WASTE TO ENERGY: USING WASTE MANAGEMENT TO CREATE A SUSTAINABLE URBAN ECOSYSTEM IN MUNCIE, IN

A CREATIVE PROJECT
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Contents

Chapter 1: Waste to Energy 3

History 4

Chapter 2: Waste to Energy Technology 18

Economic and Environmental Benefits of an Energy District 20

Chapter 3: Case Study 24

Hennepin County Energy Recovery Center and Downtown Energy District 24

Chapter 4: Current Waste to Energy Projects in the U.S. 33

Chapter 5: WTE plant in Muncie, IN 41

Site Selection Criteria 41

Possible Sites 51

Specifications of Plant 60

Potential Economic Development around the WTE site 70

References 75
Chapter 1: Waste to Energy

It has been estimated by several entities such as the United Nations and the World Bank that the amount of solid waste produced around the world may be between 2.5 and 4 billion metric tons annually. (Rogoff & Screve, 2011) A more accurate number cannot be ascertained due to uncontrolled dumping in lesser developed countries and the inaccuracy of common definitions of different waste streams between countries. More reliable data exists in the form of Municipal Solid Waste, which is estimated to be 1.2 billion metric tons.

What to do with all of this waste has become a large problem in developed and undeveloped countries alike. Cities around the world must find ways to stay competitive on a global market. They must manufacture goods, create commerce, and maintain healthy conditions in which the city’s residents can live, work, and play. Cities must expand and grow, and with this growth comes several problems. More people and jobs lead to an increased demand for electricity. Increased manufacturing and increased consumption of goods leads to excess waste. Finding long term sustainable ways to reduce and recycle waste and produce clean energy are paramount for any city looking to grow through the next few decades.

Waste to energy plants seek to alleviate if not eliminate both of these problems
and recent advances in technology have increased their efficiency and have led to a resurgence of interest in waste to energy plants in North America, Europe, and Asia. On top of the local benefits of a waste to energy plant, the International Panel on Climate Change (IPCC) and other experts have identified waste to energy (WTE) technology as the key greenhouse gas emission mitigation technology. (Rogoff & Screve, 2011) Local plants will have a positive effect on the planet as a whole. They also have a positive impact more locally, on the communities they serve. This paper will look to prove the feasibility of a waste to energy plant in Muncie, IN, and provide an assessment of how a waste to energy plant will fit in to the urban ecology and economic system already in place in the community.

**History**

Waste to energy plants themselves are nothing new in this country. The idea of large scale trash incineration first came to the United States in 1885 when an incinerator plant was built on Governor Island in New York, shown in image 1.1. It arose as a solution to combat the large amount of trash that was piling up around New York City as a result of not having enough land available to dispose of the waste the city was producing. These early incinerators produced problems of their own, however, and did not convert the waste to usable energy, but produced rampant pollution coming out of untreated smokestacks. (Young, 2010)

![Figure 1.1: New York’s first waste incinerator.](http://www.sciencephoto.com)
Today, waste to energy plants are much cleaner and much more efficient. Even the last 10 years have seen substantial technology improvements and due to pollution mitigation measures, these facilities can be built in an urban setting instead of the periphery of a city such as a landfill. A New York times article from April 12, 2010 argues that “the plants run so cleanly that many times more dioxin is now released from home fireplaces and backyard barbecues than from incineration.” The article was referring to a new waste to energy plant in Denmark.

With these improvements, waste to energy plants are popping up all over the world. Countries like Denmark and the Netherlands, who do not have a lot of space for sprawling landfills, have embraced the technology with open arms. Denmark alone, home to only 5.5 million people and about 228 times smaller than the United States, has 29 waste to energy incinerators, with 10 more in various stages of development. (Rosenthal, 2010) Across the European Union, it is expected that 60 to 80 new plants will be in production by 2020 because of EU directives on landfilling.

Asian countries have also heavily invested in the technology. As of 2010 there are 1,300 waste to energy facilities in the world, with 764 of them on the Asian continent. Because of limited space and high population densities, it is estimated that 70% of Japan’s MSW is processed in waste to energy facilities. (Rogoff & Screve, 2011) China, with its well publicized pollution problems and large urban areas has increased its waste to energy capacity from 2.2 million tons in 2001 to over 14 million in 2007. This increase has made China into the 4th largest WTE user in the world after the EU, Japan, and the United States.

The U.S., however, has not heavily invested in WTE since the 1970’s - 1980’s.
Of the 87 WTE plants within the United States, none have been built between 1995 and 2006, although some communities are returning to WTE as an solution to waste disposal problems. (Rogoff & Screve, 2011) Cities such as Ames, Iowa and Saugus, Massachusetts made the idea popular as they looked to alleviate local landfill capacity problems, and the federal government backed the technology with tax incentives. This government assistance helped attract private industry to form partnerships with local governments.

So what happened? Why did a technology with so much promise die in the U.S.? The answer lies in several problems. First, a lot of the tax incentive made available in the 1970’s and 1980’s expired, making the construction of new plants much less feasible. Carbon trading (cap and trade) also made it more economically feasible for communities to choose to simply ship their MSW to far off regional landfills. (Rogoff & Screve, 2011)

Second, a lot of local groups with a not in my back yard (NIMBY) attitude have nixed any new plants in cities such as New York, where the technology is greatly needed. (Rosenthal, 2010) Many of the anti-WTE groups believe that the process produces lots of pollution and a foul smell. Neither of these arguments are valid, as a modern plasma-arc gasification plant requires sophisticated scrubbers to negate any toxic pollution, as is required by the Environmental Protection Agency (EPA). There is also no foul smell being emitted from the plants, as buildings the incinerators are housed in produce negative air pressure, meaning that any smell from the waste remains in the building itself.

Another aspect is that communities have not been looking at long term solutions for MSW disposal. The up-front capital costs for a 500 ton/day plant are estimated at $79
million, and many communities balk at these numbers before going any further. (Young, 2010) However, in almost every community it is cheaper in the long term to operate a WTE plant than to landfill their MSW in the long term.

Land-filling has become the most popular form for the disposal of municipal solid waste (MSW) since the 1920’s. It is estimated that 55% of the U.S.’s MSW is hauled off and buried in sanitary landfills. But due to exponential increases in trash, many landfills have been filled or are close to reaching their total capacity. Larger cities, such as New York, now have to have their excess waste transported to large regional landfills located sometimes hundreds of miles away. Some of New York’s waste is send as far as Ohio and South Carolina. This practice is costly, extremely inefficient, and is not a sustainable solution.

Landfills themselves have become more environmentally friendly in the past century, with liners, leachate collection systems, gas collection systems, and environmental reporting now required for all MSW landfills. This is done to ensure that a municipal landfill has a minimal effect on the health of the community, and its contents do not pollute the air, land, and water quality of the area surrounding it. This is not always the case with older sites, where improper capping of a landfill has allowed methane and other gases to escape into the atmosphere, contributing to global warming and potentially putting the health of nearby residents at stake. Some modern landfills even collect some of this methane gas before it escapes and use it to create power. Landfill gas is typically about 50 percent methane, 50 percent carbon dioxide, with trace gasses mixed in. A typical modern landfill is shown in figure 1.2 on the next page.
Power from methane gas collection in landfills produces 169 megawatts of electricity and 16.7 million cubic feet of gas daily for heating and other uses in New York, Connecticut, and New Jersey. In New York and New Jersey, energy from methane capture exceeds solar power. (Rather, 2008) More and more landfills are looking to capture this valuable source of energy, and the government is encouraging them to do so with tax credits and other incentives. If these landfill gasses are not captured, the EPA warns the methane in these gasses is 20 times more potent than carbon dioxide when it comes to contributing to global warming. Scientists estimate that a quarter of all methane releases from human activity come from landfills.

Many methane capture projects are underway across the nation. Starting around 2008, Waste Management invested $400 million to develop methane capture systems.
at 60 landfills in the U.S. (Rather, 2008) Some landfills burn off the methane, which prevents it from entering the atmosphere, but does not obtain energy from the process.

Experts say the amount of methane produced from a landfill varies with several factors. The first is the composition of the waste. Municipal solid waste filled with organic components is the best producer of methane, while construction materials produce much less. How tightly packed, how old the waste is, the quantity, and especially weather patterns all effect how much methane will be produced. Hot and dry places will produce less methane than rainy, warm areas, due to accelerated decomposition.

There are those that do not like creating energy from landfill gas. (Ewall, n.d.) They claim it is dirtier than using natural gas, and that it should not be considered a renewable energy source just because we keep creating more waste. They argue that the dioxins in the gas can be very toxic and should not enter the atmosphere. Instead they could be stored underground until a process is developed to safely use these gasses to produce electricity.

All landfills, even those with plastic liners and cutting edge leachate collection systems will leak toxins into the ground at some point. Plastic liners are usually only good for about 20 years before they start to fail, and the EPA acknowledges this by allowing a certain amount of leakage. Leachate detection systems are sometimes poorly designed and not well maintained.

So while methane capture from landfills and waste to energy plants both produce energy, the main difference is that waste to energy looks to prevent the waste from being landfilled at all while methane capture tries to make the best of a bad situation by utilizing
existing landfills. WTE also promotes recycling, with plastic, ferrous and non ferrous metals, paper, glass, and other recyclables taken out before they go to the WTE plant, reducing if not eliminating the need for a landfill in the municipalities they serve.

Landfills also face a lot of problems with their site location. Due to federal and state regulations, landfills must be located away from any substantial populations, which makes transportation of these wastes more expensive. They face a large amount of NIMBY-ism with residents when trying to find land to construct new landfills on. This same land could be used for more valuable purposes such as agriculture.

The idea of a landfill itself is part of the problem. Residents pay an annual fee, put their trash in a container, and each week, someone comes along and takes it away. The resident never has to see this trash again, and will probably never think about where it goes or what they could do with it instead. It is out of sight and out of mind.

The same thing is true with energy production. Most energy plants, much like landfills, sit on the periphery of a city, and most residents don’t see the plant. Many do not know how their electricity is produced, whether it is from coal, natural gas, hydroelectric, nuclear, or from some other technology. Now, as long as these resident’s trash is taken away and their electricity turned on, they do not think about either being their problem; but as soon as the trash stops getting picked up and piles up on their front lawn, or the power goes out and they can’t turn the lights on at night, they’ll notice.

That is one of the reasons it is important for this proposed waste to energy plant to be located in an urban setting. It will allow residents to see where their trash is going and where their energy and/or heating comes from. Seeing this, the residents may become interested in these more sustainable options and make better choices in their own lives.
Even though this paper focuses on WTE, the best practice is to reduce the amount of waste each person produces, and re-use whatever materials we can and not just throw them away.

When looking at a proposed WTE facility for Muncie, there are several factors that need to be considered for the project to be a success. The first and most important aspect to consider is if there is a need for the project in the first place. Waste to energy is important to consider if the area in question has, or anticipates that they will need new solutions for landfilling or if they are shipping their waste to other parts of the country. Likewise, if the community is having energy trouble, whether that is due to excess demand or rising fuel costs, they would do well to look at a renewable resource such as WTE.

Secondly, alternatives to WTE should be discussed to find the one that is the most cost effective and environmentally friendly for the community. Of course landfilling and gasification are not the first choice in the management of waste. The hierarchy of waste management, shown on the next page, shows the best practices of how to deal with waste. At the top is the prevention of waste, by not creating it at all. This is achieved by living more naturally and not consuming so many goods that will be thrown away. After that is minimizing and reuse. An example of this is using canvas shopping bags instead of plastic or paper bags, or at least using plastic bags more than once.

After that is recycling and energy recovery, which is exactly what WTE is. Despite the best efforts of many, millions of tons of waste are still created annually in the United States and must be dealt with. Recycling and producing energy from waste that cannot be recycled at least brings a positive outcome from a negative situation. Last
on the list is the disposal of waste, with similar pyramids listing sanitary landfills with methane capture above burning off the methane. Finally, the worse practice is disposing of untreated waste illegally, or in a landfill that does not have mandatory pollution mitigation controls.

One alternative to landfilling or WTE is mechanical biological treatment. This process of dealing with MSW is popular in European countries that have signed an EU directive to reduce the amount of untreated waste that is landfilled. The process starts at home with the removal of recyclable materials and organic waste before each household’s waste is sent to the MBT facility. Once at the facility, the non-recyclable material is usually shredded and any remaining recyclable material is removed. This is the mechanical stage.

In the biological stage, the waste is digested or composted to produce biogas
(mostly methane) through anaerobic digestion which reduces the amount of total waste. For each ton of waste put through the biological stage, 0.6 tons remain as residue. (Friends of Earth, 2008) Anaerobic digestion can be used in a variety of ways to treat different forms of waste. It can treat sewage, animal waste, and waste food from households and restaurants. Furthermore it produces a compost that can be used for fertilizer in addition to the biogas.

Most experts feel anaerobic digestion is slightly more environmentally friendly than WTE, the problem is that the costs to build an anaerobic digestion plant are roughly the same as a WTE plant, but the amount of energy produced per ton of waste processed is only about one-fifth of the output of WTE. (Arsova, 2010) This makes WTE much more attractive economically. Anaerobic digesters also leave more waste behind after treatment that must still be landfilled.

Other alternatives include pyrolysis, which is similar to plasma-arc gasification, but it is used more frequently to burn wood residue or other biological feedstocks to create biofuel. Plastic can also be used to create biofuel through anhydrous pyrolysis. But this process is shown to be less cost effective and no more environmentally friendly than plasma-arc gasification. (Young, 2010)

Finally, one of the biggest concern for this type of project is the political leadership involved in getting the project started and seeing it to the end. Most local politicians are elected every 2 or four years, and a large scale waste to energy project can take several years to get from the planning stages to a finished operable project. A municipality that engages in a waste to energy project must remain committed to the final goal and not deterred by the initial start-up costs, which can be intimidating.
There are several implementing entities that exist for projects like this. Working with an experienced partner can alleviate a lot of the guesswork associated with these projects. This implementing partner could be an electric utility company, waste disposal company, a municipality that already operates its own WTE plant, or a number of other sources. For example, companies such as Covanta and Wheelabrator have many years of experience in the waste to energy field, and have worked with a number of energy producers through the United States and abroad.

Another important factor to consider is to secure a reliable, quality waste stream. This can be MSW diverted from landfills, bio-waste such as wood residue, or the feedstock can even be taken directly out of existing, at-capacity and covered landfills. Agreements for these waste sources and the reliable delivery of them to the plant are critical to long term success. Selecting and obtaining the rights to an appropriate site is also very important. This can be very tricky and time consuming because there are many aspects to consider in the site selection process and many residents and political leaders will have many concerns such as perceived project aspects and aesthetics. Many of the arguments against waste to energy plants are made under misconceptions of the process, so addressing the concerns of the citizens effected by the development of a WTE facility is of the utmost importance in order to get the project implemented.

One of the most frequently cited arguments against WTE facilities are that they cause pollution. This was mentioned earlier in this paper, and to re-iterate, the pollution from any modern WTE facility is minimized by pollution mitigation controls and well below acceptable EPA standards. There are two by-products from the plasma-arc gasification process. The first is the syngas, which is run through scrubbers to
remove any contaminates from entering the atmosphere. The second is the vitrified slag that results from the high temperature process. This slag is classified by the EPA as a “product” not a “waste.” Which means it is well below the EPA’s accepted levels of contaminants, and is safe enough to reuse without any additional treatment. (Young, 2010) With modern pollution controls and mitigation, some of the more advanced European facilities do not even feature smokestacks, which would also improve the aesthetics of the WTE building, helping it to fit in to an urban landscape.

WTE plants in fact help reduce pollution in cities in a few different ways. They remove or reduce the need to landfill waste, which prevents greenhouse gasses, such as methane, from being released in to the atmosphere. This also frees up space that would be used for a landfill, so that land can be used for something else, such as agriculture, or left in its natural state. A WTE facility located in an urban environment would also eliminate or reduce the need to ship waste to landfills, which are almost always located well outside city limits and in some cases, like New York City, are located in distant states like Ohio and South Carolina. (Rosenthal, 2010)

WTE facilities also offer the benefit of energy creation. Whether this is through electricity production to the grid, heat, biogas production or a combination thereof, WTE plants can offer additional resources that cities can take advantage of. WTE reduces the need for energy to be created in coal or natural gas energy plants which create much more pollution than that of a WTE plant and are not considered renewable sources, as waste is.

Another popular argument against WTE operations is that incinerating this waste to create energy would reduce our ability to recycle by destroying the MSW. This is a good point, but as part of the WTE process, all recyclable materials are removed from the
MSW before it is incinerated and is recycled instead. Several studies have proven that the presence of a WTE plant increases a city’s rate of recycling instead of reducing it. (Young, 2010)

Along with removing recyclable materials such as plastic and paper from the feedstock that produces energy, ferrous metals are removed from the mix and sent to recycling facilities that specialize in those materials. Metals that are not caught before the feedstock goes through the incinerator can be extracted from the vitrified slag at the end of the process.

Another concern of those that will be living, working, or playing in close proximity to the plant is the fear of foul smells emanating from the plant. As briefly mentioned previously, modern waste to energy plants use negative air pressure to keep any foul odors from escaping from the facility. Many existing WTE plants have also taken extra steps to make sure this concern is addressed. For example, the WTE plant in Hennepin County, Minnesota has taken measures such as landscaping the area surrounding the plant, installing rapid close doors, and spraying an odor killer at the entrances to the loading bay. This ensures those around the facility would not only remain unexposed to any foul odors, but they would be treated to pleasant, natural smells and scenery. This enables the Hennepin County WTE facility to operate right next door to a Major League Baseball field and a major commuter rail/light rail interchange. This strategy of being a good neighbor to those around the facility can do a lot to dispel any myths of odor that WTE plants carry with them.

While many arguments against the creation of a WTE facility can be dispelled with empirically proven facts and figures, there are many issues that are very real
and must be addressed for a WTE plant to become a success and for the neighbors of
the facility to accept it into their community and way of life. Keeping open lines of
communication with those residents that will be effected is very important.
Chapter 2: Waste to Energy Technology

The technology behind modern WTE facilities has come a long way since the mass burn incinerators of the 19th and 20th centuries. According to Young, the most economically sound and ecological sensitive technology is plasma-arc gasification. This process is explained as “a high temperature pyrolysis-process whereby the organics of waste solids (carbon based materials) are converted into syngas and inorganic materials and minerals of the waste solids produce a rock-like glassy by-product called vitrified slag.” (Young, 2010, p. 8) In a plasma-arc reactor, the MSW is not technically incinerated at all. Instead, Young explains the waste is “non-incinerated in a thermal process that uses extremely high temperatures in an oxygen-starved environment to completely decompose input waste material into very simple molecules. The intense and versatile heat generation enable a plasma gasification/vitrification facility to treat a large number of waste streams in a safe and reliable manner.” A comparison of these WTE processes is available in table 2.1 on the next page.

The vitrified slag that is produced from this process is “basically non-leaching” and according to EPA standards, is a product, and not a waste. Any excess metals can be removed from this slag, and the rest of the slag can be used as floor and roofing tiles, or as road pavement materials. The fact that this by-product can be sold to create an
additional income stream for the municipality instead of producing ash piles as a by product makes the technology more attractive and economically feasible, as well as more ecologically friendly.

