UNIVERSITY OF MINNESOTA
CROOKSTON

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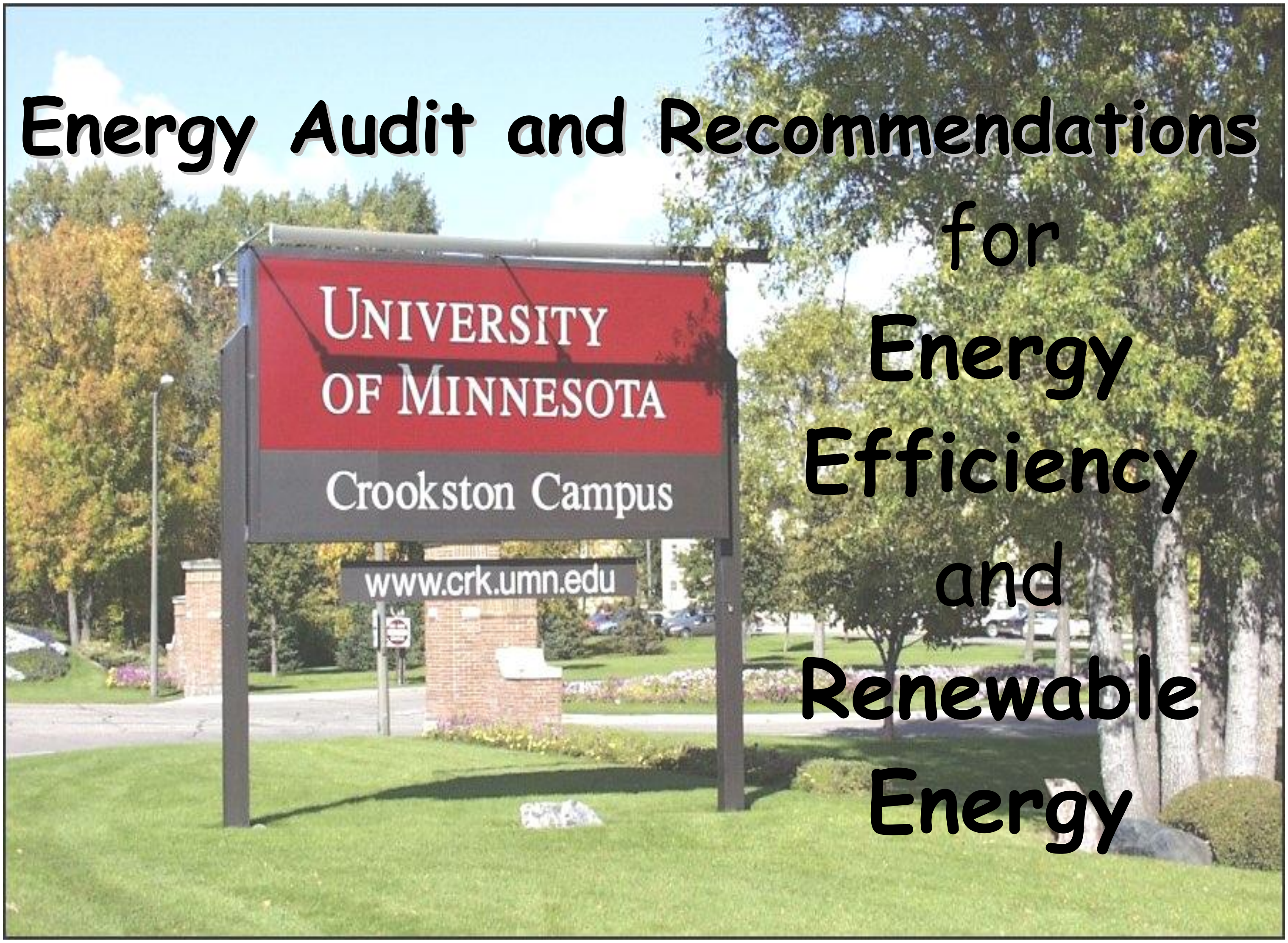
# Energy Audit and Recommendations for Energy Efficiency and Renewable Energy

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***Internship***
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# ACKNOWLEDGEMENTS

Sometimes living in a country different than one's own can be difficult. In Crookston and at UMC I found a second family. I had a great time during this internship, but I also learned more about America people. I did what I have hoped before coming: live like an American, with American people to develop my own point of view about the U. S., and not just take media opinion.

For a long time I wanted to do something to protect the environment. In my point of view, conserving and managing resources of our world is a priority. Sustainability is a way to do it. This internship was a good opportunity to learn a lot. That's why I would like to thank Dr. Dan Svedarsky who was the first to give shape for the project, and also for his extensive support and encouragement with all stages of this project. I would also like to thank Linda Kingery for her important involvement and motivation. Thanks also to Dr. David DeMuth for his interest in this project.

A special thanks to the Extension Service and Heartland Ingredients people who were more than just co-workers. I will never forget time in the break-room! In addition, thanks to all UMC faculty and staff I met who always did their best to help me. Special thanks to Erica White for her help with transportation data and her interest in the project. Thanks to Rand Rasmussen for his tiresome work of correcting my English mistakes. I would also like to thank John Magnusson, Kent Freberg, Tom Mulvaney, and Peggy Sherven for their help with this project. I don't forget Scott Sigette from Ottertail Power Company and people from EERC, at the University of North Dakota, especially Bradley Stevens who were really nice and helpful.

And on the other side of Atlantic Ocean, I would like to thank my parents for their support.

# ABSTRACT

Recently, sustainable development has become more of an important issue at UMC. The development of a **Center for Sustainable Development (CSD)** is evidence of this and will provide an umbrella connection for various campus programs which intersect with economics, environment, and social factors. My project is the beginning of such an overall sustainable view at UMC.

Understanding current and past energy use is how many organizations identify opportunities to improve energy performance and gain financial benefits (Energy Star, 2005). That's what I did for UMC in the first part of the study. UMC spends about $425,000.00 each year (average of the last 4 years) for the campus energy bill (included dorms, and organizations outside of UMC). After the UMC energy overview, I explain how we can understand the energy use and identify opportunities to improve energy efficiency.

I describe the problem at UMC regarding building and energy monitoring. I created "action slips" with suggestions about lighting, heating, and cooling. I then described and analyzed student, faculty, and staff behavior at UMC (except with regard to computer and printer use). I purposed some actions to reduce energy use by increasing awareness, reducing energy from lighting, reducing energy from heating and cooling, and acting with sustainable daily actions.

Because of the importance of computers and printers at UMC, there is a special section focusing on that topic. Managing energy use also means studying UMC transportation. For the moment, UMC does not implement activities to deal with transportation issues. In the last few years, motivations to implement a transportation program are quite varied. The greenhouse effect is a big issue, especially since the Kyoto protocol and oil prices are major problems that prompt people and organizations to think about alternative transportation. First, I define characteristics of UMC, then I describe considerations for

transportation management success and different actions to develop bus lines, vanpooling, carpooling, or biking.

My research not only considers available buildings, but also landscape improvements that could alleviate impacts of adverse environmental conditions. Indeed, a well-designed landscape protects buildings from winter wind and summer sun, modifies the microclimate so it is less of an "energy consumer," and insulates buildings. All of these factors reduce energy consumption. Landscaping also creates a nicer environment and reduces water, pesticides, fuel consumption (less maintenance) and can help to control noise and air pollution. I list the benefits of landscaping and the way to use it. Finally, I provide some information about coal alternative(s). For example, a wind turbine could be a realistic project for the campus.

# FRENCH ABSTRACT

A la suite de mon semestre d'étude dans l'Université de Crookston, Minnesota (USA), j'ai réalisé un stage de trois mois ayant pour thème : « Audit énergétique et recommandations pour l'efficacité énergétique et l'utilisation d'énergies renouvelables à « l'University of Minnesota, Crookston campus ».

Au sein de l'université, un groupe d'enseignants mené par le Docteur Svedarsky (Responsable du pôle ressources naturelles) travaille pour la création d'un centre de développement durable qui verra le jour en octobre 2005. De nombreuses discussions avec ce professeur ont abouti à la création de mon stage en partenariat avec un groupe de travail réunissant des professionnels pour le développement des énergies renouvelables dans le Nord du Minnesota.

Tout d'abord mon travail a consisté à réaliser un état des lieux de la facture énergétique de l'établissement. Sur la base d'exemples portant sur les actions déjà en place dans différentes universités j'ai collecté et analysé des données sur la consommation de charbon (chauffage dans une région sous la neige la moitié de l'année), d'électricité, et de gaz naturel. Collecter les informations nécessaires fut un vrai casse tête malgré la bonne volonté de tout le personnel. En effet j'étais le premier à réaliser un travail de ce type et la majorité des données n'étaient pas disponibles, ou étaient erronées. J'ai cependant réussi à me procurer ces informations auprès des compagnies. J'ai ainsi pu calculé la facture énergétique de l'université (425000$ pour une université d'environ 1200 étudiants) et j'ai estimé la production de $CO^2$ correspondant à cette dépense énergétique (6000 tonnes). Sur cette base il m'a fallu chercher des solutions pour réduire ce coût monétaire et environnemental.

J'ai voulu axer mon rapport sur les bénéfices économiques d'une réduction de la consommation énergétique mais aussi mettre en avant l'aspect environnemental trop souvent masqué par les dollars. J'ai utilisé la production de $CO^2$ comme un « indicateur écologique » et tenter de le rendre moins abstrait (saviez vous que si l'on réduit notre consommation de 7060 kWh par an, cela équivaut à retirer une voiture de la circulation).

Après avoir mis en avant l'intérêt majeur d'une maîtrise énergétique à l'échelle de l'université, j'ai proposé des actions concrètes. Un audit énergétique des bâtiments

s'avérait une priorité. J'ai ainsi contacté divers organismes et amorcé un partenariat avec la compagnie d'électricité. J'ai aussi recommandé de nombreuses actions pour lutter contre les pertes d'énergies constatées et j'ai estimé les bénéfices économiques prévisibles.

Une partie de mon stage a été consacré à un état des lieux des mentalités et pratiques des gens quant à la maîtrise de l'énergie mais aussi au développement durable. Sur cette base j'ai réalisé des fiches proposant des activités à mettre en place pour tenter de modifier les habitudes et faire évoluer les mentalités.

Sur le modèle de l'ESA j'ai aussi fait des propositions pour la mise en place « d'un plan de déplacement ». Cette université située en périphérie d'une petite ville voit chaque matin arriver un flot de voitures à passager unique. Les étudiants, enseignants et employés viennent de 30 kilomètres à la ronde. J'ai ainsi donné des idées chiffrées pour la réalisation de programmes de covoiturage, vanpooling, transports alternatifs.

La partie la plus atypique de mon stage fut la recherche d'informations concernant l'influence de la végétation sur la consommation d'énergie. J'ai réalisé une bibliographie d'une dizaine de pages qui m'a permis de proposer des actions concrètes applicables à l'université, comme la plantation d'arbustes autour des climatiseurs pour améliorer leur efficacité de 10%, ou l'introduction d'un coupe vent fait d'arbres et d'arbustes…

J'ai eu l'occasion de participer à une formation de deux jours sur le thème de la transformation du charbon en énergie, mais aussi de rencontrer des chercheurs et des professionnels en énergies renouvelables. Grâce à ces informations j'ai fait des propositions pour la mise en place d'une éolienne sur le site de l'école.

J'ai réalisé deux présentations : l'une auprès des personnes de l'université, l'autre pour les professionnels de l'énergie.

Déjà les premiers résultats se font sentir. Ce stage a engendré une prise de conscience des bénéfices d'une meilleure gestion énergétique (dans une contexte d'inflation de ces produits). Certaines actions décrites dans le rapport vont ainsi être appliquées à la rentrée.

Fabien POMMIER

Etudiant en 5ème année à l'Ecole Supérieure d'Agriculture d'Angers (ESA)

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# CHAPTER 1: Introduction

Energy? Management? How can these two words be combined, and what are the opportunities of this association?
Walter Simpson, energy officer at the State University of New-York at Buffalo describes in 1996 the issues of energy conservation and efficiency:

> Energy users, including colleges and universities, are primarily interested in energy conservation and efficiency as means of saving money. But of greater significance is the fact that conservation and efficiency mitigate numerous adverse environmental and social impacts associated with energy production and consumption. These include air pollution, acid rain and global warming, oil spills and water pollution, degradation of land and loss of wilderness areas, construction of costly and sometimes dangerous new power plants, and the risk of international conflict and war over energy supplies (State University of New York at Buffalo, 1996).

Mr. Simpson wrote in 1996 “We have already seen the consequences of a full-fledged oil war, following the 1990 Iraqi invasion of Kuwait. Over 100,000 people lost their lives. I believe we should do whatever we can to decrease the chances of future wars involving energy” (State University of New York at Buffalo, 1996). Eight years later, the Iraqi war shows us that energy is an important issue.
Recently an hurricane caused a disaster in the South of the US. The greenhouse effect probably amplify the natural phenomena.

In this context, UMC start a thinking about sustainable development, and energy management.

# CHAPTER 2: Energy management

## 1 Energy management: a part of "Resource Conservation Management"

Washington State University Cooperative Extension Energy Program defines of a Resource Conservation Management (RCM) as "a tool that gives you more control over the operating costs of your facilities. It helps you reduce operating costs, increase efficiency and promote environmentally friendly operations" (Washington State University. 2005).

An RCM program is a coordinated effort to manage the resources and services used by your facilities. It involves careful tracking of resources and attention to operational efficiency. The program focuses on occupant comfort, cost-effectiveness and assuring that equipment is used only when needed. Operational savings are gained through organization, analysis and communication.

With a comprehensive RCM program in place administrators, managers, etc. can expect to see quantifiable results in the first one to six months. Most RCM programs achieve 10 to 15 percent savings on utility bills after the first year depending on the number of facilities involved and level of management commitment.

What are the benefits of an RCM Program?

Resource Conservation Management can offer your organization numerous benefits, both in the short and long term. A successful RCM program will:

⇒ Reduce energy, water and solid waste costs through low- or no-cost measures,

⇒ Track resource use, costs and revenues promptly,

⇒ Stimulate resource efficiency interest among staff and occupants,

⇒ Identify cost-effective and efficient capital projects,

⇒ Demonstrate responsible resource use to the public,

⇒ Leverage human resources.

# 2 Some steps need to be followed…

To achieve results with energy management, a process needs to be applied. The figure 1 is a diagram showing steps for energy management.

This research describes the different steps proposed by Energy Star (2005). For more detail readers can scan the summarized document in Appendix 1.

## 2.1 Commitment to continuous improvement

Successfully improved energy performance is based on regularly assessing energy performance and implementing steps to increase energy efficiency. The common element of successful energy management is commitment.

Establishing the energy program becomes paramount. To realize this purpose an energy team lead by an energy director is necessary. This team will advice the university to institute an energy policy. (Energy Policy Examples in Universities are in Appendix 1). An Energy Policy provides the foundation for successful energy management. A "sustainability and energy efficiency" policy has been adopted in July 2004 by the University of Minnesota Board of regents. "University is committed to incorporating sustainability into its teaching, research, and outreach and the operations that support them". But also the President of the University of Minnesota act with an "Initiative on Environment and Renewable Energy" (See http://www1.umn.edu/pres/01_init_env.html)

## 2.2 Assess performance and energy accounting

Understanding current and past energy use is how many organizations identify opportunities to improve energy performance and gain financial benefits (energy accounting theme is develop in Chapter 3 Part 1). It is really important to read the document Energy Star (2005) for advice about the different steps that need to be followed:

- Data Collection and Management (Gather and Track Data is important because evaluating energy performance requires good information on how, when, and where energy is being used),
- Baselining and Benchmarking,
- Analysis and Evaluation,
- Establish Baselines (Measure energy performance at a specific time to establishe a baseline and provide the starting point for setting goals and evaluating future efforts and overall performance Benchmark),
- Benchmark (Allows you to compare the energy performance of similar facilities or an established level of performance Analyze Data),
- Analyze data (Understand the factors that affect energy performance and identify steps for reducing energy consumption),
- Conduct Technical Assessments & Audits (Periodic assessment of the performance of equipment, processes, and systems will help you identify opportunities for improvement).

This subject will be discussed in the Chapter 3, Part 2.

## 2.3 Set goals and objectives

Well-stated goals guide daily decision-making and are the basis for tracking and measuring progress. Communicating and posting goals can motivate staff to support energy management efforts throughout the organization. To develop effective performance goals we have to:

- Determine scope - Identify organizational and time parameters for goals.
- Estimate potential for improvement - Review baselines, benchmark to determine the potential and order of upgrades, and conduct technical assessments and audits.
- Establish goals - Create and express clear, measurable goals, with target dates, for the entire organization, facilities, and other units.

For each theme of this report, goals are described.

## 2.4 Create Action Plan

An action plan is a roadmap to ensure a systematic process. We have to update regularly this action plan to reflect recent achievements. We determine the gaps between current performance and goals (described by the technical assessments and audits). In the light of the evaluation we establish technical steps that are necessary for upgrading and moving facilities from current performance to the desired level of performance as defined by the goals. Then targets are defined. The targets have to be created for each facility, department, and operation of the organization to track progress towards achieving goals. Also timelines for actions are important (including regular meetings among key personnel to evaluate progress, completion dates, milestones and expected outcomes). Finally to track and monitor the progress of action items, a tracking system should be established.

The plan involves people. An inclusive strategy that establishes roles and actions throughout the organization can help to integrate good energy management practices.

In this report “Action slips” have been develop by theme and sub-theme.

## 2.5 Implement Action Plan

Gaining the support and cooperation of key people at different levels within the organization is an important factor for successful implementation of the action plan in many organizations.

