Waste Gasification & Pyrolysis: High Risk, Low Yield Processes for Waste Management

A Technology Risk Analysis

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Executive Summary

Gasification and pyrolysis attempt to convert solid waste into synthetic gas or oils, followed by combustion (meaning they are regulated in U.S. and EU as waste incinerators). Companies have been experimenting with these technologies for over three decades. This report finds that while there is little data available on the operations of attempted commercial facilities, there are numerous examples of plants that have been forced to shut down due to technical failures and financial failures. In addition, other projects have failed in the proposals stage — after raising significant investments — due to community opposition and government scrutiny into false and exaggerated claims.

Over $2 billion was invested in the projects listed in this report alone, all of which closed or were canceled before commencing operations. Companies involved include Air Products & Chemicals, Thermoselect, Plasco, Compact Power, Caithness, Interserve, and Brightstar.

Technical and economic challenges for gasification projects include failing to meet projected energy generation, revenue generation, and emission targets. Gasification plants also have historically sought public subsidies to be profitable. In particular, vendors seek renewable energy subsidies, however, such facilities would emit carbon dioxide from fossil fuel-sourced material including waste plastic and coal, contradicting the purpose of "renewable energy."

We conclude that the potential returns on waste gasification are smaller and more uncertain, and the risks much higher, than proponents claim. Municipal programs that rely on waste prevention strategies, source separation, intensive recycling and composting, and redesign of no-value products have demonstrated economic and technical success.

Introduction

As the world grapples with increasing amounts of waste, entrepreneurs and local governments are looking for new ways to treat and dispose of solid waste, which includes a bewildering variety of plastic and composite materials. There is renewed interest in gasification and pyrolysis in some regions around the world, which, although not new processes, aim to dramatically reduce waste volume while producing energy. Investors who may be interested in supporting these practices, particularly in developing countries, would be well served by investigating previous efforts and resulting impacts on local waste systems.

This document analyzes technology proponents' claims, documented challenges at operating facilities, and offers guidance to potential investors and regulators.

What are gasification and pyrolysis technologies?

Gasification and pyrolysis are energy-intensive processes that attempt to reduce the volume of waste by converting it into synthetic gas or oils, followed by combustion. Waste gasification is classified as a form of incineration by the European Union and U.S. Environmental Protection Agency (USA 40 CFR §60.51a; EU Directive 2010/75/EU Art 3.40) as it includes both thermal treatment of waste and in most cases leads to the combustion of the resulting gases (either on site or as a distributed fuel).

Gasification subjects solid waste to high heat (generally above 600C) in a starved-oxygen environment. Oxygen levels are kept low to prevent immediate combustion; instead, the carbon-based fraction of the solid waste decomposes into synthetic gas (syngas) and a solid residue, known as slag, ash, or char. It should be noted that starved oxygen or oxygen free operating conditions (claimed by multiple vendors) are difficult to implement during commercial scale operations. Syngas is composed primarily of carbon monoxide, hydrogen, and carbon dioxide, with contaminants [1]. The syngas has sufficient calorific value to be burned for energy, but requires advanced pollution control systems (APC).[2] Operating facilities have frequently failed to produce enough energy to be financially successful.[3] Byproducts resulting from these processes include air emissions, slag (a form of solid waste), fly ash from the air pollution control equipment (requiring special handling due to its toxicity), and liquid wastes and/or wastewater.

Pyrolysis is a similar approach which applies heat with no added oxygen in order to generate oils and/or syngas (as well as solid waste outputs) and requires more homogenous waste streams. Some vendors offer smaller facilities for fuel generation, compared to typical gasification vendors (see box "The Waste to Fuels approach").

Plasma arc applies a higher temperature in gasification, and occasionally to pyrolysis processes. This is a much higher energy process than gasification and pyrolysis, further increasing cost barriers.

The differences between each of these processes are not always clear,[5] there are variations within each overarching approach, and vendors often claim that their process has unique attributes.

