can bring countries financial resources, technology and management skills but countries often lack the knowledge of the track record of good international partners with these attributes.

Recommendation 5: Identify good partners and monitor the performance of such partnerships.

WTE PPPs for the SDGs should partner only with enterprises that display WTE technologies compatible with CE processes.

[43] See online: https://openknowledge.worldbank.org/bitstream/handle/10986/32192/Innovative-Finance-Solutions-for-Climate-Smart-Infrastructure-New-Perspectives-on-Results-Based-Blended-Finance-for-Cities.pdf

Specific recommendations

5.1 Governments should consider using all means available to help companies roll out their innovative technological solutions beyond their borders especially to the low- and middle-income countries which lack such technologies. Such promotion can have beneficial outcomes on lowering emissions in such countries which predominantly use landfills.

5.2 Investment promotion agencies should identify opportunities and ways to use foreign direct investment to green their economies and give greater visibility to green investment opportunities e.g. through successful pilot projects and the preparation of pipelines of bankable projects.

6. Public procurements and good governance

Challenge

Many countries lack proper procurement regulatory frameworks that can lead to a lack of transparency and poor governance.

Recommendation 6: Establish transparent and open procurement processes and the adoption of a zero-tolerance approach to corruption in public procurement.

WTE PPPs for the SDGs for non-recyclable waste should participate in open, competitive procurements and be selected on the basis of their commitment to CE values and processes, their track record and their own commitment and rigorous endorsement of a zero-tolerance approach to corruption.

Specific recommendations

6.1 Critical for the improvement of projects and their impact on society and the environment are transparent and open procurement processes and the adoption of a zero-tolerance approach to corruption in public procurement.

6.2 Governments should be encouraged to comply with the ECE Standard on a Zero Tolerance Approach to Corruption in PPP Procurement44 and inform the ECE secretariat on how they are implementing this option.

6.3 Establishment of (or the coordination with existing) regulatory authorities is key to ensure the continuous monitoring of the operations, and to advance the confidence of the public and the investors.

6.4 WTE PPPs for the SDGs for non-recyclable waste should follow green PPP/public procurement principles throughout the whole lifecycle of a project, by which for example, goods, services or works would be sourced with a reduced environmental impact.

7. Stakeholder and community engagement

Challenge

WTE plants are sometimes located in poor and marginalised communities that lack the economic power to resist and challenge the location of WTE plants and have been accordingly criticised for “environmental discrimination”.

Recommendation 7: Enhance local participation in projects by supporting women’s empowerment, including vulnerable groups and ensuring strong stakeholder engagement.

WTE PPPs for the SDGs for non-recyclable waste should engage with stakeholders in a new “social contract” that regularly consults with communities, providing them with information and data on their performance and be accountable to monitoring and scrutiny by local communities where plants are located.

[44] ECE Standard on a Zero Tolerance Approach to Corruption in PPP Procurement (ECE/CECI/WP/PPP/2017/4),https://www.unece.org/fileadmin/DAM/ceci/ppp/Standards/ECE_CECI_WP_PPP_2017_04-en.pdf

Specific recommendations

7.1 Include local groups in the design, construction and operation of the plant to help public acceptance and advance the social contribution of the projects.

7.2 Project sponsors should promote the development of civil engineering projects for the community, e.g. land restoration, open dumps to land, WTE, etc.; and with benefits to the community, e.g. cheap energy, lower collection costs, green areas among others.

VI. Conclusions and follow-up

The WTE industry for non-recyclable waste forms an interesting sub plot of the transition to the CE. For WTE processes to ensure a contribution to the CE, the right pre-conditions and enabling framework are required. In addition to promoting and resorting to WTE for non-recyclable waste only, it is vital that Governments and all stakeholders, adopt or endorse the seven best practice optional policy recommendations proposed in this document:

1. Embed CE visions and principles into Government policies;
2. Internalise externalities, gain social acceptance and mobilise investments;
3. Select suitable technologies that are innovative and less polluting;
4. Provide economic incentives and price supports;
5. Identify good partners and monitor the performance of such partnerships;
6. Establish transparent and open procurement processes and the adoption of a zero-tolerance approach to corruption in public procurement; and
7. Enhance local participation in projects that includes women's empowerment and vulnerable groups and ensure strong stakeholder engagement.

As a follow up to these Guidelines, the following can be suggested:

(a) **Promote discussion** on the WTE Guidelines and its best practice recommendations by Governments, the industry and civil society. In this regard, **consult** with those governments who have ample experience well as governments whose engagement with WTE is still at an emerging stage.

