Report to

VENCorp

The value of customer reliability for gas

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GLOSSARY, DEFINITIONS AND ABBREVIATIONS

AMDQ	Authorised Maximum Daily Quantity
Crucial industrial customers	Crucial industrial customers have continuous processes that cannot be interrupted without causing major damage to furnaces or plant. They have an allocation of gas under Curtailment Table 9.
Curtailment tables	A set of tables that specify the order and extent of curtailment of categories of gas customers with the objective of shedding load before the security of the gas transmission system is threatened. Customers are shed during an emergency progressively from Curtailment Table 1 to Curtailment Table 11.
GMCC	Gas Market Consultative Committee
IEAR	The Interrupted Energy Assessment Rate is a factor that defines the cost to a representative customer for each unit of unsupplied energy due to interruptions. (See Goel et al, 1991)
Large industrial customers	Customers on Curtailment Tables 3 and 5. There are currently 62 large industrial customers in Victoria.
LPG	Liquefied petroleum gas
Major industrial customers	Customers on Curtailment Tables 2 and 4. There are currently 14 major industrial customers in Victoria.
MDQ	Maximum Daily Quantity. This term is sometimes used for AMDQ.
NEMMCO	National Electricity Market Management Company
Curtailment Table 1	For the purpose of this assignment, Curtailment Table 1 customers include gas fired electricity generators scheduled by NEMMCO, but gas used for starting generators, converting a generator to another fuel or used as part of a dual fuel is excepted. Customers on Curtailment Table 1 are sometimes referred to as gas powered generators. Note that Curtailment Table 1 also covers exports of gas, but these exports are assumed to cease totally when there are major constraints and curtailment occurs.

Curtailment Table 2	Curtailment Table 2 covers customers with an MDQ equal to or above 5,000 GJ/day, which would curtail to 40% of their MDQ. The balance of Curtailment Table 2 consumption is curtailed on Curtailment Table 4. These customers are sometimes referred to as major industrial customers.
Curtailment Table 3	Curtailment Table 3 covers customers with an MDQ equal to or above 1,000 GJ/day but less than 5,000 GJ/day, which would curtail to 40% of their MDQ. These customers are sometimes referred to as large industrial customers.
Curtailment Table 4	Curtailment Table 4 covers those customers in Curtailment Table 2, and curtails the balance of their load, that is, the remaining 40%.
Curtailment Table 5	Curtailment Table 5 covers those customers in Curtailment Table 3, and curtails the balance of their load, that is, the remaining 40%.
Curtailment Table 7	Curtailment Table 7 covers those customers with an MDQ equal to or above 250 GJ/day but less than 500 GJ/day.
Curtailment Table 9	For the purpose of this study, Curtailment Table 9 covers customers which have continuous processes that cannot be interrupted without causing major damage to furnaces or plant, for example, glass making operations. Curtailment Table 9 also includes allocations of gas for gas powered generators to start their generators or to switch over to diesel.
VCR	Value of Customer Reliability
VoLL	Value of Lost Load

EXECUTIVE SUMMARY

VENCorp commissioned McLennan Magasanik Associates (MMA) to conduct a Value of Customer Reliability (VCR) study for gas in Victoria. VCR is used for long-term planning, analysis of the reliability of the gas transmission system and market modelling.

The analysis of the available data for participants on Curtailment Tables 2 to 5 is summarised in Table 1.[1] The total cost incurred for the eight hour interruption was $6.4 million, rising to $14.6 million for 24 hours and $86.2 million for the 7 day interruption.

In combination, these sources of data give VCRs of $184.21 for the eight hour interruption, $104.54 for the 24 hour interruption and $67.82 for the 7 day interruption.

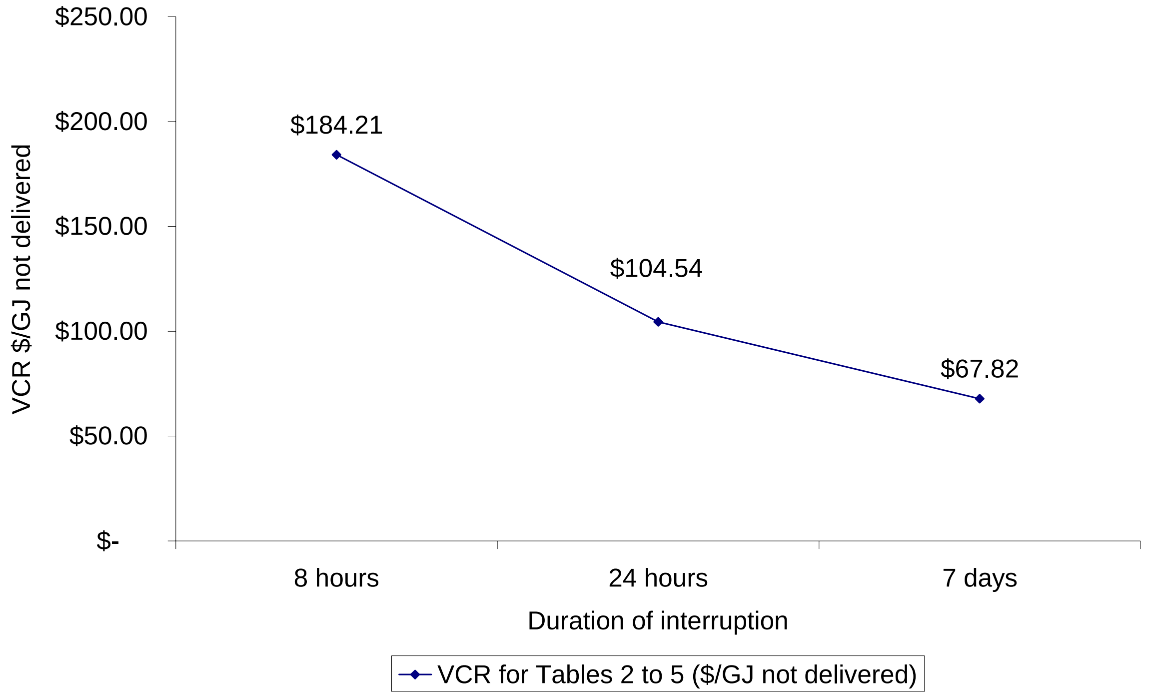
Table 1 – VCR for Curtailment Tables 2 to 5

Duration of interruption	Sample	Total costs incurred ($)	Total gas not delivered (GJ)	VCR for Curtailment Tables 2 to 5 ($/GJ not delivered)
8 hours	n=41	$6,412,100	34,810	$184.21
24 hours	n=41	$14,643,075	140,075	$104.54
7 days	n=41	$86,194,674	1,270,990	$67.82

Figure 1 shows the shape of the customer cost function for Curtailment Tables 2 to 5.

1 See the section titled *Glossary, definitions and abbreviations* on page iv for the definitions of the Curtailment Tables.

Figure 1 – Customer cost function for Curtailment Tables 2 to 5



The scenario chosen by VENCorp for the study was a mid-week morning during winter. However, for a number of participants who process milk, fruit and vegetable products, their costs would have been significantly higher if the scenario for the study had been during the summer months rather than during the winter months. Based on the data analysed in this study, the worst time of the year for major gas interruptions is from October through to March. It is also likely that the value of VCR for shorter interruptions varies with the time of day and the day of the week but, based on the comments provided by participants, these differences are unlikely to be significant.

The study collected some data on the expected costs that would be incurred if gas under Curtailment Tables 7, 9 and 11 was not available.[2] This data indicates that the VCRs under these tables would be significantly higher, but the samples are too small for reliable estimates.

Similarly, too few of the gas powered generators provided information on their likely costs, so we were not able to calculate their VCRs using the method developed for customers under Curtailment Tables 2 to 5. To overcome this, other sources of data were used.

[2] One of the participants had an allocation of gas under Curtailment Table 7.

1 INTRODUCTION

VENCorp commissioned McLennan Magasanik Associates (MMA) to conduct a Value of Customer Reliability (VCR) study for gas in Victoria. VCR is used for long-term planning, analysis of the reliability of the gas transmission system and market modelling.

The current gas market in Victoria uses the term Value of Lost Load (VoLL) as an estimate of the costs incurred when gas is not delivered to customers. The value of VoLL was set at $800/GJ in 1997 before the gas market began operating in Victoria. In 2003, the Gas Market Consultative Committee (GMCC) decided to review the value of VoLL for the new gas market that was being designed, and VENCorp undertook this task. At the same time, VENCorp adopted the term VCR to cover the concept of the costs incurred by customers when gas is not supplied.

As the assignment progressed, VENCorp elaborated its requirements and requested separate VCRs for gas powered generators, industrial customers on Curtailment Tables 2 to 5 and sites which had an allocation under Curtailment Table 9 because of their uninterruptible or continuous operations. Table 2 summarises these VCRs.

Table 2 – Potential VCRs

Customers on	Gas powered electricity generators (Curtailment Table 1)	Large (Curtailment Tables 3 and 5) and Major (Curtailment Tables 2 and 4) customers
Curtailment Table 1 only	√	
Curtailment Tables 1 and 9	√	
Curtailment Tables 2 to 5 only		√
Curtailment Tables 2 to 5 and 7 or 9		√

For convenience, this report is set out under the headings of:

- Background
- The sample
- Methodology
- The survey instrument
- Results

- Summary of recommendations.

The term *gas* is used in this report to refer to reticulated natural gas bought from a gas retailer. Liquefied petroleum gas is abbreviated to *LPG*. Specialised gases, such as ethane and plant gases, are described as such where they are discussed. The term *gas not delivered* is used to describe the gas not consumed by a customer during a curtailment period. This concept is described in more detail in *Appendix 2, Technical note on the calculation of the gas not delivered* on page 50.

2 BACKGROUND

The basic function of a gas transmission and distribution system is to meet its users' energy and load demands at the lowest possible cost to its customers, while maintaining acceptable levels of quality and continuity of supply. This study calculated the costs to gas powered generators, large and major industrial customers when their supply of gas was interrupted, and it focuses on those interruptions where customers are told to reduce their gas consumption by VENCorp because of concerns for the integrity of part or all of the transmission system. Interruptions caused by local events, such as damage to a gas main by excavation, or a problem on the customer's side of the meter, are not covered.

A wide range of methods for quantifying the worth of reliability, and its application to cost-benefit evaluations in system planning, have evolved.[3]

Subramaniam et al (1990, page 1,711) described the situation for understanding losses resulting from interruptions to the electricity supply in a paper in 1990. Their points apply equally well to gas.

> *"An area which is receiving considerable attention is that of assessing the benefit or worth of power system reliability. A related area, namely, the determination of electric power system reliability and evaluation of cost to achieve this reliability, has a well established methodology. A major aspect of assessing the worth of reliability is to study the costs of losses which result from system unreliability. This approach has been the subject of a number of studies, but is still an immature technique. Reasons for this are that interruption cost assessment has only recently become a matter of significant study, and that quantification of interruption costs is a complex and often subjective task. Effects resulting from service interruptions may be categorized as direct effects (those attributed directly to cessation of supply) or indirect effects (those not directly caused by the interruption but are a consequence of it). It is relatively easy to assign dollar values for many impacts such as damaged equipment or spoiled food, but others such as reduction of manpower efficiency, injury or loss of life are difficult to quantify. Other indirect effects such as civil disorder during blackouts or businesses moving to areas with higher reliability tend to be even more difficult to predict and evaluate.*
>
> *The assessment of indirect effects is made still more difficult by the tendency for these situations to be long term effects as compared with direct effects which tend to be short term. The magnitude of all these effects is highly dependent on characteristics of the users (e.g., type of user, size of operation, energy dependency) and on characteristics of the interruption (e.g., duration, frequency, and time of occurrence of interruptions). Further complexities are that the level of reliability that users have experienced and expect in the future, and the variation in the extent of the interruption (e.g., a short local interruption as opposed to a large widespread blackout may have a significant effect on the interruption costs."*

[3] Wacker et al, 1989.

In the context of this study, the term reliability has a broad definition. It includes load or demand-side measures by customers, including the use of alternative fuels. A number of participants in this study could make use of demand-side measures and alternative fuels.

Wacker et al (1989, page 919) point out in a discussion of electricity reliability that, for many customers, reliability is simply a question of whether the supply is available or not. