Whistler Demand Side Management Study

An Analysis of Measures to Reduce Peak Day Propane Demand

FINAL REPORT

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Executive Summary

Overview

Ideally, from the perspective of a number of key stakeholders, DSM measures would be found that could delay, or even avoid, costly propane infrastructure additions

The Resort Municipality of Whistler (Whistler) has experienced significant increases in energy demand over the past decade, the result in turn of significant increases in the region's tourism-related industries. Terasen Gas Whistler Inc. (Terasen) has expanded its propane system over time to meet this growth. Land constraints and increasing capital costs, coupled with a desire within the municipality to pursue sustainability-related initiatives has resulted in a push to examine demand side management (DSM) options as alternatives to further expansion of the propane infrastructure. Ideally, from the perspective of a number of key stakeholders, DSM measures would be found that could delay, or even avoid, costly propane infrastructure additions.

The project team of Compass Resource Management and BC Research Inc. were hired in September 2003 to investigate what potential cost-effective DSM measures could be applied to the unique market characteristics of Whistler.

The focus of this study is on DSM measures that reduce peak day demand. Peak day demand refers to the largest quantity of propane the system must deliver in a single day. The peak day demand typically occurs under extremely cold conditions during the busy holiday season. Peak demand drives the size of storage and delivery infrastructure that is required to provide reliable service. Annual or average demand of propane is the quantity of propane required over an entire year or on an average per day. Some DSM programs can reduce peak demand without altering annual or average demand (e.g., simply shifting demand between peak and off-peak periods). Some DSM programs can reduce average or annual demand without substantially altering peak demand (e.g., measures that reduce night-time loads). In this study, we only explored measures that would have a significant impact on peak demand. There may be other DSM programs with economic, social and/or environmental benefits, but these are unlikely to affect the need for new peaking capacity given current behaviours and technologies.

In the course of this work, the project team:

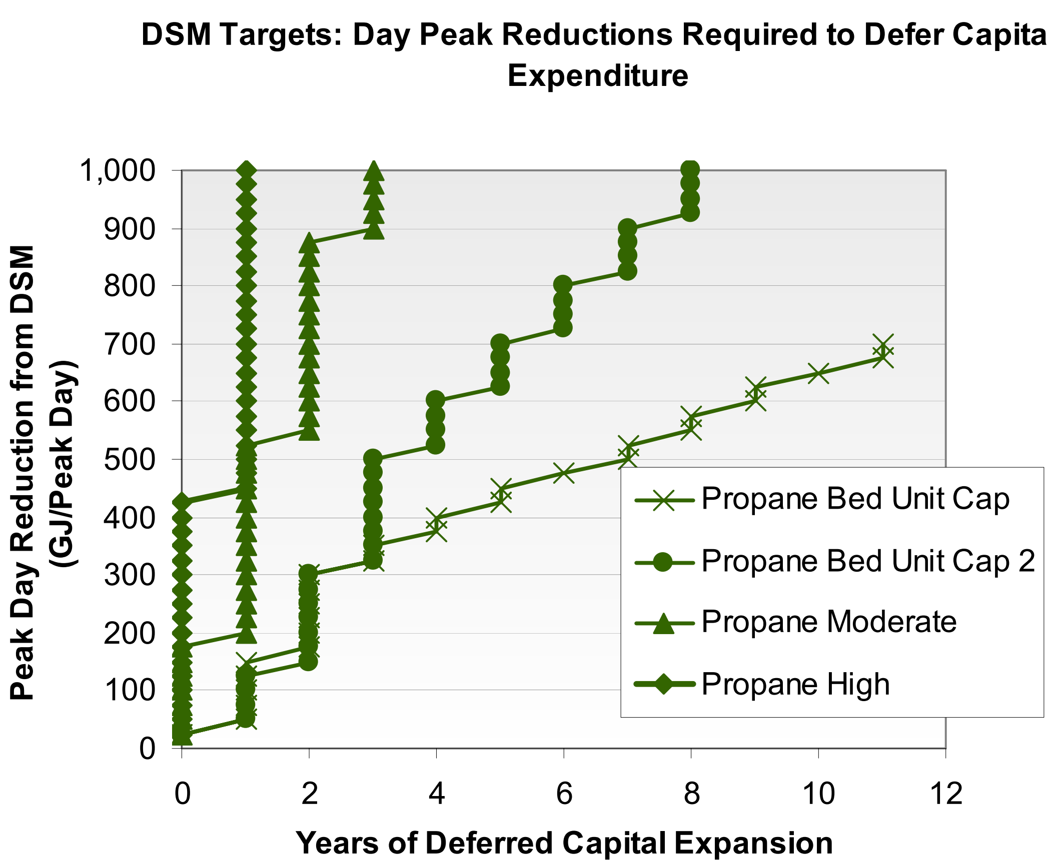
- Reviewed the findings of previous integrated resource plans for Whistler (e.g., 1997 Resource Plan Update), and the January 2003 Review of Supply Alternatives prepared by the utility.
- Undertook a brief literature review in the academic and grey literature on gas distribution DSM experiences.
- Reviewed the recently completed Community Energy Plan, and the documentation behind the "*Whistler, it's our Future*" initiative.
- Interviewed representatives from the utility, the municipality, and key RMOW community and business stakeholders.
- Conducted two site visits to Whistler to view first-hand the nature of propane usage among different customer types, and to meet with selected stakeholders.
- Interviewed numerous energy service consultants and equipment suppliers to obtain required technical and performance data.
- Using historical and forecast demand data supplied by Terasen, conducted an analysis on the system and economic impacts of a number of candidate DSM measures

Findings

- Figure 1 shows the daily peak demand capacity reduction required from DSM measures to defer capital investment in the Whistler system under four different scenarios of future demand growth. Even in the most modest growth scenarios (Propane Bed Unit Cap), a daily peak demand reduction of around 150 GJ is required to defer new capital investment for two years using 'best estimate' assumptions.
- The benefits of DSM depend not only on program assumptions, but also on demand forecast assumptions. Terasen plans peak day requirements, which are based on

assumptions about customer numbers and demand per customer. Peak demand is estimated for a busy day under extremely low temperatures (the design day). Terasen's design day assumptions had not been tested in many years due to mild winters over the last decade. This raised some uncertainty regarding the peak day multipliers used by Terasen, since behaviour and technology can change over time. By coincidence, extremely low temperatures during the most recent holiday season in late December and early January provided a timely test of some of these assumptions. Dispatch data collected from the holiday indicate that the assumptions used by Terasen in their demand forecast are reasonable, at least for the short to medium term (i.e. for the next three to six years).

Figure 1: Peak Day Reductions Required to Defer Capital Expenditures



- We have analyzed five DSM programs:
  - Spa Audit Program
  - Ornamental Fireplace Replacement Program
  - Large Commercial Audit Program
  - Commercial Patio Heater Management
  - Large Residential Fireplace Efficiency Program

- Table 1 shows the peak day capacity reductions we consider may be possible under this portfolio of DSM measures. The peak day savings in the short term sum to around 110 GJ. Future savings depend in part on demand forecast assumptions.

- A sensitivity analysis shows that this figure does not change significantly with changes in key assumptions

- Based on this analysis, ***we do not expect DSM programs to be able to defer capital expansion for more than one or two years.*** A *full* implementation of the *entire* portfolio described here could, however, result in savings for all parties through such a brief deferral.

- Even if the benefits capital deferral are excluded, almost all of the measures we explored in this study had a positive Total Resource Cost, implying that the total benefits exceeded the costs when both utility and participant costs and savings are considered. However, according to the Ratepayer Impact Measure (RIM), all of the programs would result in some rate increase in at least some scenarios, implying revenue losses exceed utility cost savings. If programs are implemented as a package and are sufficient to defer new capital one or more years, there would be no rate impact. Ratepayer impacts could also be lowered through program design (e.g., requiring more of the costs to be borne by program participants, if possible). Ratepayer impacts are also sensitive to demand assumptions. Higher rates of growth reduce ratepayer impacts, but also reduce the potential length of any deferrals provided by programs.

Table 1: Relative Contribution of Programs to overall portfolio peak reduction performance

	Peak Day Saving (GJ/day)				
	2003/2004	2017/2018	2017/2018	2017/2018	2017/2018
DSM Program	**All Scenarios**	**Propane Bed Unit Cap**	**Propane Bed Unit Cap 2**	**Propane Moderate**	**Propane High**
Spa Audits	48.9	48.9	48.9	48.9	48.9
Ornamental Fireplaces	7.1	9.7	12.0	20.8	30.6
Large Commercial	35.4	35.4	35.4	35.4	35.4
Patios	11.1	21.3	31.7	71.3	100.3
Large Residential	7.8	7.8	7.8	7.8	7.8
Total	**110.4**	**123.2**	**135.9**	**184.3**	**223.1**

Conclusions

DSM is unlikely to defer capital expansion for an extended period

- Based on the information presented and the explicit assumptions we have made, it appears unlikely that DSM measures could defer peak capacity expansion in propane capacity for an extended period of time.

- Under more modest load growth assumptions, several DSM measures *may* be able to defer the timing of new propane capacity additions to serve peak demand by one or two years, provided customer participation in a portfolio of activities is adequate. Longer deferrals are unlikely, particularly if the bed unit cap is raised.

- The most promising peak reduction programs are likely in the large commercial sector, particularly large hotel complexes. We present an example of success in reducing peak propane demand in Whistler in the *Legends* hotel. We caution, however, against extrapolating conclusions from only one example. Given Whistler's unique set of peak demand drivers, finding useful experiences from other places has proven challenging.

- Some of the DSM measures examined highlight a possible tension between sustainability objectives. Many sustainability plans assume technological solutions exist to eliminate social, economic and environmental trade-offs. This is not always the case. For example, outdoor patio heaters are highly popular but use significant quantities of energy. Peak use can be reduced through the implementation of storage tanks or alternate fuel sources, but these may conflict with safety or aesthetic concerns. Similarly, heat loss can be reduced through drop walls and awnings. These management options, however, may also conflict with aesthetic objectives. Whistler may benefit from addressing these trade-offs more explicitly.

- In addition to demand growth assumptions, reliability criteria are a key determinant of system capacity requirements. Historically, planning has emphasized maximizing system reliability subject to technical constraints. Increasingly, utilities are being asked to look explicitly at the trade-offs between reliability and other criteria such as cost and social or environmental impacts. One common approach is to allow individual customers more choice over their level of reliability through interruptible or curtailable rates to manage peak demand. However, this assumes there are customers willing and capable of curtailing loads in response to system conditions. This is more common among industrial energy users. We believe such opportunities are less likely in the case of large commercial loads that depend on offering a high quality visitor experience.

Recommendations

- A number of DSM activities could be undertaken that collectively could defer capital expansion for one or possibly two years and would also minimize the possibility of peak supply shortfalls between now and the next expansion of peak capacity. Terasen should consider requesting approval for recovery utility costs associated with promising DSM programs in Whistler. The most promising programs include the following:

    - **Energy Audits for Large Commercial Customers (Hotels):** Utility-assisted audits would help to establish the magnitude of potential savings and provide a tool for encouraging cost-effective demand management. The Chateau Fairmont Whistler and The Legends offer two benchmarks for energy savings.

- **Patio Heater Program:** Working with the local government, Terasen should explore ways to manage peak and average demands from patio heaters, including fuel switching, on-site storage systems or even forging agreements not to use them.

- **Residential Fireplace Efficiency Program:** Based on discussions with local contractors, we believe wood-burning fireplaces some residences *may* have been converted to propane without the utility's knowledge. The typical technology used in these conversions is highly inefficient and could be a major contributor to peak loads. Replacing these fireplaces with new, more efficient fireplaces could reduce both peak and annual energy requirements.

- Local sustainability groups should consider how to support successful implementation of these energy saving programs.

- Terasen and the BCUC should consider explicitly the trade-off between increased peak supply curtailment risk and capacity expansion costs. Stakeholders should be involved in selecting a suitable balance between cost and reliability targets.[1]

[1]New BCUC resource planning guidelines are expected to require an update of the last major Terasen Whistler IRP, completed in 1997. Such a trade-off analysis as we recommend would be best performed sooner, rather than later, to ensure optimal resource capital expenditures. The results of such a trade-off analysis could form part of any later, larger Terasen Whistler resource planning exercise.

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1 Introduction

Whistler's propane system is running out of peak day capacity

The Resort Municipality of Whistler, B.C. ("Whistler"), 120km north of Vancouver, is home to one of the world's premiere ski resorts and receives approximately two million visitors each year. 'Terasen', formerly Centra Gas) operates a piped propane system in Whistler on behalf of the municipality, serving mainly hotels and stratas.

In January 2003 Terasen issued a review alternatives for increasing the peak supply capacity of the propane system in response to recent increases in peak day demand for the fuel. After studying nine supply alternatives from the perspectives of technical feasibility, cost, and ratepayer impact, Terasen concluded that its preferred option was to upgrade an existing propane storage and vaporization site (Function Junction) and to link it to a new additional storage site nearby (Cal-Cheak)[2]. At a meeting in February 2003, however, several of Terasen's larger customers indicated their interest in a more thorough review of Demand Side Management (DSM) initiatives that may be available to avoid the need to expand the system.

This study investigates whether DSM measures could offset the need for new propane supply capacity

The primary purpose of this study is to investigate whether DSM measures exist that could either preclude the need for new propane supply capacity, or that could save money by deferring investment in new supply capacity into the future.

> *Peak Day versus Annual Demand*
>
> Since this study is focused on DSM measures that reduce peak day demand, it is important to clarify the distinction between peak day and annual propane demand. **Peak day demand** is the largest quantity of propane that must be delivered by the system on any day in the year. The peak day demand usually occurs when extreme cold conditions coincide with a busy holiday season. **Annual demand** of propane is the quantity of propane delivered over the course of one year. *In this study, we do not consider measures that reduce annual demand without reducing peak day demand* (e.g. measures to exclusively reduce night time loads). However, we do consider the annual demand implications of measures that reduce peak day demand (e.g. restricting the use of propane system-connected patio heaters).

This section provides relevant background information on the Community of Whistler, its planning context, and introduces its propane storage / delivery system.

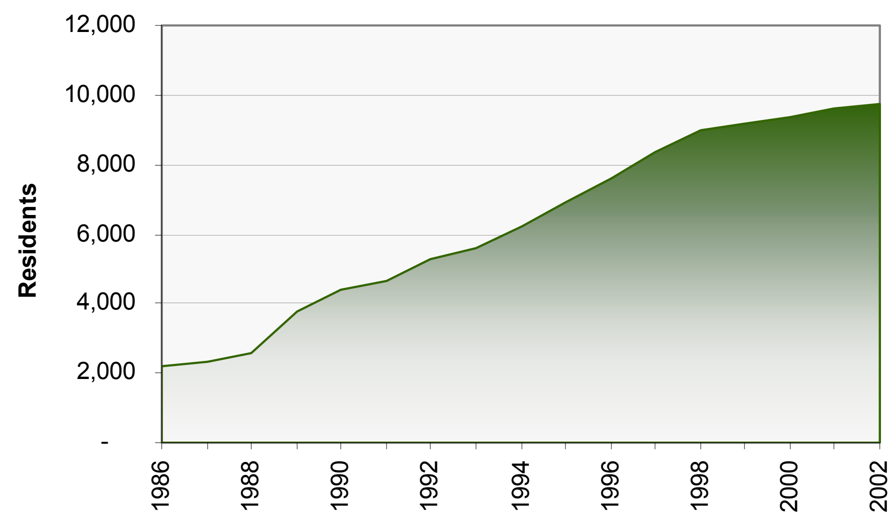
1.1 Whistler Community Profile

A resort community, Whistler comprises primarily residential and small commercial propane end-users. The propane demand of industrial consumers is negligible for planning purposes.

Whistler's resident population accelerated quickly in the past, but the rate has recently slowed dramatically

As of 2002, the Resort Municipality of Whistler had approximately 9,700 permanent residents. This figure has increased fourfold since 1986. While annual growth over the years from 1986 to 1997 averaged 14%, residential growth has slowed to an average of 2.0% since 1999 - See Figure 2). A significance of this is that most building stock is relatively new.

Figure 2: Whistler Resident Population (1986 - 2002)[3]



[2] This conclusion is open to ongoing review.

[3] http://www.bcstats.gov.bc.ca/data/pop/pop/estspop.htm

Whistler has wide seasonal population variations

During the winter a further 2,000 season workers are based in the city. The municipality receives almost half of its two million visitors during the period from November to February[4]. During the winter, around 16,000 visitors are present in Whistler on any given day. Table 2 summarizes the breakdown of people in Whistler on a winter day.

Table 2: Estimated 2002 Whistler population on a winter day[5]

Population Segment	Number	% of total
Full-time resident	9,700	37%
Seasonal residents (winter)	2,000	8%
Day visitor	1,600	6%
Overnight visitor	13,100	50%
Total Average Population	**26,400**	

Whistler has distinct areas of high density and low-density residential developments

The municipality is situated in a narrow valley surrounded by mountains, and so developable land is scarce. Consequently, there is a relatively high proportion of multi-family housing developments. Offsetting these higher–density developments, however, is a high number of large, single-family homes built in the 1980s. Table 3 illustrates the relative floor areas occupied by these two main residential building types.

[4] http://mediaroom.mywhistler.com/facts_stats/statistics.asp

[5] Data from Whistler's Community Energy and Air Quality Management Plan, Sheltair Group Resource Consultants Inc. February 2003. Table 4, pg. 22.

