A DEMAND-SIDE-MANAGEMENT EXPERIENCE IN EXISTING BUILDING COMMISSIONING

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ABSTRACT

As part of a suite of demand-side management (DSM) program offerings, Xcel Energy provides a recommissioning program to its Colorado commercial customers. The program has a summer peak-demand savings goal of 7.8 MW to be achieved by 2005. Commenced in 2002 as a pilot, the program offers no-cost recommissioning services and incentives to participants to buy-down implementation costs to achieve a one-year simple payback. To date, four projects are complete and twenty-three more are underway. It is anticipated that approximately 65 projects will be completed through the program by 2005.

This paper describes the basic program design and implementation process. The choices made in response to market barriers and program constraints are highlighted. In addition, the paper details the marketing efforts, the competitive bidding process, the standardized program elements, measurement and verification activities, and project savings to date. For each program aspect, program successes, uncertainties, and lessons learned are presented.

INTRODUCTION

As part of its 1999 Integrated Resource Plan, Xcel Energy is seeking 124 MW of cost effective demand-side management (DSM) resources by 2005 in its Colorado Front-Range Service Territory. To achieve this savings goal, the utility offers a suite of DSM programs, which include commissioning of existing buildings. Nexant, Inc. provides program design and administration services for this DSM program.

The objective of the Recommissioning Program is to reduce peak electric demand by 7.8 MW through the systematic evaluate of building systems and the implementation of low-cost measures. This is a resource acquisition program targeted at operation and maintenance (O&M) improvements. Its anticipated demand savings cost $450 per customer kW saved. This cost is competitive with the utility's other DSM programs and provides electric resources that are cost-effective compared to supply-side resources.

PROGRAM DESIGN

The Recommissioning Program started its first year as a pilot in 2002 and will continue through 2005. The program is available to commercial and industrial customers. To be eligible, customers must meet the following minimum eligibility requirements:

- Existing building or facility must have a minimum of 75,000 square feet of conditioned space and a summer peak demand of 300 kW.
- Building must have a motivated in-house O&M staff that is available to support the project.
- Building owner must be prepared to assume costs and expenses totaling $10,000 for agreed-upon measures that net a simple payback of one year or less.

Although most buildings can benefit from recommissioning, priority is given to participants with the following characteristics.

- The building is equipped with an energy management control system with a substantial number of monitoring and control points.
- The system is free of major problems requiring costly repairs or replacements.
- Building documentation is accessible.
- The building gross square footage is 250,000 square feet or greater.
- The building has high, normalized demand (peak kW/square foot) and normalized annual energy costs ($/square foot year).

Program funding and incentives are provided to participants in two ways: 1) incentives covering 100% of recommissioning services costs and 2) incentives to offset the cost of implementing low-cost measures. The aim of the latter payment is to buy-down the implementation costs to achieve a one-year simple payback. For highly cost-effective projects that have overall simple payback periods of less than one year, no incentives will be paid. Thus through the program, the building owner is guaranteed a one-year or shorter payback.

Program Features

Many studies have identified barriers that impede recommissioning from being widely accepted in the marketplace. Some of the major barriers include:

- Few building owners and property managers are familiar with the benefits of recommissioning services
- Lack of procurement vehicle for building managers for O&M services
- Lack of demonstrated savings for recommissioning services

Because of these recognized impediments, the program design includes specific elements to mitigate market barriers. To minimize the risk of investment to the building owner, incentive levels were tied to achieving a one-year simple payback. This design element facilitates facility financing of O&M services since the expense can be absorbed within a single-year operating budget.

The program helps to build credibility for recommissioning as a competitive energy-saving strategy. Each project conforms to a structured process that encourages consistent and quality recommissioning services. The project investigation includes a cost-benefit analysis (including savings, costs, and simple payback) of each recommended measure. This approach quantifies the major components of the building tune-up, treating them similarly to capital improvement energy-efficiency projects.

Structured Project Process

To promote consistency and quality in the recommissioning services offered, a structured program process was adopted and tools developed to support the program. The program administrator fosters these service attributes by working with recommissioning service providers (RSPs), providing report templates, giving calculation guidelines, and performing due-diligence technical review.

The structured program process follows the recommissioning phases and activities identified by PECI (ORNL 1999). The basic program phases include the Planning Phase, Investigation Phase, Implementation Phase, and Verification Phase. The process, shown in Figure 1, includes elements that address the specific program needs for quantified savings and measurement and verification (M&V).

Planning Phase

The planning phase begins with the service provider consulting with the building facilities personnel, reviewing the building system documentation and utility bills, and completing the Site Assessment form. From the information gathered, the RSP develops a Recommissioning Plan that provides guidance for the remainder of the recommissioning process.

Investigation Phase

During the investigation phase of the recommissioning process, the service provider, with assistance from building facility staff, will conduct a site assessment to develop an in-depth understanding of the building's systems. Information and test results gathered during this phase are presented in the Investigation Report. Specific investigation phase activities include:

- Gathering operational and functional data to assess equipment operation
- Developing diagnostic and calculation plans to direct the investigation effort
- Collecting monitored data to verify scheduling and loading and to support engineering calculations
- Developing a Master List of significant deficiencies and potential improvements
- Implementing measures identified on the Master List once sufficient information is collected to estimate the measure's energy savings potential
- Defining an implementation verification procedure (i.e., visual inspections, spot measurements, or trend logging) to be used to verify savings for each recommended measure
- Agreeing about measures to be implemented

The objective of the diagnostic and calculation plan (D&C plan) is to layout the procedures to be followed to quantify recommissioning savings potential and identify up-front all data that must be collected. The collected data also serve as the baseline characterization for the project M&V. Calculation templates and specific cost-benefit analysis procedures for common measures are available to the service providers as part of the program materials. As the program matures and more measures are implemented, the library of D&C plans grows. Offering these tools to the providers helps

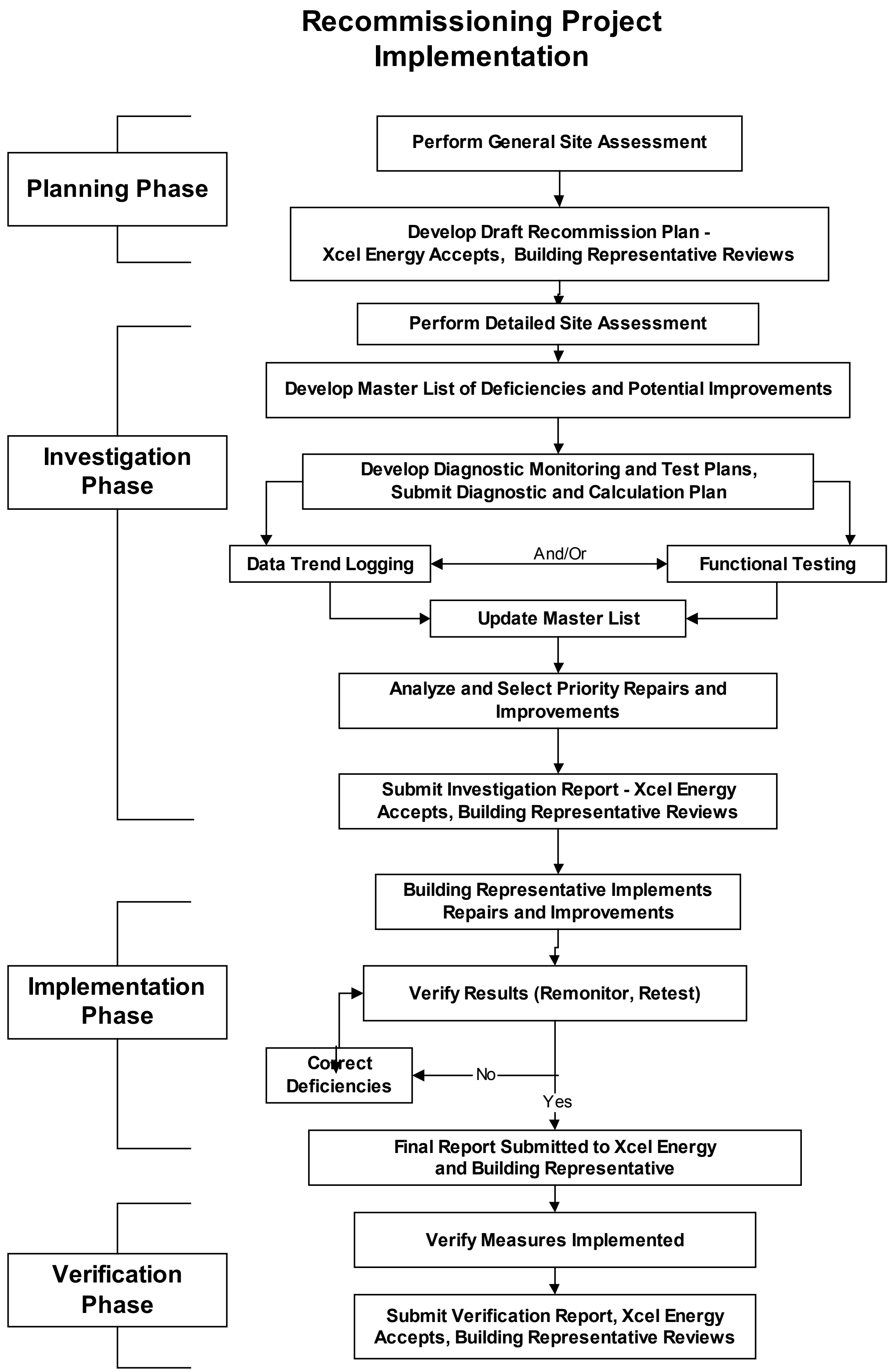

Figure 1. Xcel Energy Recommissioning Program Process

reduce analysis time and promotes program consistency and service quality. Another program aspect worth noting is the implementation verification procedure that is outlined as part of the Investigation Report. This simple M&V plan outlines the methods the service provider will follow to verify that the installed measures will achieve the estimated savings.

Implementation Phase

The building owner is responsible for implementing the agreed-upon measures recommended in the Investigation Report. As part of this responsibility the building owner outlines a brief work plan including the scope, schedule and staff involved. If in-house staff are not available or do not possess sufficient skills or expertise, outside help may be required. In-house labor, out-of-house labor and equipment expenses comprise the $10,000 investment obligation.

The building owner's work plan must identify the facility staff member assigned to either observe or participate in each aspect of the implementation. This has important implications for the persistence of the measures' savings because facility staff on-the-job training is essentially taking place during implementation.

After the work plan is developed and implementation completed, retesting and verification by the staff/contractors of some measures is recommended to verify that the expected results have been achieved.

Verification Phase

To confirm that the recommended recommissioning measures were properly implemented, the RSP is required to execute the implementation verification procedures outlined in the Investigation Report. Verification activities typically include witnessing equipment operation, examining EMCS programming and set points, and visual inspection of installations. If necessary, spot measurements are made or data trends are reviewed. If the service provider was involved in implementation, the program administrator completes this task.

Based on the verification results, the project savings calculations are adjusted. For example, if a measure is based on the supply-air duct static pressure set point being set to 1.0 inch of water but the verified value is 1.3 inch of water, the savings for the measure would be revised based on the verified value. The adjusted project savings are the basis for establishing the implementation incentive.

MARKETING

The current marketing strategy employed for the program has proved sufficient to secure the targeted number of participants. The program marketing strategy uses a two-pronged approach. Both Xcel Energy account executives and RSPs market the program to potential participants. Through May 2003, 42 applications have been received for 24 accepted projects.

The utility account executives, who provide customer service and DSM support, receive a financial incentive for each program application they refer that is selected for participation. Nearly 70% of applications received for the program have been referrals from account executives. Of these applicants, 50% have been selected to participate. Training the account executives to screen for desirable applicants is ongoing. As the program continues, it is expected that a higher percentage of their referrals will be accepted.

A project referred to the program by a RSP is assigned to the RSP. The RSPs use the program offering as a value-added service for existing and new customers. The generous incentives work well to entice reluctant customers to use recommissioning services. Of the 30% of applications received that were referred by RSPs, over 90% of them have been accepted. This stems from RSPs understanding of desirable project characteristics and their familiarity with the facility.

SERVICE PROCUREMENT

To satisfy Colorado Public Utility Commission (CPUC) requirements laid out as part of the 1999 Stipulation Agreement, all services provided through the utility's DSM programs must be competitively bid. This requirement was satisfied through the release of a request for proposal (RFP) to secure qualified service providers for the full-scale program. Eligible providers needed to be national or local entities and to have experience in providing quality recommissioning services, identifying demand savings opportunities, and prioritizing tasks to control costs.

The RFP was released electronically and sent to 55 contractors identified through the utility. The RFP was also posted on utility's website. Eleven contractors responded to the RFP and eight were chosen as pre-approved RSPs through a best-value selection process.

Successful bidders were categorized into two types: A-list RSPs and B-list RSPs. Successful bidders receiving high scores and not associated with specific equipment suppliers, distributors and product brand names are on the A-list. These bidders qualify to have projects offered to them through the utility's marketing efforts. Successful bidders associated with supplier/distributor/product brand names and lower-scoring independent providers comprise the B-list. These bidders may provide services for the program but they must propose work directly to an eligible customer and be identified on the project application. A-list RSPs may also obtain projects in this manner. Of the selected RSPs, 5 are on the A-list and 3 are on the B-list.

To meet the bidding requirement, the RFP provided service bids for 3 buildings characterized in detail in the RFP. The bids needed to be supported by costing formulas proposed by the RSP to be used for costing future program projects. Most formulas were based on building area. However, more complex formulas also included building age, building type, and number/type of HVAC equipment.

IMPLEMENTATION

2002 Pilot Program

The first year of the Recommissioning Program was a pilot. Four projects were selected from twelve applicants. Three RSPs were selected through a request-for-qualification process to perform the services. The program administrator completed the savings analysis. The total cost of services provided totaled $30,000 per project.

The projects included three offices and one hospital. These were large projects with an average area of 585,000 square feet and peak demand of 2875 kW or 5.0 W/ft^2. The average demand savings achieved was 0.36 W/ft^2 or 7%. Project statistics for each building are presented in Table 1.

Table 1. 2002 Pilot Program Projects

Project	Office 1	Hospital	Office 2	Office 3
Floor Area	410,000	600,000	790,000	540,000
Peak kW	2,415	3,130	3,700	2,250
kW saved	190	289	252	12
W/ft^2	5.9	5.2	4.7	4.2
W/ft^2 saved	0.46	0.48	0.32	0.02

In general, the buildings selected had the desired participant characteristics. However, one had a relative low demand benchmark of 4.2 W/ft^2. Of the four, this one had the lowest identified demand savings potential and appears as an outlier in the pilot program group. If this building is excluded from the group, the savings average 0.47 W/ft^2 or 9% of peak demand.

The measures that were found in these projects are summarized in Table 2. Some of the large demand-reduction improvements include reduction of supply air temperature and/or static pressure to reduce fan motor demand, revising the chiller plant sequence of operation for highest efficiency, and relocating the outside air temperature sensor to achieve efficient air-side economizer operation.

For each project, the payback period for the recommended measures was less than one year. Therefore, the program paid no implementation incentives. Nonetheless, the building owners agreed to install all of the recommended measures. It is worth noting that for two projects the implementation costs exceeded the obligatory $10,000 investment by the building owner.

The M&V for these projects is in progress. While an original pilot goal was to have implementation complete in 2002, this goal was not met. The implementation has been delayed for several reasons, as explained below.

The Office 1 project is mostly completed. The original savings were estimated at 239 kW. The majority of the savings (190 kW) were verified in 2002 but an additional 25 kW are expected. During the 2002 verification, it was discovered that not all measures were implemented to their full extent (e.g. static pressure was only reset to 1.5 inch water instead of 1 inch water). Implementation of another measure has been delayed due to an asbestos abatement project. Thus, the project savings calculations were adjusted to account for the actual implementation status.

For the Hospital project, implementation of the measures was delayed due to a new chiller installation during winter 2003. This delay was mostly due to the operators being fully occupied by the chiller replacement, and having little time to attend to rebalancing the air handling units.

No.	Measure	Annual Savings kW	Annual Savings kWh	Annual Savings Cost	Implementation Cost $	Simple Payback years
Measures Implemented at Project Office 1						
M1	Move outdoor air temp.sensor	14	20,739	$ 3,885	$ 500	0.1
M2	Reduce supply air static press.	37	30,033	$ 4,414	$ -	0.0
M3	Revise chiller operation	123	247,231	$ 20,328	$ -	0.0
M4	Insulate supply air duct	2	5,062	$ 400	$ 5,000	12.5
M5	Elevator shaft loss	4	3,397	$ 450	$ -	0.0
M6	Main AHU => 2nd floor	0	21,876	$ 360	$ 1,720	4.8
M7	Reduce supply air temperature	2	4,046	$ 387	$ -	0.0
M8	Shift filter schedule	9	7,508	$ 1,111	$ 200	0.2
	Subtotal	**190**	**339,892**	**$ 31,335**	**$ 7,420**	**0.24**
Measures Implemented at Project Hospital						
M1	Reduce supply air temp.	289	1,656,562	$60,326	$24,908	0.54
	Subtotal	**289**	**1,656,562**	**$60,326**	**$24,908**	**0.54**
Measures Implemented at Project Office 2						
M7	Repair duct & door air leaks	1	2,594	$ 190	$ 1,650	8.7
M9	Reduce AHU-19 supply air temp	26	116,667	$ 7,562	$ -	0.0
M12	Convert exit signs to LED	6	49,056	$ 1,599	$ 6,800	4.3
M15	Lighting sweep controls	219	219,350	$ 17,901	$ 5,000	0.3
	Subtotal	**252**	**387,666**	**$ 27,252**	**$ 13,450**	**0.49**
Measures Implemented at Project Office 3						
M2	Reduce supply air static press.	6	35,904	$ 1,337	$ 200	0.1
M18	Elevator demand limiting	5	10,470	$ 780	$ -	0.0
	Subtotal	**12**	**46,374**	**$ 2,117**	**$ 200**	**0.09**

Table 2. 2002 Pilot Project Savings Summary

Table 3. Project characteristics of applicants accepted in 2003

Proj. No.	Building Type	Project Floor Area (ft^2)	Customer Peak Demand (kW)	Project Demand Benchmark (W/ft^2)
1	Hospital	321,000	1,706	5.3
2	Office Campus	260,000	18,696	NA
3	Stadium	350,000	5,700	NA
4	Hospital	342,488	1,768	5.2
5	Office	324,645	1,640	5.1
6	Hospital	847,615	2,991	3.5
7	Office and Labs	86,000	570	6.6
8	Office	289,000	2,400	8.3
9	Office	240,000	1,061	4.4
10	Office	274,700	1,859	6.8
11	Office Campus	440,000	24,460	NA
12	Office	118,500	598	5.0
13	Bank	135,620	682	5.0
14	Office	288,447	1,630	5.7
15	Hospital	480,000	2,700	5.6
16	Prison	277,033	1,000	3.6
17	University building	237,511	928	3.9
18	Office	175,000	1,100	6.3
19	Office	160,000	792	5.0
20	Office	860,000	4,424	5.1
21	Office	215,000	1,814	8.4
22	Hotel	210,500	810	3.8
23	Stadium	474,629	5,409	NA
ESTIMATED AVERAGE PROJECT[1]		309,635	1,604	5.2
ESTIMATED TOTAL (2003 Completion)		4,334,886	22,454	5.2
ESTIMATED TOTAL (2004 Completion)		2,786,712	14,435	5.2
	ESTIMATED TOTAL	**7,121,598**	**36,888**	**5.2**

[1]To determine average, all projects were considered except for office campuses or stadiums (which could not have accurate demand benchmarks calculated from currently available data).

Office 2 and Office 3 have the same owner and share one city block in downtown Denver. The same service provider recommissioned these large offices. The Investigation Report for the projects fell behind schedule and was submitted in February 2003. Currently the building owner is making arrangements to complete implementation for the project.

The building owners and operators involved in the pilot project are an exceptional group. Easily classified as early adopters, most were involved in energy engineering professional organizations. All were committed to energy efficient building operation. These characteristics contributed to their full acceptance of all recommissioning recommendations. However, the pilot experience showed that even with highly motivated participants, implementation of no-cost and low-cost measures often receive lower priority than “bigger” projects. In addition, the pilot projects were highly cost-effective projects with simple paybacks less than one year. Thus, they did not receive implementation incentives, which can drive the implementation process. These factors contributed to slower than anticipated implementation schedules and delayed savings credited to the program.

Lessons were learned from the pilot regarding applicant screening and project scheduling. These lessons drove the following design refinements for the full-scale program. The 2003 applicant screening process more heavily weights demand and energy benchmarks than the pilot project did. The 2003 application also more effectively evaluates the potential of specific measures. In addition, more information is gathered to determine whether peak load shaving techniques (including not meeting loads) are currently in effect. To shorten project completion time, specific project schedules are now set for completing program deliverables. For example, the contract between Xcel Energy and the building owner explicitly states that measure implementation must be complete before the end of 2003. The effectiveness of these program changes will be evaluated as the 2003 program proceeds.

2003 Program

The demand savings goal for 2003 projects is 1.1 MW. So far in 2003, 23 participants have been selected from 42 applicants. These selected projects total about 7.1 million square feet of building floor area. Of the 23 projects, 14 will be fast tracked for a completion in 2003. The other 9 projects will be completed in 2004 along with 18 more, which have yet to be selected.

Statistics describing the 2003 accepted projects are presented in Table 3. The table presents total and average floor area and peak demand data. Based on average project characteristics, 0.25 W/ft^2 of savings must be implemented and verified in order to meet 2003 savings goals. This amounts to an average building peak demand reduction of 5%. Based on the pilot program results, achieving these savings appears reasonable. However, building owners adherence to implementation scheduling requirements is uncertain.

In addition to other criteria, desirable program participants have high demand benchmarks, generally greater than 5.0 W/ft^2. Not all selected projects adhered to this criterion though. Some of these were buildings with 24/7 operation. Others were part of large campuses and are hoped to lead to other program projects. Others had known performance problems that would benefit from recommissioning.

For 2003 projects, service costs are determined from the costing formulas of the pre-approved service providers. This permits the program administrator to quickly assess the service provider that is the best value and offer the project to them. So far, all projects have been accepted at the offered service cost. The program process for costing and offering projects has been very effective. It has minimized contract negotiations and hastened new project starts while still meeting the Colorado bidding requirements.

It is apparent from the program costing experience that servicing smaller buildings (less than 200,000 square feet) is less cost effective than large buildings. Based on the smaller projects accepted, demand savings will need to be greater (on the order of 10% -15% of peak demand savings) to be as cost-effective as an average project. In light of this, only small projects believed to have high savings potential will be accepted.

A new project scheduling issue became apparent in 2003. The time required for the building owner to enter into contract with Xcel Energy caused many projects starts to be delayed. Of the 15 projects that are contracted, it took an average of 33 days to get a signed contract following the acceptance of the project by the RSP. The range of the contracting period spanned from 6 days to 85 days. To hasten the process, regular follow-up communication with the project applicant was instigated. In addition, getting an earlier start on 2004 projects is planned. Of the 27 projects anticipated for 2004 completion, it is planned to start 16 in 2003 and 11 in 2004.

Overall, the 2003 program experience has been a positive one. The administrative and technical processes developed for the program are working effectively. The RSPs are receptive to the program service structure and calculation requirements. They appreciate that the program is developing credible savings attributed to recommissioning services in Colorado. The biggest challenge pending for 2003 is enforcing implementation-scheduling requirements. In addition, refining program elements to further improve measure persistence is an action item.

CONCLUSIONS

While recommissioning services may be classified under market transformation programs by some utilities, the Xcel Energy program experience demonstrates that it is also a competitive resource acquisition strategy. It is competitive compared to its other DSM programs and supply-side resources. In addition, capital-improvement-type DSM programs and recommissioning programs are complimentary. Measures identified through the recommissioning program but outside its scope are referred to the capital-improvement program - and vice versa.

The program design elements that have worked well for the Recommissioning Program in the Colorado service territory include:

- No-cost recommissioning services
- Implementation incentives tied to a one-year payback
- Program administrator with strong technical skills
- Careful applicant screening
- Structured program process
- Calculation guidelines and tools
- Quality assurance review
- Agreed-upon RSP costing formulas
- Keeping the group of pre-approved RSPs to a manageable size

Future program design refinements hope to yield improved project scheduling and measure persistence. Program project information regarding scope, savings, and costs will be documented as part of the program process. While generated to serve the program needs, the information will be publicized to increase the general awareness of the cost-effective savings achievable through recommissioning projects.

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