Most mixed municipal solid waste technologies attempt to treat large quantities of heterogeneous mixed waste streams. This can be appealing to governments which do not want to source separate waste and seek a single, technological solution. However, the approach of looking for a technology fix for mixed waste treatment presents unique challenges, and is not as successful as more comprehensive source separation strategies. Gasification, pyrolysis and plasma arc technologies are most applied for homogeneous material streams. The heterogeneous nature of municipal waste is not well suited to this type of technology.

The 'Waste-to-Fuels' Approach

Some companies propose to use pyrolysis and gasification to turn waste into fuels that would be combusted at other locations, a process that has not been successfully applied at a large scale. This would require additional gas cleaning steps to make the fuel work, and these steps are energy intensive, which reduces overall efficiency.[4] Such an approach raises additional concerns about emissions and monitoring given the inherently distributed use of such fuels. Additionally, smaller combustion units are not generally equipped with the air pollution control or monitoring equipment that is required at large, centralized facilities. This can result in excessive emissions of Persistent Organic Pollutants (POPs) such as dioxins and PCBs; lead, arsenic, mercury, and heavy metals; polycyclic aromatic hydrocarbons, such as those produced from the combustion of flame retardants, and other pollutants subject to regulatory scrutiny. When such oils are distributed for different uses in vehicles, boilers, for example, off site emissions may be nearly impossible to monitor.

Biogas

Anaerobic digestion and similar biological processes are sometimes described as 'waste to energy' because these technologies generate biogas from organics materials like food and plant debris. As biological processes (as opposed to thermal processes) they are beyond the scope of this paper.

A 2008 U.S. study[6] for a government agency surveyed a large range of gasification and plasma technologies and found these processes are unproven on a commercial scale for treating MSW in the U.S. It also found that solid and liquid residuals may be hazardous, and further more, that the technologies require pre-treatment of waste and are more expensive than conventional incineration or landfilling.

Gasification has a more than three-decade long track record with which to test vendor claims about the technology's suitability for waste treatment.[7] Unfortunately, gasification plants have made very little operational data available.[8],[9],[10],[11] Project proponents routinely use projected or target data but the short operational history of most facilities and the lack of ongoing monitoring makes it impossible to conduct post-hoc verification of these targets or even basic mass and energy balance calculations.[12]

Compared to gasification processes, fewer facilities have attempted to use pyrolysis and plasma processes at a similar scale.[13] Similar to gasification, little operational data is available. Information about some facilities is included in the cases in this paper.

Existing data does show that dozens of projects have failed, for a variety of technical and financial reasons, as discussed below. These failures highlight a widespread inability to meet projected energy generation, revenue generation, and emissions targets, or to simply maintain consistent operation. The primary lessons to be drawn are that the benefits of waste gasification are smaller and more uncertain, and the risks much higher, than technology proponents claim.

Public investments in gasification and pyrolysis in the UK

The United Kingdom provides an interesting case study of public investments in these processes due to a series of now-expired incentives that supported the financing of new gasification, pyrolysis, and plasma facilities. In 2006, DEFRA (Department for Environment, Food, and Rural Affairs) began the New Technologies Demonstrator Programme (NTDP) to "overcome the perceived risks of implementing new technologies in England and to provide accurate and impartial technical, environmental and economic data."[14] The NTDP was intended to spend £32 million[15] on 10 projects.[16] Resulting projects were subsequently evaluated and found to be largely unsuccessful:[17] of the four gasification and pyrolysis projects, two projects did not proceed to operational status during the program, a third was not able to run long enough to study the process and was closed,[18] and the fourth project had numerous problems and remains under reconstruction.[19],[20]

Gasification attempts in the UK depend on high tipping fees and public subsidies to support operations. However, future public subsidy options seem limited. These technologies are excluded from the UK's Feed in Tariff program. The national Renewable Obligation Certificates provided a second funding opportunity, but this program will not accept new generating capacity after March 2017. A new national government program called Contract for Difference is still accepting applications from proposed gasification projects in the near term, but has yet to make a decision about inclusion of gasification in future years.