Table 3: Breakdown of Whistler residential Floor Space by Housing Type (2000)

	# units	Floor Area (m^2)	% of Total Area
Single Family Dwelling	2,400	598,000	39%
Duplex	430	78,000	5%
Municipal / Multi-family	6,200	872,000	56%
Total	**8,640**	**1,548,000**	

Whistler's commercial sector comprises primarily hotels

Table 4 illustrates the breakdown of Whistler's commercial floor space by sub-sector. About 60% of commercial floor space is in the hotel/motel segment. There are about 20 large and medium-sized hotel complexes, together with a few dozen smaller hotels and motels. A further third of the total commercial floor space is related to ancillary support services such as restaurants, cafes, food stores, sporting goods stores, fitness facilities, tourism-related services, and other entertainment-based businesses.

Table 4: Breakdown of Commercial Sector Floor Space in the RMOW (2000)

	Floor Area (m^2)	% of Total Area
Hotel / Motel	289,700	60%
Retail	82,500	17%
Recreational and Cultural	70,700	15%
Warehouse	12,600	3%
Institutional	6,900	1%
Office	5,600	1%
Other	12,700	3%
Total	**480,700**	

1.2 Whistler's Sustainability and Planning Initiatives

Whistler's growth is now strictly governed by planning regulations

Whistler's recent slowdown in population growth is largely the result of planning measures undertaken by the municipal council in the late 1980s, culminating in the 1988 Official Community Plan that laid out a clear vision for the future of the City.

In the mid 1980s, Whistler's leaders recognized that rapid growth in a naturally confined area was not sustainable. Without careful planning, the city could easily lose the high calibre of experience that was the key to its success. Since then, Whistler has become an interesting testing ground for sustainability thinking, initiatives and planning.

A "bed unit cap" is used to limit future growth.

Among the many policies implemented to slow growth in the early 1990s was one that established a bed unit cap (see side bar "Dwelling units and Bed units") that limited developments to those already committed at the time. This limit was 52,600 units, of which less than 30,000 had actually been built even into the early 1990s. For this reason, population continued to grow aggressively, as Figure 2

Dwelling units and Bed units

Planners within the municipality use "dwelling units" and "bed units" as measures of the amount of residential development. These measures include all types of accommodation. A dwelling unit is a self-contained accommodation unit. For example, a single-family house is one dwelling unit, while a duplex is two dwelling units. A bed unit reflects the servicing and facility requirements for one person. A single family house is allocated six bed units, while a town home is allocated two to four bed units, based on size (Complete details can be found in the 1993 Official Community Plan). The total number of bed units committed to development is 55,500, with 47,657 units developed as of December 31, 2001, approximately 86 percent of the bed unit cap. The total number of developed dwelling units was 13,029 as of December 31, 2001, with 2,350 dwelling units yet to be built[6]. The historical growth in bed units is illustrated in Figure 3, relative to the current bed unit cap[7].

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[6] www.whistler.ca/directory/

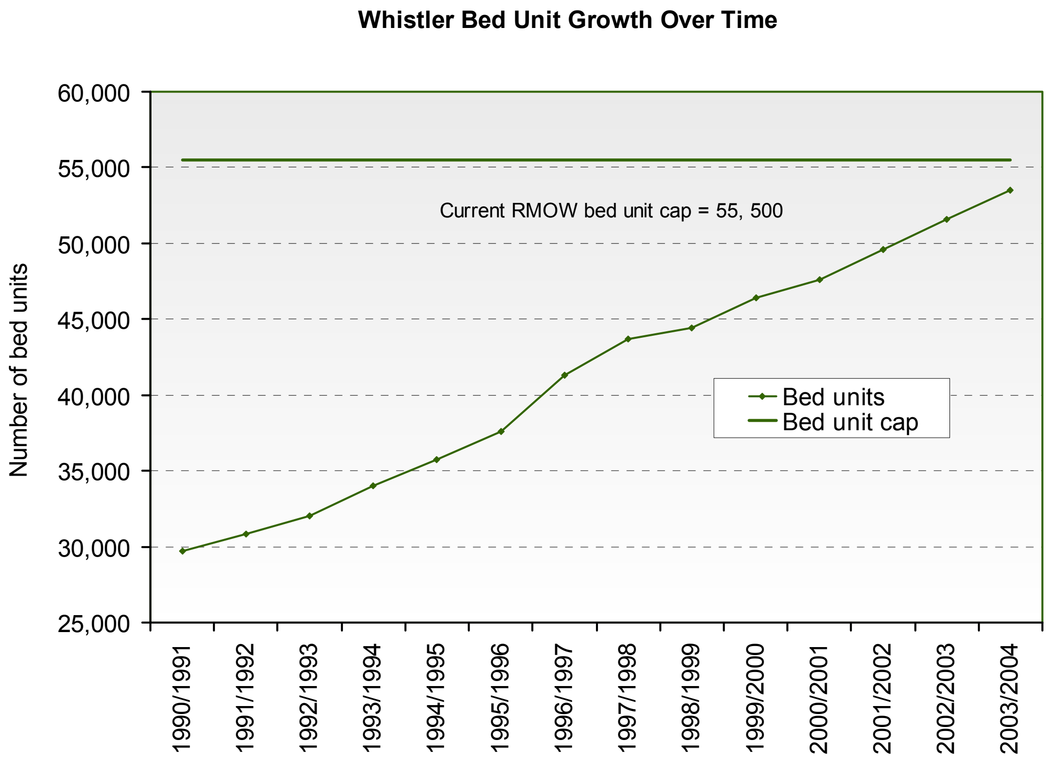
[7] Updated from Source: http://www.whistler.ca/directory/#b

illustrates, well into the late 1990s.

Future changes to the bed unit cap are a major community issue.

As of 2003, the bed unit cap has risen to approximately 55,500. Figure 3 shows how the build out towards this figure has progressed in the intervening time. Future futures changes to the existing bed unit cap are a currently major political issue in Whistler, and are discussed further in the following section.

Figure 3: Recent Whistler Bed Unit Growth



Whistler has a broad range of sustainability initiatives that any energy program must consider

Whistler's commitment to the notion or philosophy of sustainability goes much further, however, than the simple issue of unit caps. Over the past several decades or so, several planning initiatives have attempted to articulate more comprehensively Whistler's aspiration to become a 'sustainable' resort. These include:

- Whistler's program to promote and support sustainability, *Whistler. It's Our Nature*, grew out of the Early Adopters of The Natural Step Framework, and is managed by the new Whistler Centre for Sustainability. Sustainability for Whistler means "maintaining opportunities for future generations and not diminishing economic, social and environmental capital"[8].

- *Whistler 2002 —Charting a Course for the Future* reflects this vision. It is a collaborative document, developed by residents, key stakeholders, and the municipality. Adopted by the municipal council in spring 2000, it identifies five priority areas: Building a Stronger Resort Community, Enhancing the Whistler Experience, Moving Toward Environmental Sustainability, Achieving Financial Sustainability, and Contributing to the Success of the Region.

- The municipality is currently developing a *Comprehensive Sustainability Plan (CSP),* a strategy intended to address key issues such as the continued provision of employee housing, infrastructure, and environmental, business and social sustainability. It is meant to consolidate and supersede existing policy documents such as the *Comprehensive Development Strategy*, and will ultimately replace the OCP. The new Plan aims to integrate sustainability into all aspects of the community.

Other planning documents that have a more direct influence on propane supply and demand are the *Centra Gas 1997 Integrated Resource Plan*, and a draft *Community Energy Plan (*CEP). These documents are discussed further in subsequent sections.

[8] www.whistlerfuture.com

2 Propane Use

2.1 Background on the Whistler Propane System

Terasen ensures propane is delivered daily by rail to two storage areas, and vapourized and dispatched from two sites.

Terasen operates a piped propane distribution system in Whistler serving about 2,200 residential and commercial customers. Propane is transported daily to Whistler by railcar and tanker-truck, and stored in above-ground tanks at two sites owned by Terasen – a large facility at the Nester Junction located in the north of the Village and a smaller storage facility at Function Junction, located in the south. Propane stored at these two locations is vapourized and distributed through underground gas lines to local residences and commercial buildings.

The distribution pipes themselves do not need to be replaced.

Terasen's Whistler distribution system – the underground lines that transport propane from storage sites to the utility's customers — is adequate to serve the community's needs for the foreseeable future.

However, both instantaneous dispatch capacity and storage backup may need to be expanded.

The Whistler system's capacity is limited in two different ways: The peak rate of dispatch is operationally limited by the rate at which propane can be vapourized into the pipes. Without DSM measures, this limitation could be removed by expanding the capacity of the propane vapourizers and related infrastructure. Secondly, Terasen considers the volume of propane storage to be too small to guarantee propane supply in an emergency. Without DSM measures, this limitation can be addressed by increasing the amount of propane storage in Whistler.

Both sites are fully developed. Small 'satellite' tanks have been rejected for safety reasons. To expand storage, more land will have to be acquired.

Both of the current propane storage sites are fully developed. Any expansion of propane storage would require the acquisition of additional property within the municipality. Land costs are high and there are many competing land uses for developable land. Expansion of propane storage has also raised public safety-related concerns. These concerns are also reportedly preventing the use of many small "satellite" propane tanks to meet load growth in the municipality[9].

[9] Such an approach would see the installation of relatively large propane tanks in select locations within the RMOW. These tanks would be independent of the distribution grid, and would thus be able to help meet load growth without expanding the existing system. The 2010 Olympics information booth located within Whistler Village is currently heated by such a propane tank.

2.2 Regulation of Propane Service

Terasen is required to provide propane service to all who request it so long as it is technically and economically feasible to do so.

Terasen Gas Whistler Inc. is a utility regulated by the British Columbia Utilities Commission (BCUC). The regulator reviews the company's rates to ensure that it is not charging rates that are excessive or otherwise inappropriate, while permitting it to earn some return on its investment. Part of Terasen's responsibility as a regulated utility is its "obligation to serve". This obligation means that Terasen is required to provide propane service to all who request it so long as it is technically and economically feasible to do so.

Terasen charges customers for the cost of procuring propane without any mark-up.

The rates charged by Terasen consist of two fractions: the cost of the propane (the commodity), and the cost of providing delivery service. The "cost of propane" is a flow-through; i.e., the utility charges customers for the cost of procuring propane without any mark-up.

Terasen adds a charge covering its costs, plus a regulated rate of return

The "cost of service" consists of all the costs incurred by Terasen in serving its customers through the operation of the RMOW propane storage and distribution system. These costs include labour, maintenance, and a return on the capital invested in the utility's Whistler facilities. The rate of return earned by the utility is set by the BCUC to reflect appropriate risk and return for operating such a business in municipality. Increased expenditures on propane infrastructure will translate into an increased cost of service. Expenditures on conservation or other DSM programs are also recovered in the cost of service portion of rates.

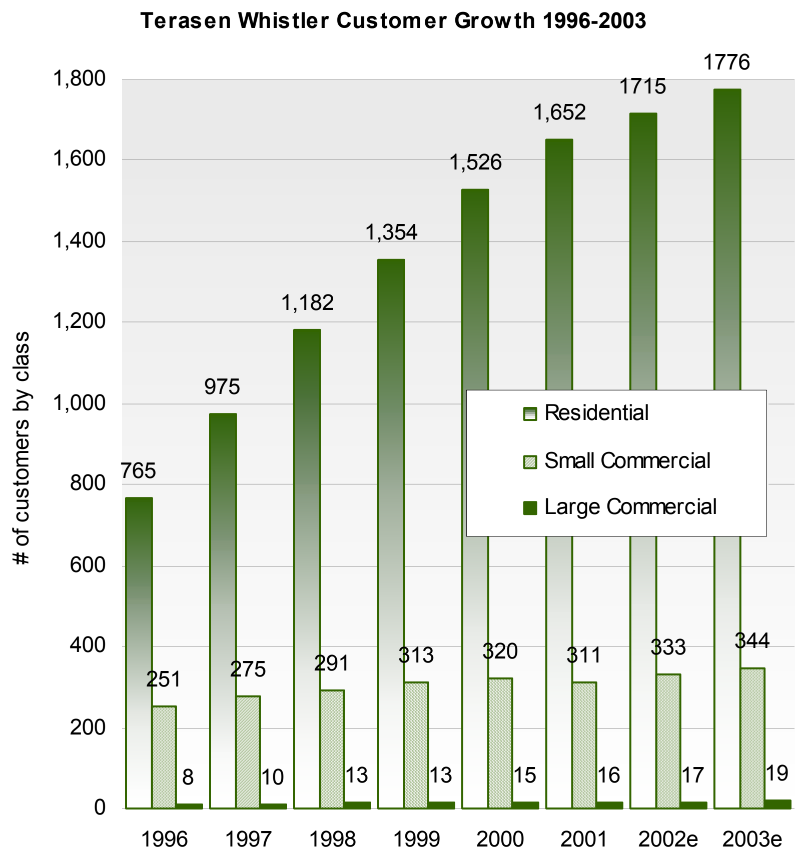
2.3 Historical Demand

Customer growth

The number of residential customers and large commercial customers have doubled over the last eight years

Figure 4 illustrates the number of customers served by the propane system over the past eight years, divided into the three main propane customer segments. The number of residential customers and large commercial customers has more than doubled over that period. Small commercial establishments (restaurants, cafés, retail outlets, etc.) increased by nearly 40%.

Figure 4: Terasen Propane Customer Growth by Class

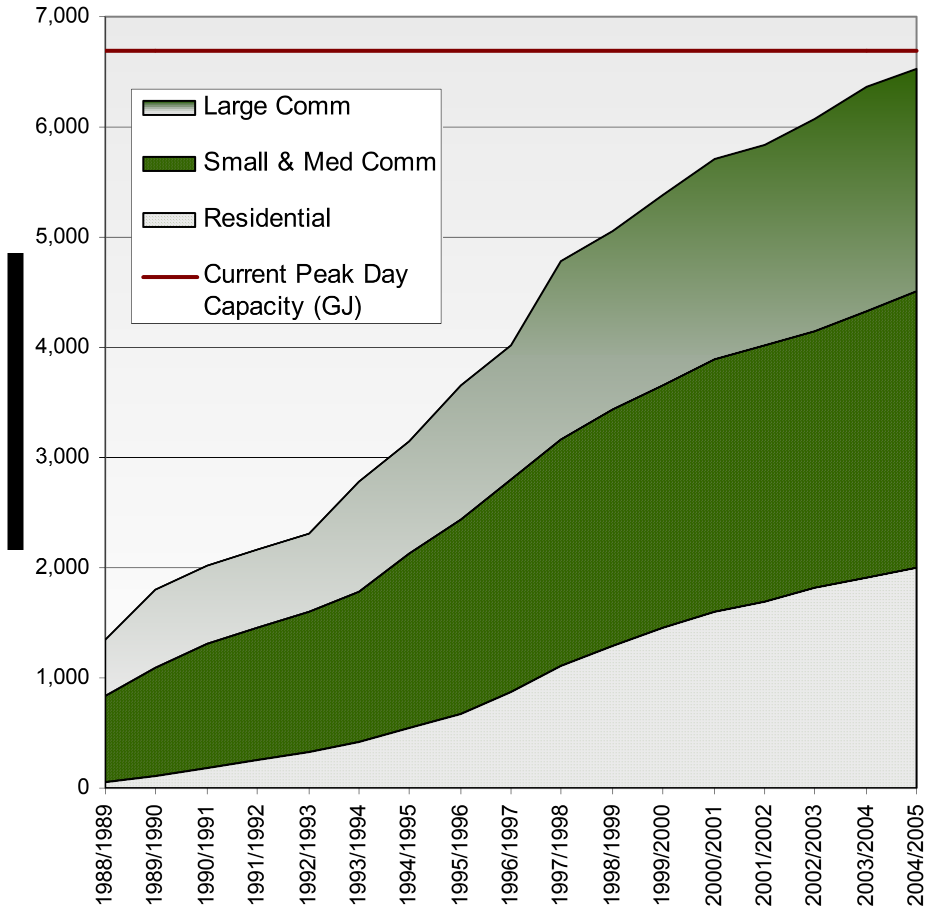


Historical Distribution of Peak Day Demand

currently account for roughly 67% of the peak load on the system, with around 20 "large commercial" hotels and strata-title lodges consuming nearly half of this amount.

e break-down of peak day capacity between the residential, small / medium commercial and large commercial customers in Whistler since 1988. The current peak system capacity, shown as the red line, is also shown for reference. While the growth in residential peak demand over the 1990s is most noticeable, this has tapered off considerably over the past three or four years. Residential demand now accounts for one third of current peak demand. Commercial customers consume the remaining two-thirds, of which almost a half is attributable to 20 large hotels and stratas.

Figure 5: Commercial Sector Dominates Peak Day Demand



2.4 Future Propane Demand – Setting the Challenge for DSM

The question at hand is whether DSM measures exist that could defer or preclude the need to expand the propane system.

This study examines whether DSM measures exist that could defer or preclude the need to expand the propane system beyond its current limit, and, if so, whether doing so would be preferable to the best option for expanding the system supply capacity. Before looking at available DSM measures, we must therefore understand when, and by how much, the current system capacity limit will be exceeded without additional DSM measures, and what the costs of system capacity expansion will be.

Answering this requires a forecast of future demand.

The issue of how much peak day capacity must be reduced to defer propane system expansion is more complex since it involves forecasting future Whistler propane demand.

