Engineering Management
Field Project

Reducing a Companies Carbon Footprint through Energy Saving Best Practices at a Dairy Manufacturing Facility

By

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Acronyms

CAA	Clean Air Act (CAA)
CFCs	Chlorofluorocarbons
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
EPA	United States Environmental Protection Agency
GHG	Greenhouse Gasses
GHG Protocol	Greenhouse Gas Protocol Corporate Standard
GWP	Global Warning Potential
HFCs	Hydrofluorocarbons
HVAC	Heating, Ventilating and Air Conditioning
NASA	National Aeronautics and Space Administration
NOAA	According to the National Oceanic and Administration
PFCs	Perfluorocarbons
P&ID	Piping and Instrument Drawings
OEM	Original Equipment Manufacturer

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Executive Summary

Today global warming and the issues that cause it are a high priority to consumers. They want the companies that provide their products and services to reduce the global warming gasses in the atmosphere and as such consumers are willing to reward these companies with increased sales. These global warming gasses are made up of both naturally occurring and non-naturally occurring gasses. Naturally occurring gasses are carbon dioxide (CO_2), methane, nitrous oxide, and ozone gasses while non-naturally occurring gasses are chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). To accurately measure these gasses in relationship to each other they will need to be converted into a common measuring unit and the most widely excepted common unit is the carbon dioxide equivalent (CO_2e). There are also several different ways to look at tracking a company's production of the CO_2e and each way have a slightly different definition of what CO_2e are counted. This paper will use the Greenhouse Gas Protocol Corporate Standard (GHG Protocol) to insure that we have a uniform way to identify, track, and compare company's carbon footprints. The GHG Protocol only considers the GHG emission in which the company has control over and such will be counted in the company's carbon footprint calculations. Using the eleven step process, as defined in this paper, to reduce a company's carbon footprint and introducing some helpful tools that will assist in this process. The XYZ Company facility found through this process that their greatest area of opportunity was the lighting of their facility and by installing efficient lighting reduced their carbon footprint by 3.4% and realized an electrical savings of $ 14,000.00 per year.

Chapter 1 – Introduction

In December 2007, then President George W. Bush signed the Omnibus Federal spending package in which set aside money to develop and publish a draft rule within 18 months that would require mandatory reporting of greenhouse gas emissions above appropriate thresholds in all sectors of the economy of the United States (Kenney 2008, 48). According to the United States Environmental Protection Agency (EPA) greenhouse gasses are gasses that trap heat in the atmosphere and the greenhouse effect (see Figure 1.1) is when these gasses radiate this heat back to the earth's surface to warm it. So without this natural occurring "greenhouse effect", temperatures would be about 60 degrees Fahrenheit lower than they are now, and life as we know it would not be possible.

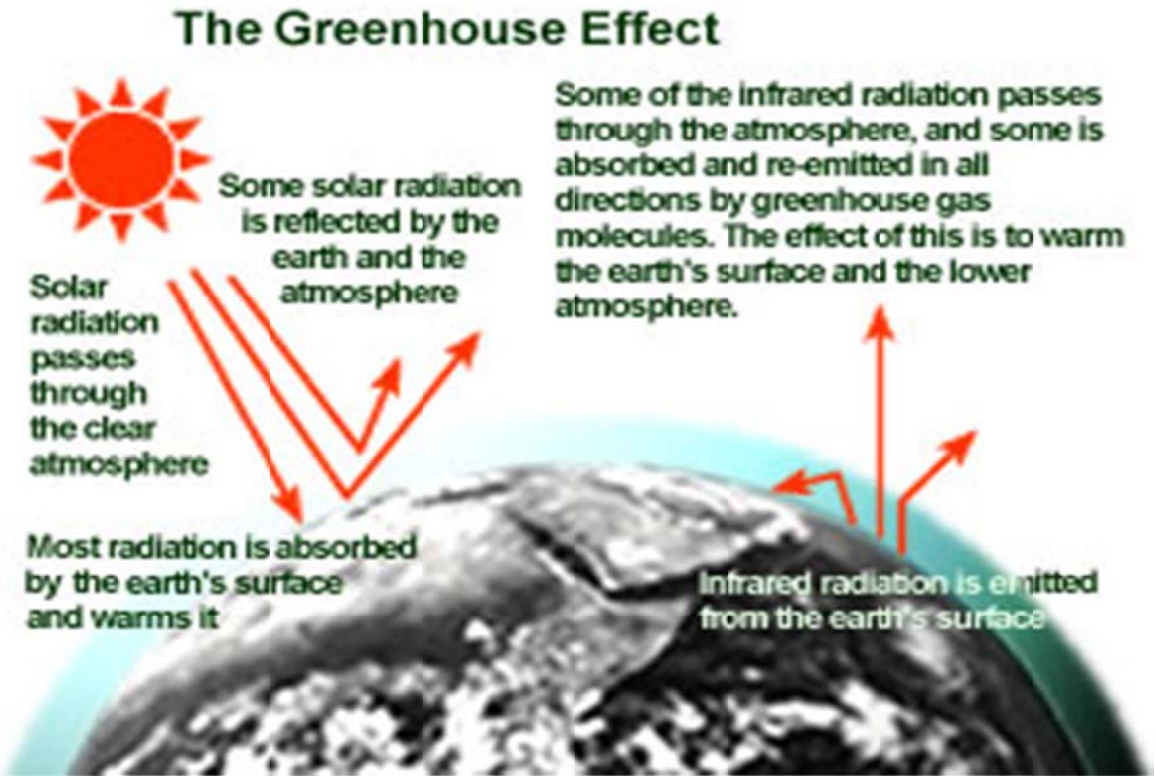

Figure 1.1: Greenhouse Effect (Source: U.S. Environmental Protection Agency website www.epa.gov).

These natural occurring greenhouse gasses (GHGs) which include water vapor, carbon dioxide (CO_2), methane, nitrous oxide, and ozone make the greenhouse effect possible. During the past century humans have substantially added to the amount of naturally occurring GHGs in the atmosphere and in doing so have dramatically increased the greenhouse effect causing an increase in the average temperature of the earth known as global warming. According to the National Oceanic and Administration's (NOAA) 2008 State of the Climate Report and the National Aeronautics and Space Administration's (NASA) 2008 Surface Temperature Analysis: Since the mid 1970s, the average surface temperature of the Earth has warmed about 1 ºF, the Earth's surface is currently warming at a rate of about 0.29 ºF/decade or 2.9 ºF/century and the eight warmest years on record (since 1880) have all occurred since 2001, with the warmest year being 2005 (EPA 2010).

This increase in production of some of the natural occurring gasses such as carbon dioxide (CO_2), methane, nitrous oxide, and ozone gasses are mostly caused by the burning of fuels (CO_2), disposal of solid waste (methane), and industrial processes (nitrous oxide and ozone). To add to the naturally occurring gasses, non-naturally occurring gasses such as chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) from industrial refrigeration and aerosol products have also increased the greenhouse effect. According to EPA carbon dioxide comprises as much as 85% of the GHGs released into the atmosphere each year (See figure 1.2).

"Carbon footprint" or GHG emission inventory is the total amount of GHG emission for which an organization is responsible and is expressed in terms of carbon dioxide equivalents (CO_2e) as they relate to global warming potential (GWP). Currently, most companies in the United States do not track their carbon footprint, but this will change with the implementation of new legislation and public education.

