RAPPORT

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CLIMIT

BORG CO_2 AS

Rapporttittel:
Tilleggsrapport: CCS i WtE
Mulighetsstudie CCS-klynga på Øra og regionalt

Forfatter(e):	Johnny Stuen, produksjonsdirektør Renovasjons- og gjenvinningsetaten Oslo Kommune
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Innhold

Summary:

Waste to Energy is a concept/technology to incinerate waste or residual waste after sorting. The technology enables the possibility to recover energy from waste streams, either as electricity or heat.

The technology is widespread in western Europe, Japan and China, and some installations in USA. China and Great Britain have been the two areas where the technology has grown most the last decade. The largest potentials for further growth are in South East Asia, Middle East, Eastern Europe and Brazil.

Carbon capture from WtE-plant have been tested for some years, but fullscale applications have yet to be started.

The main technology for WtE is advanced grate combustion, and there are some applications using 2-stage gasification and combustion and some fludized bed applications.

Carbon capture for WtE is mainly based upon amine solvents, but there are also other technologies being tested, such as hot potassium and ammonia. There is a lot of technology development happening in this area.

The potential for carbon capture application in the WtE industry seems to be biggest/most applicable in Europe and South East Asia, and in markets where WtE not yet has been applied.

WtE worldwide and the potential for carbon capture

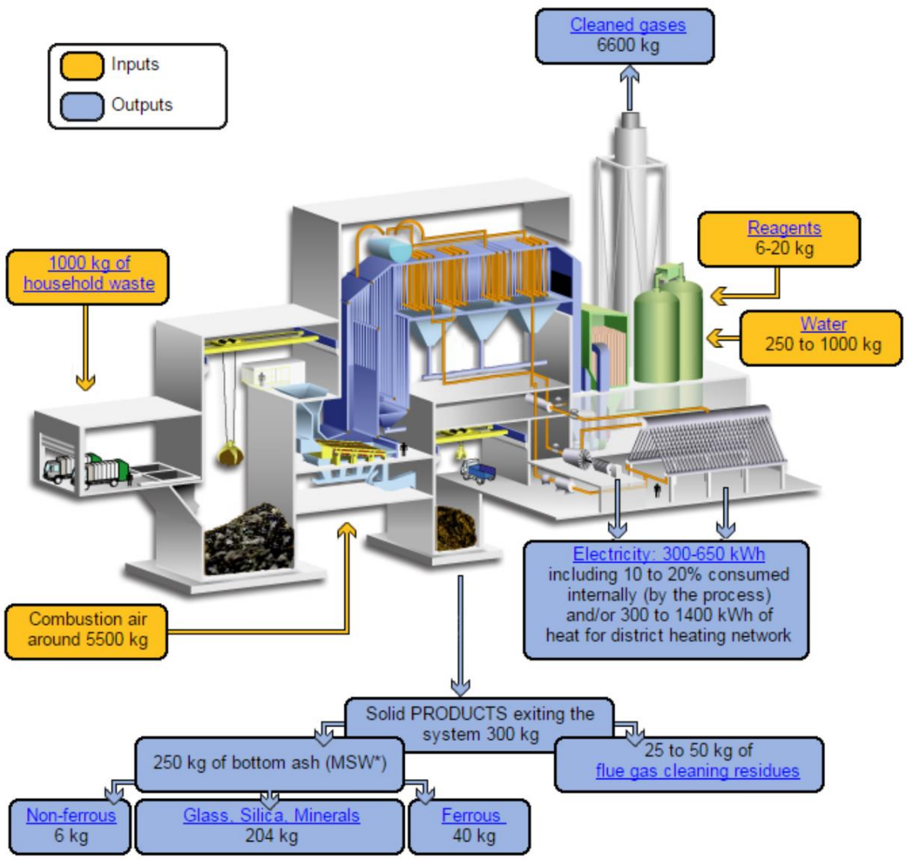
Waste to Energy (Energy from Waste, Energy recovery from waste), short named WtE, is a name used for technologies to recover energy from waste streams, and include incineration technologies for mixed waste, gas engines for landfillgas and biogas from organic waste. In this paper it is used for incineration technologies to recover energy from mixed waste streams.

WtE in this form has mainly been used in western Europe and Japan, with some use in the US and China. This paper examines the spreading of this technology, some of the different technologies used and the potential for carbon capture at these areas and technologies.

Technology

Waste to Energy

The most used technology is advanced moving grate technologies, developed over the last 100 years.



This technology does not demand any pre-treatment of the waste before incineration and has proven very efficient and reliable. At least 90% of the installed capacity worldwide is based upon this technology.

