April 13, 2008

COMM 436

Information Systems Analysis & Design

Final Report:
AMS Utilities Project

Presented by:

Dorothy Cheung

Sam Lin

Geraldine Ong

Priscilla Tsang

TABLE OF CONTENTS

COVER LETTER

Sauder School of Business

University of British Columbia

2053 Main Mall

Vancouver, BC V6T 1Z2

April 11, 2008

Ms. Miriam Stein

AMS Sustainability Strategy Coordinator

University of British Columbia

6138 SUB Boulevard

Vancouver, BC V6T 1Z1

Dear Alma Mater Society Sustainability Strategy Coordinator:

As part of our course project on Information Systems Analysis and Design, we are pleased to provide consultation to the Alma Mater Society on energy and water usage of the Student Union Building (SUB). Given the limited timeframe for this project, we managed to gather energy and water usage data of the SUB and provide analysis on our findings.

The following report examines the current processes and the work system, the possible options, our recommendations and the implementation plan. We hope that our analysis, recommendation and implementation plan will help AMS improve its current work and IT system and take another step towards achieving sustainability at the SUB according to the AMS Lighter Footprint Strategy.

Yours truly,

Priscilla Tsang, Dorothy Cheung, Sam Lin, Geraldine Ong

AMS Utilities Project Consultants

EXECUTIVE SUMMARY

In 1990, the University of British Columbia signed the Talloires Declaration as its first commitment to creating a sustainable environment. Later, the Sustainability Office was established with a vision to put sustainability into action in campus operations, research, and teachings.

The Alma Mater Society (AMS), having a significant influence on the members of the University, also committed themselves through adopting the Environmental Sustainability Policy in January 2007. The Lighter Footprint Strategy (LFS) under the policy was designed to help AMS set constructive targets on areas that will benefit the most. One of the proposed interactive targets is to reduce energy consumption and greenhouse gas emissions at the Student Union Building (SUB) by at least 33% by 2020.

Our project is a first step towards achieving the above reduction target. According to our findings, the problem we have identified is that currently there is no known database to the AMS that will allow them to track energy and water usage in the SUB. In this project, our team is involved in data collection from various sources, the analysis of the work and IT system, as well as the exploration of possible database creation alternatives. The three alternatives examined are: 1) building a brand new database monitoring system, 2) outsourcing to an energy management firm to build a database and generate analyses for AMS and 3) maintaining the status quo. Given a low budget and other requirements from the client, we arrived at our recommendation of maintaining the status quo, which is to take advantage of UBC Utilities existing ION database and create a customized spreadsheet with Microsoft Excel.

In this report, we will first provide the background, objectives and scope of the project, an overview of the AMS, our analysis of the current process and the system, the possible options, our recommendations and the implementation plan. We hope that our recommendation along with the implementation plan will help improve the existing work and IT system of the AMS and bring sustainability to the SUB.

PURPOSE OF DOCUMENT

The following project report will:

- Define objectives and scope of the project, the main activities and information sources and the specific limitations
- Identify relevant work system elements, business processes, existing IT technologies/ applications and provide detailed analysis
- Provide the alternatives considered and our recommendation for implementation

DESCRIPTION OF PROJECT

Background, Objectives and Scope

The proposed project includes designing a database system for the AMS to record the energy (steam, gas, electricity, water) usage for the UBC Student Union Building. The information will be analyzed to provide solutions for energy reductions in specific areas of the building. The proposed system is set to reduce Greenhouse Gas emissions and to lower energy consumption as mandated by the University.

It is expected that the traditional SDLC development methodology and OOEM conceptual modeling will be used for the project. We will look into details on how energy and water is distributed and used in the SUB during different times of the day. The collected energy and water use data will be represented on spreadsheets that will be act as inputs for the new database for the SUB. The new database designed will contain information on the source and usage of energy and water, the associated cost and Greenhouse Gas emissions. The database will allow the AMS to closely monitor and review their usage in order to meet certain reduction initiatives.

Information from multiple sources will be integrated (e.g. heating, room bookings) in order to determine the optimal energy reduction approach. In addition, we will provide recommendations on how to extract the information from the database and relate the energy usage information to the members of the community, either through online portals or throughout the school's premises. The information will be made publicly available to increase the awareness of and advise students and other faculty members on primary areas of improvements.

Main Project Activities

Data Collection on SUB energy and water use

Purpose:	to collect any data relevant to SUB energy and water usage and gain an understanding of the business
Outcome:	to understand how energy and water is being used at the SUB and the relevant monitoring process as well as client's requirements for a database
Deliverable:	Usage Data, Spreadsheets
Responsibility:	- interview with AMS Sustainability Strategy Coordinator to understand her requirements for the project/database and gather energy & water use information for businesses owned by AMS - interview with UBC Energy manager and the Utilities Department

Data Analysis

Purpose:	to analyze data collected from interviews, information sources (metering website/reports/internal documents) and to provide solutions
Outcome:	- analyzed data will provide insight to the "as is" work system and processes - possible areas for improvement will be explored
Deliverable:	process models of business
Responsibility:	- analyze collected data - discuss problems identified and areas for improvement - suggest possible solutions to be further studied

Exploration of Alternatives and Recommendations

Purpose:	to examine the possible alternatives of database creation using the data collected (metering websites and spreadsheets) for AMS to monitor and review their usage
Deliverable:	a list of possible alternatives and our recommendation for implementation
Responsibility:	- identify the cost of energy and water usage - identify the methods to calculate the associated Greenhouse Gas emissions using the energy & water data - explore possible options that will allow the creation of such database o e.g. meet and discuss with Small Energy Group project manager (who have been working on similar databases for UBC) on the possible implementation of a database specific for the SUB (the associated requirements, steps and costs) - Provide related information on implementation for client

Information Sources

Stakeholders:	Internal Documents	External Information
• AMS Sustainability Strategy Coordinator (Miriam Stein) • UBC Energy Manager (Orion Henderson) • UBC SEEDS Project Manager (Brenda Sawada) • AMS Facilities Manager (Jane Barry) • AMS Designer (Michael Kingsmill) • AMS IT Staffs	• Energy and water metering website • UBC Sustainability website • SUB floor plan • UBC Sustainability reports • SUB Energy Assessment Report from last year • Utilities bills for the SUB • Spreadsheets for calculating Greenhouse gas emissions	• Details and costs of acquiring software for creating databases and automated reporting system • Natural Resources Canada website (to identify the conversion factors for Greenhouse gas emissions)

Special Considerations

Below are some of the constraints to be considered in the course of this project:

- **Time constraint**: Due to the limited timeframe of the project, we will not be able to carry out the implementation. Instead, we will focus on the analysis and design which will act as a guide to implementation for the AMS.
- **Scope constraint**: Due to the scope and time constraint, we will not be able to expand our project scope to look at the other alternatives for energy reduction at the SUB (e.g. the Building Management System at the SUB)
- **Constraints from related activities elsewhere:** We become aware midway though the project of the referendum in March 2008 relating to SUB Renewal, which could entail reconstruction or renovation to the existing SUB. Therefore, we are unable to guarantee our current analysis and design (based on the existing SUB) will be applicable the new or renovated SUB. And due to the uncertainty and non-existence of a new SUB and the limitations in time and scope, we are unable to provide analysis and design on energy and water use for a potential new SUB.

DESCRIPTION OF BUSINESS

Energy Supply at UBC

Electricity at high voltage is transmitted from the BC Hydro Sub Station to the UBC Utilities Department, as illustrated in Figure 5. The high voltage electricity is then transformed into low voltage (110V) by the UBC sub-stations' transformers. The low voltage electricity, monitored by a central meter in each building, is then supplied to each building on campus.

Water from the Greater Vancouver Regional District (GVRD) and gas from Terasen are fed into the boilers in the UBC Power House, generating steam. Steam is then supplied to each building on campus and monitored by a central meter in the individual buildings. Hot water is produced by the heat exchanger, which uses the steam to heat up water in the building.

Greenhouse Gas is emitted where energy is produced, at the BC Hydro Sub Station and the UBC Power House. For our project, the Greenhouse Gas that is to be evaluated is CO_2, based on the amount of energy consumed in a year using a conversion factor.