In addition to implementing the technical aspects of your action plan, consider the following:

- Create a communication plan - Develop targeted information for key audiences about your energy management program.
- Raise awareness - Build support all levels of your organization for energy management initiatives and goals.
- Build capacity - Through training, access to information, and transfer of successful practices, procedures, and technologies.
- Motivate - Create incentives that encourage staff
- Track and monitor - Using the tracking system developed as part of the action plan to track and monitor progress regularly.

Actions are described in this report to motivate people, create a communication plan, raise awareness, and build capacity.

## 2.6 Evaluate Progress

Planners need to review both energy use data and the activities of the action plan. The evaluation is used by many organizations to create new actions plans, identify best practices, and set new performance goals.

## 2.7 Recognize Achievements

Providing recognition to those who help the organization achieve the preferred results motivates staff and employees and brings positive exposure to the energy management program. Rewarding particular efforts from the university in the organization sets the example for what constitutes success and helps motivate employees through increased job satisfaction. Recognition can strengthen the morale of everyone involved in energy management. The University can receive acknowledgment from a third party (as Federal and State Government Agencies, Regional energy programs, etc.). The recognition provides satisfaction but also an organization's public image and give a competitive advantage. Some interesting partnerships are referenced in this report (Appendix 1).

# CHAPTER 3: UMC spends around $425000 for energy !

## 1 Energy accounting

Energy accounting, that is a system to record, analyze and report energy consumption and cost on a regular basis, can be one of the most cost-effective tools. California Energy Commission (2000) wrote an interesting document explaining how to do energy accounting (The summary of the document is in Appendix 2). This article states the advantages of energy accounting, how to use it and recommend software programs. Washington State University (2005) also gives advice on their website (Visit the link: http://www.energy.wsu.edu/projects/rem/accounting.cfm). L. Elliott and M. West (2005) from University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS) also explain how to realize an energy accounting.

Because I didn't find a software easy to use and interesting for UMC characteristics, I tried to create an excel file using the base of the Facilities Department energy files. But since so much data is missing. So the first step is to find ways to create these data (such as regular electrical meter reading each month to compare yearly variances. For the moment, facility personel just read meters sometimes every one, two or three months). We also need to have an idea about what method to use: spreadsheet, software, hire a energy accounting services, etc. Data we will collect depends on this decision.

## 2 Coal, Electricity, and Gas…the ingredients for UMC lights, heating, cooling, etc…

I didn't have time to describe with precision UMC energy characteristics. An analysis of the heating and cooling system, and also the power plant should be done. Initially I will describe how to track and gather data, the problems encountered and the future data needed for energy management. Then I will do some observations of UMC energy bill…. I did not follow the guidelines exactly because I did not have the necessary data and time.

## 2.1 Gather and track data to assess energy performance

We have to understand current and past energy use to identify opportunities to improve energy performance and gain financial benefits (Energy Star, 2005. The summary of this document is available in the appendix 3)

To gather data about UMC energy used, I interviewed John Magnuson (Vice-Chancellor of Facilities Department); his associate Michelle Ramstad. Michelle provided data entered into Excel the last 2 years (Example of a month in Appendix 2). Data came from UMC facilities employees who read meters each month. Some problems need to be addressed: meters have a maximum so some of them they go back to 0 frequently, and Michelle isn't sure about this "maximum number" for each of the meters. This program is used to calculate the cost for some UMC organizations but not a UMC department. Thus cost/KWh used isn't totally right. Also because of the snow, or other reasons, the meters do not reading. I also didn't get the coal data from Michelle.

These electrical and gas data are the more precise numbers. UMC can already read the meters for Westside and Lee apartments and already started to try to account the cost. Also I felt a real motivation and need from John Magnuson to manage the energy used.

Then I went to the Business Office. Jana Hodgson is in charge of the energy bills. She gave me all the energy bills for the last 10 years (Example in Appendix 3). These bills are difficult to analyze because during a year there is some pay-back from the company (for coal for example), or some money is given by some other organizations (electrical and gas bills), and the bill month is not available every time. These bills are not generated to manage energy consumption or even the energy cost.

After I tried to gather data in UMC, I asked the energy companies that sell coal, gas and electricity to UMC to send me a precise energy accounting of UMC energy consumption.

All of the companies responded. Ottertail was a really involved partner. Scott Sigette (Energy Management Rep. of Ottertail) came at UMC to bring data and to speak about it. We had a meeting with Dr Svedarsky. All of the interesting information discussed during the time are in different parts of the report. Ottertail provided data for each month (Appendix 5 and summarize on Table 1):

- number of days,
- KWh of consumption,
- KWh of the peak,
- cost.

Scott also explained how they calculate the amount they charge UMC.

> "The consumption component of your bill is based on the amount of electricity, in kilowatt-hours (kWh), that the building consumes during a month. The demand component is the peak demand (in kilowatts) occurring within the month or, for some utilities, during the previous 12 months. Demand charges can range from a few U.S. dollars per kilowatt-month to upwards of $20 per kilowatt-month. Because it can be a considerable percentage of your bill, you should take care to reduce peak demand whenever possible. As you read the following energy cost-management recommendations, keep in mind how each one will affect both your consumption and demand (Ottertail Power Company, 2005).

These peaks must happen between 8 am to 10 am when everybody arrive at UMC and turn on lights, equipment, and computers (those that are turn off during the night!). But a study must be done to describe UMC peaks (Contact Mr. Sigette).

I entered all these data (Appendix 4 and summary on Table 1) and calculate the cost for each month cause by the consumption and the peak! I also calculate some reference number to analyze like:

- KWh / day
- cost/KWh
- Cost/KWh peak
- Cost/KWh conso

I also enter the cost I calculated from UMC business office bills. UMC data are bigger than Ottertail data. I tried to understand and ask Jana Hodgson but I could not figure out the difference! Ottertail and UMC business office data don't correspond as well with UMC facilities Department data.

I received the bill from Great Plain Gas by fax. On the paper I can read the consumption (in dk=MMBtu)/bill, the cost/bill, and the number of the days for the bill (around 31 days). With those numbers we can analyze for each month, and compare between each year the gas consumption. I enter all those data in an Excel file (Appendix 6 and summary on Table 2) and calculate the dk used/day, the cost/day and the cost/dk.

I compared UMC business bill with Great Plain data. They are not the same but close for the first 3 years (for the last year, I probably didn't have all the bill for 2005). However the data are not equivalent (even with Facilities department data). I used UMC business department data to describe coal. (Appendix 7 and summary on Table 3).

I received coal data from Kennecott Company and communicated with Becki Dale (Communication Specialist, External and Government Affairs). They gave me some interesting information, notably about the number of tons they sell to UMC each year and the BTU/lb (indispensable to calculate the CO2 EF). The coal price is about $9/ton and the freight is $20+/ton. Add the freight and coal and you get the delivered price. According to UMC the price is more about $36/ton. I did not receive freight price data from Northern Coal Transportation. That is why I used data from UMC business bills. I did not have time to interview people of UMC power plant. That should be done in the future.

I also collected facility and operational data as suggested by Energy star (2005). I have the building size (from Thomas Feiro Environmental Health & Safety Spec), and years of the construction. Because there was no change, these data were not updated.

Energy Star (2005) describe how to gather and track data, and which data are needed (Appendix 3)

## 2.2 A preliminary analysis

### 2.2.1 Total energy bill

UMC spends about $425,000.00 each year (average of the last 4 years) for the campus energy bill (included dorms, and organizations outside of UMC) (Table 4). It's about $380/student for one year calculating with 1125 students (UMC data). Electricity is the largest energy cost with more than half of the total cost, coal is about 30%, and gas 12% of the bill (Fig. 2)

From a financial point of view the most important decisions must be done to reduce the electrical bill. But managing energy is not just to save money, it also protects the environment.

The figure 3 shows us the difference for the $CO^2$ EF (Emission Factor) for each fuel type. Coal contributes the most to the greenhouse gas (52%). We have to focus on the electrical bill, but also on the coal bill which contributes to the greenhouse effect. Some action to reduce gas consumption must be implemented, too.

### 2.2.2 A look at electrical bill from different angles.

***Yearly examination***

Figure 4 shows that the cost of electricity during the last 4 years was about the same each year. That is good because during the last 4 years the campus added some new buildings, which normally increases costs without a management plan. It is to be noted that we do not have the electrical consumption due to the new student center in these data.

***Monthly examination***

The figure 5 was created to compare each year. The lines for each year demonstrate the same trend, so we probably can study the average year of the 4 years and have a "global idea" of the electrical consumption during the year (Fig. 6). Between months when students are on campus and the "summer months" (Mid May, June, July, August) there is a difference of $10,000-$5,000 (during the summer just faculty and staff are present but utilize air-conditioning). The cost during the school month doesn't vary so much.
It could be interesting to compare these data with the percentage of building occupancy during particular months.

***Proportion of the consumption and demand component***

As Ottertail said the demand component is an important part of the bill (Fig. 7). Reduce this peak means we have to use less electricity in the same time. A would show when these peaks happen, and how we can reduce them. If we reduce the peak utilization to 10,000 KWh/year (inside of an average of 13000/year) (Fig. 8) we can reduce the bill by about $20000. The study must have a level of detail of the month or days, not the year. This study of the year just gives a brief overview.

Just to give an idea of the "environmental benefit" of reducing electrical consumption we use the Environmental Protection Agency number:

- saving 3450 kWh/yr. = 1 acre of trees planted(C02)
- saving 7060 kWh/yr. = 1 car removed from the road(C02)
- saving 11 kWh = 1 gallon of gasoline saved(energy)(2)"

(University of Pennsylvania, 2005)

As a symbolic number: $730 is spent in electricity each day at UMC!

To manage the electrical bill we have to create and gather new data. A meeting between Ottertail Company, the Facilities Department and Dr DeMuth (who can create some equipment to measure data) needs to be done.

### 2.2.3 Gas bill changes during the year

***Yearly examination***

Contrary to the electrical bill, we can observe (Fig. 9) that the cost during the last 4 years increased with a slight decreasing in 2003-2004. The major increase was between 2001-2002 and 2002-2003. I couldn't explain why. We need to study the weather data (Temperature and wind) to do a real interpretation of the data. The increasement could be a consequence of strong winter.

***Monthly examination***

The figure 10 was created just to see if each year is comparable (I didn't have time to realize statistic tests). We can conclude that lines for each year demonstrate the same trend. So we probably can study the average year of the 4 years and have a "global idea" of the gas consumption during the year (Fig. 11).

Between June to September, no gas used. Between October to May we have a parabola with a maximum in January. But in January, UMC usually pays for 35 days. So the comparison with other months is not accurate. The figure 12 represents the average cost/day for each month. We observe another parabola. So actions to reduce gas consumption must focus of months between October to May. The average cost per day due to gas is $110.

### 2.2.4 Few coal data

I only have data for each year, so I didn't study the evolution between years.
The coal bill seems to increase since 2002 after a little decline between 2001 and 2002 (Fig. 13). The cost increased by more than $50000 (33% of the 2004 bill).
Coal is used for heating buildings. Again we have to study the weather data to analyze those data.

After this UMC energy overview I'm going to explain how we can understand the energy use and identify opportunities to improve energy efficiency.

# CHAPTER 4: Technical study : improve buildings and energy monitoring

## 1 Conducting an audit

Two main solutions are possible: an employee from UMC can use documentation, software and complete the audit, or UMC can hire a company.

### 1.1 The first job of the new "UMC energy officer"

The first step of managing energy should be to hire an employee as an energy officer. One of his/her first job will be to realize an energy audit. The appendix 8 references documentations for this purpose. If qualified for the job, it is better to have UMC audit done by a UMC employee because after the audit he will be involve in this problem solving, more than if he read a report! Michigan State University (2000) created a document "development of an energy assessment methodology for university academic buildings with a case study of the Natural Resources building" (Summarize of this document available in Appendix 9).

The main steps for conducting technical assessments and audits are:

**Assemble audit team** - Expertise should cover all energy-using systems, processes, and equipment. Include facility engineers, system specialists, and other support. **Outside support** may be helpful and provide an objective perspective or specific expertise.

**Plan and develop an audit strategy** - Identify and prioritize systems for evaluation, assign team members to tasks, and schedule completion dates for the activities.

**Create audit report** - Based on the audit results, produce a detailed summary of actual steps that can be taken to reduce energy use. The report should recommend actions from simple adjustments in operation to equipment replacement.

Estimates of resource requirements for completing actions should be included.

(Energy Star, 2005)

## 1.2 Hire a professional auditor

There are professional auditing companies that can implement actions. Two systems exist. UMC can pay the company to do an audit in which they give a report suggesting opportunities to save energy. In the other case, audit companies are paid by the money (or a part) they save their customers.

For UMC, a partnership is possible with Ottertail. Actually Ottertail can pay half of the audit cost. According to Mr. Sigette, UMC audit cost could be around $20,000. Before hiring a company for this work, Ottertail needs to give its agreement. Ottertail also can give advice to UMC about companies.

# 2 Upgrade buildings and improve energy monitoring.

## 2.1 New construction

UMC is planning to build a new “dorm building”. Why not build an “Environmental Living & Learning Center” as found Northland College. Northland’s newest dormitory shows how Northland is committed to the environment. The McLean Environmental Living & Learning Center (MELLC), was built in the late 1990s.

On the outside, reporters can expect to see the whirring of a wind tower and blue photovoltaic panels with heat efficient windows. The roof has local cedar slats to serve as exterior protection. A number of the materials used to build the dorm focus on sustainability. Some of these features include; lumber from a sustainably managed forest, recycled paper attic insulation, bio-composite counter surface material made from soy resin and paper, organic-based linoleum flooring, 100% recycled plastic toilet partitions and exterior decking, furniture made from recycled milk jugs, two waterless urinals, and wallboard made from recycled newspaper, gypsum and perlite. The building also contains a two story greenhouse for growing food year round.

Students were involved in the design process of MELLC from the very beginning. Students produced an initial list of desired environmental qualities and this was used as a base by the design team. Students were occasionally asked to determine the most environmentally responsible material between several choices. The end result created a building that exceeds energy efficiency standards by 54 percent (Northland College, 2005).

## 2.2 Improve buildings to reduce energy

I didn’t focus my internship on this part. However I did a brief description of the problem at UMC about building and energy monitoring. After I created “action slips” with propositions about lighting, heating & cooling, I know that slips are not completed and numerous more improvements can be done. That is why I generated a “green library” with some documents about “sustainable building” where interested people can find advices for planning and implementing profitable upgrades that will improve energy performance (and more)of the University (appendix 10).

Building operation and maintenance programs specifically designed to enhance operating efficiency of HVAC and lighting systems can save 5 to 20 percent of the energy bills without significant capital investment according to the U.S. Environmental Protection Agency (EPA Climate Protection Division, 1999). Also the U.S Department of Energy (2005) created a **“**DOE's Building Toolbox offers a comprehensive guide to creating more efficient, affordable buildings. Whether you are building or renovating, the Toolbox provides many guidelines, tools, success stories, and links to guide you through the process of designing, constructing, or renovating high-performance buildings”

### 2.2.1 Lighting

The principal problems are:

- outside lights turn on when not necessary,
- overlighting,
- inefficient light sources.

I am going to describe some ways to solve this problems, and give ideas for further consideration.

## Building and equipment improvements

### *Theme: Lighting*

*Lighting should probably be the first place we look for potential energy savings. Changes are often very easy to make, and many of them cost little or nothing to do. Lighting usually offers 20% to 50% of savings energy dollars.*

*Reduce the amount of electricity may also reduce the peak demand, and achieve additional saving. In addition: less lighting, lower air-conditioning costs.*

*Documents for more information are reference in Appendix 11.*

| | *Objectives* | *Description* |
|---|---|---|
| *UMC actions now…* | **No-costs projects (for more information, see Ottertail (1991) available in UMC green library)** | **Determine how much light is enough?**<br>Most of the time light used is more than needed. It could be really effective take a close look at each area to see what lighting are really needed. For that we can check people's impression, measure the amount of light with a light meter ( ask Ottertail probably). We can compare (See the Society of Illuminating Engineers (IES) Lighting Handbook) and adjust our present lighting level to nationally accepted recommendations. |
| | | **Review outside lighting needs**<br>As explained previously, UMC lose lots of money because of the outside lighting . "You may have lighted parking areas, signs, entrances, walls, and landscaping. You may be able to turn off some of this lighting if you find it is not needed, or use it fewer hours, or use lower wattage lamps." (Ottertail, 1991)<br>I propose to review every timer for outside light and modify it to turn it on only when necessary (Thinking to use more light sensor). |
| | | **Keep lamps and fixtures clean**<br>"Dust, grease, and other dirt accumulations on lamps, lenses, globes, and reflecting surfaces of the fixtures can reduce light output by as much as 30%)" (Ottertail, 1991). |

| | | |
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| | **No costs projects** **(for more information, see Ottertail (1991) available in UMC green library)** | **Remove unneeded lamps: "De-Lamping**<br>Many spaces at the University have too many fixtures in the space and are over-lit. Site surveys will be conducted by a professional illumination consultant in 2004-5 and reduction of the number of light bulbs (de-lamping) will be based on their assessment. Final foot-candle readings for all spaces will be at or above the standards established by the Society of Illuminating Engineers." (Northwestern University, 2004).<br><br>**Removing fluorescents:** remove two of the lamps in the four –lamp fixtures, and see if the remaining standard lamps yield enough light for your needs. |
| | | **Retrofit Exit signs**<br>According to Ottertail (1991, be careful because numbers have probably changed): "Exit signs contain two or more small incandescent lamps which use a total of 20 to 50 watts and last from 2000 to 5000 hours. An exit light burn 8769 hours a year (every time), so a single sign may use from 175 to 438 kWh of electricity per year" (For UMC that's a cost for each sign of $8 to $20.).<br>"In addition, it requires lamp replacement perhaps four times a year, an added expense and maintenance burden."<br>"Compact fluorescent replacements for these incandescent lamps are available that operate at 12 W per sign or less and last two to five times as long as the incandescents. The new exit signs use two to seven watts and can last many years". |
| | | **If actions to change behavior are not efficient**, change all the light switch in restrooms and corridors by automatic switch! |

| | | |
|---|---|---|
| ***UMC actions now…*** | **Low-costs projects(for more information, see Ottertail (1991) available in UMC green library):** | **Install higher efficiency fluorescent lamps to replace standard ones.**<br>**"Lighting Modifications**<br>About half of the space at Northwestern has older, inefficient lighting that could be retrofitted to more efficient lighting technology such as T8 lamps, electronic ballasts, compact fluorescent lamps, and LED technology. Since approximately one-third of annual electrical usage can be attributed to lighting it is important to determine the most effective way to provide the appropriate lighting levels and to determine the interaction of these retrofits with other steps that will be taken (e.g., cogeneration, de-lamping, occupancy sensors, etc.). A consultant analysis has been funded to verify lighting retrofit opportunities and to better define payback (including the determination of the impacts of interactivity with other measures). The study will be completed in 2005" (Northwestern University, 2004).<br>"Use energy-efficient compact fluorescent bulbs-especially in fixtures that operate more than two hours a day. They cost more initially but use 75 percent less electricity and last about ten times longer than incandescent bulbs" (Ottertail, 2005)<br>Otter Tail Power Company offers rebates on high-efficiency electric heating applications. Conditions are:<br>• **Eligible fixtures** include T8 lamps, compact fluorescent fixtures and lamps, efficient HID lighting, induction lighting systems, electronic ballasts, and occupancy sensors.<br>• Rebates for most hard-wired systems are **20¢ per watt saved**.<br>• Screw-in compact fluorescent rebates are **5¢ per watt saved**.<br>• All rebates over $2,500 must be pre-approved. |

**Think about a lighting control system when planning a new premise and improve buildings**

In many cases, substantial savings can be achieved using fully or partly automatic lighting control systems. The cost effectiveness depends heavily on the availability of daylight and on the occupancy pattern of the lit space. A full system would combine one or more of the following sub-systems(Energy Office, 2005):

**Time Control Systems:**

For greatest benefit timed control systems will switch lights off according to a specified schedule, with the occupants using an overriding control to switch lights on. To optimize the use of daylight, those fittings nearest to the windows should also be controlled according to the amount of daylight available.

