Circular Economy: Transforming Burden to Bounty

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1. Waste: A Universal Burden

Despite having no consensus, two commonly cited definitions provide well-rounded explanations on what waste is (and is not).

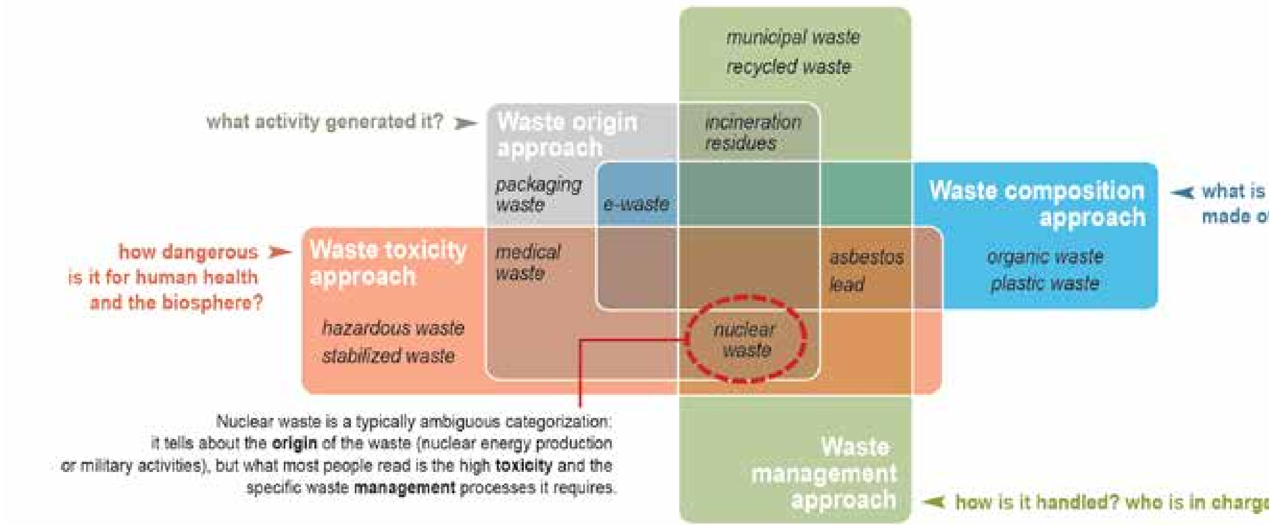
According to Basel convention, "wastes are substances or objects which are disposed or are intended to be disposed or are required to be disposed of by the provisions of national laws"[1] .

More elaborately, the United Nations Statistics Division defines wastes as materials that are not prime products (that is products produced for market) for which the generator has no further use in terms of his/her own purpose of production, transformation or consumption, and of which she/he wants to dispose. On the aspects of generation, it further states that "wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded" [1] .

As hinted in the definitions, 'waste' is a complex subject which necessarily making it difficult to classify. The multitude of variables acting upon it is illustrated in the Figure 1 below. It also highlights the underlying complexity of 'management' of waste, which an intensifying theme of discussion, globally.

Figure 1: Complexity of waste and its overlapping classifications,

[Graphic source: GRIDA-Arendal, 2017, http://www.grida.no/resources/5875]



Despite the broad scope of the subject, herein we focus on the most bothersome aspect of waste; Municipal Solid Waste [MSW] to illustrate how a burden could be transformed to a bounty through the use of sensible management practices and respective technologies.

Substantiated by the current definitions and the negative connotation tethered to it, 'waste' in general is considered as a burden, a nuisance, and something that must be put 'away'. Away from the socio-economic systems. For time immemorial, this 'away' has been a hole in the ground or a water body (either flowing or stagnant, salty or fresh). With increasing population, rapid economic growth, diminishing land availability, and nearly manic societal metabolism, this 'away' has come rapidly and dangerously close to the socio-economic systems itself that generate waste, globally. At the turn of the Anthropocene, we have realised that there is no 'away' anymore to dispose of our societal metabolic by-products.

According to a World Bank report, it was estimated that the global burden of MSW is going to be over 2.2 billion tonnes per annum with a generation rate of 1.42 kilograms per capita by 2025; ca. a factor-3 increment compared to that of the base year (2002). See Table 1. It underscores the fact that already strained global MSW management methods such as landfilling and incineration shall implode under the mounting pressure not only due to the limited capacity issues but also due to the heavy environmental burden resulting from them. Therefore, a paradigm shift in MSW management is required, pronto.

YEAR	GLOBAL POPULATION [billion]	MSW PER CAPITA [kg/day]	MSW PER ANNUM [billion tonnes]
2002	2.9	0.64	0.68
2012	3.0	1.2	1.3
2025	4.3	1.42	2.2

Table 1: Trends in global MSW generation
[Data source: What a waste: a global review of solid waste management, 2012, WBG
http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/0,,contentMDK:23172887~pagePK:210058~piPK:210062~theSitePK:337178,00.html]

2. Burry or Burn: Equally Bad Options

Notwithstanding the level of income or the economic status of a country, most widely employed methods of MSW management to date are –in order of frequency– landfilling, dumping and incineration. The negative consequences of landfilling and/or dumping are extensively studied, well documented, and thoroughly understood, yet continued to be practiced in most parts of the world. Some of its impacts include (but not limited to); ground, water, and air pollution due to gases, leachate etc., deterioration of well-being and loss of quality of life, mounting economic burdens on municipalities, loss of resources and associated revenues.

