



City of Gillette

APPA DEED Student Internship

**Schedule for HVAC & Related GIS Based
Inventory and Depreciation of Equipment**

James Rundel-Sustainability Intern

Michael Foote- Sustainability Coordinator; Supervisor

APPA DEED Student Internship

Project Title: Schedule for HVAC & Related GIS Based Inventory and Depreciation of Equipment

Utility Name and Address:

City of Gillette
201 E. 5th Street
P.O. Box 3003
Gillette, WY 82717

Utility Description:

The City of Gillette is the county seat of Campbell County Wyoming and has a population of 29,389 (2011). Gillette provides water, wastewater, sanitation and electric service to its citizens. In 2010 Gillette served approximately 12,043 residential and 2,230 commercial/industrial customers. The City has an annual power demand of approximately 318,000 MWh. In 2010, total revenue from sales of electricity was \$23,198,849. The City has also acquired an ownership interest in the Wygen III coal fired power plant, located just east of the City and co-owned by Montana Dakota Utilities and Black Hills Power and Light, which operates the plant. The plant supplies roughly 30% of the City's energy demand. The City also purchases power from the Municipal Energy agency of Nebraska and is entitled to an allocation of preference power from the Western Area Power Administration. Due to the local abundance of natural resources, namely coal, the state and local utilities are primarily coal based generation.

Project Term

June 17, 2013-July 31, 2013

Personnel

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Purpose

Due to the nature of public funding and reserve accounts, municipal utilities often experience difficulties during forecasting and purchasing processes which tend to be atypical, when compared to the private sector. Various challenges in this area include the management of preventive maintenance, purchasing of new equipment, and forecasting repair budgets. When attempting to manage these challenges, public staff often finds that available data is inadequate for optimum management of these issues. These challenges are particularly relevant to HVAC equipment due to the high replacement costs and installation barriers inherent in the nature of HVAC equipment.

The purpose of this project is to develop a method of tracking and documenting historical data, current configurations, and ascertain future equipment needs, as related to HVAC equipment. This project utilizes GIS technology to store all HVAC inventory data throughout City Hall. This data includes, but is not limited to: location, equipment manufacturer, model/serial number, installation date, estimated replacement costs, life expectancy, and a short item description. It is the intent of this project that this enhanced GIS-based inventory system can be used to ameliorate some of the challenges associated with the forecasting and maintenance of HVAC equipment in public and municipal utilities. By consolidating HVAC data from various sources into a single, more comprehensive database, public and municipal utilities would be better equipped to manage some of the challenges associated with the forecasting and purchasing processes.

Description

The primary objective of the project was to collect and consolidate a variety of data related to the HVAC equipment within City Hall. The first step in this process was using “as-built” plans for City Hall to physically locate and document all relevant HVAC equipment within City Hall. After the equipment was physically located, the location of the equipment was recorded on a hard copy map. In conjunction with recording the physical location, other relevant information, such as model/serial number, equipment manufacturer, and a short description of the equipment was also recorded. Once the equipment data had been recorded on hard copy maps, it was then digitized into the City’s GIS database.

The basic location data was entered into GIS database and developed into an inventory of the existing HVAC equipment. After the basic inventory of the equipment was developed, historic and maintenance data was then collected. Research was also conducted in order to ascertain the lifecycles and approximate replacement costs for the large equipment that had been identified. After this auxiliary information was collected, it was linked to the corresponding location points within the GIS database.

After all relevant information had been entered into GIS, a depreciation schedule was developed for the equipment that had been identified. The development of this depreciation schedule required collaboration with the finance department in order to structure a schedule that was appropriate for the City’s book-keeping. The depreciation schedule can be used as a tool to help plan for the maintenance of the HVAC system.

Overview

The goal of the project was to develop a GIS-based inventory of the HVAC equipment in City Hall that also includes supplementary information about the equipment. By including supplementary information about the equipment along with the inventory, it was anticipated that developing this enhanced inventory system would help mitigate some of the planning and procurement challenges faced by municipal utilities, especially in the area of HVAC equipment. Overall, using GIS to construct a more robust inventory system has proved very applicable and effective.