**Occupancy-linked Control Systems:**

These systems use some form of presence detection, usually ultrasonic, infrared, microwave or acoustic to control luminaires. They usually switch lighting on when occupancy is detected and off again once they have failed to detect an occupant for a set time. Occupancy-linked Control Systems are most appropriate in store areas, corridors and toilets.

**Daylight-linked Control Systems:**

This type of control is based on a series of photocells and can be used to switch lighting off when daylight is adequate. Recent developments have led to the introduction of dimming controllers that maintain a constant lighting level by dimming luminaires to balance the available daylight.

**Localised Switching:**

Localized switching is important where only part of a large space requires the electric lighting to be on, either because the other parts are unoccupied or because certain areas have adequate daylight."

| | | |
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| ***Idea: Action from literature review*** | Maximize effectiveness of light | **"Use light coloured walls and ceilings**<br>Paint the surfaces of the rooms (including the ceiling) with matt colours of high reflectance to maximise the effectiveness of the light output. Light/bright colours can reflect up to 80 % of incident light; dark/deep colours can reflect less than 10 % of incident light."(Energy Office, 2005) |
| | | When setting up a new office think about the light requirements at the beginning of the planning phase and develop an illumination concept to ensure sufficient and satisfactory lighting of the area by maximising the use of daylight in working areas and by taking into account energy efficiency criteria."(Energy Office, 2005) |
| | | **Daylight**<br>When properly designed and effectively integrated with the electric lighting system, daylighting can offer significant energy savings by offsetting a portion of the electric lighting load. A related benefit is the reduction in cooling capacity and use by lowering a significant component of internal gains. In addition to energy savings, daylighting generally improves occupant satisfaction and comfort. Recent studies are implying improvements in productivity and health in daylighted schools and offices. Windows also provide visual relief, a contact with nature, time orientation, the possibility of ventilation, and emergency egress.<br>(U.S Department of Energy, 2005)<br>Info: http://www.eere.energy.gov/buildings/info/design/integratedbuilding/passivedaylighting.html |
| | Policy | **"Centralized Controls**<br>Centralized building controls or building automation systems can be used to automatically turn on, turn off, or dim electric lights around a building. In the morning, the centralized control system can be used to turn on the lights before employees arrive. During the day, a central control system can be used to dim the lights during periods of high power demand. And, at the end of the day, the lights can be turned off automatically. A centralized lighting control system can significantly reduce energy use in buildings where lights are left on when not needed" (U.S Department of Energy, 2005). |

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| | Policy | **Energy-Efficient Equipment Purchases**<br>All University equipment purchases must be Energy Star-rated (or, if there is no Energy Star rating for the desired equipment, individuals are asked to purchase highly efficient equipment). Energy Star is a program helping businesses and individuals protect the environment through superior energy efficiency (for further details please see http://www.energystar.gov). EPA offers a proven strategy for superior energy management with tools and resources to help each step of the way. Based on the successful practices of Energy Star partners, purchasing Energy Star-rated equipment will improve the University's energy and financial performance while distinguishing our institution as an environmental leader.<br><br>(Northwestern University, 2004). |

| Idea: Action from literature review | | |
|---|---|---|
| | Policy | **"Energy efficiency in new construction and renovation projects**<br>**LEED Certification**<br>Northwestern University will use the United States Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system as a standard for the design and construction of new buildings (for further details please see http://www.usgbc.org/leed).<br>All new buildings will be LEED-certified at a minimum; each project will be assessed on an individual basis for further certification at the Silver or Gold levels. The goals of sustainable design include:<br>• Reducing the destruction of natural areas and habitats<br>• Reducing air pollution, water pollution and solid waste<br>• Reducing depletion of finite resources<br>• Healthier and safer indoor environments<br>• Healthier outdoor environments<br>• Occupant satisfaction<br>Major renovations of existing spaces will also meet the LEED certification guidelines."<br>(Northwestern University, 2004). |
| | Policy | **"Campus Energy Management System**<br>All new construction projects and renovation projects (where feasible) will include installation of Direct Digital Control (DDC) systems linked to the Campus Energy Management System for all spaces so that the temperature set-point policy can be applied to a larger percentage of University space over time. (The Campus Energy Management System is a central, computer-based program that allows remote monitoring and adjustment of temperature in individual spaces from a central control point)."(Northwestern University, 2004). |

| | | |
|---|---|---|
| ***Idea: Action from literature review*** | Policy | **"Energy efficiency in new construction and renovation projects**<br>New construction projects (and renovation projects, where applicable) will be designed to provide at least a 20% improvement over energy code requirements where technically feasible and where payback is reasonable."<br>(Northwestern University, 2004). |
| | Lighting purchase | Lighting is an important component of your whole-building design. This Web site http://www.eere.energy.gov/buildings/info/components/lighting/ provides information on available lighting technologies—as well as those that are emerging—to help you select the best lighting products for your building. |
| | | Energy star website must be in the favorite of every staff people: purchase!!<br>.(U.S Department of Energy, 2005). Info: http://www.energystar.gov/index.cfm?fuseaction=find_a_product |
| | Use less energy with more efficient lights. | **"Lighting Modifications**<br>About half of the space at Northwestern has older, inefficient lighting that could be retrofitted to more efficient lighting technology such as T8 lamps, electronic ballasts, compact fluorescent lamps, and LED technology. Since approximately one-third of annual electrical usage can be attributed to lighting it is important to determine the most effective way to provide the appropriate lighting levels and to determine the interaction of these retrofits with other steps that will be taken (e.g., cogeneration, de-lamping, occupancy sensors, etc.). A consultant analysis has been funded to verify lighting retrofit opportunities and to better define payback (including the determination of the impacts of interactivity with other measures). The study will be completed in 2005" (Northwestern University, 2004). |
| | Efficiency | **"Vending Misers: Facts and Issues**<br>Vending Misers are nifty little devices that can be installed on beverage vending machines. Vending machines run very inefficiently. At Tufts, each vending machine costs the University about $380 in electricity costs each year. With a Vending Miser, the electricity consumption can be cut in half. Vending misers cost about $165 and have a pay-back of about 1-2 years" (Tufts Climate Initiative. 2005c) |

## 2.3 HVAC (heating, ventilating, and air-conditioning)

HVAC (heating, ventilating, and air-conditioning) refers to the equipment, distribution network, and terminals that provide either collectively or individually the heating, ventilating, or air-conditioning processes to a building. HVAC systems provide heating, cooling, air handling, ventilation, and air quality

HVAC accounts for 40% to 60% of the energy used in U.S. commercial and residential buildings. This represents an opportunity for energy savings using proven technologies and design concepts" (U.S Department of Energy, 2005). According to SULIS (2005), "In Minnesota and other northern states, people usually spend about ten times more for heating than for cooling, even if homes have air conditioning, but energy savings in all seasons should be considered."

## Building and equipment improvements

***Theme: Building…***

***Sub theme: HVAC (heating, ventilating, and air-conditioning)***

It’s possible to save 30% or even more on the HVAC energy bills. Think that HVAC/Envelope building/Lighting are in relation: when you make your lighting more efficient, the air conditioning loads will be less, when you tighten the building envelope, heating and air conditioning loads will decrease. (Ottertail, 1991)

| | ***Objectives*** | ***Description*** |
|---|---|---|
| ***UMC actions now…*** | Run it less | **For heating, set thermostats lower**<br>“During the heating season, keeping the temperature a little lower can really pay. Your savings will depend on how much you lower the thermostat setting and how cold the climate is. Make the temperature change gradually, say 1degre lower every week, so people have time to adjust-and check to see if they are comfortable” (Ottertail, 1991). Experiment to see how low a setting is still comfortable. In Crookston we are in an area with a normal number of heating degree days per year of 9000. According to the figure 14 at UMC we can save 6% of the heating energy if thermostat setting is reduced by 3degre (11% and 15% if reduce by 5 and 7 degrees respectively). Let’s calculate that we reduce from 6% the UMC coal bill, we would about $10000 in 2004! |
| | | Reducing heating and cooling temperature must be writen down like a strong policy. Northwestern University (2004) is an example: **“Temperature Policy-Set Points**<br>Indoor temperature settings in all spaces controlled by the University's energy management system will be standardized to a range of 68° - 71° F during the heating season and a range of 73° - 76° F during the cooling season. Occupants who control the temperatures in their spaces are expected to follow this policy by using these ranges” |

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| ***UMC actions now…*** | Run it less | **"For cooling, set thermostats higher**<br>Research indicates that energy savings are even greater, per degree, for raising air conditioner thermostat settings than for reducing heating levels. As with changes in your heating system thermostats, make the temperature change gradually. Once again experiment to see how high the settings can be without causing undue discomfort" (Ottertail, 1991). |
| | | **Thinking:**<br>Could not people have be a bite warm during the summer, or couldn't there wear a sweat during the winter?<br>**I like Walter Simpson point of view:**<br>He "does not shy away from suggesting that the heat or the fan needs to be turned down or off. Nor does he believe that "conservation" is a dirty word because it may imply some sacrifice. Instead he claims that in many cases what is being "sacrificed" by conservation is an overextension of comfort. Simpson cautions, how-ever, that while a little sacrifice is good, too much is bad. Once a conservation measure is truly causing discomfort then it becomes detrimental both to the productivity of building occupants and the support of the conservation program. Through this orientation Simpson has been able to tap the synergies between technological efficiency and conservation driven by behavioral change. (State University of New York at Buffalo, 1996) |

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| ***UMC actions now…*** | Turn it off when not needed | **Eliminate unnecessary use of HVAC system during unoccupied hours**<br>Contrary to what we can often heard:<br>"it does save energy dollars to turn off the HVAC system and let a building cool down or heat up during off-hours, and then restore it to the desired temperature some time later" (Ottertail, 1991).<br>At UMC we may be using energy to heat, cool, or freshen the air when nobody is there to benefits (at night or on weekends).<br>Your present temperature controls can be operated manually by a person who has been given the responsibility for seeing that is done every day. If you feel this may not be reliable method, you can have a programmable thermostat or seven-day timer installed that will turn the system, or some part of it, on and off automatically. Also energy is used to run the circulating fans and pumps, so the ventilation system should be shut down when the building will be unoccupied (unless health code provisions require round the clock)" (Ottertail, 1991).<br>For heating, a 14 hour night setback (can adjust the thermostat settings a half hour before occupants leave, the building will stay warm or cool for some time) and full week end setback, from 65degree to 55degree day area, would result at UMC in energy savings of 11%.<br>"Michigan Tech University estimates that turning off ventilation and reducing heating by 10oF for 8 hours per day, when buildings are mostly unoccupied, would reduce energy costs by more than 10%, saving $35,000 in a typical 100,000 square foot building" (Bradof, K and Stoneberg, M., 2005). |
| | Make it more efficient | Simpler maintenance jobs can make HVAC more efficient: check thermostats (make sure that the thermostats give true readings). |
| ***Idea*** | More…<br>roofs colored | "Architects and designers have long known that light-colored building roofs can reduce cooling needs. Recently, monitoring studies in Florida have made an effort to quantify these savings. Experiments in existing residences have shown that a white reflective roof can reduce cooling requirements by an average of 20%. However, until now there has been no investigation in Florida's climate to examine the potential in commercial scale buildings. (Parker D. et al. 1996)" |

# CHAPTER 5: Campus behavior

"Campus Energy Manager (from Michigan Tech University) has identified potential savings of 12.8%, or $107 per student ($619,000 total), simply from minimizing wasted resources, such as lights and computers left on when not in use. This waste minimization requires no initial financial investment, only awareness and cooperation throughout the campus community" (Bradof, K and Stoneberg, M. 2005).

The idea for Crookston is the same. Without important investment, but only with the will of everyone in UMC guided by a strong UMC policy, UMC can save 745,068.8 KWh (12.8% of the electrical bill), that correspond to $35,850 on the electricity bill. But we will also discuss about action to reduce heating and cooling energy, gas, water and papers.

In the first part we will describe and analyze students, and Faculty/Staff behavior from UMC (except computer and printer). Then we will purpose some actions to reduce energy use by:

- increasing awareness
- reducing energy from lighting
- reducing energy from heating and cooling
- acting with sustainable daily actions

Because of the importance of computers and printers at UMC, we did a special part focus on it.

# 1 A change in UMC students, faculty and staff behavior would make a difference

## 1.1 Students

### 1.1.1 Limited awareness about energy saving in most of the dorms.

During the spring semester I stayed in Lee Apartment. I lived with three other American students. I'm going to list some behavior that caught my attention: (It's not a generality!)
- The stereo played throughout the day and turned off at night.
- Some lights in the living are on during the night
- Computers are still running during the night
- During warm days air-conditioners are running all the day long without management.
- No awareness about energy cost, saving,… "They don't pay the bill, so they don't care!"

I can just do some observation about non sustainable practices:
- Start car a long time before using it during the winter (for heating), and sometimes during summer (for cooling).
- Cook twice much food than needed
- See printers, transportation, computer study

### 1.1.2 Students' behavior at the university

I think that only a few people have the reflex "light turn off when nobody need it"! That's why we can see so many lights still working during the night, and even during the week-end.

### 1.1.3 Their point of view about sustainability

A survey about "students' point of view about sustainability" could be implemented. Or some questions could be introduced in a transportation survey!

I did not notice much awareness in a part of the student population about sustainability. UMC, despite its Natural resources majors, does not have an environmental student association.

## 1.2 Faculty and staff

Before documentating faculty and staff behavior at UMC a important point needs to be written. UMC, like every university is divided in departments. Each department has a budget…but the energy bill isn't paid by the department. That means that departments are not concerned by energy costs!

### 1.2.1 In the "break room"

Almost each department has a break room or at least a place with a coffee maker and microwave. This room is used no more than 2 hours a day but can have lights turned on between the morning when the first employee arrives and the night when the last employee is leaving. Some of the equipments works all the day long. The most important example is the coffee maker.
A quick calculation shows how much electricity a coffee maker uses. The table 5 shows us the cost lost if we let the coffee maker turn on during the entire day to keep coffee warm. Refrigerators also need a particular attention to conserve energy, such as a good management.

### 1.2.2 In their office

The most important energy change concerns computer and printer continued use.
At UMC there is different way to run air-conditioning and heating. In some buildings people can change the temperatures, in the others they can not.
Most of the time when people modify the temperature, they do not really follow the good practice. That is why sometimes you can see the heat really high and a window open!
Lighting is an important problem. People can leave their office for lunch or a meeting and keep the light on.

### 1.2.3 Faculty: Sustainable development: program in the class.

I just stayed one semester at UMC so can not do some global observation about UMC teaching policy. However I will offer some observations:

- There are no "sustainable agriculture" classes at UMC. The world is changing, classes need to do the same.
- Except in Natural Resources classes, students never hear about "sustainability"

### 1.2.4 Staff: a philosophy for each day!

UMC Staff have a really important role to play in the "energy efficiency" and "sustainability" programs. Actually the people are in charge of lots of purchases, buildings, landscape and food for example. If they do their job with a sustainable state of mind many improvements can be done.

## 1.3 Important places…

### 1.3.1 Campus

When I walk in the campus during the night or week –end, I feel bad. So much light in corridors and offices are still working! Almost nobody turn off lights in corridors!

### 1.3.2 Dining room

Sustainability for me isn't "you eat as you can", but more "you eat what you need". And that's the biggest problem in UMC's dining room. People pay about 6-7 dollars for a meal. We can eat as much as they want.