<table>
<thead>
<tr>
<th>Thermal Process</th>
<th>Plasma Arc Gasification</th>
<th>Conventional Gasification</th>
<th>Pyrolysis Gasification</th>
<th>Pyrolysis</th>
<th>Mass Burn (incineration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>kWh produced per ton of MSW</td>
<td>7,200-12,600 F</td>
<td>1,400-2,800</td>
<td>1,400-2,800</td>
<td>1,200-2,200</td>
<td>1,000-2,200</td>
</tr>
<tr>
<td>Capital investment at 6%, 20 years</td>
<td>816</td>
<td>685</td>
<td>685</td>
<td>571</td>
<td>544</td>
</tr>
<tr>
<td>Plant Capacity</td>
<td>101,583,800</td>
<td>$80,337,800</td>
<td>$102,593,400</td>
<td>$86,936,900</td>
<td>$115,997,700</td>
</tr>
<tr>
<td>Operation and mainenance (capital budget, cost of ash disposal at $40/ton and $/year)</td>
<td>$7,483,400</td>
<td>$6,871,800</td>
<td>$7,711,100</td>
<td>$7,193,700</td>
<td>$8,216,600</td>
</tr>
<tr>
<td>Tipping Fee</td>
<td>$35.00</td>
<td>$35.00</td>
<td>$35.00</td>
<td>$35.00</td>
<td>$35.00</td>
</tr>
<tr>
<td>Green Tags (revenue)</td>
<td>2cents/KWH</td>
<td>2cents/KWH</td>
<td>2cents/KWH</td>
<td>2cents/KWH</td>
<td>2cents/KWH</td>
</tr>
<tr>
<td>Production energy sales (revenue)</td>
<td>6.50 cents/KWH</td>
<td>6.50 cents/KWH</td>
<td>6.50 cents/KWH</td>
<td>6.50 cents/KWH</td>
<td>6.50 cents/KWH</td>
</tr>
<tr>
<td>By product (tons/ton MSW)</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.21</td>
<td>0.2</td>
</tr>
<tr>
<td>Residue</td>
<td>Vitrified Slag</td>
<td>ash/slag</td>
<td>Ash</td>
<td>Ash/Char</td>
<td>Ash</td>
</tr>
</tbody>
</table>

Data taken from Young, 2010
For the following reasons, Young (2010) concludes why plasma-arc gasification is the most viable form of WTE technology:

- Thermal Efficiency
- Ability to process a variety of different solid wastes
- Production of “syngas” for conversion into a variety of energy sources such as steam, electricity, and/or liquid fuels
- Environmentally sound, since the solid by-product, vitrified slag can be reused as a construction material and is environmentally neutral.
- Environmentally sound, since the “syngas” can be used to produce various energy products and any discharged gaseous effluents treated by currently acceptable environmental processes
- Ability to minimize if not eliminate the need for a landfill
- Plasma-arc technology can be used to process wastes from an existing landfill and potentially eliminate the old landfill.

**Economic and Environmental Benefits of an Energy District**

An energy district is an area that receives energy services such as heating and cooling from a common source rather than each building doing this individually. Energy districts have become popular in downtown areas of high density because they offer several advantages over each building heating and cooling itself. For instance, energy districts are very reliable. They are operated 24 hours a day, every day of the year, and are built with redundancies and back-up systems that give them a reliability rate of over 99 percent. The technology is so reliable that the San Francisco energy district maintained operations through the 1989 earthquake that struck the city. This reliability can be a major draw to businesses that need reliable energy systems such as hospitals or software companies and data centers for cooling their servers. (NRG Thermal, 2012) They also reduce the need for backup generators.
Energy districts can also offer lower capital and life cycle costs. By eliminating the need to install and maintain a boiler and air conditioning units, the capital cost of new construction goes down. Depending on the size of the building, this can reduce the capital cost of the project by thousands of dollars, if not tens of thousands. It also reduces energy costs to building tenants, sometimes as much as 50% savings, (University of Minnesota Facilities Management, 2012) which is very attractive when looking for property. Furthermore, not having to install these heating and cooling units in-house reduces labor costs, hazardous materials insurance, maintenance, and eliminates interest payments made on the system. This reduces risk and increases the return on investment for a development that connects to the energy district versus heating and cooling itself. It also eliminates the need for buildings to include their own smokestacks and other infrastructure, which gives architects more freedom and space to work with and developers more space to sell or lease, shown in figure 2.1.

Energy Districts are built to be fuel-flexible, which means that it can use a variety of fuel sources to power the downtown energy district. In most circumstances, it will use the cheapest and most readily available fuel, or a combination of different fuels such as MSW and wood residue. An individual building with its own heating and cooling does not have this flexibility, and is stuck with whatever fuel source it was built for.

Figure 2.1: District energy systems eliminate the need for a rooftop cooling unit. Taken from IDEA report, 2005
whether or not that fuel is the cheapest.

Because the energy district is producing energy in bulk, it can purchase fuel in bulk. This cuts down on costs further and reduces the shock of market fluctuations on these fuels. This also means that energy prices are more predictable and stable. Costs are even further reduced as more and more customers connect to the energy network and operational costs are shared among a larger population.

Energy districts flatten cooling costs over the course of a year. A 350,000 sq. ft. office building in Cleveland, OH replaced its electric chillers with an energy district service, and experienced a drop of 1485 KW to 798 KW in July. Over the course of the year, the building experienced less than a 2% difference (figure 2.2) in cooling costs each month summer through winter. (International District Energy Association, 2005)

![District Cooling Customer Electric Demand Profile](image)

**Figure 2.2:** Annual electric demand is flattened with district energy, making costs lower and more predictable. Taken from IDEA Report, 2005
Energy districts are also much more energy efficient and greener than each building heating itself. WTE facilities are held to tougher emissions standards than buildings are on their own, so with this system, there is much less pollution overall. Customers also only pay for only the energy they use, and there is less wasted heating and cooling than what there would be on site. Energy districts have 100% efficiency for steam and hot and cold water after it arrives at the customers building. These same units are only about 80% efficient when produced on site. (Hennepin County, 2009)

The energy district in Minneapolis, Minnesota provides heating and cooling to a 130 block area in the downtown of Minneapolis. In total, 43 million square feet of approximately 100 buildings are heated and 22 million square feet of 50 buildings are cooled through this system. (NRG Thermal, 2012) The energy district does this partially through the Hennepin County Waste to Energy (WTE) plant, better known as the Hennepin Energy Recovery Center (HERC), located on the former brownfield of a bus garage in the downtown. HERC has been in operation since 1989, and in addition to heating and cooling, the plant also provides an average of 25 megawatts of energy to the local electrical grid, enough to power 25,000 homes.
Chapter 3: Case Study

Hennepin County Energy Recovery Center and Downtown Energy District

This case study will seek to give a brief history of the HERC plant and the downtown energy district to which it supplies partial heating and cooling. This will include basic financing for the plant, how the project came to be, and the identity of the players in the development process. Moreover, it will look at the fiscal and environmental advantages of the energy district, and how it can be used as a draw for businesses by reducing both capital and long-term costs. It is important to note that information pertaining to the energy district itself is limited because the infrastructure was added to and expanded since 1926. The energy district as it stands today can be seen in figure 3.1.

Figure 3.1: Downtown Energy District, (nrgethermal.org, 2009)
History

The HERC project’s planning was initially launched in 1983 as a somewhat delayed response to the energy crisis’ of the 1970’s, and construction started in 1986. The state of Minnesota had passed the Waste Management Act in 1980 to protect land, air, water, other natural resources, and public health by improving waste management practices, and HERC was a big step in addressing the waste and energy needs of the Minneapolis area. (Hennepin County, 2009) This act has recently been reinforced with the completion of the Hennepin County Solid Waste Management Master Plan in April 2012, which looks to increase recycling rates and reduce waste streams.

In 1985, as a result of developing the Hennepin Energy Recovery Center, the state also banned landfilling of unprocessed municipal solid waste generated in the Minneapolis/St. Paul metropolitan area effective January 1, 1990. This was a statement of intent to the local area and assured that HERC would have enough waste to produce electricity for years to come. (Hennepin County, 2009)

Dr. Andrew Leith, the head of HERC’s Air and Energy Unit, who was contacted via a phone interview, revealed that HERC was originally built by the Blount Development Company, which has since gone bankrupt. After that it was owned and operated by General Electric until 2004 when it was purchased by Hennepin County, which owns the facility today. It is, however, operated by Covanta Hennepin Energy
Resource, Inc. The two entities engage in a limited partnership, through which the revenues are split between the two entities. The electricity the facility produces is sent to Xcel Energy, and is routed to Xcel’s Aldrich substation through a county-owned transformer and transmission line, this power purchase agreement is set to expire in 2018. Excess steam from the combustion process is sent to the downtown energy district owned by NRG, which has a similar power purchase agreement also through 2018.

The location of HERC is unique in the fact that it is in an urban setting. Most energy producers are on the fringes of a community because of health and safety concerns that arise from pollution and other negative externalities. But heating and cooling facilities need to be near the area they are serving because pumping these utilities over long distances diminishes their efficiency. Therefore it was necessary to locate in an urban setting and HERC has learned to work with its neighborhood, and has taken extensive measures in order to be a great neighbor to those around the facility such as exceeding pollution mitigation controls and taking several steps to ensure odor and refuse does not plague the area.

The original infrastructure for the downtown energy district was built in 1926 by the Baker Properties to serve ten buildings. This was expanded in 1967 when IDS Properties purchased and continued to expand the system and started working with Minnegasco, a local natural gas supplier. NRG Thermal assumed ownership over the energy district infrastructure in 1993 and HERC now provides the downtown with steam heat through a partnership established in 2008. The energy district also provides hot and chilled water for air conditioning.
A 1,600 ft. steam line that cost $3.4 million was built to connect HERC to the energy district and service began in February 2009. This line was built by NewMech, and the costs on HERC property was covered by the county, while the rest of the costs were split by Hennepin County and NRG. The county spent $2.9 million on the project, and payback is expected to take 5 years. Maintenance of this steam line is split in the same fashion they were paid for. (Michaud, 2009) Today, there are 6 miles of steam piping and 4 miles of chilled water piping in the energy district. (NRG Thermal, 2012)

Financial Aspects

The Hennepin Energy Recovery Center was constructed for a total capital cost of 160.5 million dollars in the late 80’s. (SWANA, 2011) It was funded primarily by a bond debt of $134.5 million. Construction of the facility was completed on schedule and within the projected budget. Because the company that developed the project in the 80’s went
bankrupt, Dr. Leith was not sure how the rest of the project was financed, although he said it was not through any federal grants. A similar plant constructed today would cost in the neighborhood of $300 million.

HERC’s operating costs for 2010 (the most recent year available) were $28.97 million, but this includes debt service of $13.2 million. Revenues for the same year totaled $27.2 million. The difference between the total operating costs and revenues for 2010 was $1.8 million, and a break-even point was reached with the help of a subsidy from Hennepin County for this amount. With the facility processing roughly 365,000 tons that year, the per-ton subsidy equaled $4.95. (SWANA, 2011) This has been relatively consistent with previous years, with the county providing a subsidy to make up the difference between operating costs and revenues.