The Organizational Environment

A) The Organization

The Nature of Organization:

<table>
<tr><th colspan="6">Name of work system: UBC Alma Mater Society (AMS)</th></tr>
<tr><td colspan="3"><u>Customers</u>
• Students
• Businesses
• Professors
• Residents
• Visitors
• UBC community</td><td colspan="3"><u>Products and services</u>
• Student Clubs
• Career counseling
• Tutoring service
• Rent service
• Communications consulting and design services
• Copy service
• Health/dental plan service
• Non-academic courses
• Exam database
• Dining
• Travel agency
• Ticket Booking
• Other businesses</td></tr>
<tr><td colspan="6"><u>Work practices</u>
• Allow student clubs to operate
• Provide career advice, counseling service, communications consulting and design services, conference services, rent service
• Provide old examinations for courses for students
• Conduct non-academic courses
• House a theatre for movie entertainment
• Provide study rooms and auditoriums for students to interact and hold activities
• Own and operate businesses - dining, travel, copy, and various services
• Allow businesses to operate</td></tr>
<tr><td colspan="2"><u>Participants</u>
• Students
• Businesses
• Professors
• Residents
• Visitors
• AMS executives
• AMS employees
• UBC community</td><td colspan="2"><u>Information</u>
• Databases
• Advertisements
• Utilities records
• Financial records
• Business registration records</td><td colspan="2"><u>Technologies</u>
• Telephones
• Computers
• Software tools
• Internet
• Email</td></tr>
</table>

Short History:

The UBC Alma Mater Society (AMS) was founded on October 15, 1915, the same year as the opening of the University of British Columbia. Students met and adopted constitution for new student society. Sherwood Lett was elected as the first AMS President. The first student clubs at UBC were established in 1915-16. In 1968, the current Student Union Building (SUB), also largely supported by AMS funds, was opened September 26, 1968. The SUB consists of three levels – lower, main and second (please refer to Figure 1 for SUB floor plan).

Important Measures:

The AMS represents more than 44,000 UBC students and students at affiliated colleges. Students own and operate a number of businesses through the AMS. Over 400 students are employed and paid in a total of $2 million in student wages. Student services, as illustrated in the work system snapshot above, are supported by revenues from AMS businesses.

B) The Environment:

The AMS operates student services, resource groups and clubs in an academic environment. Its mission is to improve the quality of the educational, social, and personal lives of the students of UBC by promoting high-quality student learning and advocating interests of the students and those of UBC and post-secondary education.

The AMS is administered by the AMS Executive, which consists of five members who are elected annually by UBC students. The Student Council, which comprises the Executive members and members from all the constituent societies, governs the AMS and determines its overall direction each year and its priorities and activities.

C) Important Relevant Business Processes

Operation of student clubs and provision of services

The student clubs have meeting rooms within the SUB where they conduct weekly gatherings or hold scheduled meetings to plan for the individual club's activities. The usage of the meeting rooms are controlled by the student club committees, and hence the electricity usage of the meeting rooms. The electricity usage of each room is monitored by a central meter that monitors the overall electricity usage of the SUB.

The service groups, such as the counseling service group, design services group, and rent service group, occupy rooms in the SUB where consultation services are rendered to the clients. These individual groups have similar control over the usage of their individual work spaces and thus control the electricity usage of those rooms. The electricity and energy usage is similarly monitored by the central meter the monitors the general energy usage of the SUB.

Theatre for movie screenings

The theatre within the SUB screens movies from Mondays to Fridays from 9:30 a.m. to 5 p.m. and Saturdays from 9:30 a.m. to 4 p.m. Its operation is controlled by the AMS, in deciding when and for how long the theatre should operate. The electricity, energy and water usage of the theatre are monitored by the central meters for electricity and water that are overseen by the AMS. The central meters for water and electricity monitor the general water and energy usage of the SUB at the same time.

Provision of study rooms and auditoriums

These areas are set aside for students to do group studying or hold activities and events. The study rooms are usually available 24 hours for students to hold study sessions late into the night, while the auditoriums are available and open upon request by student groups or faculty members who wish to utilize them for functions or activities. The energy and electricity usage is also monitored by the central meter as mentioned before.

Operation of businesses

The dining and retail businesses operating within the SUB are mainly owned by the AMS, with some businesses operated by students. The energy and water usage of the individual tenants are thus monitored mainly by the AMS, using the central meters for both electricity and water as mentioned before. Businesses usually operate from Mondays to Fridays for about 8 hours and on Saturdays for about 5 to 6 hours for certain stores like The Outpost. Food stores are usually closed on Saturdays and Sundays. All stores are closed on Sundays and public holidays.

Sources of Energy and Water Usage in the SUB

	Electricity	Water	Source of Usage
Food Outlets • **E.g. Subway, A&W, Koya, PitPub, Blue Chip Cookies**	X	X	• Cooking Equipment • Stoves • Dishwashers
Other SUB Businesses • **E.g. The Outpost, Copyright, TravelCuts, Theatre**	X		• Depends on type of business (some examples: computers, cash tills)
Offices • **E.g. AMS staff offices, student representatives offices**	X		• Lights • Photocopiers and Printers • Computers
Clubs • **approximately 90 clubs that own offices in the SUB** • **E.g. Aqua Society, Photo Society, Table Tennis Club**	X		• Lights • Computers
Function Rooms and Study Spaces • **E.g. SUB Ballroom, Auditorium**	X		• Lights • Television • Computers and/or Projectors
Public Washrooms and Water Fountains	X	X	• water sinks • flush toilets

The Information System and Use of Information Technology

A) Main IT Applications

An Information Technology system was needed by UBC Utilities to remotely monitor the energy usage of all core and ancillary buildings in the university. The demand for such a system was largely due to the university's commitment to the ECOTrek initiative in 2002 – to reduce the energy footprint of the campus. The extensive manual labour needed to gather such information from all the buildings also prompted the installation of the automated water, steam, and electrical meters.

The users of the system included building managers, classroom services, UBC Plant Operations, UBC Utilities, students, staff/faculty members.

Power and energy meters, ION 7330, from Schneider Electric were installed in all the buildings in the project and which is able to collect the electrical consumption, and connected to the central operations software, ION Enterprise, via Ethernet cables on the Local Area Network. The centralized software is able to manage the information from all the meters and display it online. Information is stored in a Sybase SQL database server, which information can be retrieved by any user via ODBC or OPC with the appropriate connection software.

B) Evaluation of Existing Systems

The only system that is currently fully implemented is the UBC Utilities Remote Metering Site (http://142.103.191.161/ion/). At the moment, it contains energy meters in over 70 buildings that are on campus. It provides 15 minute interval real-time monitoring of electricity, water, and steam. It is able to store the information in a database 24 hours a day, 7 days a week. The information dates back to March 29, 2006. Any user with the website address is able to view this information, as well as plot the specified time interval on an automatically generated graph (see figures 2 – 4).

This information is certainly valuable to the scope of our project as the data collection has already been implemented. However, currently the meters only provide a general overview of the buildings, including the SUB – which contains many different businesses and users of the facility. We have determined that in order to propose any valuable and viable solutions to our customer, a more detailed level of data collection is necessary (either by means of manually checking individual meters or intelligently estimating the energy usage).

C) Constraints to be considered

The database which stores the historical remote metering information is highly secure, and only a few members of UBC Utilities has access to read and write directly from the database. An automated method to gather this information is not possible without the use of proprietary OPC connection, which limits our ability to manipulate data and calculate trending values without manual intervention.

ANALYSIS OF THE CURRENT PROCESS AND THE SYSTEM

Elicitation

The elicitation of requirements is carried out mainly through interviews and reviews of documentation. Interviews with stakeholders provided us with most of the information about energy and water usage at the SUB and how they are monitored. Interviews is our main elicitation method since we are able to speak with the people directly involved in the process and ask them questions immediately if clarification is needed. Although extensive time commitment is required for meetings, but this process is more beneficial that it ensures information collected are clearly understood. This is especially crucial in systems development as inaccurate requirements or information in early stages could be costly to fix later. Despite carrying out interviews, we also reviewed documents to understand the background of the client's need for system development. In our project, we reviewed both the University's sustainability policies and AMS's Lighter Footprint Strategy to give us a background to understand AMS's need for a database to monitor energy and water usage at the SUB for their reduction initiatives. The requirements identified for the database are as follows:

- user-friendly and easy to use
- ability to show related cost and associated greenhouse green emissions
- ability to display usage data in the correct unit (i.e. electricity – kilowatt hours, water - cubic meter, steam - pounds)
- ability to display graphs of usage in daily, monthly and yearly view, so that users will be able to make usage comparisons between day and night and between summer term and winter term
- low cost of implementation (budget is approximately $20,000)

Analysis

According to the requirements we collected from our client, we considered the following AP (Analysis and Possibilities) question with regards to the technology element in the work system:

AP6: How might better technology help?