Risks and Challenges

Technology Risks and Operational Challenges

Decades of attempts to apply gasification, pyrolysis, and plasma arc to municipal waste have exposed the underlying complications with this approach, as evidenced by the high failure rate of these plants.

Of the commercial-scale facilities that have been established in Europe, United Kingdom, Canada, and the U.S., many have had trouble maintaining regular operations and producing sufficient energy to remain in business.[21]

Operations have been impaired for technical reasons including:

- Inability to meet pollution control limits (described in the following environmental risk section),
- Corrosive damage to equipment (such as the collapse of the roof and steel chimney of a waste gasification plant in Hamm-Uentrop, Germany, see environmental risk section),
- Problems maintaining satisfactory reaction temperatures, and
- Energy inefficiency.

Gasification has been most widely employed on uniform fuels such as coal or wood chips, but even these face serious technical obstacles.[22],[23] A 2010 report by the German development agency GTZ (now called GIZ) on gasification of biomass concluded that although biomass gasification is "theoretically an interesting option for rural development," severe challenges are unsolved, specifically: "There is no reliable technology readily available. High costs for technical development, repair and maintenance make it unprofitable. Dangerous threats exist to the environment and health due to carcinogenic waste."[24]

In comparison, modern unsorted MSW streams are extremely heterogeneous and thus more technically complex to treat and manage than wood chips. Municipal solid waste streams typically include large proportions of food waste, yard trimmings, plastics, metals, paper, electronics, furniture, household hazardous waste, etc. They can also vary temporally: for example, displaying strong seasonality in moisture content in tropical climates.[25] As gasification operates above the boiling point of water, high moisture content dramatically reduces process energy efficiency. Varying composition and moisture content of the waste presents challenges to maintaining stable operations, particularly reaction vessel temperatures, which are crucial to syngas production.

The UK Government Energy from Waste Guide describes that syngas needs to be cleaned to be burned in a gas turbine or engine, and that the cleaning is an energy-intensive process. This overall process may be less efficient than conventional incineration.[26]

Please see the list of notable cases in the deployment of gasification, pyrolysis, and plasma arc at the end of this report for information about facilities around the world.

Reliable energy generation is a common problem at gasification plants. While some technology vendors claim that the syngas can be sold as a chemical feedstock, in practice, it generally is too contaminated and too dilute to be sold as a commercial product.[27] Instead, most vendors intend to burn syngas on-site to produce energy. Even then, many operators find that the energy produced is little more than that demanded to operate the energy intensive system.[28] This problem is exacerbated in developing countries, where the waste stream is comparatively higher in organics (i.e. food and biomass). This results in a syngas so low in calorific value that it cannot even produce energy, demonstrating the unsuitability of these technologies for large-scale MSW management in developing countries.[29] Even in developed countries, with higher calorific value waste streams, gasification plants are challenged to meet projected energy production targets (see in Notable Cases section of this paper including Scotgen, Thermoselect, Plasco cases).

One approach to address these issues is to co-fire waste with fossil fuels. Fossil fuels are added to waste for gasification in at least some facilities in Japan (Hitachi Metals[30] & JFE Steel[31] add coke). Another approach is to add relatively small amounts of syngas (up to 10%) to burn with coal. Exact energy balance data for these practices is not available. It should be noted that this approach increases reliance on continued combustion of fossil fuels, which increases regulatory risk (described below) and should exclude the technologies from receiving renewable energy subsidies.

Another approach is pre-treatment of the waste, by removing wet organics and inert material while retaining the high-energy plastics in the waste stream. But this eliminates the primary attraction of gasification as a "one size fits all" technology to treat waste.[32] Higher concentrations of plastics, which are also fossil fuels, increases tarring[33] and again should eliminate the possibility of renewable energy subsidies.