One goal, in the original scope of the project, was to include historical maintenance data in the inventory system in order to create equipment specific maintenance alerts. This objective proved more difficult to implement than originally anticipated. This particular objective proved more difficult to achieve than initially anticipated, due to the accuracy and availability of the maintenance records. The information contained in the existing structure of the maintenance records was not sufficient to complete the goal of creating maintenance records and alerts within the inventory system. However, the City is currently engaged in a retrofit project, in which many features in the HVAC system will be replaced or upgraded. Upon the completion of the retrofit project, a more complete maintenance record could easily be developed. This would allow the addition of maintenance records and alerts into the inventory system.

It is necessary to note the nature and quantity of information that was already contained in the GIS database prior to the start of this project. When this project was initiated, the floor plans of City Hall had already been mapped within the GIS database. This project utilized and built upon the basic floor plans in order to develop the enhanced inventory system. It should be noted that the floor plans utilized in this project were developed prior to the start of this project. Therefore, if a similar project was attempted from scratch, additional efforts would be necessary to develop the basic floor plans.

As a point of interest, it should be noted that during the extent of this project that other systems within City Hall, in addition to the HVAC system, were mapped using the same technique. Some of the other features that were mapped using this technique include the fire protection system, electrical features, architectural features, and plumbing features. The auxiliary information for these additional systems was not developed as completely as for the HVAC system; however, the principle behind the inventory system is unchanged. This shows that the project's concept is applicable to a wide range of systems.

Applicability

This project is very applicable to public and municipal utilities that are seeking to develop a more comprehensive or robust inventory system of key features within the utility. As previously stated, this project applied the concept of mapping large or expensive HVAC equipment to other systems within City Hall. Even though the main objective of the project was intended to provide a tool that would help manage the forecasting and purchasing processes for particularly large or expensive equipment, the concept has shown applicability to maintaining a location based inventory system for a variety of systems/features.

This GIS-based inventory concept is particularly useful because it has the ability to manage a large amount of data with the potential to represent this data in a variety of ways. In the GIS database, information can be sorted by, and presented in layers that are based on user specified criteria, such as location or feature type. This allows for an extensive database that can be quickly and easily manipulated to show only the desired data. Another attribute of this GIS based system is in the presentation of data. Since the GIS system is based on data layers and point locations within the database, all data pertaining to a specific feature is directly linked to the point that represents that feature. However, data can also be displayed in an attribute table based on a selection of feature points or entire data layers. This allows for the analysis or revision of data on a point by point basis or by an entire selection of points.

Results

The project was successful in its main goal of creating a GIS-based inventory system for HVAC equipment in City Hall. The locations of both major HVAC equipment and smaller HVAC features, in City Hall, were physically mapped and recorded. These features included large equipment such as boilers and chillers, as well as smaller features such as vents and thermostats. All of these features were physically located and successfully digitized into GIS. The GIS software served to catalogue the detailed location of equipment and features within the building. Along with cataloguing the location of the HVAC equipment and features, relevant attribute information was also linked to the HVAC features within the GIS software. This attribute information includes, but is not limited to: three-dimensional location, equipment type, make and model of equipment, installation date, expected lifetime, estimated replacement cost, and a brief description.

In addition to mapping the locations and attributes of HVAC equipment, other equipment features within City Hall were also mapped. These feature classes included fire protection equipment, electrical equipment, architectural features, and plumbing features. Mapping these additional feature classes demonstrated the immense potential in a GIS-based inventory system. The system is continually enhanced as more data is added. The result is an interactive system that is capable of storing vast amounts of data, and presenting that data in a very accessible fashion.

One component of the project that did not develop as planned was the gathering and utilization of historical maintenance data related to the HVAC systems. Due to vague and inconsistent record keeping, obtaining the maintenance records proved more difficult than initially anticipated. As a result, this project was not able to incorporate historical maintenance data into the GIS-based inventory system or provide alerts for future maintenance needs within the system. It is anticipated that this could be a common difficulty faced by other entities attempting to utilize this method of inventory. However, if more complete maintenance data became available at a later time, it could be easily integrated into the existing system.

It should also be noted that City Hall is currently in the process of pursuing a retrofit project, in which many of the major HVAC features will be upgraded, relocated, or replaced. This retrofit project is intended to service the existing HVAC equipment and system, with the intention of also increasing energy efficiency. Although it would be necessary to update equipment information and locations after the retrofit is complete, the foundation for this update would already be in place as an element of the current project undertakings. Also, in reference to the previously stated difficulty with obtaining historical maintenance records, the retrofit project would allow for the development of more precise and current maintenance records. After this new set of records is developed, it could be integrated into the GIS-based inventory system as originally proposed. The accomplishments of this project, in relation to current equipment, will serve to form a baseline for comparison to the new equipment, after the completion of the retrofit project.

