Utility Data Web Page Design— Presenting the Data

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ABSTRACT

Presenting utility data in a meaningful way may be an art or it may be a science. However, one thing is for sure: the design of the presentation depends entirely on those who will be using it. Once the general specification for the utility information is created, it is the responsibility of the developer to make the pages informative, intuitive, reliable, and robust. Using web technologies, a developer can make large amounts of utility data come alive with informative "vision" into utility consumption. Web pages full of utility data can be transformed instantaneously from one report to another. Trends can show critical values that may have been missed otherwise. Data can be compared and analyzed immediately rather than sifting through reams of paper reports and spreadsheets. The user of the data becomes the master of it, rather than the other way around.

INTRODUCTION

The two most important things to remember about displaying utility data on a web page are to display as much data as will fit on the page and to use as many links as possible. Links are both informative and functional. They display data as well as provide a means of changing the display. Database filtering options are lists or text fields used to define dates, locations, type of utility, or other variables. They should be visible and available to change at all times to make the application robust.
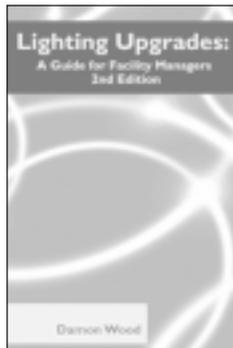
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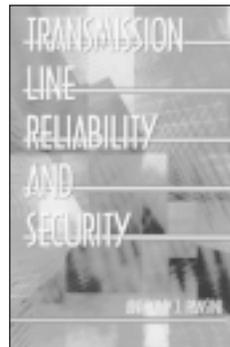
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These options are used to narrow the scope of the data returned from the database query and displayed in the reports. Reports provide both the means of displaying the information found in the database and the links that allow the user to navigate the application.

Links are used to navigate to graphs or help pages. They connect to filter routines or sort routines to change the data display. "Onmouseover" is a DHTML feature that helps make the links more intuitive by displaying a description of the actions in the message line of the browser. Toggle links are great for options that only have two or three choices and do not change often. The user can browse through the options very quickly. Browser arrows are used to change a date, day, month, year, or any other value, incrementally up or down. (1)

Options are usually made available in a separate frame from the data display. The option values are stored in a "user table" uniquely named for each user. This insures that the selected options will remain until the next time the user accesses the application. HTML forms will be used most of the time to select and submit values for options. Drill-down lists allow the user to change levels and provide lists of options specific to the selected level.

Reports containing both data and links are displayed in a frame of their own. Reports must always display the values of options so that if the report is printed, it is well qualified. Filtering or sorting changes the reports most dramatically. Filter and sort options can also be stored. Data that fall outside a specified range are highlighted in the report. Highlighted data are called flags since they stand out in the report. Flags help the user focus on problem areas. Page widths must be limited for viewing and printing the data.

Graphs are an important way of conducting trend analysis on utility data. Line graphs and bar graphs are useful for creating comparison graphs from month to month or year to year. It is important to include legends and all qualifying information on the graph. Dual-axis graphs are useful for comparing utility values to some other value, such as outside temperature data. (2)

It is helpful to provide a means of creating an image file of the graph for emailing to others. Some graph applications are "server-side" applications that create the images first and then use them to display in a web page. Other methods use Java applets or Active-X to generate the images on the client browser in real-time.

LINKS TO GRAPHS,
HELP SCREENS, FILTERS AND SORTS

HTML links are what bring utility data alive. They provide the path through the data that gives the application its robust look and feel. They make the application intuitive for the user by providing a quick response to easy requests for change. Changing the presentation of the data is essential to providing the information in a way that is meaningful to a wide range of users. Links provide instant access to information not directly related to the data itself, such as help instructions or contact information. Options can be quickly changed using links rather than pull-down lists or text fields. Links should be the first choice for changing the web page content.