Prominent proponents of 'waste to energy' acknowledge these shortcomings of applying gasification processes to waste. As Hakan Rylander, former President of International Solid Waste Association (ISWA) and CEO of the South Scania Waste Company (Sweden), a conventional waste incineration company, writes, "Waste is not a homogenous fuel. It has so far turned out to be too heterogenous to be able to treat in a gasification or pyrolysis process, irrespective of how you pre-treat the waste. It is absolutely not applicable for mixed MSW with today's technology. Another very negative factor is that the energy balance very often has turned out to be negative."[34]

It is not always possible to distinguish between technological and financial failure: many plants are shut down before achieving stable operations, as the costs become excessive (see Financial Risk, below).

Conventional 'waste to energy' incineration

Waste gasification, pyrolysis, or plasma has similar drawbacks to combustion in conventional 'waste to energy' incinerators. Cost is a striking factor as these facilities have been shown are the most expensive treatment option for waste.[35] Consequences also include:

- 20-30% of the weight of waste is left as ash.[36] Rather than avoiding landfills, incineration is merely a step before landfilling wastes that become more hazardous through combustion.
- Carbon intense emissions, and emissions of persistent organic pollutants (dioxin, furans, mercury), heavy metals, particulate matter, nanoparticles, and other pollutants.[37]
- In China, a 2015 report on the country's 160 existing and operating MSW incinerators found that 40% have incomplete air emission data and only 8% have dioxin emission data available to the public. Among those that have incomplete data, 69% have a record of violating new environmental standards.[38]

Financial Risk

Many gasification projects have failed because of financial non-viability. Examples include:

- The 2016 cancellation of two Tees Valley, UK gasification projects which lost U.S. company Air Products between US$900 million and $1 billion.[39]
- The Thermoselect gasification facility in Karlsruhe, Germany lost over $500 million in 5 years of operations.
- In the UK, Interserve left the "energy-from-waste" field after losing £70 million on gasification projects, and other companies have gone bankrupt attempting to construct gasification or similar processes, include Energos, BCB Environmental, Waste2Energy, Biossence, Compact Power, and New Earth Solutions Group.[40],[41]

A 2013 U.S. industry trade journal estimated the following capital costs for facilities with 15 MW output:

Estimated Costs (in U.S. Dollars) [42]		
Ranges for Capital Costs for each of the Thermal Technologies:	**Low Range**	**High Range**
Direct Combustion (Mass Burn and RDF) ranges from $7,000 to $10,000 per kW.	105,000,000	150,000,000
Pyrolysis ranges from $8,000 to $11,500 per kW.	120,000,000	172,500,000
Conventional Gasification ranges from $7,500 to $11,000 per kW.	112,500,000	165,000,000
Plasma Arc Gasification ranges from $8,000 to $11,500 per kW	120,000,000	172,500,000

In general, costs are higher and more uncertain than project proponents foresee, and revenues are lower and more uncertain. Research on facilities in Europe finds that many facilities have failed due to economic problems, citing inadequate revenues and costs from preparing feedstock.[43] Additionally, when the facility does not operate as intended or shuts down for repair, companies with contracts to treat waste must cover the added costs of sending that waste elsewhere.

The high capital costs and high energy consumption of gasification make it financially unattractive compared to other waste management strategies, including recycling, composting, and landfilling. In order to recoup these costs, financial models often count on charging tipping fees (also called gate fees, these are disposal costs charged to waste generators, e.g., municipalities). These projects also need to derive income from the syngas. Some technology vendors also claim that that the slag can be sold as a building material, a practice which raises risks and potential liability for health impacts to building habitants and workers.

An additional financial challenge is the cost of pre-treatment of the waste. This waste as delivered to the facility is often unsuitable for gasification: it has too much moisture content, too little calorific value, or too great an inert content. Some facilities have disclosed the use of additional conventional fossil fuels, or have added a waste separation process to create a suitable feedstock.[44] This can be a major additional operational expense.