<table>
<tr><td>Work System Principles

#15: Use cost effective technology
#16: Minimize effort consumed by technology</td><td>Diagrams and Methods</td></tr>
<tr><td>Performance Indicators

• Training time to ensure proficiency
• User-friendly programs
• Compatibility with existing technologies
• Maintainability
• Reliability
• Cost vs. performance</td><td>Strategy Decisions

• User-friendliness of technology
• System cost
• Maintenance</td></tr>
<tr><td>Stumbling Blocks and Risks

• Expensive software development
• Lack of trained IT personnel to maintain new technology
• Limit on budget</td><td>Possibilities for Change

• Develop and install a database in-house by hiring a database developer and maintain the database by hiring a database administrator
• Outsource database development and maintenance to a specialized company
• Utilize the existing database</td></tr>
</table>

Specification

To model AMS, we used Object Oriented Enterprise Modeling since it is more important to understand how AMS used energy and water in the SUB. It will be helpful to model the different services provided by the AMS instead of looking into details of the various business processes. Although the AMS offers a wide range of services to students, faculty staff and clubs, we have only listed a few examples of these services for illustration purposes (please refer to Figure 7 for the model).

Validation

Throughout the project, we validated information accuracy and completeness with the client through emails and interviews. For example, we defined the scope of our project to our client through email, clearly stating our responsibilities and the deliverables to expect from this project.

PROBLEMS NOTED

The main problem identified for our project is that there is no known database to the AMS that allows them to monitor and track energy and water usage in the Student Union Building.

Since the AMS does not have its own current database system in place to track the water and energy usage of the SUB, we will be looking at the possible alternatives for database creation to include the required features and graphs that will help facilitate monitoring in future by the AMS.

ALTERNATIVES CONSIDERED

We are proposing these 3 alternative solutions after taking into consideration the constraints to this project and the various findings we have gathered: (Please refer to Figure 8 for details on each option)

1) **Build a brand new database monitoring system**

   In order to build a new database for the AMS to monitor the energy and water usage at the SUB, these factors have to be considered:

   - Tight budget given to project—as such, most decisions made regarding which software product to purchase will be based mainly on the cost of the product.
   - Volume of relevant data and scale of project—this database is used to contain a smaller volume of data sets, compared to the usual enterprises, and the scale of this project is smaller compared to the other projects AMS is currently executing. As such, this project only requires a database that has adequate capacity for the given volume of data sets and has sufficient functions to perform the basic queries.

Hence, keeping the above factors in mind, we have decided to recommend these products and steps to take to build this database system:

- MySQL Enterprise (Basic): $599.00 per server
  - Main database software package that enables storage of data and generation of relevant analyses as supported by available functions
- OPC Systems Windows Service: $795.00 per license
  - Data logging to SQL Server, SQL Server Desktop (MSDE), Access, Oracle, mySQL, and CSV files.
  - Unique data handling from local and remote services
  - Runs as a Windows Service and comes with free configuration application to allow on-line modifications from local or remote systems
- Dell PowerEdge™ SC1430: starting from $949
  - Server required to host database
- Hire a Database Administrator with an estimated salary of less than $33,380 per year to maintain the database for future use and generate the relevant analyses for AMS
- Hire a SQL Database Programmer for an estimated cost of $8,000 to $10,000 for 2 to 3 months to program the database software to suit the requirements of AMS

As such, in building a brand new database for the AMS, the total estimated cost incurred would be $45,742.

2) Hire an energy management firm to build a database and generate analyses for AMS

The proposed firm would be Small Energy Group (SEG) in this case because SEG has already been hired by UBC to build a database for the other buildings on campus such as the libraries and the university hospital, so it would be more convenient and cost-efficient to hire SEG for this project since they have the relevant infrastructure in place for the database, and all they have to do is to create a similar database for the SUB to monitor its energy and water usage as required by the AMS.

SEG is an energy management group that provides solutions to address the energy management needs of building managers. Their approach to energy efficiency is to focus on improving energy usage in a way that is not disruptive to the rest of the organization. They have advisors who have experience in the energy sector, as well as other professional staff who have received training in areas such as electrical engineering and business management. As such, SEG would have adequate expertise and skills to provide the necessary advice to fulfill the requirements of the AMS.

As SEG is a consulting firm, we are not able to come up with a definite cost for hiring them unless a concrete contract has been formed between the AMS and SEG. Thus, we have estimated the cost of hire to be around $30,000-$35,000, and the contract would probably include meter and data logging installations, a customized website for the AMS to broadcast its findings and data, and consultation and maintenance services.

3) Maintain the status quo

The last solution proposed would be for AMS to utilize the existing database, which is maintained by the utilities department, to extract the data that they need for energy and water usage, and using an additional Excel utility, prototyped by our group, to analyze the relevant data. This approach would not cost AMS anything as they already have the necessary software installed into their systems. However, this approach would require an administrator to create and maintain the utility as well as to generate the necessary analyses from the worksheets. AMS may need to hire an additional IT assistant or administrator if they do not have the necessary human resource to manage this additional workload. Hiring an additional personnel would cost AMS approximately $24,000 or less a year, since the system created does not need to be handled by someone highly proficient in database systems.

RECOMMENDATIONS AND IMPLEMENTATION PLAN

Based on the alternatives stated above, we considered the following RJ (Recommendation and Justification) questions to arrive at our recommendation.

RJ1: What are the recommended changes to the work system?

- Utilize the current database system (from the ION website) and extract required data from that database instead of creating a new database for the SUB

- Make use of Excel utility to generate relevant analyses
- Lower cost alternative is preferred due to the given tight budget, hence adopting a status quo position should be the preferred solution

RJ2: How does the preferred alternative compare to other alternatives?

- The preferred alternative is more cost and labor efficient since the person attending to the current database system and generating the relevant analyses in Excel does not need to be highly proficient in IT
- As presented in the pricing table in the appendix (Figure 8), the preferred alternative incurs the lowest cost out of all 3 alternatives

RJ3: How well do recommended changes address the original problems and opportunities?

- Originally, a database was required by the AMS to monitor the SUB's energy and water usage and to generate the relevant analyses for AMS to study the usage patterns of energy and water so that they can find ways to reduce future usage of energy and water
- Currently, the proposed solution includes both the database and the excel spreadsheet that helps them to generate the analyses that they want and allows them to do so without additional cost
- Given the tight budget and consideration for future projects that AMS may be involved in that contribute directly towards helping them implement solutions to reduce future energy and water usage, the solution to remain status quo would be the best approach they should adopt

Recommendation

After careful consideration of the three possible alternatives, we would recommend the status quo option to AMS. By implementing the status quo option, we will be utilizing the current energy tracking system to provide a snapshot energy/cost figure before efforts to reduce the energy usage in the SUB are implemented. Information included in the generated report contains the total electricity, steam, and water usage over a day or an entire year and the related costs. It also includes the estimated amount of greenhouse gas emissions associated with producing the energy. This snapshot can be used as a comparison baseline figure as more snapshots are taken throughout the course of the energy-reduction phase, and once more at the end, when determining whether sustainability goals have been met.

Implementation Plan

According to our recommendation of maintaining the status quo, we will provide information on each of the seven stages of implementation:

1) Coding

Through prototyping, we have found that most cost-saving way to design such a utility is through the use of existing software, instead of building a completely new interface. We are recommending that the utility be built within Microsoft Excel, with the use of macros coding. The program allows us to easily manipulate number data, and can generate charts from a series of numbers to view trending patterns. These are basic, but powerful features that have been used extensively by many, and allow us to save time and money developing these features in a new program. In addition, many people have already used Excel before and are familiar with its operation.

Visual Basic for Applications (VBA) is the language used for macros coding in Excel. It is compiled at runtime, so the programmer is able to code on any computer (Windows or Mac) that has Microsoft Excel installed for maximum portability. The coder will need to possess general coding knowledge, as well as a good understanding of Excel, the object models involved, the basic functions one can perform on a spreadsheet. The code will be written from scratch, as there are no similar tools that we know of that currently does this type of analysis, nor is there one customized for use with the current ION website.