Because it was written in 2011, the SWANA report for HERC could only estimate costs and revenues for 2011 and 2012. That being said, the operational costs for 2011 were estimated to be $21.5 million. The cost is reduced from 2010 and earlier because of reduced debt service due to the retirement of a bond series used to fund the capital costs of the plant. Debt service for 2011 is $4.3 million. Projected revenues are $28 million, a slight increase from 2010. This results in a positive cash flow of $6.5 million. This excess revenue will be used to fund several capital projects to ensure that the plant continues to operate efficiently in the coming years.

As a business asset, HERC will become even more valuable in 2012 when it finally retires its debt service. This will significantly reduce the cost of operating HERC and will therefore increase its profits. Along with that, the value of the energy produced by HERC will increase as the cost of producing energy with fossil fuels increases. Also,
the county can structure its future energy sales contracts to maximize revenues by using the steam produced by HERC to either produce electricity or to heat and cool buildings depending on the price of electricity and fossil fuels. (SWANA, 2011)

Another revenue stream that HERC may take advantage of is renewable energy credits. Waste to energy is considered a renewable form of energy and therefore HERC has been registered with the Midwest Renewable Energy Tracking System (M-RETS), which allows the renewable energy credits from HERC to be sold. One renewable energy credit is created for every megawatt-hour of renewable energy produced. The county plans to sell 220,000 renewable tax credits per year, the value of which fluctuates with energy market supply and demand.

**Economic development around the site**

The area around HERC has changed dramatically since the facility was built in 1989. Most prevalent in the surrounding development is the addition of Target field, home of the Minnesota Twins. Opened in 2010, this ballpark was constructed 122 feet away from HERC and is directly connected to the facility. There it is provided with a heating and cooling, as well as a heated field for playing in colder temperatures. This connection to HERC has helped Target field become only the second MLB stadium to reach LEED silver designation. (SWANA, 2011)

HERC has worked with the surrounding neighborhoods to try to mitigate any negative impacts and maximize the positive ones. Hennepin County, the owners of HERC, regularly meet with several partners around the plant, including the Minnesota Twins, the North Loop neighborhood, and the warehouse district to the north. Some
of the steps HERC has undertaken in the last few years to mitigate its effect on the neighborhood have included:

- Moving the receiving doors from the east side that faces target field and moving them to the south side of the building.
- Installing quick-closing doors to maintain a negative air pressure in the plant which does not allow the odor to escape the facility.
- Releasing an odor-diminishing agent at the receiving door’s entrances on Twin’s game days, so the crowd does not smell anything unpleasant.
- Utilizing a street sweeper one to three times a week to pick up any loose waste that may have fallen from a truck.

Other projects directly adjacent to HERC include a transit interchange and pedestrian plaza that is under development to the east and south of HERC, shown above. This interchange links a commuter rail line from the suburbs to a light rail line that enters the downtown. Ever-green Energy, a long-standing green development partner of Hennepin County, has plans underway for this station to recover energy that is currently being lost at the HERC cooling towers and use it to heat new buildings that will be constructed on the site. In addition, water that would have been sent to the cooling towers will be used in a snow melt system for the pedestrian plaza and new light rail tracks.

(SWANA, 2011)
The future of HERC is open to speculation. As mentioned earlier, HERC has two power purchase agreements due to expire in 2018. One is with NRG to receive steam, and the other is with Xcel for the electricity generated at the plant. Hennepin County is now in the process of deciding on how to proceed once these contracts expire. Dr. Leith speculated that the county and Covanta will likely look to renegotiate the power purchase agreement in a deal that is thought to be worth $8.5 to $9 million. There are also tentative plans to provide hot water heating to Nicollet Mall which is near the facility in the downtown. More ambitious is the proposal for HERC to develop its own district energy system in the North Loop neighborhood. This system would be independent of the downtown energy district owned and operated by NRG.

The north loop area has been the subject of intense redevelopment in the last few years. This is mostly due to its proximity to the downtown, the commuter and light rail interchange and Target Field to the south, and the Mississippi River to the north. Originally a warehouse district, the north loop has seen a lot of these buildings converted into loft space, with ground floor retail and other uses mixed in to the development.

While Dr. Leith suggested that the energy district might be a little late in coming to the neighborhood with so much redevelopment already taking place, he was confident a potential energy district established there would further fuel the area’s redevelopment and reduce costs to developers and residents alike. He speculated that a combined heating and cooling district infrastructure that utilized water instead of steam would cost upwards of $30 million dollars. (A water delivery system would be more efficient for HERC than steam) This is due to the fact that HERC does not have the capacity to produce chilled water, and so a chilled water facility would need to be built elsewhere.
within the North Loop neighborhood. A heating district alone would cost around $12 million, but would not have as big of a pull with developers, who would then have to install and maintain air conditioning units in their buildings.

While the financing for this proposed new energy district has not been established, Dr. Leith speculated that it could be partially paid through revenue bonds issued by the county and partially paid through a public-private non-profit that would be set up to run the system. This system was used to finance a similar energy district in St. Paul, Minnesota.

**Conclusion**

While HERC and the downtown Minneapolis energy district are very different from a more traditional community development project, they can, and have had, a profound effect on the area they serve. Reducing the capital costs of new development by eliminating the need to install cooling and heating units, and freeing up space within the development itself means more profit and reduced risk of development. It also means lower life-cycle for the building because district energy is more efficient, maintenance costs are reduced, and operational costs are split amongst many users. Furthermore, there is less pollution in the downtown, making it more attractive to those that live, work, and play there.

While HERC’s future remains undecided, it has recently paid off its debt service and has proved to be a valuable asset to the community. Whether it decides to build a new energy district in the North Loop neighborhood, or continue to provide energy to the downtown, the people using the system will continue to reap the benefits.
Chapter 4: Current Waste to Energy Projects in the U.S.

As mentioned earlier in the paper, WTE plants are making a re-appearance in the United States as an alternative to landfilling. This re-emergence comes after a period from 1995 to around 2006 when there were no waste to energy plants built or planned in the United States. But since then there are a few new projects in various stages of planning and construction. Of those projects that have been proposed in the last few years, some have been cancelled due to the struggling economy and other reasons. A plasma-arc gasification plant in St. Lucie, Florida was abandoned in 2012 after the proposed plant’s permits were rescinded by the county commissioners. (Metro Venture Capital, 2012) This plant was to be the first commercial plasma-arc gasification WTE plant in the United States.

In 2010, a similar plasma-arc gasification plant is under development near Milwaukee. (Content, 2010) At the time of writing, the project is still going forward, but little information is available. Other municipalities that are in various stages of planning and development for plasma arc gasification plants include: (Circeo, n.d.)

Tallahassee, FL: 1,000 TPD (Green Power Systems, LLC)
New Orleans, LA: 2,500 TPD (Sun Energy Group, LLC)
International Falls, MN: 150 TPD (Coronal, LLC)
Madison, PA: Waste-to-Ethanol Facility (Coskata, Inc.)
Somerset, MA: CoalPower Plant Retrofit (NRG Energy, Inc.)
However, because these cities are in the early stages of development, little information is available on these projects.

A project that is a little further along is the Carroll/Frederick County Renewable Waste to Energy Facility. In 2009, county commissioners from both counties decided to enter into agreements with the Northeast Maryland Waste Disposal Authority (NMWDA) after looking at long-term waste management options for the previous 5 years. (Carroll County Government, 2012) The facility will process 1,500 TPD, 600 of which will come from Carroll County, and 900 from Fredericks County. The WTE facility will be located in Fredericks County, in the McKinney Industrial Park, right next to the Ballenger-McKinney Water Treatment plant. A rendering of the plant is shown in figure 4.1.

![Figure 4.1: Carroll/Fredericksburg WTE facility rendering. Taken from wheelabratortechnologies.com](image)

The facility will produce 55 MW of power, and sell 45 MW of that to the grid. This is enough to power 45,000 homes in the surrounding area. It would take 130,000 tons of coal or 500,000 barrels of oil per year to produce the same amount of power.

The state of Maryland, along with 23 other states, including Indiana, consider waste to energy a renewable energy source. The U.S. Department of Energy also considers the technology renewable. This means that both counties may use this plant,

34
with its renewable energy capability, to meet their respective long-term renewable energy goals at a lower cost than using other renewable sources of electricity. The plant will also help both counties, and the state of Maryland reach its recycling goals.

As discussed earlier in this paper, WTE plants have been proven to increase recycling rates in areas around the plant. This will be no different, and in addition to increased recycling, the plant will recover approximately 15,000 tons of ferrous and non-ferrous metals annually that would not be otherwise recycled. (Carroll County Government, 2012) The Frederick/Carroll County WTE plant will also have some of the most advanced emissions and environmental protection controls of any WTE plant.

Economically, the plant is being funded without putting either county into debt. The capital costs of these projects are the main reason so few have been built in the past decade or two. This project is funded through the Northeast Maryland Waste Disposal Authority, to which the counties will pay a yearly fee to use the facility. After 30 years, the savings the plant provides are expected to be around $229 million. The construction of the facility is expected to cause a local stimulus of $260 million on local good and services during construction, and an extra $12 million each year the facility is in operation.

**Economic Benefits of Waste to Energy**

Waste to energy plants, especially if they are located near other developments, can create unique economic benefits for a community and spur growth. For instance, in the Hennepin Energy Recovery Center case study, the WTE plant was surrounded by developments that wanted to take advantage of certain benefits HERC could provide.
Target Field, home of the Minnesota Twins, seats 39,000 people and is located only 122 feet from HERC. It cost $545 million to construct. From HERC, it receives heating to the interior facilities and a heated field for cold weather games.

A $79 million light rail/commuter rail pedestrian interchange is also being constructed next to the facility that will service several thousands of people a day, every day of the year. HERC will provide snow melt systems and heat buildings that are part of the project. This case study not only shows that WTE plants can be an economic powerhouse for a city, but that with proper air and water quality monitoring and pollution mitigation measures, these plants can fit in to an urban environment. Many people visiting the transit station or watching a baseball game probably don’t even know the building next door is burning garbage.