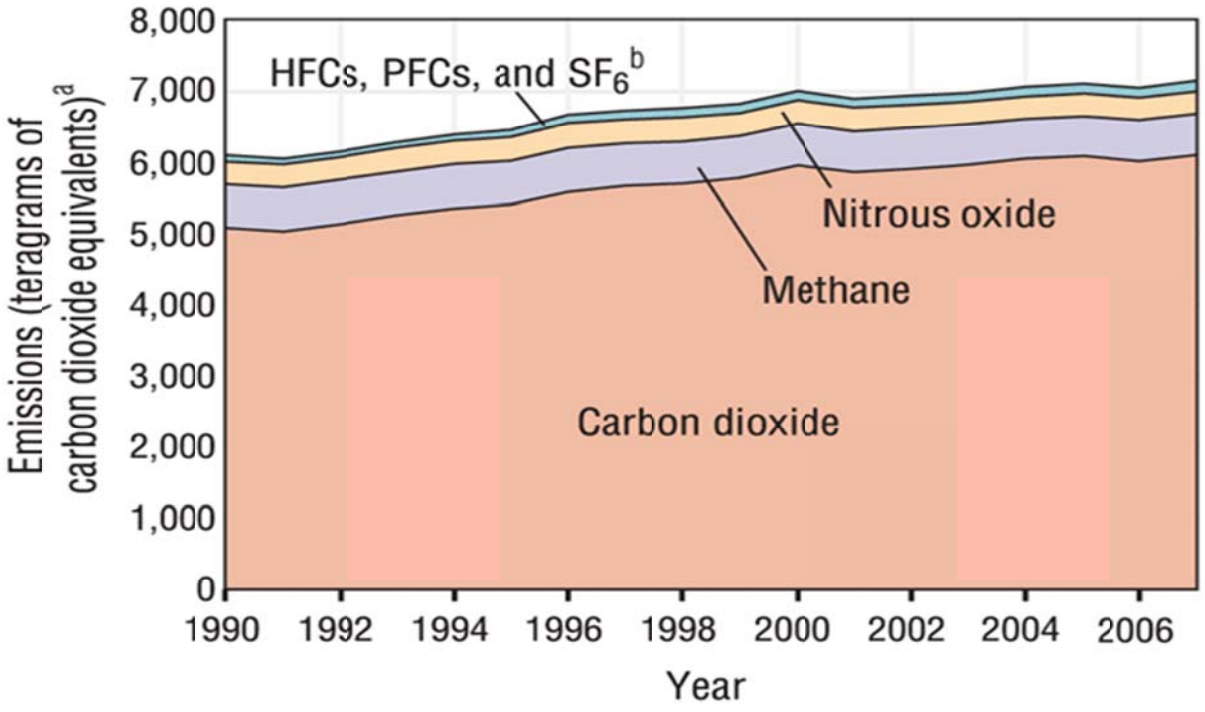

Figure 1.2: GHG Emissions by Gas in the U.S (Source: U.S. Environmental Protection Agency website www.epa.gov).

According to Len Sauers, Vice President Sustainability for Proctor and Gambles (P&G), "The vast majority of consumers (50-75%) feel environmental issues are important" (Wasserman 2008, 49). Today's consumers are extremely aware of GHGs, global warming, and carbon footprint. Many have researched this issue and have formed their own opinion of who is responsible and who should fix the problem. In a recent report from Iowa State University, Associate Director Rich Pirog, consumers were asked

their perception of who was responsible for consumers' carbon footprint, would they be willing to pay more for products that emitted half the GHGs, and who should take the biggest future role in minimizing the carbon footprint of products. The results were 48 percent of the respondents said that manufacturers and processors are responsible for consumers' carbon footprint, while 11 percent said government, and only 3 percent said it was farmers (see Appendix A-1). In the same report when consumers were asked if they would be willing to pay more for products that emitted half the GHGs, 54 percent said that they would be willing to pay the same amount, and 29 percent said that they would be willing to pay 10 percent more (see Appendix A-2). When asked who should take the biggest future role in minimizing the carbon footprint of product, 45 percent of respondents said it should be manufacturers, and processors, while 21 percent said it should be government and only 3 percent said it should be farmers (see Appendix A-3) (Pirog, 2008, 22-24). From these studies it is evident that today's consumer wants the manufacturers to take the first steps in reducing their carbon footprint and thus reducing global warming. Companies that develop and implement climate change strategies now will gain a competitive advantage as the economy adjusts, improve the companies' public image, and enhance corporate social responsibility. Len Sauers also states that "by 2012, P&G plans to cut its carbon footprint by as much as 40%" (Wasserman 2008, 49).

Chapter 2 – Literature Review

Introduction

A literature review was conducted through the EPA web site, Google Scholar, and Wilson Omnifile search engines using the keywords greenhouse gasses, carbon footprint, and dairy manufacturing and its purpose was to find the current and proposed government regulations on GHG emissions, a widely acceptable way to record and trace a company's GHG emissions, and to find energy saving best practices that would pertain to a dairy manufacturing facility infrastructure such as: boilers, refrigeration, lighting, and HVAC.

Current Government Regulations

Global warming and the reduction of carbon dioxide emissions are at the top of the environmental policy agenda today (Weidema 2008, 4). There are no current laws that require food manufacturing companies, in particular the dairy industry, to track and/or report their GHG emissions or company's carbon footprint at this point. The only EPA regulation or rule is the mandatory reporting of greenhouse gasses rule. This rule was prepared in accordance with the FY2008 Consolidated Appropriations Act, which was signed into law in December 2007. EPA issued the rule pursuant to its authority under the Clean Air Act (CAA) (EPA, 2007). The mandatory reporting rule was published in the federal register on October 30, 2009 and thereby the effective date is December 29, 2009. This rule will apply to fossil fuel suppliers, industrial gas suppliers, direct GHG emitters, and manufacturers of vehicles. According to the rule these reporters will begin collecting data on January 1, 2010 and will be required to report their

GHG to EPA on March 31, 2010. There have been no threshold limits or permit requirements by the EPA at this time in regards to this rule.

Proposed Government Regulations

In Kyoto in 1997, the U.S. government agreed that between 2008 and 2012 it would limit average annual emission of GHGs to seven percent below 1990 levels (Fischer 1998, 1). There are currently two theories of how to regulate the GHGs omitted from the U.S., the first theory is a cap and trade system and the second is a government taxation system. The cap and trade system would start by issuing permits to the "upstream" sources (i.e. power plants, steel mills) at the total levels of seven percent below 1990 levels emissions as required by the protocol. Then these GHG producers could buy and sell carbon credits that they need or did not use on the open market. A carbon credit would be equal to one unit of GHG emission or CO_2e. This would let the market fluctuate the price of the carbon credits based on supply and demand. Companies would have to identify, track and report their GHG emissions to a government agency such as EPA who would oversee the permits but just to ensure that companies were properly recording their total GHG emissions inventory and have the proper credits to cover that amount. A government taxation system would still start with a permit that would meet the requirements of seven percent below 1990 levels of GHG emissions and then companies would pay a tax to the government for any GHG emitted over their GHG emissions permit level. This would be a fixed taxation cost per unit of CO_2e or GHG emitted and would be set by the government through legalization. Companies would still have to identify, track and report their GHG emissions to the EPA or another government agency as in the "cap and trade" system but they would also have to pay any additional

fees for violating their permits to the government. These costs would not fluctuate as the government would have a set cost of the taxation rate and could even set different levels of cost the higher the emissions went.