2) Testing

Testing of the utility will be done by the developer in Visual Basic Editor within Excel. Since the language is compiled at runtime, the developer will need to be familiar with using the built-in debugger to step through the code manually as it runs. The editor also automatically checks for valid coding syntax as each line of code is written, lowering the risk of leaving syntax errors unnoticed and building up until runtime. After all the individual functions have been tested, a small team of 1-3 beta-testers will be needed to verify its functionality and any GUI-related or logical errors.

3) Installation

The final product, an Excel file, will be deployed to the end users, who are mainly the managers. It is small enough to be distributed via CD, memory stick, or e-mail with appropriate compression software (ZIP). It will be a direct installation, since there was not previously any energy analysis utility installed. Also, the file is self-contained, so it will not cause any conflicts with any other software.

4) Documentation

The developer of the utility shall be required to produce the proper user documentation such that any user of the utility will be able to use it without much assistance. It will contain step-by-step instructions on how to generate, saving, and comparing a basic report, as well as supplemental screenshots to help the user understand which cells are user-modifiable.

5) Training

Since the utility is very straightforward, the developer can hold a one-time tutorial session where users of the spreadsheet utility can learn hands-on and be familiarized with the interface.

6) User support

Since one of the goals of this recommendation is also to reduce the cost as much as possible, the end-user support will be very limited.

The existing ION website database (data) will be supported and managed by the UBC Utilities Department.

7) Maintenance

Depending on the agreement with the developer, the code may or may not be released to the client. If it is not, fixing any bugs not spotted before the acceptance testing or implementing new features may incur additional costs.

Appendices:

Project Consultants:

Name	Telephone	Email Address
Priscilla Tsang (Coordinator)	604-339-3488	priz105@interchange.ubc.ca
Sam Lin	604-808-5126	linsam@interchange.ubc.ca
Dorothy Cheung	604-603-7892	dorothyc@interchange.ubc.ca
Geraldine Ong	778-838-2039	ongsmger@interchange.ubc.ca

Important Sources

Name: Miriam Stein
Position: AMS Sustainability Strategy Coordinator
Email: sustainability@ams.ubc.ca

Name: Orion Henderson
Position: UBC Climate Change and Energy Manager
Email: orion.henderson@ubc.ca

Name: Brenda Sawada
Position: UBC SEEDS Project Manager
Email: brenda.sawada@ubc.ca

Relevant Information/Support Documents (please refer to the next few pages)