The WTE plant built in 1988 by Wheelabrator Technologies in Bridgeport, CT is situated in an area of the city which has been the focus of many current and future development projects, both residential and commercial. The plant supplies 67,000 kilowatts, enough to provide 83,000 homes with electricity. (Wheelabrator, 2008)

Wheelabrator Technologies Inc. is currently working together with the city as a member of The City of Bridgeport Sustainability Implementation Program. The goal of the collaboration is to identify scenarios where the waste-to-energy facility can support the sustainability initiatives of Bridgeport. Much of this initiative revolves around encouraging new developments around the site like what is seen in the Hennepin Energy Recovery Center case study.

In fact, the Bridgeport WTE facility is also located near a baseball stadium, the Harbor Yard Ballpark, home of the Bridgeport Bluefish, a minor league team. There is
also a minor league hockey arena located next to Harbor Yard Ballpark. Together with the reinvestment to a nearby Holliday Inn, these public/private developments were worth $57.3 million in 1998.

In 2006, a $12 million supermarket opened less than half a mile away from the WTE facility. In 2007 Seaside Park, a “rural” style park was completed about the same distance from the facility. It represented a $9 million investment. Bridgeport also saw a regional ice cream wholesaler build a new warehouse on a remediated brownfield, a bakery and distribution center, a wholesale flooring company, and other investments move in to the area.

There have also been several reinvestments into the downtown of Bridgeport, which is about two miles away from the facility. This includes the Bijou Theatre, which re-opened in 2010 after becoming vacant in the 1990’s. This theatre is the oldest surviving movie house in the country and was part of a bigger redevelopment known as Bijou Square. This was made possible in part by the fact that the WTE facility in Bridgeport has helped spur industry in a town that was losing jobs rapidly before the plant was built. The WTE plant is also the city’s biggest taxpayer, paying property taxes more than double that of the second highest property assessment.

There are developments planned in the future as well. One of which is the Pequonnock Development, a $222 million mixed commercial and residential project. This development includes a hotel, retail space, and mixed income housing. The Steelpointe Harbor multi-phase project is worth $1.4 billion and will feature a mixed-use community, a waterfront promenade for pedestrians, and a marina. In total, Steelpointe Harbor will include 3 million square feet of mixed retail and commercial space and 1,200
mixed income residences. It is one of the largest such projects in the northeastern United States.

Economic Benefits from WTE plants are not limited to a handful of plants either. The Solid Waste Association of North America (SWANA, 2012) published a report that highlighted several cases across the United States of waste to energy plants proving to be sound investments and very beneficial to the communities they serve.

In Lancaster County, Pennsylvania, the goal of preserving valuable farm land and minimizing landfill consumption led lawmakers to waste to energy technology. (SWANA, 2012) The plant led to reducing the waste sent to their landfill by 90%, preserving their existing landfill for an additional 20 years. The plant gains revenue by selling power to 30,000 homes and by recovering 500 tons of ferrous metals and 16 tons of non ferrous metals each month, recycling, and then selling them. The plant also offers stable tipping fees at $62 per ton, $7 less expensive than it was when the plant opened in 1991.

In the 20 years the Lancaster waste to energy plant has been open, it has processed over 7.5 million tons of waste, which, if landfilled, would take up 190 acres, 100 feet deep. It has recovered 128,000 tons of ferrous metal and 800 tons of non-ferrous metal. It has produced enough electricity to power all of Lancaster County’s homes for three years, and finally it has produced $256 million in electric revenue. This is a substantial return on the $135 million it took to build the plant.

Another plant in York County, Pennsylvania processes an impressive 430,000 tons of waste per year, which is about 75% of the county’s total waste. This is enough to generate 30 megawatts of power, which it sells to Metropolitan Edison, the local energy
supplier. The plant has a strong credit rating, and due to its reliable debt payments, it will be able to reinvest in the facility to provide for the county’s long term waste disposal. (SWANA, 2012)

Palm Beach County, Florida is building a second waste to energy facility that will increase their capacity an additional 3,000 tons per day. This will produce an estimated 97 megawatts of electricity after construction is completed in 2015. It was the original WTE plant’s success that allowed for the expansion.

In Pinellas County, Florida, their waste to energy plant has kept tipping fees at $37.50 per ton of waste since 1986. Through electricity sales and other revenues, the plant brings in $80 million annually, and its operating costs are only $58 million per year. This represents a substantial profit for the county. The project has been so successful the county board has authorized up to $80 million to be borrowed from the plant’s reserve fund to help pay for the county’s capital improvement projects.

The revenues from the Marion County WTE plant in Oregon go towards funding the county’s waste management programs such as waste reduction, reuse, recycling, and composting initiatives. These programs have helped Marion County have the highest waste recovery rate in the state.

Spokane, Washington’s plant has been around for over 20 years. During that time, it has paid off its debt, increased recycling rates from 28% to 50%, recovered over 200,000 tons of ferrous metal, and produced 2.8 billion kwh of renewable electricity. Other communities in Washington have had to resort to long haul transportation to dispose of their waste, but Spokane’s plant allows them to handle the waste locally, retaining wages and economic benefits within the area. A privately operated regional
materials recovery facility is planned next to the plant, which is expected to bring in an additional $10 million for the community annually.

For a more in depth review of the economic benefits a waste to energy plant can have on a community, SWANA has released a report called “The Economic Development Benefits of Waste-to-Energy Facilities.” This report concludes the following:

- Communities can expect to pay less for MSW disposal over the lifetime of the facility than they would with a landfill.
- Money spent on a landfill will remain in the community, while 90% of the money spend on landflling will be transferred out of the community.
- WTE plants and their construction generate stable, high paying jobs that cannot be outsourced
- WTE plants generate a significant amount of renewable electricity that can be sold to the local electrical grid.
Chapter 5: WTE plant in Muncie, IN

Project Proposal

The central purpose of this creative project is to propose a new high efficiency waste to energy plant for the city of Muncie, IN. This paper will develop site selection criteria, estimate waste streams that can be captured to produce energy, give a possible site layout, and talk about the economic development that this project can spur.

The proposed waste to energy plant will provide district heating to the downtown of Muncie, a total area of which will be decided by the waste streams that can be collected. This district heating will be offered to residences and businesses in the downtown area at a reduced price in an effort to draw more people in to a historic, mixed use, and walkable downtown.

Site Selection Criteria

Selecting a specific site for a waste to energy plant is often a long and difficult process. After the need for a plant has been determined, a rough estimation of how much waste will be diverted to feed the plant must be established. This is accomplished through talking with several local and regional partners as to how much waste is going in to landfills, how much can be diverted to the proposed WTE plant, and what other sources may be able to contribute waste to the project reliably; thus determining the
Criteria for site selection in this paper will be split and looked at from two different angles; the technical or physical side, and the political side. The technical side deals with factors such as zoning, acreage, circulation, and environmental concerns. Conversely, the political side of the site selection process deals with securing local funding and support from politicians, establishing partnerships with the community, and most importantly addressing nimby-ism and working with the public in an effort to avoid opposition and address citizen concerns.

**Political Criteria**

The problem with finding a site for a waste to energy plant is that often the political side of things conflicts with the technical side. “The best site in terms of financial feasibility and geologic suitability may very well be the most troublesome politically.” (Powell, 1984, p. 20) These two sets of criteria must be developed and assessed side by side with each other, and compromises on both sides are key to developing a successful project. No two WTE projects are ever the same, and each will encounter its own problems and limitations.

It is also important to include the public fairly early on in the project. A delicate balance must be struck on when to bring in public participation for the project. If the project planners bring the WTE proposal to the public too early, without making a number of initial judgments of project desirability and feasibility before consulting the public, the public may feel the WTE developers do not know what they are doing. These judgments include whether a project could be financed, whether it could be technically
feasible, and whether the project would offer any significant benefits for the city.

If the citizen’s groups are involved too late and there is nothing meaningful left for them to participate in, they may feel they are being used as a “rubber stamp” in the process and are being otherwise ignored. If either of these situations occurs, these same groups could become leaders of an effective opposition movement. (Powell, 1984, p 21)

The most successful scenario, as pointed out in Powell’s report for Cerrell Associates is to first discern that financial and technical resources are available for the project to move forward to the site and planning stage. Then the project staff should look at possible sites around the city in which the WTE plant is to be located. These possible sites must meet certain technical requirements in order to be considered. These technical requirements will be further explained later in this paper. After drawing up a list of potential sites and identifying their individual pro’s and con’s, this list should be taken before the public to face rejection, modification, or approval for each identified possibility. Recommendations for alternative sites should also be heard, but the suggested alternatives are still subject to the same criteria as the sites already identified by the project planners.

After the public has voiced its opinion and its concerns have been addressed, then, and only then, can the project move forward. It is important to keep the public informed throughout the process and listen to any suggestions they may have. Ideally this can be established through creating a citizen advisory committee that will meet regularly and discuss the progress of the development with those in charge. This committee can be made up of local politicians, alderman, business owners, and ordinary citizens, likely those that will be most directly affected by the WTE plant. Their job will be to consult
with the project team and advise them on what the public’s interests are on a continuing basis. A successful public relations campaign can mean the difference between the project reaching completion or failing to do so.

**Technical Criteria**

The first choice to make concerning technical criteria for a site is to decide what kind of waste to energy plant will work best. As discussed earlier in the paper, the most efficient, most economically sound form of waste to energy today is plasma-arc gasification. (Young, 2010) It produces the most energy at 816 kWh per ton of trash burned, and because of its high temperatures, there is no waste ash at the end, but a re-use-able, sell-able vitrified slag.

As part of this project, an energy district will be established in the downtown area to supply hot and cold water to be used for heating and cooling. This provides numerous benefits to those within the energy district, but means the WTE plant must be located near the downtown. Close proximity to the energy district the plant will service is important because pumping hot and cold water over long distances will decrease the system’s efficiency. Proximity will also reduce the cost of installing the piping infrastructure that will connect the downtown to the WTE plant.

So, in order to find the best sites to locate the plant, the proposed district’s boundaries must be set. To do this, Geographic information systems (GIS) was used. GIS layers were provided by the City of Muncie, and put in to ArcGIS. In order to define the borders of a downtown energy district, the properties zoned as Central Business in the downtown area will be used.
In the site selection process, industrial properties were identified because they already have a lot of the infrastructure a WTE plant would require, such as access to railroads, major roads, and large areas of land. Industrial properties would also not have to be re-zoned or given a special exception, which would save time and hassle, and nimby-ism should be at a minimum. The following is a step by step discussion of the site selection process. Maps for each step are available at the end of this section.