Calculating Carbon Footprints

There are several different widely accepted standards for calculating a company's carbon footprint but for the purpose of this paper I will use the Greenhouse Gas Protocol Corporate Standard (GHG Protocol) to monitor and calculate the amounts of GHG emitted or carbon footprint produced by a company. The GHG Protocol I will also just focus on the production facility and in particular a dairy manufacturing facility's direct emissions but will not include production, packaging materials, or the supply chain. The GHG Protocol establishes organizational boundaries of where the company's responsibilities start and where they end with respect to the carbon footprint that their product or service has on the environment and global warning.

Industry Best Practices

My research did not find any specific best practices related to the milk industry or milk processing facilities but the good practice guide series were found that are intended to provide advice on practical ways of improving the energy efficiency of manufacturing facilities. This series was produced for United Kingdom's Department of the Environment and contains many best practices for a range of topics related to manufacturing facilities, equipment, project management, and employee training. This series did contain best practices in facility light, boiler, HVAC, and refrigeration system in which are common to milk processing facilities.

Chapter 3 – Procedures and Methodology

The top three leading pressures that are compelling companies to have a "green strategy" are corporate social responsibility, corporate advantage, and cost of doing business (Kenney 2008, 50). While these are not the only pressures pushing companies to develop a greener approach to their products they are some of the strongest. Now, let's look at one way a company can produce a road map to a greener future by reducing their carbon footprint. As in any journey a company must first have a vision to where they are going, document where they are currently, and map out the best path to travel between these two points before they get started. This paper will identify the eleven steps to reducing a company's carbon footprint (developing a vision, kick-off, mapping, benchmarking, focus activities, implementing, employee involvement, communicate, celebrate, tracking, and sharing best practice), and introduce some helpful tools to use to keep a company's journey focused while moving in the right direction.

Developing a Vision

Developing a vision for the future and setting a target is the key to starting a company's journey off on the right path. This process has to start at the top with full upper management support and involvement. The United States Dairy Industry has committed to reducing their carbon footprint by 25% by the year 2020 this is according to the Innovation Center for United States Dairy, which represents nearly 70 percent of the dairy supply chain (Unknown, 2009). There has to be a direct buy in and support from the top management to complete this directive. They have to lead the charge and support this process with their words and actions throughout the process. This will motivate the employees to continue to drive the reduction of the company's carbon footprint lower and

lower. Reducing the company's carbon footprint as much as 40 to 50 percent in some cases by the time they are done. To illustrate this process this paper will use examples from a dairy manufacturing facility that we will call the XYZ Company facility. At XYZ Company the top management has set a goal of reducing their carbon footprint by 25% by the year 2020. As most milk manufacturing facilities have a relatively small number of employees (10 to 50 employees) and older facilities, some built in the early 1900's, there is a lot that they can do to improve their carbon footprint if properly motivated. The XYZ Company facility has 45 employees, operates a 24 hour per day 6 day a week operation, the original plant was built in 1936, and has had several additions to the facility since then. The facility is like most other manufacturing facilities they have all of the facility systems that you would find in a typical food manufacturing plant such as facility lighting, ammonia refrigeration, compressed air, boilers, and heating, ventilation and air conditioning (HVAC) systems.

Kick-Off

The kick-off of this process should be a celebration used to get everyone motivated and involved. As in any long trip there must be a proper send off to get thing started on the right foot. Be creative to push the theme of reducing the company's carbon footprint. Use such things as green tee shirts, florescent light bulbs for employee's homes, or grocery recycle bags to get the employee's engaged in the carbon reduction process. This will help get employees involved in management's vision to lower the company's carbon footprint and reinforce the support of the upper management to accomplish this vision. At the start, management must speak of their dedication to this process and how they will support the efforts of the employees as they travel through the

long process of reducing the facilities carbon footprint. Management must also speak of the benefits to both the employees and the company for creating a greener process to produce their products. It is extremely important to get started with a bang and to get a lot of enthusiasm from the employees to make this incentive work. At this stage, employees need to know that this is not just another flavor of the month initiative that management is implementing and that they are serious about seeing this process through to the end. At this kick-off meeting it is best if the upper management speaks to both the group and the individuals personally that make up this effort to reduce their facilities carbon footprint. Don't cut it short and involve as many employees of the plant as possible. In today's manufacturing world most facilities manufacture their products around the clock and this makes it extremely difficult to gather all of the employees in one place at one time. At XYZ Company they had an employee picnic day that involved not only the employees but also their families. Although company picnics are not unique at every company this was XYZ Company's first such event that involved employee's families making it special to this facility. The picnic was held on a Saturday to involve all shifts and had a tremendous turnout. There were games, with "green" prizes, lunch, and the management speech was kept short but individual talks went on throughout the event with key employees. Although it was not mandatory to attend the picnic all employees were encouraged to participate in this activity.

Mapping

Mapping is easy it is just writing down the steps of your process and a short description of what takes place during that step. Start at the beginning of the process and write down each step that the process goes through to complete the production of a

company's product. The easiest way to complete this step is by making a picture that describes the steps to produce the product. A drawing of the facility will come in handy to record the steps that make up the company's process and identify all of the steps that are taken each time that a product is produced. The map may have to be reviewed several times before all of the steps are recorded properly and no steps have been omitted or forgotten. These are usually easy steps that are not normally thought about when completing the process but they are extremely important to include in the map of the company's process. To complete the mapping process use plant layout drawings, equipment layout drawings, piping and instrument drawings (P&ID) as these documents will aid in the recording of the company's process flow. Also use goods receipts such as for packaging, product materials, natural gas, and electricity to develop what the company's inputs are, follow them throughout the process, and also identify all of the output that leave the facility. Get as many different disciplines involved as possible as they tend to have a different view of the process than the other. Start to write down the steps that are taken complete the process that is being map not leaving out any steps no matter how small. Start at the receiving bay doors (beginning of the process) and document every step from that point until the product gets to the shipping bay doors (end of the process) this will provide a great start on the mapping of the process. Also don't forget by products of the process such as trash created by the process, cleaning of the process, and product waste must all be included to gain a complete view of the company's process. This will be a living document as it is always changing and evolving as the company invests in new processes or changes to the current processes. Some examples of these documents are located in appendix B including the XYZ Company

facility drawing (See Appendix B-1) and the XYZ Company facility's equipment inventory (See Appendix B-2). At XYZ Company they used the energy bills such as electric, natural gas and, gasoline as these are a great place to start with identify the related facility carbon footprint for their facility. At most location these bills are especially easy to obtain and will be a great start to find what inputs are for the XYZ Company facility. Started at where these inputs come into the facility and where they go but remember limit the search to just one specific area or it will become overwhelming quickly with steps.