Recently, there have been calls to provide additional public financing in more countries through renewable energy incentives and subsidies, such as a Feed-In-Tariff (see Regulatory Risk, below).

Regulatory Risk

As a technology still under development, gasification relies upon a strong regulatory environment, including real time environmental emissions monitoring, to ensure operational safety and compliance. Few governments today have the capacity, technical knowledge, or regulatory framework in place to ensure safe operation of gasification facilities, but due to the environmental and health risks inherent with these technologies, investors should anticipate an evolving, and increasingly stringent future regulatory environment.

"Many operators find that the energy produced is little more than that demanded to operate the energy intensive system."

On the other hand, the industry's financial challenges have led to calls for public subsidies, for example, in the form of a Feed-in Tariff (FIT).[45] The FIT is an electricity production subsidy that has had success in encouraging widespread adoption of renewable energy, most notably solar photovoltaic in Europe. Unlike FITs designed to provide widespread subsidies to homeowners for switching to solar panels, a gasification FIT would benefit only a handful of commercial operators, and could not expect to enjoy the kind of popularity that a solar PV FIT does. Advocates of renewable energy programs have joined others in calling for renewable energy policies like Feed In Tariffs to exclude "waste to energy" approaches such as gasification. This would leave the operator's balance sheet extremely vulnerable to any change in policy.

Even more problematic is that while vendors often tout syngas as a "green" or "renewable" energy source, syngas created from primarily fossil-fuel derived plastics and other nonrenewable resources are essentially fossil fuel. For example, a gasification incinerator accepting only plastics would generate entirely fossil-fuel derived syngas and electricity. These are not renewable fuels from a scientific perspective, and in fact, even the syngas coming from the biomass portion of wastes is not necessarily climate-neutral.

This poor carbon performance of waste gasification works directly against efforts to decarbonize electricity grids, making long-term inclusion of gasification in renewable energy schemes particularly vulnerable to regulatory corrections. One example is the recent move by the European Union to discourage renewable energy subsidies for waste incineration, and require mandatory separation of organics.[46]

An additional risk is found in those jurisdictions where vendors have created regulatory confusion by describing technologies as non-combustion. The syngas created during the initial high temperature treatment phase of gasification is nearly always intended to be combusted, either on site or as fuel, disqualifying these processes from any regulatory definition that includes "non-combustion."

Furthermore, most countries are signatory to the Stockholm Convention[47] and obliged therefore to reduce and eliminate releases from unintentionally produced POP (persistent organic pollutants), such as those created through conventional waste incineration, waste gasification, pyrolysis, and plasma arc.

Environmental Risk

Although gasification is billed in academic studies and vendor documents as a "cleaner" form of combustion than conventional "waste to energy" incineration, the data does not support this claim. While operating facilities rarely disclose comprehensive emissions data, regulatory agencies and media reports described serious and repeated emissions violations at numerous facilities (see the "Notable Cases" section in this paper).

As long as gasification is used on a mixed waste stream or plastics waste stream — which includes chlorinated materials and heavy metals — it will result in a similar emissions profile as conventional incineration. Emissions may include NOx, SOx, hydrocarbons, carbon monoxide, particulate matter (PM), heavy metals, greenhouse gas emissions such as CO_2, and dioxins/furans.[48]

Mixed plastics contain chemicals that lead to hazardous emissions in such systems. Polyvinyl chloride (frequently called PVC or vinyl) is a common plastic that contains chlorine, a precursor to dioxin creation when heated or burned. Manufacturers introduce additives including lead, arsenic, chromium, and phthalates to improve PVC's ductility, strength, and rigidity. These additives, and their combustion byproducts, represent an emissions challenge for gasification or any thermal treatment of mixed plastics.