In light of that, incineration of MSW is promoted as a 'viable' alternative even in environmentally conscious advanced economies partly owing to misconceptions and lack of understanding of its inner working. In certain instances, incineration, compared to landfilling and/or dumping, performs better due to the fact that incineration of MSW produces a significantly high volume of usable energy (electricity and heat) that results in better environmental offsets (see for example Assamoi and Lawryshyn (2012)[1] . However, frequently, taken out of context –sometimes based on unfounded claims–, MSW incineration is inordinately promoted as an overall environmentally sound solution for MSW management. A comprehensive account of 'why MSW incineration is the wrong choice' is provided by Leonard (2010)[2] whereas Table 2 below highlights some key arguments those that oppose MSW incineration.

Table 2: Incineration is the wrong choice, [Sources: Leonard, 2010; NTN[1] , n/a]

ARGUMENT	CASE IN POINT
1. Releases toxic air pollutants and produce toxic ashes	Incinerators' emissions include persistent organic pollutants (e.g. dioxins and furans and also nanoparticles and toxic heavy metals that impact human and ecosystem health. All incinerators produce ash (fly ash and bottom ash) contaminated with toxic heavy meatless and POPs.
2. Dirtiest form of energy that wastes embedded energy	Burning waste produces toxic emissions and greenhouse gases. It dissipates the embedded energy in resources such as in plastics or synthetic polymers and recovers only a minute fraction by way of calorific value.
3. Undermines recycling efforts and destroy resources	High calorific value 'fuel' required to run the incinerators are also the high market value resources (such as plastics, paper, and wood) with embedded energy that can be easily recycled, that is burnet and destroyed to produce toxic ashes.

ARGUMENT	CASE IN POINT
4. The costliest waste management option that entrenches a linear economy	The lifecycle costs of incineration are among the highest of all waste management solutions whereas it [incineration] relies on a steady supply of waste for decade. That encourages steady waste generation through the use of virgin resources and prevents recycling, sustaining a liner economy.

With current exhaust gas treatment technologies, as standardly required in developed countries such as Germany in its "Technical Instruction Air Safety (TA Luft)" the first two arguments could be countered. A set of different high-tec filter cascades does the magic, but at high cost. In average, in Germany the treatment cost in waste incineration plants sums up to a 160EUR per ton of MSW. That´s a negative added value and lead to tremendous high energy prices, which above the levelized cost of energy (LCOE) achieved by competitive renewable energy technologies.

Despite a broad spectrum of persuasive evidence opposing the conventional MSW management practices, landfilling, dumping, and incineration continues to thrive globally due to the general lack of 'enforced' laws, political and social willingness to change, and tangible alternatives. To that end, the need of the hour is a paradigm shift.

3. Waste-to-Resources: A Paradigm Shift

Evident from the European frontier of sustainable environmental management, it is clear that waste is no longer considered a burden thanks to the enabling policies and enforced laws those that actively support the sustainable resource management models –such as the Circular Economy model– and environmentally benign waste-to-resource technologies.

Moving out of the existing 'linear economic model' –which is based on the premise that resources are unlimited, which perpetuates the 'extract, process, use, and discard' iteration– is a major paradigm shift. For example, in Germany, this process is accelerated through the policy implementation of 'closure of the landfills by (2005)[3]. The alternative model pursued; the Circular Economy model, is, as the European Parliament Research Service noted, "the notion that the value of materials and products is kept as high as possible for as long as possible", through cyclical use of the material in an economy. It further notes that "this [CE model] helps to minimise the need for the input of new material and energy, thereby reducing environmental pressure linked to the life-cycle of products, from resources extraction, through production and use to end-of-life"[4]. Figure 2 synoptically presents the concept of Circular Economy where waste is no longer viewed as a burden, instead 'a resource' that fuels a multitude of cyclic economic activities. CE concept is based on the ecological principles of symbiosis and material recycling in nature, thus true to its principles the scale and scope of CE applications are vast.