Benchmarking

Benchmarking will start to place a value on each of the steps or inputs that were identified in the previous mapped step. Gather all of the measurements that can be found for the process that will be benchmark again keep it to just one process or a well defined piece of a process. This can include utility bills, supplier's invoices, equipment OEM standards, gage measurements, and individual average measurements that can be taken. Just use the meter readings that are currently in place such as incoming electrical reading and then follow the flow of the input throughout the facility until the process is completed. Benchmarking is how the company can gage a progress and identify the company's best starting point to reduce its carbon footprint. First assign values to all of the points that have been identified on the mapping chart. This paper will use the GHG Protocol to benchmark our carbon footprint and the facility's total yearly utility usage broken down into months (See Appendix B-2). Using these utility bills for the monthly usage rate to start will give us a general sense of monthly usage and trend high usage areas. These bills will only take the benchmarking so far and usage will have to be

broken down further by either installing meters in key locations that can be define as high volume users or using manufacturer's guidelines to what their equipment requires to function properly. These yearly totals are from 7/1/09 to 6/1/10 at the XYZ Company facility and not all of these CO_2e are from the facility.

Scope	Conversion Factor Used	Amount of CO_2e (lbs)
Scope 1 (Natural Gas)	1 Therm = 11.64 lbs CO_2e	6,975,037
Scope 2 (Electricity) (kWh)	1000kWh = 661 lbs CO_2e (Coal-Fired Power Plant)	2,424,760
Scope 3 (Fuel Oil)	1 gallon = 21.5 lbs CO_2e	0
Scope 4 (LP Gas)	1 gallon = 20 lbs CO_2e	0
Scope 5 (Gasoline)	1 gallon = 20 lbs CO_2e	1200
Total		**9,400,997**

Figure 3.1: Total carbon footprint by utility used at the XYZ plant facility calculated by the GHG Protocal.

Remember that these totals include all of the utility usage for the XYZ Company facility and not just the facility itself but it will give a good idea of what the major contributor are to the carbon footprint at the XYZ Company facility. By identify that the largest over all contributors to the XYZ Company carbon footprint is the natural gas usage. Now try to break these totals down into just the ones that relate to the facility. At XYZ Company we also used OEM cut sheets on the facility equipment we have

identified to get a general energy usage on each piece of facility equipment and what the manufacturer says it will use. This is a good start to finding the high usage areas for the facility. When applied this information to the XYZ Company facility equipment and the numbers below were found. (See Figure 3.2, Figure 3.3, and Figure 3.4).

Scope (Electrical)	Conversion Factor Used (Coal-Fired Power Plant)	Amount of CO_2e
Scope 2 (Lighting)	1000kWh = 661 lbs CO_2e	269,418
Scope 2 (HVAC)	1000kWh = 661 lbs CO_2e	43,626
Scope 2 (Refrigeration)	1000kWh = 661 lbs CO_2e	810,737
Total		**1,123,781**

Figure 3.2: Facility electrical breakdown of carbon footprint at the XYZ Company facility.

Scope (Natural Gas)	Conversion Factor Used	Amount of CO_2e
Scope 1 (Steam Heating)	1 Therm = 11.64 lbs CO_2e	1,314
Scope 1 (Facility Cleaning)	1 Therm = 11.64 lbs CO_2e	154,587
Scope 1 (Domestic Hot Water)	1 Threrm = 11.64 lbs CO_2e	978
Total		**156,879**

Figure 3.3: Facility natural gas breakdown of carbon footprint at the XYZ Company facility.

Scope (Gasoline)	Conversion Factor Used	Amount of CO_2e
Scope 5 (Lawn Equipment)	1 gallon = 20 lbs CO_2e	900
Scope 5 (Fire Pump)	1 gallon = 20 lbs CO_2e	300
Total		**1,200**

Figure 3.4: Facility gasoline breakdown of carbon footprint at the XYZ Company facility.

By using these figures it was found that the electrical usage is the XYZ Company's highest usage point for the facility. Remember that these numbers are just estimates and will not help track the improvements in these areas as it will not provide an accurate measurement for that purpose.

Focus Activities

Focus activities in the high usage areas that were identified in the benchmarking part of this process. These are the best place to start to reduce the company's carbon footprint, a good place to start researching is best practices that other facilities have use successfully, and develop quick wins for the company's carbon footprint reduction efforts. The next step is to form a focus improvement team to concentrate on the areas that have been identified in this process and to research industry best practices in this area. XYZ Company did form a focus improvement team that includes management, engineering, production employees, and maintenance. As they identified two key areas to focus activities on and they were the electrical lighting and the freezer/cooler

refrigeration. XYZ Company chose to just focus on the electrical lighting for the facility. The next step was to breakdown the electrical lighting into smaller area to apply the team's focus. In Figure 3.5, there is a breakdown of the electrical lighting usage at the XYZ Company facility into different types of fixtures. When the team completed this step it was clear that the team could look at all of the lighting fixtures in the XYZ Company facility and not be overwhelmed with data. As they researched best practices and found two areas of great success in reducing other company's usage. These fixtures were replaced with energy efficient florescent lighting and the use of motion sensors to control lighting in unoccupied areas location in the XYZ Company facility. Both of these best practices appear to fit perfectly with the operations at the XYZ Company facility.

Current Electrical Lighting	Conversion Factor Used (Coal-Fired Power Plant)	Amount of CO_2e
400 W Metal Halide	1000kWh = 661 lbs CO_2e	154,198
HP Sodium	1000kWh = 661 lbs CO_2e	128,498
T-12 - 4'	1000kWh = 661 lbs CO_2e	23,606
T-12 – 8'	1000kWh = 661 lbs CO_2e	22,606

Figure 3.5: Facility lighting breakdown by fixture of carbon footprint at the XYZ Company facility.

Implement

Implement recommendations from the focus improvement efforts. Start slow and get some easy wins to get the ball rolling. These can be anything that is quick and easy to

complete from steam traps repair, air leaks, or lighting changes anything to get a little momentum going. At XYZ Company facility it was determined that the install of energy efficient lighting, in the form of T-5 high efficient fixture to replace the 400 W metal halide fixtures in the warehouse and freezer/cooler areas. XYZ Company will also install motion sensors for the new light fixture that have been broken into small zones so that if a zone is unoccupied the lights will remain off. In Figure 3.6 and Figure 3.7 are the estimated returns that the team expects to receive by completing these initiatives. It was concluded that XYZ Company could reduce the warehouse lighting carbon footprint by as much as 1/5 by using sensors to control the lighting in the freezer/cooler area. Also identified was the load out and scale areas which were also unoccupied during most of the day.

Current Electrical Lighting	Proposed Electrical Lighting	Current Amount of t CO_2e	Amount of CO_2e Avoided
400 W Metal Halide	T-5 Florescent	154,198	21,784
HP Sodium	T-5 Florescent	128,498	9,149
T-12 - 4’	T-8 Florescent	23,606	3,939
T-12 – 8’	T-8 Florescent	22,606	4,472

Figure 3.6: Facility lighting breakdown by fixture with related avoidance of carbon footprint at the XYZ Company facility.

Current Electrical Lighting	Proposed Electrical Lighting	Current Amount of t CO_2e	Amount of CO_2e Avoided
400 W Metal Halide	Sensors on/off	154,198	30,839
HP Sodium	Sensors on/off	128,498	12,416
T-12 - 4’	Sensors on/off	23,606	0
T-12 – 8’	Sensors on/off	22,606	0

Figure 3.7: Facility lighting breakdown by fixture with related avoidance of carbon footprint at the XYZ Company facility.

