CO_2 - To waste or not to waste?

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1 Introduction

Living nearby a brewery, Joseph Priestley, a British clergyman was fascinated by the "air" that was floating over the fermenting liquor. Finding himself "at loss for proper terms" he called it fixed air. He was fascinated by different types of gases and has produced six volumes of 'Experiments and Observations on Different Kinds of Air' between 1774 and 1786. In his works he mused on how respiration "injures common air" and, to his surprise, found that plants have the ability to "restore air that have been injured by respiration". The first scholarly and quantitative work on the greenhouse effect of CO_2 was done by the Swedish Nobel chemist Svante August Arrhenius (1896). In 1899, Chamberlain published the theory that climate changes may be related to fluctuations in atmospheric CO_2, and, in 1956, Guilbert N. Plass indicated that CO_2 is the major 'greenhouse' gas. In the 1950s, studies of CO_2 in the atmosphere were strictly a matter of satisfying general scientific curiosity. Charles David Keeling was the first of many scientists that would eventually dedicate his work to climate change, his interest being study of geochemistry, vaguely invoking possible applications to agriculture (Weart 2008). Since then, there has been a tremendous amount of work on the science of global warming, culminating in the now famous Intergovernmental Panel on Climate Change (IPCC) reports. However, CO_2 was not regarded as a pollutant until the late 1980s, and thus there were no significant policies aimed at restraining CO_2 emissions in effect.

2 Objectives of the research

The main interest of this research is to evaluate the reaction to CO_2, and evaluating the history of dealing with CO_2, contrasted with the history of waste.

3 Results

The EU Waste Framework Directive (WFD) 2006/12/EC defines waste as "any substance or object which the holder discards or intends or is required to discard". It is remarkable that the WFD recognizes waste at the point of its generation. This is due to the fact that legislation is concerned with the control of the conditions of waste treatment and disposal. The definition itself does not make judgment whether waste is any measure of inefficiency. It merely recognizes waste as something to be dealt with. The author has previously done over 10 years' long research on the conceptual analysis of waste and waste management and suggested that instead of recognizing the instance of waste, we need to look into the concept of waste. The idea behind his reasoning is that if we know the reason of wasting, we have an insight into how it can be avoided. An innovative description of the concept of waste was achieved using an object-oriented modelling language PSSP. The acronym PSSP stands for purpose, structure, state and performance, which are object attributes, as this language is devised

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using object formalism (Pongrácz 2002). In this continuing research effort, CO_2 as a waste of industrial processes is analyzed.

3.1 CO_2: A waste or a resource?

Carbon dioxide (CO_2) as an anthropogenic emission of energy generation is an unavoidable concomitant of the process and, as such, has no purpose. Therefore, for all intents and purposes, CO_2 from energy generation is a waste. What makes this CO_2 a waste is, firstly, that it is anthropogenic. The concept of waste in legal sense and also in popular understanding is related to human activity. Second, by the word of waste legislation, waste is defined by the intent of discard and, most power plants have no other plans for emissions than discard. This means that, while a CO_2 molecule from anthropogenic source is indistinguishable from one coming from bionatural sources, the first one is waste and the second is a natural thing.

This CO_2 could be viewed as a resource to be exploited and, certainly, it would cease to be waste, if it was a part of a useful object. Pure CO_2 is a valuable chemical feedstock, the problem is that most emissions are not pure; they are a mixture of a number of components such as nitrogen oxides, sulphur oxides, water vapour, volatile organic compounds, aso. This is but one item on the extensive list of technical, economical and environmental challenges to CO_2 utilization. An issue, which is under much discussion of today, is CO_2 disposal. We are dealing with the storage of an unwanted substance, and seeking potential locations in which to store it such as in geological formations and the sea. There is myriad of questions surrounding this discussion such as storage security, leakage, location and access to it, ownership of such places, rights and responsibilities, intergenerational transfer of risk. The discussion is a lot reminiscent to that of surrounding landfilling, which is one of the least preferable waste management alternatives.

3.2 Waste management vs. CO_2 management

Figure 1 depicts a 47 years' outlook on waste management from 1960 to 2007 in the USA. It is very illustrative of the development of trends in waste growth and treatment alternatives.

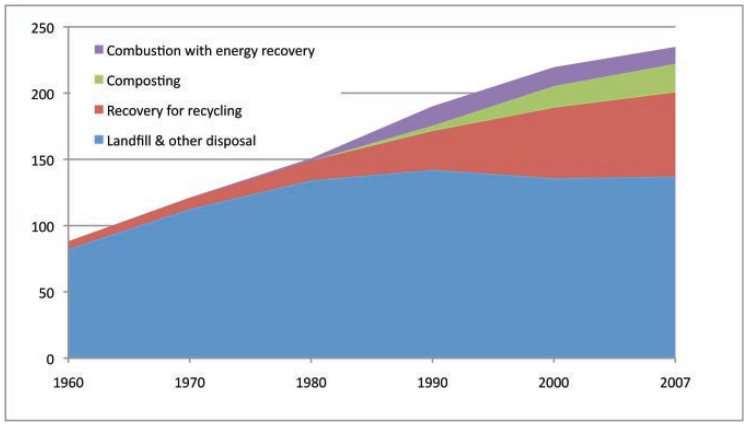

Figure 1 Trends in waste generation and treatment in USA in million tons (Source USEPA)

Due to increasing population and level of affluence, the level of waste produced was growing steadily in the 20th century. Awareness levels increased in the 1970s, especially due to littering and alarming reports on landfill shortages. Recycling was heralded in the 1980s as the one to save us, which is clearly seen in the tendency of increasing recovery percentages. However, as the overall growth of waste amounts has been faster, the amount of waste going to landfill continues to grow. It was only in the 1990s, with the birth of pollution prevention and extended production responsibility initiatives that a slight indication of decrease in landfill is observed. However, we are yet very far from significant diversion from landfill. It appears that CO_2 management is heading toward the same path. Table 1 summarizes some key milestones in the history of waste management, contrasted with CO_2 management.

