

Disney's Enterprise Energy Management Systems

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ABSTRACT

Disney's Enterprise Energy Management Systems integrates commercial energy management systems with custom web-based energy information systems. This technology-based solution is used throughout the Walt Disney World Resort organization by administrative managers, engineering, operations and maintenance staff, and cast members. Using Disney's energy information system, each Disney business unit's energy usage is continually measured using a "utility report card." This special report format stokes some healthy competition between the areas by ranking them based on their energy usage target. Disney's energy management system is used to control the energy usage of air conditioning and lighting systems. Building tune-ups are used to continually adjust the energy management systems to match the facility operational requirements. This combination of people and technology has resulted in a sustainable energy management program at the Walt Disney World Resort. The goal of this chapter is to show how these technical systems all work together to drive Disney's energy management efforts.

DISNEY'S ENERGY MANAGEMENT SYSTEM INFRASTRUCTURE

The energy management systems (EMS) used at the Walt Disney World Resort are used to control energy consuming equipment—primarily for heating, ventilating, and air conditioning (HVAC) equipment, and lighting control.

Over the years, Disney has installed a variety of energy management systems from different vendors, which it continues to operate. One vendor's EMS, the Carrier Comfort Network (CCN)* from Carrier Corporation, controls more than 80 percent of the installed EMS base at the Walt Disney World Resort. ComfortVIEW (formerly called ComfortWORKS) is the Windows-based graphical user interface for the CCN

and is based on a client/server network-based system that uses an SQL database on a server and custom client software on the workstations.

Since ComfortVIEW was designed as a client/server-based system, it is already designed to accommodate multiple EMS networks using a common SQL server database. Connecting a new attraction or resort to an existing ComfortVIEW server involves the installation of a Carrier CCN-to-Ethernet converter. This device provides the connectivity to the Ethernet Lan and the CCN RS-485 controller network. Up to 32 CCN networks can be connected to one ComfortVIEW server in this fashion. Using the high-speed Ethernet, there is no physical distance limitation of the CCN-to-Ethernet converter to the ComfortVIEW server. As an example, the World of Disney Store in New York City is connected to one of the ComfortVIEW servers at the Walt Disney World Resort using a CCN-to-Ethernet converter.

There are five ComfortVIEW EMS servers that connect all of the parks, resorts and support facilities together at the Walt Disney World Resort. Likewise, there are ComfortVIEW EMS servers at the Disneyland Resort in California, Disneyland Paris Resort in France, and Hong Kong Disneyland. All of these ComfortVIEW EMS servers can be accessed from a user's PC using the ComfortVIEW client software. Logon access control is through a UserID and password that defines the user's access rights. Other features of Disney's EMS infrastructure are shown below:

- Review of EMS field panel programming and real-time operation can be made "globally" through any desktop PC on the corporate network.
- The EMS program and data are stored on network servers maintained by the Walt Disney World Information Services group. Backups are made daily.
- Automatic reset of equipment time and setpoint schedules are made daily from a server-side control program.
- Data collection for both EMS point trends and utility meter data can be collected and used by the energy information system for quick and easy display.
- Maintenance and training of the EMS is simplified.
- Service contracts are minimized or eliminated.

*Any reference to specific products or name brands of equipment, software, or systems in this article is for illustrative purposes and does not necessarily constitute an endorsement implicitly or explicitly by the authors of this article or the others in this book.

- EMS spare parts inventory is minimized.

The key to Disney's success is that it is able to design, install, program, and operate its EMS. As facilities are added or upgraded, the new HVAC and lighting controls are also upgraded and added to one of the existing ComfortVIEW EMS servers. In the end, everything works; that's the most important thing.

DISNEY'S ENERGY INFORMATION SYSTEM INFRASTRUCTURE

In 1997, Disney developed its first energy information system and chose to go the "do-it-yourself" route, primarily because there were few choices available at the time. Today, there are numerous software and hardware tools on the market that can be used to create an energy information system. Likewise, there are numerous companies that provide an EIS for an ongoing monthly service fee. Even with these new options, Disney's "do-it-yourself" approach has proven to be the most cost-effective strategy based on the amount of utility data processed.