Employee Involvement

Employee involvement is extremely important throughout this process. The quickest way to improve is to get everyone involved and always provide feedback to keep them involved. Encourage everyone to participate and submit ideas on energy and carbon reduction ideas. At XYZ Company they have developed an energy team that will continue to identify both new facility opportunities and to expand this process to include other plant processes. XYZ Company has started a suggestion box for ideas from the employees that could save energy, reduce the facility’s carbon footprint and have implemented an energy talk attached to each monthly safety meeting that is held at the plant to keep all of the employees engaged in the carbon reduction initiatives.

Tracking

Tracking will allow the carbon reduction initiative to build momentum for the future. Once the team has identified the areas to target it will have to develop an accurate way to track the improvements. This is where the installation of meters or similar devices will allow you to get a true measurement of what is being used in your focused area. Someone needs to be assigned both to gather the information on a regular schedule and to trend this data for analysis by the team. This information will also allow management to do their part in directing the efforts in the right directions and keep everyone moving in the same direction. When you assign a specific individual to update the information always allow them the time to complete this task because this information is extremely important in the efforts to reach your company's carbon footprint goal. For XYZ Company we have decided to install meters at our warehouse lighting panels and track this area closely as we feel this is the greatest area of improvement. Although we did not install meters at the other locations we continue to track our total electrical usage on a daily bases as this is still the goal of reducing the total carbon footprint by 25%.

Communicate

Communicate throughout this process to all involved or effected by the reduction efforts at the company and post all of the results on a common board that will allow everyone to get involved and participate in the process. This needed to be updated frequently at least once a week if not every day. This will help everyone to have the common targets and help pull everyone together in your efforts to reduce the company's carbon footprint. Encourage all of the employees to look frequently at the information

but make it fun. Ask questions about the information for prizes in plant meetings or quiz employees on the floor for prizes about the information on the boards. This will keep employees engaged in the process and keep the ideas for carbon reduction coming.

Celebrate

Celebrate your plant's progress as it doesn't always take a full blown party just a thanks works at a monthly safety meeting or just results shared to assure employees that this is still an ongoing priority with management. Try to mix it up don't just do the same thing over and over again. Employees tend to get use to pizza parties and they forget the original purpose for the party. Also make sure everyone knows the reason that you are having the party. This would be for hitting a milestone, completion of an improvement installation, or the completion of benchmarking another process.

Sharing Best Practices

Sharing best practices with others in the organization to help them get started and watch the ideas come back with even better ideas from other facilities. Although it is a good idea for the company to develop a best practice form to insure all of the required information is recorded. This will help all the company's facilities to benefit from each other's learning. This is the documentation step that will allow everyone to improve and make the company stronger in the market place.

Chapter 4 – Results and Conclusions

By following the basic eleven steps outlined in this field project any company can reduce their company's carbon footprint, improve their company's perception with their customers, and reduce utility cost in the process. Just remember that this is a never ending, always evolving process, and there is always opportunity to improve. As the public continues to push produces to improve their carbon footprint so will the government bodies that are elected by this same public. The global warming issue will continue to be a hot topic with consumers and this will push legislators into action. In our example at XYZ Company they have lowered the total calculated carbon footprint already be 3.4%, by our estimates as shown in this document, by first identifying our high usage areas then applying some of the industry's best practices to reduce the carbon footprint generation in these areas. As shown above they found that at XYZ Company electrical lighting and refrigeration were the two greatest areas of usage and they choose to attack the electrical lighting by installing new technologies in the form of energy efficient florescent lighting fixture that require less power to produce the same or better lighting and electrical sensor to control the operation of the unoccupied area lighting.

Some next steps for XYZ Company are to continue to monitor and track the lighting areas that they have already applied best practices and to continue to apply best practices to the refrigeration that was also identified to be a high volume usage area. They also need to apply this methodology to the other processes at the XYZ Company plant to continue on our path to meeting their goal of 25% reduction of our carbon footprint by 2020.

Chapter 5 - Suggestions for Additional Work

Some additional work areas that could be explored in this area are production processes (involving manufacturing equipment, production materials, and packaging materials), supply chain (i.e. packaging supplies, logistics (truck traffic), raw product, finished product), share of best practices data bases, and compare different carbon calculation techniques.

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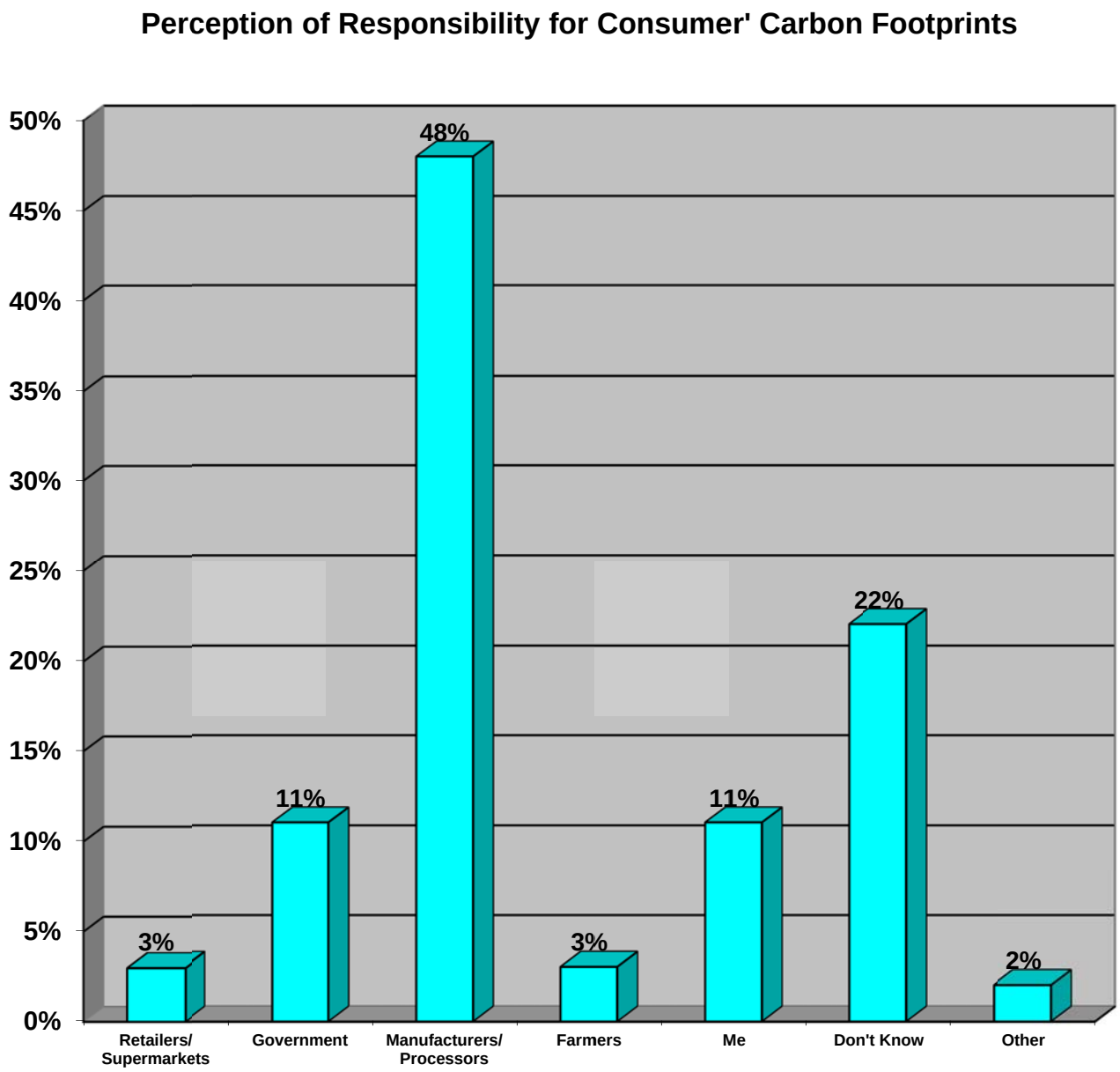
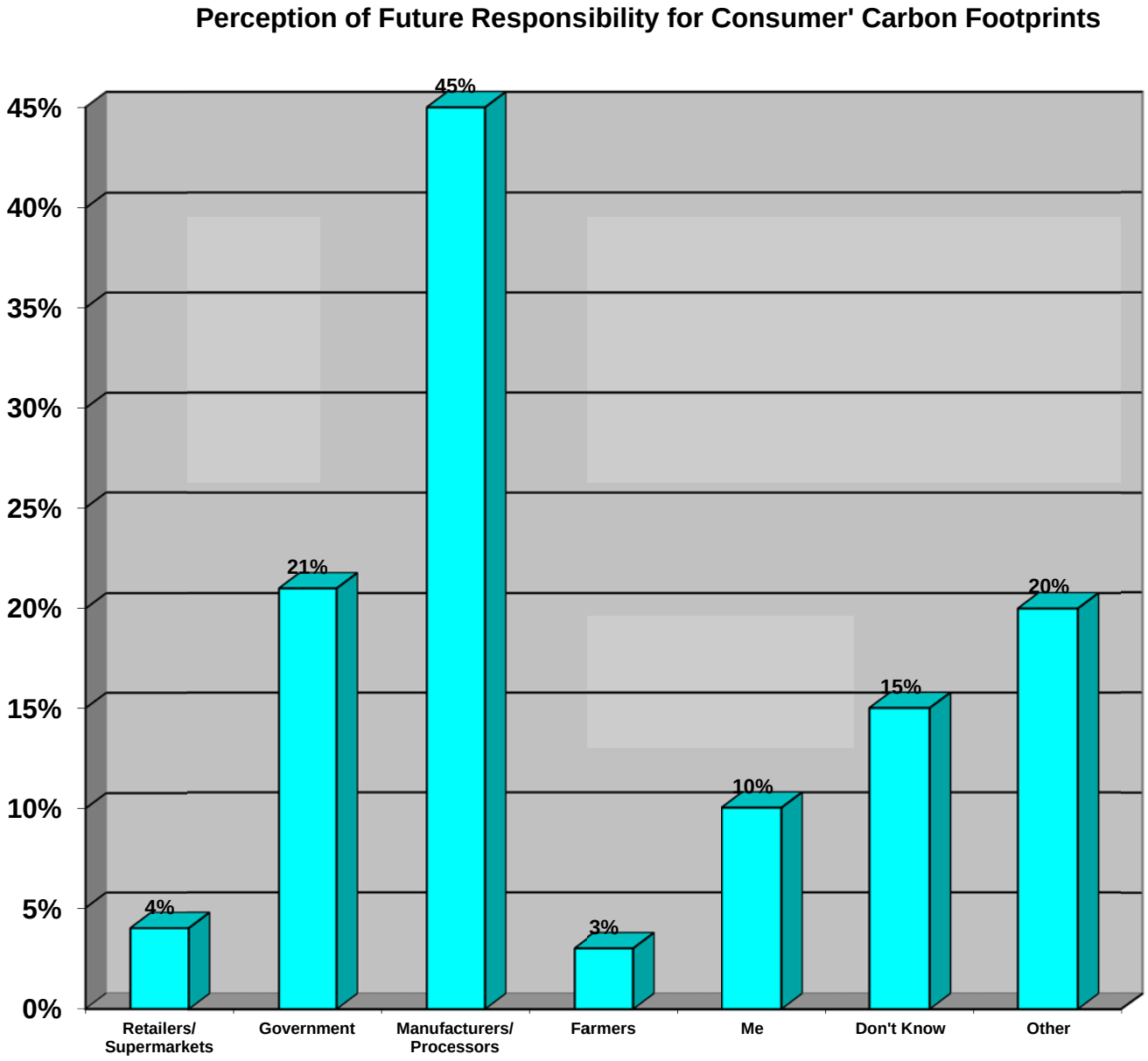
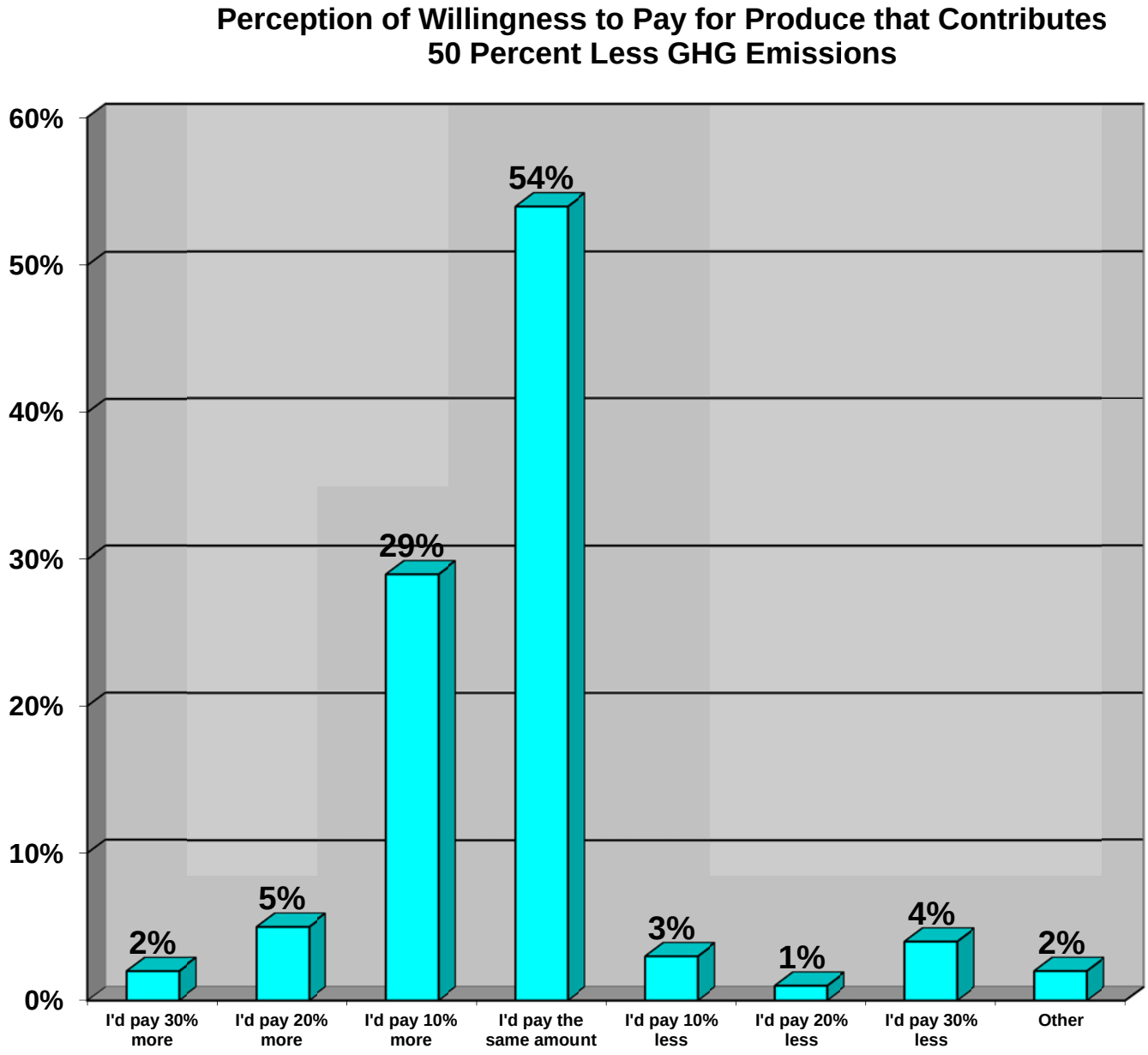
Appendices A