Syngas combustion requires significant air pollution control measures, particularly since it is contaminated with particulates, tar, alkali metals, chlorides and sulfides.[49] Some of these must be scrubbed out before the syngas is burned to avoid serious damage to the combustion engine.[50] Others must be filtered out of the exhaust gases post-combustion. This requires two stages of pollution control, each creating its own waste product: hazardous wastewater and fly ash. Even modern pollution control technologies do not always prevent serious emissions and equipment damage, as was dramatically demonstrated by the collapse of the roof and steel chimney of a waste gasification plant in Hamm-Uentrop, Germany, destroying the power plant. The collapse was attributed to corrosion from acidic flue gases.[51]

The disposal of the remaining outputs has also been controversial. The fly ash, wastewater, and slag are all contaminated to some degree with a variety of toxic contaminants, including dioxins, mercury, and heavy metals. In addition, water consumption and contamination was a significant problem at the short-lived but large scale Thermoselect facility in Germany.[52]

Reputational Risk

For a technology with an intermittent track record, gasification has already acquired a negative reputation in the public mind, and gasification companies risk local opposition, including lawsuits, protests, and extended campaigns, which are common at proposed sites for 'waste-to-energy' facilities. In part, this is due to earlier attempts to oversell the technology, such as a 1997 report by the Juniper consulting firm that projected gasification would cover 20% of the European market by 2007, or unscrupulous vendors that promise facilities without smokestacks or "zero emissions."

In part, reputational risk for gasification is due to the failure of the few commercial facilities. Defunct facilities like the large Air Products gasification project in Tees Valley, UK, Plasco's plasma gasification operations in Ottawa, Canada, and Scotgen in Dargavel, Scotland, have received regional and international media coverage.

Additionally, waste-to-energy facilities often face resistance due to job loss in the cities and communities where they are built. Waste-to-energy facilities often displace recycling workers, and create significantly less jobs than programs that depend on source separation and intensive recycling and composting. This can make gasification and similar projects unpopular locally, creating further challenges to their construction.

This negative reputation stands in stark contrast to materials recovery and circular economy systems (including recycling, which generally enjoys very positive views among the public.[53],[54]

Alternatives

Traditional approaches to managing mixed waste streams -- landfilling and conventional incineration -- have fallen out of favor, and no single technology has emerged to replace them. Instead, many cities are finding success with source separation followed by intensive recycling and composting, and other innovative steps to reduce excess plastics and other problematic materials, and create the conditions for redesign. This comprehensive approach is known as Zero Waste.

Case studies in zero waste programs have shown both technical and financial success, including diverting up to 90% of waste from incinerators and landfills, saving money for municipalities, and increasing local employment rates.[55],[56],[57] There are opportunities in zero waste not only for philanthropic participation, but also for the establishment of revolving loan funds or finance mechanisms to support such city-scale shifts toward these self-sustaining programs.

Conclusion

From examination of existing attempts to commercialize these processes for municipal waste, it is apparent that the benefits of waste gasification are smaller and more uncertain, and the risks much higher, than technology proponents claim.

Even as companies attempt to increase the technological functionality of gasification technologies, gasification and other 'waste-to-energy' technologies compete with municipal recycling and composting programs, which are growing in popularity globally. Increasing numbers of cities are moving toward zero waste systems that will make 'waste-to-energy' technologies obsolete.

In contrast to the reputation of 'waste-to-energy' as harmful to the environment and health, zero waste systems enjoy broad support from local governments and civil society. These programs also gain support due to cost savings for cities and job creation in local recycling, composting, and reuse operations, and offer opportunities for investment.