Figure 1a: SUB Floor Plan - Lower level

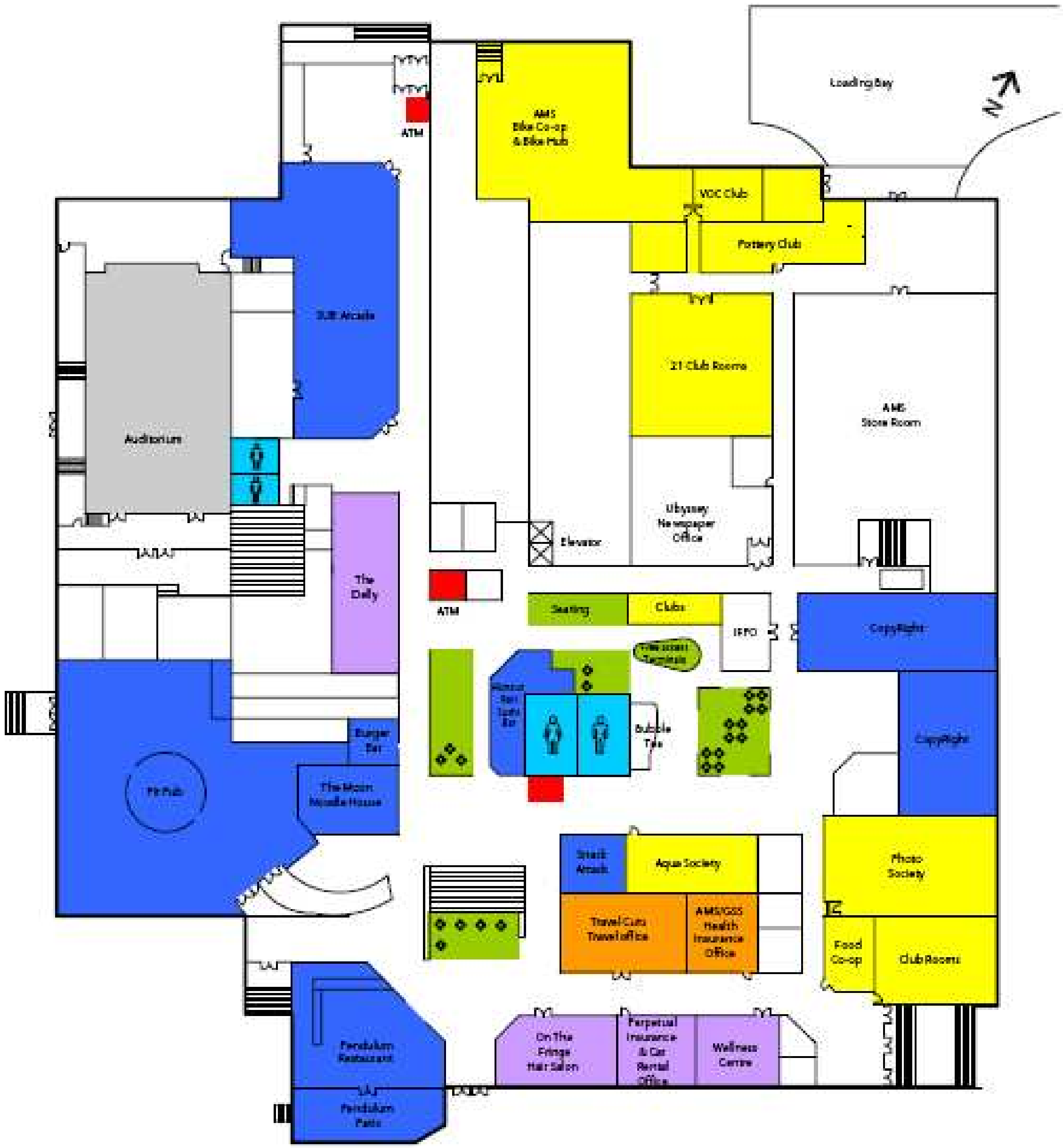


Figure 1b: SUB Floor Plan - Main Level

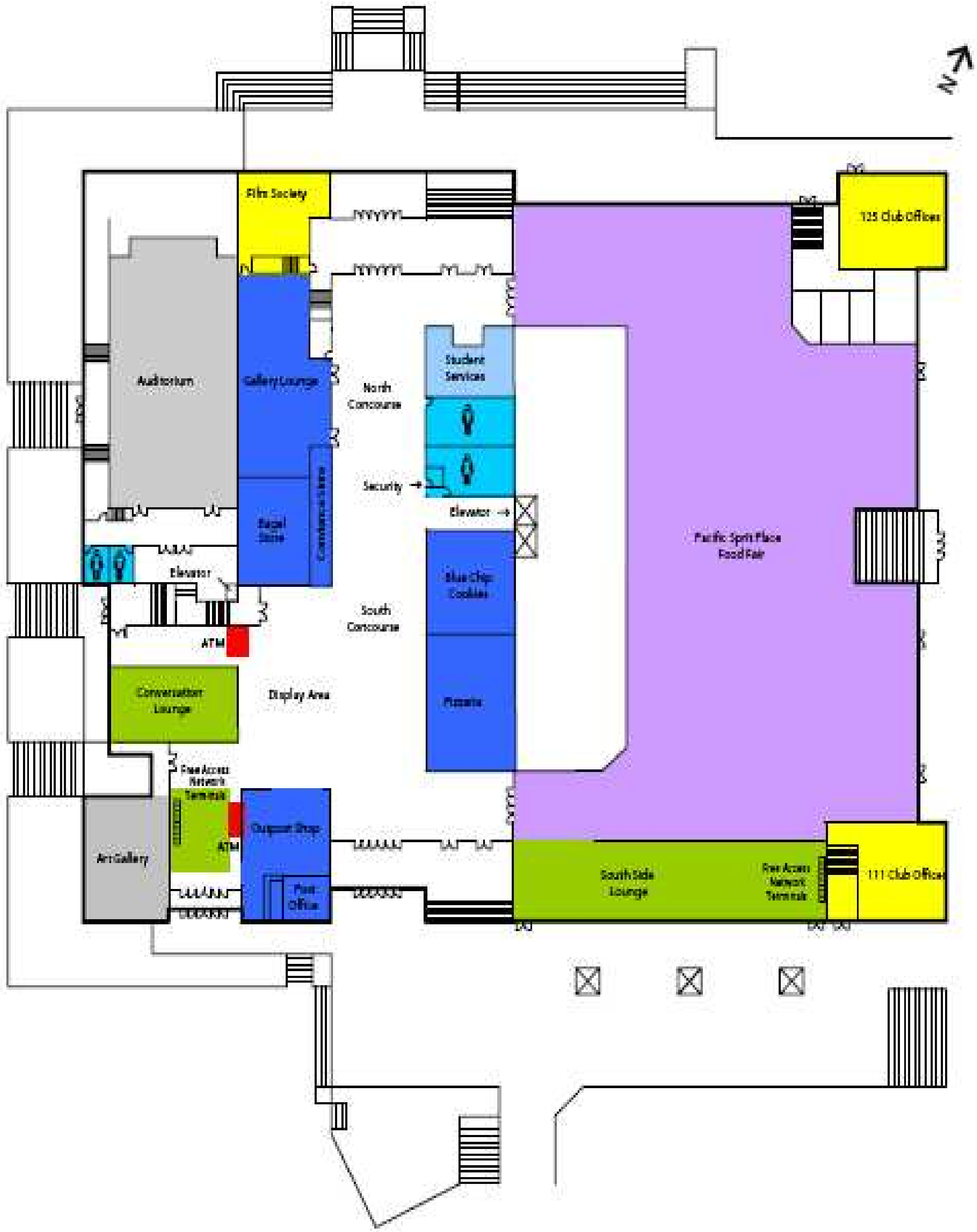


Figure 1c: SUB Floor Plan - Second Level

Figure 2 – SUB Energy Usage Data

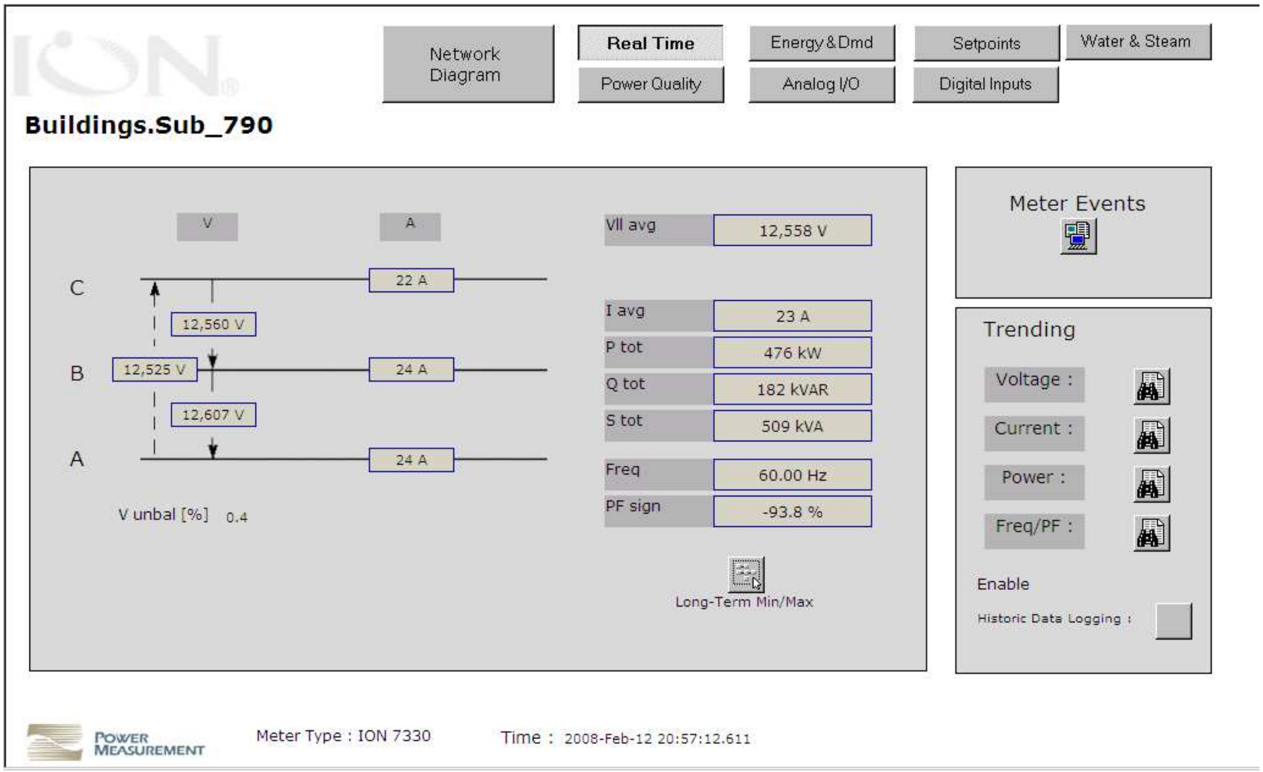


Figure 3 – SUB Historical Energy Usage from Database Website

Buildings.Sub_790

Device Diagram | Change Date Range

Show Graph

Timestamp	kW tot mean	kVAR tot mean	kVA tot mean
2008-Feb-12 21:00:00.000	498.929	180.516	530.622
2008-Feb-12 20:45:00.000	519.211	179.097	549.247
2008-Feb-12 20:30:00.000	521.308	177.778	550.8
2008-Feb-12 20:15:00.000	516.424	179.168	546.648
2008-Feb-12 20:00:00.000	543.552	189.011	575.508
2008-Feb-12 19:45:00.000	590.441	192.991	621.228
2008-Feb-12 19:30:00.000	574.479	188.785	604.743
2008-Feb-12 19:15:00.000	544.005	186.836	575.206
2008-Feb-12 19:00:00.000	564.484	191.541	596.131
2008-Feb-12 18:45:00.000	598.998	194.337	629.772
2008-Feb-12 18:30:00.000	620.95	202.845	653.266