**Step 1.** Because of Muncie’s layout, there are several industrial properties close to the downtown area. Figure 5.1 shows all the industrial properties within a quarter mile, half mile, and mile radius of the downtown.

Industrial properties that were outside of the target area of one mile were dropped from consideration. The cost of building the infrastructure needed and loss of efficiency the distance would create means these properties are not feasible. Those that were closer to the site were given heavier consideration than those barely within the one mile boundary. The map was refined to show only the properties that were to be considered, along with their approximate distance from the downtown target area.

**Step 2.** The next step was to see which of these properties had rail access. To do this, all active rail lines were given a buffer of 200 ft, and any industrial properties that intersected with this buffer was considered to have access to rail. This is important for this project because it is a cost effective way to import MSW from outside communities. The result is shown in Figure 5.2.
Step 3. Arterial roads were added to the map and given a buffer of 500 ft. on either side of only the industrial properties with access to rail. Sites that are located close to major roads would have less impact on the surrounding local roads since the plant will have many trash trucks going to and from the site. The sites that have access to both rail and major roads (according to the criteria described in this paper) are displayed in green, while those that do not have optimal access are displayed in yellow and red. (Figure 5.3)

Step 4. Next, the properties that were identified as having access to rail and a major road were then separated and judged by their distance from the downtown. In figure 5.4, the properties in the dark green are the best possible sites, given that they are the closest industrial properties to the downtown and have access to rail and major roads.

This map does not represent a definitive list of the only properties that will be considered, it merely is a guide to judge which properties would likely work best. Other factors such as property availability, value, size, and the surrounding neighborhood need to be considered. Many of the properties identified in step 4 already have businesses on them or are otherwise unsuitable, and therefore are unlikely to be used.

Figure 5.4 shows that the most likely industrial properties to be used are to the southwest and southeast of the downtown, and to the northeast. Now that these areas have been identified, individual properties will be compared to find the best possible sites. Some of these properties have buildings already on them, and some are vacant lots, but new construction will be needed for any site, as no facility in Muncie is currently designed to handle the needs of a WTE facility.
Image 5.1: All Industrial properties within a mile of the downtown. Map created by Kevin Kroll.
Image 5.2: Industrial properties from step 1 with direct access to a rail line for importing waste outside of the county and/or state. Map created by Kevin Kroll
Image 5.3: Industrial properties with close proximity to rail lines and a major arterial road. Map created by Kevin Kroll
Image 5.4: Best possible sites given the criteria of steps 1-4. Map created by Kevin Kroll
Possible Sites

Former Chevrolet Plant

The 70 acre site of the former Muncie Chevrolet transmission plant is in dire need of redevelopment. Since the plant was closed in 2006, plans for the site have been proposed, but nothing has come to fruition. As it stands today, the property is a giant void cutting off the surrounding neighborhood and bringing down property values of the homes around it. The site is far larger than what the waste to energy plant would require, but this could present an opportunity to redevelop the rest of the site with some enterprise that could spur further economic development in the neighborhood surrounding the plant. The plant itself would take up less than 10% of the total area.

The location may receive some opposition from the homeowners around the site, but a modern WTE facility with its stringent environmental controls would produce much less pollution than the former Chevrolet plant ever did, and any development on the vacant site should expect a majority of approval from the surrounding area.

The former Chevrolet plant does have rail service directly to the north and access to major roads in State Route 32 via Perkins Avenue and Hoyt St. through W. 8th St. There are a few drawbacks. It is over a quarter-mile away from the downtown, so there are closer alternatives. The site is also a brownfield, so the cost of remediation could be expensive, but remediating the area could potentially be achieved through living machines or other similar applications that take the pollutants out of the ground via natural biological processes. Creating a partnership with the City of Muncie to develop the entire property could be the key to making this site work.
**Downtown Industrial Center**

The Downtown Industrial Center is a combined 167,000 sq. ft. mostly vacant warehouse/manufacturing facility to the southeast of the downtown. MITS does have its headquarters at the southeast corner of the lot, so there may be some conflict with them. The building on the property would not fit the purposes of a waste to energy plant, so the existing structure would have to be torn down.

The site is about the same distance from the downtown as the former Chevrolet plant, and while it does have access to rail, it does not have as good of access to a major road as the Chevy site.

**1800 Block of E. Jackson St.**

This is the former site of a factory that has been vacant for some time. It is now owned by EGR Properties out of Lansing, MI, who bought the property in 2009. The size of the property is 3.5 acres, which would work well for the WTE plant. It has access to rail and a major road, but is over a half mile away from the downtown. It is also very near the White River and the Craddock Wetlands Preserve across the river, so locating here might face some opposition. The distance is the major drawback to this site.

**Norfork and Western Property on Dr. Martin Luther King Jr. Blvd.**

Further north is a roughly 10 acre property owned by the Norfork and Western Railroad Company. The site is adjacent to the White River and has access to both rail and a major road. It is also the closest site to the downtown at less than a quarter-mile away.

The main drawback of this site is that it is located on a wooded property. It is
zoned industrial, but the lot has remained vacant for some time. It is very near the White River, which could lead to problems with trash possibly coming off of the trucks that ship the waste it and flowing down the river before they can be collected.

Because it fits all of the criteria previously listed, has ample space for not only a WTE plant, but also further economic growth, and because it is a property desperately in need of redevelopment with probable public support, the former Chevrolet Transmission site will be used to site the WTE plant.

**Zoning**

The Chevrolet plant is zoned as intense industrial in the Muncie Zoning Ordinance. No rezoning or special use permit will be required for this site, as all industrial and business uses are allowed, including the manufacturing of chemicals and explosives. Vegetative composting is also allowed in this zone, as long as it meets state and federal requirements.

**Projected Waste Flow**

There are currently no Municipal Solid Waste landfills in Delaware County, but the neighboring Jay, Randolph, and Henry Counties each have one. The table below has more information on each of these landfills. It shows how much space has been already been used at each location, as well as how much capacity is left and an estimate of how long it will take to reach capacity at each landfill.

The numbers were taken in 2010, the most recent year the data was available. They show that these three nearest landfills have a combined remaining capacity of
23,948,216 cubic yards, and receive 485,469 tons of MSW annually. This means that the three landfills combined can expect to last about 35 more years based on current projections. This is representative of the rest of the state, as all of the landfills in Indiana are expected to last 37 years at the same projections.

### Table 5.1: Landfills near Muncie

<table>
<thead>
<tr>
<th>County</th>
<th>Name</th>
<th>Gross Airspace (cubic yards)</th>
<th>Remaining Capacity (cubic yards)</th>
<th>Waste Received (tons)</th>
<th>Life (years)</th>
<th>Active &amp; Future Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry County</td>
<td>HAYES LANDFILL</td>
<td>3,581,051</td>
<td>2,837,377</td>
<td>75,153</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Jay County</td>
<td>JAY COUNTY LANDFILL</td>
<td>15,529,608</td>
<td>12,140,473</td>
<td>142,485</td>
<td>57</td>
<td>155</td>
</tr>
<tr>
<td>Randolph County</td>
<td>RANDOLPH FARMS LANDFILL</td>
<td>11,546,653</td>
<td>8,970,366</td>
<td>267,831</td>
<td>22</td>
<td>123</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>30,657,312</strong></td>
<td><strong>23,948,216</strong></td>
<td><strong>485,469</strong></td>
<td><strong>35</strong></td>
<td><strong>308</strong></td>
</tr>
</tbody>
</table>

Data from Indiana Department of Environmental Management

Data for the origin of collected municipal solid waste is only collected on a state and county level, so it is hard to find anything at a smaller scale. Delaware County produced 148,336 tons of waste in 2008, the most recent year reported. On average, Delaware County produced an average of 150,469 from 2000-2008, the breakdown of which is available in table 5.2. This equals 412 tons per day. However, the Indiana Department of Environmental Management (IDEM) estimates that the amount of waste generated by each county is overestimated by 20-40 percent due to some loads of municipal solid waste being mixed with non-municipal solid waste but identified only as municipal solid waste. (Vallely, Weddle, & Staller, 2008)

A more accurate estimation is difficult due to the manner in which waste is
collected and transported to landfills. Usually the waste truck will take the waste directly to the landfill, and the county of origin will be reported. However, if the waste is from more than one county, the deliverer must estimate the percentage of waste that originated in each county. The waste could have also been brought to a transfer station before being landfilled. In this case the waste is marked as being from the county in which the transfer station is located. These IDEM guidelines cause a lot of discrepancies.

The counties surrounding Delaware County are responsible for producing an average of 405,510 tons per year from 2000-2008. This equals a total of 1,111 tons per day in addition to the 412 produced by Delaware County, for a total of 1,523 tons per day or 555,979 tons annually. Of these six counties, only Jay, Henry, and Randolph have their own landfills, the rest must transport their waste to other counties, some of which may be more than one county away. Madison County, which produces the most waste of these counties, does not have its own landfill, nor does Delaware County, the second highest. Trash from Muncie must travel at least 20 miles to reach a landfill. These 7 counties combined produce on average more waste than there is landfill capacity. There are 70,510 more tons of waste produced than what is landfilled in this same area annually.