The policy tries to limit food waste. The first passage to take food, students can have only one piece of meat. But students can go again and again to take what they want and sometimes not what they need.

I am going to list some aspects that need consideration :

- There is a waste of food because people want to eat what they pay.
- People say the price is too much, that's why some prefer go to eat outside. So they use a car and consume gas.
- For people wanting to eat in an other place, they receive food in polystyrene boxes.
- Often people use more than 2 glasses.
- Everytime people go to take some food, they have to use a new plate. That means more plates need to be clean, using more water and energy. The reason for this practice being santitation.

### 1.3.3 Library

Lots of computers are available for students. I don't know if all the computers are turned off for the night!

# 2 Actions to change behavior

| Change BEHAVIOR ACTION PLAN | | |
|---|---|---|
| ***Theme: Change BEHAVIOR…*** | | |
| **2.1 Sub-theme: Awareness** | | |
| ***Main goal:*** Our main goal is to raise awareness of energy saving, and to promote sustainability and awareness of global environmental issues. We have a long way to go in order for UMC to meet its goal of becoming "An environmental university." A large number of universities around U.S.A and the world already have university-supported energy saving and sustainability programs in place. | | |
| ***Communication based on***: "Lighting, heating, cooling, car, etc. use energy. This energy is a cost for UMC, so directly or indirectly also for student and for the planet. Daily actions can significantly reduce this energy cost. Everyone must think "energy saving"!!! | | |
| ***Hoped Impact*** | ***Objectives*** | ***Description*** |
| +++++ | UMC partnership | Become an EPA Energy Star partner (Bradof, K and Stoneberg, M., 2005)<br>Sign Talloires declaration (University Leaders for a Sustainable Future, 2005)<br>Participate at the Campus ecological organize by National Wildlife Federation (2005),<br>(see links in the resources cited part) |
| ++++ | UMC policy | **Adopt an official University energy policy**<br>We "encourage the University to adopt an official energy policy to encourage more efficient practices among students, faculty, and staff. Leadership from the administration sends a far stronger message to the University community than any recommendations" (Bradof, K and Stoneberg, M., 2005) we did. Links to good examples of environmental policies endorsed by upper-level administration can be found in Appendix . |

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| ++++ | Increase people awareness with communication | Develop an Educational Campaign<br>We can develop an upbeat campus educational campaign on a theme such as "Going Green to Save Green" to emphasize how individuals practicing conservation can save the University money, with the savings funding energy efficiency equipment and programs. This campaign will have many benefits, such as increasing environmental education on campus and enhancing UMC's environmental credibility (Bradof, K and Stoneberg, M., 2005)<br>We can create our own UMC energy awareness campaign. For that use the CD of the U.S Department of Energy: You have the power. (CD available in the energy library). The Office of Energy Efficiency Canada (2004) developed a guide "Saving Money Through Energy Efficiency: A Guide to Implementing an Energy Efficiency Awareness Program" available online (http://www.oee.nrcan.gc.ca/publications). |
| | | Develop a website explaining all the good practices, UMC data, etc. (See appendix 12 about University Website) |
| ++ | Rewarded people that are "good" | Several of benchmark institutions excel in involving the campus community in various competitions designed to increase participation in energy saving. Three activities can be created:<br>**a.** Energy Awards on campus→ for the most energy saving department, room in the dorms, …<br>**b.** Investigate intercampus activities such as "Ecolympics" and similar programs that involve students in competition→ create competition for students<br>**c.** Institute intra-campus competitions related to environmental activities, such as recycling challenges between dorms, fraternities and sororities, etc.<br>(Bradof, K and Stoneberg, M., 2005) |

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| +++++ | Energy manager and energy team creation | Bradof, K and Stoneberg, M. (2005) advice that "Committees and environmental coordinators are often vital for implementing energy conservation strategies. At Carnegie-Mellon, an Environmental Practices Task Force submitted a draft Environmental Practices Policy to the Administration in 1997, after which a Green Practices Committee (faculty, staff, and students) was established in 1998 to develop a more comprehensive waste reduction and energy conservation program. Carnegie-Mellon hired a full-time staff environmental coordinator in 2000, in addition to a staff energy manager. At Rennselaer Polytechnic University, the Greening of Rensselaer Initiative employs both a Greening Coordinator and an Energy & Water Conservation Coordinator (full-time student co-op positions). The University Committee for a Sustainable Campus (UCSC) at Michigan State University has a director of the Office of Campus Sustainability, who is leading a new course in fall 2002, "Topics in Sustainability: Walking the Talk at the University We Call Home." This course will begin to conduct a campus environmental assessment. UCSC and Physical Plant staff have already prepared a report, "Development of an Energy Assessment Methodology for University Academic Buildings: Case Study of the Natural Resources Building, Michigan State University." |
| ++ | Thinking Energy efficiency | Each day on a board in the main entrance of UMC write an advice, or a number, or… something that can shock people!!! |
| ++++ | Increase awareness of students | Each dorm must pay his electrical consumption. Now just Westside apartment has different meter for each room. So in this place this measure can be executed quickly (next semester). |
| | Increase involvement of students | Help for the creation of a "environmental association" at UMC. In Appendix 13 Environmental Students Association are listed. |

| | | |
|---|---|---|
| +++++ | Increase awareness of teachers | As said before, it's really important that each department pay his electricity, and other energy bills.<br>We can purchase some Kill-a-Watt© Watt-Hour meters. "These meters are low-cost, portable watt-hour meters that plug directly into a<br>wall outlet, and measure the watt-hours consumed by appliances plugged into the watt-meter. 20<br>watt-meters per commons is based on the need for 3-4 watt meters (one per each outlet) to<br>measure the total electricity consumption of a typical student room" or office (Middlebury College, 2003). |
| +++ | | For the first meeting of the year in each department have an energy speakers (form UMC) or movie that explain the good practices and UMC data. |
| ++ | | **Allen A (1999) from Tulane University relate a story:**<br>One day he asked a Tulane University teacher: "Are you an environmentalist?"<br>"He laughed at me, profusely denying any such thing. Surely he though that I - with my long hair - was one of those "crazy tree-hugging environmentalists." But I jovially prodded him a little more: "Well, don't you recycle or carpool or . . . ?" "Of course I do!" he cut me off. What kind of guy did I think he was? He continued, matter-of-factly: "I reuse all my envelopes for sending non-professional letters; I recycle everything; I work in my office with the lights out and the blinds up; I print on both sides of the paper, even when using my computer printer. . . ." I replied, "So you are an enviro?" He thought for a moment. Then he exclaimed, "Oh no! They've incorporated me! I don't believe it!"<br>This professor was "incorporated" from the continual barrage of education by students and staff at Tufts. Environmental responsibility became part of the institutional culture; everyone else was doing it, and despite not being an environmentalist, he just went along with the way things were and never thought about it - until I prodded him. " Let's incorporated UMC faculty and staff in a Green thinking! |

| Sub-theme: Awareness by education | | |
|---|---|---|
| **Main goal:** Create a UMC educational policy about sustainability. | | |
| +++++ | UMC sustainable university | **Do a "UMC sustainable year".**<br>During one year, all illustrations, projects and practice cases use in Class must when they can use a sustainable example.<br>Implement actions purpose in this report during classes. Examples:<br>- Communication to influence people to use carpooling, vanpooling: realize this project during a marketing class and implement it,<br>- Landscaping to save energy. Use a part of the literature review from this report and during a landscaping/horticultural class find the best place and species for UMC,<br>- Infrared study of the building to find energy lose: understand how this equipment is working and use it at UMC,<br>- Create a video to diffuse in each class in the beginning of the year to explain "energy challenge at UMC: video class! (Appendix 14)<br>In appendix 15 you can find links to universities or organizations give resources for teaching energy and sustainability.<br>Already a first contact has been done with the EERC to see for a partnership. Contact: Chris J. Zygarlicke (deputy Associate director). |

| | | |
|---|---|---|
| ++++ | A place to "give" the knowledge | Baltensperger, B and Culver, S and Stoneberg, M. (2005) from Michigan Tech University purpose the creation of a "**Environmental Education Center to increase awareness:**<br>"Sustainable programs for environmental awareness require some university resource commitments.<br>We propose creation of the position of Environmental Coordinator and the establishment of a Center for Environmental Education. The center and coordinator would take the lead in developing programs with major, lasting impact, such as student environmental internships; an ongoing environmental and energy speaker series; coordination of course development; production of newsletters; maintenance of the web site; and innovative ventures such as working with the Enterprise program."<br>This proposition will be done with the creation of the "center for sustainability". |
| +++ | Training students that are going to educate the other students | Tufts University created a internship/class to educate Eco-Representants:<br>"They learn about environmental issues and organize environmental actions in their dorms and around campus. The program is held each fall semester and students receive $150 stipends if they successfully complete the program. The goal of the Eco-Reps program is for students to learn how their lifestyle effects the environment and engage them in on campus environmental activities. The program helps increase overall student awareness of environmental actions and ways to affect individual change on campus" (2005b) |
| | | Harward University created the REP: "A unique peer environmental education program, the FAS Resource Efficiency Program (REP) relies on paid student representatives who share information with their dorms about sustainability, comfort, health, and efficiency issues. The Reps also provide suggestions to Harvard administrators about infrastructure and policy improvements that will remove barriers to student conservation. And, we have a lot of fun!"<br>More information available on http://www.greencampus.harvard.edu/rep/ |

| Change BEHAVIOR ACTION PLAN | | | |
|---|---|---|---|
| ***Theme: Change BEHAVIOR…*** | | | |
| **2.2 Sub-theme: Lighting** | | | |
| ***Communication based on*:** “Lighting is a large category of energy use. Just three fluorescent lights left on continuously for a year costs Carnegie-Mellon $175, but turning lights off when leaving for the day reduces that cost to $46/yr” (Bradof, K and Stoneberg, M., 2005). | | | |
| | ***Hoped Impact*** | ***Objectives*** | ***Description*** |
| ***Communication*** | +++ | Explain people how to reduce energy for lighting + increasing people awareness | Create or find a paper sheet with suggestions to save energy with lighting. (See appendix ) Stocking this information in the reference place, and e-mail it. |
| | | | Providing information on UMC’s website. |
| | | | Including an article in UMC newsletter. |
| | | | Do an exposition about paper waste and deforestation. |

| | | | |
|---|---|---|---|
| | ++++ | Communication with campaign | Create a campaign or use an existing one.<br>The energy office (2005) created 3 campaigns that can be used. For lighting these 2 can be implement:<br>• *"More Action! Less Power!" (Appendix 16 )*<br>• *"Round Table for Organizational Measures"*<br>*Addressed to: Those responsible for building maintenance*<br>*Theme: Saving power and heat energy through organizational measures*<br>For each campaign they give materials and principle of actions!<br>One of the main actions will be to put posters next to lighting switch. Stickers or posters reminding employees to switch off the light before they leave the room are simple and cost-effective measures to increase awareness. Actually some people think they are not "allowed" to turn off light in restrooms or corridors for example! |
| | +++++ | Hire someone to shut down lights and reduce consumption. | In Michigan Tech University they "hired a student to shut off lights each night in seven buildings and asked employees, through a series of articles in" the university's newspaper, "to shut off lights and other electrical devices when not in use. […] They saved 52% of the wasted energy identified in the survey" (Bradof, K and Stoneberg, M., 2005)<br>I did a quick account of the light left on Saturday, July 9th. Just with the corridors and restrooms I accounted 134 neon tubes and 91 bulb lights. And that's just in the main buildings!<br>I purpose to use about the same action at UMC. Every night a person do a round in UMC building and turn off lights in office, corridors, and classrooms. Maybe this person can be the security man. This round must also be done Friday night, and before breaks. |
| | ++ | Change lights for desks | Michigan Tech University recommends energy efficient "task lighting" such as desk lamps to provide light only where needed (Bradof, K and Stoneberg, M., 2005) |

| | | | |
|---|---|---|---|
| | ++ | UMC policy:<br>Faculty implication | **Get staff actively involved in energy saving**<br>"Staff should be actively involved in energy saving. Without their co-operation most control strategies will not be successful. Explain that energy savings are not being made at the expense of their lighting conditions. Properly designed and implemented energy efficient lighting schemes will not degrade the working environment. It is vital to provide staff with regular feedback on how the strategy is working. Lack of information creates indifference and the potential level of savings might not be realized.<br>Everybody should be encouraged to participate in energy saving by switching off lights when they are not needed. In addition to the direct cost-saving benefits of such actions, environmental benefits resulting from the lower consumption of electricity should also be highlighted" (Energy Office, 2005).<br>Example of policy in Northwestern University (2004):<br>**Occupant Responsibilities**<br>Individuals are expected to turn off lights when exiting rooms that are no longer occupied and to turn off office equipment (including personal computers, where possible) at the end of the day. Facilities Management employees will turn off lights and equipment (other than personal computers and fax machines) that have not been turned off by occupants at the end of the normal business day. |

| | Hoped Impact | Objectives | Description |
|---|---|---|---|
| Actions | ++++ | Turn on the light just when it's used | Install motion sensors in classrooms, laboratories, and restrooms where lights are often left on |
| | +++ | Competition in Dorms to reduce energy | Tufts University with Tufts Climate Initiative (2005a) program created a competition "Do it in the Dark". "This competition is for residential halls to reduce energy usage during a month-long period each fall semester. The contest focuses on competition among dorms, inspiring students to save more energy than other students (prizes were advertised). The winning dorm is treated to a party with free pizza, entertainment, and prizes!" See the webpage http://www.tufts.edu/tie/tci/DoItInTheDark.html for more information. |

| | | | |
|---|---|---|---|
| | +++ | Reduce energy use with light change. | "Almost every college student brings a desk lamp with them to school, along with an incandescent light bulb to put in it. This strategy proposes that the college provide a Compact Fluorescent Light bulb (CFL) to each student to place in his or her lamp. The CFL bulb uses $\frac{1}{4}$ of the energy of an incandescent bulb to produce the same amount of light. The bulb can be waiting in the student's dorm room and can be included in the check-in sheet. The college can then get the bulb back at the end of the year and can re-use the bulb during language school and the following school year to utilize the bulbs lifetime and to ensure proper disposal of the bulb.!!!!" The reduction of carbon dioxide throughout the year will depend on how often the bulb is used, however, if each CFL bulb lasts its lifetime of 6,000 hours, then every single bulb will save 270 kWh of electricity. In other words, each bulb will save the college $24.30 (only $13.5 for UMC with $0.05/KWh) over its lifetime, in addition to preventing 0.02 MTCDE from being released into the atmosphere."(Middlebury College, 2003). If 50% of students in dorms use CFL bulb, UMC can save (371/2)*13.5= 2504.25$, prevent 3.71MTCD.<br>"Http://www.bulbs.com gives the following price for the purchase of 48 or more 15-watt CFL bulbs (this gives the equivalent light of a 60-watt incandescent bulb): $5.79" (Middlebury College, 2003) |

| Change BEHAVIOR ACTION PLAN | | | |
|---|---|---|---|
| ***Theme: Change BEHAVIOR…*** | | | |
| **2.3 Sub-theme: Heating and cooling** | | | |
| "One of the easiest and most cost effective ways to reduce energy consumption is through education. Education is fundamental in converting ignorance (of the environmental impacts associated with personal space heating) to knowledge. By teaching people that they can help reduce CO2 emissions associated with heating, they will become more cognizant of their ecological foot print and may in turn start promoting more environmentally friendly technology." (Middlebury College, 2003).<br>***Communication based on***:<br>"Through conscientious ventilation and heating of offices, classrooms, dorms, building users can realize a massive energy saving potential and have the same comfort!" | | | |
| | ***Hoped Impact*** | ***Objectives*** | ***Description*** |
| ***Communication and Actions*** | ++++ | Explain people how to reduce energy use for heating and cooling+ increasing people awareness | Create or find a paper sheet with suggestions to reduce energy with a better heating and cooling use.<br>Stocking this information in the reference place, and e-mail it. |
| | | | Providing information on UMC's website. |
| | | | Including an article in UMC newsletter. |
| | | | Do a campaign. Take example and media from the energy office: *"Heating and Ventilation - Done Correctly"*<br>*Addressed to: All building users*<br>*Theme: Saving heat energy through transformed user behavior*<br>Campaign is in Appendix 17. |

| | | | |
|---|---|---|---|
| ***Communications and Actions*** | +++ | UMC Policy | "Where possible, consolidate schedules to reduce the number of hours a building is occupied. This will allow Facilities Services to reduce ventilation during off-hours in non-laboratory buildings.<br>Do not use electrical space heaters. Electrical space heaters are prohibited in University facilities. They can overload circuits; they are a fire hazard; and they are "energy hogs" (one electric space heater uses as much electricity as 45 fluorescent light fixtures).<br>If you use a building after-hours or on weekends, do not expect the heating/cooling systems to be in full operation" (University of Washington, 2005) |
| | ++++ | Give responsibility to people | "We feel that one of the better ways to educate the community is by enticing them into competition with one another and rewarding those who perform the best.<br>We can create a game: "How Low Can You Go?" This competition would be between different dormitories on campus.<br>See for meters on campus that measure the steam flow to an individual dormitory<br>"In a dormitory, there are strategies that can be implemented in order to reduce the amount of steam needed to heat the building and its water. Students could take shorter showers and not leave the faucet running when shaving or washing their faces. By minimizing these simple daily activities the steam needed per dormitory will decrease. Also, by closing window blinds at night not only will the sun not wake them up, but also there is less heat loss between the cold outside and the warm room due to the added insulation" (Middlebury College, 2003) |

| | | | |
|---|---|---|---|
| ***Communications and Actions*** | ++++ | People aware, reduce demand | "From the energy management system computer operated by Facilities Management, the temperature in the different offices can be controlled. Our plan is to first educate faculty on how they can lower heating costs associated with their offices. Since the space is small there are only a few steps that can be taken. First, they can comfortably work in their office at lower temperatures if they were to wear a fleece instead of only a long sleeved shirt. Next, they can inform Facilities Management of their normal office hours so the temperature in their offices can be lowered when not in use. Also, faculty could inform Facilities Management if they will not be in town for a few days, so their office is not heated to such a high degree when they are gone. |
| | +++++ | | Do a meeting with every UMC employee to explain how to use heating and cooling equipment, good behavior, etc.<br>Do the same for students in dorms that can regulate the temperature. |

