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**Economic Commission for Europe**

Committee on Innovation, Competitiveness and Public-Private Partnerships

**Working Party on Public-Private Partnerships****Fourth session**

Geneva, 1-2 December 2020

Item 4 of the provisional agenda

**Review of the work since the third session of the Working Party on Public-Private Partnerships  
on 3-4 December 2019****Guidelines on Promoting People-first Public-Private  
Partnerships Waste-to-Energy Projects for the Circular  
Economy\*****Note by the secretariat***Background*

The following document is based on the mandate included in the Intersessional Implementation Plan for 2020-2021 of the Committee on Innovation, Competitiveness and Public-Private Partnerships (ECE/CECI/2020/INF.2) and contributes to the theme of the 69<sup>th</sup> session of the Commission in April 2021.

It explores how the Waste-to-Energy (WtE) industry through the use of People-first Public-Private Partnerships (PPPs) for the Sustainable Development Goals (SDGs), can contribute to a transition towards a circular economy.

The document (parts II-V) was prepared by the secretariat with substantive inputs from A.C. (Thanos) Bourtsalas, Columbia University, United States, and Jiangrong Yu, Swiss Engineers Co, Switzerland.

The document is submitted to the Working Party on PPPs at its fourth session for decision.

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\* The present document was submitted after the negotiated deadline owing to circumstances beyond the secretariat's control.



## I. 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<sup>1</sup> per day worldwide. According to the World Bank, this figure will grow to more than 8 million tonnes per day by 2050.<sup>2</sup> Increasing prohibitions of transferring waste across borders also puts a burden on national Governments to find practical solutions themselves.

At the same time, in many countries, there has been considerable progress made in waste management by Governments and a high degree of sophistication in the way they manage waste. Long gone are the days when trash was simply “thrown out” of the house or the factory. It has become an issue both of great public concern on the one hand as well as, importantly, a rather flourishing business with considerable commercial opportunities on the other (see description of the Waste-to-Energy (WtE) industry and its global spread below).

There is now a growing consensus that the response to waste must be part of moves to promote a “circular economy” - a concept that is increasingly driving policy makers. This approach calls *inter alia* for the nine “Rs” as a foundation stone for action and for protecting the planet by eliminating waste altogether.<sup>3</sup>

In this regard, circular economy approaches are consistent with commitments the United Nations (UN) Member States made in adopting the 2030 Agenda for Sustainable Development and specifically SDG 12 on responsible consumption and production. In this context, WtE activities appear from first glance as a sustainable solution. Waste is processed in state-of-the-art facilities and is converted into energy. But is it so certain that WtE is consistent with the “circular economy”? Is it in fact promoting circularity and is the WtE industry really supporting the SDGs? Indeed, recently, European Union (EU) policy makers have taken a series of decisions that question the circularity of the WtE industry.

The central thesis of these Guidelines is that WtE projects can contribute to a transition towards a circular economy. They can embrace circular economy approaches, and as such, they can be placed “in the loop” especially as an energy recovery activity. However, for WtE to contribute to a circular economy transition is far from automatic: Governments and private sector need to adopt better approaches to PPPs, namely People-first, and support best practices in WtE projects.

### **Purpose**

The purpose of the Guidelines is to inform policymakers, industry, and civil society on the potential contribution of WtE to circular economy approaches and to demonstrate the type of projects – People-first PPPs – that can best serve this task.

### **Organisation**

The Guidelines are divided into four parts:

Part 1 examines both the WtE industry and the circular economy and sets out the debate that has taken place on whether WtE is compatible with the circular economy.

Part 2 looks at the project level and how WtE projects should change and the need for holistic solutions to the way projects are designed and structured focusing on ECE’s People-first approach.

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<sup>1</sup> Tonnes is the metric unit of mass equal to 1,000 kilograms according to the International System of Units (SI).

<sup>2</sup> What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050, World Bank, 2018, available online <https://openknowledge.worldbank.org/handle/10986/30317>

<sup>3</sup> In the beginning of the century the 4 Rs: Reduce-Reuse-Recycle-Recover were introduced, which evolved into the circular economy and the 9 Rs approach: Refuse-Rethink-Reduce-Reuse-Repair-Refurbish-Remanufacture-Repurpose-Recycle-Recover. The concept puts emphasis on the redesign of materials, and production of new cycles that will secure sustainable development.

Part 3 focuses on the policy level response, at local regional and national levels on WtE and set out a possible “road map” towards the transition to a circular economy. In this regard, it also presents the experiences of Switzerland.

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

## II. Is Waste-to-Energy compatible with the Circular Economy?

This Part explores the arguments surrounding the compatibility of the WtE industry with the circular economy and the recent responses of policy makers to this debate.

### A. Background to the debate

#### 1. Linear economy

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, it is fair to argue, assumes it has unlimited resources for its consumption and production cycle.

#### 2. The main consequences arising from the linear economy

This model has, however, consequences. Currently, there are more than seven and a half billion people in the world and this population is growing by roughly 80 million each year.<sup>4</sup> The energy consumption amounted to 14,282 million tonnes of oil equivalent (mtoe) in 2018 (in 1971 it was 5,519 million tonnes of oil equivalent),<sup>5</sup> and the CO<sub>2</sub> equivalent emissions reached 36.6 billion tonnes (in 1971 it was 15.4 billion tonnes).<sup>6</sup>

Global Municipal Solid Waste (MSW) of approximately 2.01 billion tonnes per year is generated with at least 33 percent of that – at an extremely conservative estimate – not managed in an environmentally safe manner. The global MSW generation is expected to increase to around 2.2 billion by 2025 and to 3.4 billion tonnes by 2050.<sup>7</sup>

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

#### 3. Circular economy

In response to the problems of a wasteful linear economy, the concept of the so called circular economy has emerged – an economy that 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.<sup>8</sup> The transition towards a circular economy 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 a circular economy 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.

#### 4. Moving away from landfills to circularity

The huge rise in waste has in many countries made traditional dumping in landfills unsustainable. One example of this is the “fast fashion industry”. Textiles represent one of

<sup>4</sup> See online <https://data.worldbank.org/indicator/SP.POP.TOTL>

<sup>5</sup> See online <https://www.iea.org/reports/world-energy-balances-overview>

<sup>6</sup> See online <https://data.worldbank.org/indicator/EN.ATM.CO2E.KT>

<sup>7</sup> See online [https://datatopics.worldbank.org/what-a-waste/trends\\_in\\_solid\\_waste\\_management.html](https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html)

<sup>8</sup> The term was coined by the World Bank in 2008. A number of agencies such as the European Union as well as the Ellen MacArthur foundation have since then given its strong credence by operationalising it on a systematic basis.

the world's fastest growing streams of discarded material, and include all forms of fabric, including materials used to make clothing. In the developed world, fast fashion industries encourage consumers to purchase new apparel in quick succession and as a result, more used, and not-so-used clothes are being tossed into landfills.

Increasingly though diverting waste from landfills is becoming commonplace for urban dwellers. Recycling and composting programmes are now a feature of urban life, the familiar recycling bins almost everywhere ubiquitous. The benefits also are significant. Recycling materials such as wood pulp and paper, plastics, glass and metals help prevent the depletion of natural resources. A circular economy also creates economic opportunities with more companies producing new products from diverted materials. In many instances, less energy – fossil fuels for example – is required to produce recycled goods than similar items made from raw materials.<sup>9</sup>

## 5. Waste-to-Energy

WtE is a process that uses heat to recover energy or fuels from waste materials. It has been applied for many decades, as a well-established waste management method in many highly environmentally sensitive economies, e.g. in Europe and in countries like Japan, Republic of Korea, Singapore etc.<sup>10</sup>

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. Most of the existing WtE plants are located in China with a total capacity of approximately 130 million tonnes per year,<sup>11</sup> the EU with approximately 90 million tonnes per year,<sup>12</sup> Japan with approximately 60 million tonnes per year,<sup>13</sup> the United States with approximately 27 million tonnes per year,<sup>14</sup> South Korea with approximately 4.5 million tonnes per year,<sup>15</sup> and in Singapore with approximately 2.5 million tonnes per year.<sup>16</sup>