<table>
<thead>
<tr>
<th>County</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delaware</td>
<td>154,664</td>
<td>139,272</td>
<td>154,054</td>
<td>148,748</td>
<td>164,217</td>
<td>153,745</td>
<td>149,093</td>
<td>142,089</td>
<td>148,336</td>
<td>150,469</td>
</tr>
<tr>
<td>Blackford</td>
<td>18,025</td>
<td>15,813</td>
<td>17,597</td>
<td>31,461</td>
<td>24,582</td>
<td>26,341</td>
<td>25,342</td>
<td>21,918</td>
<td>12,092</td>
<td>21,463</td>
</tr>
<tr>
<td>Grant</td>
<td>86,924</td>
<td>91,298</td>
<td>82,840</td>
<td>80,030</td>
<td>81,485</td>
<td>87,506</td>
<td>87,342</td>
<td>83,934</td>
<td>70,572</td>
<td>83,548</td>
</tr>
<tr>
<td>Henry</td>
<td>62,868</td>
<td>65,101</td>
<td>66,298</td>
<td>62,376</td>
<td>71,183</td>
<td>63,308</td>
<td>58,367</td>
<td>75,314</td>
<td>60,195</td>
<td>65,001</td>
</tr>
<tr>
<td>Jay</td>
<td>23,032</td>
<td>25,997</td>
<td>32,009</td>
<td>28,084</td>
<td>21,768</td>
<td>23,012</td>
<td>25,638</td>
<td>23,708</td>
<td>23,596</td>
<td>25,205</td>
</tr>
<tr>
<td>Madison</td>
<td>171,067</td>
<td>187,423</td>
<td>169,789</td>
<td>185,259</td>
<td>174,710</td>
<td>173,199</td>
<td>180,672</td>
<td>153,627</td>
<td>168,210</td>
<td>173,773</td>
</tr>
<tr>
<td>Randolph</td>
<td>24,829</td>
<td>45,917</td>
<td>26,942</td>
<td>28,748</td>
<td>26,521</td>
<td>25,462</td>
<td>53,367</td>
<td>60,435</td>
<td>36,455</td>
<td>36,520</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>386,745</td>
<td>431,549</td>
<td>395,475</td>
<td>415,958</td>
<td>400,249</td>
<td>398,828</td>
<td>430,728</td>
<td>418,936</td>
<td>371,120</td>
<td>405,510</td>
</tr>
</tbody>
</table>

Table 5.2: Waste generated in Delaware and surrounding counties

Data taken from Indiana Department of Environmental Management
Indiana also receives waste from out of state sources. Of the waste landfilled in Indiana in 2008, 18.58% of it was from outside the state. Roughly 99% of this out of state waste comes from the four states surrounding Indiana (Ohio, Illinois, Michigan, and Kentucky), but some travels here from further away, and 2006 saw the first occurrence of waste from Canada being landfilled in Indiana. (Vallely, Weddle, & Staller, 2008) In 2008, 86% of the out of state waste comes from Illinois and of that amount 92% came from the Chicago area. Similarly, Indiana transfers some of its waste to out of state sources.

The waste to energy facility proposed in Muncie would seek to bring in some of this out of state waste to supplement the more local supply. Rail is a much easier and economical way to transfer this waste, and is why it is so important to locate the facility along a rail line. Bringing in reliable waste streams from out of state sources can increase the amount of waste processed and therefore increase energy production, benefiting Muncie and the downtown energy district.

In 2008, Indiana landfills received 2,464,489 tons of all waste from Illinois, 183,149 from Ohio, 119,802 from Kentucky, and 76,238 from Michigan. Certain counties send a lot more waste to Indiana than others. An estimated 2,268,681 tons of MSW comes from the Chicago area, and is by far the biggest out of state waste source. Other significant sources include Kankakee, Illinois at 136,741 tons, Allen and Miami Counties in Ohio at 72,427 and 54,235 tons respectively, and Louisville, Kentucky at 101,927 tons. (Vallely, Weddle, & Staller, 2008) This means that there are plenty of opportunities to divert waste to the Muncie waste to energy facility, and all of these areas are connected via rail. (Image 5.5)
Image 5.5: Waste streams from outside Indiana. The insert shows locations of landfills in Indiana and regional rail networks through which waste could be sent to the proposed WTE plant. Maps created by Kevin Kroll
Of these waste streams from outside the state, an average of 1,816,503 tons consist of municipal solid waste from 2000-2008. If this waste to energy plant can divert 5% of this amount to the site, additional tons could be converted into energy annually, or 497 tons per day.

So if it is assumed that all of the waste in Delaware County will go to the WTE plant, then we can assume an average of 412 tons per day will be processed. The counties immediately surrounding the site, assuming 25% of their waste will be diverted to the plant, would be 278 tons per day, and the rest of Indiana (not including the counties already mentioned) would contribute about 1% of their total waste, or 319 tons per day. Finally, waste from out of state sources are estimated to equal about 249 tons per day based on the amount of waste already coming in to the state. Combined, this equals a potential 1,258 tons of waste per day, shown in table 5.3 below.

<table>
<thead>
<tr>
<th>Table 5.3: Amount of Potential Waste Captured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tons per year</td>
</tr>
<tr>
<td>Delaware County</td>
</tr>
<tr>
<td>Surrounding Counties</td>
</tr>
<tr>
<td>Rest of Indiana</td>
</tr>
<tr>
<td>Out of State</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Data taken from Indiana Department of Environmental Management

For a number of reasons, this number could be inaccurate. The Indiana Department of Environmental management reports that due to reporting complications, these county source estimates may be 20-40% percent higher than the actual amount of
MSW generated. Taking this into account, the amount of waste processed at the facility could be as low as 754.8 tons per day (tpd), but because these numbers are not precise and because the amount that can be diverted to this WTE facility is also an estimation, it will be assumed that 80% of the projected 1,258 tpd is the most accurate estimation, and that equals 1006.4 tpd. Therefore, for the purposes of this paper, the number will be rounded to an average of 1,000 tpd.

Of course, a significant amount of this waste will be recycled out before it reaches the gasification chamber, and it is recommended that Muncie create an initiative within the city to reduce the amount of trash produced in the first place. This means the amount of trash coming into the plant could be lower still. But trash from other counties and other states could make up the difference, or the plant could bring in other sources of waste besides MSW. The number of 1,000 tons per day is merely a likely figure with which to calculate the capital and operating costs as well as the amount of energy generated.

Because the MSW going into the plant is first processed to remove any recyclables, it is important to look at existing recycling centers that could be utilized, and Muncie has East Central Recycling, Omni Source Corporation, and New Life Center. A partnership with these recycling entities could be established, but none of these facilities are equipped to handle the amount of excess waste the WTE plant would bring in. Therefore, it is recommended that the proposed WTE plant be equipped to handle recyclables from the waste on site.
Specifications of Plant

The proposed facility is of average size for a waste to energy plant, as most process between 500 and 2,000 tons per day. Most WTE plants are built to be able to easily expand their capacity in the future, but expansion is not typical until the plant has been in operation for about 20 years and has either paid off its debt or is close to doing so and is therefore in financial position to do so.

Capital and Operational Costs

The capital costs of a modern waste to energy facility is the major hurdle that must be cleared in order to make the project a reality. Capital costs can vary widely with construction costs such as steel prices. It is hard to find the cost of a plasma-arc gasification WTE plant in the U.S., as none have been successfully completed yet, although a few are in various stages of completion.

In his book Municipal Solid Waste to Energy Conversion Processes, Gary C. Young estimates that a WTE plant processing 500 tons per day would cost $79,170,000 to build. Assuming it would be fair to double that number for a 1,000 ton per day facility, the capital costs would be $158,340,000. (Young, 2010) Dr. Louis J. Circeo, one of the pioneers of the plasma-arc gasification process seems to agree with this assessment. The graph on the next page made by Dr. Circeo shows the comparative capital costs of three different WTE technologies. His estimate of around $150,000,000 is close to Young’s estimate. Rogoff (2011) suggests a more conservative cost of $142,506,000. So for the purposes of this paper, we will split the difference and assume a capital cost of $150,000,000.
Operating costs are also hard to calculate. This depends on the debt service structure, the amount of waste processed, the efficiency of the system, wages, and several other factors. Young (2010) estimates the operating costs of a 500 ton per day plant to be $7,483,400 per year, plus debt service. Again doubling this number for this 1,000 ton project, the operating costs would be $14,966,800 per year plus debt service. Rogoff (2011) estimates the debt service of a 600 ton per day facility $11,485,874. Again adjusting to a 1,000 tpd plant, the debt service would be around $19,143,115 per year at an 8% interest rate.

**Energy generated**

Plasma Arc gasification generates a net of 816 kwh per ton of waste processed. (Young, 2010) This is more than any other type of WTE technology, including Pyrolysis and conventional gasification and is a big reason it is the technology chosen for this
project. Since the plant will process 1,000 tpd of MSW, it will generate 816,000 kwh of electricity which it will send to the grid daily. This equals about 34 megawatts of renewable energy, which is enough to power between 25,000 and 30,000 households. As of 2012, the city of Muncie had 27,716 households, so theoretically, the proposed waste to energy plant could power every household in the city. (ESRI, 2013) The number of households in Muncie is only expected to rise 0.1% through the next five years.

WTE plants, at least those located in an urban setting usually have an associated energy district that benefits from the excess heat used to gasify the waste. This is usually in the form of steam, however, in certain instances hot water pipes can also be used.

A water-wall system or other configuration could capture the excess heat produced and pump it to a district heat system in the downtown. During a phone conversation with Dr. Andrew Leith, head of the Air and Energy unit for HERC in Minneapolis, he suggested that a hot water line would actually be more efficient than a steam line. It depends somewhat on how the buildings the energy district is meant to serve are already heated. A WTE plant would not be able to produce cold water for cooling buildings in the energy district though, and an energy district without a chilled water service would not have as much of a draw with developers and potential residents and businesses as a joint hot and cold water system would.

The infrastructure for this downtown Muncie energy district would cost in the neighborhood of $30 million. This includes the cost of a chilled water plant, which could be built next to the WTE plant or closer to the downtown itself. (Leith, 2012) The infrastructure for a heating district without a cooling element would be around $10-$12 million.
Characteristics of Area Around Former Chevrolet Site.

It's important to look at how the potential WTE plant would fit into and affect the neighborhood surrounding the former Chevrolet site for a number of reasons. Most importantly, to make sure the plant would have as much positive impact on the area as possible, and would not hinder the lives of the people who live there and would not diminish their property values or damage their health and well being. ESRI Community Analyst was used to obtain demographics and other characteristics for these neighborhoods.

In order to do this, half-mile and one mile rings were drawn from the center of the former Chevrolet property. (Image 5.7) The half mile ring represents the area that would be the most affected by the construction and day to day operation of the WTE plant. The mile ring would be those potentially still affected, but less so.