Table 1 History of waste concern vs. CO_2 concern

History of the waste concern	History of the CO_2 concern
1348: The birth of the waste concern (Black Death), hygiene and public health the main drivers	1774: Priestley: "fixed air"
19th century: Reported practice of turning by-products into valuable inputs, economics the main driver	Late 18th century: monitoring of CO_2 in air starts; 1899: Theory on climate change related to CO_2
Early 20th century: waste management as a government activity in EU countries, response to uncontrolled disposal of wastes into the environment	1956: The CO_2 Theory of Climate Change; Mauna Loa weather observatory built
1970's: Waste awareness brought by littering; The first EU waste legislation in 1971	1979: World Climate Conference – Concern on the impact of man's activities on global change
1980's: Alarming reports on landfill shortages, great hopes in recycling as a solution	1980s: CO_2 started to be regarded as a pollutant; 1988: IPCC established – Policy relevant, but not policy prescriptive
EU waste legislation revised in 1991; first EU legislation mandating recycling in 1994	1994: United Nations Framework Convention on Climate Change comes in force
1990's: Pollution prevention, Industrial Ecology	1997: Kyoto Protocol – First attempt to enforce source reduction
2000's: Extended producer responsibility	2000's: Renewable energy policies

The concern of waste started with severe health impacts consequent of unsafe disposal, and further grew when the amounts surpassed nature's capacity to neutralize them. Landfilling as a solution for safe disposal is still the most significant waste treatment option. The next issue has been if we have enough landfill space, attention turned later to its potential danger e.g. pollution to groundwater. As illustrated earlier, recycling did not really fulfil expectations. A key reason is that the waste stream is complex; individual materials are easy to recycle but getting them out of the waste mass is difficult and expensive. By now, waste management cumulated into a resource management issue, firstly because prevention is more efficient than treatment and, secondly, due to the recognition that we do not have that many resource to go around with. Regulative forcing has been a keen driver every step of the way.

As for CO_2, since the consequences of rising amounts were not so obvious, regulative action has been slow. With carbon capture and storage, the discussion is at the level of waste in the 1970s. The key issues are where to put it, and its potential risks. Some proposals exist for recycling, but we have not reached the avoidance part yet.

Another interesting analogy is legislative action to drive avoidance. The first actual effort of CO_2 avoidance is the 2005 EU Directive on Energy-using Products (2005/32/EC), aiming at reduction of electricity use of electronics, although their CO_2 contribution is not a top concern. Similarly, recycling was also mandated first for packaging, although they are not largest waste fraction either; one of the most visible perhaps.

4 The relevance of research

Anthropogenic waste and CO_2 have been of no concern of man when amounts were below the nature's capacity to absorb them. Growing amounts brought concern when environmental impacts were felt at personal levels and bore economic consequences. Neither waste management, nor CO_2 management seems to be drawing most wind from the fact of resource scarcity and the social injustice of lack of intra- and intergenerational equity. In both cases, lots of attention is on dumping first – only milder interest in minimization and recycling. In both cases regulation took a controversial action. The packaging directive received a lot of criticism that excessive effort on collection and transportation may consume more resource than it saves. Similarly, there is critique on some biofuels, if their contribution to CO_2 reduction is sizeable. The intention of this analysis is to point out similarities in the tendency of dealing with wastes and CO_2 through time. The aim is to draw some lessons from waste management in hopes of skipping through some phases of inefficiency in CO_2 management. There is clearly a need for more attention on avoidance, and to generate another paradigm shift from waste to resource management, towards a low-throughput, matter-recycling economy.

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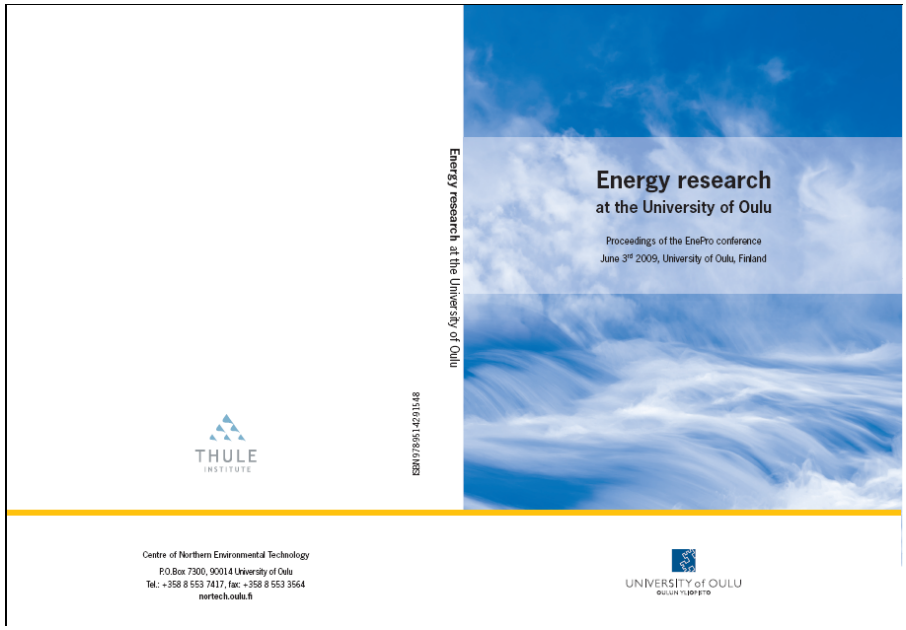

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