There are also other technologies used, but all these technologies relate on pre-treatment of the waste. The following technologies are in operation today:

Fluidised Beds combustion (FB) – both as "bubbling bed" and "circulating fluidized bed". These technologies are also more used for specific waste streams and biomass.

Gasification – mostly used in Japan, and in normal operation only as a "2-staged" incineration. Some smaller plants are also run in Europe, i.e., plants based on ENERGOS gasification technology. Two of the partners in Borg CO2 operates such plants with very good results.

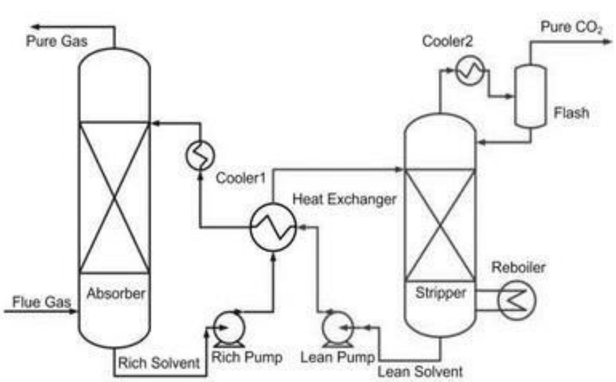
There are also a couple of other technologies that has been tested for WtE, but none other has come up with reliable industrial scale solutions.

Carbon capture technologies tested in WtE.

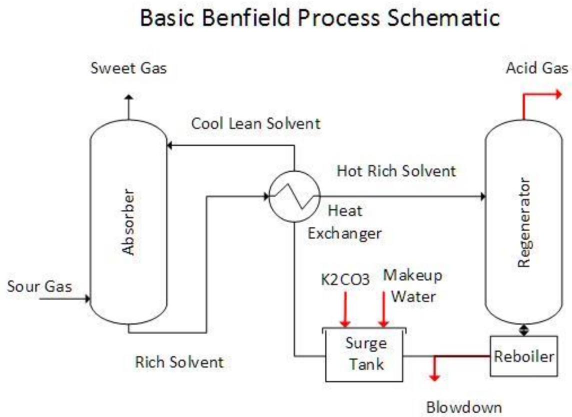
When the Klemetsrud project started working in 2015, we found 4 known projects for capturing CO_2 from waste streams, and with different usage. All of them pilot plants, with the capacity to treat 10 tons/day or less.

1. Saga City in Japan – amine-based capture technology, using the CO_2 to grow algae.
2. Sedibex, hazardous waste in Le Havre, France – amine based (MEA) technology, 1 year test plant
3. Twence, Netherlands – regeneration of Sodium bicarbonate using CO_2 from the flue gases
4. HVC, Alkmaar, Netherlands – capture test facility, amine based.

Since then, technologies have been tested at several WtE plants, with two types of technology. Amine based scrubbing/stripping – different amines and hot potassium carbonate (BenField), also scrubbing/stripping.



Generic amine CO2 capture process



Waste to Energy usage and potential

Countries with already installed capacity:

Europe

There are approximately 460 WtE plants in Europe, incinerating 90 mill ton mixed waste every year. The plants are mainly located in northern and western Europe, and the composition of the waste is quite similar. This means that the CO_2 emissions from these is around 100 mill ton CO_2 pr year, whereof 45% is fossile and 55% is biogenic. The sizes of the plant vary from around 100.000 tonnes pr year up to 1.000.000 tonnes pr year.

The majority of the plants are either owned, operated or under contract with municipalities, and may therefore be subject to stricter and faster changes in regulation than private industry, regarding emission levels in general, and CO_2 levels in specific. The BREF/BAT process of EU (which adheres to more than 90% of these plants) har already mentioned CO_2 removal (post combustion) as an interesting and coming technology for this business.

There are conceptual projects in many places in Europe for CO_2 capture, and cooperation between academia and industry to develop framework and solutions for this technology. First and foremost are Netherlands, Norway, Sweden and Denmark, but there are also concrete alternatives in Germany, Switzerland, UK, France and Belgium.

Asia

Japan – there is a waste generation in Japan at approximately 80 mill tonnes MSW pr year, whereof 42 mill tonnes goes to WtE. There are 1200 plants, whereof 380 are CHP plants. The typical WtE plant in Japan consists of small units, and much of the energy recovered is used to neutralize and make the residues from WtE inert. The ownership of most of the WtE plants is municipal, and due to the size, probably well suited for modular approach to CO_2 capture. There is no knowledge of any other CO_2 projects than the former one in Saga City. There is an initiative from the Japanese government to make this branch more energy efficient and developing the energy use and CO_2 footprint.