The "onmouseover" event method provides information about links to help the user determine the effect of its action before clicking it. Holding the mouse cursor over a link will cause a custom message, pertinent to the link, to appear in the browser status field at the bottom of the window. The message can include data retrieved dynamically from form fields or databases as well as text. The messages add to the help features of the application by letting the user anticipate the functionality of the application with very little effort. Using the "onmouseover" event adds some overhead to the processing required to load the web page in the browser window. However, their helpfulness far outweighs the cost of implementing them.

The anchor element to create the link with the "onmouseover" event method looks as follows:

**<a href='display.php4?sortby=school' onmouseover=
"window.status='Select This Link to Sort the List by School';
return true" >SCHOOL**

Toggles are an especially quick way to change options related to a particular page design or its content. A toggle is a link that changes between two or three choices at the most. Each time the user clicks the link, a new choice is displayed as the link. This makes it easy for the user to scroll through choices rather than picking from a small list. Toggles are best used for options that do not change frequently. The following example shows a toggle for turning the auxiliary axis of a graph on or off.

Aux Axis Off ↔ **Aux Axis On**

Browse arrows are great for sequential options such as dates or integers. A set of arrows, one on either side (or top and bottom) of the value can be linked to the next value in the sequence. This lets the user quickly scroll through a large list of option values in either direction if desired. Often the number of date options are too numerous to list. Typing in the dates requires too many keystrokes. Calendars are nice for large jumps in values, but require at least a few mouse clicks for each change, whereas browse links can change values with a single click. For dates, the combination of a calendar and browse buttons provides the best access to those option values. Varieties of arrow images are available for free download on many of the image internet sites. In the example below, selecting the arrows on the left will change the month to the previous month—May 2002. Selecting the arrows on the right will change the month to the next month—July 2002.

<<June 2002>>

OPTIONS

Options are the heart of the data presentation. Options describe which data to display and describe how to display the data. Options are unique to each user. A user enters and changes options by using links or forms. Sequential lists of links can be helpful in "drilling down" to a particular option such as a location. Frames are sometimes helpful to separate the options display from the content display. Common options are dates, utility types, locations, sort columns, and filters.

Obviously, each user requires his or her own particular options, and it would be nice if those options are retained as long as the user desires. This is best done by using a *user data table* to store the current options for a particular user. User data tables are stored on the server side of the web application and are therefore quite reliable. The table can be named by a unique identifier associated with the user, like the user id (if the application requires a log in). This method provides a "state" for the user that remains indefinitely.

Label	User Id	Month	Year	Aux Axis	District	Sort By
A01	GREEN D	6	2002	On	Green	Pct Btu/Sf
A01	PJA	7	2002	Off	Green	Cost

Figure 1. User Data Table

HTML forms may be used to select and store options. They contain pull-down lists, text fields, radio buttons, or check boxes. All forms require a "submit" button to execute some process that sends the form field values to the database. Forms should only be used if necessary, since they tend to distract the user from the data itself. Chances are, the form will have to temporarily occupy the same space on the page as the report. Forms are okay for configuration items that the user will rarely change after the initial setting. Sometimes options simply require many choices, and forms are needed.

School District GREEN COUNTY PUBLIC SCHOOL ▼ Go

Figure 2. List of School Districts

Drill-down lists are a great way for the user to select from a group of hierarchical values such as schools within large school districts. A list of links associated with each level and linked to the level below allow the user to move quickly from the top of the hierarchical tree down to whichever level is desired. Once the appropriate level is reached, a list of options and data specific to that level is displayed.