The hardware and software products selected by the development team were based primarily on its familiarity with the products. The first item required was a server. Disney's I.T. department supplied and maintains the server hardware and operating system. It is responsible for updating the operating system security and anti-virus updates, along with routine backups for the server.

To create programs that display energy data on an intranet or the internet, web server software is required. Microsoft Internet Information Server (IIS) was used as the web server program since it was already included with the Microsoft XP server operating system supplied with the server.

To "warehouse" the large amount of data collected from meters and energy management systems, a relational database management system is needed. Microsoft Visual Foxpro was used as the database management system. Another program, called Foxweb, was chosen to interface the Visual Foxpro programs and the web server software. More information about FoxWeb is available at <http://www.foxweb.com>.

Utility usage graphs are also useful for charting trends in the utility data. Kavacharts uses Java applets for graphing and can be downloaded for free at <http://www.ve.com>.

Finally, the Autotask 2000 program was used to schedule when data collection programs are launched during the day. Additional information on Autotask 2000 is available at <http://www.cypressnet.com>.

UTILITY REPORTING SYSTEM (URS)

The utility reporting system (URS) was Disney's first web-based energy information system and was created in 1997. The URS was developed to report and graph monthly utility data from the Reedy Creek Improvement District (RCID) to track the results of energy saving efforts at the Walt Disney World Resort. [1]

The URS uses an off-the-shelf database management system program to (1) gather the data from all data sources and (2) publish the data on the Disney intranet. The advantage of this approach is that the programs can be customized to collect all utility data—no matter its source—from a variety of existing utility data sources.

The URS was developed to make sub-metering more effective. By continuously "shining a light" on utility usage at each facility, utility costs are minimized by the actions of people who receive timely and informative reports. Continuous feedback on utility performance pinpoints problems in the energy management system that needs attention.

The URS is used everyday by users throughout the Walt Disney Company. The URS is now used at the Disneyland Resort in California, Disneyland Paris Resort, and Hong Kong Disneyland. This is a testament to the URS, simplicity and low cost of operation.

URS Program Overview

Each month the RCID utility billing data are output from the RCID utility billing system as a comma delimited file for each meter showing the account number, utility, consumption, and cost. By making the RCID billing data available electronically each month, the time required to update the data is reduced significantly and data input errors are eliminated.

A custom Visual Foxpro program was developed to read the RCID monthly data into the database tables used by the URS. Aside from updating the monthly billing data, the program also determines if any new RCID utility accounts were added and automatically updates the

URS meter account definition table.

To speed up web-browser access to the URS, the meter-level monthly billing data are summed to different hierarchical levels. Besides the meter level, which provides the finest level of detail, the utility data are aggregated for each building or group of buildings to produce a subarea level data table. Likewise, the utility data for each business unit are aggregated to produce an area level data table.

Besides the monthly billing data, the URS also provides access to a wide range of hourly submetering data. These data can be very useful for determining how energy is used on a near-real time basis. They provide a finer level of detail and help energy managers quantify their energy saving efforts on an hourly/daily basis. Problems can be pinpointed quickly and controls adjusted to keep energy consumption minimized.

The URS updates the submetering data tables on a daily basis. The data are recorded hourly by the respective data collection system and transmitted to the URS web server on a nightly basis. Visual Foxpro programs read the various raw submetering data files into common submetering database tables. Once the database tables are updated with the prior day's submetering data, they are copied to the appropriate subdirectory on the web server and are then available for viewing using the URS web-publishing program.

Data Collection Programs

A variety of data collection programs are used to pull the utility data into Visual Foxpro data tables. Custom programs read the various data sources and organize the data into common data tables. A separate data collection program was developed to read each utility data source.

Shown below are the various data collection tasks in the URS:

- **Monthly Utility Data:** The RCID billing system data are downloaded monthly in an ASCII comma delimited format. As new utility accounts are added, a new record in the account definition table is added.
- **Power Monitoring Hourly Data:** RCID's supervisory control and data acquisition (SCADA) power monitoring system records max, min, and average hourly data for electric meters and outputs these data to an ASCII file each day. A Visual Foxpro program reads these data and reformats them into an hourly data table.