Notable Cases in the Deployment of Gasification, Pyrolysis, and Plasma for Municipal Solid Waste

Air Products, Teeside, Tees Valley, UK

In 2014, the Fortune 500 company Air Products signed a contract with the UK government to provide power to the government using gasification of waste, and proposed the construction of the facility in Tees Valley, UK. Two years later the company abandoned the technology due to “design and operational challenges.” A waste industry trade press article said "…Tees Valley could be remembered as one of the most expensive waste infrastructure blunders in years.”[58] Shortly before the company called off the project, the CEO of Air Products stated: “The technology is proving to be a lot more difficult than people thought at the beginning and I have to say we haven't made a lot of significant progress since we talked to you last time."[59] According to Air Products, it spent in the range of $900 million to $1.0 billion on assets associated with its “energy from waste” business.[60]

Scotgen (a subsidiary of Ascot Environmental), Dargavel, Scotland, UK

Scotgen operated a gasification facility for municipal solid waste from 2009 to 2012, and exemplifies each type of risk described in this paper. In 2012, the Scottish Environmental Protection Agency revoked the facility’s permit, which resulted in permanent closure of the facility.

The agency gave a series of reasons for revoking the gasification facility permit:

- Persistent non-compliance with the requirements of the permit;
- Failure to comply with an enforcement notice;
- Failure to maintain financial provision and resources to comply with the requirements of the permit; and
- Failure to recover energy with a high level of efficiency.[61]

This enforcement action followed emissions exceedances and fires at the facility, which received extensive local media coverage and international attention.[62]

Plasco, Ottawa, Canada

From 2008 - 2011, Plasco ran a plasma gasification demonstration project near Ottawa, Canada. The company received investment from Soros Fund Management[63] among others. During these years, the facility provided an unusual amount of information about operations online, including emissions, tons received, and tons processed. Some of the emissions issues disclosed included high sulphur dioxide emissions and other emission exceedances.[64],[65] Over these three years, operating problems were so extensive that the facility only processed waste on 25% of days, and on those days it processed an average of 23 tons per day.[66] This is approximately 7% of what Plasco projected it could process (85 tons per day). $390 million of equity capital was committed to Plasco between 2005-2015. [67]

In California, Plasco attempted to construct a plasma gasification incinerator in the predominantly Latino community of Gonzales. The project failed to obtain needed permits due to strong community opposition, and the proposal stalled after failing to secure state renewable energy subsidies.

In 2012, Plasco signed a 20-year, $180 million contract with the city of Ottawa to finance a new 300 ton per day plasma gasification project for municipal waste.[68],[69] The company missed financing deadlines repeatedly over two years.[70] In 2015, the city terminated the contract and Plasco filed for credit protection.[71],[72]

Oneida Seven Generations Corporation, Green Bay, Wisconsin, U.S.

In 2011, the Common Council of Green Bay, Wisconsin approved a permit from Oneida Seven Generation Corporation (OSGC) waste gasification permit in the city.[73] Activists subsequently combed through state regulatory filings and determined key evidence was not disclosed to the council concerning potential environmental harm and 60 foot smokestack heights exceeding the City's 35 foot limit. The Common Counsel eventually rescinded the permit[74] for the company's failure to adequately disclose this information in both verbal statements and on renderings which omitted stacks. OSGC litigated the rescission, and the Wisconsin Supreme Court overturned the trial court's summary judgment ruling in favor of the City. The matter was sent back to the trial court to continue the original litigation, but OSGC failed to continue its lawsuit, making the matter subject to a Wisconsin state law dismissing stale lawsuits and giving the defending party a ruling on the merits of the lawsuit.[75]

New Earth Solutions, UK

New Earth Solutions is associated with six failed or abandoned gasification projects in the UK.[76] The company told shareholders in July 2015 that: "…the level of performance has consistently fallen well short of targeted levels. The programme of works communicated in March, whilst undertaken, has proven to be unsuccessful. Operational, manpower, maintenance and repair costs have consistently proved to be much higher than originally planned." In 2016 the company disclosed that it would be unable to pay £9 million to creditors. Local governments were also impacted financially: the failure of one of the New Earth Solutions projects cost the Scottish Borders Council at least £2.4 million pounds.[77]