Table 5.4 shows some of the key demographics of the half-mile area. The population is expected to be very stagnant through the next five years, with almost no change. It is a fairly low income area, with 88% of the households at or below $50,000 in annual income and the median income for the area is only $23,411.
There have not been any new housing additions since before 2000 and over 95% of the housing was built before 1979. Over half were built before 1939 and over two-thirds of the housing stock is single family detached housing. The lack of any new housing is a factor in the stagnant population growth of this area. The area has more renters than homeowners and 76.3% of housing units are heated by natural gas utilities, which could potentially be switched to a hot water district heating system.

There are 71 businesses located within the half mile radius, with 783 employees. Given the residential population in the table above, the employee/residential population ratio is 0.36. A majority of these businesses are retail trade and service oriented businesses. Only 7 industrial enterprises are located in the area, which employ 12.9% of the employees in the area.

The 1 mile area around the site is very similar to the half mile ring in terms of demographics. The population is much higher at 12,222, but it is also very stagnant, and actually shows a slight decline in population for the next five years. The area is slightly wealthier, with a median income per household of $24,916.

The housing stock within the 1 mile radius has had more recent additions than the
half mile area, though only 3% of housing units were built after 2000. Nearly 50% of the housing stock was built before 1939. Roughly two-thirds of the housing units in this area are rentals, and 71.7% of units are hooked up to utility natural gas for their heating source.

There are 593 businesses within the 1 mile area. These businesses employ a total of 6,879 workers giving the area an employee/residential population ratio of 0.57. The service industry again has the most businesses employing the most people, and the number of manufacturing employees is 11.9%, a slight decrease in percentage from the half mile area.

Traffic patterns around the site are also important to consider, because of the increase in the number of waste vehicles delivering MSW to the plant every day. The entrance these waste collection vehicles will be using to drop their waste at the facility is the same used by the Chevrolet plant during its operation, where 5th St intersects S. Perkins Ave.

Kilgore Ave. (state route 32) and Memorial Drive will be the two most used roads to funnel the waste trucks toward the facility. Both of these roads already have substantial average daily traffic counts (ADTs) and will not be effected by the extra traffic. Perkins Ave. has access to both of these roads and is where these waste trucks will turn to enter the facility.  Image 5.8: Traffic patterns within a half mile radius of the site. Taken from ESRI Community Analyst
Figure 5.8 shows that Perkins Ave has an ADT count of 1,173, much lower than Kilgore or Memorial. This road has not been used except by locals since the plant closed. It did, however, handle traffic to and from the Chevrolet plant when it was in operation, so a road widening or reconstruction should not be necessary, but resurfacing the length of Perkins Ave from Kilgore to Memorial is important.

Characteristics of Potential Downtown Muncie Energy District

The downtown area which will receive heating and cooling from the WTE plant had 920 residents as of 2012. That number is expected to grow by 0.26% per year for the next 5 years, which is faster than the expected growth around the WTE facility, but slower than the rest of the state as a whole. The median income is 15,977, and most downtown residents live alone. Over 40% are between the ages of 20 and 34. Renters comprise 85% of the occupied downtown housing stock so getting the approval of landlords is crucial, but of the total housing stock, 33% are left vacant. Reduced energy costs from an energy district could be a draw to attract more residents, especially home owners, to move downtown.

In the downtown area there are 337 businesses, which employ 4,551 employees. Almost 30% of downtown employees work for the government, while the service industry, financial, real estate, insurance and manufacturing industries also have significant amounts of employees.

An ESRI report on restaurant market potential shows family style restaurants and cafes or bakeries are in high demand in the downtown area. Market spending patterns and retail market potential shows apparel products, especially women’s apparel, fine
jewelry, an insurance offices could all do well in the downtown. Market spending on most goods and services is below the national average however, so in order to draw more businesses to the downtown, more full time residents would be desired. A energy district could be a catalyst for future development in the downtown area through reduced capital costs brought on by the elimination for each building to buy and maintain its own heating and cooling systems, and by reducing the operational costs by receiving cheaper and more stable heating and cooling.

**Site Plan**

Locating the WTE plant at the site of the former Chevrolet transmission plant means there is a lot of room to play with. The site is 70 acres, not including the parking areas to the south of 8th St. The main building will only take up approximately and acre, and the rest of the WTE infrastructure will only take about 10% of the total area. Figure 5.9 on the next page shows an overhead view of the site, and a rudimentary design of the WTE plant itself.

Trash collection vehicles will enter the site from Perkins Ave. It will then proceed to a weighing station that will measure how much waste the vehicle is carrying, so the tipping fee can be accurately calculated. All recyclables will either have already been taken out, or a process to remove them from the waste inside of the plant can be established. It is usually easier to do this on site. Then the vehicle will circle around to the waste drop off area, also known as the tipping floor, where it will deposit its contents. Trains will similarly drop off their waste here, but in a different fashion. The waste will be put in a waste storage area, and all recyclables including ferrous and non-ferrous
metals will be removed from the waste before it is moved to the plasma-arc gasification chamber. A diagram of the WTE process is shown in Figure 5.11 on the next page.

**Image 5.9**: Site plan for former Chevy plant. Photo by Kevin Kroll

**Image 5.10**: Detail of WTE plant. Created by Kevin Kroll
Image 5.11: Plasma-Arc gasification process diagram. Taken from http://alfin2300.blogspot.com
Potential Economic Development around the WTE site

This excess land creates an opportunity for other projects to spring up around the plant. WTE creates a large amount of electricity, steam, and heat that other industries can use. For instance, The Plant, a vertical farm being built in a former meat packing facility in Chicago could be a great idea. The plant will feature an anaerobic digester, aquaponics farm that grows fish and plants simultaneously, beer brewery, Kombucha tea brewery, mushroom farm, and commercial kitchen. (The Plant, 2013) The idea is to create a process that mimics an ecosystem where the waste of one process feeds another. As an example: the anaerobic digester creates biogas, which powers a turbine to create electricity for the grow lights that feed the plants. The plants clean the water for the fish, and the fish produces waste that feeds the plants. Excess waste from all of the combined uses in the building go to the anaerobic digester, which again creates electricity. The plant will be a net zero building, meaning it creates all of its own electricity, and it will produce no waste. Moreover it will create 125 green jobs in a distressed area and be a valuable source of healthy food.

The exact business model of The Plant would probably not make much sense next to the waste to energy plant, because it is a net zero facility that would not need to rely on the WTE plant. But the idea behind The Plant should work, where the excess heat and 70
electricity created by the plant is used by another process such as urban agriculture.

Perhaps a manufacturer can locate next to the plant that buys and uses the vitrified slag that is produced by the plasma-arc gasification process. This vitrified slag can be used in a number of ways, as mentioned earlier in this paper. The product it becomes depends largely on how the slag is cooled after it comes out of the plasma-arc gasification chamber.

According to Young, (2010) roughly 75% of vitrified slag produced in plasma-arc gasification plants in Japan go towards producing road paving material. This, he says, is sold for around $15 per ton, a conservative estimate. Rock wool, which can also be produced from the vitrified slag is commonly used in insulation, and is similar to fiberglass. A 1,000 ton-per-day plant can produce approximately 105 tons per day of this material. (Rogoff, 2011) This insulation material is sold for about $190 per ton, giving the plant an additional profit of $20,000 per day.

The plant also has other by-products that could be sold to other companies that have a use for them. Part of the process produces distilled water, which can be used in a vast number of industrial and commercial capacities. Hydrochloric Acid is another waste from the process that can sold.

Directly to the east of the former Chevrolet transmission plant is a school bus parking lot. If the bus fleet were switched to electric busses, the excess electricity from the plant could be use to charge the busses overnight. The same goes for MITS busses, which are currently stationed not too far away from the site of the proposed WTE plant. There could also be a car charging station offered for a reduced price for local residents, to encourage the adoption of electric vehicles, or a battery exchange system, where a
used battery in the car is replaced by a full one. Market forces would have to dictate how recharging electric vehicles will play out.

Another idea is that a collection system could take the liquid leachate from the MSW as it sits in the tipping floor, mix it with stormwater from Muncie’s sewers or other waste water sources, and deliver it to a living machine that treats this waste by creating a wetland-like filtration system. The wastes are used as nutrients for these wetland plants and the result is clean water, clean air, and healthy plants. Roth Ecological Design and others have perfected a process that converts raw sewage into pure water in just over two days time.

Image 5.13: Example of a living machine. Taken from http://www.popularmechanics.com
This could be done in a greenhouse setting or by building a wetland on the rest of the site. Doing either would create a valuable learning opportunity for local school children and adults alike. Wetlands make a great place to learn about plants and animals, as well as how sewage is being treated through natural processes with minimal energy expended. These green developments, especially a wetland, should also help raise the home values around the site and be more friendly for pedestrians. The site as a whole would also go a long way towards improving the image of Muncie, from a struggling rustbelt community to a green energy and sustainable living powerhouse.

The rest of the site can be used for any number of things. These are just a few ideas that would add to the ecological and economic viability of the WTE plant itself. It is important that a project such as this is seen as a catalyst to transform Muncie into a much more environmentally friendly and economically stable community, not just solve a waste problem.

**Conclusion**

While the up front costs of the facility at $150 million represent a risk, a partnership with a proven WTE company like Covanta or Wheelabrator would bring valuable experience, leadership, and private dollars into the project. Moreover, it would take over five years to plan, design, and build the project and about 20 years to fully pay off the capital costs. It is not an easy commitment for a city with a limited budget to make. But waste to energy plants have proven to be reliable projects and long term assets to the communities they are located in. Plasma-arc gasification is an improvement on established WTE plants in the United States, and produce more energy per ton of trash processed, making them more economically viable than in the past. They also do not
generate bottom ash as a by-product, but usable, sellable vitrified slag, which becomes another source of revenue. Dioxins and other harmful toxins present in past technologies are much more limited due to the high temperatures required with gasification technologies.

The state of Indiana categorizes waste to energy plants as a renewable source of energy, and therefore the technology can help the state as a whole meet energy creation and landfill reduction targets in the years to come. It also means the plant should be eligible for tax credits from the government based on how much energy is produced. Waste to energy is experiencing a comeback in the United States and in other countries in Europe and Asia. It produces more energy per ton of waste than anaerobic digestion, methane capture from landfills, pyrolysis, and any other waste elimination or reduction process. While reducing waste and reusing as much as is possible, as long as there are humans, there will always be waste. Waste to energy is the most sustainable long term option for large amounts of waste that are normally landfilled.
References