- **Energy Management System (EMS) Hourly Data:** An EMS can be programmed to produce files that include trends of analog/digital points and consumable data from utility meters connected to the EMS. Data collection programs copy these files from the EMS servers to the URS server after the EMS creates them each night. A Visual FoxPro program reads the data from these reports, reformats them, and then adds them to an hourly data table
- **Acquisuite Data Collection:** Hourly data are recorded in local data collection devices called Acquisuites. On a nightly basis, the EnertraxDL data collection program supplied by Obvius automatically uploads data from each Acquisuite into comma separated files (CSV). A Visual FoxPro program pulls the data from these CSV files, reformats them, and then adds them to an hourly data table.

It is important to point out that an enormous amount of data can be generated from hourly utility data. To keep the data manageable, the hourly data are broken up into separate monthly data files.

Once the data collection programs finish updating all of the data from the various hourly data sources, a Visual FoxPro program creates additional files that total the hourly data to sub-area and area levels. This step speeds up web-browser access to the URS. Finally, the data are copied to the URS server data directory where they are ready for viewing on the Disney intranet.

URS Email Reports

To make the URS easy to use, it sends HTML-based reports via email on a daily basis (to report on hourly data collected) and a monthly basis (to report on monthly billing data). A daily utility report is created for each business unit and emailed to the business unit distribution list. Using HTML-based email reports allows the tabular report to link to graphs showing daily and monthly utility profiles. Users view the reports using their email program (Microsoft Outlook) and are able to produce graphs by simply clicking on hot links in the email. Sending email on utility usage helps increase employee participation in reducing the facility's energy consumption.

Email also increases the likelihood that the user views the utility data. Instead of waiting for the user to visit the URS web site and figure

out how to generate the same report, the URS delivers the report via email.

Web Publishing Program

Visual Foxpro is the program language used to generate the web pages for the URS. FoxWeb is another program used to interface Visual FoxPro with the Microsoft Internet Information Server web server. The URS uses several reports to view and graph both the monthly utility billing information and the hourly utility data. Kavacharts Java applets, called from the Visual FoxPro programs, generate the graphs used in the URS.

The challenge of producing an effective EIS is to create reports that are both informative and easy to use. The program should be designed so that a user can easily produce reports and graphs with a few clicks of the mouse. The URS makes extensive use of embedded links to sub-reports and graphs. This programming interface makes the URS intuitively easy for the user to navigate.

A new report format, called the utility report card (URC), was recently added to the URS to let users see how their energy saving efforts rank relative to other facilities. Areas that have increased consumption are easily identified from the URC report. Executive management can question the increases and that is generally all that it takes to motivate responsible individuals to take action. Knowing that everyone is looking keeps the focus on finding new ways to save energy.

URS Results

The URS, like all EIS programs, does not result directly in energy reductions. Instead, the knowledge, operational insight, and experience gained from utility data can result in operational changes and corresponding energy savings.

The most significant result of the URS has been increased awareness of utility usage. Wasteful practices are corrected and energy-efficient systems are showcased as best practices. Individual have the URS to track and monitor their energy use, and this has translated into lower utility bills.

One other significant result of the URS is its ability to report on utility cost reimbursement to quantify operating participant utility usage. Utility submeters are automatically read each day and a daily report emailed to each operating participant. At the end of the month,

the Disney Accounting Department uses the URS to totalize the utility cost reimbursement for each operating participant. Submetering results in more accurate utility cost recovery compared to a cost per square foot allocation method.

BUILDING TUNE-UP SYSTEM (BTUS)

The building tune-up process is one of the most cost-effective energy management projects available to an energy manager. The actions taken are generally low-cost or no-cost adjustments to an existing EMS, and will not only minimize current operating costs, but will also lower future maintenance costs. [2]

The building tune-up does not necessarily involve the purchase and installation of new equipment or technology. Instead it requires an investigative-style approach to ensure that the EMS controls are working and controlling the HVAC and lighting systems optimally. The building tune-up process is a systematic approach to fine tuning an energy management system for optimal performance. This effort can be considered one of those proverbial “low hanging fruit” energy projects that all energy managers should focus on.

The non-technical side of the building tune-up focuses on the development of the building tune-up team. It allows both technical and non-technical staff to work together in an ongoing continuous improvement process to lower utility costs with minimal capital outlay. This provides an excellent venue to organize energy conservation efforts within an organization. Every team member can play an important role and contribute to the overall team success.