There have been two independent approaches to forecasting Whistler's future

Both Whistler and Terasen have undertaken planning exercises that envision future demand scenarios.

Municipal Scenarios

The municipality's approach looks generally at long term development

Whistler. It's our Future is the planning process being used by the municipality to develop "a long-term, shared vision, priorities and plan for a sustainable future"[10]. Phase 2 of the plan, recently completed, sought public input into the viability of five possible futures for the RMOW. In outline, these are:

1. No New Development, which retains the current Official Community Plan.
2. Resident Housing Within Existing Corridor, which increases the bed cap for resident restricted housing built in areas within and adjacent to existing neighbourhoods from Function Junction to Emerald Estates.
3. A New Neighbourhood in the Callaghan, which increases the bed cap to permit resident restricted housing in the Callaghan Valley.
4. A Diversified Economy, which explores expanding the economy to compatible businesses with resident housing in the Lower Cheakamus and Callaghan Valley.
5. Increased Market Housing, which increases the market bed cap to facilitate the development of resident restricted housing.

At the time of writing (December 2003), Phase 3 of this process was expected to see the issue of a preferred plan by the municipality that would combine aspects of these scenarios.

[10] www.whistlerfuture.com

The municipal scenarios examined so far include a bed unit cap limit range of between 55,500 and 62,600.

At this point, while this planning exercise has not concluded, the range of bed unit cap limits being considered range between 55,500 and 62,600 between now and 2020. The increase in bed unit cap limit considered in most of the scenarios is a departure from recent planning policy. It cannot be assumed that these limits amount to definitive limits on future Whistler growth, particularly given the impact of the 2010 Olympic games.

Terasen Gas Scenarios

Terasen has developed four scenarios specifically referring to the propane distribution system.

In parallel to the municipality's process, Terasen has also developed a number of future growth scenarios, and has quantified the impact on propane demand that would result. Since we use these data as the basis for our analysis of the potential impact of DSM measures, we highlight here some of the key assumptions of those scenarios.

"Propane Bed Unit Cap" and "Propane Bed Unit Cap 2" Scenarios

Two of Terasen's scenarios assume a bed unit cap.

The Terasen demand forecast has two scenarios limited by bed unit caps. The first, "Propane Bed Unit", is capped at 55,174 from 2004/2005 to the end of the forecast period, 2017/2018.

The second, "Propane Bed Unit 2", is capped at 55,174 from 2004/2005, with the cap rising linearly to 63,600 in 2017/2018.

Terasen has developed simple algorithm that estimates peak day demand in the following way:

- In each year, the bed cap unit limit is converted to number of customers in one of six customer classes based on relationships between the two in previous years. Manual adjustments are made to the larger classes.
- Customer numbers are then converted to peak day demand and average annual demand using a single constant throughout the forecasting period.

"High" and "Moderate" Growth Scenarios

Two of Terasen's scenarios are based on extrapolations from past growth.

Terasen has also developed two scenarios that are not limited in any way by a bed unit cap: "High" and "Moderate" growth scenarios. The 90th and 50th percentiles of the historical aggregated range of annual customer growth define these categories. These numbers are applied on an annual basis to add new customers in each class to existing totals. The assumption is made that these additional customer numbers are constant into the future. For example, six new small commercial customers are added per year to 2017/2018 under the 'moderate growth scenario".

Terasen's four scenarios lead to very different forecasts of peak day demand.

Figure 6 below shows the peak day demand assumed by the four Terasen scenarios. Each line represents a different demand growth scenario. The shaded region shows the current assumed peak day demand capacity.

Figure 6: Historical and Forecast Peak Day Demand under four scenarios

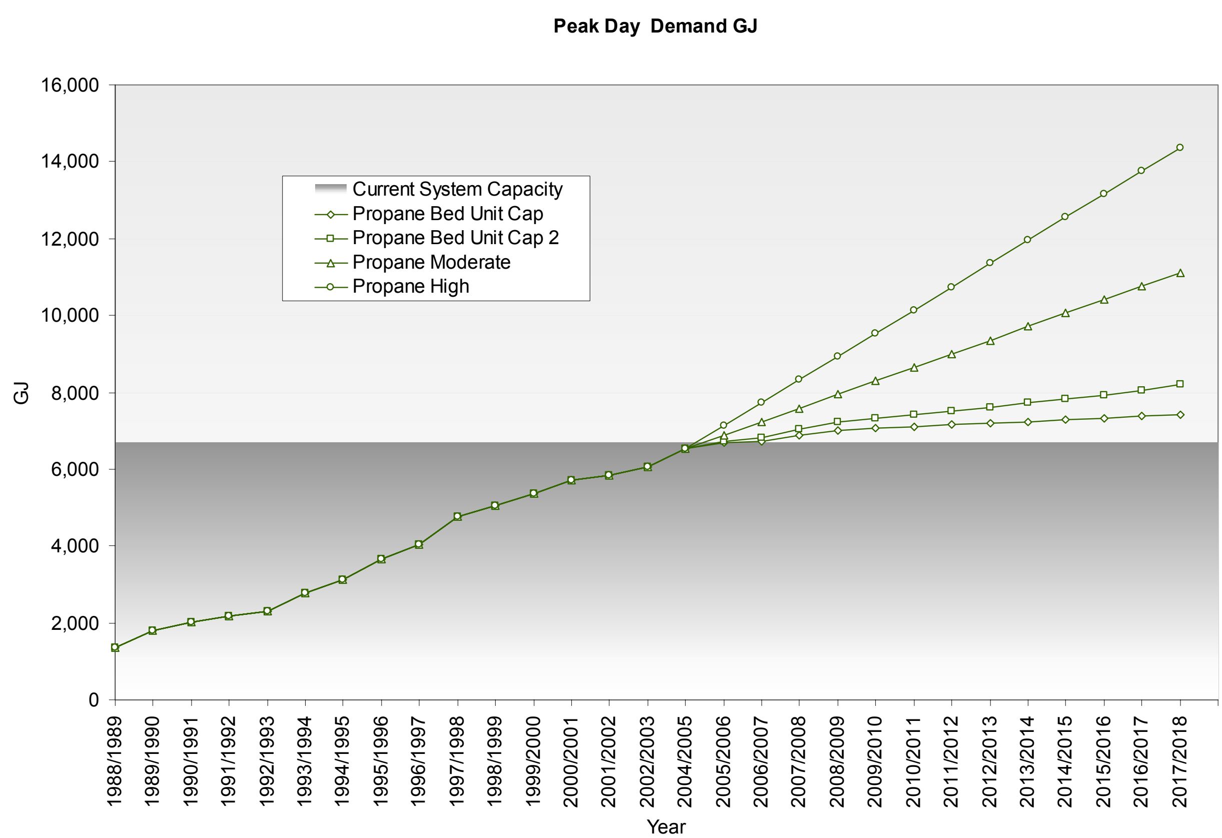
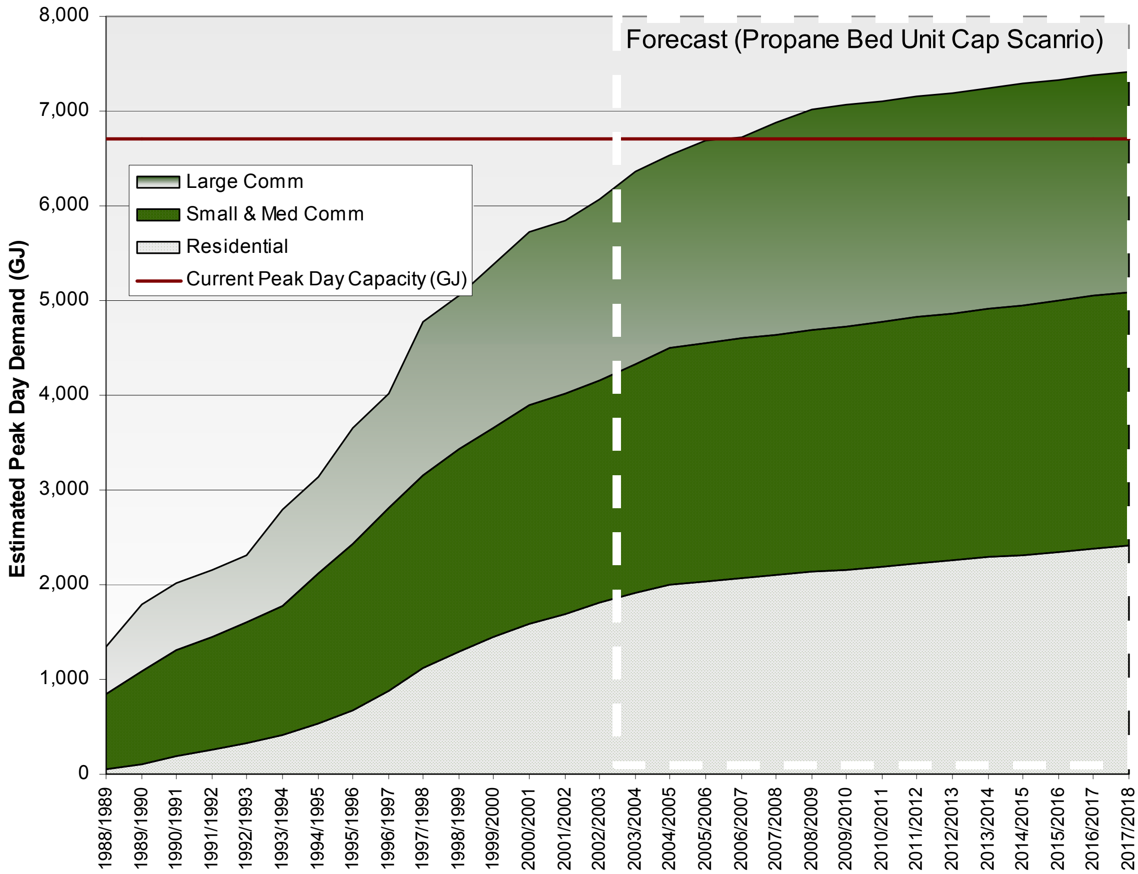


Figure 7 illustrates the break out of the forecast for the "Pipeline Unit Cap" scenario between the customer groups

Figure 7: Breakout of the Peak Day Demand Forecast for the Propane Bed Unit Cap Scenario



In three of Terasen's scenarios, construction on a new supply facility must begin this year.

Figure 7 shows the peak day demand exceeding the current system limit in around 2006/2007 in this scenario[11]. In the other three scenarios, the peak day capacity is exceeded earlier, in 2005/2006. Given that Terasen's preferred supply-side solution (see below) would take two years to construct, this suggests that construction must begin on new vapourization / storage facilities this winter if the design peak

[11] Historical figures have been developed by applying Terasen's demand per customer figure to actual historical numbers. These may not be the actual GJ dispatched in a peak day.

day is not to be exceeded. Any DSM measures to prevent this, therefore, must be capable of producing immediate results.

2.5 The Default Supply-Side Solution

Terasen's preferred supply solution is to build new storage near Function Junction and to upgrade the vapourization capacity at that facility.

Terasen concluded in January 2003 that the least cost supply-side solution to the system's capacity limitation, was to expand the system storage capacity at a new location (Cal-Cheak), and to pipe the propane to the existing Function South Vapourization Site, which would itself be upgraded to increase its instantaneous dispatch (vapourization) capacity[12]. Table 5 summarizes the costs of this supply-side solution. Capital costs are spread over a 24-month period, with the bulk of expenditure in the second year of construction[13].

Table 5: Capital Costs of Propane Capacity Expansion

Source: Centra Gas Whistler (Terasen) January, 2003

	Year 1	Year 2
New Storage Site (Cal-Cheak); Install 12 New 30,000 Usg Tanks	$ 2,360,000	$ 5,340,000
Increase Capacity of the Vaporizer Facility in South Whistler	$ 10,000	$ 615,000
Cal-Cheak New Site to Function South Vaporization Site	$ 75,000	$ 4,710,000
	$ 2,445,000	$ 10,665,000

Note: Costs are net of AFUDC to avoid double counting

The Net Present Value (NPV) (i.e., cost of the project in $2003 Canadian[14]) is $11,400,000, assuming a real discount rate of 8%.

[12] Note that this conclusion may be revised over time as circumstances change. However, it is reasonable to suppose that the costs of whatever capital expansion system may be ultimately proposed will be of this order of magnitude.

[13] Costs are correct as of January 2003; cost may now be somewhat higher.

[14] All costs are noted in $2003 Canadian.

If the decision to taken to defer construction of the facility for one year (i.e. to begin construction in 2004/2005), then the NPV of the investment drops by almost $850,000

Table 6 shows the value of postponing this project for a number of years. If the decision to taken to defer construction of the facility for one year (i.e. to begin construction in 2004/2005), then the NPV of the investment drops to $10,560,000, a saving of almost $850,000 resulting from the time value of money. Each additional year that investment can be delayed brings further savings. Deferring investment for eight years, for example, would reduce the NPV of the cost of the new facility by over $5,000,000.

Table 6: Deferrable Cost Table for Propane Expansion

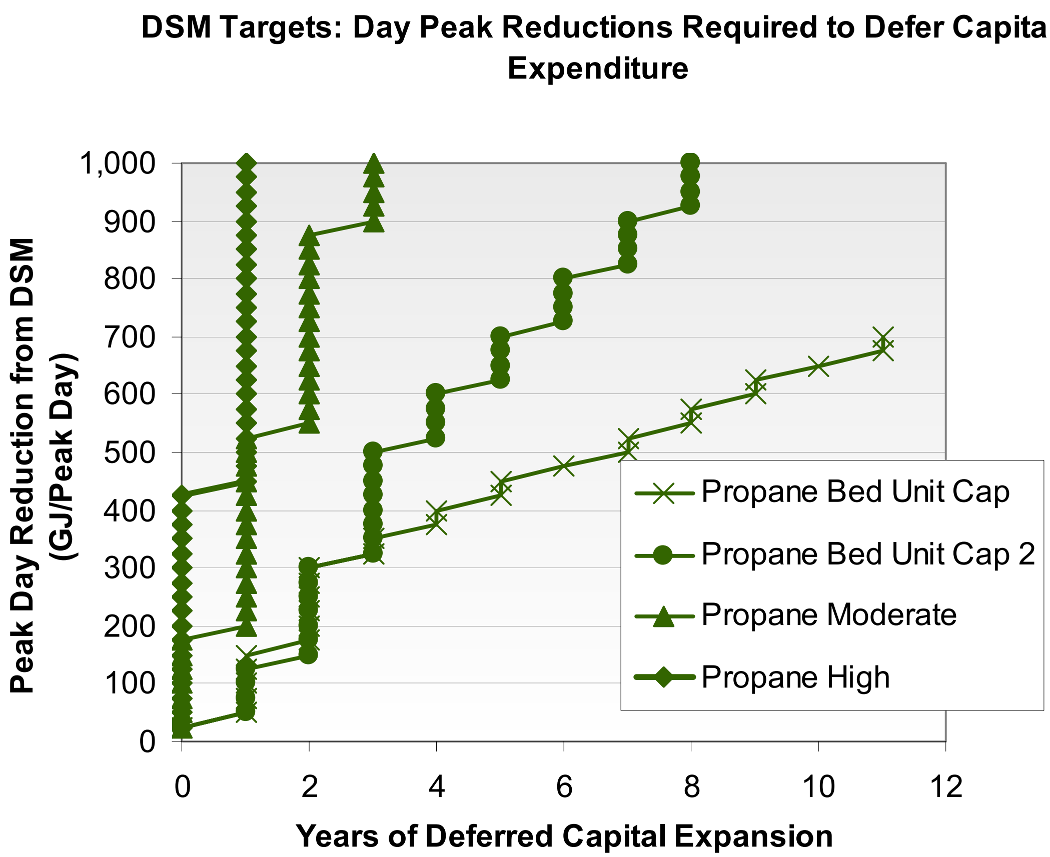
				Year of Capital Investment				
Year	**Deferral**	**NPV**	**Difference**	**1**	**2**	**3**	**4**	**→**
2003/2004	No deferral	$ 11,407,407	$ -	$ 2,445,000	$ 10,665,000	$ -	$ -	$ -
2004/2005	Defer 1 year	$ 10,562,414	$ 844,993	$ -	$ 2,445,000	$ 10,665,000	$ -	$ -
2005/2006	Defer 2 years	$ 9,780,013	$ 1,627,394	$ -	$ -	$ 2,445,000	$ 10,665,000	$ -
2006/2007	Defer 3 years	$ 9,055,568	$ 2,351,840	$ -	$ -	$ -	$ 2,445,000	$10,665,000
2007/2008	Defer 4 years	$ 8,384,785	$ 3,022,622	$ -	$ -	$ -	$ -	$ 2,445,000
2008/2009	Defer 5 years	$ 7,763,690	$ 3,643,718	$ -	$ -	$ -	$ -	$ -
2009/2010	Defer 6 years	$ 7,188,602	$ 4,218,806	$ -	$ -	$ -	$ -	$ -
2010/2011	Defer 7 years	$ 6,656,113	$ 4,751,295	$ -	$ -	$ -	$ -	$ -
2011/2012	Defer 8 years	$ 6,163,067	$ 5,244,340	$ -	$ -	$ -	$ -	$ -
2012/2013	Defer 9 years	$ 5,706,544	$ 5,700,864	$ -	$ -	$ -	$ -	$ -
2013/2014	Defer 10 years	$ 5,283,837	$ 6,123,571	$ -	$ -	$ -	$ -	$ -
2014/2015	Defer 11 years	$ 4,892,442	$ 6,514,966	$ -	$ -	$ -	$ -	$ -
2015/2016	Defer 12 years	$ 4,530,038	$ 6,877,369	$ -	$ -	$ -	$ -	$ -

2.6 The Challenge for DSM

This information specifies financial savings that could result from DSM

From this information, it is possible to describe the relationship between peak day savings and the financial rewards of deferring new capital expenditure. Figure 8 shows the peak day reductions required of DSM measures to defer investment in the new propane system infrastructure.