Appendix A-1 (Source: Pirog, R., and Rasmussen, R., 2008, Food, Fuel and the Future: Consumer Perceptions of Local Food, Food Safety and Climate Change in the Context of Rising Prices. September 2008)



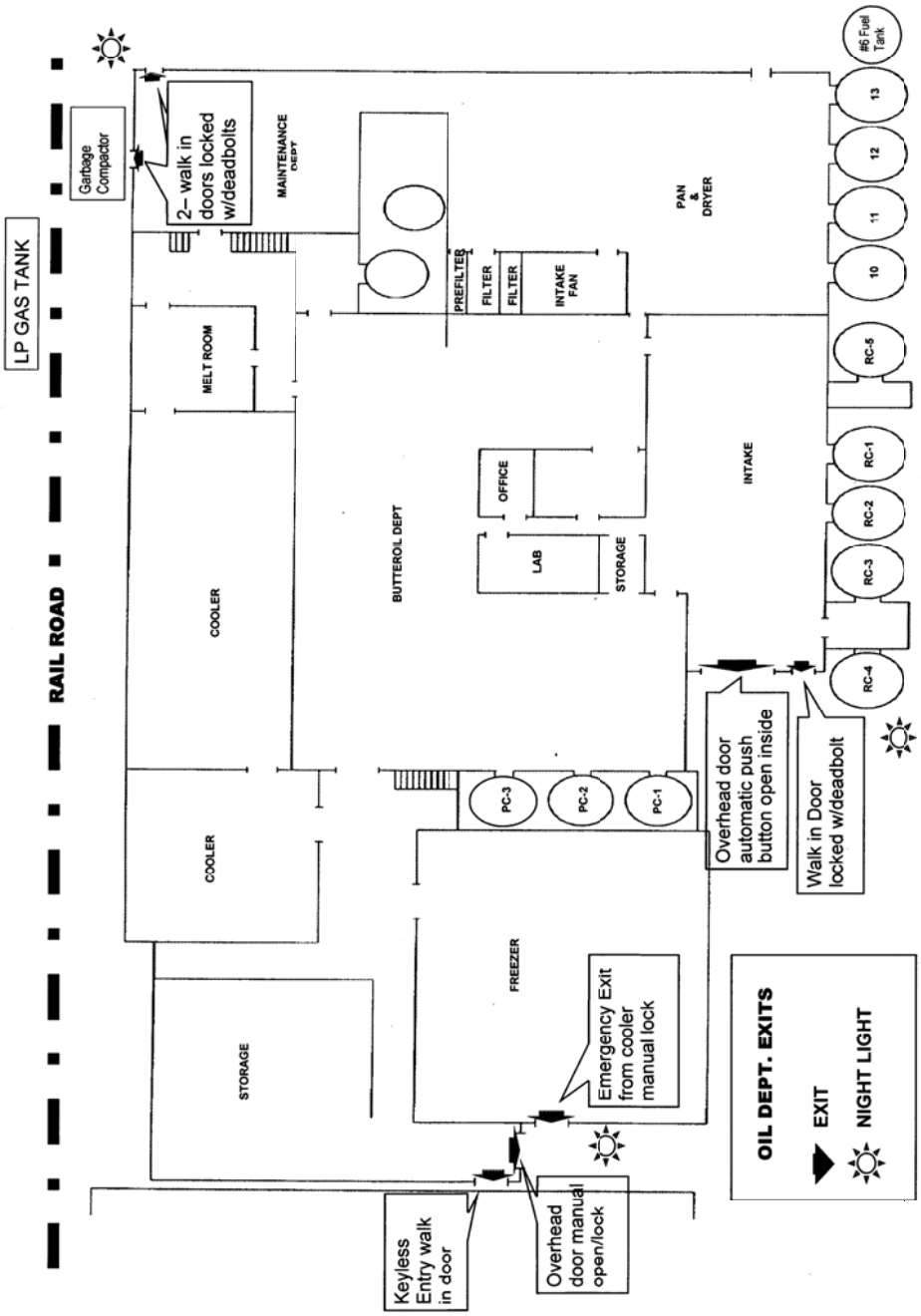
Appendix A-2 (Source: Pirog, R., and Rasmussen, R., 2008, Food, Fuel and the Future: Consumer Perceptions of Local Food, Food Safety and Climate Change in the Context of Rising Prices. September 2008)