Examples for options in energy reports are location levels such as district, school type, or school. Then there are the values for each of the levels, such as specifically which district, school type, or school. An option for which utility to focus in on is usually needed (electric, water, gas, etc.). The date is also a common option. Date options can take many forms, as in month/year combinations, month only, year only, month/year range, date only (single day), date range, etc. It is useful to provide an option to define comparison data to be shown along with the primary data on a graph. An example is outside temperature data. However, any data may be needed as comparison data along with the primary data set.
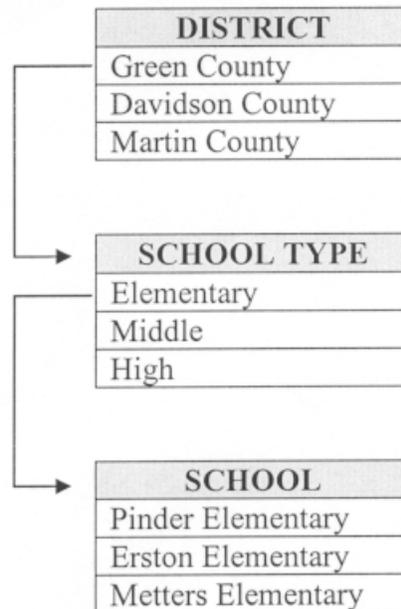
Figure 3. Drill-Down List

REPORTS

Reports are best displayed in HTML frames. This allows the option choices to be separated from the database information itself. However, option values displayed in the report provide background information to describe the data. Links are used to navigate throughout the frames. Filtering links allow the user to "zoom" in on specific areas of interest. Sorting links make evaluating the data much easier. Links to graphs allow the user a quick look at trends in the data. Flags highlight data with colors or markers that make them stand out. The report inside the HTML frame may need to be sized appropriately to fit most printers. Columns and rows can be arranged to best suit the purpose of the report. Use a font that is clearly readable in a web browser. Adding a link to a file containing the data in some other format, such as an Excel file, a Word document, or an Acrobat PDF file, is quite valuable.

HTML frames are helpful to separate the options from the data display so they are always visible and available to change. This also makes the data display less cluttered and more like a report that can be

printed if desired. The database information itself is displayed in the largest frame as a report. Typically, the option frame is located along the left side or the top of the browser window, or both. Frames are frequently referred to by name within HTML and the document object model (DOM). It is helpful to pick names that are easy to remember. For example, "title," "options" and "display," etc. Option values should be redisplayed in the report so that if the report is printed, the background information necessary to qualify the data is there. Most of this information can go into the title of the report or the headings of columns.

TITLE FRAME	
OPTIONS FRAME	DISPLAY FRAME
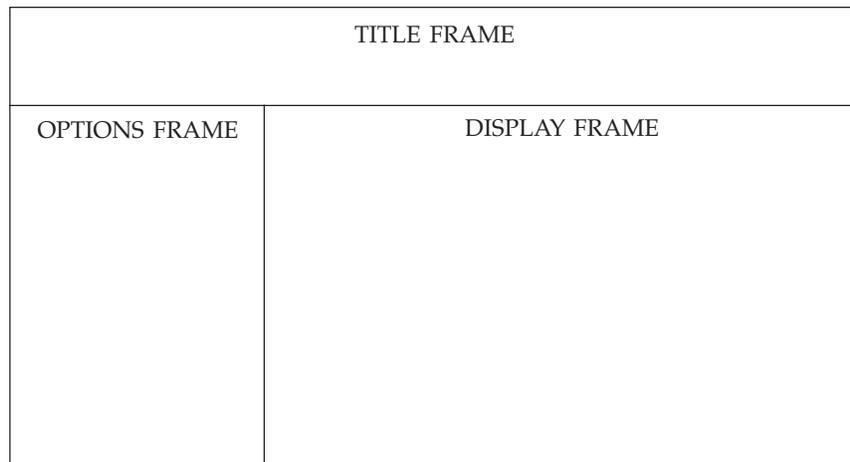
Figure 4. Layout of a Webpage with Frames

Links allow the user to navigate through the pages to change options, filter, sort, and graph. Links associated with some items in the report may be used to filter by location, utility type, etc. This gives the user the ability to "drill down" into the report and look specifically at areas of interest or print a report that is not cluttered with irrelevant information. Links on headings are used to sort the columns by the respective heading. This quickly shows how values in the list compare, allowing easy evaluation. Sorted columns should be denoted in some way, such as shading the column heading. Links to graphs show trend analysis quickly without re-selecting options. Pre-defined graphing routines take the data to a larger or smaller scope, such as the last 30 days, last 12 months, or a 24-hour period. Graphs can be used to compare one period to another or one data set to another.