Figure 4 – SUB Daily Energy Usage Graph

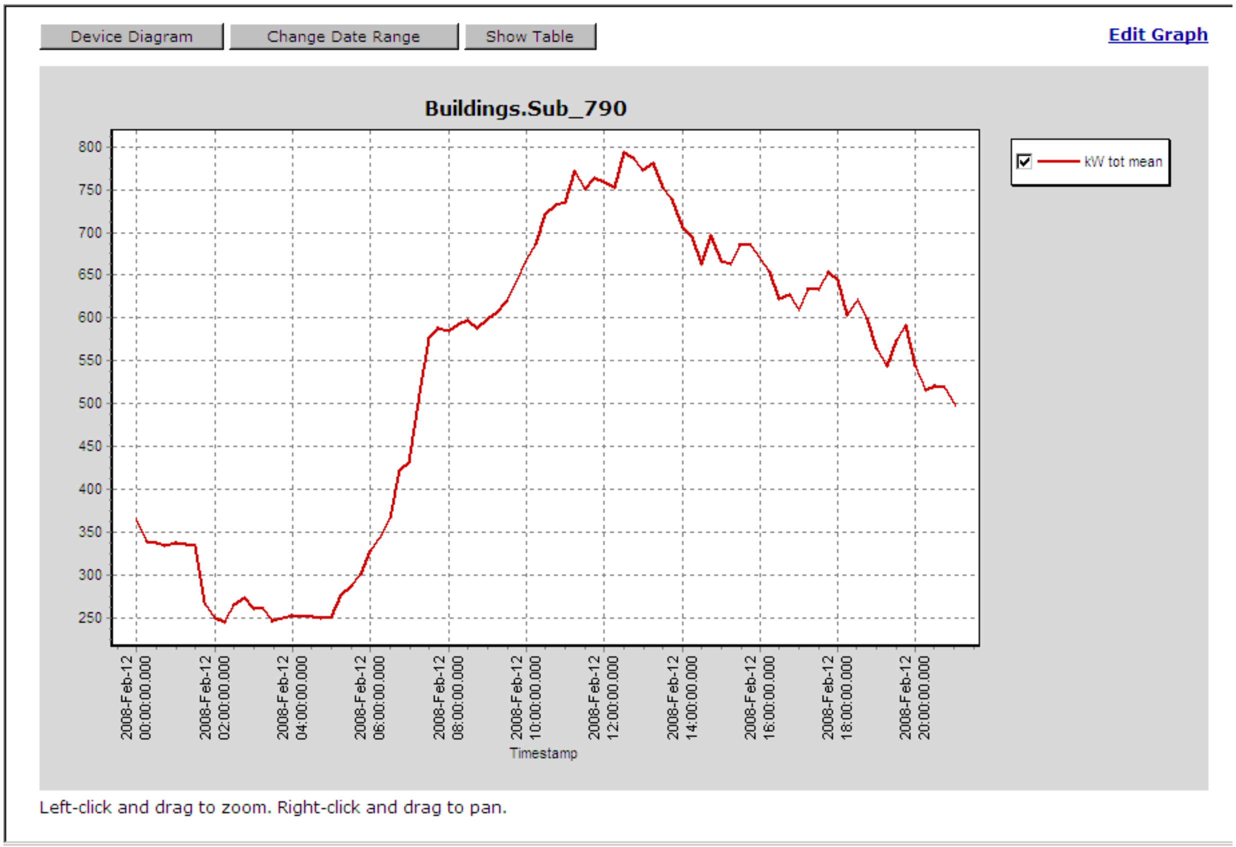


Figure 5 – Energy Supply at UBC

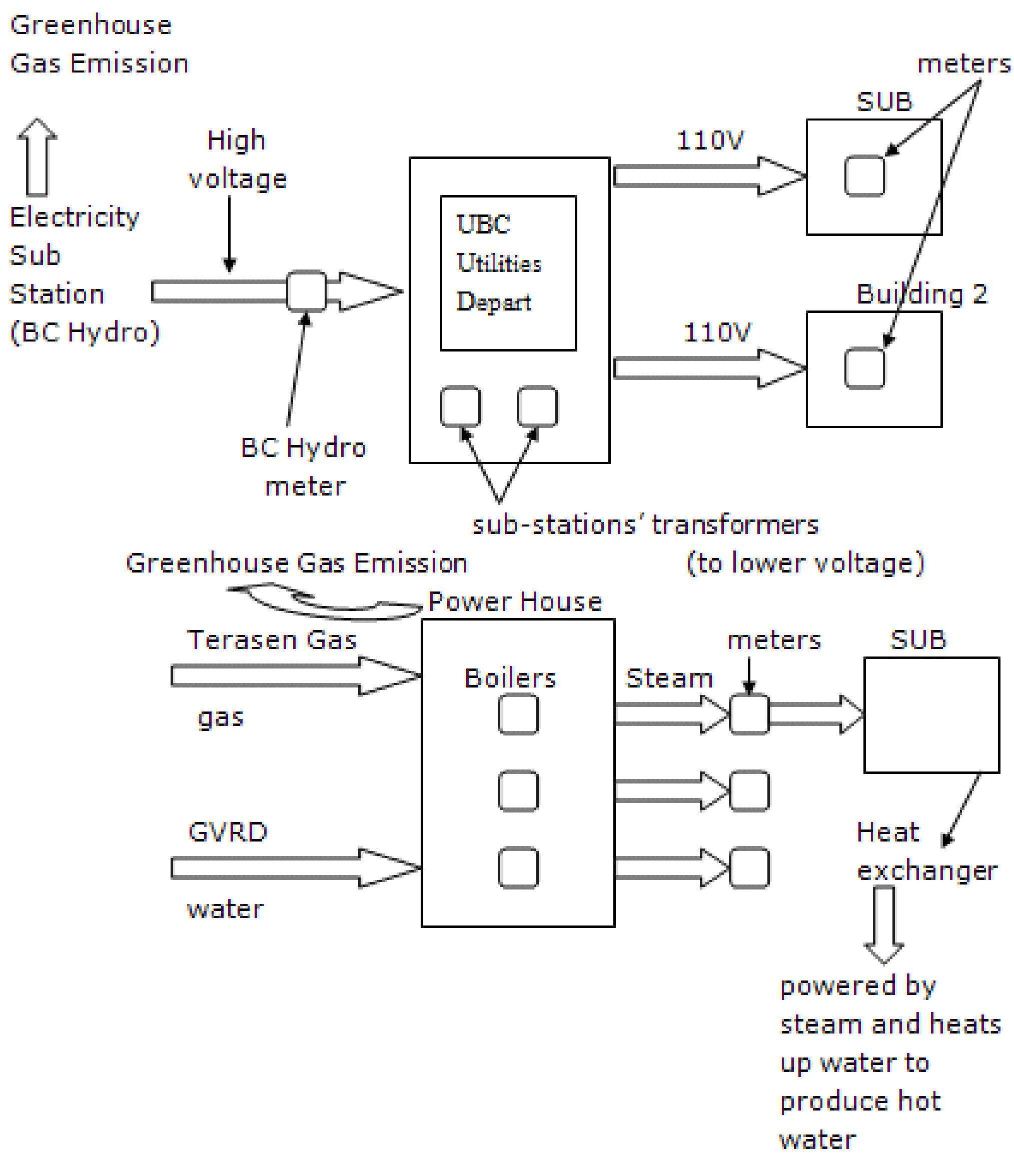


Figure 6 – "Clean-Air Cool Planet" Spreadsheet Calculator (for calculating Greenhouse gas emissions)

MODULE	Input								
WORKSHEET	Data								
UNIVERSITY									
On-Campus Co-generation Plant									
Fiscal Year	Enter fuel use and plant efficiencies for the On-Campus Cogeneration Plant								
	Residual Oil (#5 - #6)	Distillate Oil (#1 - #4)	Natural Gas	Propane	Coal	Electric Output	Steam Output	Electric efficiency	Steam Efficiency
	Gallons	Gallons	MMBtu	Gallons	Tons	kWh	kWh	%	%
1990									
1991									
1992									
1993									
1994									
1995									
1996									
1997									
1998									
1999									
2000									
2001									
2002									
2003									
2004									
2005									
2006									
2007									
2008									
2009									
2010									
2011									
2012									
2013									
2014									
2015									
2016									
2017									
2018									
2019									
2020									

Figure 7 – OOEM Model of the Alma Mater Society (AMS)