The technical side of the building tune-up focuses on computer programs that keep the energy management system settings at their optimal state. The building tune-up system (BTUS) is a web-based program that allows all users to view the time schedules and cooling/heating setpoints from their own PCs using web browser software. The purpose of the BTUS is to give building owners a view into their building’s heating, ventilating and air conditioning (HVAC), and lighting systems without accessing the EMS directly. The building owners provide the information on how their HVAC systems are controlled by establishing the time and cooling/heating setpoint schedules. Because it is web-based, it also allows a broader audience to access it via its

web browser interface, and makes it simple for everyone to know how their facilities are operating.

The BTUS keeps track of the following information for each HVAC system:

- Description of area serviced. A color-coded floor plan can be displayed if available.
- Time and setpoint schedules. Includes both desired schedules and a link to look at the most recent schedules broadcast by the FTS program.
- Shows equipment in need of repair.
- HVAC temperature, humidity, and status trends can be graphically displayed if available

The main control on the BTUS is a drop-down menu that allows the user to select the area desired. The user is then presented with a list of buildings from which to pick. Once the user selects an individual building, the detailed data for each HVAC system is displayed. Links are available to show the detailed information on each HVAC system.

Another key feature of the BTUS is its ability to display trend data from an EMS. Most EMSs on the market today have some method for collecting data from sensors, control devices, and meters attached to the system. The EMS text files produced from these trend reports are huge. There is generally no easy way to graph, sort, or filter the data from these reports. The BTUS organizes this voluminous amount of data so it is visualized easily and quickly for each HVAC system. Simply clicking on a link for each HVAC system displays the EMS trend data report and shows the history of the temperatures, humidity, and status to let users know what is actually happening.

FACILITY TIME SCHEDULE (FTS) PROGRAM

While the BTUS helps users keep track of their optimal HVAC system settings, the facility time schedule (FTS) program provides a

method to prevent EMS degradation by auto-resetting time and setpoint schedules on a daily basis. Without this automatic daily reset feature, the EMS time schedules and setpoints eventually get changed from their optimal settings in response to routine “too hot/too cold” calls. [2]

The FTS program is a custom client/server program that interfaces with the Disney’s Carrier ComfortVIEW energy management system. The purpose of the FTS program is to provide the energy manager a method to manage the time and heating/cooling setpoint schedules for a large campus facility in a master schedule database. Time schedules can be set up as “relative schedules” that incorporate the facility opening/closing times, dusk/dawn times, and day of the week. Each day, the FTS program determines the appropriate open/close/dusk/dawn times and calculates actual time schedules that are broadcast to the Carrier EMS controllers on the Carrier ComfortVIEW Network (CCN).

The FTS program can also handle special events that occur after the normal open/close time schedules by sending additional time schedules that effectively increase the HVAC/lighting equipment run-time to accommodate the special event. The FTS program provides some additional operational features:

- Users can make local EMS panel adjustments to both time and setpoint schedules to respond to building conditions without worrying that the changes would be permanent. All schedule changes will revert to the master schedule at the programmed download time the next day.
- Setpoint schedules can be grouped into common areas or types and programmed with a bias offset. This offset can be used during loadshed conditions to change the setpoint low and high values to a user adjustable level, reducing energy consumption. Schedule groups can also be used to pre-cool or pre-heat an area during special functions. The setpoint bias will be removed from the setpoints after the next automatic download.
- These master schedules are sent automatically to each Carrier EMS controller on a daily basis. For each schedule, the system administrator can choose whether and when to send either or both time and setpoint schedules.

- If the facility open/close times are changed during a given day, the new time schedules are re-calculated and downloaded again to the EMS controllers to reflect these changes.

The key feature of the FTS program is to automatically reset the energy management system time schedules and heating/cooling setpoints to their optimal values. Keeping the control values optimal ensures that the EMS is operating at peak efficiency.