Figure 8: Peak Day Reductions Required to Defer Capital Expenditures



Under the Bed Unit Cap scenario, reducing peak day demand by 10% would defer capacity expansion for over ten years

For the Bed Unit Cap scenario, for example, a reduction in peak day demand of 700 GJ over and above the base case would defer the need for a capacity expansion for over ten years, at saving of $6.5 million (minus the costs of DSM measures). A reduction of 700 GJ is approximately 10% of the current system' peak day capacity of 6,700 GJ per day.

Under the other scenarios, the ability of DSM to defer investment is much reduced.

Under the other scenarios, however, a 700 GJ daily peak demand reduction from DSM would have less of an impact. Under the 'Propane Bed Unit Cap 2' scenario, the same reduction would defer construction for five years, at a saving of around $3.6 million in real terms before the costs of DSM are considered.

For the non-bed unit capped scenarios, a 700 GJ peak day reduction from the base case would only defer investment for one or two years.

The challenge for DSM is highly dependent on which forecast scenario is considered

It is therefore clear that likely success of DSM in reducing the need for propane capacity expansion is highly dependent on the demand forecast assumptions used.

2.7 Sensitivity to Key Assumptions

This DSM analysis is sensitive to other assumptions in Terasen's demand forecast

There are at least two key assumptions made by Terasen that, while justified in a general planning context, have the potential to strongly influence the degree to which DSM programs would be considered worthwhile. We highlight these assumptions here not as a criticism of Terasen or their selection of their values, but simply as an illustration of their critical influence on a DSM analysis.

Peak Day System Capacity Limit

The peak day capacity may be limited by rate at which propane can be vapourized into the system, or by the adequacy of storage of propane over a long cold spell.

As previously noted, during periods of extreme cold weather, propane demand "spikes", and challenges the capacity of the system in two different ways:

- The short term ability of the system to vapourize propane gas into the distribution system at a rate sufficient to keep up with demand on a short term (hourly or daily) basis.
- Since propane is delivered to Whistler by rail in batches, the capacity of the system to store enough propane between deliveries during an extended cold period.

Short Term Dispatch Capacity Limit

The value of 6,700 GJ as the current daily peak capacity is of key importance to this analysis since DSM measures must keep peak day demand below this figure to defer infrastructure expansion.

Table 7 and Figure 9 illustrate the difference between the actual peak day dispatch from the Whistler dispatch sites and the design peak day of 6,700 GJ used by Terasen.

Table 7: Peak Day Dispatch Data, 2000 - 2003

Day of week	Winter	Day	Pk hr(s)	Peak Hr GJ	Pk Day (GJ)
Sat	00/01	Dec 16	4-6 pm	188	3,916
Fri	01/02	Dec 21	5-6 pm	185	3,666
Sun	02/03	Dec 29	5-6 pm	215	3,900
Sat	03/04	Jan 3			5,050

Figure 9: Safety margin between actual peak day dispatch and design peak day capacity

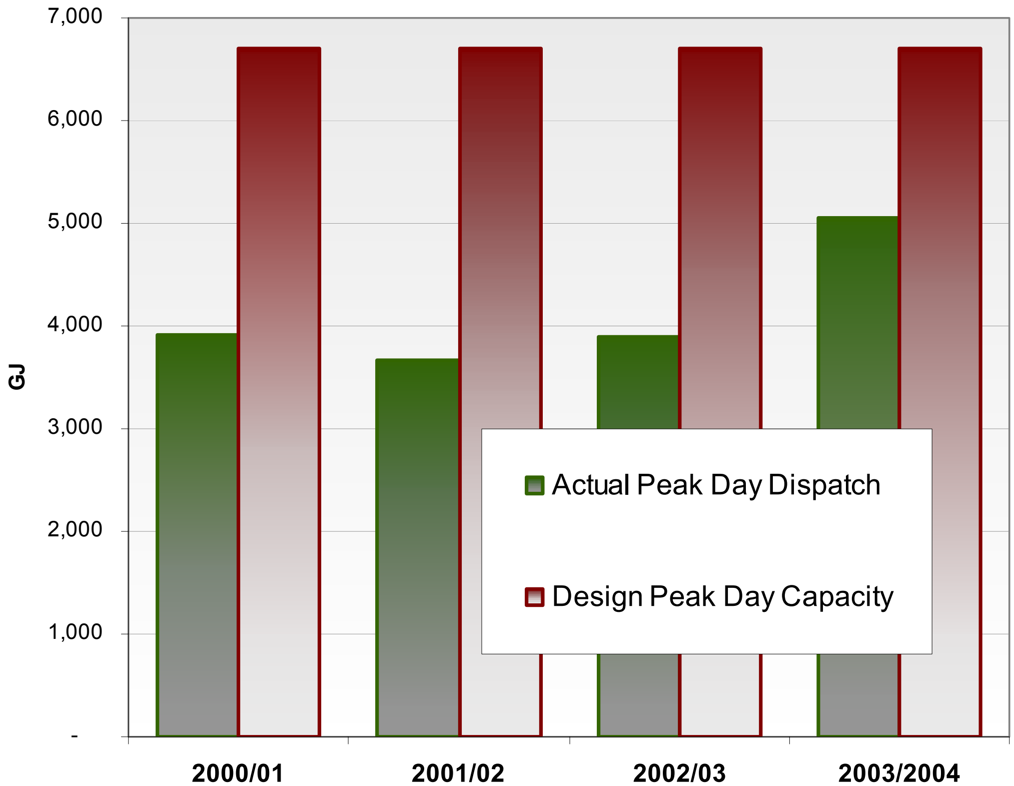


Figure 9 shows how the extreme peak days of the most recent four winters has varied. The system design peak is presented for reference. Until the winter of 2003/2004, it may have been reasonable to question whether the system peak day capacity of 6700GJ was overly conservative, given that the actual peak day for the winters 2000/01, 2001/02 and 2002/03 had not exceeded 4000 GJ. Indeed an earlier draft of our report did question just that. However, actual dispatch data from January 3, 2004, where the temperature dropped to 29.5 Heating Degree Days (HDD), appears to dispel such a concern.[15]

Extended Cold Period Storage

Whistler receives propane deliveries every day, but has storage capacity for 4.5 days. The question of how much storage is enough comes with trade-offs that stakeholders may wish to explore.

Deliveries of propane usually occur on a daily basis during peak winter periods, and are scheduled to ensure that under normal winter conditions stored propane is adequate for several days of supply. Specifically, the Terasen storage system is currently designed to provide 4.5 days of peak extreme winter demand, based on the storage tanks being 85% full at the start of a cold snap.

Terasen feels that delivery disruptions during a period of prolonged cold could make it difficult for the utility to meet all of its customers' demands. The utility believes such an event plausible enough to warrant expanding its propane storage capacity[16]. However, this assumption may be one other stakeholders may wish to explore with Terasen. A reduced backup storage requirement would reduce the assumed peak capacity of the current system. The utility is obliged by the regulator to ensure security of supply, so the issue is one of risk tolerance. Stakeholders may wish to 'trade-off' an increased risk of insufficient supply in the event of an extremely cold year against the cost of increasing peak demand infrastructure to deal with it. This is conceptually represented (with fictional data) in Figure 8

[15] Data provided by Terasen on 12 January 2004.

[16] BC Gas Utility completed a storage capacity risk assessment for the City of Revelstoke in 2001. For similar reasons of growth and potential for delivery disruption, that risk study recommended the addition of another large storage tank to the City's existing tank farm.

Table 8: Conceptual format for illustrating risks associated with peak day shortages versus the costs of reducing those risks

	Alternative A	Alternative B	Alternative C
Estimated risk of peak day shortages per year to 2010	0.01 %	1 %	10%
Investment required ($)	$10,000,000	5,000,000	$0

The consequences of demand outstripping supply may be severe, and could include shutting down the entire system for a number of hours.

However, one possibility would be to find individual customers willing to accept curtailment to address peaks as an alternative to deferring investment in system expansion. This would typically require some compensation (e.g., a lower curtailment rate), there may be technical limits (e.g., ability to curtail customers or certain end uses with timing and certainty that would support system operations).

That said, it may be difficult to find such customers willing to accept lower reliabilty given the reliance on tourism and importance given to quality of visitor experience.

Stakeholders may prefer to live with the increased risk of peak day supply shortages in order to avoid capital expenditure.

Nevertheless, we suggest that Terasen, its stakeholders, and the Commission discuss this issue to ensure that a common understanding of an appropriate degree of risk tolerance to peak day shortages is reached.

Average Day Peak Demand By Customer Class Assumptions

Another Terasen assumption of key sensitivity to our analysis is the average day peak demand by customer class. The utility's customers are divided into six classes, each of which are assumed to have an average, single, constant value for daily peak demand per customer on which the forecasts depend to 2017/2018.

Peak demand per customer class is assumed to be constant to 2017/18. This is unlikely to be the case.

The assumption is made that peak demand per class is constant to 2017/18, which is unlikely to be realistic. However, as more modern building energy technologies become a more dominant feature of the existing building stock, these figures may actually fall considerably[17]. (Conversely, if propane-consuming equipment is not properly maintained, there is the potential its efficiency could drop over time.)

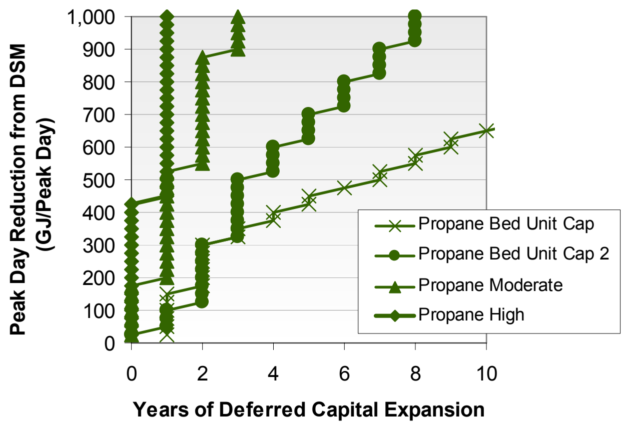
Table 9 shows the Assumed Peak Demand Per Customer (GJ) used by Terasen in its demand forecast, alongside alternative figures used to test their sensitivity. Figure 10 illustrates the impact of each of these three assumption sets on calculated peak day demand.

Table 9: Sensitivity Analyses Performed on Average Peak Day Demand Assumption

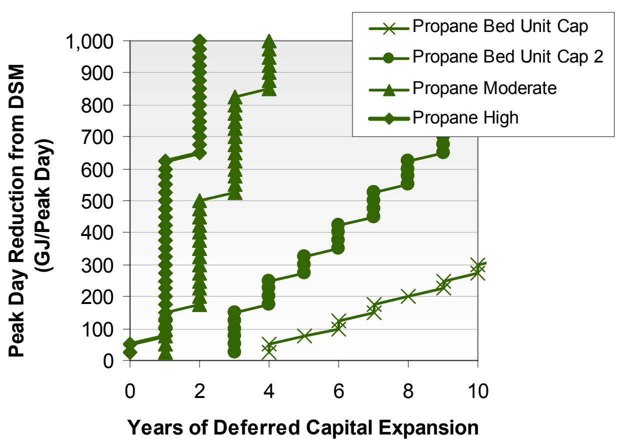
Customer Class	Description	Assumed Peak Demand Per Customer (GJ)	Peak Demand Per Customer Reduced by 5% (GJ)	Peak Demand Per Customer Reduced by 10% (GJ)
WSC1	small commercial	0.71	0.67	0.64
WSG1	small general	0.75	0.71	0.68
WSC2	larger commercial	1.62	1.54	1.46
WSG2	larger general	3.35	3.18	3.02
LGS-1	large	9.19	8.73	8.27
LGS-2	large	28.20	26.79	25.38
LGS-3	large	101.33	96.26	91.20

[17] Note, however, that Terasen's assumed figures forecasted the January 2004 peak day demand accurately.

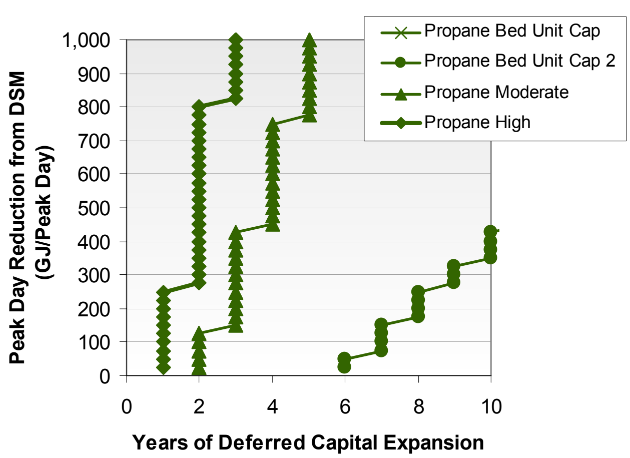
Figure 10: Sensitivity to Average Peak Day Assumption



Peak Demand Per Customer (GJ) as assumed in Terasen Demand Forecast



Peak Demand Per Customer (GJ) reduced by 5%



Peak Demand Per Customer (GJ) reduced by 10%

Reducing the each of the customer classes' assumed average peak load assumption by just 5% reduces the DSM target considerably: a ten-year deferral could be achieved under the Propane Bed Unit Cap scenario for a peak day reduction of 300 GJ per day over and above base case, rather than the 700 GJ per day required by the default assumption figures.

Reducing each customer classes' assumed average peak load by just over 10% eliminates entirely the need for a propane capacity expansion under the bed unit cap scenarios.

Reducing the assumption by just over 10% from base eliminates entirely the need for a propane capacity expansion under the bed unit cap scenarios.

One conclusion of this discussion is that because the demand forecast approach used projects forward from past use, projections are highly sensitive to initial figures, whatever those figures may be. A more sophisticated demand forecast that more explicitly takes the issues we have raised into consideration may be of greater planning value.

3 Demand Side Management Experiences

3.1 Introduction

DSM comprises different ways of reducing demand

Demand side resources are those measures or programs that are able to modify or influence energy requirements at the energy end use. Such resources require a utility to take action to alter customers' energy use, such as through customer behaviour modification; improving the efficiency of existing equipment; replacing equipment with more efficient units; and fuel-switching.

3.2 DSM in the 1997 Integrated Resource Plan

Past efforts at DSM met with a lacklustre response.

DSM as a resource option is not new in Whistler. A consultative group met several times in 1995, and proposed an integrated resource plan to the company. The 1997 IRP was created with considerable input from regional stakeholders including RMOW staff, the Whistler Chamber of Commerce, the large hotels, Whistler/Blackcomb mountain, a local environmental group, et al. The IRP investigated 11 separate DSM programs:

<u>Residential</u>:

1. Residential Water Heater Upgrade
2. Residential Home Visit Program
3. Residential Home Retrofit Program
4. Residential Furnace Upgrade

<u>Commercial</u>:

1. Commercial New Envelope Upgrade
2. Commercial New Heating Upgrade
3. Commercial Existing Envelope Upgrade
4. Commercial Existing Heating Upgrade
5. Commercial Interruption
6. Commercial Audit Program

<u>Combined Residential and Business</u>:

1. Energy Sustainability Education

Unfortunately, very little DSM activity followed the 1997 IRP while Whistler continued to grow. Interviews conducted by the project team indicate that the initial DSM efforts were met with a lacklustre response from the Whistler propane stakeholders. Some stakeholders argue that the utility could, and should, have pushed the programs harder than they did at the time. Concerns over the cost of any DSM activity, and related ratepayer impacts, apparently helped quash any concerted DSM effort at the time. Furthermore, the residents, at that time at least, appeared to be unreceptive towards energy sustainability education. Negligible interest was shown in the efforts made to launch such educational initiatives.

There are some reasons to hope that DSM may be more successful now.

Given the recent surge in interest within Whistler in sustainability, and the success of some sustainability projects in Whistler, some stakeholders feel that the community is now more receptive to DSM-related offerings. Perhaps, too, the Whistler Futures exercise is sensitizing the local population and businesses to issues such as energy planning and costs.

In addition, the British Columbia Utilities Commission Act was modified following the November 2002 release of the provincial government's Energy Plan. The Act now includes a component related to energy efficiency, which provides incentives to utilities to consider ways of reducing consumer energy demands as an alternative to acquiring new supplies to meet load growth. Essentially, this is calling for utilities to develop energy efficiency programs, should they be justifiable within the context of resource planning. In addition, the Act now includes a provision whereby public utilities can recover their costs and lost revenue, and even earn an incentive on successfully delivered energy efficiency programs.[18] This change, coupled with a greater focus on municipal sustainability, may now make it easier to implement propane DSM programs in Whistler than in the past.

We must learn what we can from past DSM experiences, here and elsewhere.

Nevertheless, we believe that it is important to learn from the experiences of the 1997 IRP, and have avoided repeating programs explored during that process.

[18] For the specifics, see 6.1(c) under Section 45 and (b)(ii) under Section 60 of the BCUC Act.

3.3 Lessons from Other Jurisdictions and their Transferability to Whistler

Most DSM experience is with electricity.

The project team reviewed utility DSM programs from numerous North American jurisdictions. Unsurprisingly, the bulk of utility-led DSM efforts are focused on electricity – there are many more electricity end uses, and electricity demand growth continues to outpace continental population growth.

Most other DSM experiences are not transferable to Whistler because factors unique to the community:

Whistler as a community, though, is unusual in several different ways; finding extra-jurisdictional examples of value to Whistler has therefore proven remarkably challenging. Some of the factors that go to making Whistler's situation unique include:

Resort community

Unstable population…

The permanent resident population of less than 10,000 is outnumbered by average winter daily visits of about 16,000. Sudden influxes of visitors and their pattern of energy usage poses unique planning challenges to the gas utility.

Relatively affluent population…

The relative affluence of many large home-owners and visitors to Whistler likely means that energy costs are not given the same priority as they are in other communities.

Relatively new building stock

Relatively new building stock…

Terasen Gas in its Lower Mainland service area has undertaken successful natural gas DSM programs. Natural gas savings in the order of 20% have been achieved at a number of multi-family, strata-titled residential complexes across the Lower Mainland[19]. However, the buildings used in these DSM projects were built roughly 30 years ago, when energy conservation was not considered to the extent it now is when constructing buildings. The great majority of the municipality's building stock is less than 15 years old, and therefore will not provide the same degree of savings potential through the same sorts of efforts used by Terasen Gas in the Lower Mainland.

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[19] These cases studies are described on the main Terasen Gas website: www.terasen.com/Gas/ForOurCustomers/Commercial/EnergyProfiles/default.htm

Methodology

In our efforts to find utility DSM experience of value to this context we have undertaken the following tasks:

- Reviewed the published literature
- Researched grey literature
- Researched utility and municipal websites
- Discussed potential and existing energy conservation options with operating engineers, energy consultants, and utility employees.

Summary of Findings

In other major resort communities, sustainability efforts have focused on electricity

Those DSM efforts across North America from comparable cities to Whistler have been almost entirely focused on electricity. While concerns over climate change and air quality have caused some alterations in ski resort energy usage (and some examples are described below), emissions reductions have generally been achieved through green power purchases versus significant end use reductions in the use of fossil fuels.

The only directly applicable example we discovered relevant to the current study was the hot tub tax implemented by the Town of Vail. If a hot tub is supplied by renewable energy, it is not taxed. Such a levy would, however, fall within the municipalty's jurisdiction; it could not be implemented by the utility.

The draft Community Energy Plan[20] lists a number of sustainable energy precedents, but these are largely geared towards transportation, not residential and commercial end use of fossil fuels.

The Interior community of Revelstoke B.C., like the RMOW, is not connected to the provincial natural gas grid, and so also relies on a propane distribution system. Discussions with regional utility staff indicate that propane DSM programs have not been used in the Revelstoke service area, and no plans currently exist to do so.

[20] Pages 66, 67.

In other resorts, a focus is on purchasing renewable power and greenhouse gas offsets.

Following are some of the climate change initiatives ski resorts are implementing. They are presented here because it is instructive that not one of these locations has introduced significant programs to reduce space-heating consumption. The focus on purchasing offsets from energy projects elsewhere is also illustrative of the problems encountered reconciling energy and 'indulgence'-intensive ski resorts with sustainability ethics.

- Five ski areas (Gore Mountain, Holiday Valley, and Peek 'n Peak in New York and Mount Bachelor and Mount Hood Meadows in Oregon) are teaming up with Green Mountain Energy Company to purchase enough pollution-free wind power to run the resorts' main chair lifts for the day — 18,000 kilowatt-hours — offsetting more than 10 tons of carbon dioxide emissions.

- In California, Mammoth Mountain is rolling out a new alternative energy project: the use of solar heating for lift shacks. Mammoth recently installed a solar external thermal heating panel on the lift shack at the top of Thunder Bound Express and plans to install solar panels on additional resort lift shacks within the next month. Mammoth has also announced plans to use renewable, biodiesel fuel made partly from recycled cooking oil in its Snowcats.

- Northstar-at-Tahoe is conducting a biodiesel test program with five of its on-site transportation buses. If successful, Northstar plans to eventually run its entire transportation fleet on biodiesel.

- In Colorado, Keystone Resort purchases 16,500 kilowatt-hours of renewable wind power per month, the maximum amount available from the local utility. In addition, Keystone's River Run Information Center features natural daylighting and is powered by a new solar energy system.

- Vail Mountain purchases 300,000 kilowatt-hours per year of wind energy to power the Wildwood Express Lift, preventing 300 tons of carbon dioxide emissions.

- Aspen Skiing Company (ASC) purchases wind energy to power the Cirque Lift at Snowmass and the Sundeck Restaurant on Aspen Mountain. ASC recently announced that guests driving low-pollution hybrid vehicles will park for free at certain lots all season long.

- Winter Park Resort has installed an integrated computer program called AreaNET, which saves energy by managing electrical-power consumption at the resort for maximum efficiency. The program was designed by one of the resort's own electricians.

- In Vermont, Mount Snow Resort has cut energy consumption in half at the Main Base Lodge and Snow Lake Lodge by replacing hundreds of conventional light bulbs with compact fluorescents. Mount Snow has also installed dozens of energy-efficient snowmaking tower guns, which reduce the energy needed to pump water and compressed air. Mount Snow also re-uses energy, using heat extracted from snowmaking compressor systems to heat its Main Base Lodge and Clocktower buildings.

- In Wyoming, Jackson Hole Mountain Resort purchases wind energy to power two of its chairlifts: Moose Creek and Union Pass.

- Mt. Hood Meadows in Oregon is offering customers a chance to buy $2 "Mini-Green Tags" from the Bonneville Environmental Foundation to support electrical production from renewable energy facilities. The average single-car round-trip between Portland and Meadows produces 140 pounds of carbon dioxide, and the purchase of a $2 "Mini-Green Tag" allows guests to offset those emissions and ski "pollution free."

3.4 Successful Propane DSM in Whistler: A Case Study

We found two examples of propane-related DSM in Whistler itself

The project team did in the course of its research uncover two good examples of propane conservation within the municipality itself.

The first example was at Whistler’s largest hotel, the Fairmont Chateau Whistler, a 550-room facility built in 1989. The hotel’s chief engineer outlined for the project team the many measures that have been undertaken to save propane, and these are summarized below:

- The hotel has 12 patio heaters rated at 40,000 Btu rating each[21]. While these are not on timers, hotel engineering staff do control when they are used. Hours and times of operation are staggered to reflect guest numbers (shoulder vs. peak season) in order to minimize gas usage.
- The hotel has two 300,000 Btu outdoor, propane-fuelled "fire pits" on their patio. These are also controlled by hotel operating staff, and are usually used only in response to demand during slower seasons; i.e., they are not continuously operated throughout the year. One, instead of both, are used if relatively few patrons are using the patio.
- The hotel holds quarterly meetings that focus on energy usage and savings, including the need for employee education. Regular meeting attendees consist of the hotel's comptroller, chief operating engineer, and another operating engineer.
- The hotel has a reporting system that allows tracking of energy costs in a detailed fashion, which in turn facilitates energy-related actions.
- The Fairmont Chateau had examined the possibility of installing a ground source heat pump at the hotel a few years ago. However, the champions of that idea have since moved on to other jobs. Further, 2003 tourism revenues were down significantly, adversely impacting capital budgets. The hotel estimated that replacing propane heat with ground source heat would cost an estimated $6.5 million. The payback period would be greater than five years.
- The hotel has over 50 propane-fuelled fireplaces. These are relatively efficient, and use external air. Efficiency is maintained through annual tune-ups. The hotel is considering installing fireplace timers.

The Chateau Fairmont Whistler's efforts clearly show the diverse range of savings possibilities that exist at Whistler's large propane consumers.

- The most recent significant energy-savings project was optimization of the hotel's boiler system. As part of their regular annual maintenance (which means next to no incremental cost), hotel operating staff worked with the maintenance company to ensure that in addition to the regular annual equipment tune-ups, boiler set points were optimized, and the hotel's most efficient boiler set up to operate the greatest number of hours over the year. Hotel staff feels that

[21] These were installed only three years ago, thereby providing a fairly significant, one-time seasonal demand increase.

typical boiler efficiencies are 83-84%, but are aiming to achieve 88-89% with their lead unit this winter[22].

The second successful propane conservation project is that undertaken by the strata council at the 121-room Legends strata-titled hotel. The strata council generously shared the findings of their internal energy audit with the project team. Even though the hotel complex is only three years old, concerted efforts by their strata council have resulted in significant energy savings at the complex[23].

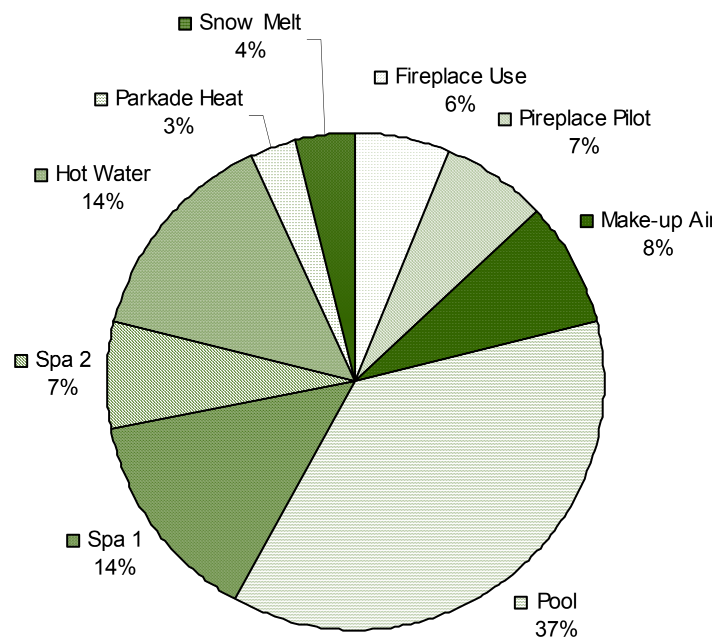
At The Legends, the pool and spa consume over 60% of all the propane used at the hotel.

Propane consumption is the largest source of energy at The Legends, comprising over 60% of the total energy used at the complex. Figure 11 breaks out their propane consumption by end use. The pool and spa facilities (hot tubs) account for over 60% of the total propane used at the complex. Also noteworthy is that fireplace pilot lights use more propane in a year than the fireplace burner. This is because the pilot light stays lit continuously, while the burner is used at most two hours per day occasionally throughout the year.

[22] A 5% savings improvement using a nominal (typical size) 2 million Btu/hr boiler output would save an estimated 100,000 Btu/hr, equivalent to about 75 GJ/mo. savings, equivalent in turn to about $14,000 energy cost savings annually.

[23] The fact that significant energy inefficiencies were built into such a new, large hotel complex is informative. Clearly changes must be made in the design and approval processes of new Whistler buildings if the resort community is going to achieve its sustainability-related goals.

Figure 11: Breakdown of Legends Propane Use



Legends purchased and began using outdoor pool and hot tub covers in 2001, and the outdoor pool temperature was reduced from 92 degrees F to a range of 80-85 degrees F[24]. Fireplace timers also replaced unit thermostats.

The complex subsequently installed a Direct Digital Control System. The DDCS is used to manage spa energy use, reducing temperatures during periods of typically low demand; to reduce hot water system propane consumption during periods of low demand; and to reduce propane consumption by the complex's snow melt system when snow melt heat is not required.

[24] Typical temperatures at Whistler hotel outdoor pools are 80 degrees F during summer months and 85 degrees F during winter periods.

At the Legends, simple DSM measures appear to have reduced propane use by just under 19% per year.

The Legends' energy consultant calculates that to-date in 2003 the complex has reduced its propane consumption by 19%. Overall yearly savings may be higher once the savings achieved in peak demand winter months are calculated.

4 DSM Measure Screening

In researching DSM measures that may be of value to Whistler we have sought to emphasize:

- **Learning from past experience**: there is little point repeating programs that have failed in the past if none of the underlying reasons for that failure have changed in the meantime;
- A clear focus on **measures to quickly reduce the peak day** (or peak hour) demand rather than to reduce energy as such. All stakeholders must remember that reducing energy without reducing peak capacity increases rates since the system expansion costs have less of a payer base to be divided between.
- A technical awareness of programs that would be difficult or impossible to physically implement in Whistler;
- **Sensitivity to ongoing sustainability planning** programs, and the value to be leveraged through them;
- A sense of realism about the degree of interest and commitment towards energy issues in a community primarily geared to leisure and entertainment.
- Performing only the precision of analysis warranted by the key uncertainties involved; detailed analyses are of little value if their products are dominated by sensitivity to key assumptions and other data uncertainties. It is more helpful to instead clarify and highlight the impact of these uncertainties.

For these reasons, a key task has been identifying and screening potential measures to ensure that resources focused on programs with a reasonable chance of rapid success and efficacy.

4.1 Screened Measures

Before describing programs examined in detail, we first describe some avenues considered not analyzed in detail. Screening potential measures has involved two main criteria: applicability to Whistler's situation; and technical feasibility to Whistler's situation. Table 10 summarizes measures screened out for detailed analysis. This section discusses some general issues considered in screening measures.

Peak day load shifting

If peak daily capacity is limited by the rate of instantaneous dispatch, daily load management may help reduce peak demand by 'shaving' the peaks from the demand profile

Peak hourly demand can also be a key issue when instantaneous dispatch volumes are limiting. A DSM program may be able to 'smooth the peaks' in a daily demand profile to ameliorate this issue.

Figure 12 illustrates the peak day load profile for Whistler propane demand from both storage and vaporization sites. Two daily peaks are clearly evident: the morning peak of roughly 9-11 a.m., and a higher evening peak of roughly 6-8 p.m.

Figure 12: Peak Day Propane Send-Out

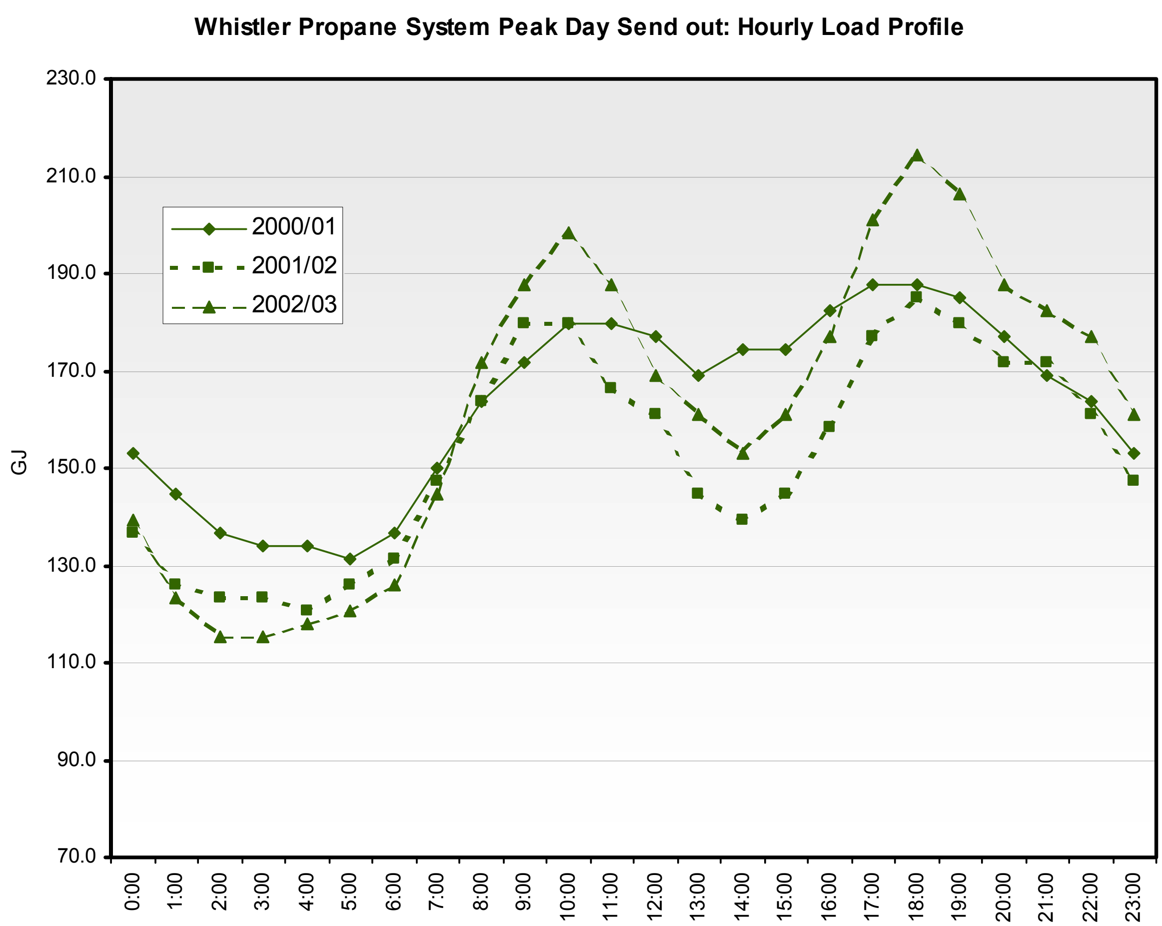


Figure 13: Ratio of Hour to Peak Hour winter day energy use at four large commercial establishments in Whistler