<table>
<tr><th colspan="4">Change BEHAVIOR ACTION PLAN</th></tr>
<tr><th colspan="4">Theme: Change BEHAVIOR…</th></tr>
<tr><th colspan="4">2.4 Sub-theme: Sustainable daily practices</th></tr>
<tr><td colspan="4">Communication based on:<br>“In everything you do, you can act to save energy, money, reduce greenhouse effect, and …feel better.”</td></tr>
<tr><th></th><th>Hoped Impact</th><th>Objectives</th><th>Description</th></tr>
<tr><td rowspan="6">Communication and Actions</td><td rowspan="4">++++</td><td rowspan="4">Give information to people</td><td>Create or find a paper sheet with suggestions about sustainable practice and energy saving (turn off stereo…).<br>Stocking this information in the reference place, and e-mail it.</td></tr>
<tr><td>Providing information on UMC’s website.</td></tr>
<tr><td>Including an article in UMC newsletter.</td></tr>
<tr><td>Do an exposition about sustainability.</td></tr>
<tr><td>++</td><td>UMC policy</td><td>Not allow to let the car turn on with nobody in more than 10 min (give a ticket) + communication about gas used and greenhouse effects.</td></tr>
<tr><td>+++</td><td>UMC Policy</td><td>Recycling! People need to be educated. If UMC start a REAL recycling plan, they have to put different trashes but also organize a communication plan!</td></tr>
</table>

| | | | |
|---|---|---|---|
| | ++++ | Break rooms action | Create a campaign or use an existing one.<br>Energy office (2005) in the program: *"More Action! Less Power!" (Appendix 16)* has lots of communication tools for break rooms.<br>One of the easiest way to reduce energy is to buy thermos for each breaks room with coffee maker. We can save about $60 each year for each coffee maker!!!<br>Stick on thermos a paper "When the coffee is ready, turn off the machine and put it in a thermos pot!" and advertises about the use of the thermos pot and gives an idea of the saving effects. |
| | +++ | Hot water | A study must be done about "hot water use". We can save lots of energy and water in this area |
| | ++++ | Give materials to Staff people to do the good and green choose. | Create a "green library" with literatures about landscaping and energy, green building construction, cooling and heating naturally, etc.<br>See appendix 10 about the document already in the UMC green library. |
| | +++++ | Dining Room | A thinking need to be done about some points:<br>- Is it necessary to change the plate for each time people go to take food? → if you reduce the number of plates used, we decrease water, energy use.<br>- Can't people take only 2 glasses and go to fill them? → if you reduce the number of glasses used, we decrease water, energy use.<br>- Can't we use a reusable plastic box instead of a box we put in a trash after use?<br>- Why not have a meal (1salad, 1meat and vegetable, and desert) where we can fill our plate just once and reduce the price of the meal? →reduce food waste, car use to eat outside, less water and energy use. |
| | +++ | Library | If nobody check yet each night computer to know if they are off. An action must be implement. |

# 3 Computers (room and university) and printers

## 3.1 Paper: What a waste!

### 3.1.1 Network printers used more than 425.000 pages of paper…

Peggy Sherven provided UMC's available printer data.
The number of network printers is 50. That includes student and departments printers. This number does not include the number of personal printers people have in their office.
Of the 50 printers, about 20 are students' printers (with the 2 new ones in the new student's center). They are listed on the computer help desk page (http://www.crk.umn.edu/technology/computerserv/helpdesk/html/printing.htm).

Each department is in charge of buying paper and toner. The students' printers are run by 6 people. They buy paper in the bookstore, and ask for toner at the help desk. Peggy Sherven tries to keep a registration of all paper and toner people buy. (see Toner/paper cost-area104 on the http://www.crk.umn.edu/technology/computerserv/helpdesk/html/printing.htm)
But she does not have all the data to complete the database for students' printers.

The table 6 used data provided by Peggy Sherven. Consequently during one school year (between 09/01/2004 to 05/10/2005) just the network printers used, 428,917 pages!
If we consider students' printers (even if some faculty and staff use it!), 346,467 pages of paper have been used during the last year. That's 308 sheet of paper per student (using 1125 number provided by Erica White). The estimated cost per students is about $6.16 (for $0.02 per page) and $15.40 (for 0.05 per page).
Department network printers used 82,450 pages last year. But this number does not account all the individual printers.

The campus owned one printer for students with duplexing capability (in Owen Hall, Natural Resources Department. Recently three news duplexing-printers were installed.

We have no data available to estimate the toner consumption. Peggy estimates the toner utilization but doesn't have all the data needed for the account.

Residential Life does it's own printing.

The wasted paper is normally put in recycling bins. Today UMC has problems finding people to recycle paper. That's another issue to reduce paper use!

### 3.1.2 Reduce printing use to save energy, trees and money

| Change BEHAVIOR ACTION PLAN | | | |
|---|---|---|---|
| ***Theme:*** **Printing** | | | |
| ***Communication based on***: "Rather than creating paperless office, computer use has vastly increased paper consumption and paper waste. Some easy actions can reduce this waste" | | | |
| | ***Hoped Impact*** | ***Objectives*** | ***Description*** |
| ***Communication*** | +++ | Explain people how to reduce paper + increasing people awareness | Create or find a paper sheet with suggestions to reduce paper and ink waste. (See appendix 18) Stocking this information in the reference place, and e-mail it. |
| | | | Providing information on UMC's website on Computer Help Desk webpage. |
| | | | Including an article in UMC newsletter. |
| | | | Do an exposition about paper waste and deforestation. |
| | | | Put poster next to printers, to give advice |
| | ++ | Give good behavior | Including information in the new hire packets |
| | +++ | UMC Policy | Include reducing printing in UMC sustainable policy. |
| | | | "Adopt a university policy for buying paper products with post-consumer recycled content. The policy should reflect the U.S. Environmental Protection Agency's Comprehensive Procurement Guidelines (www.epa.gov/cpg)" (Stoneberg, M. and Bradof, K. 2005). |
| | ++ | Faculty implication | Send assignments on Internet: |
| | +++ | | Reduce paper give to students and must be print on the two sides whenever it's possible. |

| | Hoped Impact | Objectives | Description |
|---|---|---|---|
| | +++ | Aggressive communication…people have to think about that | Do poster and communicate about the price they pay for paper (that's not free because that's in the technologic fee) and environmental data.<br>Problem with technologic fee: people use paper has they can because they don't see the cost of it! |
| | ***Hoped Impact*** | ***Objectives*** | ***Description*** |
| ***Actions*** | ++++ | Give responsibility to people | The average of paper use per students is about 300 per year. That means some people use really more than that. People need to understand using printing isn't free.<br>Jeff Sperling has developed software to control the page number per student. So he can use it to limit the number of sheet per student.<br>Limited paper use each semester by 300 pages the first semester (that's twice the average). and modulate after.<br>Reduce the technological fee to show to students that printing cost money. And when people used the 300 sheets, they have to pay something to put more on their account! |
| | ++ | Event to encourage reduce paper waste | Do a game during the semester between dorms. The dorm that has the less bags of recycling paper at the end of the semester wins the right to go somewhere.<br>Problem: Do rules. But if people really want to win they can put the paper in the normal trash. |
| | ++ | Reduce paper waste + communication | Do paper blocs note (the printing service at UMC) with paper print on only on side, and give it to students and staff. |
| | + | Buying green | Refill printer toner cartridges. (but already try and some problems, but maybe less now!) |
| | + | | "Buy vegetable (or non-petroleum-based) inks. These printer inks are made from renewable resources; require fewer hazardous solvents; and in many cases produce brighter, cleaner colors (University of Michigan. 2004). |

| | | | |
|---|---|---|---|
| | ++ | Buying green and smart | Consider using inkjet printers. They use 80 to 90 percent less energy than laser printers. |
| | ++ | | "Buy and use recycled paper in your printers and copiers. If skeptical, buy a small quantity first and check results. From an environment point of view, the best recycled paper is 100 percent post consumer recycled content and is wither not de-inked or is "process chlorine free" (bleached without chlorine)" (Simpson, W.2000). |
| | ++++ | UMC policy: Duplexing | Add each year Duplexing printer. |

## 3.2 Computers

“Personal computers are one of the fastest-growing electricity loads in the business and academic worlds. According to the U.S. Environmental Protection Agency (EPA), they account for five percent of commercial electricity consumption. The EPA predicts that, at the current rate of growth, this number will rise to 10 percent by the year 2000” (University of Michigan, 2004)

Especially at UMC, computers are an important part of daily life, so we have to understand how they affect our environment. They can help us to conserve resources; but they also are an important energy user.

The worst part is that much of the electricity used by personel computers is wasted. “The EPA states that most PCs are not being used most of the time they are running. In addition, 30-40 percent of all PCs are left running at night and on weekends” (University of Michigan, 2004).

At UMC, Peggy Sherven estimates 1160 Laptop computers, and 250 Desktop computers. We can see on the table 7, laptop energy consumption according to J. Roberson. (Robertson, 2002). For our study we will take the average number as reference.
For the desktops we use the data from W. Simpson.

> A typical desktop PC system is comprised of the computer itself (the CPU or the “box”), a monitor and printer. Your CPU may require anywhere from 50 to 150 watts for a 15-17 inch monitor, proportionately more for larger monitors. […]Thus, a typical PC system can use electricity at the rate of 110 to 300 watts or more. At current electric prices, what does this cost the University? That all depends on how the computer system is operated (W. Simpson, 2000).

We will estimate that a desktop and monitor consume 200 watts.

We have two cases. The worst case is a computer turned on continuously.

The best case is a system that operates just during the convention business hours (40 hours per week). We calculated the cost per computer, and cost global for UMC (at $0.0485/ kWh, number used by the facilities Department). To do the accounting per year, we estimate 46 weeks/ year of use. In this energy cost we did not account for printers energy cost.

We can see that a computer uses an important amount of electricity, and on UMC's scale this energy use is so huge. People's behavior can change to arrive at the best case, but the worst case is done by some people.

I observed that lots of students never turn off their computer. Perhaps they are still thinking that "a computer's life is shortened by turning it on and off" (Simpson, W. 2000) That is wrong. Simpson explains:

> Most experts agree that turning PC equipment off at night or on and off a few times a night will not appreciably affect its useful life which may only be a few years in any event because of technological obsolescence. Electronic equipment life is a function of operating hours and heat. Both these factors are reduced when equipment is switched off. Concerning hard drive reliability, modern drives are designed and tested to operate reliably for many thousands of hours including thousands of on/off cycles (W. Simpson, 2000).

Other people leave their computers on just to eliminate the inconvenience of waiting a minute or two for a computer to reboot! What is a minute during a day? And I'm sure people can do other stuff during this time if they really want not to lose a minute. I would estimate that we can save $10000 at UMC if people use better their computer! Also "PCs produce heat, so turning them off reduces building cooling loads. (On the other hand, PCs are not a cost-effective source of heat during the winter.)" (U.S Department of energy, 2003).

### 3.2.1 Easy actions can reduce computer energy consumption by 80%:

## Change BEHAVIOR ACTION PLAN

### *Theme:* **Computer**

***Communication based on***: "With some easy actions you can reduce your computer energy consumption by 80 percent or more without losing any productivity or other benefits of your computer system."

***Break the wrong common thought***:

- **screen savers save energy: WRONG!** "A screen saver which displays moving images causes your monitor to consume as much as electricity as it does when in active use. These screen saver programs also involve system interaction with your CPU which results in additional energy consumption"

"The best screen saver is also the best energy saver, i.e. turn off your monitor when you are not using it! The next best screen saver is using your computer's power management feature to automatically shut the monitor down quickly when you are not using your computer" (Simpson, W. 2000)

- **Computer's life is shortened by turning it on and off: WRONG!** (University of Michigan, 2004 and Simpson, W. 2000)
- **Energy need for the start-up is really important: WRONG! "**If the computer is going to be inactive for more than 16 minutes, consider turning it off. After this time, the energy needed to run the computer outweighs the start-up energy" (University of Michigan, 2004). "They use about the same amount of energy to startup as they use when they are on for about two seconds" (U.S Department of energy, 2003)

| | *Hoped Impact* | *Objectives* | *Description* |
|---|---|---|---|
| ***Communication*** | +++ | Explain people how to use their computer for energy efficiency + cleaned wrong common thought | Create or find a paper sheet with good rules that need to be follow. (For some example see Appendix 19). Explain how to "have the sleep mode"<br>Stocking this information in the reference place, and e-mail it. |
| | | | Providing information on UMC's website on Computer Help Desk webpage. |
| | | | Including an article in UMC newsletter. |

| | | | |
|---|---|---|---|
| | ++ | Give good behavior | Including information in the new hire packets |
| | +++ | Green purchase: UMC policy | Have a UMC policy about "computer and printer" purchasing". See appendix 20. |
| | +++ | Explain people need to turn off the computer | Do an aggressive campaign, with poster! (See appendix , energy office campaign, "More action, less power"). And Harvard University has a competition for students. They have to drawn a communication poster they will use after in the campus. More information available on: http://www.greencampus.harvard.edu/CERtoon/ |
| | ***Hoped Impact*** | ***Objectives*** | ***Description*** |
| ***Actions*** | ++++ | Electronic people. | "For "computer servers" which must be on to serve network functions, explore ways to turn servers off at night.<br>If monitors are not needed for "servers" to operate, keep server monitors off. if server monitor is needed during the day, at least turn it off at night on weekends" (Simpson, W. 2000) |
| | ++ | Recycle old equipment | Laptops are sending back to Dell. But a program must be done for desktop in each department and private laptop. |
| | ++ | Reduce energy waste | Have a guy every Friday night or every night during the week (maybe the security guy) that control every computer in the office to know if they are shut off. (the same guy will turn off lights also) |

# CHAPTER 6: Transportation

Transportation management! What's that? UMC did not implement activities to deal with transportation issues. This is because UMC does not have the components to need it. Most of the universities that started a TDM (Transportation Demand Management) in the early 1990's had these characteristics (Graves, 1993):

- downtown or in an urban area, they have to deal with the lack of parking and the costs to build new ones. Frequently they also have problems with traffic jams,
- number of students, faculty and staff are superior to 30.000 people. So their actions have a large repercussion.

Since the last few years, motivations to implement a program about Transportation are more diverse. The greenhouse effect is a big issue especially since Kyoto protocol, an amendment to the United Nations Framework Convention on Climate Change (UNFCCC), signed in 1997 about an international treaty on global warming. This was not signed by USA. Oil prices are one of the major problems that incite people and organizations to think about alternative transportation.

## 1 Current transportation for UMC people …

To define a transportation plan we have to know UMC characteristics.

### 1.1 UMC data: a survey is indispensable.

To study personnal characteristics about transportation Erica White and Tom Mulvaney provided student and faculty/staff data, respectively. Erica White used student's addresses they fill out each year on the internet. But after a first look, we understood that students do not always fill out their physical address (place where they really when they are at UMC). Actually the University of Minnesota does not keep track of physical addresses, but only 'Mailing' and 'Home'. Most of the correct data to study transportation behavior are not available. A survey (look at appendix 21) seems to be the best way to collect these data (and by the same time define transportation behavior and motivation for alternative transportation).

To have a global view about students’ transportation, we used the radius of 75 miles to generate data with the least amount of error. The majority of those with an address that is more than 75 miles away from campus most likely live closer to campus during the school year, but it is not on record with the University. Students' records with an address listed over 75 miles away from campus was excluded from the sample, as that would skew the results heavily. Numbers used for graphs come from the hypothesis that people live in a radius of 75 miles.

Tom Muvaney, from the Technology Support Services department, provided names of faculty and staff home towns. These data come from the computer help desk, along with a register of people who use a computer. That means we do not have information for a part of the staff, but most of the faculty are in these data.

The faculty and staff’s data present the same problem than students’ data. Some people list an address that can not be their current home during the week because more than 800 miles away from Crookston. We decided to include in the study people who live in a radius of 90 miles.

In my opinion data are distorted for the study because staff people that are not included numbers are more likely to live near Crookston and can change some conclusions of the project.

That is why a “transportation survey” is indispensable for faculty and staff.

## 1.2 UMC students live in towns (like Crookston or Grand-Forks)

### 1.2.1 One third of UMC students live on campus

As we see on the figure 14, one third (equal 371 people) of the students from UMC live in dorms. So we can estimate that during the week 33% of the students don't use their car to go to school. I say "estimate" because during my semester at UMC, I observed people who drive during the cold season to go from the dorms to their classrooms!

Students use their car during the week and week-end to go downtown for shopping and activities. Some week ends they drive to go to their family home that can be far away.
During holidays breaks all of them go back "home" (except some international students).
I suppose that most of them eat in the dining room or in their room. So they don't often drive to go eating outside ( a survey need to be done).
We can observe that during the college program, students are inclined to leave dorms (Fig. 15).

### 1.2.2 Students off campus

We can do a first observation thanks to figure 16. 44% of the students off campus (200 people) live in Crookston. We can estimate they ride less than 4 miles to school. My own observation after one semester is that most of people come alone in their car (except sometimes when they live together or if someone doesn't have a car).
It appears that students choosing not to come with other people have different schedules and enjoy the freedom to come or leave the university at anytime. I have no idea about their habits for the lunch time. Like students on campus, sometimes students off campus go back home for week-ends and most of the time for holidays.
Finally 571 students live at Crookston (students in the dorms and in the town). They represent more than two thirds of the number of students used in the study.