The contribution of WtE to the global renewable energy supply from the combustion of the biogenic fraction of the waste, is approximately 1%. The global WtE market size was valued at USD 31.0 billion in 2019 and is projected to register a compound annual growth rate (CAGR) of 7.4% until 2027.<sup>17</sup>

WtE is an oligopolistic industry dominated by major players from developed countries in Europe, the United States and including Japan and China in Asia. Many of the latter enter into strategic collaborations with smaller local companies or take stakes in local companies when accessing new markets, thereby contributing to Foreign Direct Investment (FDI) flows into these countries. The top players in the WtE industry are Babcock & Wilcox Enterprises Inc., Everbright Environment, CNIM (Martin GmbH owns 10.25% of CNIM), Covanta Energy, Hitachi Zosen Inova AG (formerly Von Roll Inova), Keppel Seghers, SUEZ Environment, Veolia Environment S.A., Viridor, etc.<sup>18</sup>

## 6. Waste hierarchy

Figure 1 graphically represents the EU waste hierarchy which is the basis of the EU waste policy and legislation. The waste hierarchy dictates that waste should be managed with the

<sup>9</sup> See online <https://nems.nih.gov/environmental-programs/Pages/Benefits-of-Recycling.aspx#>

<sup>10</sup> 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.

<sup>11</sup> See online <http://www.stats.gov.cn/tjsj/ndsj/2016/indexeh.htm>

<sup>12</sup> See online <https://www.cewep.eu/waste-to-energy-plants-in-europe-in-2017/>

<sup>13</sup> See online <http://gwcouncil.org/the-list-of-waste-to-energy-facilities-in-the-world/>

<sup>14</sup> See online <http://energyrecoverycouncil.org/wp-content/uploads/2016/06/ERC-2016-directory.pdf>

<sup>15</sup> See online <https://www.sciencedirect.com/science/article/pii/S0956053X19300017?via%3DiHub>

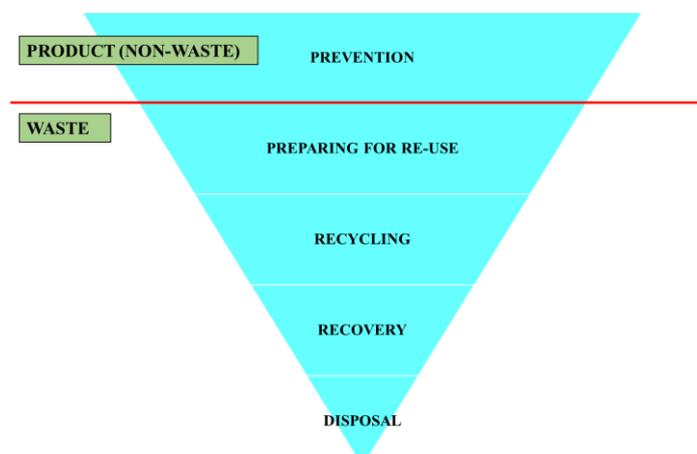
<sup>16</sup> See online <https://www.nea.gov.sg/our-services/waste-management/3r-programmes-and-resources/waste-management-infrastructure/solid-waste-management-infrastructure>

<sup>17</sup> See online <https://www.grandviewresearch.com/industry-analysis/waste-to-energy-technology-industry>

<sup>18</sup> See online <https://www.prnewswire.com/news-releases/top-20-companies-in-the-waste-to-energy-wte-market-2018-visiongain-report-868219369.html>

following priority order: prevention, reuse, recycling, recovery and disposal. WtE is only competing with landfilling for residual waste and the waste hierarchy recognise that landfilling should come last.

**Figure 1. Hierarchy of sustainable waste management**



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

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, by diverting waste from landfills. It is therefore of paramount importance that going forward this waste management principle remains a key driver in legislative actions and policies touching on waste management.

## B. Arguments against and in favour of Waste-to-Energy

Over the years, countries have modified their approach to the WtE industry. Annex 2 includes a Box with the chronology of the main actions of the EU to the circular economy and waste management which demonstrates the step-by-step declassification of WtE as a circular economy activity. It is worth now to explore, the main arguments why WtE has given rise to such concerns and negative positions as well as the arguments in favour of WtE, as detailed in Table 1 below.

**Table 1. Arguments put forward against and in favour of Waste-to-Energy**

<i>Arguments put forward against</i>	<i>Arguments put forward in favour</i>
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. The EU countries reduce landfilling of wastes, by a combined effort of recycling/composting and WtE. <sup>19</sup> In the United States of America, counties and municipalities that utilise WtE consistently show an increased recycling rate, in parallel to WtE practice. <sup>20</sup>
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. WtE plants must comply with stringent environmental standards, such as the EU Industrial Emissions Directive. The latter also sets standards for non-EU countries. WtE and incineration are different

<sup>19</sup> 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](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Municipal_waste_treatment,_EU-27,_kg_per_capita_new.png&oldid=323975)

<sup>20</sup> See online <https://www.wtienergy.com/sites/default/files/ERC-2014-Berenyi-recycling-study-1.pdf>

<i>Arguments put forward against</i>	<i>Arguments put forward in favour</i>
	processes. Incineration does cause emissions, however WtE facilities equipped with sophisticated Air Pollution Control (APC) systems have far less severe impacts on air pollution. Incinerators moreover do not produce energy. There are over hundreds of thousands of incinerators in the world, whereas WtE facilities are far less numerous, over 1,200. <sup>21</sup>
WtE raises public health concerns for the population, emitting carcinogenic pathogens.	Today's technology allows WtE projects to operate with limited to no polluting effects and WtE plants must comply with stringent regulatory requirements. The only proven alternative to landfilling of materials that cannot be recycled is WtE. Landfilling relates to methane emissions, a potent greenhouse gas, and it is well documented that WtE saves 0.5 to 1 tonne of CO <sub>2</sub> equivalent per tonne of waste. <sup>22</sup>
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. <sup>23</sup> Some cities, such as Brescia, Osaka, Paris, Vienna, have built WtE plants that have become tourist attractions. The most recent addition is the new WtE Plant in Copenhagen that is planned to have a roof that can be used as a ski slope

*Source: ECE.*

In conclusion, WtE can serve as a transition step to a more circular and more sustainable development path, depending on where countries are at the start. WtE is expected to decrease because of the increased reusing and recycling of products. However, WtE will remain necessary for residual mixed waste. Moreover, there are some good reasons why WtE has a potential to contribute to circular economy principles and practices:

- Some products simply cannot be recycled;
- Landfills are a major health and environmental problem and need to be scaled down. Even in the most developed countries their role is still too strong and WtE is a means of ultimately eliminating them; and
- There are technologies (not using combustion to produce energy) coming through which can lower CO<sub>2</sub> emissions and radically change the WtE industry and make it more circular economy responsive.

### **III. Overcoming the problems in Waste-to-Energy projects in the transition to the Circular Economy and making them People-first.**

This section explores individual WtE projects to assess their actual and potential impact on circular economy practices. It consists of two parts: the first looks at traditional PPP and why

<sup>21</sup> See online <http://gwcouncil.org/the-list-of-waste-to-energy-facilities-in-the-world>

<sup>22</sup> See online <https://www.cewep.eu/wte-climate-protection/>

<sup>23</sup> 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.

better, more expansive models are needed if the SDGs and the transition to a circular economy are to be achieved. The second part deals with the problems that WtE projects will have to overcome in order to contribute to this transition.

## **A. Public-Private Partnerships and People-first Public-Private Partnerships: a comparison and the main challenges to overcome**

### *Typical PPP in the WtE industry*

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 meet the contracted ways 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 however and developers and their financiers require assurances from the Government agency commissioning the project, that enables satisfactory returns from the investment to be recovered over time.<sup>24</sup>

Along with Government incentives (see Part III below), 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.

The gate fee is driven by the volume of waste, while energy sales are driven by the heat produced. This fact in turn can influence the business model of the WtE project. The more waste that is combustible like plastics, paper or wood, the hotter the furnaces burn and the higher the Calorific Value (CV) produced. The more non-combustible waste, like bricks or glass, the lower the CV. This mix determines the facility’s revenue streams.

In addition, safety regulations require that the facility is designed for a certain thermal capacity. If the percentage of combustible waste is too high the CV will be above the designated level and the operator will have to reduce the amount of waste going through the facility. This reduces gate fees. However, if the CV is too low, the facility generates less electricity than it can sell. The single biggest business challenge for PPP WtE projects is to balance the right CV and quality of the waste to optimise both waste volumes and sales of power and electricity.

### *People-first PPPs*

The ECE has advocated the need for a more expansive and broader developmental model, arguing that such People-first PPPs should place sustainable development at its core and the “people” as the main beneficiaries. Partnerships must now be evaluated according to a new set of criteria which are “quality infrastructure” investments. Overall, such People-first PPPs should give meaning to “value to people” and “value to the planet” through achieving and complying with five People-first outcomes as referred to in Table 2 below.

<sup>24</sup> <https://home.kpmg/xx/en/home/insights/2019/10/waste-to-energy-green-solutions-for-emerging-markets.html>

**Table 2. People-first PPP outcomes and benchmarks**

<i>Outcomes</i>	<i>Benchmarks</i>
Access and equity	Provide essential services
	Advance affordability and universal access
	Improve equity and social justice
	Plan for long-term access and equity
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
	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 A draft People-first Public-Private Partnerships Evaluation Methodology for the Sustainable Development Goals (ECE/CECI/WP/PPP/2020/3), 2020.*

## **B. Key challenges for achieving People-first Waste-to-Energy projects**

Becoming “high quality” investments and “People-first” is challenging the WtE industry. The section takes each of the five People-first outcomes in turn, demonstrating the nature of the problem under each outcome and how projects are addressing and overcoming these problem areas. The projects referred to are set out in Annex 3 to the Guidelines below:

### **1. Increase access and promote equity**

*Increasing access and promoting equity 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.*

**Challenge: WtE projects are more expensive than other energy sources and are not affordable to consumers in low- and middle-income communities.**

Some critics argue that the WtE industry itself prefer to be perceived as power plants, when in fact, they produce rather little energy and remain fundamentally waste disposal facilities.<sup>25</sup>

<sup>25</sup> “Incinerators are NOT Waste-to-Energy facilities”, Energy Justice Network, 2020.

Also, critics claim that WtE facilities do not provide cheaper energy than other sources. In such a characterisation, WtE can be hardly presented as making energy more accessible to vulnerable groups that are previously unserved or underserved in energy provision.

In the case of the volume of energy generated overall, WtE projects typically do not contribute significantly to the national grid and the energy supply of the country. Yet, this picture is changing. WtE projects in Olsztyn, Poland, and Klaipeda, Lithuania, for example, contribute significantly to the energy needs of the respective municipality, but also help the regions to replace fossil fuels and their energy imports from neighbouring countries. In the case of Olsztyn, the WtE plant produces a significant amount of heat that was previously produced from a fossil fuel plant that shut down, whereas the WtE plant in Klaipeda provides about 40% of the heating demand of the region and substitutes a significant amount of gas that otherwise would have been imported from other countries.

In rural areas the situation shows that to date, there are few WtE projects in rural areas that contribute significantly to the energy needs of rural dwellers. A similar trend is observed when looking at the cost of energy. For example, 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.

## 2. Improve projects' economic effectiveness and fiscal sustainability

*This criterion 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, profitability of the project.*

### **Challenge: WtE projects have few local economic impacts such as high-quality jobs etc.**

This challenge relates to two major points at different ends of the income spectrum: 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 livelihood of the low-income and marginalised groups, e.g. families working informally as waste-pickers, and of the vulnerable groups, e.g. refugees?

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. A major concern relates to low income families which rely for their income on informal recycling activities. Also, in this group, are those who are very vulnerable, e.g. refugees, that have no jobs. However, in many cases WtE projects can provide a viable support for these groups. For example, the project in Cox's Bazar in Bangladesh, mobilised the refugees themselves to help in the construction and operation of the facility, and in the case of Belgrade, Serbia, the municipality aided Roma families that were living on the old landfill to find new jobs and accommodation. Also, many projects provided high quality jobs, and transfer of 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 included also extensive training, and transfer of know how. In addition, more than EUR 10 million has been allocated for the community to date, paid for out of the revenues generated by the project.

Moreover, 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. What needs to change to make this happen?

## 3. Improve environmental sustainability and resilience

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

**Challenge: WtE combustion causes the release of CO<sub>2</sub> equivalent emissions into the atmosphere that can seriously damage people's health.**

This challenge consists of two components: does the project negatively affect the public health and the environment, by producing hazardous emissions, and depleting natural resources? And, does the WtE project affect the waste recycling targets of communities, which are a priority, with regard to the waste hierarchy?

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, many WtE projects produce significant environmental benefits for communities and enhance recycling with the recovery of metals and minerals from the bottom ash fraction.

For example, the WtE plant in Barcelona, Spain saves 19,000 tonnes CO<sub>2</sub> 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 in Glasgow, United Kingdom diverts 90% of materials away from landfills, saves about 20,000m<sup>2</sup> of land per year, and 90,000 tonnes CO<sub>2</sub> equivalent per year, but also, recovers about 10,000 tonnes of metals and minerals. In Doel, Belgium, the WtE plant was associated with the decommissioning of the gas-fired boilers that resulted in savings of 200,000 tonnes CO<sub>2</sub> equivalent per year, but also the process recovers about 20,000 tonnes of metals, and minerals that are used in construction. The plant in Singapore will achieve a zero waste to landfills, by co-processing the residual wastes from recycling facilities with wastewater treatment residues in a WtE plant. The development will save about 1 million tonnes of CO<sub>2</sub> equivalent per year, and about 100,000m<sup>2</sup> of land per year, and additionally, it will recover about 30,000 tonnes of metals and minerals from the bottom ash residues.

One step in the right direction has been taken by the project in Surrey, British Columbia, Canada, which at the collection stage has undertaken advanced source separation of organic materials,<sup>26</sup> e.g. food waste and then at the processing stage has built anaerobic digestion plants<sup>27</sup> (recovering bioenergy or biofuels), as a first step to divert materials from landfills. But, by contrast, by clustering different processes together in an integrated fashion, several projects elsewhere had a much more significant impact than the aforementioned project in Canada. Integrated sustainable waste management facilities consist of recycling centres to recover recyclables from dry materials, e.g. metals, paper, plastics, etc., anaerobic digestion plants to recover compostable materials, and energy from the organic fraction, and WtE plants to recover energy from the residues of these operations that in many cases are mixed with other residues, e.g. sludge. Good examples of this type of integrated approach are found in Barcelona, Glasgow, and Singapore.

These 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. These developments put emphasis on industrial symbiosis, in which several industrial entities develop mutually beneficial relationships.<sup>28</sup> Such systems increase resilience and economic gains, while reducing the environmental impact and costs.

#### **4. Replicability**

*Replicability refers to the project's emphasis on the replicability and scalability of the technologies and programmes, so as these can be developed elsewhere. For this, the governmental, industrial, and communal capacities should be enhanced, by providing*

<sup>26</sup> Organic wastes contain materials which originated from living organisms. Food scraps, e.g. vegetable waste, fruit scraps, etc. and yard waste, e.g. dead leaves, grass clippings, etc. are the main constituents of organic matter in municipal solid wastes.

<sup>27</sup> Anaerobic digestion is a series of biological processes in which microorganisms break down organic matter, e.g. food or yard waste, in the absence of oxygen. One of the end products is biogas, which is combusted to generate electricity and heat, or can be processed into renewable natural gas and transportation fuels.

<sup>28</sup> Industrial symbiosis systems are a key component of circular economy. 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.

*training opportunities for the local communities, and cultivating specific skills of the local stakeholders.*

**Challenge: Making the WtE model replicable and its use more prevalent will require extensive skills transfer and the training of local staff in sophisticated technologies. This can be expensive. WtE Projects tend not to train local people that can embed the skills necessary to develop local WtE companies and start-ups.**

In terms of skills transfer, WtE companies do frequently provide training opportunities to local people. For example, in Cần Thơ, Mekong Delta, Vietnam, the company responsible for the construction and the operation of a WtE plant provided in depth training to local people. As a result, employees became professional plant operators of a very high standard. On the technology side, however, 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 the first plasma gasification 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.

## 5. Stakeholder engagement

*People-first PPPs encourages 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.*

**Challenge: Projects do not develop plans to engage with local communities which are largely hostile to WtE plants being located near them. This negativity has even given birth to the so-called “not in my back yard” (NIMBY) effect.**

This challenge is mainly associated with two aspects: does the project engage all the stakeholders, including vulnerable groups, in the planning, construction, and operation of the plant? And, does the project provide high quality and understandable data to the stakeholders to allow zero tolerance to corruption, and transparency of the projects?

WtE projects can create strong opposition from local stakeholders. Typically, the latter are not well informed about the project. They tend also not to trust the authorities and/or the project sponsors responsible for the construction and operation of the project. Strong opposition can delay or even cancel the construction of the plant. For example, in Araucania, Chile, the stakeholders expressed strong opposition to a WtE project. This was partly because communication with the group was not very good while the concerns on the livelihood of vulnerable groups were not sufficiently addressed. As a result of the strong opposition, the WtE project was cancelled – a lesson for all project sponsors in the future.

In Trimmis, Switzerland, by contrast, 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. They were fully consulted in drawing up plans, in the setting up of the facilities, in the tendering process, etc. Also, many projects gave assurances to the citizens about the project, e.g. monitoring of emissions etc. The local community and economy received as well indirect benefits, notably to the local infrastructure. This contribution to the local community also took place in Nanning, China, where the project sponsors built new roads, as part of their WtE investment, and the municipalities enforced strict emissions standards for WtE operations, that were continuously monitored, and shared with the public.

## Overall conclusion

The above-mentioned discussion on projects demonstrates that in spite of the problems, People-first projects can achieve significant social and environmental objectives and become People-first: it is not, by any means, a lost cause. Indeed, some projects as seen above, are presented today as being consistent with circular economy criteria. However, to scale up these examples of a new more circular economy consistent approach, Governments and other stakeholders need to play a key role in moving the WtE industry onto another level.

## IV. Embracing the Circular Economy: Seven best practice options for adapting and transforming projects into People-first Waste-to-Energy Public-Private Partnerships

As stated in Part 2 above, People-first PPPs have the potential for overcoming key problems and barriers to the circular economy and to become People-first PPPs – a holistic and integrated response to problems affecting our societies economics and planet. This Part sets down tentatively seven best practice options for transforming projects into circular economy principles. These best practice options are levelled at Governments, private sector and civil society groups.

### A. Best practice options for adapting and transforming projects into People-first Waste-to-Energy Public-Private Partnerships

WtE is evolving as a result of several factors, such as government policy and actions against climate change and supporting circular economy processes, new technological developments and corporate strategies. Three scenarios can be identified:

- A scenario where the continuation of WtE as above land fill in the waste hierarchy;
- A scenario where a WtE facility is placed at the same level as landfills in the waste hierarchy; or
- A scenario where WtE is placed above its current status and becomes fully incorporated into circular economy activities.

The following are a list of best practice options – seven of them. Governments that decide to use WtE as a strategy for waste management in any of these three above mentioned scenarios, can select any of these options and ideally adopt all seven.

#### 1. Vision

##### Challenge

**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.<sup>29</sup> A high percentage of waste still goes to landfills. Waste, up until now, has been perceived as a thing to get rid of and this throwaway mentality is part of the old thinking of the linear economy and at odds with circular economy principles and processes.**

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

People-first WtE PPPs should turn waste into a resource and operate 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 circular economy as a core objective.

##### Specific options

- 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. In order to promote WtE it is therefore necessary to highlight the importance of preventing waste, reusing waste products and recycling as much as possible.<sup>30</sup>

<sup>29</sup> What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050, World Bank, 2018 available online <https://openknowledge.worldbank.org/handle/10986/30317>

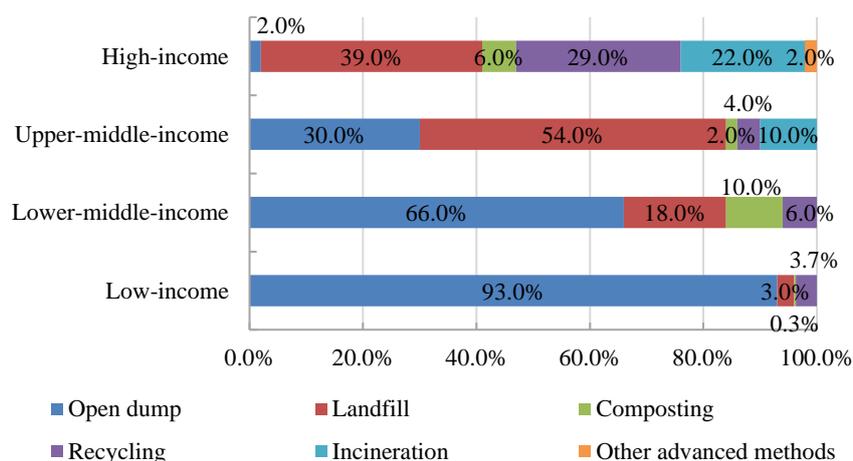
<sup>30</sup> It is estimated that about 30-40% of the WtE plants in the world, do not do any sorting of the wastes. This mainly relates to the market conditions, and the priorities of the public sector. The estimation is from data collected from the Ministry of Environment in China, the Confederation of European Waste to Energy Plants (CEWEP), and the Energy Recovery Council (ERC) in the US.

- 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 has to be promoted in the place of landfills which are cheaper but dangerous for the public health and the environment.

### 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.*

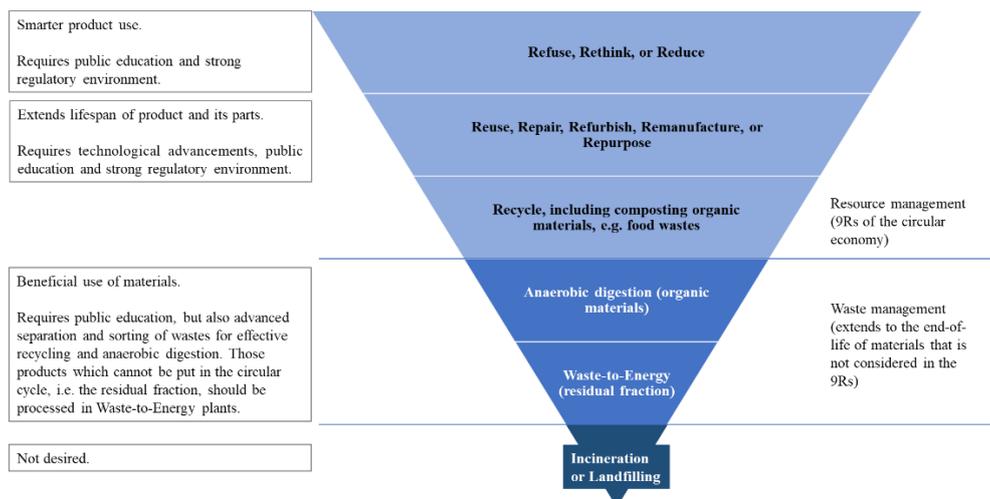
## 2. Scope and scale

### 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 circular economy, there should be a focus on smaller scale and decentralised operations serving specific purposes in decentralised systems. Waste hierarchy, that is a standard, needs to reflect the circular economy challenges.**

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

The waste hierarchy should encapsulate the circular economy 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 maximum resource and energy recovery, not landfilling or incineration of wastes without energy recovery. Also, People-first PPPs should focus on marginalised and vulnerable groups trying to survive in an ever more dangerous world, such as refugees, first nation, etc.

**Figure 2. Hierarchy of sustainable resource and waste management**

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

### Specific options

People-first WtE PPPs should focus on specific areas and purposes that are “circular” for better waste resource management:

- People-first PPPs should 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.
- People-first WtE PPPs should address the so-called “residual” fraction of waste which is waste of poor quality. This prevents the recycling cycle from being contaminated with polluted products.
- People-first WtE projects should create renewable energy out of the biodegradable fraction of wastes in the WtE process.
- People-first WtE PPPs should 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. People-first PPPs should ensure that the fly ashes from incineration are disposed of in a sustainable and safe manner.

### **Box 2. A circular economy does not mean maintaining all materials in circulation at all costs**

Bisphenol A – an endocrine disruptor and reproductive toxic substance – is used as a colour developer in thermal paper, which is for example used for sale receipts. Since thermal paper is typically recycled, it contaminates other paper products and, therefore, hampers the whole recycling chain. Through its long-standing role in decontaminating the waste, Waste-to-Energy prevents such contaminations, thus contributing to high quality recycling.

*Source: Waste-to-Energy 2050: clean technologies for sustainable waste management, European Suppliers of Waste-to-Energy Technology (ESWET), 2019.*

## **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 CO<sub>2</sub> equivalent emissions. 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.**

Option 3: Select suitable technologies that are innovative and less polluting.

People-first WtE PPPs should adopt the right circular economy 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

- People-first WtE PPPs should operate with sophisticated Air Pollution Control systems, and their emissions must be lower than strict emission standards, such as the Industrial Emissions Directive.
- A system of monitoring of emissions from WtE plants needs to be put in place with centralised registers controlled by the appropriate public environmental agencies.
- 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.**

Option 4: Provide economic incentives and price supports.

People-first WtE PPPs should benefit from fiscal incentives that encourage such projects to adopt circular economy processes and move upwards in the waste hierarchy.

#### Specific options

- Governments should increase the landfill tax and should consider a credit for WtE for renewable energy production, e.g. feed in tariffs or the issuance of tradable green certificate with a guaranteed minimum market value for capacity installed.
- Results-based financing, e.g. environmental impact bonds, should be considered to address the construction, operation, and counterparty risks in WtE investments.

## 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.**

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

People-first WtE PPPs should partner only with enterprises that display WtE technologies compatible with circular economy processes.

#### Specific options

- Governments should use 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.
- Investment promotion agencies (IPAs) should identify opportunities and ways to use foreign direct investment (FDI) 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.<sup>31</sup>

<sup>31</sup> Successful examples are presented in the Appendix. The cases include two acquisitions that occurred with the help of the Governments that allowed advancement of sustainable waste management in the countries involved.

## 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.**

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

People-first WtE PPPs should participate in open, competitive procurements and be selected on the basis of their commitment to circular economy values and processes, their track record and their own commitment and rigorous endorsement of a zero-tolerance approach to corruption.

### Specific options

- 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.
- Governments should be encouraged to comply with the ECE Standard on a Zero Tolerance Approach to Corruption in PPP Procurement<sup>32</sup> and inform the ECE secretariat on how they are implementing this option.
- The 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.

## 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”.**

Option 7: Enhance local participation in projects that includes women’s empowerment and vulnerable groups and ensure strong stakeholder engagement.

People-first WtE PPPs should engage with stakeholders in a new “social contract” that regularly consults with communities, providing them regularly with information and data on their performance and be accountable to regular monitoring and scrutiny by local communities where plants are located.

### Specific options

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

## B. Policy response of Switzerland

Having presented the above-mentioned best practice options on how Governments, businesses and civil society can promote a more circular and SDG-sensitive WtE and People-first projects, it is worthwhile to look at how Switzerland is following these in their own policies.

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<sup>32</sup> ECE Standard on a Zero Tolerance Approach to Corruption in PPP Procurement (ECE/CECI/WP/PPP/2017/4). Available online [https://www.unece.org/fileadmin/DAM/ceci/ppp/Standards/ECE\\_CECI\\_WP\\_PPP\\_2017\\_04-en.pdf](https://www.unece.org/fileadmin/DAM/ceci/ppp/Standards/ECE_CECI_WP_PPP_2017_04-en.pdf)

## 1. Vision

### Switzerland

Switzerland has been pursuing circular economy approaches since the mid-1980s and has a very exemplary record. Measures are based on the precautionary principle<sup>33</sup> and the polluter-pays principle,<sup>34</sup> as well as using cutting-edge technology, innovations, and industry collaborations. For example, every time a project is conducted, a holistic life cycle assessment is made with the help of the Ministry of Environment, to determine if projects are aligned with circular economy processes.

## 2. Scope and Scale of the transition to circular economy

### Switzerland

Switzerland has totally eliminated the use of land for the depositing of waste materials. About 50% to 60% of municipal waste is recycled/composted, and the residual fraction is processed in WtE plants that operate in the country.<sup>37</sup> These actions save billions of litres of heating oil per year and contribute to about 3.5% of the total energy demand of the country.<sup>35</sup> The bottom ash residues of the incineration processes are beneficially used in construction, after metal separation. The fly ash residues are safely disposed of in a sustainable manner.

## 3. Technology and capacity building

### Switzerland

Swiss waste recycling and WtE developments use advanced technologies which are usually produced by the local industries, and significant innovations have been observed in the country. The Government has a comprehensive database on industrial emissions that includes WtE operations, and all the WtE plants are having online monitoring systems for the emissions, which are available to the public.

## 4. Fiscal incentives

### Switzerland

Switzerland has instituted a ban on untreated and combustible waste since 2000 and has placed tariffs on specific types of waste since 2017. The country has applied decade-long EPR on materials of concern.

## 5. Partnering and Partnerships

### Switzerland

Local Governments and regions, and communities collaborate with the private sector to establish Special Purpose Vehicle (SPV)<sup>36</sup> companies to ensure optimum planning on the waste management regional strategy. Partnerships have discrete roles that are strictly monitored by the authorities. In this context, the Federal Office for the Environment strongly supports the transition towards a circular economy by promoting environmental technology through its green public procurement office.

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<sup>33</sup> The “precautionary principle” is, among others, an EU risk management tool that may be invoked when there is scientific uncertainty about a suspected risk to human health or to the environment emanating from a certain action or policy.

<sup>34</sup> The “polluter pays” principle is, among others, implemented by the Environmental Liability Directive, which aims to prevent or otherwise remedy environmental damage. Waste management operators have to take preventive measures in case of an imminent threat to the environment. If damage has already occurred, they are obliged to take the appropriate measures to remedy it and pay for the costs.

<sup>35</sup> <https://www.iea.org/countries/Switzerland>

<sup>36</sup> Special Purpose/Project Vehicle (SPV) or Special Purpose/Project Entity (SPE) is a legal entity that undertakes the construction, operation and management of projects as well as, it involves various parties and stakeholders in PPPs.

## 6. Public procurements and good governance

### Switzerland

Most of the infrastructural projects are using the Swiss Challenge System, for selecting the best possible tender. The whole process is open and transparent to the public. The decision is received by the representatives of the communities who strictly follow the communal decisions through a voting system. The WtE plants work as cooperative, competitive, collaborative and independent public services, which, are being closely monitored by the official authorities.

## 7. Stakeholder and community engagement

### Switzerland

The Swiss Government has built trust with its citizens, as they are having continuous interaction through public meetings, open discussions, etc. The Government encourages local groups to participate in project development, in the management board and in the delivery of high-quality public services. Switzerland has become a model for the world in WtE.

## V. Conclusions and follow-up

At its purest form, the circular economy has no waste; 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 ranging from the limitations of technology to patterns of human behaviour. Therefore, until this perfect cycle is achieved in practice, society has the responsibility to employ all solutions available to sustainably manage materials that become waste, including WtE.

The WtE industry thus forms in this context an interesting sub plot of the transition to the circular economy. From this perspective, it is considered an industry with a transition technology. But technologies that are transitory can go up as well as down; and the WtE industry can climb the waste hierarchy and become an industry with a future in the circular economy. As stated above, this will require the right enabling environment for the circular economy and WtE. It is therefore important that Governments and all stakeholders, as well as new projects adopt the seven best practice options proposed in this document:

- 1) Embed circular economy 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:

- **Promote discussion** on the WtE Guidelines and its best practice options by Governments, the business community and civil society. In this regard, **consult**, among others, with those governments who have ample experience in this regard, as well as those, whose engagement with WtE is still at an emerging stage.
- **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 in the WtE industry, e.g. Switzerland.

- **Use the WtE Guidelines as a test case for** the ECE People-first PPP Evaluation Methodology,<sup>37</sup> when finalised and approved by ECE member States, in some WtE projects to determine their People-first qualities and disseminate the results to stakeholders.
- **Prepare** stepwise guidance on how the WtE industry can maximize its contribution to the transition to a circular economy.

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<sup>37</sup> More information on the ECE People-first PPP Evaluation Methodology project is available online: <https://wiki.unece.org/display/pppp/Impact+Assessment+Tool>

**Annex I.**

[English only]

**Executive summary****Challenge – Making sense of the circular economy**

Waste and what to do about it, is a critical challenge facing our time, arising from the high consumption and constantly buying culture of the economy – so called linear economy – as well as increasing production, trade and urban populations and a “throwaway culture”. There is a gathering consensus that the only sustainable solution to deal with waste before it becomes a problem, is to make it part of a reuse, re purpose, reduce, and recycle circular process. Under such a process, waste is taken out as a source of problems and becomes a valued resource, like other products in the circle.

**Purpose and main thesis**

The purpose of these Guidelines is to explore the ways the Waste-to-Energy (WtE) industry can become part of the solution – not part of the problem. Although rather specialised, these Guidelines nonetheless provide lessons to other industries seeking to make the necessary adjustments to more rational and efficient production processes and the “circular economy”. While it is now fairly well understood what both the linear economy is and what the circular economy aspires to be in the future, less well understood is the “middle” of the spectrum and the actions required from Governments, businesses and the civil society needed to make the transition successfully.

The central thesis is that WtE has the potential to become a circular economy process. Specifically, it has a role to play in the circular economy as a compliment to recycling. But People-first Public-Private Partnerships (PPPs) – a high quality version of the PPP model – are needed to make WtE projects compatible with the Sustainable Development Goals (SDGs). Considerable efforts, moreover, will be needed to make this transition become a reality.

**WtE not compatible with circular economy processes**

The WtE industry was, until quite recently, considered positively especially compared to landfills the oldest and most common form of waste disposal. In many European countries, landfill space is at a premium. Furthermore, one of the main arguments in support of WtE is that it creates a net positive impact in terms of greenhouse gas reduction and climate change mitigation because it produces energy, thereby displacing the equivalent electricity and heat generated from other sources, generally fossil fuels.

But that positive perception towards WtE, has almost disappeared: the European Commission and the European Investment Bank (EIB) for example, no longer consider WtE as a circular economy process. The major reason for this position is that WtE diverts waste that could be recycled and reused as part of the circular economy.

**Three main arguments critical of WtE as a circular process**

There are three main arguments against treating WtE as consistent with circular economy processes:

- 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 raises environmental concerns, exacerbating climate change, emitting toxic emissions and giving rise to air pollution.
- WtE raises public health concerns for the population, emitting carcinogenic pathogens.
- 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.

In fact, on closer inspection, these arguments are far from being clear cut. There is, for example, the empirical fact that WtE takes place in developed countries where recycling also takes place. In this context, WtE is the only proven alternative to landfilling for materials that cannot be recycled.

However, the industry needs to re develop itself with a new vision and product line. The best practice options for this to happen and to make the projects in WtE industry genuinely compatible with ECE's People-first approach to PPPs are as follows:

Vision: Embed circular economy visions and principles into Government policies

- *People-first WtE PPPs should turn waste into a resource and operate 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 circular economy as a core objective.*

Scope and scale: Internalise externalities, gain social acceptance and mobilise investments

- *The waste hierarchy should encapsulate the circular economy 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 maximum resource and energy recovery, not landfilling or incineration of wastes without energy recovery. Also, People-first PPPs should focus on marginalised and vulnerable groups trying to survive in an ever more dangerous world, such as refugees, first nation, etc.*

Technology and capacity building: Select suitable technologies that are innovative and less polluting

- *People-first WtE PPPs should adopt the right circular economy enhancing technologies including "cleaning" the circular process by removing dangerous harmful substances and helping the local economy with skills development to utilise these technologies.*

Fiscal incentives: Provide economic incentives and price supports

- *People-first WtE PPPs should benefit from fiscal incentives that encourage such projects to adopt circular economy processes and move upwards in the waste hierarchy.*

Partnering and partnerships: Identify good partners and monitor the performance of such partnerships

- *People-first WtE PPPs should partner only with enterprises that display WtE technologies compatible with circular economy processes.*

Public procurements and good governance: Establish transparent and open procurement processes and the adoption of a zero-tolerance approach to corruption in public procurement

- *People-first WtE PPPs should participate in open, competitive procurements and be selected on the basis of their commitment to circular economy values and processes, their track record and their own commitment and rigorous endorsement of a zero-tolerance approach to corruption.*

Stakeholder and community engagement: Enhance local participation in projects that includes women's empowerment and vulnerable groups and ensure strong stakeholder engagement

- *People-first WtE PPPs should engage with stakeholders in a new "social contract" that regularly consults with communities, providing them regularly with*

*information and data on their performance and be accountable to regular monitoring and scrutiny by local communities where plants are located.*<sup>38</sup>

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

- **Promote discussion** on the WtE Guidelines and its best practice options by Governments, the business community and civil society. In this regard, **consult**, among others, with those governments who have ample experience in this regard, as well as those, whose engagement with WtE is still at an emerging stage.
- **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 in the WtE industry, e.g. Switzerland.
- **Use the WtE Guidelines as a test case for** the ECE People-first PPP Evaluation Methodology, when finalised and approved by ECE member States, in some WtE projects to determine their People-first qualities and disseminate the results to stakeholders.
- **Prepare** stepwise guidance on how the WtE industry can maximize its contribution to the transition to a circular economy.

Developing effective partnerships to implement these Guidelines is now high on the agenda for moving to a circular economy. The ECE secretariat, based on respective mandates and resources, will follow up this work. It is suggested that a survey is conducted to understand and assess the performance of WtE projects with regard to circular economy. As a result, a stepwise guidance on how WtE industry can maximise its contribution to the circular economy could also be developed.

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<sup>38</sup> WtE plants serve communities as small as 10,000 inhabitants. However, economies of scale dictate that for a WtE plant to be financially viable its capacity should not be below 150,000-200,000 tonnes/year. In this context, small cities may band together to build a WtE plant

## Annex II.

### Chronology of the main actions of the European Union to the circular economy and waste management<sup>39</sup>

**1975:** The European Directive 75/442/EC<sup>40</sup> on wastes, requires European Union (EU) Member States to take measures to prevent or reduce waste production and to recover waste by recycling, re-use, reclamation or any other processes, or to use waste as a source of energy.

**1991:** The European Directive 75/442 was amended (91/156/EEC)<sup>41</sup> to put emphasis on the recycling and reuse of waste as raw materials. Also, it included an updated definition of waste materials.

**1999:** The EU legislation (1999/31/EC)<sup>42</sup> introduces stringent technical requirements for waste and landfills, which is the least preferable option that should be limited to the necessary minimum.

**2000:** The Waste Incineration Directive (2000/76/EC)<sup>43</sup> repealed former directives on the incineration of hazardous waste (Directive 94/67/EC) and household waste (Directives 89/369/EEC and 89/429/EEC) and replaced them. The Waste Incineration Directive sets emission limit values and monitoring requirements for pollutants to air and water from waste incineration. The Waste Incineration Directive makes a distinction between incineration plants, e.g. thermal treatment of waste with or without heat recovery, and co-incineration plants, e.g. cement or lime kilns, steel plants or power plants.

**2001:** The European Directive 2001/77/EC<sup>44</sup> on renewable energy laws considers Waste-to-Energy (WtE) as a renewable source of energy, but preferably if biodegradable waste is processed.

**2006:** The EU legislation (2006/12/EC) repealed Directives 75/442 and 91/156. The European Commission established strict limits for the landfilling of wastes and provided a comprehensive definition of the several waste materials.<sup>45</sup>

**2008:** The Waste Framework Directive (2008/98/EC)<sup>46</sup> repealed Directive 2006/12. It set the basic concepts and definitions related to waste management and requires the EU Member States to adopt waste management plans and waste prevention programs, according to the waste management hierarchy. The Directive established the R1 energy efficiency formula for waste incineration.<sup>47</sup> It also introduced the “polluter pays principle” and the “extended producer responsibility”.

**2009:** The European Directive (2009/28)<sup>48</sup> on the promotion of the use of energy from renewable sources, amended and subsequently repealed Directives 2001/77/EC and 2003/30. It considers WtE as renewable, but only if the feedstock is biodegradable waste.

**2010:** The Industrial Emissions Directive (IED 2010/75/EC)<sup>49</sup> was introduced on the prevention of industrial emissions and repealed the Waste Incineration Directive (2000/76).

<sup>39</sup> Prepared by A.C. (Thanos) Bourtsalas.

<sup>40</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31975L0442>

<sup>41</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31991L0156>

<sup>42</sup> See online <https://ec.europa.eu/environment/waste/landfill/index.htm>

<sup>43</sup> See online <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0076:20081211:EN:PDF>

<sup>44</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0077&from=EN>

<sup>45</sup> See online <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32006L0012>

<sup>46</sup> See online <https://ec.europa.eu/environment/waste/framework/>

<sup>47</sup> See online <https://ec.europa.eu/environment/waste/framework/pdf/guidance.pdf>

<sup>48</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN>

<sup>49</sup> See online <https://eur-lex.europa.eu/eli/dir/2010/75/2011-01-06>

It focused on five pillars: 1) an integrated approach, 2) use of best available techniques, 3) flexibility, 4) inspections, and 5) public participation.

**2015:** The Energy Union Framework Strategy considered WtE as a technology that contributes to the EU strategy for heating and cooling.<sup>50</sup>

**2015:** The EU first action plan<sup>51</sup> for the circular economy (COM (2015) 614),<sup>52</sup> proposed specific recycling targets, for several types of wastes, and strengthened separate collection of other streams, such as hazardous wastes and bio-wastes. A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2035 was established. WtE was encouraged in countries with high rates of landfilling.

**2017:** The European Commission (COM 2017/0034) advocated the use of WtE for the transition to a circular economy only when it does not prevent higher levels of prevention, reuse and recycling.<sup>53</sup>

**2017:** The European Commission Implementing Decision (2017/1442)<sup>54</sup> established the best available techniques (BAT) for large combustion plants, including WtE, and following the Industrial Emissions Directive of 2010. The Decision set very strict emission limits for WtE operations as compared to the limits of the Waste Incineration Directive of 2000.

**2018:** The proposed EU regulation 2018/0178 on the establishment of a framework to facilitate sustainable investment (also known as “taxonomy”) listed activities like “avoiding incineration and disposal of waste” as sustainable (Art. 9.1.i), while activities that “[lead] to a significant increase in the generation, incineration or disposal of waste” (Art. 12.d) were considered as harming environmental objectives.<sup>55</sup>

**2018:** The Directive 2018/850<sup>56</sup> was introduced, amending Directive 1999/31/EC on the landfill of waste. The Directive made emphasis on the restrictions and gradual reduction on landfilling to all waste that is suitable for recycling or other material or energy recovery. That reduction should avoid the development of excessive capacity for the treatment of residual waste facilities, such as through energy recovery or low grade mechanical biological treatment of untreated municipal waste.

**2018:** The Directive 2018/851<sup>57</sup> was introduced, amending Directive 2008/98. The Directive promoted waste prevention and intensified separate collection schemes, while avoiding support to landfilling and incineration. WtE is desired as long as it delivers the best environmental outcome in accordance with Article 4. In addition, the Directive considers the recovery of metals and minerals from WtE by products, as contribution to recycling, as long as these comply with quality standards. Also, the Directive provided an update on the R1 energy efficiency formula for WtE, by including local climatic conditions.

**2018:** The Directive 2018/2001<sup>58</sup> was introduced on the promotion of the use of energy from renewable sources, and amending and subsequently repealing Directives 2009/28, 2001/77/EC and 2003/30/EC. The Directive considered WtE as a renewable energy source, as long as it does not prevent the reusing and recycling of products, and only processes biodegradable wastes.

<sup>50</sup> See online <https://ec.europa.eu/info/strategy/priorities-2019-2024>

<sup>51</sup> See online [https://ec.europa.eu/environment/circular-economy/index\\_en.htm](https://ec.europa.eu/environment/circular-economy/index_en.htm)

<sup>52</sup> See online [https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.03.DOC\\_3&format=HTML&lang=EN&parentUrn=COM:2015:614:FIN](https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.03.DOC_3&format=HTML&lang=EN&parentUrn=COM:2015:614:FIN)

<sup>53</sup> See online <https://ec.europa.eu/environment/waste/waste-to-energy.pdf>

<sup>54</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX%3A32017D1442&from=EN>

<sup>55</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018PC0353&from=EN>

<sup>56</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0850&from=EN>

<sup>57</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&from=EN>

<sup>58</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN>

**2019:** A common statement<sup>59</sup> was published by major EU stakeholders addressing the importance of WtE in sustainable development, by putting emphasis on Article 4 of the Waste Framework Directive establishing the waste hierarchy.<sup>60</sup>

**2020:** The European Investment Bank (EIB) decided not to finance any WtE activities/projects in its circular economy programme.<sup>61</sup>

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<sup>59</sup> See online <https://www.cewep.eu/wp-content/uploads/2019/02/Joint-statement-taxonomy-February-2019.pdf>

<sup>60</sup> See online <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&from=EN>

<sup>61</sup> See online <https://www.eib.org/en/publications/the-eib-in-the-circular-economy-guide>

## Annex III.

### Case studies<sup>62</sup>

#### 1. People-first outcome “Increase access and promote equity”

##### *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 People-first 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.

##### *Olsztyn, Poland*

**Challenge:** The region was heavily relying on non-sanitary landfills.

Description of the project: The WtE plant will process 300 tonnes of waste per day and will produce 12 MW of electricity. The Polish WtE facility will provide electricity and heat to some 270,000 people in Olsztyn. The project created over 100 jobs for local people during the construction phase, and about 30 jobs during the operation.

Partners: The French investment fund Meridiam has been awarded a PPP contract of 25 years to build and operate the plant. Meridiam has an 80% share in the project, while the remainder is held by Madrid-based waste management company Urbaser SA. The capital investment of the plant is EUR 183,276,653, with the EU’s Cohesion Fund contributing EUR 39,608,601 through the “Infrastructure and Environment” Operational Programme for the 2014-2020 programming period. The investment falls under the priority “Environmental protection, including adaptation to climate change”.

Contribution to the People-first outcome “increase access and promote equity”:

- The Olsztyn’s Michelin combined heat and power plant is to be closed. The WtE plant will use residual waste as a new heat source and will also provide electricity to the 270,000 inhabitants of the city.

##### *Klaipėda, Lithuania*

**Challenge:** The region was heavily relying on imports of gas for the production of energy, and on landfills for the disposition of their waste materials.

Description of the project: The Fortum Klaipėda combined heat and power plant (CHP) is situated in Klaipėda Free Economic Zone. The plant processes 272,000 tonnes of waste per year to produce 380 GWh of heat and 120 GWh of electricity. It covers about 40% of the city’s heat requirements. The project was commissioned in spring 2013, and it is the first WtE in Lithuania and all the Baltic countries.

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<sup>62</sup> The findings, interpretations, and conclusions expressed in the case studies in Annex 3 do not necessarily reflect the views of the UNECE secretariat. Mention of company names or commercial products does not imply endorsement of the United Nations.

**Partners:** The plant is a part of the Finnish energy company Fortum and 5% of the shares are owned by the heat distributor AB Klaipėdos energija. The total amount of Fortum's investment in the plant in Klaipėda is EUR 140 million, of which EUR 70 million is covered by a seven-year loan from Nordic Investment Bank (NIB). The flue gas treatment and heat recovery system were supplied by Alstom. Fisia Babcock was responsible for the design, development, and erection of the boilers, as well as commissioning and trial operation. Honeywell provided the Experion Process Knowledge System (Human Machine Interface) and safety manager emergency shutdown.

**Contribution to the People-first outcome “increase access and promote equity”:**

- The project covers about 40% of the city's heat requirements and helps the country to reduce imports of gas for energy production.

## 2. People-first outcome “Improve projects economic effectiveness and fiscal sustainability”

### *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 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.<sup>63</sup> The initial investment of developing the site and installing the equipment was approximately USD 400,000.

**Contribution to the People-first outcome “Improve projects economic effectiveness and fiscal sustainability”:**

- The project considered the refugees for the construction and operation of the landfill.
- The project significantly reduces health risks for refugees and host communities and the likelihood of diseases outbreak.

### *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 does not meet Serbian or EU standards for Sanitary Landfills and poses 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 and occupied about 40 hectares of land near the bank of Danube river.

**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-

<sup>63</sup> See online <https://www.unhcr.org/news/briefing/2019/2/5c540fe74/worlds-biggest-refugee-settlement-gets-biggest-waste-facility.html>

European equity fund Marguerite II. The capital investment is EUR 370m. IFC and MIGA, members of the World Bank Group, are providing a EUR 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 People-first outcome "Improve projects economic effectiveness and fiscal sustainability":

- 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.
- One of the biggest non-sanitary landfills in Europe will be redeveloped into a "green" area.

### *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. 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 People-first 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 EUR 10 million for the community to date, with an additional future annual contribution of EUR 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 euro, of which 277.6 million euro were provided by the Government of Azerbaijan and 149.9 million euro by the Islamic Development Bank.<sup>64</sup>

<sup>64</sup> See online <https://www.ebrd.com/work-with-us/procurement/pn-51281.html>

Contribution to the People-first 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.

### 3. People-first outcome “Improve environmental sustainability and resilience”

#### *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 People-first outcome “Improve environmental sustainability and resilience”:

- The city reduced its fossil fuel consumption by 58%.
- The project saves about 19,000 tonnes of CO<sub>2</sub> equivalent per year.
- The energy performance of the buildings served by the network improved from 99.83 kgCO<sub>2</sub>/m<sup>2</sup> (E-label) to 55.14 kg CO<sub>2</sub>/m<sup>2</sup> (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.

#### *Singapore*

**Challenge:** With just 700 km<sup>2</sup> and a high population density Singapore needed to find an alternative to the land-intensive method of landfilling waste.

Description of the project: Singapore’s new Integrated Waste Management Facility (IWMF) will be the world’s largest energy recovery facility. IWMF will consist of a recycling facility with a capacity of 250 tonnes per day, and a WtE plant with a capacity of 2,900 tonnes per day. With 2x4 combustion lines, the IWMF will be able to treat more than 2.5 million tonnes of solid waste annually. In IWMF, it will also operate a food waste facility for treatment by anaerobic digestion, and a sludge incineration plant with two fluidised bed combustion systems. The total site area equals 68 acres of land. The capital investment for the construction of the IWMF is USD 1.5 billion. The facility is located next to a new water reclamation plant (Tuas WRP), combining the food-energy-water nexus in one site.

Partners: The project sponsors for the recycling facility and the WtE plant, comprise Keppel Seghers Engineering Singapore (the environmental engineering arm of Keppel Infrastructure), China Harbour (Singapore) Engineering and ST Engineering Marine, part of Singapore Technologies Engineering. The project sponsors will work closely with the National Environmental Agency (NEA), and Singapore’s National Water Agency (PUB) as well as their consultants – a multi-disciplinary consultancy team led by Black & Veatch and

AECOM, in association with Ramboll, for the design, construction and commissioning of this project.

Contribution to the People-first outcome “Improve environmental sustainability and resilience”:

- The integrated facility aims to minimise land use while at the same time ensuring environmental protection and maximising energy output.
- After the completion of IWMF, Singapore will achieve “zero waste” targets, with no need for landfilling of waste.
- The IWMF along with the water treatment facility, provide a sustainable solution for the energy-water-food nexus.

### *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 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. The project created 18 new apprenticeships and over 250 jobs.

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

Contribution to the People-first outcome “Improve environmental sustainability and resilience”:

- Delivering a saving to Glasgow of 90,000 tonnes of CO<sub>2</sub> every year.
- Diverts 90% of green bin residual waste away from landfill.
- Regenerated the existing Glasgow City Council waste facility at Polmadie, on the South side of the city.

### *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 EUR 10 million in financial support from the Flemish Government.

Contribution to the People-first outcome “Improve environmental sustainability and resilience”:

- Decommissioning the current individual gas-fired boilers lead to a yearly saving of 200,000 tonnes of CO<sub>2</sub> emissions, equivalent to the savings brought by 100 wind turbines.
- The process recovers metals and minerals, and thus contributing to recycling.

*Surrey, British Columbia, Canada*

**Challenge: The city was sending all the organics to a landfill.**

Description of the project: The Surrey Biofuel Processing Facility is in Port Kells industrial area, and it is designed to receive and process all the organic waste of the city, or 115,000 tonnes of organic waste annually. The process converts source separated organic wastes, into 120,000 gigajoules of renewable natural gas and 45,000 metric tonnes of compost, which is produced “in vessel”. The natural gas is used to fuel the City’s waste collection trucks. The plant occupies 14,323 square metre of area. The biofuel facility creates more than 15 new, full-time, and long-term jobs.

Partners: The project is a PPP with Orgaworld Canada (a leading organics waste treatment company), Smith Bros & Wilson Ltd. (construction), and the City of Surrey over the 25-year contract term. The capital investment was USD 68 million. Twenty-five percent of the cost of the facility was funded by the Government of Canada and the remaining 75 percent was funded by Renewi plc., which is also responsible for the operation and maintenance of the facility.

Contribution to the People-first outcome “Replicability”:

- It is estimated that this diversion of waste from the landfill will amount to approximately 25,000 tonnes of CO<sub>2</sub> reduction per year.

**4. People-first outcome “Encourage the replicability of projects”**

*Cần Thơ, Mekong Delta, Vietnam*

**Challenge: Can Tho is the largest city in the Mekong Delta with a population of around 1.2 million. It is also an important tourist destination and one of the most economically advanced cities in the country. Currently, household waste in the city is primarily incinerated without energy recovery or is disposed of in landfills.**

Description of the project: The project is designed to have a daily household waste processing capacity of 400 tonnes and will be equipped with a 7.5MW generator able to produce around 60,000 GWh of electricity annually. It will be built on an area of 53ha in Trường Xuân Commune, Thới Lai District. The project setup the emission control target to comply with the EU standards. The capital investment is USD 47 million.

Partners: The project is a PPP with a BOT structure for 22 years. The constructor and operator is Everbright Environment, which has secured a USD 100 million loan from the Asian Development Bank to develop a series of WtE plants in the Mekong Delta, Vietnam.

Contribution to the People-first outcome “Replicability”:

- Everbright Environment organised training programme to more than 20 local staff become professional operators, opening 1 day per month to the public for visiting and learning the project.
- The well-organised clean environment and transparency approaches has helped Everbright Environment built trust with the local authorities and citizens, win the satisfaction from the public will leads more projects and more jobs will be created for the local communities in the future.

*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 People-first 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. People-first outcome “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 USD 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 People-first 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 liters 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 People-first 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.

*Nanning, China*

**Challenge: The land occupied in the Project of Nanning was considered as the “Geomantic and Treasured Land” by local villagers. Landing of the Project thus meant to destroy local “Feng Shui” (Chinese geomancy), and significant opposition was associated with the project.**

Description of the project: The plant processes 2,000 tonnes of waste per day.

Partners: It is a PPP project between the municipality of Nanning, and Sanfeng Energy Co. It is a BOT model, which is built and operated by Sanfeng. The plant uses Martin SITY 2000 technology.

Contribution to the People-first outcome “Stakeholder engagement”:

- The municipal governments strengthened publicity efforts; invited committee leaders to existing WtE plants, organised open discussions with the community, printed and distributed brochures promoting WtE, supported the local economy by the construction of roads, and by hiring local people of the community to the construction and operation of the plants, etc.
- Also, the municipalities enforced strict emissions standards for WtE operations.