(b) **Disseminate** the WTE Guidelines to low- and middle-income countries in the ECE region. In this regard, **encourage** countries to cooperate both bilaterally and multilaterally to disseminate best practise People-first PPPs for the SDGs in the WTE industry. Subject to resources and demand by countries in the ECE region, the secretariat could provide capacity building and policy advisory services on the topic.

(c) **Use the WTE Guidelines as a test case for** the ECE PPP Evaluation Methodology for the SDGs[45] for WTE projects to determine their sustainability credentials and adherence to the five desirable outcomes, and disseminate the results to stakeholders.

(d) **Prepare** further stepwise and targeted guidance on how the WTE industry can maximize its contribution to the transition to a CE through a PPPs for the SDGs approach.

[45] More information on the ECE PPPs for the SDGs Evaluation Methodology is available online: https://unece.org/ppp/em

Annex I.

[English only]

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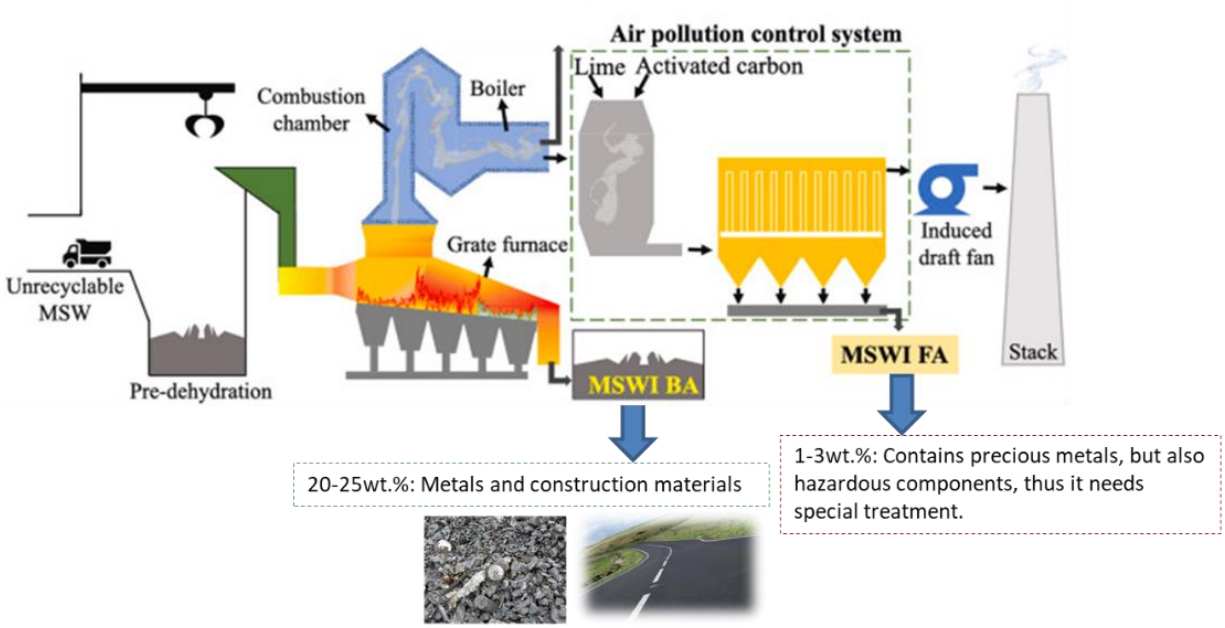
Annex II.

[English only]

Incineration-based Waste-to-Energy



Source: Lam et al. "Use of Incineration MSW Ash: A Review", Sustainability 2020 2(7)[46]

[46] See online: https://www.mdpi.com/2071-1050/2/7/1943

Annex III. [English only]

From open dumps to sustainable waste management: a case study from a refugee camp in Bangladesh

Refugee's camps in Cox's Bazar, Bangladesh

Challenge: The camp was using an open dump for the disposition of approximately 40 cubic meters of waste a day, creating significant public health effects. For example, more than 200,000 cases of acute diarrhoea were reported in the Rohingya camps in 2018, as well as respiratory infections and skin diseases.

Description of the project: Transform the open dump into an engineered landfill to process the waste of 150,000 people – equivalent to the population of Abuja, as a first step towards sustainable waste management.

Partners: The development was funded by the United Nations High Commissioner for Refugees (UNHCR). A suitable site was provided by the Government of Bangladesh and the project was delivered in collaboration with the Refugee Relief and Repatriation Commissioner's Office in Cox's Bazar. Oxfam engineers and Rohingya refugees have built and operated the system. The initial investment of developing the site and installing the equipment was approximately $400,000.

Contribution of this project to the five PPPs for the SDGs outcomes:

- The project considered the refugees for the construction and operation of the landfill; thus promoted equity (outcome 1).
- The project significantly reduced health risks for refugees and host communities and the likelihood of diseases outbreak; thus promoted environmental sustainability and resilience (outcome 3).
- The developers trained the refugees and included them in the different stages of the development; thus promoted replicability (outcome 4), and stakeholder engagement (outcome 5).

Annex IV.

[English only]

Arguments put forward against and in favour of incineration-based Waste-to-Energy

Arguments put forward against WTE	*Counterarguments*
WTE reduces recycling/composting, acting as a disincentive or even barrier to circular economy or zero waste practices. Turning unsorted and usable trash into a valuable fuel commodity means communities are less likely to choose to reduce, reuse and recycle it.	WTE can be part of a holistic waste management strategy, if it processes non-recyclable waste only. The EU countries reduce landfilling of wastes, by a combined effort of recycling/composting and WTE.[47] In the United States of America, counties and municipalities that utilise WTE consistently show an increased recycling rate, in parallel to WTE practice.[48]
WTE raises environmental concerns, exacerbating climate change, emitting toxic emissions and giving rise to air pollution.	Today's technology allows WTE projects to operate with limited to no polluting effects. In addition, WTE plants must comply with stringent environmental standards, such as the EU Industrial Emissions Directive. Incineration does cause emissions, however WTE facilities equipped with sophisticated Air Pollution Control systems have far less severe impacts on air pollution. Incinerators which are not WTE facilities do not produce energy. There are over hundreds of thousands of incinerators in the world, whereas WTE facilities are far less numerous, over 1,500.[49] [50]
WTE raises societal concerns and communities are opposed to them in their neighbourhoods. In some countries, popular protests have taken place over the location of WTE plants reflecting serious concerns by residents on the impact to their health.	WTE plants monitor their emissions continuously, and report these on site and/or online. Many WTE plants around the world are built in the middle of residential or industrial sites so as to facilitate the use of heat for district or industrial heating or cooling.[51]

Source: ECE.

[47] See online https://ec.europa.eu/environment/industry/stationary/ied/legislation.htm and https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Municipal_waste_treatment,_EU-27,_(kg_per_capita)_new.png&oldid=323975

[48] See online https://www.wtienergy.com/sites/default/files/ERC-2014-Berenyi-recycling-study-1.pdf

[49] See online http://gwcouncil.org/the-list-of-waste-to-energy-facilities-in-the-world

[50] See online https://www.cewep.eu/wte-climate-protection/

[51] The United Nations Environment Programme identifies modern district energy as the most effective approach for many cities in transition to sustainable heating and cooling, by improving energy efficiency and enabling higher shares of renewables. WTE is presented as a way to produce low-cost heat and often initiate development of a city's district heating network, utilising the energy content embedded in the waste. According to the EU experiences, if plants process over 50% of biodegradable and non-recyclable materials. See online https://wedocs.unep.org/handle/20.500.11822/9317

Annex V.

[English only]

PPPs for the SDGs: outcomes and criteria

Outcomes	*Criteria*
Access and equity	Provide essential services
	Advance affordability and universal access
	Improve equity and social justice
	Plan for long-term access and equity
	Avoid/minimise and mitigate physical and economic displacement
Economic effectiveness and fiscal sustainability	Avoid corruption and encourage transparent procurement
	Maximise economic viability and fiscal sustainability
	Maximise long-term financial viability
	Enhance employment and economic opportunities
Environmental sustainability and resilience	Reduce greenhouse gas emissions and improve energy efficiency
	Reduce waste and restore degraded land
	Reduce water consumption and wastewater discharge
	Protect biodiversity
	Assess risk and resilience for disaster management
	Allocate funds for resilience and disaster management
	Advance community-driven development
Replicability	Encourage replicability and scalability
	Standardise PPP preparation and tender
	Enhance Government, industry and community capacity
	Support innovation and technology transfer
Stakeholder engagement	Plan for stakeholder engagement and public participation
	Maximise stakeholder engagement and public participation
	Provide transparent and quality project information
	Manage public grievances and end user feedback

Source: ECE, based on the Public-Private Partnerships Evaluation Methodology for the Sustainable Development Goals (ECE/CECI/WP/PPP/2021/3), 2021.

Annex VI. [English only]

List of projects[52]

1. PPPs for the SDGs: outcome number one "Increase access and promote equity"

Glasgow, Scotland

Challenge: The city was sending 72% of their wastes to landfills. As landfill tax continues to rise alongside ambitious Scottish Government zero waste targets, the city council has been planning for change, by focusing on waste reduction, re-use, enhanced recycling rates, and recovering renewable energy from residual waste

Description of the project: The Glasgow Recycling and Renewable Energy Centre (GRREC) in Polmadie has a designed capacity of 200,000 tonnes of waste every year. GRREC produce materials that have a value in the market through the recycling facility, energy from the organic fraction through Anaerobic Digestion, and 97GWh of energy through the processing of the residual fraction in the WTE plant, which is enough power to supply 26,500 households with electricity, and 8,000 homes with heat.

Partners: The project is a 25-year partnership between Glasgow City Council and Viridor. The capital investment was GBP254 million.

Contribution to the outcome "Increase access and promote equity":

- The plant provides clean electricity to 26,500 households, and heat to 8,000 homes, by substituting fossil fuels and enhancing the energy security of Glasgow.
- The project created 18 new apprenticeships and over 250 jobs, mainly for low income communities

Maardu, Estonia

Challenge: About 300,000 tonnes of mixed municipal waste per year were disposed of in non-sanitary landfills.

Description of the project: The WTE plant is designed to receive 220,000 tonnes of municipal waste and produce 17 MW of electricity and 50 MW of heat.

Partners: Eesti Energia, Constructions industrielles de la Méditerranée (CNIM), Merko Ehitus, Martin GmbH. The capital investment of the PPP was EUR 105M.

Contribution to the outcome "Increase access and promote equity":

- The project contributes to approximately 20% of the heating demand of the local communities of Tallinn and Maardu, at one-fourth of the price provided by the conventional energy sources.
- The electricity production meets the electricity consumption of the town of Paide and its surroundings.

2. PPPs for the SDGs: outcome number two "Improve economic effectiveness and fiscal sustainability"

Dublin, Ireland

Challenge: The project faced significant opposition, associated mainly with concerns on the traffic and emissions, but construction work finally started in 2014, and completed in 2018.

[52] The findings, interpretations, and conclusions expressed in the case studies in this Annex do not necessarily reflect the views of the ECE secretariat. Mention of company names or commercial products does not imply endorsement of the United Nations.

This was about 20 years after the commissioning of the plant and was related to a significant increase in the capital investment required for the project.

Description of the project: The plant is located in Poolbeg, Dublin Port, and has a treatment capacity of about 1,600 tonnes of waste per day to generate electricity for up to 80,000 homes annually, and district heating for a further 50,000 homes. The designed capacity of the plant is up to 61 megawatts of energy. The operation of the plant substitutes about 250,000 tonnes of fossil fuels per year.

Partners: The Dublin WTE project is a PPP between Dublin City Council (acting on behalf of the four Dublin Local Authorities) and Covanta Energy, as part of the Dublin Regional Waste Management Plan. CDM Smith was the representative of Dublin City Council for the successful completion of the project.

Contribution to the outcome "Improve projects economic effectiveness and fiscal sustainability":

- Covanta Energy provided about 100 jobs, 60 of which are full time at the facility, and 35-40 full-time contractor and service support roles.
- More than 300 jobs were created during construction, of which more than 50 jobs were given to local people. Many have secured permanent employment at the facility. ¨
- Covanta Energy has allocated more than €10 million for the community to date, with an additional future annual contribution of €600,000 based on the annual throughput of waste

Baku, Azerbaijan

Challenge: Baku was using non-sanitary landfills for the deposition of the waste materials, which was associated with significant methane emissions. The country aims to reduce GHG emissions by 35% by 2030.

Description of the project: The WTE plant processes 500,000 tonnes of municipal waste per year and 10,000 tonnes of hospital waste to produce over 230 million kWh of electricity/year. The project covers 10 hectares of land and it is one of the largest facilities in Europe.

Partners: "Tamiz Shahar" JSC, a joint stock company 100% owned by the state of Baku, was created to manage the municipal solid waste of the region. The company awarded CNIM the design, construction and operation (DBO) for 20 years of an energy recovery facility. The capital investment was €377.5 million, of which €277.6 million were provided by the government of Azerbaijan and €149.9 million by the Islamic Development Bank.[53]

Contribution to the outcome "Improve projects economic effectiveness and fiscal sustainability":

- CNIM hired up to 900 people for the construction of the plant.
- For the operation, the plant employs 90 local staff.

[53] See online: https://www.ebrd.com/work-with-us/procurement/pn-51281.html

3. PPPs for the SDGs: outcome number three "Improve environmental sustainability and resilience"

Belgrade, Serbia

Challenge: A landfill has been operated for more than 40 years at the Vinča locality, located approximately 12 km of Belgrade. This landfill is the largest unmanaged landfill site remaining in Europe and does not meet Serbian or EU standards for Sanitary Landfills posing a source of pollution of groundwaters and surrounding soil. The landfill received about 90% of the waste produced by thirteen municipalities in the greater city of Belgrade (more than 1,500 tonnes of household waste and around 3,000 tonnes of construction waste every day) and occupied about 40 hectares of land near the bank of Danube River. Due to decomposition and poor waste treatment, fires emitting dense smoke are frequent at the site. In August 2021, following a fire eruption at the site, much of Belgrade was covered in smoke, foul smells, and haze, prompting the authorities to warn citizens to stay inside due to the heavy air pollution

Description of the project: The PPP contract involves the construction and operation of the Vinča WTE plant, the construction of a landfill, and a recycling facility for construction and demolition wastes. Also, the project sponsors will be responsible for the closure and remediation of the Vinca non-sanitary landfill. The 103MW WTE facility will have capacity for a volume of approximately 340,000 tonnes of household waste every year.

Partners: The WTE facility is being developed by Beo Čista Energija (BCE), a special purpose company formed by French utility company Suez, Japanese conglomerate Itochu, and pan-European equity fund Marguerite II. The capital investment is €370m. IFC and MIGA, members of the World Bank Group, are providing a €259.57 million financing and guarantees package to Beo Čista Energija. IFC's PPP transaction advisory department acted as the City of Belgrade's lead transaction advisor from 2014 to structure and tender the project.

Contribution to the outcome "Improve economic effectiveness and fiscal sustainability":

- The development replaced the largest unmanaged landfill site in Europe posing a source of pollution of groundwaters, surrounding soil and atmosphere.

- 17 Roma families were living on the site and working informally as waste-pickers. The city relocated the families and helped them find new apartments and jobs.

Barcelona, Spain

Challenge: Barcelona was using fossil fuels to provide steam to the 16.8 km long district heating and cooling network.

Description of the project: The Integrated Waste Management Plant (PIVR) of Sant Adrià de Besòs includes two plants: The WTE Plant, managed by TERSA, and the Mechanical-Biological Treatment (MBT) Plant, managed by Ecoparc del Mediterrani. The MBT plant processes unsorted wastes for recycling, and organic materials for composting, and for the production of a small fraction of energy through anaerobic digestion (AD). The residues of the MBT are mixed with non-recyclable municipal solid waste and are processed in the WTE plant. The WTE plant processes 360,000 tonnes of municipal waste per year to produce about 195 GWh of electricity, and over 125,000 tonnes of steam that is used for district heating and cooling.

Partners: The city of Barcelona, is responsible for the collection and treatment of municipal solid waste. The construction project was awarded to Ros Roca SA, Hitachi Zosen Inova's partner in Spain. Ros Roca then commissioned the design, supply, and test operation of incinerators and peripheral equipment to Hitachi Zosen Inova.

Contribution to the outcome "Improve environmental sustainability and resilience":

- The city reduced its fossil fuel consumption by 58%.
- The project saves about 19,000 tonnes of CO_2 equivalent per year.
- The energy performance of the buildings served by the network improved from 99.83 kgCO_2/m² (E-label) to 55.14 kg CO_2/m² (C-label).
- The project recovers about 30,000 tonnes of dry recyclable material, e.g. paper, plastics, etc., and about 35,000 tonnes of compost.

4. PPPs for the SDGs: outcome number four "Encourage the replicability of projects"

Doel, Belgium

Challenge: The city was using gas-fired boilers to produce energy for the chemical companies operating in the region.

Description of the project: The project operates two WTE plants: Indaver's three grate incinerators and SLECO's three fluidised bed incinerators, with a total capacity of 1 million tonnes of non-hazardous household, industrial, and sludge waste per year, to produce 250 MW of heat. The energy is fed primarily into the ECLUSE-steam network to meet the demand of six industrial companies in Waasland Port. The remainder is converted into electricity. The process recovers recyclables from the bottom ash fraction: metals: ferrous and non-ferrous metals; aggregates: used in the construction industry, including for road sub-bases and other structures; sand fractions: used for construction or stability applications at landfill sites.

Partners: SVEX (a joint venture of Indaver and SITA) were responsible for the construction and operation of the plants. The project received €10 million in financial support from the Flemish Government.

Contribution to the outcome "Replicability":

- The consortium organised training programmes for local stakeholders
- The facility is open to the public for education.

Tees valley, United Kingdom

Challenge: The project sponsors wanted to build the first plasma gasification plant in the world, and thus advance WTE technology and the industry.

Description of the project: Located at the New Energy and Technology Business Park, Teesside, North East England. The plant had a designed capacity of 300,000 tonnes of waste. Production of 49MW of electricity (approximately 50,000 homes). Westinghouse plasma to vitrify the residues. Create 700 and 50 jobs during construction and operation, accordingly.

Partners: Air Products, Westinghouse, and the Stockton Borough Council. Stockton Borough Council approved the plan in 2011, to start operating in 2014. The environmental permitting was consented from the Environment Agency. The project had a significant support from all the stakeholders, including NGOs, MPs, etc.

Negative contribution to the outcome "Replicability":

- Due to technical difficulties the project did not finish and resulted in the loss of about 700 jobs.
- The estimated losses were between USD 900 million to USD 1 billion of its assets, and the company discontinued its WTE business segment.

5. PPPs for the SDGs: outcome number five "Ensure stakeholder engagement in projects"

Araucania, Chile

Challenge: 15 out of the 32 communes in Araucania do not have disposal sites and of the existing 18 landfills, 15 are non-sanitary, 2 are controlled and 1 is sanitary landfill. The sites currently operating for most of the waste disposal are close to collapse. A significant challenge was reported in a non-sanitary landfill in Boyeco, which was receiving 160,000 tonnes of waste materials per year. It has been reported that this landfill received about 1.6 million tonnes of waste since its opening in 1992. The landfill reached its maximum capacity in 2014 and it closed.

Description of the project: The annually treatment capacity of the project would have been about 190,000 tonnes per year to produce 98.8 GWh of electricity. The capital investment required was estimated at about $80 million. However, because of significant public opposition the project did not start the construction, after many years of efforts, and discussions.

Partners: WTE-Araucania, a consortium of entrepreneurs from the Araucanía region of Chile, in collaboration with the municipality of Temuco.

Contribution to the outcome "Stakeholder engagement":

- The project didn't assess the several needs of the stakeholders and didn't progress.
- Stakeholders were not well informed about the technology, and strongly opposed the project.
- Significant concerns were reported on the vulnerable groups that live nearby the landfills and were securing income from informal activities.

Trimmis, Switzerland

Challenge: To preserve its natural resources, the Government of Switzerland put emphasis on the advancement of recycling, and energy recovery, to eliminate landfilling of waste materials.

Description of the project: The annually treatment capacity is about 100,000 tonnes. The total electricity production amounted to 64,103 MWh in 2018 in a 24/7 operation scheme. The supply of building heating energy saved 9 million litters heating oil in the same year.

Partners: It is a standard example out of 30 plants in Switzerland. Operated by a non-profit organisation - the Association of Municipalities for Waste Management Graubünden, Chur (the south-east of Switzerland) who represents the Public / Citizens since 1975 - the plant has been evolved from a straightforward waste incinerator plant to a sustainable energy supply and natural resources recycling facility in the region. The plant operator is an SPV under the supervision of 7 board members elected by the 25 communities participating to the organisation, thus representing the citizens. In 2020, the Association responsible for the operation of the plant changed the entity to a Public company, namely Community Association for Waste Disposal in Graubünden (GEVAG), putting a lot of emphasis on gender equality, and securing opportunities and benefits with regard to the public interests.

Contribution to the outcome "Stakeholder engagement":

- The financial budget must be agreed by the public representatives through a voting system, ensuring the viability, affordability, and sustainability of the investment.
- The operation team works closely with the public and the private sector to create additional jobs and to boost innovation.
- The project equipment and management are localised, and it creates indirect jobs that support the economy, but also builds trust among the stakeholders.

Annex VII. [English only]

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