The other parts of the students who are off campus and have an address within 75 miles are 258. With figure 17, we study the repartition of the residential town for this population. First there is no gradient in function of the distance (the number of students within a ten mile radius is about the same as the radian between 20-30 miles). That is the most interesting radius part: 55% of the students outside Crookston live between 20 to 30 miles away.

We studied this radius part. Figure 18 shows us that most of the students live in GF (Grand Forks) and EGF (East Grand-Forks). There are 90 students who live in GF and EGF, that is more than half of the radius 20-30 miles, and about 35% of all the students outside Crookston. We conclude that action for the population of GF and EGF can touch a big part of the students. We can also see that 20 and 12 students reside in Red Lack Falls and Fertile, respectively. Fischer (10 miles from Crookston) and Thief River Falls (38 miles from Crookston) are residential town for 16 students each. A survey could define the transportation habits for this population.

## 1.3 UMC faculty and staff

### 1.3.1 Transportation pooling between home to work for people outside Crookston, GF and EGF

With the data we have (see previous part about UMC data) we conclude that there is the same number of faculty and staff from UMC who live in Crookston and outside Crookston. There is almost the same number of faculty in Crookston than staff (and the same for outside Crookston).

We studied people who live outside of Crookston. We used the same technique as with students. We can see a descendant gradient between 0 to 60 miles (except between 20 to 30miles). And after 60 miles it is irregular (Fig 19). Again the most important observation is the radius of 20 to 30 miles where 46% of the concerned population

resides. There is a big difference between this radius and the others (the biggest one after the radius 20-30 miles is between 0-10miles with only 12.5%).
Why again is this radius so important? The figure 20 shows GF is still the most attractive town with 17 people. GF and EGF bring together 23 people. Mentor is also a town where faculty and staff are numerous (9).
By analyzing figure 21, we conclude that GF and EGF people account for more than half of the population in the radius 20-30 miles. This population is more than one forth in the UMC employees' residents outside Crookston. Similar to the students, we have to deal with this population and find actions.

Other data that would be interesting to know are lunch time and flex-time schedule behavior. A survey is indispensable to implement a transportation plan.

### 1.3.2 Use of UMC vehicles to attend a meeting in the same town

This theme shows that UMC can save money and improve environment (reduce greenhouse gas) in the area by combining several into one car.
Michelle Ramstad, Administrative Specialist in the Facilities Management Department, manages the use of UMC cars. She keeps track of "who used the car, when, for where, how many miles were done and the cost for the department". She gave me this information for the last year (between June 2004 to May 2005).
To do this study I hypothesized: "Each time some people go to the same town on the same date; they can drive together and use just one car, and save one round trip of gas." It is really important to read the study with the hypothesis in mind. Actually we know this supposition isn't real every time. Sometimes people go to the same town but not at the same time. Also if two cars are used to go to a meeting, perhaps cars are full. But I would believe that there is an important probability people go, for example to the twin cities on the date and can go together! This example is the most usual illustration.

Manually I account

- How many times each month were two cars driven on the same date to the same location? At one day difference?
- After accounting how miles were lost (like for each time two cars go to the same place I account miles for one round trip), I estimated how many gallons were lost. For that I used the National Highway Safety Traffic Safety Administration estimation “that the actual composition (November 2004) of the models in the US passenger car fleet yielded an average 29.3 mpg” (Green Car Congress).
- Finally I calculated the money lost, using the estimation of 0.340/miles and $10 for each way (used by the facilities department).

Results (table 8) show that 91 times during one year, two UMC cars went to the same town on the same date. That is an average of 7.6 miles per month.
Because of the duplication, UMC cars traveled approximately 28,500 extra miles. That is an average of 315 miles per round trip, and average of 2,385 miles per month. According to SafeClimate website (a project of the World Resources Institute and the Center for Environmental Leadership in Business), one gallon of gasoline produces 8.87 kg of $CO^2$. So UMC employees produced 8.87*976.5=8661.55 kg of $CO^2$ that they could save traveling together! The cost lost is more than $10500 (the price for a new car)!

We also studied cars that go to the same town with one day difference. Hypothesis is, “Each time some people go to the same town with one day difference; they organize their planning to drive together and just use one car, and save one round trip of gas.” This supposition is less realistic than the previous one. Few hypothesis are:
- If three consecutive days a car went to the same town, we accounted two round trip lose. (We never had the case for four consecutive days).
- We did not account again for the time when a car goes to the same place on the same day.

This presents same problems as the last study. We presume that the drivers can modify by seeing someone or bringing something with better transportation plans.

The calculation uses the same estimations before (Table 8).

Results show that 55 times during one year two UMC cars went to the same town with one day difference. That is an average of 4.6 miles per month.

Consequently UMC cars traveled approximately 20,200 miles more than necessary. That is an average of 367 miles per round trip, and an average of about 1,680 miles per month. Again people ride on long trips alone producing 8.87*683.28=6070 kg of $CO^2$ that they could save! The cost lost is about $7360

Now we know better transportation habits at the university can result from better action planning.

# 2 Transportation action for the future

The most important lines for a UMC transportation plan can be realized. The essential conditions for creating a successful transportation plan are outlined and different actions will be explained

## 2.1 Principal conditions for success

The ESA is a school in France that started an important action about transportation. Three years ago, eight students did a research study to find action that can be implemented (Bernandin et al, 2002).

According to this study there are some conditions for transportation management success:

- The actions must be available for students and faculty and staff without distinction. This idea isn't really confirmed by American universities that implement actions (especially about vanpooling only for their employees),
- The two principal populations are new students, and faculty and staff. To change the state of mind of people, it is easier to start with new students. During freshman registration, information about alternative transportation can be available. Faculty and staff must be motivated and set an example for students.
- Actions must be implemented and not just on paper. For that a "reference group" must be created. The goal will be to communicate to the campus alternative transportation plans, implement actions and perpetuate them.

I would like to add an important condition. Top level leadership is essential for achieving excellence in energy sustainability, so also transportation management. Administrators must show their involvement and implication, but also take actions. Conducting a survey is one of the most important steps to define actions.

Interviewing people concerned by transportation must be done to help define the context better and their expectation.

People who should be interviewed:

- UMC CEO,
- UMC Head of facilities department,
- UMC parking responsible,
- Crookston local councilor responsible of transportation,
- People from the US Department of Transport or/and MN Department of Transportation,
- Association in Crookston concerned with problems.

**Meeting and work together**

Surveys are a good way to understand people, but meetings are also good places to exchange ideas. In the first part of the project, that can be also a good way to define more precisely the survey questions.

Three populations must be involved: UMC employees, UMC students, and community members. Even if the plan will be centered on UMC, some actions can be an opportunity for UMC and the community to work together (ride to Grand-Forks, Vanpooling and carpooling with non UMC people, bike road, etc.).

**A survey about transportation, an essential step.**

As shown previously, a survey is indispensable to define the mobility profit. I just listed the principal questions that need to be asked. (Appendix 21)

## 2.2 Alternative transportation … so much choice!

As mentioned before, a reference group should be created, but also a "reference place" must be found. In the different actions we are going to explain, we will draw the contour of this place.

### 2.2.1 Biking and walking: why not during the warm season!

UMC has a climate that does not facilitate biking or walking all the year around! Also the university location, outside the town, is an other negative point.

The Airlington Transportation Partners (ATP) describe the benefits of biking and walking programs:

> A bicycle- or pedestrian-commuting program can help with employee issues such as health care costs, turnover, morale, productivity, absenteeism, and monthly parking costs. When employers support biking or walking to work, they provide a service that is highly valued by employees, cost-effective, beneficial for the environment, and a good business decision.
>
> *Employees who exercise regularly have lower health care costs and less absenteeism.*
>
> The Centers for Disease Control reports that physical activity saves 5-12% in medical costs per year. Physically fit people are also absent an average of two fewer days per year than people who are not physically fit. Commuting by bicycle combines the need to travel to work with the desire for exercise.
>
> *Walking to work or commuting by bicycle can lead to higher productivity and reduced turnover.*
>
> Employees who walk or bike to work arrive less stressed and more alert than those who drive alone. Happier employees tend to stay with their employers longer, reducing the high costs associated with losing and recruiting staff.
>
> *Walking or biking can help reduce parking costs.*
>
> Reducing the demand for parking (when employees bike to work) can help lower the cost of employer-paid parking. The cost of providing bicycle parking or storage facilities is also much lower than that for vehicle parking. The square footage necessary for one vehicle parking space can provide enough room to park 12 bicycles.
>
> The cost to purchase and maintain spaces for 12 vehicles can total $70,000 per year; the cost to acquire and maintain space for 12 bicycles can total $12,000 per year.

Actions can be done to increase (or start!) this alternative transport.

| TRANSPORTATION ACTION PLAN | | | |
|---|---|---|---|
| ***Theme:*** **Biking and walking** | | | |
| ***Communication based on:*** "Bicycling and walking are great way to commute to the campus and lets you gets your exercise at the same time" (California State University Sacramento (CSUS), 2005) and save money. | | | |
| | ***Hoped Impact*** | ***Objectives*** | ***Description*** |
| ***Communication*** | +++ | Show biking and walking advantages | Create or find a paper sheet with all the positive point of this transport.<br>Stocking this information in the reference place, and e-mail it. |
| | | | Including an article in UMC newsletter |
| | | | Providing information on UMC's website |
| | +++ | Give good behavior before taking bad one! | Including information in the new hire or students packets (employees and new students) |
| | + | If people start… | Safety program |
| ***Actions*** | ++++ | Do successful actions | Survey |
| | +++ | Improve biking and walking safety and motive people to use it. | Built a bike and walking path between Crookston and UMC. (Lots of students live in Broadway and ABC apartment next to the High School, so think about a bike path from the high school!)<br>(do it attractive with plant and their name (done by a UMC Class)) |
| | +++ | | Put bicycle compounds located next to the main entrance. (CSUS, 2005) |
| | + | | "Adding shower and changing facilities to your buildings" (ATP, 2005) |
| | ++ | Encourage people | Give money advantage (on the parking cost, for example) for people who come to UMC with bike or walk during the warm season. Rent bicycle lockers |
| | +++ | UMC Policy. | All roadway improvement must be considered with bikes in mind (Graves T. 1993) |

### 2.2.2 Created bus line

***From Crookston…***

Many students off campus live in Crookston (44%). To avoid everyone taking his/her car we can create a bus line. A survey is indispensable to know at what time people are interested to ride the bus and identify their motivations.

50% of the faculty and staff people live in Crookston. Even if a part of the population lives far from downtown, another part can use bus line from Crookston downtown. The survey can estimate the number of people interested in bus travel.

The virtual population is between 300 to 500 people.

Communication and financial advantages are very important to change people's behavior. Lots of universities have a bus program to incite people to use this alternative transportation. Most of them are based on cost sharing. At UMC, a "transportation card" that a student could buy at the beginning of a semester can be created. The University of Washington Seattle created a U-PASS. For $24 per quarter, students and employees have improved public transit, carpool parking and discount vanpool fares (Graves T., 1993). Other universities give a percentage discount on bus passes like University of Minnesota Twin Cities (Graves T., 1993).

UMC is a small campus, so one of the problems is that we can't have a bus every 20 min. Perhaps two ways in the morning and two ways in the afternoon could be a solution, but we need to let the surveys speak. A bus line can also be implemented for students on campus that need to go to the town for shopping or activities.

Students go to the bar in Crookston sometimes during the week and the week end. A "night bus" could be a excellent way to reduce car use and increase safety for people after parties. A program can be created with Crookston bars, UMC and the Department of Alcoholism, Drugs Prevention from UMC.

***From Grand-Forks…***

35% of the students off campus and 25% of the faculty and staff outside Crookston live in GF and EGF. We can estimate that approximately 100 to 150 people from UMC live there. This population drive more than 45 miles each day. That's an important cost for them.

This population may be interested to take a bus each day. The bus could stop in Fisher and other places. Also students who live in Crookston (on and off campus) go quite often for shopping and activities to GF. A bus ride is an interesting way for them

Again the problem is the number of people. A simulation must be done to learn if this alternative transportation can be cost effective.

### 2.2.3 Carpooling an excellent alternative…

> Carpooling is an arrangement by a group of commuters to drive together in the same car to their place (or places) of business. Carpools usually consist of individuals who live near each other and are employees of the same company (or are employees of different companies located only a short distance apart) and have the same work hours (ATP, 2005).

The advantages of a carpool program are:

- Saves money. According to the ATP using carpools can save $1,500 a year by lowering gasoline bills, car maintenance. For example driving from 30 miles (a bit more than GF and EGF) costs individual drivers $230 per month. If three people share expenses, they can save $154 per month.

  According to Clayton College & State University the "IRS estimates it costs 34.5 cents per mile for gas, depreciation and maintenance". Checking on the commuter costs calculator on the website of Clean Air Campaign (www.cleanaircampaign.com), we can account the cost for each person to use their car alone and how much they can save with carpooling. Saving money can be an important way to communicate carpooling.

- People have less stress traveling to work or study (ATP, 2005)
- Reduce need for parking and therefore can reduce parking costs (ATP, 2005)
- "Employees who carpool show improved productivity, less tardiness, and lower absenteeism" (ATP, 2005)
- Increase social circles (meet other employees, make new friends, have time to catch up on the lastest news or gossip) (Clayton College &State University, 2005)

On UMC's website, we can find a rideshare page (http://www.crk.umn.edu/student/rideshare/). This database is used very little, quite non-existant. This example illustrates that communication is the most important point for a transportation plan success. Also the webpage isn't easy to find!

Actions need to be implemented to develop transportation. It's important to organize the program and make it easier to understand and accessible, a coordinator should be assigned for this task.

| TRANSPORTATION ACTION PLAN | | | |
|---|---|---|---|
| ***Theme:*** **Carpooling** | | | |
| ***Communication based on***: "The potential benefits of vanpooling and carpooling are saving money from reduced gasoline, maintenance, and parking costs, in addition to being environmentally sound" (University of Wisconsin-Madison, 2005). "That's also an ideal way to make your daily commute more enjoyable and less expensive" (University of Denver, 2005) | | | |
| | ***Hoped Impact*** | ***Objectives*** | ***Description*** |
| ***Communication*** | +++ | Show carpooling advantages | Create or find a paper sheet with all the positive point of this transport.<br>Stocking this information in the reference place, and e-mail it. |
| | | | Providing information on UMC's website on UMC today page. |
| | | | Including an article in UMC newsletter.<br>Including a special rideshare column in the newspaper |
| | | | Develop a software accessible online by UMC website to calculate how much we can save! |
| | +++ | Give good behavior | Including information in the new hire packets |
| | +++ | UMC Policy | Provide a commuting incentive program for those who carpool, bike, or walk to work |
| | +++ | Aggressive communication… | On a hoarding write the cost per month for people who come from each town!<br>And write the money saving with carpooling |
| | ++++ | Give opportunity for people interested to find other people.<br>Show the new UMC dynamism | Host a lunch time carpool formation party to let employees form or join carpools. Do the same for students.<br>To facilitate give a badge with different color in function of the town (and white with the name of the town for the less common town). |
| | ++ | Encourage people | Give a 10 days parking free per semester (days when they can use the carpool) |

| | | | |
|---|---|---|---|
| | ++ | Everybody must heard about the program | Posters, informational presentations and pamphlets could be presented at department meetings to familiarize staff with programs. But also in class! |
| *Actions* | +++ | Encouragement $ | Offer free or reduced-fee parking for carpools (define some rules like: vehicles must be parked in non-carpool parking lots when driving to campus without the members of the carpool, for that only one carpool parking permit must be issued to each carpool applicant) |
| | + | | "Free tank of gas or discount on gasoline per month for the driver" or other free gifts (University of Wisconsin-Madison, 2005 and Clayton College &State University, 2005) |
| | ++ | Discouragement $ of using car alone | Charge a parking fee to discourage single-occupant vehicles |
| | +++ | Make it easy for carpooler | Provide preferential parking (closer to the building) for carpoolers |
| | + | | Designated drop-off spaces at each building for easy loading and unloading of riders (University of Wisconsin-Madison, 2005). |
| | +++ | Coordinate carpooling and make it easy for people who want use it | Create a database on UMC website to coordinate carpool groups by area, size and membership. (see University of Maryland, 2005) and marketing it!!!<br>The carpool should be use also for the week end and holidays break. In the database, differentiate carpool for each day, week end and holidays.<br>Like have a secure webpage where people can provide "email address along with a starting point and a destination. Also provide the standards work or class schedule. The service could then provide them with others that have registered to carpool or vanpool and that have schedules compatible to theirs. The match list may also provide you with suggestions for improving your match list" (California State University Sacramento, 2005) |
| | ++++ | | Have a board where everyone can ask for a ride (specially for the week end and holidays break) |
| | +++ | Idea | See financial help from Minnesota Department of Transportation. |

With carpooling, “the university could help set a standard of energy efficiency for the institutions of this county by offering an extensive and organized […] carpool system” (University of Wisconsin-Madison, 2005). Actually a system could be created with the community participation. The carpools should also be used for the week-end and holiday breaks. In the database, differentiate carpools for individual day, week ends and holidays.

A limit might encourage people to live outside of Crookston like in GF. But in an other hand that can encourage people from GF to come to Crookston to study or work.

### 2.2.4 Vanpooling,

> Vanpooling is an arrangement by a group of commuters to drive together in a van to their place (or places) of business. Full-size vans and minivans carry 7 to 15 passengers and therefore are the next step up from carpools. Vanpools usually consist of individuals who live near each other and are employees of the same company (or are employees of different companies located only a short distance apart) and have the same work hours (ATP, 2005)

According to Pierce transit, vanpooling has grown 250% in the last decade,

ATP clearly explains how carpooling works:

> - Most of the time a group of commuters leases the van on a month-to-month basis (no long-term commitment). In some cases employers will lease or even purchase the van for their employees, and occasionally employees will use their own vehicles. Most often though, the vehicle is leased from a private vanpool company.
> - One member of the group volunteers to be the driver and collects the riders' monthly fares. The driver gets personal use of the van, and in many groups doesn't pay, depending on how the group wants to work it. Sometimes he just pays the fuel cots associated with running the van (University of Michigan, 2005) or pay like everybody because he can use the van during the week end and the night.
> - The vanpool leasing company usually covers maintenance and repairs, insurance, and even provides a backup van when needed. (ATP, 2005)

In most cases this program is available only for faculty and staff.

The benefits of carpooling are important:

- For UMC that is an important option to recruit employees from longer distances.
- The environment benefits
- Reduces need for parking
- Employees arrive relaxed and ready to work
- Viable option for employees who don't drive
- Back-up transportation for ridesharing employees who work late
- Saves money. According to Pierce Transit, the average vanpooler saves more than $5000 per year.
- "Vanpooling is popular with employees because they are designed to be as close to a car as possible in terms of comfort and reliability, while trading off a reduction in flexibility for less cost and less driving hassle" (Enoch M., 2003).

We can use the entire "carpooling action plan" to encourage vanpooling. We just added some specific actions that can be done for vanpooling.

| TRANSPORTATION ACTION PLAN | | | |
|---|---|---|---|
| ***Theme:*** **Vanpooling** | | | |
| ***Communication based on***: "The potential benefits of vanpooling and carpooling are saving money from reduced gasoline, maintenance, and parking costs, in addition to being environmentally sound" (University of Wisconsin-Madison, 2005). "That's also an ideal way to make your daily commute more enjoyable and less expensive" (University of Denver, 2005) | | | |
| | ***Hoped Impact*** | ***Objectives*** | ***Description*** |
| ***Actions*** | +++ | Encouragement $ | Subsidizing the cost of vanpooling for employees |
| | + | Idea to make it easier for UMC. | See for a partnership with a vanpool operator like King County Metro or Vanpooling Services Incorporated (VPSI)…(Enoch M., 2003) |
| | ++ | | Thinking about using vans during the day for UMC purposes (employees to go to a meeting). And give a special subsidy to commuter groups that make their vehicles available (Enoch M., 2003) |
| | +++ | | See fee reduction from the state |
| | + | Make it easy for carpooler | Create a vanpool smart card to pay the fuel (where everybody deposit the same amount) |

Some advice:

- According to M Enoch (2003), “Vanpools work best when employees working for the same company live relatively near each other in suitable clusters, but more than 25km ( about 15 miles) from their workplace.”
- “Vanpool Wisconsin indicated that by using mini-van as well as larger vans, participation in the program can be better” (University of Wisconsin-Madison, 2005).
- To be successful, there needs to be aggressive promotion, campus coordination, and thorough organization. I advise developing a marketing program for students.
- Tips on forming a successful vanpool:
    - Set the ground rules upfront, including: food, smoking, radio and cell phone preferences.
    - Decide how long the vanpool will wait for late passengers and how passengers will communicate with each other about schedule changes.
    - Decide who the driver will be, and whether or not he/she will be compensated.
    - Decide how to reimburse the driver for expenses, if necessary.
- “In the 1990’s University of Illinois – Champaign/Urbana offered a free van with maintenance to anyone who could gather eight employees to form a vanpool. No one took the offer” (Graves T., 1993). This example shows that a vanpooling and carpooling program must be associated with an important communication program.

The alternative transport is the ideal way for faculty and staff to commute from GF, for example.

One of the most common causes for people not using alternative transportation is the fear to need a ride for an emergency. That is why almost every university, state, and association programs include in their transportation plans a “guaranteed ride home”.

### 2.2.5 The guaranteed ride home

The principle is the same for each program but the realization is different. Some examples are described below:

***<u>Brown University, 2005</u>***

- A guaranteed ride home is provided by a taxi.
- All Guaranteed Rides Home are subject to availability of public transport - please remember that taxis and even RIPTA shut down for safety reasons during inclement weather. Neither Brown nor RIPTA can offer a guaranteed ride home under these circumstances. Keep an eye on the weather and plan accordingly. If the rest of your carpool is leaving early because of bad weather, you should probably go home also!
- Students are not eligible to be Brown carpool members.
- You may use the RIPTA guaranteed ride home twice a year. Rides to which you are entitled may not be carried over from one year to the next.

***<u>Clayton College &State University, 2005</u>***

- With GRH you can get a free taxi ride or rental car in case of an emergency or unplanned overtime if you commute to work using alternative transportation (carpool, vanpool, bus, rail, bike or walk).
- Note: Students are not eligible for GRH but are eligible for carpool incentives and promotional drawings at Clayton State University once they start carpooling at least one time a week.

***<u>University of Maryland, 2005</u>***

- For those who utilize ridesharing programs or public transportation, the Guaranteed Ride Home program through Commuter Connections can provide you with a reliable ride home when an unexpected emergency arises.
- Through this program, commuters can get home for unexpected personal emergencies or unscheduled overtime up to four times per year. Best of all, the ride home by taxi, rental car, bus, or train is FREE.

- Participants register in advance and must reside and work within the designated regions of the program

***University of Washington - Seattle Campus (Graves T., 1993)***

- Reimbursed Ride Home program: All faculty and staff who purchase a U-PASS receive an allowance of 50 taxi-miles per quarter as a means of guaranteeing a ride home when their regular means of transportation is not available.
- A ten percent co-payment by the user is required for each trip

***University of California - Los Angeles (Graves T., 1993)***

- An Emergency Ride Home is guaranteed for full-time vanpoolers. The Commuter Assistance-Ridesharing Office maintains several rental cars that are available for overnight use in case of emergency.
- They are free for the first use each quarter. There is a mileage charge for the second use. There is a mileage charge and small rental fee for the third use.

All of the programs use taxis. I would suggest borrowing UMC's car for an emergency ride. The cost for the university will be much less expensive.

## 2.3 Other thoughts …

### 2.3.1 UMC vehicles for attendance…

As mentioned previously UMC employees don't use carpools to go to meetings. Presently UMC uses a system to manage vehicles: SURE (Scheduling University Resources Electronically (see http://www.crk.umn.edu/Facilities/sure/index.htm). This system already can facilitate carpooling for meetings. But it is important for people complete the data (like the town,the reasons of the drive, people email), and maybe add a space "agree to share ride".

Some rules must be implemented to force people to share a ride. These rules must be added in the "transportation information" (http://www.crk.umn.edu/people/org/z-ClubHandbook2004/Ch5_Transportation.pdf) as a major policy. Measures to punish or reward participants can be used. To punish, a fee can be issuedto people who don't share the ride without good reason. To encourage, UMC can give some money back to people who use carpools.

### 2.3.2 Why students leave the dorms during college program..

A way to reduce transportation is to have more people living in the dorms. The study shows that students leave the dorms during the college program. A study to understand this problem and find solution must be done.

### 2.3.3 Lunch time, why going outside to eat

Another idea to reduce car use is to keep people at UMC for the lunch. A survey and a study must be done about the UMC dining facility. Also a kitchen with a micro-wave, and water should be created to keep more people on campus for the lunch.

### 2.3.4 Flextime, compressed work schedule some others way to reduce energy

Flextime allowing employees to modify their schedules with other people in the carpool or vanpool is a policy that can be encouraged by UMC.

"Compressed work schedule is an arrangement between the employer and employee to work their normal work week hours in few days" (LITM, 2005) (like 80 hours in less than10 days). The result is less car use.

"Telecommuting is the act of performing one's work at a location other than the office, usually the employee's home" (LITM, 2005).

# CHAPTER 7: Landscaping for energy conservation

## 1 Buildings lose energy to the environment

### 1.1 Understanding heat exchange…

Before knowing how to save energy with landscaping we have to learn how we lose energy. Relationship between buildings and the outside depends on heat exchange. In a building it occurs through three major processes: air infiltration, heat conduction and solar radiation.

L.Walter defines **air infiltration** as "the passage of outside air through cracks around windows and doors or other openings in house walls or ceilings. One way outside air is forced through these openings is by pressure differences caused by wind on the outside of the home." When the force wind increases, the air pressure increased too. On the wall that face the wind the air enter is really important. During the winter, heat is lost because of the air infiltration is about 20 to 30 % according to K. Powel from North Carolina. For L. Walter (from Colorado), the loss can go as 50% on the windiest and coldest days.

The second process is **conduction** through materials from which the home is built (Walter, 2004). Conduction depends on the insulation of the buildings, the surface area available for heat exchange, and the temperature difference between the inner and the outer surface of the building. The principle is to reduce the temperature difference between the outside surface and inside the building. The outer surface temperature depends on the wind, the air temperature and solar radiation.

This process represents up to 50% of the total heat exchange between a building and the outside environment (Powel, 1996)

The third process is **solar radiation**. That is the transmission of the heat into buildings by penetration of the sun's rays (Powel, 1996). Today our buildings are well insulated, therefore very little of the sun's energy enters buildings through the walls and roofs. Windows are the major reason. Half of the unwanted heat in a building during the summer comes from sun by the windows (Anonymous, 1998 and Sand, 1993). Just 5% comes from roof and walls combined (Sand, 1993)

According to M. Sand., the National Renewable Energy Laboratory (NREL) and the Sustainable Urban Landscape Information Series, the largest part of the sun's energy strikes the east and the west windows of the buildings (because of the angle of the sun). The south area is less affected by the solar radiation during the summer, but can be a source of heat for the winter (5 to 20% of the heat needed for the home in accordance with )

### 1.2 …to understand how to reduce its unwanted action

The heat exchange produces unwanted heat and cooling is an important part of the energy bill. Landscaping can reduce this unwanted heat exchange, maintain comfortable buildings and reduce the cost for energy.

## 2 Landscaping is one of the best long term investment to reduce energy consumption.

I'm going to list the benefits of landscaping. Each point will be developed more precisely in the following list.

### 2.1 Save energy with a cleaner environment

A well designed landscape protects buildings from winter wind and summer sun, modifies the climate around to create a microclimate less "energy consumer", and insolates buildings. All of these reasons reduce energy consummation. Landscaping also creates a nicer environment and reduces water, pesticides, fuel consumption (less maintenance) and can help to control noise and air pollution.

## 2.2 Saves money

Saving energy, saves money year-round! With landscape planning to reduce energy use, we can reduce the winter bill as much as 15% (Powel, 1996) to 25% ( Walter, 2004). Walter and Powel agree that summer cooling bills may be reduce as much as 0% . The Department of Energy's (DOE) Energy Efficiency and Renewable Energy Clearinghouse (EREC) says utility bills can decrease 50% and return an initial investment in less than 8 years. In addition, landscaping increases property values. In Minnesota, studies estimate that air conditioning bills could be reduced by 25% and "windbreaks could reduce annual fuel bills up to 10 and 20%" (Sand M., 1993)

The following list describes ways to save energy during winter and summer. We have to keep in mind that Minnesotans spend about ten times more money for heating than cooling, even if homes are fully air-conditioned (Sand, 1993 and Sulis, 1998)

# 3 Reduce solar radiation and conduction during the summer: shading

Air conditioning bills in Minnesota can be reduced. Even if for NREL "homes in cool regions may never overheat and may not require shading". One reason is the peak electricity use. During the day electrical consumption isn't constant. "The highest use of electricity occurs late in the afternoon on the hottest days of the year when air-conditioning use is highest" (Sand, 1993) The peak of electrical use for each consumer is a factor some electrical companies use to calculate the bill. The less your peak is, the less your bill. Furthermore, the current trade of electrical use is increasing. To satisfy the future need, a new power plant will be necessary. We have to reduce air conditioning use to avoid or delay that. An other reason is that “conventional air conditioners use refrigerants made of chlorine compounds, suspected contributors to the depletion of the ozone layer and global warming” (NREL, 1994).

## 3.1 Landscaping shades building and create a microclimate.

By shading walls, roofs and especially windows, landscaping reduces solar radiation. In addition, leaves use light for photosynthesis. Large amounts of water vapor escape through the leaves, cooling the passing air. NREL says that tree and plants can reduce surrounding air temperatures as much as 9 degrees F (5 degrees C) and 25 degree F (14 degree C) under the tree.

These two actions can reduce temperatures indoors as much as 8 to 10 degrees F says K. Powel and even 20 degree F according to NREL (1994)

## 3.2 To have strategic shade we need to have a strategic tree planting.

Almost all the authors agree about the place to plant tree in a cool climate. To shade during the hottest period of the day, and also to let the winter sun give some heat trees should be planted on the west and east side. This provides shade in “the late morning and afternoon sun, which adds the most solar heat to homes in summer” (SULIS, 1998).We need to avoid having trees reduce energy in the yard south of a building. In summer the midday sun is high (almost directly overhead). If we want to shade the roof we should have tree close to the building and taller than the roof. For L. Walter we can use a species that is not susceptible to breakage. But he admits that “leaves in the gutter is an undesirable consequence of a large deciduous tree”. SULIS and M. Sand have the same advice and assert that, “trees planted to the south of the home will have an adverse effect on energy savings”. In summer the shadow of the tree misses the building . In winter,

because of the sun lower angle, trees will provide shadow and avoid the heat from the sun. To avoid that problem any trees south of the house must be “located at least twice their mature height away from the house” (Sand, 1993)
Sand who is from Minnesota recommends planting priority shade trees due west of west windows and secondary priority shade trees east of east windows.

According to most of documents, deciduous trees are the ideal species. They may reduce solar radiation reaching a building by more than one-third (Walter, 2004). Because this species will lose their leaves in the fall, they create minimum winter shade. To select trees, we have to consider the height, growth rate, branch spread, and shape and choose plants native to our area that survive with minimal care.

Select a tree that can be planted within twenty feet of the window (for a house about 20 feet high) and will grow at least ten feet taller than the window. The NREL says that “a 6-foot to 8-foot (1.8-meter to 2.4-meter) deciduous tree planted near your home will begin shading windows the first year.” “When space permits, use as many trees as needed to create a continuous planting along all major west and east facing windows” (Sand M., 1993) or plant in an arc encompassing the home on the east, southeast, south, southwest and west sides (recommendation from L. Walter from Colorado, so probably not applicable in Minnesota). We also need to be careful about the space required for the tree at maturity.
The sun on the buildings during winter must be the maximum. Sand suggests that

> Any trees on the southwest or southeast sides of the home should be pruned as they grow to remove their lower branches to allow more winter sun through; however, lower branches on trees northwest of the home are desirable to create the most shade in the late afternoon. Large deciduous trees very close to the south side of the building can have their lower branches removed to allow more sun to reach the building in winter.

## 3.3 When space is limited, vines are the solution for reduction of energy year around!

Sometimes we do not have enough space to plant tree for shade. Vines can be used. The principle is that vines can absorb the sun's heat and shade the wall's surface to reduce the heat conduction, but also create a dead air space next to the foundation. This low moving air "forms an insulating layer that reduces the greater heat loss caused by moving air". Vines insulate the buildings during the summer and the winter. They can also reduce noise and dust pollution.

According to Rothenberger (from Missouri), deciduous vines are most effective on southern and western walls. These species will shade walls during the summer and drop leaves in the beginning of fall to let the sun reach walls during the winter. The same author and L. Walter recommend using clinging vines for masonry walls, but not directly on wood walls. Using trellises placed next (not against) wooden walls are best for growing twining vines.

Vine species recommended are different for each state. K. Powel from Carolina says that "Carolina Jasmine, ivy, wisteria or grape vines are popular vines which are well adapted to most of the state". Rothenberger (North Carolina State University) proposes using Wisteria or bittersweet on trellises. The NREL recommends to use vines to shade the east and west walls. Vines can shade only after one year contrary to shrubs and small trees that need few years.

Evergreen plants are the more useful to use on north walls where the sun never shines. They can reduce heat loss during the winter thanks to the insulation all year around. "The most effective use of plants for this purpose comes from a continuous line that extends along the wall and around the corners" according to R. Rothenberger who says to use, "different kinds of plants with a variety of leaf textures, heights, forms and shades of green" for this purpose. He advises to use Yew, juniper, mugho and holly depending on climates and locations.

Using shrubs and small trees follow about the same principles: reduction in the amount of wind that hits the building and insulation,… SULIS and NREL agree that mature plants must be approximately 1 foot away from a wall to avoid "allowing the dense foliage to grow immediately next to a home where wetness or continual humidity are problems" (NREL, 1995). K. Powel is not of the same opinion: "They should be planted close enough to eventually form a solid wall and far enough away from the house (about 4 to 5 feet, minimum) to create a dead air space". He also considers evergreen shrubs to be foundation plantings and that includes many dwarf or slow-growing types (Dwarf Hollies, Boxwoods or Junipers)

## 3.4 Shade air-conditioners and parking places to improve energy efficiency and increase aesthetic value

Air conditioner units can increase efficiency by as much as 10% with shading (NREL, 1995) because the unit will run in a cooler environment. "The American Refrigeration Institute shows that shading of this type can reduce the temperature inside the home as much as 3 degrees F" (Powel, 1996). However, shrubs planted near the compressor will not obstruct the air flow or access for service. But the Facilities Management person in charge of air-conditioning ask to watch out for good maintenance of shrubs next to air-conditioner.

Shade parking will reduce energy (gas) used to cool it and increase the esthetic value

"You might also consider low ground cover such as grass, small plants, and bushes. A grass-covered lawn is usually 10° F (6° C) cooler than bare ground in the summer. If you are in an arid or semiarid climate, consider native ground covers that require little water" (NREL, 1994).

# 4 Reduce energy loss cause by wind

## 4.1 Landscaping as a windbreak

The wind during the winter is an important energy cost, especially in Minnesota. Landscape windbreaks cut and redirect the flow of wind. Windbreaks reduce air movement around buildings and "thereby slowing heat loss from the walls of the buildings" (Rothenberger , 2000).

## 4.2 Cut the wind and the bill…

Estimation says that a windbreak can reduce the wind force as much as 50% (Rothenberger, 2000). Research on the Great Plains (Colorado) concluded that 25% of energy saving from heating is possible (Walter, 2004). "The effectiveness of a windbreak is determined by the number of rows of plants, type of plants, height of plants, prevailing wind speeds and proper maintenance" (Rothenberger, 2000).

A South Dakota study "found that windbreaks to the north, west, and east of houses cut fuel consumption by an average of 40%" (NREL, 1995). The same study about houses with windbreaks placed only on the windward side (the side where the wind is coming) allow 25% less fuel consumption than unprotected homes. In a windy climate like Minnesota a well-planned landscape can cut the winter heating bills by approximately one-third. That data is significant when discussing increased fuel costs.

## 4.3 … and much more

Windbreaks can be used like a snow fence, look aesthetically pleasing, and give foods and protection to birds and mammals. Also increasing the air flow next to buildings improves summer comfort and reduces the need for air conditioning.

## 4.4 Well planned landscaping needs to follow some rules.

### 4.4.1 North and northwest of buildings are the best location

The most common type of windbreak is planted to the north and northwest. This side corresponds to the strongest winter winds and will let the southern summer winds hit walls and provide positive effects.

### 4.4.2 On large sites, multi-rows are ideal.

Where enough land is available planting perpendicular, multiple rows to the wind direction is really efficient. Sand recommends to plant at least 7 rows of trees for several hundred feet L. Walker (Colorado) reduces this recommendation to five rows of several evergreen species. And Rothenberger from Missouri advises only two or three rows of evergreen trees and four to five deciduous plants; and recognizes that a mixture of both is most effective. Actually the best windbreak must combine trees and shrubs (with low crowns) to block wind close to the ground. The space between evergreen trees must be between 6 to 8 feet apart and rows should be 12 to 20 feet apart (Sand, 1993 and Rothenberger, 2000) needed. The principle is to let the sun reach lower branches of evergreens that are needed for a windbreak, so the distance depends to the mature size of the plants

SULIS, NREL, R. Rothenberger propose that a windbreak will reduce wind speed for a distance of as much as 20 to 30 times the windbreak's height, respectively.
But to maximize the windbreak effect, we should plant trees two to five times the mature height of the trees away from the building. This advice is from the NREL is contradicted by Walker (Colorado) who suggests only a optimum distance of one to three times tree height (and reasonable distance of six times tree height). All of these references are for a house's height. We didn't find study about university buildings. So recommendations can be different for a higher building.

Also a “windbreak should be much longer than the buildings being sheltered” because the “the wind will increase some at the edges of the windbreak” (Sand, 1993).

### 4.4.3 The shape of the windbreak

Most effective windbreaks are planted in U or L shapes (Rothenberger, 2000).

### 4.4.4 Species use for windbreaks differs by region

The species need to be “be dense enough, tall enough and the ideal windbreak tree is a dense evergreen whose branches extend from ground level to a height at least twice as tall as the building being sheltered” ( Sand, 1993). This information is important for the case of high buildings (for example a University). Powel from North Carolina says that “Hemlock, Cedar, Southern Magnolia, White Pine, Loquat, and Deodar Cedar” are preferable his view interesting evergreen trees for large windbreaks. He continues with the 6-12 feet evergreen shrubs : “Camellia, Sasanqua, Cleyera, Elaeagnus, Holly varieties, Ligustrum, Waxmyrtle, Oleander, Osmanthus, Photinia, Pittosporum, and Viburnum”.

### 4.4.5 Where space is limited: use a single row of evergreens

If we can use only one or two rows, the space between trees should be about ten feet apart. The sun can hit tree on the outside of the row. In this case pines are the most satisfactory for Missouri Climate ( Rothenberger, 2000).

## 4.5 Windbreaks can create snow drift

Snow drift can be “a nuisance if a driveway is located between the trees and the home, where possible extends a row of trees 50 feet beyond the ends of the area being protected" (Walter, 2004). But the action can be also have positive effect. Instead of seeing the windbreak like snow drift, we can use it like snow fences. SULIS describe the action:

> Lower shrubs planted on the windward side of the windbreak will trap snow before it blows next to the home or buildings. Winds will funnel around the ends of a snow fence. If possible, the row of plants should extend at least 100 feet beyond the snow drive problem area. Because of the decrease of wind velocity, snow will settle immediately downwind from a windbreak or snow fence. The windward row of a living snow fence should be placed at least 100 feet from the building or area that needs protection. A minimum of two rows of evergreens and one row of shrubs is most effective for snow control.

**NREL's advise for siting and designing a new building.**

In the paper, Landscaping for Energy Efficiency produced for the U.S Department of Energy by the NREL, they explain how to site and design a new building to best use the natural energy.

> A well-oriented and well-designed home admits low-angle winter sun, rejects overhead summer sun, and minimizes the cooling effect of winter winds. If you are building a home, pay attention to its orientation.
>
> In the northern hemisphere, it is usually best to align the home's long axis in an east-west direction. The home's longest wall with the most window area should face south or southeast. The home's north-facing and west-facing walls should have fewer windows because these walls generally face winter's prevailing winds. North-facing windows receive little direct sunlight.
>
> You may be able to design and orient your new house to maximize your homesite's natural advantages and mitigate its disadvantages. Notice your homesite's exposure to sun, wind, and water. Also note the location and proximity of nearby buildings, fences, water bodies, trees, and pavement -- and their possible climatic effects. (NREL, 1995)

# 5 Before landscaping, develop a plan

Now that we know how reduce energy consumption, we have to plan how implement it. To have energy-conserving trees requires taking a careful look at the situation and careful attention to where and how to planting.

To write this part I used the advise form the NREL, L. Walter, T. Rembert, and M. Sand. They explain the steps to planning a landscape:

First use a paper and different-colored pencils. Drawn a map of the area and :

- Identify the cardinal point
- Locate its buildings, walks, driveways, and utilities (e.g., sewer, electric, and telephone lines),
- Note the location of all paved surfaces (streets, driveways, or sidewalks) near the house,
- On the buildings mark doors, windows and other glass areas,
- Identify potential uses for different areas of the yard,
- Draw arrows to show sun angles (Observe at different seasons and during the winter between 9 a.m and 3 p.m, time of the most important south facing winter solar heating),
- Identify winds for both summer and winter. And identify potential areas needing shade or wind protection,Note the patterns made by drifting snow (indicator of the direction of the winter winds).
- Mark routes of noise pollution we wish to block,
- Note existing vegetation (trees and shrubs) and look if they provide values for shade and windbreak or if they need to be move,
- Notice which place of the yard suffer from poor drainage or standing water. (to know where some trees or shrubs will not grow well),
- Mark areas that can be convert in *xeriscaped* areas. “Xeriscaping is a landscaping technique that uses vegetation that is drought resistant and is able to survive on rainfall and groundwater once established. Converting a traditional lawn to alternative, water-

conserving grasses or other forms of xeriscaping saves energy and reduces water consumption" (NREL, 1995)

# 6 Choose the right tree for the right place…

One of the last steps is to choose the right trees, shrubs or vine. How we select them and how we plant them will directly affect building's comfort and energy efficiency.

## 6.1 Don't let the temptation to plant the fast-growing species mislead you.

Slow-growing will take more time to be efficient. But they have lots of advantages compare to fast-growing species. Slow-growing live longer, have deeper roots and stronger branches (NREL, 1995) so "are less likely to break in wind and ice storms" (Powel, 1996). They are also more resistant to insects and diseases than fast-growing trees (Powel and NREL).

## 6.2 Density, locale, species… are the points to consider to choose the vegetation

Density of tree's leaves or needles is an important point to consider. Two major species can be use. Deciduous vegetation leafs out in spring and drop their leaves in fall (Sand, 1993) when the heating season begins. During the summer when they are mature they block 60 to 90% of the sun. During the winter they block approximately 30 to 50% of the light (SULIS, 1998 and Sand, 1993). The trees are the best to provide shade during the summer and let solar heating during the winter. "Trees that meet these characteristics are the most solar friendly" according to M. Sand. She gives some examples of species that have "moderately dense summer shade with sparse winter branching" like "kentucky coffeetree, walnut, and ash" or "sugar and red maple that have denser summer shade with moderately open winter branching”. The best place for these trees is on the east and west of the building. Evergreen trees keeping they keep leaves all the year around. They are really efficient in windbreaks. So they can be plant in the North and west on the buildings.

In the species we can choose various density. Dense evergreen are great for windbreaks, but if we want impede summer winds we can choose vegetation with more open branches and leaves (ideal on the east to filter morning sun). (NREL, 1995). The shape of the tree is also important. For example a broader crowned tree casts a much larger shadow than a pyramidal shaped tree of the same height (Sand, 1993)

“The bigger the tree, the more benefits it will provide from an energy saving and air cleaning view” says SULIS. Sand confirm this and advises to “select a tree that will grow as big as growing space permits.” But we have to remember that trees grow their branches and their roots. A tree’s root system can damage sewer lines or sidewalks when it’s mature. (Rembert, 1999).

But the most important advice is to choose native plant that will grow well and will need minimal maintenance. Do not plant non-native trees, such as Norway maple, “that wait until November to lose their leaves and those oaks that retain their leaves throught the winter” cautions M. Sand She also suggests choosing cultivars because they vary significantly in the timing of leaf drop.

Sand lists some undesirable energy –conservation plantings for various reasons: “because they keep their leaves in winter (such as many oaks), because their branching is too sparse (such as ginkgo), because their form is too narrow to cast the best shadows in summer and their branches too dense in winter (like Greenspire linden), or because they grow too large and weak wooded to be planted very close to a building (such as silver maple and cottonwood)”. Also consider the soil, light, and moisture conditions. For example “trees planted close to the house should be strong and resistant to damage from disease, insects, and storms” (SULIS, 1998). In the Appendix 22 we can see “Trees recommended for energy conservation” for Minnesota by Sand M.

## 7 UMC landscaping plan

> Horticulture students Cayla Wieland and David Walther, who are focusing on environmental landscaping, are developing a set of recommendations on the selection and design of plantings that would require lower maintenance (for example, perennial vs. annual plants) and that could be used to help a professor teach a class (thus reducing the need to travel to an off-campus location to view the plant). The students, who are working closely with facilities management head John Magnuson and lead groundskeeper Jerry Rude, will also identify areas on campus where mowing might be reduced, thus saving energy. (Oo, 2005)

I gave to Cayla Wieland and David Walther my literature review about "Landscaping for energy conservation". They probably did a UMC landscaping plan.

# CHAPTER 8: UMC could and should develop long-term alternative to "coal" power

## 1 Current "coal" electricity, heating, air-conditioning energy use…

A quick observation shows us that UMC only use coal to produce energy. The electricity from Ottertail is produced from coal. So air-conditionning, lighting or computer use coal to run.
UMC has a power plant to produce the heat. They use coal again.

## 2 Wind power plant: a project that need to take shape

Today we can see trades like:

- •Declining Wind Costs
- •Fuel Price Uncertainty
- •Green Power
- •Energy Security
- •Federal and State Policies to incite renewable energy
- •Economic Development
- •More and more university buy green power and use wind or solar power

Ex: Morris built a wind turbine last year

A real alternative seems to be possible

## 2.1 Turbine characteristics, and application for UMC

During my internship I interviewed people about wind power. Scott Sigette (Ottertail energy management representant in Crookston) and Bradley Stevens (Research engineer at the Energy and Environmental Research Center in Grand-Forks) gave me lots of information about wind power. I also learned during CERTS meeting. I summarize the most important data in the figure 22.

The figure 23 shows the application for UMC

## 2.2 A project led by a team of partners

I think this project is realistic. I felt a real motivation from lots of people. To led the project UMC need to create a working team with partners. I would recommend to include in this team at least:

- Energy and Environmental Research Center (EERC)→ Bradley Stevens
- Ottertail → Scott Sigette
- Crookston community
- UMC top level people

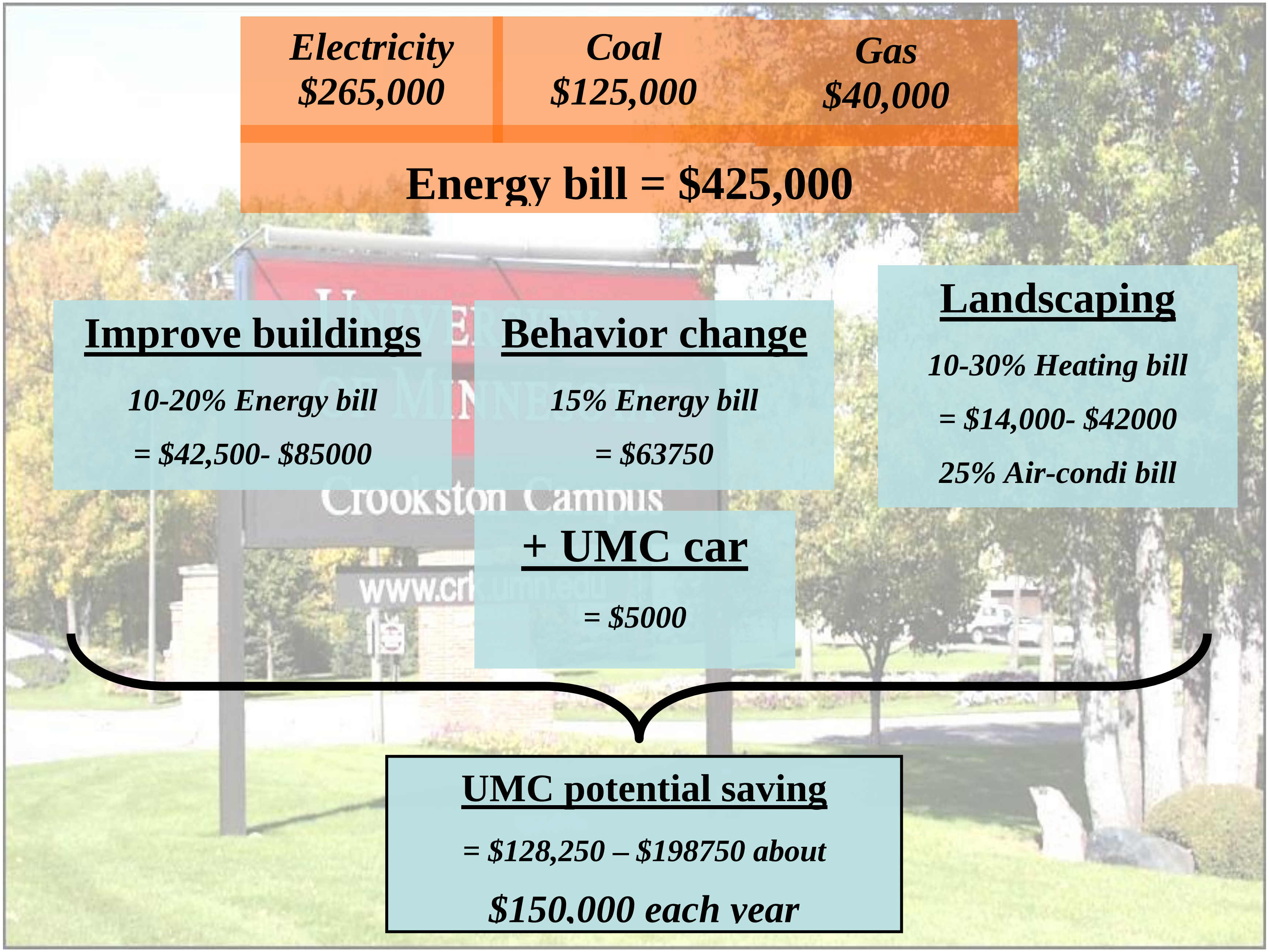
- UMC teachers like Mr Dan Svedarsky, Mr David DeMuth, Mr Ken Freberg, Mr John Magnuson,...
- Linda Kingery
- UM Morris

This list is not exhaustive.

# 3 Other alternative energy

So much other alternative can be study. Biomass, geothermy , digester, and so much more should be studied for a use at UMC.

# CHAPTER 9: Summarize savings



# CHAPTER 10: Conclusions and considerations

The current global context with gas price and greenhouse effect that amplify natural disaster like hurricane incite people to think more and more about way to reduce energy consumption.

This report give a view of energy consumption and sustainable practice at UMC. Energy bill and the $CO^2$ effect caused by UMC are very important. Each year UMC spends about $425,000.00 for the campus energy bill (included dorms, and organizations outside of UMC). It's about $380/student for one year calculating with 1125 students (UMC data). Electricity is the largest energy cost with more than half of the total cost, coal is about 30%, and gas 12% of the bill.

Now we can find some way to do a better energy management. I start to give some actions. the "action slips" easy to use. For example, I propose to review every timer for outside light and modify it to turn it on only when necessary or suggest to shade the external unit of air conditioners with vegetation has the potential to reduce their energy use by 10 percent. Lots of easy things can be done quickly.

But the main goal is to give a start point for the creation of an action plan. To realize this purpose an energy team lead by an energy director is necessary. This team will advice the university to institute an energy policy. An Energy Policy provides the foundation for successful energy management. An important factor for successful implementation of the action plan is gaining the support and cooperation of key people at different levels within the organization.

Now my hope is to see the project continue...

"Can changing the way a university campus looks or manages its environment make a difference to future generations? Yes, say four students at the University of Minnesota, Crookston" (Oo, 2005). I want to believe that in a few years everybody at UMC will answer YES to this question!

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