Finally, a depreciation schedule was successfully developed as a complement to this project. The depreciation schedule is closely tied to the current retrofit project for City Hall and is based largely on the projected costs of the new equipment and upgrades planned for the retrofit project. Although it is not comprehensive for the existing HVAC system, it is an important tool that will assist the City in planning and budgeting for future needs of the HVAC system.

Future Plans

The future plans currently associated with this project are related mainly to the maintenance and improvement of the inventory system that was developed. At this point, the immediate future plans involve updating the HVAC inventory after the retrofit project in City Hall is completed. This will consist of adding new data points, and relevant data associated with these points, while updating or removing other location points. It is the hope of this project that after the retrofit project is completed, accurate maintenance records of the new equipment could be added to the existing database. This would allow for this project's original goal of including maintenance alerts to be recognized. Also, expanding of the goal of this project, data and information on other key systems in City Hall, as well as other buildings in the City's portfolio, could be added to the database.

Budget

The costs of this project were relatively basic. The two main costs associated with this project were the time that was invested and the licensing cost for the GIS software. However, the licensing for GIS software was not seen as a direct cost to this project because the software has already been purchased and licensed for the City's GIS department. The main investment in the project was the time devoted by the Intern, Sustainability Coordinator, and GIS department.

Equipment

There was a limited use of equipment in this project. The only significant equipment used for the project was the ArcGIS software. The specific application that was used in this project was ArcMaps 10.1. This is an extremely robust program that is also very flexible. Although the program is not the most intuitive when starting out, it is much better suited to handle variations of mapping and location services, used in this project, than a traditional CAD program. The ArcGIS software, while rather complex, proved to be an extremely capable and effective tool within the scope of this project and it is highly recommended.

References

Investive Building Projects, (2012). *Gillette City Hall Retro-Commissioning Report*. Littleton, CO

Leach, M., Lobato, C., Hirsch, A., Pless, S., & Torcellini, P. National Renewable Energy Laboratory, (2013). *Technical Support Document: Strategies for 50% Energy Savings in Large Office Buildings*. Garden, CO

Appendix I.

Deliverables to DEED

Lessons Learned

Throughout this project, using GIS to create an inventory system. GIS has proven itself to be more than a location and mapping service; it is truly a data management tool. Consolidating relevant data about equipment from multiple fields into one platform allows for a much more efficient management system. Since all relevant data can be presented in a single platform, it would not be necessary to manage multiple databases to maintain the same information, saving both time and money.

Since the GIS program is location based, the first step in using GIS to create an inventory system is to physically locate the features that are going to be inventoried. The fact that every feature must be assigned a location point within the GIS database has both positive and negative attributes. By assigning a location to every point, there is more relevant and useful information associated with that feature. However, if the physical location of a feature is unknown or constantly changing, the necessity of applying a location point within the database only supplies inaccurate or incomplete information.

Due to the location orientated system, this method of GIS-based inventory works best for objects whose location is static. For example, in the scope of this project, mapping HVAC equipment was very useful and effective. However, this method would not be as successful for inventorying equipment, such as vehicles, that is not attached to a specific location.

One of the aspects that is particularly useful in this inventory method, is its ability to manage a large amount of data with the potential to represent this data in a variety of ways. In the GIS database, data can be sorted by, and presented in layers that are based on a user specified criteria, such as location or feature type. This allows for an extensive database that can be quickly and easily manipulated to show only the desired data.

Another attribute of this GIS based system is in the presentation of data. Since the GIS system is based on data layers and point locations within the database, all data pertaining to a specific feature is directly linked to the point that represents that feature. However, data can also be displayed in an attribute table based on a selection of feature points or entire data layers. This allows for the analysis or revision of data on a point by point basis or by an entire selection of points.

Depreciation Schedule

A depreciation schedule was successfully developed as a complement to the equipment management basis of this project. The depreciation schedule is closely tied to the current retrofit project for City Hall and is based largely on the projected costs of the new equipment and upgrades planned for the retrofit project. The depreciation schedule calculated an estimated annual depreciation expense based on the projected cost of the equipment that will be modified in the retrofit. The schedule also calculated a future replacement cost for the modified equipment that assumes a 3% annual inflation rate. Although it is not comprehensive for the existing HVAC system, it is an important tool that will assist the City in planning and budgeting for future needs of the HVAC system.