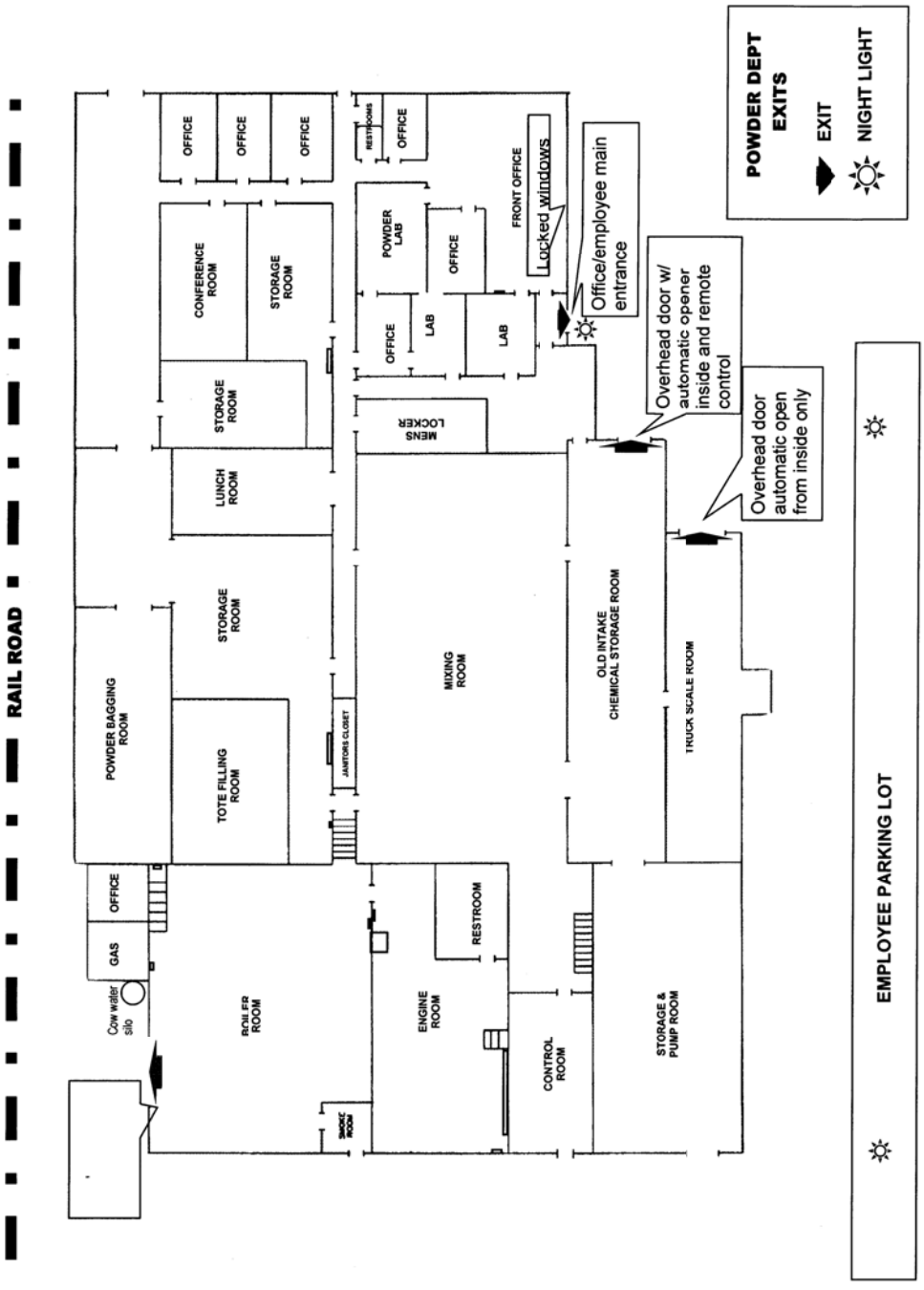


Appendix A-3 (Source: Pirog, R., and Rasmussen, R., 2008, Food, Fuel and the Future: Consumer Perceptions of Local Food, Food Safety and Climate Change in the Context of Rising Prices. September 2008)

Appendices B

Facility Drawing





Appendix B-1 XYZ Company facility drawings

Equipment Inventory

Equipment	Area	Type	# of Units	Energy Used (Est.)
Lighting	Warehouse	400 W Metal Halide	45	129,600
Lighting	Butter/Oil Dept	Florescent (T-12) 8’	25	34,200
Lighting	Cooler/Freezer/Storage	400 W Metal Halide	36	103,680
Lighting	Main Office/Lab	Florescent (T-12) 4’	31	35,712
Lighting	Mix room	HP Sodium	26	140,400
Lighting	Intakes(Old/New)/Scale	HP Sodium	10	54,000
HVAC Unit	Main Office	10 ton Freon	2	24,000
HVAC Unit	Butter/Oil Dept	50 ton Ammonia	1	42,000
Evap Units	Cooler/Freezer	20 Ton Ammonia	6	1,226,532
Steam Heater	Intakes(Old/New)/Scale	Forced Air Steam Coil	7	476
Steam Heater	Butter/Oil Dept	Forced Air Steam Coil	4	272
HVAC Unit	Main Office	10 ton Steam	2	566

Appendix B-2 XYZ Company Facility Equipment Inventory

Cost & Usage Monthly Report

Electric Power (kWh)

Date	Volume	Cost	Unit Cost
7/1/2009	333,920	$ 29,367	$ 0.088
8/1/2009	421,520	$ 42,463	$ 0.101
9/1/2009	302,240	$ 29,927	$ 0.099
10/1/2009	253,120	$ 23,499	$ 0.093
11/1/2009	252,560	$ 20,600	$ 0.082
12/1/2009	244,000	$ 28,048	$ 0.115
1/1/2010	79,040	$ 52,998	$ 0.671
2/1/2010	340,000	$ 32,297	$ 0.095
3/1/2010	271,680	$ 24,462	$ 0.09
4/1/2010	359,040	$ 37,062	$ 0.103
5/1/2010	350,960	$ 42,953	$ 0.122
6/1/2010	460,240	$ 40,296	$ 0.088
Total	**3,668,320**	**$ 403,972**	**$ 0.11**

* All Numbers based on invoices received. Current invoice participation level: 94%.

Natural Gas (MMBtu)

Date	Volume	Cost	Unit Cost
7/1/2009	5,460	$ 22,506	$ 4.122
8/1/2009	5,057	$ 20,640	$ 4.081
9/1/2009	3,463	$ 11,594	$ 3.348
10/1/2009	4,070	$ 18,535	$ 4.554
11/1/2009	5,018	$ 28,440	$ 5.668
12/1/2009	6,880	$ 38,923	$ 5.657
1/1/2010	7,337	$ 48,875	$ 6.661
2/1/2010	4,780	$ 30,676	$ 6.418
3/1/2010	5,107	$ 29,170	$ 5.712
4/1/2010	4,465	$ 20,429	$ 4.575
5/1/2010	4,025	$ 18,640	$ 4.631
6/1/2010	4,262	$ 19,766	$ 4.638
Total	**59,923**	**$ 308,193**	**$ 5.143**

* All Numbers based on invoices received. Current invoice participation level: 96%.

Water (MMgal)			
Date	Volume	Cost	Unit Cost
7/1/2009	4,243	6,138	1.446592034
8/1/2009	5,025	7,300	1.452825871
9/1/2009	4,628	5,905	1.275942092
10/1/2009	4,261	5,888	1.381781272
11/1/2009	4,812	6,545	1.360241064
12/1/2009	4,812	6,667	1.385573566
1/1/2010	5,890	10,543	1.789988115
2/1/2010	4,269	7,520	1.761543687
3/1/2010	4,064	7,651	1.88269439
4/1/2010	5,623	10,166	1.807883692
5/1/2010	4,325	7,618	1.76139422
6/1/2010	4,701	8,368	1.780116996
Total			
LP Gas			
Date	Volume	Cost	Unit Cost
7/1/2009			
8/1/2009			
9/1/2009			
10/1/2009			
11/1/2009			
12/1/2009			
1/1/2010			
2/1/2010			
3/1/2010			
4/1/2010			
5/1/2010			
6/1/2010			
Total			

Fuel Oil			
Date	Volume	Cost	Unit Cost
7/1/2009			
8/1/2009			
9/1/2009			
10/1/2009			
11/1/2009			
12/1/2009			
1/1/2010			
2/1/2010			
3/1/2010			
4/1/2010			
5/1/2010			
6/1/2010			
Total			

Appendix B-3 XYZ Company Utility Usage By Month