EMS REPORTS

The data that are reported from an EMS (energy management system) can be very useful in managing system operations. [3] Typical EMS reports include data trending, alarm reports, and EMS system activity. Most EMS on the market today do an adequate job of collecting the data, but a poor job of publishing and presenting the data to a wide audience. In the past, the EMS was the only system that could access and display the data collected. Only a few people in any one organization could turn this raw data into something meaningful. Sharing EMS data with others, perhaps across the globe, is a reasonable expectation. Simply put, the internet has changed the way we share data

The amount of data that can be produced from an EMS is huge and overwhelming. To turn this raw EMS data into useful information, the data need to be pulled into a relational database so they can be reported, filtered, sorted, and graphed. If the report files are formatted so they can be read into a relational database, a custom web-based program can be written to display, search, sort, filter, and graph the data using a standard web-browser interface. Access to these data becomes quicker and easier than ever and is also available to everyone on the company intranet instead of the limited few who are EMS users.

The EMS reports program was developed as a custom web-based program to display this information in an intuitive and user-friendly interface that further enhances and broadens the access to this information. The EMS report program has provided the engineering services department with a simple tool to track the activities on their EMS. Knowing what changes were made, by what EMS user, and when they were done, has proven invaluable in troubleshooting EMS issues by

continuously tracking all events and alarms.

This approach provides a low-cost method for enhancing an existing EMS by simply capturing existing EMS report data. All of this information helps provide continuous improvement for a successful EMS operation.

EMS TUNE-UP SYSTEM (ETS)

The energy management tune-up system (ETS) was created to provide a means to focus attention on EMS control points that might not be working properly. The ETS identifies defective points that are in need of repair on the Carrier ComfortVIEW Energy Management System. These defective points in most cases are wasting energy and increasing utility expenses.

The ETS is actually two separate processes. The data collection process uses a feature in Carrier ComfortVIEW that allows the real-time EMS data to be read one EMS panel at a time and recorded into a relational database. Since Disney's EMS is so large, the ETS data collection program is set to record each panel's real time data only once per day. Even with this limited scan rate, defective EMS control points can be easily identified for repair.

A separate web-based program was developed to allow users to search the EMS data for specific problems. The ETS web program allows for problems to be identified and corrected in a timely manner. The ETS web program can identify the following problem areas:

1. Chilled water valves that are closed, but the supply temperature is still cold (valve is not shutting).
2. Fans that are commanded off, but the fan status is shown on (fan is not turning off).
3. Temperature and humidity sensors out of range (defective sensors).
4. EMS points that have been forced (points not working in automatic control).

To get these items repaired, users can select the records to have

work orders automatically generated though Disney's preventative maintenance program.

OTHER WEB-BASED PROGRAMS

Several smaller web-based database programs were developed to meet specific needs and are described below:

- *Project Tracking System (PTS)* was developed to keep track of energy conservation project results. This program was created to prepare executive management reports on the cost-effectiveness of the energy projects. The PTS provides the project scope, the annual energy consumption and dollar savings, the cost of installation, and the internal rate of return for the project. Reports can be displayed by business unit or for a particular type of conservation project across all business units.
- *Building Square Footage System (BSF)* was developed in partnership with the Walt Disney World Tax department to display building square footage data for each facility based on county tax records data.
- *Environmental Permit Tracking System (EPTS)* was developed to keep track of environmental permit reporting due dates. Environmental checklist reports can also be generated to aid in permit compliance verification.
- *Daily Production Reporting System (DPRS)* was developed to track and report utility production data on Reedy Creek Energy Services operations.
- *Facility Time Schedule Web Program (FTSW)* was developed to let users view the park hours and special events times programmed into the FTS programs on each EMS server.
- *Carrier Alarm Notification (CAN)* was developed as a means to notify users of critical alarms generated by the energy management system. The program sends a text page to the group responsible

for the equipment and automatically generates a repair work order through Disney's preventative maintenance program.

CONCLUSION

Disney uses data from its utility meters and energy management systems to drive its energy management program. By using off-the-shelf tools and taking full advantage of low-cost web-based programs, Disney has created systems that let users understand their energy usage and continuously keep the focus on reducing energy consumption. Using a monthly utility report card as a scorecard on how each business unit is doing relative to each other is the key and keeps everyone focused on improvement. As the Walt Disney World Resort continues to expand, Disney's Enterprise Energy Management Systems will continue to play an important role in lowering energy costs in both new and existing facilities.

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