FILTER LINK   SORT LINK   GRAPH LINK   SORTED COLUMN

Electricity - May, 2002		Consumption		
SCHOOL TYPE	SCHOOL	KWH	Last Year KWH	PCT KWH Change
ALTERNATIVE EDUCATION	GATTERTON	15132.00	17329.00	-3.19 %
ALTERNATIVE EDUCATION	TARSTON AVENUE	19600.00	22944.00	-4.10 %
ALTERNATIVE EDUCATION	CHEROSITY SCHOOL	39505.00	31171.00	55.93 %

Figure 5. Data Display Frame with Links

Links change the sort or filtering by passing a parameter in the HTTP request similar to the sort link shown below. Graph links work in a similar manner. Below is the address, used in a link, to sort the data display by "cost."

href='display.php4?sortby=cost'

Flags are used to make certain data stand out from all the rest. Highlighting the values or marking them in some manner when they breach a certain threshold will quickly show the user which data are critical. For example, kWhs that increased from one year to the next would show a positive percent change and could trigger a flag so the viewer can easily see which locations increased their kWh consumption. Configuration settings can pre-define which data and values trigger the flags.

Positive Percentage Change Flagged

Electricity - May, 2002		Consumption		
SCHOOL TYPE	SCHOOL	KWH	Last Year KWH	PCT KWH Change
ALTERNATIVE EDUCATION	GATTERTON	15132.00	17329.00	-3.19 %
ALTERNATIVE EDUCATION	TARSTON AVENUE	19600.00	22944.00	-4.10 %
ALTERNATIVE EDUCATION	CHEROSITY SCHOOL	39505.00	31171.00	55.93 %

Figure 6. Flagged Data

The display frame may need to be sized appropriately to view or print the data. Portrait printouts typically need to be no more then 670 pixels wide. Landscape printouts can be larger, up to 970 pixels, but require a note to remind the user to adjust their page settings to landscape mode before printing. Use the **TABLE** HTML element to control the page width, as shown below.

<table border=1 width="670" CELLSPACING=0 CELLPADDING=2>

Sometimes the reports are more complicated than just rows and columns. Some columns may need to be split into sub-columns to further define a different set of data. The same goes for the rows. Rows can be combined to organize the data into groups that stand out by highlighting in different colors or separating with a blank row. A good font is Verdana or Arial. It is recommended to use a few alternate fonts in case the user's browser does not accommodate the primary one. Using the **FONT** HTML element, you can specify alternate fonts as shown below.

<font face=Verdana, Arial, Helvetica, sans-serif size=1>

It is a good idea to provide the data in other formats for compatibility with other programs. A simple link at the bottom of the report or options frame can lead to a report in another format such as MS Excel or XML.

GRAPHING

Graphs allow for trend analysis of the data on a regular basis. Line graphs are the most useful, since multiple data sets can easily be compared. Graph titles, axes, and legends should contain enough of the information found in the options to qualify the data. Graphs can contain multiple data sets for comparison along the same axis or opposite axis. Outside temperature is a good item to place on an opposing axis. Graphs are created in the browser window or frame using a variety of methods. Java applets or Active-X make use the of client processor to display the graphs, but often lack the ability to create an image for emailing or saving. Server-side graphing applications provide the graph

Sub-Columns   Delimit Row Groups with Blank Line

Electricity - May, 2002		Consumption		
SCHOOL TYPE	SCHOOL	KWH	Last Year KWH	PCT KWH Change
ALTERNATIVE EDUCATION	GATTERTON	15132.00	17329.00	-3.19 %
ALTERNATIVE EDUCATION	TARSTON AVENUE	19600.00	22944.00	-4.10 %
ALTERNATIVE EDUCATION	CHEROSITY SCHOOL	39505.00	31171.00	55.93 %
ELEMENTARY	ERSTON ELEMENTARY	11600.00	16999.00	-44.49 %
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ELEMENTARY	ORIS ELEMENTARY	13875.00	14189.00	22.58 %
ELEMENTARY	CORLES ELEMENTARY	14191.00	15226.00	9.53 %

Figure 7. Data Display with Sub-Columns and Row Groups

as a GIF or JPEG image and then display it within the HTML of the frame or window.

