

CopperLeaf ESP



Using ESP to Model, Analyze, and Evaluate Demand-Side Management Programs

A White Paper Prepared By:

CopperLeaf Technologies Inc.
4170 Still Creek Drive, Suite 450
Burnaby, BC, V5C 6C6 Canada

Contact:

Phil Jones
+ 1 604 4840254
PJones@CopperLeafGroup.com



Introduction

Demand-side management (DSM) initiatives have historically been seen as environmental programs used by electric, gas, and water utilities to demonstrate good corporate citizenship. However, with energy prices at all-time highs, infrastructure straining with utilization and age, and new, cost-effective, and energy-efficient technologies entering the market, many utilities are taking a second look. Many utilities now see DSM as an economic way to manage demand and reduce consumption, and thereby offset the need for investment in supply and delivery infrastructure.

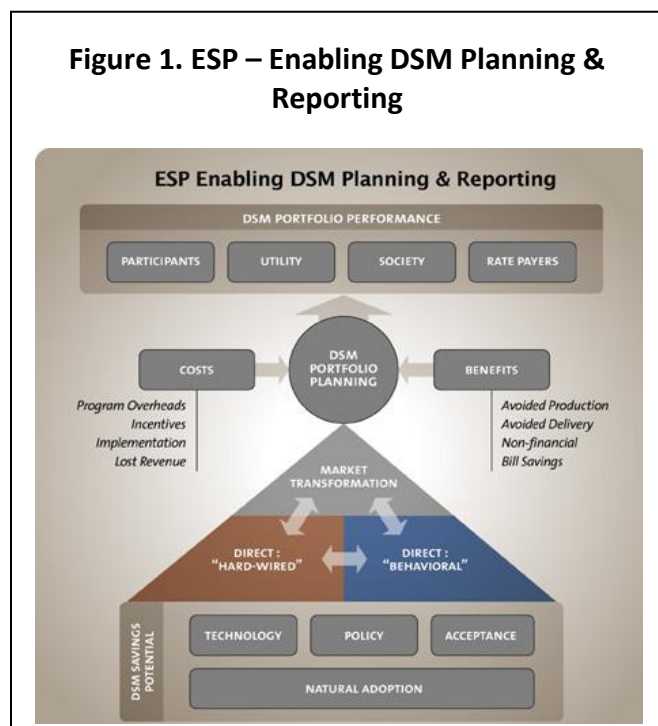
DSM economics are complex and require more involved analysis than does modeling of supply-side investments, however. Consequently, many utilities employ specialist consultants to perform complicated custom modeling to evaluate and justify DSM investments. Utilities also have difficulty explaining the economics of their programs to ratepayers and regulatory bodies. Accurate modeling and tracking tools have not been widely available off-the-shelf, until now.

CopperLeaf ESP has been designed specifically to meet the modeling requirements of DSM. By using ESP, utilities are better able to analyze, justify, prioritize, and manage performance of their DSM projects and programs, using the specialized characteristics of DSM economics. The web-based architecture allows multiple users access to a central relational database to ensure consistent use of assumptions and algorithms. Further, the ability to internally build annual budgets and import actual costs and performance metrics enables users to track and report on projects and programs as they migrate through their life cycle.

Using ESP to Model DSM Programs

The goal of DSM programs is to help customers change their consumption of a resource in ways that are beneficial to the customer, the utility, and to ratepayers overall. As shown in Figure 1, peak demand and consumption savings can be achieved through behavioral and operational changes, and “hard wired” technologies. DSM programs encourage behavioral changes and customer adoption of new technologies until their buying decisions and operating philosophy “transform” permanently.

While customer savings can be easy to identify, utility impacts are more difficult to establish. A reduction in consumption results in a loss of revenue, which affects the overall cost burden placed on ratepayers. Analysis becomes further



complicated when incentives are used to aggressively target savings, particularly when needing to consider factors such as the rate of natural adoption and free-ridership.

ESP was designed with these needs in mind by providing utilities with a means to develop and justify DSM programs using sound, supportable economics. In addition, ESP helps utilities throughout the program life-cycle by providing a single tool for planning, budgeting, and execution.

How ESP Models DSM

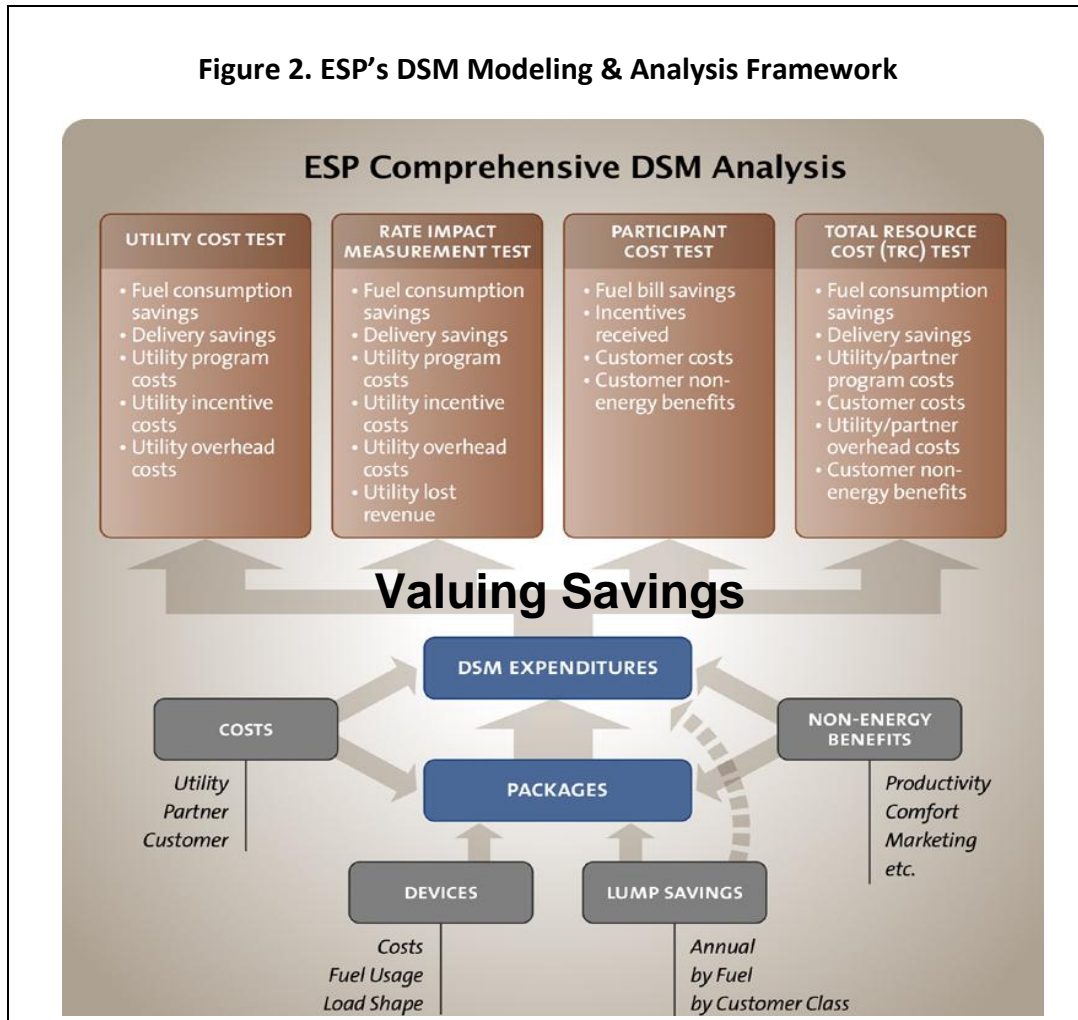


Figure 2 shows how ESP models DSM projects and programs for multiple “fuels” (e.g. electricity, gas, water) using the following building blocks:

- “Devices” are end-use technologies from which DSM savings are derived. “Lump” blocks of savings can also be modeled which are not specifically tied to individual Devices. Individual and customer class load shapes identify fuel usage patterns before and after a DSM initiative;

- Program cost elements include incentives, variable operational costs, and fixed program overheads;
- ESP modeling elements called “Expenditures” and “Packages” are available to combine utility costs and customer participation, and enable users to construct DSM programs in a variety of structures; and
- Customer rates and marginal fuel costs are used to derive avoided costs and lost revenues for commodity consumption and delivery.

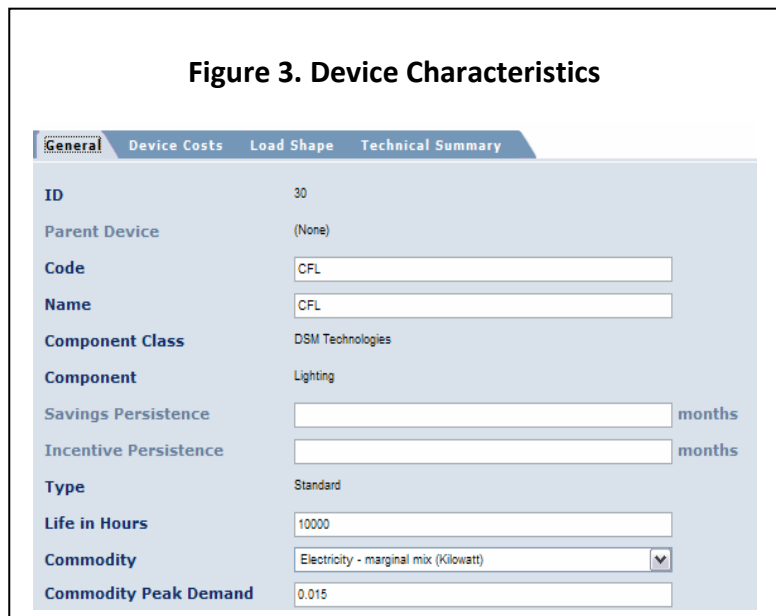
Standard DSM economic tests are available, including utility cost test, rate impact test, participant test, and total resource cost test. ESP allows a utility to model and prioritize its entire DSM portfolio, to ensure investment is targeted towards the programs with highest overall value.

Devices & Customer Load-Shapes

“Devices” are end-use technologies that are used by customers in their homes, offices, and factories, and that are targeted by DSM programs. For example, common energy efficient Devices promoted by DSM programs include lighting, motors, and controls.

ESP allows utilities to model the DSM savings that can be achieved through the use of a new type of Device such as, for example, introduction of setback thermostats and occupancy sensors into an office building. ESP also allows utilities to model the benefits associated with the operating change or retrofit of a legacy Device such as, for example, replacement of common household bulbs with compact fluorescent lights.

Figure 3. Device Characteristics



General		Device Costs	Load Shape	Technical Summary
ID	30			
Parent Device	(None)			
Code	<input type="text" value="CFL"/>			
Name	<input type="text" value="CFL"/>			
Component Class	DSM Technologies			
Component	Lighting			
Savings Persistence	<input type="text"/> months			
Incentive Persistence	<input type="text"/> months			
Type	Standard			
Life in Hours	<input type="text" value="10000"/>			
Commodity	<input type="text" value="Electricity - marginal mix (Kilowatt)"/>			
Commodity Peak Demand	<input type="text" value="0.015"/>			

The potential savings from the retrofit or introduction of a Device depends on how much time that Device is “on” and the rate at which it consumes its fuel. In turn, the cost-effectiveness of the Device depends on its installed cost, expected life (i.e., time before replacement is required or savings stop), and usage pattern (i.e., load shape).

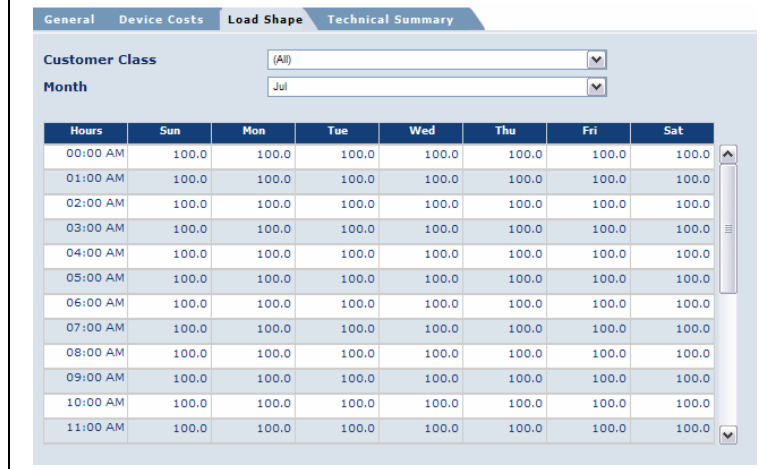
As shown in Figure 3, ESP enables utilities to configure Devices using the attributes necessary to determine DSM savings. Further, as shown in Figure 4, ESP facilitates the configuration of Device-specific load shape for individual facilities (e.g. an industrial plant or office buildings), customers, or customer classes.

ESP also supports more sophisticated levels of modeling. For example, customers routinely replace legacy Devices at end-of-life or because of new requirements, so some demand or consumption benefits would be expected in absence of the DSM project/program. ESP allows utilities to evaluate cost-effectiveness of a program in view of legacy Device attrition and the natural adoption of new technologies.

ESP also allows utilities to employ modeling adjustment factors to tailor expected resource savings for circumstances unique to a project or program. For example, evaluation of

previous DSM programs may show that only 90% of forecast savings for a given project actually materialize one year later. Or perhaps energy savings are dependent on ongoing maintenance or tuning of a new technology to allow it to function at maximum efficiency, and that reduced savings are achieved when this work is not performed. ESP offers user-configurable modeling adjustment factors to reflect these kinds of situations.

Figure 4. Device Load Shapes (by Customer Class)



Hours	Sun	Mon	Tue	Wed	Thu	Fri	Sat
00:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
01:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
02:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
03:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
04:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
05:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
06:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
07:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
08:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
09:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
10:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0
11:00 AM	100.0	100.0	100.0	100.0	100.0	100.0	100.0

DSM Project and Program Costs

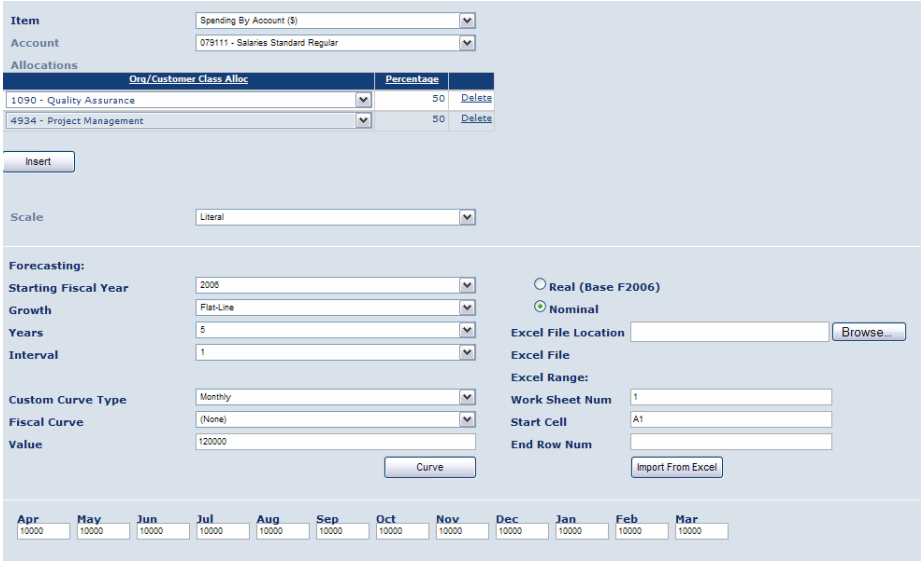
DSM programs can take a variety of forms, and program cost is a direct result of program structure and the nature of the offer. For example, one type of program may offer financial or non-financial incentives, while another type may be focused on providing education through training or communication initiatives. Implementation costs can be fixed for an entire program, or may be variable (e.g., per participant). ESP is capable of handling all types of DSM program costs, and for all kinds of programs.

ESP models variable costs (e.g., per participant or per project) by assembling “Packages” of costs and activities. Packages can include up-front energy and/or engineering studies to scope a given opportunity, an incentive/grant for the technology being installed, post-project measurement and evaluation costs to verify the savings actually achieved, and administrative costs associated with processing the participant’s application and grant. The Devices associated with the program are also included in the Package, to facilitate modeling of material and installation costs.

Fixed costs are assembled in “Expenditures”, which can include costs such as program management, administration, and advertising. The number of participants is also forecast in Expenditures, which in turn translates variable per-unit costs into total project/program dollars.

ESP also facilitates allocation or sharing of costs to the utility offering the program, co-funding partners (e.g., separate gas and electricity companies jointly sponsoring a program), or a customer funding project work beyond Device installation. Costs can be identified and allocated by organizational account or resource code and by department. Costs can be forecast at a monthly grain over multiple years, in both real and nominal terms, as shown in Figure 5. Data can also be imported to ESP via Excel.

Figure 5. DSM Program Cost Forecasting



Item: Spending By Account (\$)

Account: 079111 - Salaries Standard Regular

Allocations

Org/Customer Class Alloc	Percentage	
1090 - Quality Assurance	50	Delete
4934 - Project Management	50	Delete

Forecasting:

Starting Fiscal Year: 2008

Growth: Flat-Line

Years: 5

Interval: 1

Custom Curve Type: Monthly

Fiscal Curve: (None)

Value: 120000

Scale: Literal

Forecasting Options: Real (Base F2006) Nominal

Excel File Location: [Browse...]

Excel File: []

Excel Range: []

Work Sheet Num: 1

Start Cell: A1

End Row Num: []

Buttons: Curve, Import From Excel

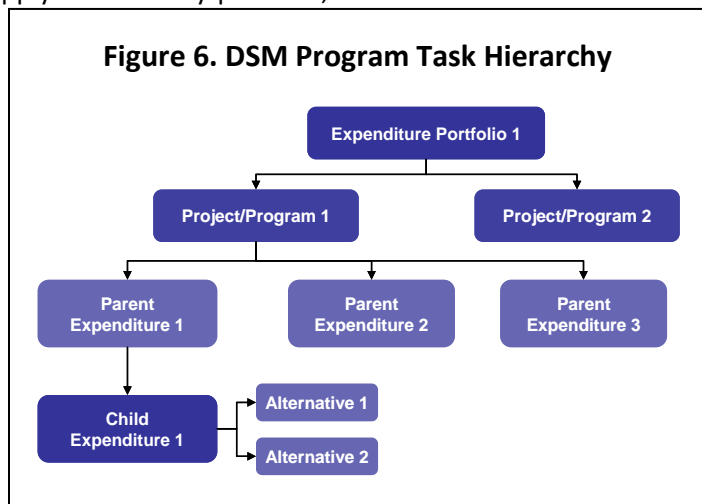
Forecast Grid:

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000

DSM Program and Expenditure Structure

DSM programs are often analyzed and delivered as part of a broader portfolio of DSM and supply-side initiatives. To effectively model the entire supply and delivery portfolio, ESP enables users to assemble specific projects and programs in a flexible, n-tier structure, as shown in Figure 6. Included in its capabilities is the modeling of multiple alternatives for a specific Expenditure, each with differing cost and performance assumptions, to enable scenario analysis and portfolio optimization.

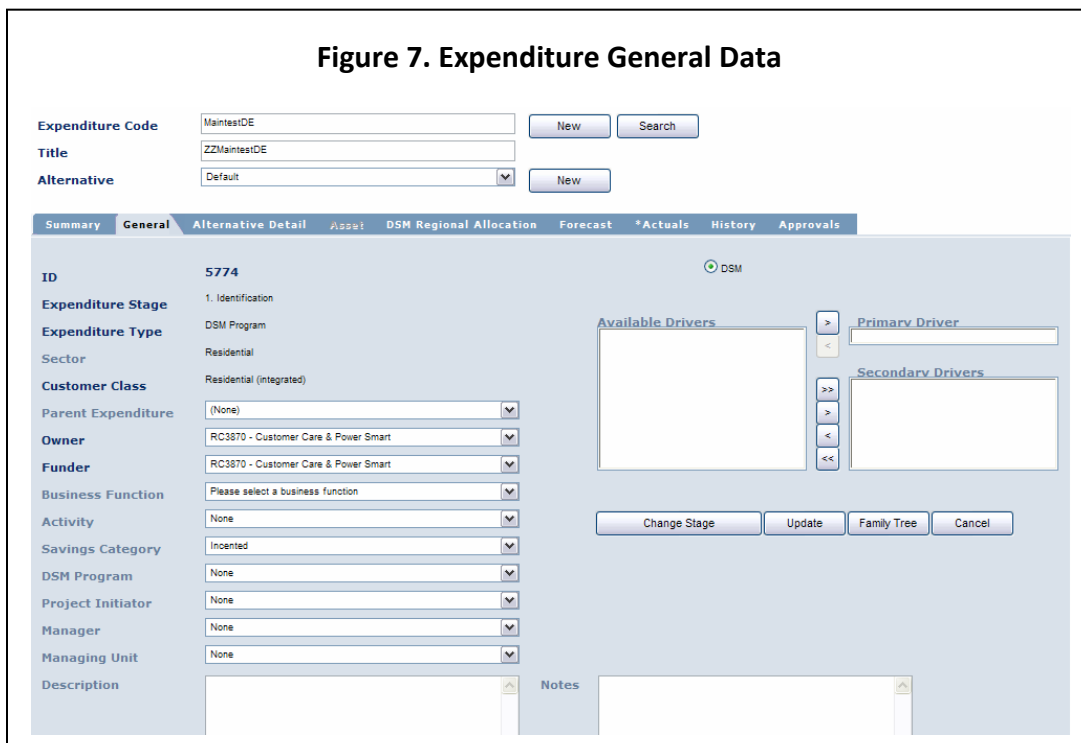
Within ESP, Expenditures collect the basic information associated with a DSM project or program, as shown in Figure 7. Basic required information includes the Expenditure name, relationship to a



project/program, and the associated customer or customer class. Optional information can be entered to assist in sorting and reporting, including project manager, savings category (e.g., hard-wired versus legislation), and drivers for the project. In addition, documents can be attached, thereby providing a single source of project information including supporting spread-sheet analysis or business case justifications.

ESP also allows each Expenditure to be tracked according to its “stage”, from definition, through to implementation, and finally completion. As a result, utilities are able to track their DSM programs as they migrate through their lifecycle, which increases project management, accountability, and reporting capabilities.

Figure 7. Expenditure General Data



The screenshot shows a web-based form for entering expenditure data. At the top, there are input fields for 'Expenditure Code' (value: MaintestDE), 'Title' (value: ZZMaintestDE), and 'Alternative' (value: Default). Below these are 'New' and 'Search' buttons. The main form area has a tabbed interface with 'General' selected. The 'General' tab contains a list of fields: ID (5774), Expenditure Stage (1. Identification), Expenditure Type (DSM Program), Sector (Residential), Customer Class (Residential (integrated)), Parent Expenditure ((None)), Owner (RC3870 - Customer Care & Power Smart), Funder (RC3870 - Customer Care & Power Smart), Business Function (Please select a business function), Activity (None), Savings Category (Incented), DSM Program (None), Project Initiator (None), Manager (None), and Managing Unit (None). To the right of these fields is a 'DSM' section with 'Available Drivers' and 'Secondary Drivers' lists, and a 'Primary Driver' field. At the bottom of the form are buttons for 'Change Stage', 'Update', 'Family Tree', and 'Cancel'. A 'Notes' field is also present at the bottom right.

Avoided Costs & Lost Revenue Price Streams

Fundamental to DSM economic analysis are the valuation of savings and lost revenue for different commodities, such as electricity, gas, water, etc.. ESP is well-able to handle these factors at a monthly and multi-year grain, from the perspectives of the utility, of participating customers, and of non-participating ratepayers. In addition, utilities can assemble multiple Price Forecast Cases for each commodity to enable sensitivity analysis on overall cost effectiveness and lost revenue in different scenarios.

ESP allows utilities to value cost savings and lost revenue for both delivery and consumption components of a commodity. DSM can provide delivery cost savings to a utility by avoiding distribution/transmission costs, as long as the savings occur at a time that is coincident with system or regional peak demand. Costs and savings can both vary by month, year and region. Lost revenues associated with delivery (i.e. monthly peak demand) can also be accommodated. ESP facilitates analysis of these factors, as shown in Figure 8, including the effects of distribution system and inter/intra-regional transmission system line losses.

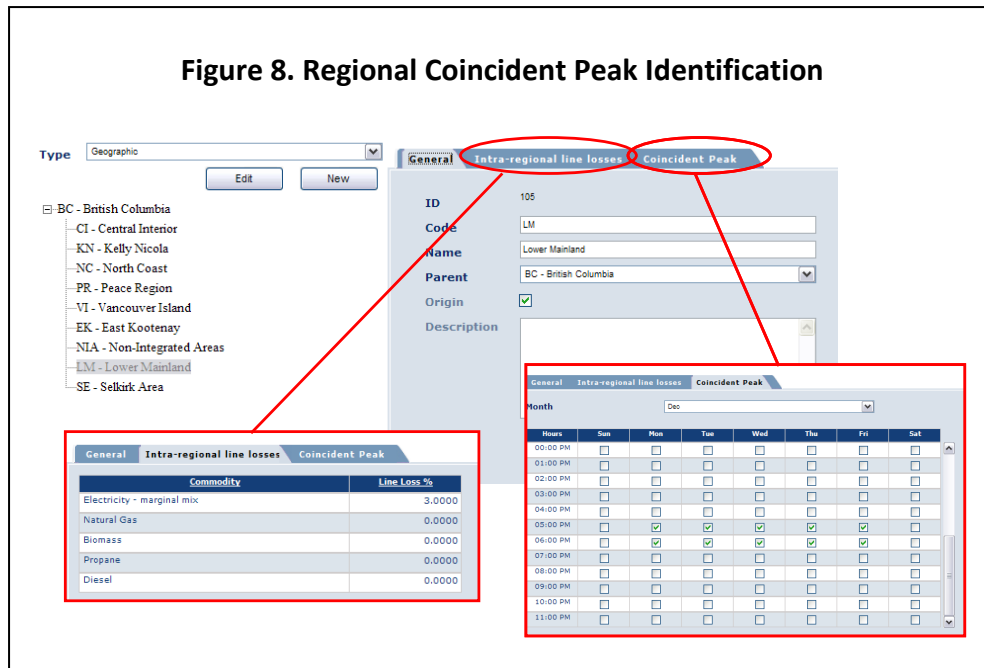
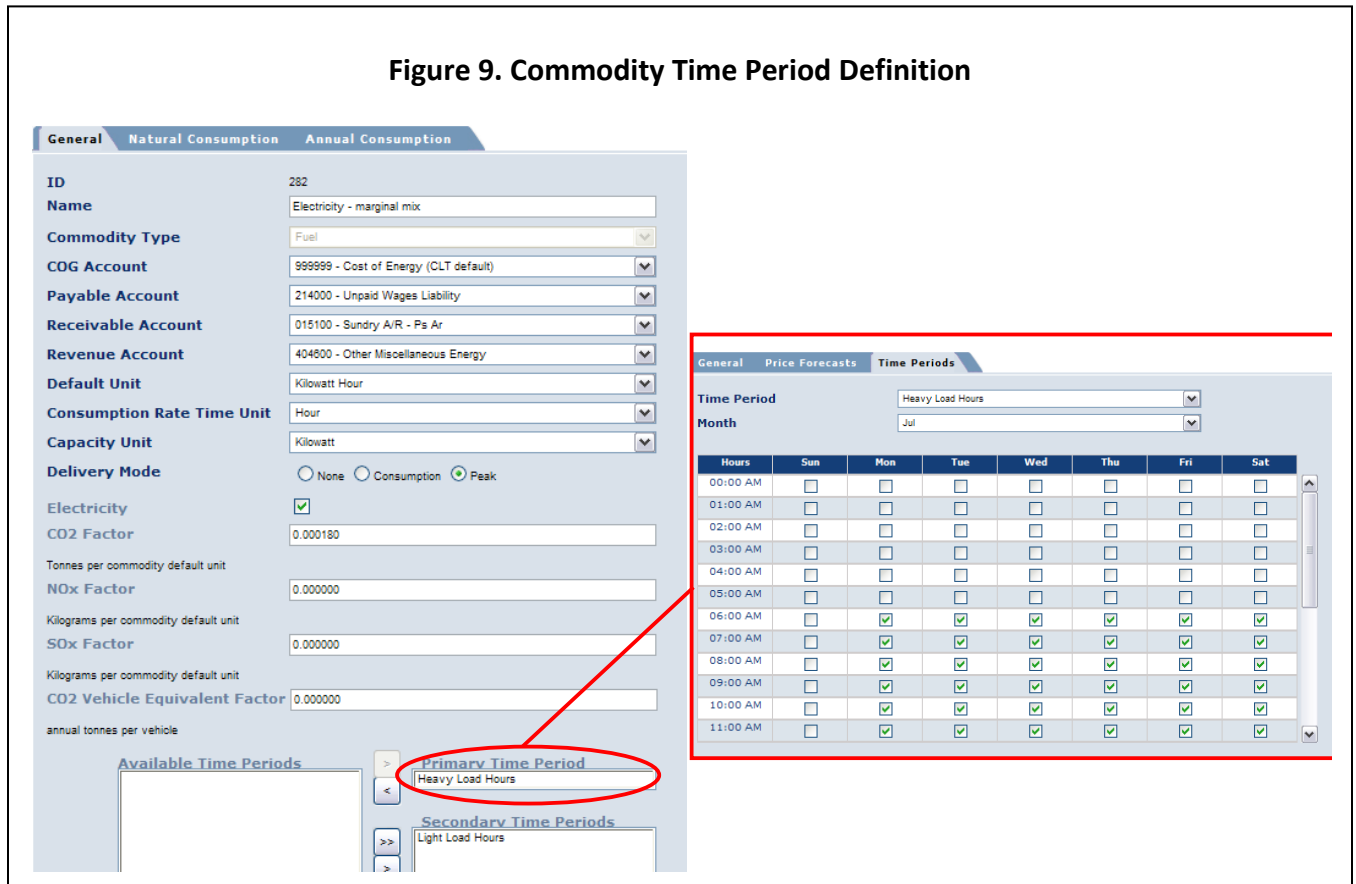


Figure 9. Commodity Time Period Definition



General | Natural Consumption | Annual Consumption

ID: 282
 Name: Electricity - marginal mix
 Commodity Type: Fuel
 COG Account: 999999 - Cost of Energy (CLT default)
 Payable Account: 214000 - Unpaid Wages Liability
 Receivable Account: 015100 - Sundry A/R - Ps Ar
 Revenue Account: 404800 - Other Miscellaneous Energy
 Default Unit: Kilowatt Hour
 Consumption Rate Time Unit: Hour
 Capacity Unit: Kilowatt
 Delivery Mode: None Consumption Peak
 Electricity:
 CO2 Factor: 0.000180
 Tonnes per commodity default unit
 NOx Factor: 0.000000
 Kilograms per commodity default unit
 SOx Factor: 0.000000
 Kilograms per commodity default unit
 CO2 Vehicle Equivalent Factor: 0.000000
 annual tonnes per vehicle

Available Time Periods: **Primary Time Period** (Heavy Load Hours)
 Secondary Time Periods: Light Load Hours

General | Price Forecasts | **Time Periods**

Time Period: Heavy Load Hours
 Month: Jul

Hours	Sun	Mon	Tue	Wed	Thu	Fri	Sat
00:00 AM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
01:00 AM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
02:00 AM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
03:00 AM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
04:00 AM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
05:00 AM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
06:00 AM	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
07:00 AM	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
08:00 AM	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
09:00 AM	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
10:00 AM	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
11:00 AM	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

As shown in Figure 9, savings and lost revenue from avoided commodity consumption can also be modeled by time of day (e.g. high load hours), month, year, and region.

DSM Program Analysis & Reporting

DSM project and program analysis and reporting is a core and powerful part of ESP. Users can generate the following kinds of reports:

- Cost Effectiveness
- Costs and Lost Revenues
- Benefits
- Greenhouse Gas Emissions
- Cost Roll-ups
- Critical Values
- Rate Impact

Figure 10 shows one of the configuration screens for the cost effectiveness test. Users can run standard DSM economic tests and examine standard economic metrics such as NPV, benefit/cost ratio, levelized cost, IRR and simple payback.

Multiple Price Cases can be set-up, which allow modeling of programs under different assumptions of avoided costs and

customer rates. This allows users to conduct sensitivity analysis, at run-time, of the impact of different pricing assumptions on program cost effectiveness from the perspective of the utility, ratepayers, participants, or society on the whole. Additional sensitivity analysis can be conducted via Sensitivity Cases on key variables such as spending or market penetration, etc. The result of the report is shown in Figure 11. All reports are exportable to Excel.

Figure 10. DSM Cost Effectiveness Report Configuration

DSM Report Type DSM Cost Effectiveness Report

Title

Price Case March 2005 Avg

Display NPV Benefit/Cost Ratio Levelized Cost IRR Simple Payback

Cost Test Utility Test All Ratepayers (TRC) Test Non-Participants (RIM) Test Participant Test

Simple Payback Options

Electricity Bill Savings Only All Participant Benefits

Incentives Excluded Incentives Included

*Show Inputs

Allocate Utility Overheads

Rollup By Sector/Project/Program None

Sensitivity Case Type (All)

Sensitivity Case Spending by Res.Code -10%

Data Choice Forecast Only Actuals + Forecast to Complete

Figure 11. DSM Cost Effectiveness Report

Expenditure Filters Configuration Report Types DR Allocation Recall Saved Report **View Report** Plan Snapshot

Print Excel Save

DSM Cost Effectiveness Report

Title:

Savings Category: All	Portfolio: All
Snapshot Date: None	Discount Rate (nominal): 8.00%
Discount Rate (energy): 6.00%	Scale: Literal
Start Date: 01/04/2001	Report Time Frame: 20 Fiscal Year(s)
Price Case: March 2005 Avg	Sensitivity Case: None
Data Choice: Forecast Only	

Customer Sector/DSM Program/Expenditure	Utility Test - Benefit/Cost Ratio	All Ratepayers (TRC) Test - NPV
Commercial	2.36	1,782,058.98
TLP - Com - Traffic Light	2.36	1,782,058.98
5759 - Com - Traffic Light - pre F06 - Default	2.36	1,782,058.98
Totals:	2.36	1,782,058.98

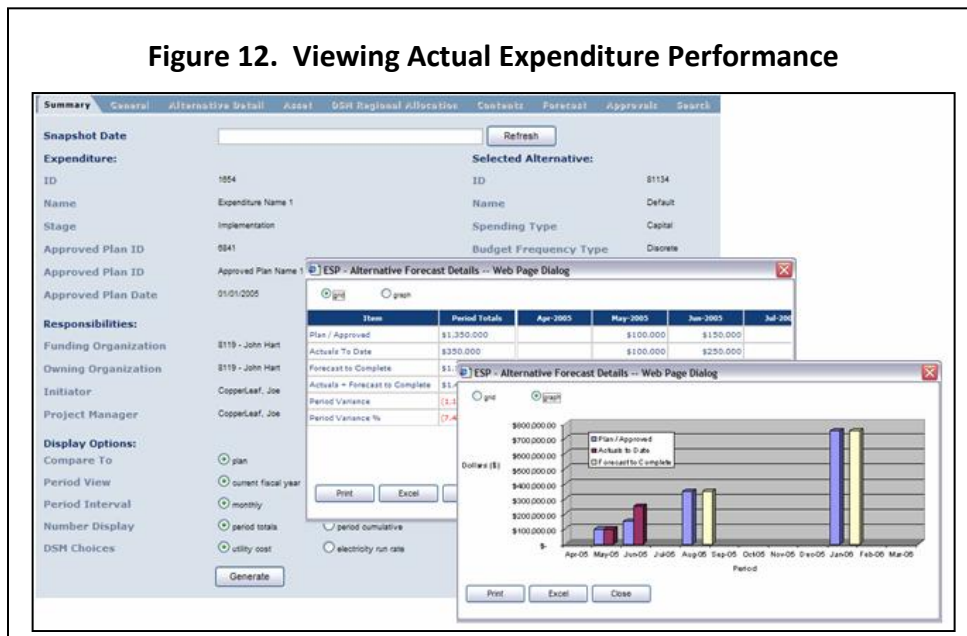
Approve Plans and Report on Performance

Once the DSM programs have been analyzed and approved, users can create annual and multi-year Plans for submission to the budgeting process. Recognizing that planning and budgeting are iterative processes, Plans can be ‘frozen’ to capture a snapshot on a specific date. Plans can be modified and re-frozen to reflect new information, with each change tracked through an audit feature. Monthly, annual and multi-year spending and energy savings targets are fixed when a Plan is approved.

If utility spending has been identified in accordance with the organizational accounting structure, budgets can be generated directly from within ESP and exported to Financial Systems via Excel.

During the year, or duration of a multi-year Plan, program managers will be required to report on performance relative to Plan, both in terms of spending and the energy savings targets that were forecast. Through integration with the corporate financial system, ESP has the capability to import actual spending and performance results and match this data with the approved Plan. This simplifies variance analysis and the reallocation of funds based on changing costs, results, and priorities. ESP also has the capability to generate performance reports for management and stakeholders, as shown through the example in Figure 12.

Figure 12. Viewing Actual Expenditure Performance



Other Features

ESP is about much more than just DSM modeling. Other features and benefits of ESP include:

Feature	Benefits
<ul style="list-style-type: none"> • Supply-Side Spending Business Case Analysis and Plan Optimization 	<ul style="list-style-type: none"> • More optimal Plans, more closely aligned to organizational objectives • Able to demonstrate greater transparency on decision-making
<ul style="list-style-type: none"> • Stores information about the assets being managed 	<ul style="list-style-type: none"> • Supports long-term planning by capturing asset related information such as asset hierarchy, condition, in-service year, original cost, and remaining life
<ul style="list-style-type: none"> • Common technical platform 	<ul style="list-style-type: none"> • Supports multiple users with concurrent access • Provides confidence that calculation methodology and basic assumptions are common across all projects
<ul style="list-style-type: none"> • Configurable permissions 	<ul style="list-style-type: none"> • Controls access to data and functionality based on user needs
<ul style="list-style-type: none"> • Audit 	<ul style="list-style-type: none"> • Tracks most system changes by date and user ID
<ul style="list-style-type: none"> • Advanced Expenditure search mechanism 	<ul style="list-style-type: none"> • Enables users to search for data via filtering against most Expenditure attributes, as well as key letters or key words
<ul style="list-style-type: none"> • Architected as a .Net web-based application 	<ul style="list-style-type: none"> • Enables multi-user internet or intranet access, and seamless integration to all Microsoft products (i.e., Excel, Word, Power Point, Exchange, etc.)
<ul style="list-style-type: none"> • Configurable user-specific personal preferences 	<ul style="list-style-type: none"> • Enables users to configure reports and interface drop-down-lists in a manner that represents their preferred view of work
<ul style="list-style-type: none"> • Searchable Online help 	<ul style="list-style-type: none"> • Enables users to quickly find the steps required to complete various tasks

About CopperLeaf

CopperLeaf Technologies works with asset-intensive organizations facing the challenges of aging infrastructure and fast-changing business environments. We help our customers re-think their approach to capital planning, life-cycle asset planning, budgeting and demand-side management. Our Asset Investment Planning and Management (AIPM) and DSM solutions help them integrate planning, analysis, approval, and execution so that they can make decisions that are effective, transparent, and focused on the long-term performance of their organizations. We offer AIPM and DSM consulting services, including process maturity evaluations (or gap analysis) to help organizations determine where they are today and how to evolve to gain the most benefits from a mature AIPM or DSM process and culture. Our technology enables organizations to identify and analyze trade-offs effectively, allowing them to achieve that elusive balance of profitability, performance, and risk, thereby optimizing the value of their assets and programs over time.

www.copperleafgroup.com