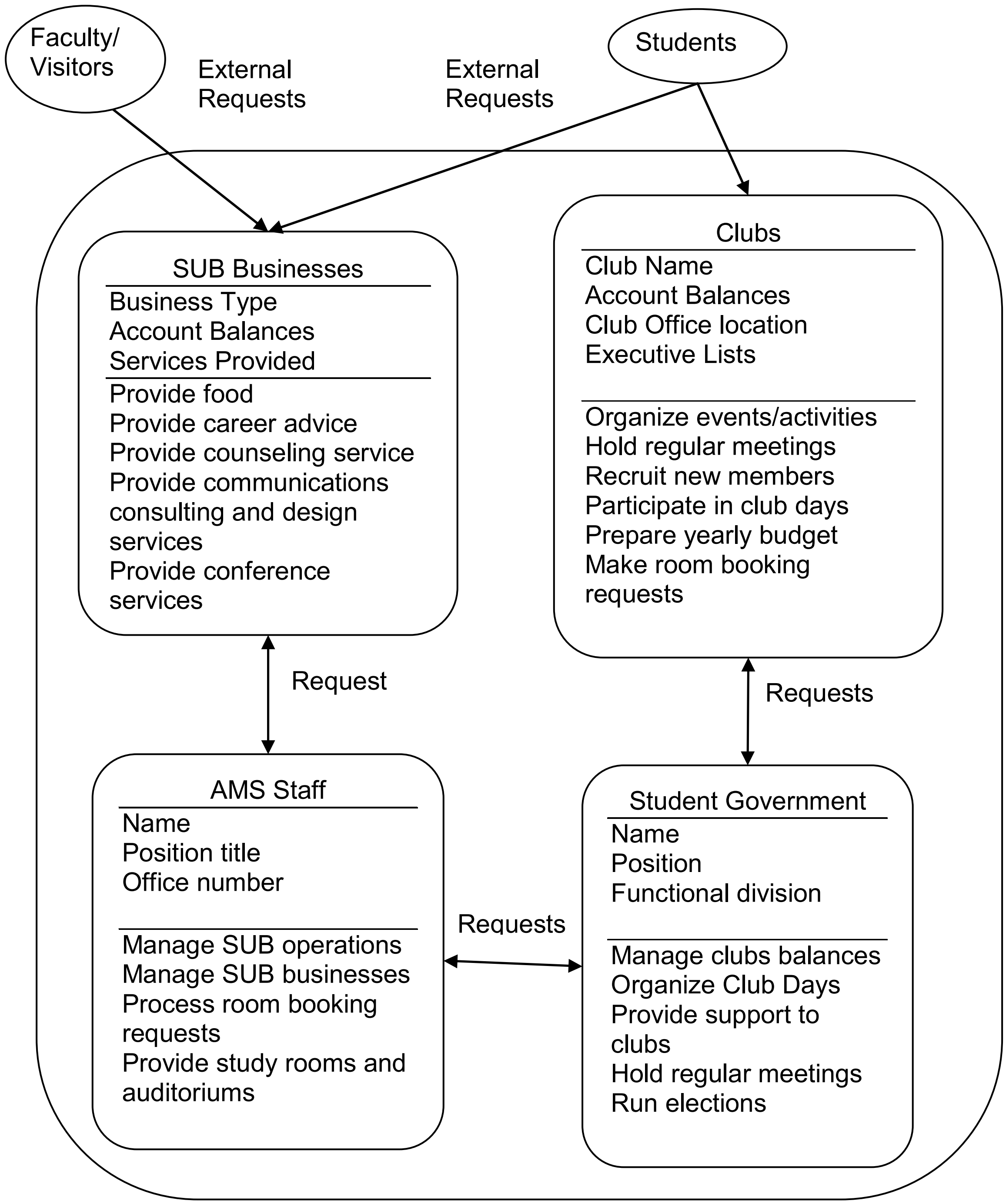


Figure 8 – Three possible alternatives of database creation

Alternative 1 - Build a brand new database monitoring system:

Build			
Database Support (License)	**Price (per year)**	**Specifications**	**Recommendation**
MySQL Enterprise (Basic)	$599.00 per server	Monthly Rapid Updates Quarterly Service Packs Software Updates Service Technical Alerts MySQL Enterprise Server Web-based Case Mgmt Support Knowledge Base Support Active Lifecycle Support	Recommended Pdt
Data Logging for SQL server (License)	**Price (per year)**	**Specifications**	**Recommendation**
OPC Systems Windows Service	$795.00 per license	Activates 1 OPC Systems Service for support of local data logging from local and remote OPC Systems Services (per license) Supports free connections to OPC Servers supporting OPC Data Access Specification 2.x or 3.0 Data source for each Tag can be a fixed value, local or remote OPC Item, or another local or remote Tag Parameter Implements .NET Remoting thus eliminating the need for DCOM configuration by connecting all OPC Servers locally with each OPC Systems Service Supports on-line modification while the system is running	Recommended Pdt
Server (to host Database)	**Price**	**Specifications**	**Recommendation**
Dell PowerEdge™ SC1430	Starting From $949	Dual Core Intel® Xeon® 5130; 4MB Cache, 2.0GHz, 1333MHZ FSB Memory: 1GB 667Mhz(2x512), Single Ranked DIMMs 1st Hard Drive: 80GB, SATA, 3.5-inch, 7.2K RPM Hard Drive On-Board Single Gigabit Network Adapter 3yr Basic Support: 5x10 HW-Only, 5x10 NBD Onsite	Recommended Pdt
Database Developer / Administrator	**Salary**	**Job Scope**	
Database Administrator	Less than $33,380 per year (Earnings of lowest 10% based on statistics compiled by U.S. Bureau of Labor Statistics, 2004)	Maintain storage systems Monitor system's performance Run networks to maximise user efficiency	
Database Programmer	**Salary**	**Job Scope**	
SQL Database Programmer	$40,000-$70,000 annual About $8,000-$10,000 for 2 months	Communicate with non-technical end-users Develop software in C, SQL, PHP, 4GL Write documents and user guides Implementation training and product support	
Total estimated cost of building (1st year)	**$45,724.00**		
Cost for subsequent years (each additional year)	**$34,774.00**		

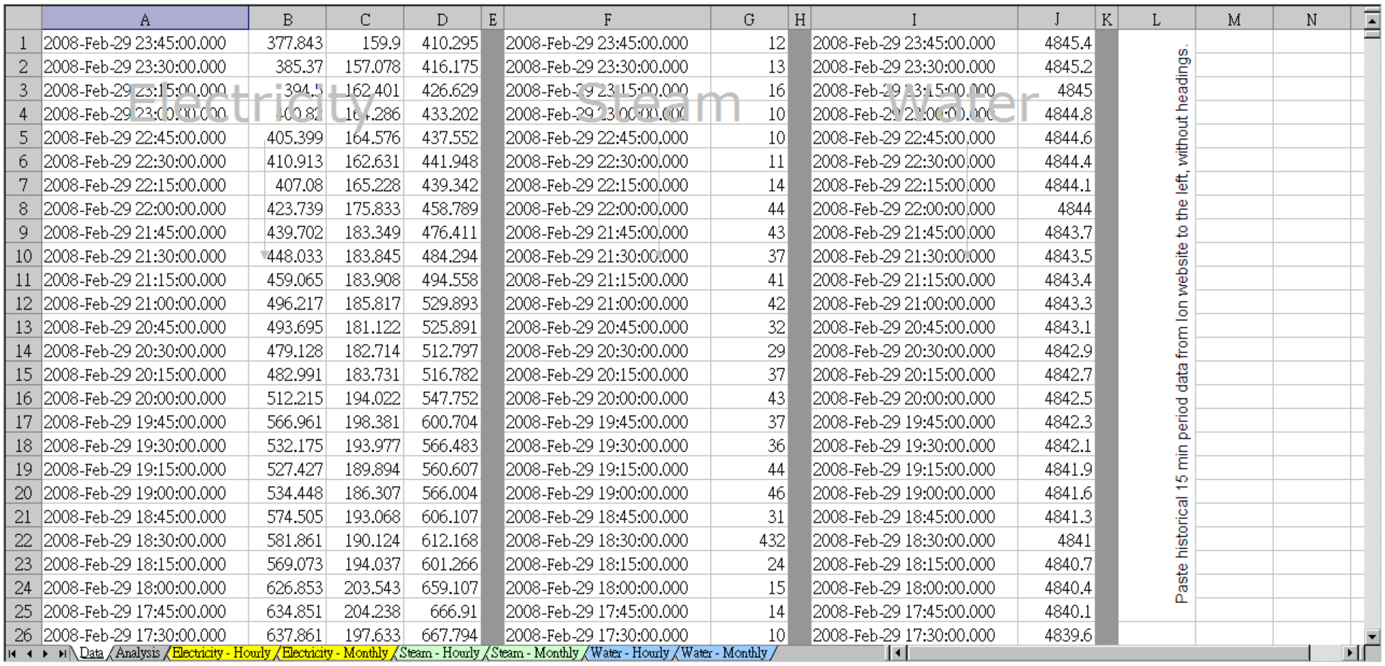
Alternative 2 - Hire an energy management firm to build database and generate analyses for AMS:

Buy	
Consulting Firm	**Fees**
Small Energy Group Meter and Data Logging installations Customized Website Consultation and Maintenance Fees Monthly Hosting Fee	About $30,000-$35,000 <$100
Total estimated cost of hire	**$30,000-$35,000**

Alternative 3 – Maintain the Status Quo:

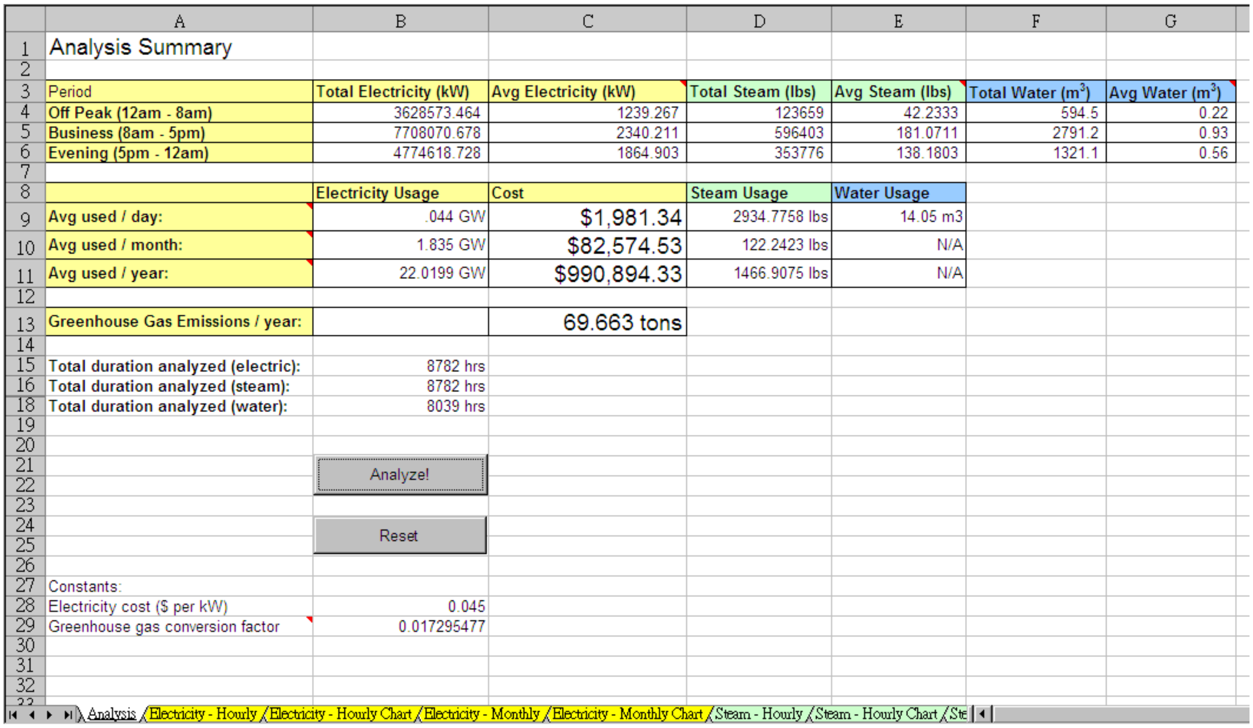
Status Quo	
Database Support	**Price**
Database on ION website (maintained by Utilities Department)	$0
Excel worksheet for data analysis (created by Sam)	$0
IT/Database Administrator (may or may not be required)	**Salary**
IT Administrator/ Assistant	<$24,000 per year
Total estimated cost (per year)	**<$24,000**

Figure 9 – Prototype Energy Analysis Utility data worksheet



	A	B	C	D	F	G	I	J
1	2008-Feb-29 23:45:00.000	377.843	159.9	410.295	2008-Feb-29 23:45:00.000	12	2008-Feb-29 23:45:00.000	4845.4
2	2008-Feb-29 23:30:00.000	385.37	157.078	416.175	2008-Feb-29 23:30:00.000	13	2008-Feb-29 23:30:00.000	4845.2
3	2008-Feb-29 23:15:00.000	394.5	162.401	426.629	2008-Feb-29 23:15:00.000	16	2008-Feb-29 23:15:00.000	4845
4	2008-Feb-29 23:00:00.000	400.82	[illegible]	433.202	2008-Feb-29 23:00:00.000	10	2008-Feb-29 23:00:00.000	4844.8
5	2008-Feb-29 22:45:00.000	405.399	164.576	437.552	2008-Feb-29 22:45:00.000	10	2008-Feb-29 22:45:00.000	4844.6
6	2008-Feb-29 22:30:00.000	410.913	162.631	441.948	2008-Feb-29 22:30:00.000	11	2008-Feb-29 22:30:00.000	4844.4
7	2008-Feb-29 22:15:00.000	407.08	165.228	439.342	2008-Feb-29 22:15:00.000	14	2008-Feb-29 22:15:00.000	4844.1
8	2008-Feb-29 22:00:00.000	423.739	175.833	458.789	2008-Feb-29 22:00:00.000	44	2008-Feb-29 22:00:00.000	4844
9	2008-Feb-29 21:45:00.000	439.702	183.349	476.411	2008-Feb-29 21:45:00.000	43	2008-Feb-29 21:45:00.000	4843.7
10	2008-Feb-29 21:30:00.000	448.033	183.845	484.294	2008-Feb-29 21:30:00.000	37	2008-Feb-29 21:30:00.000	4843.5
11	2008-Feb-29 21:15:00.000	459.065	183.908	494.558	2008-Feb-29 21:15:00.000	41	2008-Feb-29 21:15:00.000	4843.4
12	2008-Feb-29 21:00:00.000	496.217	185.817	529.893	2008-Feb-29 21:00:00.000	42	2008-Feb-29 21:00:00.000	4843.3
13	2008-Feb-29 20:45:00.000	493.695	181.122	525.891	2008-Feb-29 20:45:00.000	32	2008-Feb-29 20:45:00.000	4843.1
14	2008-Feb-29 20:30:00.000	479.128	182.714	512.797	2008-Feb-29 20:30:00.000	29	2008-Feb-29 20:30:00.000	4842.9
15	2008-Feb-29 20:15:00.000	482.991	183.731	516.782	2008-Feb-29 20:15:00.000	37	2008-Feb-29 20:15:00.000	4842.7
16	2008-Feb-29 20:00:00.000	512.215	194.022	547.752	2008-Feb-29 20:00:00.000	43	2008-Feb-29 20:00:00.000	4842.5
17	2008-Feb-29 19:45:00.000	566.961	198.381	600.704	2008-Feb-29 19:45:00.000	37	2008-Feb-29 19:45:00.000	4842.3
18	2008-Feb-29 19:30:00.000	532.175	193.977	566.483	2008-Feb-29 19:30:00.000	36	2008-Feb-29 19:30:00.000	4842.1
19	2008-Feb-29 19:15:00.000	527.427	189.894	560.607	2008-Feb-29 19:15:00.000	44	2008-Feb-29 19:15:00.000	4841.9
20	2008-Feb-29 19:00:00.000	534.448	186.307	566.004	2008-Feb-29 19:00:00.000	46	2008-Feb-29 19:00:00.000	4841.6
21	2008-Feb-29 18:45:00.000	574.505	193.068	606.107	2008-Feb-29 18:45:00.000	31	2008-Feb-29 18:45:00.000	4841.3
22	2008-Feb-29 18:30:00.000	581.861	190.124	612.168	2008-Feb-29 18:30:00.000	432	2008-Feb-29 18:30:00.000	4841
23	2008-Feb-29 18:15:00.000	569.073	194.037	601.266	2008-Feb-29 18:15:00.000	24	2008-Feb-29 18:15:00.000	4840.7
24	2008-Feb-29 18:00:00.000	626.853	203.543	659.107	2008-Feb-29 18:00:00.000	15	2008-Feb-29 18:00:00.000	4840.4
25	2008-Feb-29 17:45:00.000	634.851	204.238	666.91	2008-Feb-29 17:45:00.000	14	2008-Feb-29 17:45:00.000	4840.1
26	2008-Feb-29 17:30:00.000	637.861	197.633	667.794	2008-Feb-29 17:30:00.000	10	2008-Feb-29 17:30:00.000	4839.6

Figure 10 – Prototype Energy Analysis Utility analysis worksheet



	A	B	C	D	E	F	G
1	Analysis Summary						
2							
3	Period	Total Electricity (kW)	Avg Electricity (kW)	Total Steam (lbs)	Avg Steam (lbs)	Total Water (m^3)	Avg Water (m^3)
4	Off Peak (12am - 8am)	3628573.464	1239.267	123659	42.2333	594.5	0.22
5	Business (8am - 5pm)	7708070.678	2340.211	596403	181.0711	2791.2	0.93
6	Evening (5pm - 12am)	4774618.728	1864.903	353776	138.1803	1321.1	0.56
7							
8		Electricity Usage	Cost	Steam Usage	Water Usage		
9	Avg used / day:	.044 GW	$1,981.34	2934.7758 lbs	14.05 m3		
10	Avg used / month:	1.835 GW	$82,574.53	122.2423 lbs	N/A		
11	Avg used / year:	22.0199 GW	$990,894.33	1466.9075 lbs	N/A		
12							
13	Greenhouse Gas Emissions / year:		69.663 tons				
14							
15	Total duration analyzed (electric):	8782 hrs					
16	Total duration analyzed (steam):	8782 hrs					
18	Total duration analyzed (water):	8039 hrs					
19							
20							
21		Analyze!					
22							
23							
24							
25		Reset					
26							
27	Constants:						
28	Electricity cost ($ per kW)	0.045					
29	Greenhouse gas conversion factor	0.017295477					
30							
31							
32							

Analysis / Electricity - Hourly / Electricity - Hourly Chart / Electricity - Monthly / Electricity - Monthly Chart / Steam - Hourly / Steam - Hourly Chart / Ste

Figure 11 – Prototype Energy Analysis Utility sample generated chart