China

The numbers for China are from 2018 but increasing every year. 230 mill tonnes MSW pr year, whereof 135 mill tonness are disposed of in WtE plants, mainly grate technology, but also some fluidized bed technology. There was in 2018 331 plants in operation, and 80 more in planning. There are no known carbon capture projects on Chinese waste treatment plants. There has been interest in CCS both from Chinese owners of WtE plants in Europe and developers in China.

India

The statistics for India are very deficient, but there are some assumptions. It is assumed that India produces 270 mill ton MSW every year, and that this increases rapidly. There are only 8 known WtE plants in India, treating an unknown, but expected quite low volume pr year. There are more than 50 projects in various planning stages, but many of them are difficult to complete. CO_2 capture seems far away from waste treatment plants in India.

Singapore

Singapore has a tradition for WtE and are currently building the world's largest WtE. There are no CO_2 capture plants in planning, but the legal framework that would underpin the possibility to this, are coming in place. There is already determined high CO_2 taxes for industry in Singapore. The potential for placing CO_2 capture on the WtE plants in Singapore is realistic.

Thailand, Indonesia, Philippines and Malaysia

The first plants are in planning or first phase of operation in all these countries. The potential for building WtE and subsequently CO_2 capture in these countries is growing, but it is an immature market. If there comes into place CO2 taxes or incentives, CO2 capture seems possible to place in these countries.

Australia – 15 mill tons MSW pr year, first WtE under construction. Several WtE projects in planning, none with CO_2 facilities. The probability for CO_2 capture at WtE in Australia seems low.

Africa

One WtE plant in operation, in Ethiopia.

South Africa – generating approximately 50 mill tons of MSW every year, and no WtE is in operation, and 90% goes untreated to landfill. The potential for WtE is good, but the country is lacking infrastructure and waste management to establish WtE and CO_2 mitigation measures on the waste treatment for now.

USA

Generating some 260 mill tons MSW every year, whereof 55% is landfilled. There are 77 plants in operation, within 22 states. They incinerate 28 mill tons of waste every year, making the average size of US plants quite high. The CO_2 potential may be high, as there is demand for CO_2 for EOR, and established pipelines and distribution chains for CO_2.

South America

No WtE in operation.

Brazil – generating 75 mill tons of MSW pr year, has started to develop a plan to build around 200 WtE plants within the next decades, treating up to 60 mill tons of MSW. There are no plans for CO_2 capture at this stage in the planning. The possibility to include CO_2 capture is available, as there are few or no investment decisions taken yet.

In addition to this, there are some large projects in the middle eastern, Lebanon, Israel and the Arabic peninsula. These projects are planned without CO_2 capture, or any other CO_2 mitigation.

Conclusion

The development of CO_2 capture from WtE needs to take two routes.

There must be a route to develop technology for post plant capture, usable at already existing plants. Cost is important, and every ton of CO_2 is important. This means that there can be a good potential for modular design to capture CO_2 from these plants, or only parts of the CO_2.

The other route must aim for the coming markets for WtE, to integrate the technology in the process for flue gas cleaning, lowering the total cost for flue gas treatment at these plants including CO_2 technology. This will favour integrated technology, not so much modular design. The typical markets will be China, South East Asia and parts of South America.

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Summary på norsk:

Waste to Energy er et konsept / teknologi for å forbrenne avfall eller restavfall etter sortering. Teknologien gjør det mulig å gjenvinne energi fra avfallsstrømmer, enten som strøm eller varme.

Teknologien er utbredt i Vest-Europa, Japan og Kina, og noen installasjoner i USA. Kina og Storbritannia har vært de to områdene hvor teknologien har vokst mest det siste tiåret. De største potensialene for videre vekst er i Sørøst-Asia, Midt-Østen, Øst-Europa og Brasil.

Karbonfangst fra WtE-anlegget har blitt testet i noen år, men fullskala applikasjoner er ennå ikke startet.

Hovedteknologien for WtE er avansert ristforbrenning, og det er noen applikasjoner som bruker 2-trinns forgassning og forbrenning, og noen applikasjoner med fludisert seng.

Karbonfangst for WtE er hovedsakelig basert på aminer som løsningsmiddel, men det er også andre teknologier som blir testet, som varmt kalium og ammoniakk. Det skjer mye teknologiutvikling i dette området.

Potensialet for anvendelse av karbonfangst i WtE-industrien synes å være størst / mest anvendelig i Europa og Sørøst-Asia, og i markeder der WtE ennå ikke er brukt.

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