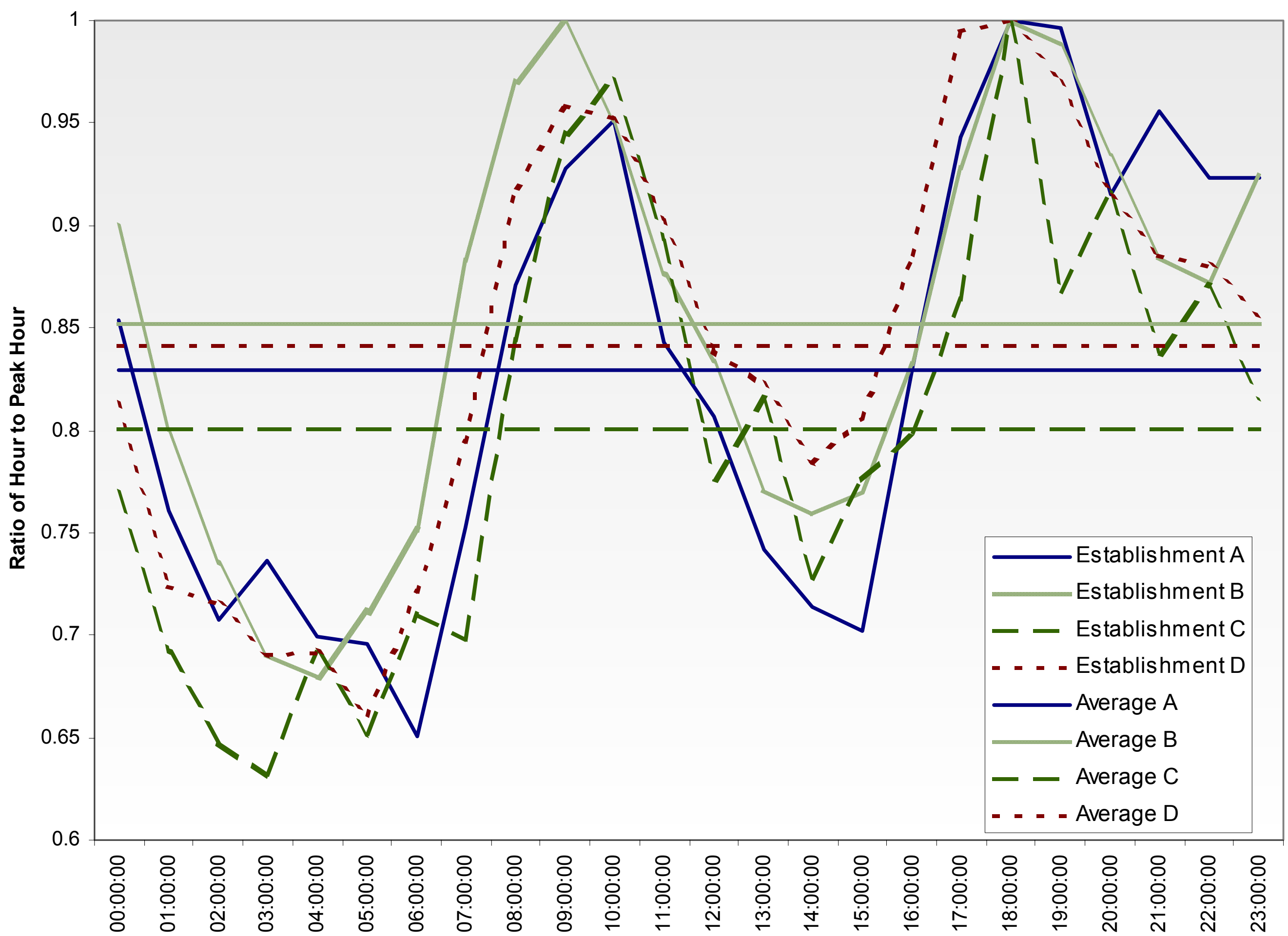


Figure 13 shows the ratio of hour to peak hour energy use for four large hotels / stratas in Whistler. This representation illustrates how the large commercial customers differ in their use of peak time load over the course of a winter day. Establishment B has the highest ratio of average hour to peak load (0.85), indicating that of the four customers, this one is most effective in spreading its peak demand over a longer time period. Through such activities as shifting non-peak essential loads (for example, propane-based laundry use) to the ‘trough’ periods, hotels can increase this ratio, thereby reducing the actual peak hour demand.

Estimating the peak hour reductions from this kind of analysis requires a detailed understanding of the propane end use patterns in each large hotel or strata. The project team undertook a high-level analysis based on data supplied by Terasen, but there was not time to correlate the data with individual establishments to the detailed daily activities in each (some results of which are presented above in Figure 13). However, as part of a co-ordinated large commercial energy audit, synchronized load shifting could make a significant reduction on peak hour demand. If Terasen considers this operationally important, this could be implemented as part of the large commercial audit program detailed in the next section.

Time of Use Programs

One way of persuading customers to shift demand peaks is to use 'Time-of-Use' rates for propane billing. This involves billing customers different rates that reflect more accurately the utility's cost of providing propane at a given time of day. A time of use program would charge these customers more for peak time energy use and less for off-peak energy use, providing a financial incentive to reduce peak time demand and its associated costs.

After discussions with Terasen, we believe that this approach to DSM would not be effective in reducing peak demand in Whistler because the costs of switching to a time of use system, which would include upgrading metering, monitoring, billing and support resources, is likely to be disproportionate to the degree of control that large customers have over their peak load usage (which is largely in the hands of hotel visitors).

Fuel Switching Approaches

Fuel-switching is a common DSM option that could theoretically reduce peak propane demands in the municipality. Theoretical alternative fuel options to propane include electricity, wood, fuel oil, and natural gas.

The recently completed (draft) Community Energy Plan[25] briefly discusses the use of wood for residential space heating. The CEP estimates that there are probably 500 homes in Whistler with full-time

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[25] Sheltair Group Resource Consultants Inc., February 2003. Pg. 32.

residents who use wood as their primary source of heat. Assuming wood consumption of four cords/year per household, this represents a total energy supply from wood of about 36,000 GJ, equivalent to less than five percent of estimated current RMOW propane consumption of over 750 Terajoules annually[26]. The CEP expresses concern that wood-burning is likely a significant source of particulate matter (PM) in the RMOW. Health concerns related to PM could limit the potential for increased use of wood for heating in the Whistler[27]. Further, it was reported to the project team that wood-burning fireplaces are not permitted in new residential construction[28].

The replacement of ornamental propane fireplaces in hotel lobbies — which generally burn 24/7 — with wood-burning units might therefore not be feasible due to air quality issues. (Replacement of hotel and apartment unit propane fireplaces with wood-burning units is not considered realistic, since the associated costs could not be recovered without substantial emissions costs).

Fuel oil is not considered a viable option for Whistler given the town's sustainability planning direction. Oil-burning releases a greater volume of both carbon dioxide and common air contaminants than does propane combustion. There are also odour and spillage concerns related to fuel oil use. Finally, oil-burning would mean an increase in truck traffic in the region since truck deliveries would be required to fill fuel tanks.

However, one possible fuel-switching alternative may be electricity. Using electricity in place of propane has impacts at a provincial planning level, but these can be analyzed. We have examined such a scenario in more detail, in the case of replacing existing propane-system connected propane systems.

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[26] This ignores the possibility of retrofitted wood fires discussed in thenext section.

[27] It is interesting to note, though, that the recent Whistler Conference Centre renovations included the installation of a substantial floor-to-ceiling wood-burning fireplace in the Centre's foyer.

[28] Tim Wake, Whistler Housing Authority, Oct. 9, 2003. *Pers. Comm.* However, B.C. currently exports large volumes of wood pellets to Germany and Sweden for use in modern, air-tight wood stoves. Wood energy usage is part of those countries' efforts to reduce greenhouse gas emissions. Further, if wood pellets were sourced locally, the RMOW could increase its use of locally-derived energy. Further analysis of this issue, though, is beyond the scope of the current study.

Measures aimed at Residential Customers

Based on discussions and past experience in Whistler, with one possible exception, we do not believe that DSM measures aimed at Whistler's residential sector would be an effective use of Terasen's resources. There are several reasons for this, some of which echo themes introduced already.

- The 1997 IRP found little response from residents to residential DSM programs.
- Many owners of the larger single-family homes are not present for much of the year.
- Most of the building stock is relatively new.
- To make a significant impact on peak day demand reduction would require the immediate participation of a large number of people, which, even if the desire were there, would be difficult for Terasen to co-ordinate.
- Tenants form a large proportion of Whistler's permanent population. As such, these energy consumers typically have their energy costs bundled into their rent payments. They do not typically receive price signals to alter their energy consumption patterns.

The one possible exception, however, that may produce peak energy reductions in large residential homes. This is discussed further in the next section.

Measures aimed at Small Commercial Customers

Most of the reasons for avoiding residential programs also apply to the large number of Whistler's smaller commercial customers.

Engaging such customers with peak day reduction programs would also be time consuming and costly due to the numbers of customers involved. Private firms typically handle small commercial customers' energy management, and there are several orders of separation between these firms and those who make the day-to-day decisions that affect energy usage.

This is not to say that small commercial users should not be pursued in future with respect to DSM activities. However, our focus is to uncover measures that can quickly be implemented to reduce Whistler's peak day demand. If the measures we discuss later for the larger commercial customers are effective in curtailing peak day demand, then Terasen should subsequently target smaller commercial enterprises.

Building design specifications

The municipality has limited leverage over the specifics of building design requirements. It cannot, for example, require that all future buildings be constructed to a particular energy efficiency standard, though it can, of course, set whatever standard it chooses for new municipal buildings.

We strongly recommend that municipal engineers and planners seek to influence future building design in Whistler as much as possible within their jurisdictional control. However, we also consider the development of a specific program aimed at furthering high-performance buildings into the future to be beyond the scope of this study, which is focused on the nearer-term goal of avoiding investments in propane supply infrastructure.

Table 10 summarizes some of the measures screened out or selected for detailed analysis in this study, along with the rationales in each case.

Table 10: Screening Matrix

Sector	Title	Applicability	Technical Feasibility	Detailed Analysis Required?	Comments
All Sectors	Time of use pricing	No	Not possible in Whistler with current metering	No	Cost of re-metering system considered prohibitive. Also, no B.C. precedent for TOU gas rates.
	Prohibit geothermal loads from propane back-up	Yes	In use already in Whistler (e.g., Beaver Flats), and being considered in new applications also.	No	Would force geothermal users to electricity or other back-up.
Residential (Small Family)	Housing Authority home audits / retrofits	Yes	Residential and multi-family audits a well-known utility DSM program	No	Great majority of Housing Authority units are electric heat.
	Mass mailing of information (Bill insert / info campaign) / Target 'green consumers' with efficiency improvements (e.g. insulation etc)	Yes	Energy efficiency information available	No	Past mailings did not register a customer response (although degree of past effort felt by some stakeholders to be too limited). Could tie energy efficiency in with RMOW's sustainability push (already is to a degree in sustainability tool kits) vs. as a separate utility-led initiative.
	Home Visit / Audits, possibly with rebates. Entire building or combination of key systems: furnace / building envelope / fireplace tune-up water heater tune-up etc	Yes	Such DSM programs have been used in other jurisdictions.	No	Residential demand only 20% of RMOW propane load. Very small returns from such efforts vs. targetting large commercial customers. Affluence (i.e., ability to bear high energy bills) and sporadic residency of many RMOW homeowners also reduce likelihood of program success.
	Home patio heaters	Unknown	Unknown	No	Some residences may have patio heaters that are fed by propane from the distribution grid. It is expected, though, that the great majority are fuelled by bottled propane.
Small Multi-Dwelling	Target strata council with efficiency improvements (e.g. insulation etc)	Yes			
	Info campaign (fridge magnet, end use info etc)	Yes	Yes	No	As with energy efficiency info. for residential customers, make such info. Programs part of a

Sector	Title	Applicability	Technical Feasibility	Detailed Analysis Required?	Comments
	info etc)				broader RMOW sustainability initiative.
	Building Visit / Audits, possibly with rebates. Entire building or combination of key systems: furnace / building envelope / fireplace tune-up water heater tune-up etc	Yes	Technically feasible	No	Focus should be placed on the 3 dozen largest hotels and strata-title complexes first. Smaller multi-units may be done in the future.
Restaurants / Cafes	Curtail use of propane in patio heaters	Yes	Yes	Yes	Encourage use of propane bottles and/or switch to electric heaters if such end uses must remain. During coldest weather such propane use may not occur as patrons may not venture outside to eat/drink.
	Increased use of patio awnings, drop cloths, other wind breaks on outdoor patios using grid-supplied propane patio heaters.	Yes	Feasible	Yes	Should be done anyway as part of RMOW sustainability strategy. Best estimates made of potential costs and savings from switch to electric heaters.
Retail / Office Space	Building efficiency improvements package	Unlikely	Feasible	No	Building envelope assumed to be efficient due to vintage; often baseboard heating used, or part of hotel complex heating system
Hotels / Large Stratas	Comprehensive energy audits	Yes	Feasible; audits of large customers often performed by utilities, energy service cos.	Yes	Best estimates made of potential savings and audit costs. Energy efficiency measures implemented by The Legends and the Fairmont Chateau Whistler provide good examples of potential savings.
	Pool and hot tub efficiency programs	Yes	Pool covers exist; behavioural component key	Yes	Best estimates made of cost of timers and of controls to prevent whirlpools from being used during very cold temperatures as energy loss increases significantly when water jets employed.
	Ornamental fireplace replacement in hotel lobbies	Yes	Feasible to replace propane with wood or electric	Yes	Estimate cost of replacements, extra labour for wood-burning units; hotel operator “buy-in” key
	Curtail use of propane in patio heaters	Yes	Yes	Yes	See restaurant propane heater discussion.

Sector	Title	Applicability	Technical Feasibility	Detailed Analysis Required?	Comments
	Curtail use of propane in patio heaters	Yes			

5 Analysis of DSM Programs

5.1 Introduction

Our analysis avoids repeating the analysis of programs presented in the 1997 IRP. Instead, our focus has been to isolate a small number of readily implemented programs of key potential to quickly slow the growth of peak day demand.

In some of these programs, assistance is assumed to be offered as incentives to participate in them. Where such costs are mentioned, it is important to be clear that they are ultimately incurred at the ratepayers' expense, even if initially administrated via a program initiated by Terasen.

We have concentrated on *verifiable* reductions, avoiding programs that cannot be monitored, which, while may have important energy savings benefits, cannot be counted on to deliver reliable peak day savings.

We have analyzed five programs:

- Spa Audit Program
- Ornamental Fireplace Replacement Program
- Large Commercial Audit Program
- Commercial Patio Heater Management
- Large Residential Fireplace Efficiency Program

First, however, we introduce the cost-effectiveness tests used to analyze these programs:

5.2 Summary of Cost-effectiveness Tests for DSM Programs

A variety of stand-alone cost-effectiveness tests have also been developed for evaluating individual DSM programs. In these tests, the cost-effectiveness of a DSM program is a function of both the costs of the program and the benefits, including “avoided costs.” In order to calculate avoided costs, the analyst must make specific assumptions about the next supply resources.

This section summarizes five standard tests that have been widely used to evaluate the cost-effectiveness of DSM programs. Each test is intended to determine if a program is “good” and for whom the program is “good.” The five tests are:

- Participant Test
- Total Resource Cost Test
- Ratepayer Impact Measure Test
- Utility Cost Test
- Societal Test

A summary of the tests is provided in Table 11. Figure 14 shows the interrelationship between the tests.

More complete information on these tests, and how to interpret them, is provided in an Appendix.

Table 11: Summary of Cost-Effectiveness Tests

<table>
<tr><th>Test</th><th>Formula</th><th>Components</th></tr>
<tr><td>Participant Cost Test (PC)
measures whether a DSM program is economically attractive to a customer by measuring the quantifiable costs and benefits of a DSM program from the point of view of the participating customer.</td><td>PC = I + BR – PH</td><td rowspan="5">BR = customer bill reductions as a result of savings achieved by the measure

E = Externalities (primarily emissions)

I = incentives or rebates to customers (including utility incentives and rebates from outside sources such as tax rebates)

LR = Lost revenue to the utility from the reduction in sales to customers installing conservation measures

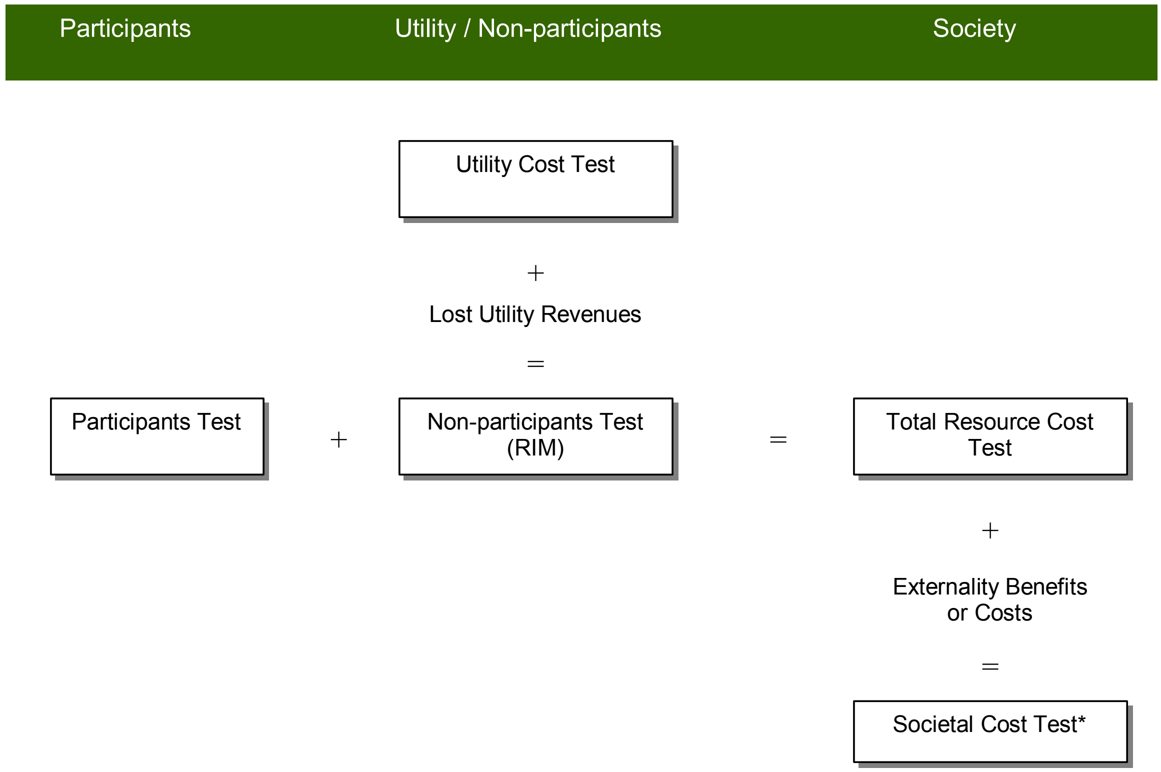
OC = Overhead program administrative cost (including upfront development or implementation costs as well as any ongoing administrative costs)

PH = net cost to customer of purchased hardware and other related costsAC = avoided utility costs

TH = total hardware cost, regardless of who pays

UH = Utility purchases of hardware or equipment</td></tr>
<tr><td>Total Resource Cost Test (TRC)
measures the total net resource expenditures of a DSM program from the point of view of the utility and the ratepayer.</td><td>TRC = AC – OC – TH</td></tr>
<tr><td>Ratepayer Impact Measure Test (RIM)
measures the impact of a DSM program on utility rates by calculating the change in total revenues paid to a utility and the change in total costs to a utility resulting from a DSM program</td><td>AC – OC – I – UH – LR</td></tr>
<tr><td>Utility Cost Test (UC)
The utility cost test measures the change in total costs to the utility from a DSM program</td><td>UC = AC – OC – I – UH</td></tr>
<tr><td>Societal Test (SC)
The Societal Test measures the net benefits of a DSM program from the perspective of society as a whole, including externalities and transfers</td><td>SC = AC – OC – TH + E</td></tr>
</table>

Figure 14: Interrelationship Among Standard DSM Cost-Benefit Tests



* May also exclude other transfers (e.g., federal taxes) and include adjustments to market prices to reflect better social opportunity costs, as well as addition of external benefits and costs[29].

5.3 Overview of Programs

The first three of our programs are aimed primarily at large commercial energy users.

While presented as three separate programs, they are in fact three independent pieces of a fully comprehensive large commercial energy saving program. The three components are:

- Pools and spas

[29] Source: Goldman et al. 1993 (Adapted from Washington Natural Gas 1992)

- Ornamental fireplaces

- Remaining miscellaneous large commercial propane end uses.

The fourth program also addresses many large users, but this time with respect to their commonalities with another group, cafés and restaurants.

Finally, the fifth program considers a potentially important issue in large residential units.

5.4 Spa Audit Program

Summary

If the Legends experience s typical, pools and spas may constitute more than 50% of the peak propane use in those hotels and stratas large enough to support them. Significant peak day and annual energy savings can be made through the observation of improved energy management practices, enhanced by relatively inexpensive equipment such as timers, temperature controls and pool covers.

This program will audit *existing* pools and spas only: therefore the cost-effectiveness tests do not vary by Terasen scenario.

Table 12: Summary Statistics

NPV of cash flows to 2017/18 ($2003)		
		All Scenarios
PC - Participant Cost Test	$	922,166
TRC - Total Resource Cost Test	$	892,166
RIM - Ratepayer Impact Measure Test	$	(30,000)
UC - Utility Cost Test	$	916,646
SC - Social Cost Test	$	877,166
Energy Savings in 2006/2007		
		All Scenarios
Peak Day Demand Reduction (GJ/day)		50
Annual Average Savings (GJ/year)		11,000

Description

The Legends Energy Management Review (See p32) revealed that more than half of that facility's propane usage went to heating the swimming pool and two spas. A review of comparable establishments shows that similar pool / spa combinations are common in Whistler; detailed audits would be required, though, to determine what proportion of total hotel energy consumption can be attributed to such end uses. This program would offer assistance to managers to audit of their pool / spa facilities. We anticipate that such audits, whether integrated into a comprehensive commercial audit program or otherwise, will clarify to building administrators the magnitude of energy savings that would be possible through the implementation of relatively simple “housekeeping” activities and inexpensive automatic temperature controls.

Implementation Issues

Because of the specific nature of this program, the relative ease of implementation, the proportionally high degree of savings and the relatively small number of target customers, we anticipate a high potential success rate for this program.

Likelihood of savings

We are uncertain about the current level of energy efficient practices currently undertaken at most establishments (with the exception of those featured elsewhere in this report). The degree of savings attainable will depend on the existing level of energy management. However, we have every reason to believe considerable savings are possible as the Legends case study illustrates.

Critical success factors for achieving high penetration

We believe that property managers are more likely to actively participate if they are made a recognized part of a community wide focus on sustainable issues. Because managers have to undertake extra activities on behalf of the community as a whole, municipal or other groups must find creative ways of encouraging the participation of building managers.

Timing and duration of savings

Savings in peak energy demand could begin immediately after audits are completed and energy use controls have been established

Key assumptions in analysis

Key assumptions in our analysis include:

- Only LGS-3 and LGS-2 customers are targeted

- Only 50% of facilities would benefit from improved energy management. Only outdoor facilities are included.
- Of those remaining facilities, there is a high (80%) participation rate, which assumes a strong leadership role from the community's sustainability advocates in motivating building managers.

Discussion of Cost Effectiveness Indicators

With a high participation rate, this program appears to have strongly positive values in all of the cost-effectiveness tests, with the exception of the Ratepayer Impact Test. The RIM test is negative due to administrative costs of the program, including the cost of the audits themselves.

The sensitivity of programs to participation rate is discussed below.

5.5 Ornamental Fireplace Resizing Program

Summary

Large ornamental fireplaces are often viewed as status symbols in large hotels. Often operated 24 hours a day throughout the year, such fireplaces also account for a sizable fraction of overall peak demand. While propane cannot be realistically replaced for this application, nor may it be reasonable to prohibit their use, a key means of reducing peak demand would be to require the resizing of ornamental fireplaces. In this program, we analyze the impacts of capping the heat rate of ornamental fireplaces at 40,000 BTU per hour.

This program address *existing* and *future* changes: therefore the cost-effectiveness tests vary by Terasen scenario.

Table 13: Summary Statistics

NPV of cash flows to 2017/18 ($2003)

	Propane Bed Unit Cap	Propane Bed Unit Cap 2	Propane Moderate	Propane High
PC - Participant Cost Test	$ 384,453	$ 470,759	$ 819,152	$ 1,228,709
TRC - Total Resource Cost Test	$ 314,353	$ 428,068	$ 887,309	$ 1,427,282
RIM - Ratepayer Impact Measure Test	$ (42,100)	$ (14,692)	$ 96,156	$ 226,573
UC - Utility Cost Test	$ 290,232	$ 376,538	$ 724,931	$ 1,134,487
SC - Social Cost Test	$ 286,353	$ 400,068	$ 859,309	$ 1,399,282

Energy Savings in 2006/2007

	Propane Bed Unit Cap	Propane Bed Unit Cap 2	Propane Moderate	Propane High
Peak Day Demand Reduction (GJ/day)	9	10	13	17
Annual Average Savings (GJ/year)	3500	3700	4900	6300

Description

Many of the major hotels in Whistler use large, ornamental fireplaces for largely aesthetic effect in public areas such as lobbies. These fireplaces typically consume large quantities of propane (one hotel in Whistler installed a fireplace that could boast a heat consumption rate of over 240,000 BTU/hr!). This program would set a cap on the energy capacity on existing and new fireplaces at 40,000 BTU/hr. Only existing fireplaces with an exterior wall would be eligible. Because of flue design issues, existing fireplaces would in most cases have to have to be replaced by new, more efficient models. No new fireplaces above this heat rate would be permitted, whether by voluntary agreement or through some other mechanism involving the RMOW.

Implementation Issues

There are various ways this program could be implemented, though none of them could be implemented by Terasen alone. In the spirit of sustainability (and long term financial planning), the large hotels and stratas could collectively agree to undertake the program voluntarily. It is unlikely that the municipality has the legal authority to require hotel owners to replace and resize their fireplaces

Likelihood of savings

The savings associated with deregulating ornamental fireplaces can be accurately estimated on a case-by-case basis, though there is some uncertainty as to the actual number of current and likely future fireplaces to which the program would apply.

Critical success factors for achieving high penetration

As with the other programs we are evaluating, this program would need to be part of a focused, determined effort by the Whistler community to live up to its sustainability ideals. Replacing ostentatious ornamental fireplaces with more modest versions would make a strong statement of commitment to the vision of a sustainable Whistler.

Timing and duration of savings

Fireplaces could be resized and savings enjoyed within weeks.

Key Assumptions in analysis

As with the spa program, we have tended to be conservative about the technical savings that could result on a single unit basis, but arguably optimistic about participation rates.

Key assumptions in our analysis include:

- Only 50% of existing fireplaces would be suitable for replacement from a technical perspective. Fireplaces not located next to an outside wall are far more difficult to change, for example.
- Existing fireplaces are assumed to average a heat rate of 65,000 BTU per hour. They will be replaced by 40,000 BTU versions at a cost of $5,000.
- Our analysis assumes that the ratepayers will pay for 50% of this cost as an incentive to customers.
- We assume an 80% participation rate for the LGS-2 and LGS-3 customer base.

Discussion of Cost Effectiveness Indicators

In the slower growth scenarios the RIM test is negative, though as demand scenario becomes more aggressive, the test moves into to the black as the customer base becomes larger.

5.6 Large Commercial Audit Program

Introduction

As noted above, this program addresses the remaining propane usage of the large commercial sector after the above two programs are removed from consideration. In reality, we would expect all three programs to be implemented together.

This program will audit *existing* facilities only: therefore the cost-effectiveness tests do not vary by Terasen scenario.

Table 14: Summary Statistics

NPV of cash flows to 2017/18 ($2003)

		All scenarios
PC - Participant Cost Test	$	384,453
TRC - Total Resource Cost Test	$	314,353
RIM - Ratepayer Impact Measure Test	$	(42,100)
UC - Utility Cost Test	$	290,232
SC - Social Cost Test	$	286,353

Energy Savings in 2006/2007

	All scenarios
Peak Day Demand Reduction (GJ/day)	10
Annual Average Savings (GJ/year)	3500

Description

Whistler's major hotels and stratas provide the ideal starting point for miscellaneous DSM measures. Not only is the fraction of Whistler's overall propane use high, but if the Legends and Fairmont experiences are any indicator, large savings in peak usage can be made through the activities of relatively few people. By focusing resources at these key centres rather than at the broad group of residential and small commercial customers collectively, we may expect participation rates to be higher than in the past, particularly given recent increases in energy prices and demonstrated local successes.

This program will focus on providing free audits to large commercial customers. It will facilitate the introduction of Energy Service Companies with building managers and property owners and will generally focus on overcoming the ‘inertia’-based barriers to peak capacity reduction activities.

Actions we expect to result in savings include:

- The installation direct digital control systems systems, managing domestic hot water systems, snow melt systems etc
- Measures to reduce energy loss from fireplace pilot lights;
- Miscellaneous changes to general energy housekeeping practices that will vary from establishment to establishment

Implementation Issues

As with the previous two programs, success here will result on the combined efforts of the Whistler community

Key assumptions in analysis

Because of the very general nature of this program, we have not attempted to undertake a detailed analysis of a component-by-component cost/benefit contribution. This would be a task for a detailed, building specific analysis. Instead, we have attempted to ‘ballpark’ the savings, primarily to peak demand, that might be expected given the experiences elsewhere.

- Base on the Legends experience and Terasen data, we have estimated the energy consumption per room of the average LGS-3 customer and calculated an average peak day load factor per room.
- We have assumed a gross overall estimate of 5% of peak energy savings per room as a result of this program

- We assume that this program would impact existing buildings only – we have not extrapolated the findings to buildings yet to be built, since we expect that such buildings will be designed with energy conservation in mind.

- We assume that 50% of establishments could theoretically benefit from such a program.

- We assume that Terasen pays for the building audit, at approximately $1000 per audit. All other equipment costs are borne by the customer.

Discussion of Cost Effectiveness Indicators

Again, the RIM test is negative here, since the avoided costs of the program are being exactly offset the lost income to the utility from customer bills, leaving the (relatively small) costs of the program as the net loss.

5.7 Commercial Patio Heater Management

Summary

Restaurant and hotel patios are a significant source of propane energy use, currently accounting for at least 15 GJ of peak day capacity, based on an approximate heater count of 44. In the future, however, we can expect this load to increase substantially as cafes and restaurants grow to accommodate increased tourist visitors. This program explores a number of variations around the theme of prohibiting the use of mains propane heaters in hotels and restaurants

This program address *existing* and *future* changes: therefore the cost-effectiveness tests vary by Terasen scenario

Table 15: Summary Statistics

NPV of cash flows to 2017/18 ($2003)

	Propane Bed Unit Cap	Propane Bed Unit Cap 2	Propane Moderate	Propane High
PC - Participant Cost Test	$ 237,187	$ 336,578	$ 728,973	$ 1,024,518
TRC - Total Resource Cost Test	$ 201,534	$ 305,408	$ 700,195	$ 983,034
RIM - Ratepayer Impact Measure Test	$ (18,800)	$ (18,800)	$ (18,800)	$ (18,800)
UC - Utility Cost Test	$ 180,303	$ 229,567	$ 421,728	$ 564,251
SC - Social Cost Test	$ (87,948)	$ (58,999)	$ 52,018	$ 132,528

Energy Savings in 2006/2007

	Propane Bed Unit Cap	Propane Bed Unit Cap 2	Propane Moderate	Propane High
Peak Day Demand Reduction (GJ/day)	16	18	26	31
Annual Average Savings (GJ/year)	3000	3200	4600	5600

Description

In this program, all customers disconnect from the mains propane supply immediately. Electrical heaters replace propane heaters. Mains propane heaters are no longer permitted for patio heating.

Note: it is possible to analyze various versions of this program, including:

- Only prohibiting incremental uses
- No electrical replacements
- Switching to bottles at peak times only, under direction from Terasen

For clarity, we have presented just one variation for illustrative purposes

Implementation Issues

A voluntary or regulatory approach to ceasing the use of propane system-connected patio heaters would be a high profile program likely to attract media attention. It would of course, either have to occur by the joint agreement of commercial property owners, or through a municipal bylaw.

Likelihood of savings

If such agreementscould be reached, savings would be immediate and verifiable.

Critical success factors for achieving high penetration

As with most of the other programs presented here, high penetration would depend on co-coordinated action, facilitated by a sponsor organization

Timing and duration of savings

Savings would be immediate and carry into the future. Without such a program, it is likely that propane-system patio heaters will expand long into the future.

Key Assumptions in analysis

Kay assumptions include the following:

- That mains-connected heaters are not used from is year 1.
- That 20% of customers do not comply
- That the replacement electrical energy supply comes at a cost of $55 per MWh to BC Hydro – this is included in the social cost calculation.

Discussion of Cost Effectiveness Indicators

Because of the transfer of additional costs to BC Hydro, the social cost test is negative in the lower growth scenarios. This may not be necessary if alternative versions of this program are analyzed as discussed above.

5.8 Large Residential Fireplace Efficiency Program

Summary

There may exist a substantial number of formerly wood-fuelled residences that have converted to using “log light” fireplace systems without the utility’s knowledge. The heating performance pf these systems is typically very poor when used in a fireplace designed for wood. Efforts should be made to uncover if this is, indeed, an issue.

This program will audit *existing* houses only: therefore the cost-effectiveness tests do not vary by Terasen scenario.

Table 16: Summary Statistics

NPV of cash flows to 2017/18 ($2003)

	All scenarios
PC - Participant Cost Test	$ 45,259
TRC - Total Resource Cost Test	$ (12,541)
RIM - Ratepayer Impact Measure Test	$ (57,800)
UC - Utility Cost Test	$ 484,451
SC - Social Cost Test	$ 484,451

Annualized ($2003)

	All scenarios
Peak Day Demand Reduction (GJ/day)	8
Annual Average Savings (GJ/year)	455

Description

We have uncovered anecdotal evidence that a substantial number of the 500 or so wood-fired homes identified by the CEP may have been connected to the propane system without the knowledge of Terasen or the municipality. In the years following the construction of these homes, we understand many residents tired of lighting fires manually and retrofitted ‘log light’ fireplaces in place of their wood burning grates. One source[30], a leading fireplace contractor at the time, told us that his firm “hauled truckloads” of these units to Whistler for installation. The source could not confirm that the units were actually installed on the propane system, though he considers this very likely. He estimates the number of residences involved could be “in the hundreds” and voiced considerable concern about their poor energy performance. These fireplaces are extremely inefficient, and may be using 60,000 BTUs to heat a few feet of living space. This program, which may require further investigation before launch, would offer information and incentives to residential owners to replace these fireplaces with something more save and efficient.

Implementation Issues

Since this issue primarily concerns the owners of seasonally-used single family homes, implementation programs on the basis of energy efficiency may be challenging. .

Likelihood of savings

Assuming such residences exist and can be found, the peak and annual energy savings associated with them are almost certain to be to be significant – similar on a case-by-case basis to the gains that might be expected from the ornamental fireplace resizing program.

Critical success factors for achieving high penetration

Again, engaging the interest of seasonal home-owners may be a challenge. Timing and duration of savings

Replacing fireplaces can occur very quickly and savings will begin immediately.

Key Assumptions in analysis

- We cannot confirm that there are any residential properties in this situation. The number involved could therefore be anywhere between zero and the ‘hundreds’ estimated by our source. We have estimated just 2% of residential owners qualify in each of the WSG1 and WSG2 categories.

[30] Who shall remain anonymous.

- Of these customers, we assume an 80% participation rate.
- We assume that these fireplaces are used for 14 hours on a peak day, but are used for relatively few (840) hours in a year.

Discussion of Cost-Effectiveness Indicators

Our assumption on customer numbers with these fireplaces may be considerably underestimating the potential energy saving. If 20%, rather than 2% of fireplaces are retrofitted, this would lead to a peak day saving of around 80GJ per day.

5.9 A DSM Portfolio

Summary

The programs introduced in the previous section were designed to be generally additive, though there may be small cost savings when implemented collectively.

However, so far, each program has been evaluated on an individual basis. Since no individual program can reduce peak demand sufficiently to overcome the threshold required to defer capital investment for one year or more in isolation of the others, avoided capital costs have not been included.

Table 17 shows the combined peak day reductions we estimate for the five programs combined assuming an 80% participation rate where applicable.

Table 17: Relative Contribution of Programs to overall portfolio peak reduction performance

	Peak Day Saving (GJ/day)				
	2003/2004	2017/2018	2017/2018	2017/2018	2017/2018
	All Scenarios	**Propane Bed Unit Cap**	**Propane Bed Unit Cap 2**	**Propane Moderate**	**Propane High**
Spa Audits	48.9	48.9	48.9	48.9	48.9
Ornamental Fireplaces	7.1	9.7	12.0	20.8	30.6
Large Commercial	35.4	35.4	35.4	35.4	35.4
Patios	11.1	21.3	31.7	71.3	100.3
Large Residential	7.8	7.8	7.8	7.8	7.8
Total	**110.4**	**123.2**	**135.9**	**184.3**	**223.1**

Table 18 shows the impact on avoided capital costs of these results on the need to defer investment in supply side infrastructure.

Table 18: Years of Supply Side Investment Deferral Under Different DSM Portfolio Participation Rates

	Program Participation Rate				
Scenario	**80%**	**60%**	**40%**	**20%**	**10%**
Propane Bed Unit Cap	**1**	**1**	**1**	**1**	**0**
Propane Bed Unit Cap 2	**1**	**1**	**1**	**0**	**0**
Propane Moderate	**0**	**0**	**0**	**0**	**0**
Propane High	**0**	**0**	**0**	**0**	**0**

Table 18 also shows the sensitivity of the figures to participation rate. One year of capital expenditure deferral is possible under the two bed unit cap scenarios when participation is 40% or greater. Under the Propane Moderate and Propane High scenarios, no deferment of capacity is possible with these assumptions.

Table 6 showed that the value of one year of deferral of capacitor expenditure was worth around $850,000. This is an avoided cost that can now be integrated into the financial evaluation tests to provide an evaluation of the entire portfolio (Table 19).

Table 19: Evaluation of Entire Portfolio

	Propane Bed Unit Cap	Propane Bed Unit Cap 2	Propane Moderate	Propane High
PC - Participant Cost Test	$ 2,818,512	$ 3,872,916	$ 3,334,702	$ 4,449,361
TRC - Total Resource Cost Test	$ 2,554,858	$ 3,668,563	$ 3,354,437	$ 4,717,223
RIM - Ratepayer Impact Measure Test	$ 654,192	$ 1,491,411	$ 85,713	$ 346,546
UC - Utility Cost Test	$ 3,006,859	$ 4,011,135	$ 3,272,688	$ 4,234,324
SC - Social Cost Test	$ 2,691,369	$ 3,730,149	$ 3,132,253	$ 4,292,710

Because of the additional $850,000 in avoided costs for the propane bed cap scenarios, the combined portfolio shown in Table 19 shows positive figures on all evaluation tests. Although the avoided capital cost is not applied to the Propane High and Propane Moderate scenarios, these scenarios are also positive on all tests due to the high RIM test value in these scenarios associated with the Ornamental Fireplace Program.

However, given the length of deferral is so short and the range of reasonable variations in the demand forecast high, these positive figures should not cloud the following key messages:

With the available information, it seems unlikely that DSM measures could defer peak day for more than one or two years.

If the full portfolio of measures described here were to be fully implemented as described, then it may be possible to defer capital investment by one or two years in a way that does not transfer increased costs to other parties.

In addition, there is a high uncertainty around the savings to be gleaned from tow of the programs mentioned here; in particular, the Large Residential Fireplace Program may, if our source is correct, lead to energy savings many times higher than discussed here.

6 Conclusions and Recommendations

Conclusions

DSM is unlikely to defer capital expansion for an extended period

- Based on the information presented and the explicit assumptions we have made, it appears unlikely that DSM measures could defer peak capacity expansion in propane capacity for an extended period of time.

- Under more modest load growth assumptions, several DSM measures *may* be able to defer the timing of new propane capacity additions to serve peak demand by one or two years, provided customer participation in a portfolio of activities is adequate. Longer deferrals are unlikely, particularly if the bed unit cap is raised.

- The most promising peak reduction programs are likely in the large commercial sector, particularly large hotel complexes. We present an example of success in reducing peak propane demand in Whistler in the *Legends* hotel. We caution, however, against extrapolating conclusions from only one example. Given Whistler's unique set of peak demand drivers, finding useful experiences from other places has proven challenging.

- Some of the DSM measures examined highlight a possible tension between sustainability objectives. Many sustainability plans assume technological solutions exist to eliminate social, economic and environmental trade-offs. This is not always the case. For example, outdoor patio heaters are highly popular but use significant quantities of energy. Peak use can be reduced through the implementation of storage tanks or alternate fuel sources, but these may conflict with safety or aesthetic concerns. Similarly, heat loss can be reduced through drop walls and awnings. These management options, however, may also conflict with aesthetic objectives. Whistler may benefit from addressing these trade-offs more explicitly.

- In addition to demand growth assumptions, reliability criteria are a key determinant of system capacity requirements. Historically, planning has emphasized maximizing system reliability subject to technical constraints. Increasingly, utilities are being asked to look explicitly at the trade-offs between reliability and other criteria such as cost and social or environmental impacts. One common approach is to allow individual customers more choice over their level of reliability through interruptible or curtailable rates to manage peak demand. However, this assumes there are customers willing and capable of curtailing loads in response to system conditions. This is more common among industrial energy users. We believe such opportunities are less likely in the case of large commercial loads that depend on offering a high quality visitor experience.

Recommendations

- A number of DSM activities could be undertaken that collectively could defer capital expansion for one or possibly two years and would also minimize the possibility of peak supply shortfalls between now and the next expansion of peak capacity. Terasen should consider requesting approval for recovery utility costs associated with promising DSM programs in Whistler. The most promising programs include the following:

  - **Energy Audits for Large Commercial Customers (Hotels):** Utility-assisted audits would help to establish the magnitude of potential savings and provide a tool for encouraging cost-effective demand management. The Chateau Fairmont Whistler and The Legends offer two benchmarks for energy savings.

  - **Patio Heater Program:** Working with the local government, Terasen should explore ways to manage peak and average demands from patio heaters, including fuel switching, on-site storage systems or even forging agreements not to use them.

  - **Residential Fireplace Efficiency Program:** Based on discussions with local contractors, we believe wood-burning fireplaces some residences *may* have been converted to propane without the utility's knowledge. The typical technology used in these conversions is highly inefficient and could be a major contributor to peak loads. Replacing these fireplaces with new, more efficient fireplaces could reduce both peak and annual energy requirements.

- Local sustainability groups should consider how to support successful implementation of these energy saving programs.

Terasen and the BCUC should consider explicitly the trade-off between increased peak supply curtailment risk and capacity expansion costs. Stakeholders should be involved in selecting a suitable balance between cost and reliability targets.[31]

[31]New BCUC resource planning guidelines are expected to require an update of the last major Terasen Whistler IRP, completed in 1997. Such a trade-off analysis as we recommend would be best performed sooner, rather than later, to ensure optimal resource capital expenditures. The results of such a trade-off analysis could form part of any later, larger Terasen Whistler resource planning exercise.

[32]New BCUC resource planning guidelines are expected to require an update of the last major Terasen Whistler IRP, completed in 1997. Such a trade-off analysis as we recommend would be best performed sooner, rather than later, to ensure optimal resource capital expenditures. The results of such a trade-off analysis could form part of any later, larger Terasen Whistler resource planning exercise.

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Appendix A: Summary of Cost-Effectiveness Tests for DSM Programs

A variety of stand-alone cost-effectiveness tests have also been developed for evaluating individual DSM programs. In these tests, the cost-effectiveness of a DSM program is a function of both the costs of the program and the benefits, including "avoided costs." In order to calculate avoided costs, the analyst must make specific assumptions about the next supply resources.

This section summarizes five standard tests that have been widely used to evaluate the cost-effectiveness of DSM programs. Each test is intended to determine if a program is "good" and for whom the program is "good." The five tests are:

- Participant Test
- Total Resource Cost Test
- Ratepayer Impact Measure Test
- Utility Cost Test
- Societal Test

These tests are described well in existing literature (e.g., Gellings and Chamberlin 1993, and Beecher et al. 1991). In this section, we simply provide a summary of the key features of each test and how the results of each can be interpreted for decision making purposes.

Of particular importance in this study is the treatment of avoided costs. It is unlikely that any single program would produce sufficient reductions in peak capacity to be able to defer capital expenditure in propane storage. However, taken as a collective portfolio, such savings may well appear. Therefore, *the avoided costs noted in the program-by-program analyses do not include the program's relative contribution to avoided capital expenditure*. Avoided Capital outlay is examined only at the portfolio level.

All of the symbols used in the equations below are computed using levelized or present-value costs and benefits. For the purposes of this summary, we present these tests as net benefit calculations – i.e., benefits less costs. They may also be calculated as benefit-cost ratios – i.e., benefits divided by costs.[33] In general, programs are cost-effective if net benefits are greater than zero, or if benefit-cost ratios are greater than one.

Table 20 summarizes some common interpretations of these tests. Figure 14 further illustrates interrelationship among these tests.

Participant Cost Test

The Participant Cost Test measures whether a demand-side management (DSM) program is economically attractive to a customer by measuring the quantifiable costs and benefits of a DSM program from the point of view of the participating customer. This test is often used to assist in program design and to assess the reasonableness of assumptions about participation rates.

The participant test is calculated as follows:

PC = I + BR – PH

Where,

PC = Net cost (benefits) to participants

I = incentives or rebates to customers (including utility incentives and rebates from outside sources such as tax rebates)

BR = customer bill reductions as a result of savings achieved by the measure

PH = net cost to customer of purchased hardware and other related costs

[33] In general, benefit-cost ratios are not a reliable indicator of the relative worthiness of alternative projects. In general, cost-benefit ratios do not adequately reflect the absolute magnitude of net benefits, capital constraints, the availability of resource alternatives, and the interaction of alternatives (Rothstein 1996).

The Participant Cost Test only measures quantifiable benefits and costs of a DSM program. For example, discomfort or indirect costs to the participant are omitted. Although this test is a good indication of the attractiveness of a DSM program to a consumer, more information is needed to determine whether a consumer will actually participate.

Total Resource Cost Test (TRC)

The Total Resource Cost (TRC) test measures the total net resource expenditures of a DSM program from the point of view of the utility and the ratepayer. Resource costs include changes in supply costs, utility costs and participant costs. However, because this test includes the impact of a DSM program on the utility and the ratepayer, it ignores transfer payments (e.g. revenue changes or incentives). The total resource cost test is calculated as follows:

TRC = AC – OC – TH

Where,

TRC = total resource cost

AC = avoided utility costs

OC = Overhead program administrative cost (including upfront development or implementation costs as well as any ongoing administrative costs)

TH = total hardware cost, regardless of who pays

The TRC test measures changes in the average cost of water services across all customers. The cost of water services to a customer differs from the cost of water to customers by the inclusion of customer equipment and operating costs. The net present value of the total resource cost represents the change in the total cost of water services to a utility's customers.

Ratepayer Impact Measure Test (RIM)

The Ratepayer Impact Measure (RIM) Test, also known as the non-participants' test, measures the impact of a DSM program on utility rates by calculating the change in total revenues paid to a utility and the change in total costs to a utility resulting from a DSM program. If the change in revenues from a DSM program is larger or smaller then the change in total costs, the rate levels may change because of the program.

The RIM Test is the only test that examines the impact of a DSM program on the customers who do not participate in the program, since rate changes affect both participants and non-participants. This test is an indicator of average rate impacts. For participants in the DSM programs, average rates may increase while total bills decrease, assuming consumption falls faster than rates increase.

Average rates may increase even when a DSM program is economically efficient. This is because rates include historical or fixed (sunk) costs. In addition to avoiding costs, DSM may result in existing fixed costs being allocated over a smaller number of sales, increasing average rates.

RIM is calculated as follows:

RIM = AC – OC – I – UH – LR

where,

RIM = Ratepayer impact measure

AC = Avoided utility costs
OC = Overhead program administrative cost (including upfront development or implementation costs as well as any ongoing administrative costs)

I = Incentive or rebate from the utility to the customer

UH = Utility purchases of hardware or equipment

LR = Lost revenue to the utility from the reduction in sales to customers installing conservation measures

Utility Cost Test

The utility cost test measures the change in total costs to the utility from a DSM program. Therefore, this test measures the impact of a DSM program from the point of view of the utility. The utility cost test is measures as follows:

UC = AC – OC – I – UH

where,

UC = Utility cost

AC = Avoided utility costs

OC = Overhead program administrative cost

UH = Utility purchases of hardware or equipment

Societal Test

The Societal Test measures the net benefits of a DSM program from the perspective of society as a whole. Externalities are included. Transfers (e.g., taxes) are typically excluded from the Societal Test. The societal test is calculated as follows:

SC = AC – OC – TH + E

where,

SC = Societal cost

AC = avoided utility costs (excluding transfers – e.g., taxes, etc.)

OC = overhead program administrative cost

TH = total hardware cost, regardless of who pays

E = Externalities (primarily emissions)

NOTE: In this draft of this report, emissions values have not been calculated. Table 20summarizes how to interpret the results of the five cost-effectiveness tests.

Table 20: Outcomes and Interpretation of Cost-Effectiveness Tests

Test	Outcome	Interpretation	Relationship to Other Tests
Participant Test	PT >= 0	Program is cost-effective from the participants perspective	In general, this test measures costs and benefits from a limited perspective of the customer, including utility incentives and any residual customer costs.
	PT < 0	Program is NOT cost-effective from the participants perspective	
Total Resource Cost Test	TRC >= 0	Program is cost-effective from a TRC perspective	The TRC measures the change in the average cost of water services across all customers. The TRC differs from the societal test because it does not include externalities.
	TRC < 0	Program is NOT cost-effective from a TRC perspective	The TRC is equivalent to the combined ratepayer impact test and participant test if the common variables are dropped (i.e., incentives and other transfers are netted out). If the incentives paid in a program are equal to the incremental cost of the equipment to the customer, the TRC test and the utility cost test are equal.
Ratepayer Impact Measure Test	RIM >= 0	Average rates will either stay the same or decrease as a result of the program.	If there are no revenue changes due to a DSM program, the utility cost test and the RIM are equal.
	RIM < 0	Average rates will increase as a result of the program.	
Utility Cost Test	UC >= 0	Program is cost-effective from a utility perspective	The utility cost test is similar to supply-side tests which generally measure the change in utility costs associated with a new supply source.

Test	Outcome	Interpretation	Relationship to Other Tests
	UC < 0	Program is NOT cost-effective from a utility perspective	The utility cost test yields the same results as the TRC if the incentives paid in the program equal the incremental cost of the equipment to the participating customer.
Societal Test	SC >= 0	Program is cost-effective from a societal perspective	The societal test and the TRC test differ because the societal test includes externalities, may use different marginal costs, may use a different societal discount rate and excludes taxes because these are simply transfers and not real economic costs.
	SC < 0	Program is NOT cost-effective from a societal perspective	

Note: These tests are also calculated in terms of Levelized Net Benefits (annualized costs and benefits) or Net Present Values (discounted costs and benefits over the life of the program).

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