Yorwaste Scarborough Power, GEM Flash Pyrolysis, Seamer Carr, UK

Yorwaste attempted to secured funding from the UK New Technologies Demonstrator Programme for the Yorwaste Scarborough Power GEM Flash Pyrolysis plant. In the formal evaluation report of the project, the University of Leeds found that the facility "suffered continual commissioning problems and did not produce a continuous and extended fully operational period to design specification on which a meaningful study could be undertaken." The report further stated "During short run commissioning trials the steady and consistent operational periods needed to gather data for reliably assessing performance do not exist."[78]

Caithness Heat and Power, Highland Council, Scotland, UK

In 2004, Caithness Heat and Power began a new biomass gasification project in Wick, Scotland with plans to provide heat for 200 local households. Operations started in 2008 but were shuttered in 2009 after technological and financial problems, resulting in a £11.5 million loss to the local authority Highland Council.[79] An export report concluded that the project would not operate successfully, and a government audit called the project an "expensive lesson" and that "the company procured 'experimental' and high risk gasification technology which could not be commissioned successfully…".[80],[81]

Compact Power, UK

Compact Power received extensive media coverage of its plans to build gasification and similar facilities, and was placed under administration with the loss to investors of £20m.[82] Compact Power faced operating and fuel challenges: a 2005 site visit report showed that the operating costs were too high and the calorific value too low to make the plant viable as an energy generator.[83]

Thermoselect, Karlsruhe, Germany

The unreliable nature of gasification technology was best demonstrated by the closure, after a problematic operational history, of Europe's flagship gasifier, the Thermoselect plant in Karlsruhe, Germany. Operational problems included low or no electricity generation in some years, corrosion, water pollution, water consumption, and exceeding air permits for dioxins,[84] NOx, particulates, and HCl.[85] The regional government discovered that the walls of the chamber were so battered that pieces had fallen off and could have caused an explosion.[86] The facility was offline frequently for these problems and during five years of operations, processed ⅕ of contracted waste. This resulted in additional costs of fulfilling municipal waste management contracts with local governments. Energy generation proved a challenge: in 2002 the facility used 17 million cubic meters of natural gas to heat the waste, and did not deliver any electricity or heat back to the grid.[87] Ultimately, the owner of the Karlsruhe facility Energie Baden-Württemberg closed the facility after losing 400 million Euros (approximately $500 million in 2004).[88],[89],[90]

Brightstar, Solid Waste and Energy Recycling Facility (SWERF), Wollongong, Australia

The only gasifier to treat municipal waste in Australia was established in Wollongong, New South Wales in 2001 by proponents Brightstar Environmental and Energy Development Ltd. The Wollongong SWERF was plagued by operational problems and emissions breaches during its three year 'test period'. Emissions breaches[91] included major exceedences of arsenic and SOx, carbon monoxide over 13 times the German limit (50 mg/Nm^3). The gasifier also produced significant emissions of dioxins, hydrogen chloride, hydrogen fluoride, polyaromatic hydrocarbons, hexachlorobenzene and heavy metals. In 2004, the SWERF facility was abruptly closed by its parent company EDL[92] following withdrawal of funding for the project in mid-2003. Brightstar Environmental was also negotiating contracts to establish waste gasifiers in India, the UK, US and other Australian cities. These contracts were canceled following the failure of the Wollongong SWERF and Brightstar Environmental no longer operates. By the time Energy Developments decided to close the facility, it had lost at least Au $175million (U.S. $134million) on SWERF.[93]

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[6] Foth Infrastructure & Environment, LLC (2008) Updated Research Study Gasification, Plasma Ethanol and Anaerobic Digestion Waste Processing Technologies. Prepared for Ramsey/Washington County Resource Recovery Project. p. viii

[7] Some lists of such facilities may give the impression that more facilities are in operation than the reality. Lists do not always distinguish between facilities that accept municipal wastes, other waste streams like tires and auto shredder materials, facilities that combine various fossil fuels with different waste streams, or ash vitrification facilities, nor facilities that have been shut down.

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