Trend analysis gives the user the "big picture" about what the data are doing over time. It is a lot easier to evaluate a graph than to look at a list of numbers, even if they are sorted appropriately. It makes communicating issues much easier as well.

Line graphs seem to be best suited for showing incremental data spread out over time. In addition, they easily accommodate comparison data sets without cluttering up the graph. Graph titles need to contain the same information that a report would contain. The remainder of the qualifying information needs to be present in the axis titles or the legend. Legends are placed immediately adjacent to the graph. Most graphing applications allow for flexible configuration of the fonts and placement of the legends. Comparison graphs are used to evaluate two or

more data sets to see if a trend is consistent or to compare data sets to values of some other nature, such as weather data.

When compared data sets differ in values to the point that the axis will be stretched too far to show accurate results, then those data sets that are outside the normal range need to be placed on an opposing axis. In the graph below, two data sets comparing values of electric consumption for two different years are on the left-hand axis. The average outside temperature is on the right-hand axis. This makes the graph very readable. The change in energy use from one year to the next is easily viewed, showing a reduction in consumption over the previous year. The consumption for each year can be compared against average temperatures to see what the weather-related effects on energy use are.

Client-side applications such as Java Applets and Active-X generate graphs using the client machine. Java applets have to be downloaded the first time, but are stored on the client machine and respond quickly afterward.

The downside to client-side applications is that they do not easily create images of the graph. The graph results can easily be communicated to others by simply emailing an image or inserting it in a document. Server-side graphing applications create images first and then embed them into the resulting web page or frame. This makes it easy to

Figure 8.
Comparison Graph with Different Left and Right Axis Values

transfer the information elsewhere and it doesn't require client processor time to generate the graph.

CONCLUSION

Utility data are complex. They are directly related to time, temperature, economic conditions, and perhaps even political variables. It's important to see the "big picture" and analyze the data in an objective light. However, many people are involved in energy decision making, and they each desire a unique approach to examine the data and turn them into meaningful information.

Web technologies provide the flexibility and portability required to query and present utility data to many different people in many different ways. These web technologies merge together into a mosaic of databases, programming scripts, links, forms, reports, and graphs that tell the story of the data collected. A robust ability to select options quickly and easily allows the user to ask questions of the data and get answers. Web-enabled database engines provide data on demand per the requests of the users. Reports provide a familiar basis for understanding the data, while graphs show trends over time. Links to sorting, filtering, and graphing routines provide an endless number of "views" for analysis of the data. However, those views are manageable. Created on demand, from logical choices, the data are streamlined to fit the need of the analyst. Visit **http://www.UtilityReporting.com/udp** to try out a utility data presentation demonstration.

References
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(2)   Visual Engineering, "KavaCharts, The Complete Solution for Java-Based Charting" [*web site*] (accessed 27 February 2003); available from http://www.ve.com; Internet.

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ABOUT THE AUTHOR

David C. Green has combined experience in Intranet/Internet technology and database queries and has developed programming for Energy Information Systems. David has been the president of his own consulting company, Green Management Services, Inc., since 1994. He has a Bachelor of Science degree in chemistry and a Master of Arts degree in computer science. David is also a lieutenant colonel in the Illinois Army National Guard and has 19 years of military service. David has successfully completed major projects for The ABB Group, Cummins Engine Company, ECI Telematics, The M.A.R.C of the Professionals, Reedy Creek Improvement District at Walt Disney World, and The Illinois Army National Guard. (dcgreen@dcgreen.com)