Figure 2: The concept of Circular Economy [CE], [Graphic source: EPRS, 2017]

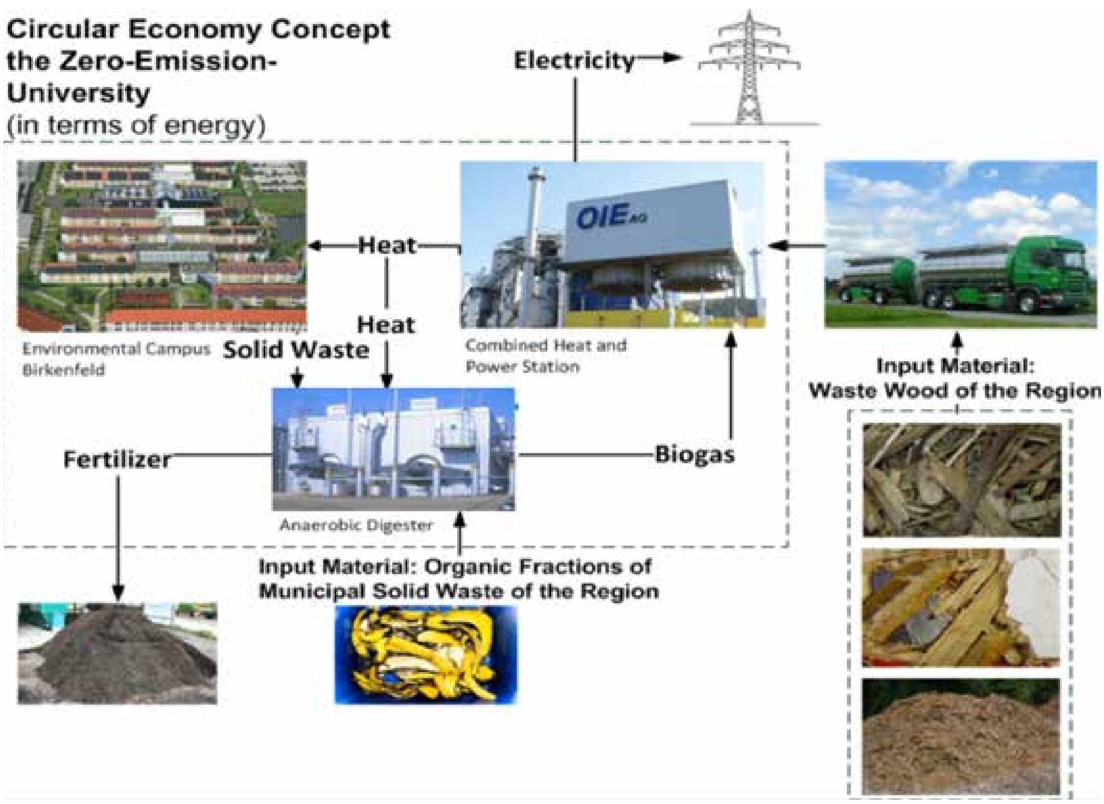
4. Burden to Bounty: A German Experience

To elaborate the practical application of sustainable waste management in the Circular Economy, here we provide an example from the Europe's First Zero Emission Campus; the Environmental Campus Birkenfeld [ECB].

ECB (established in 1996); a sub-campus of the Trier University of Applied Science is a converted, disused American reserve military hospital employing eco-compatible building methods and zero emission technologies to become the first Zero Emission Campus in Europe. Among an extensive portfolio of cutting-edge ZE technologies, ECB is maintaining its energy autonomy to date through the use of Zero Emission, renewable, and green energy by utilising regionally available biomass. Energy –both heat and electricity– are supplied by a neighbouring biomass combined heat and power station, which uses regionally available waste-wood and organic MSW. Based on the principles of industrial symbiosis [IS], ECB is connected to the neighbouring eco-industrial park via a district heating system and a low-voltage electricity transmission grid (for energy flows), whereas to reciprocate the flows, the biomass generated on campus is supplied to the biomass-based power station. The wood-chip-based power station –established in 1997– has an installed thermal capacity of 28MW, which utilises ca. 65,000 tonnes of low and high contaminated waste wood per year sourced from regional forestry, agriculture, landscape gardening, and industry to produce 8MW heat, 37.5 tonnes per hours of steam and up to 8.3MW electricity for ECB, the neighbouring industrial facilities, and the national electricity grid. In addition, the cogeneration unit utilises the biogas output of the nearby anaerobic digester that treats ca. 40,000 tonnes of bio-waste annually, collected from the Municipalities of Birkenfeld (including the food and other organic waste of ECB) and Bad Kreuznach. The by-products of anaerobic digestion of bio-waste, both liquid and solid fractions, are provided to the local farmers to be used as fertiliser and soil amendments in the agricultural croplands thereby close the regional nutrient cycle. This further reduces the soil, water, and air pollution due to the disposal of bio-waste in a conventional landfill. Also, this action strengthens the regional economy by preventing the net cash outflow by eliminating the need to purchase synthetic fertiliser for crop production. Figure 3 below schematically presents the waste-to-resource system of ECB based on the CE model.

In addition, this waste-to-resources initiative of ECB has created a large number of direct and indirect employments in the energy and environmental management sectors. It also serves as a regional and national ‘lighthouse project’ for ZE, CE, and suitable regional development knowledge dissemination. Annually a large number of students, researchers, public and private sector employees, and interest groups and citizens visit this faculty to learn from the practical example, which is organised as part of the knowledge sharing efforts of ECB[5].

Figure 3: Waste-to-resources in Circular Economy, [Graphic Source: IfaS, 2017]



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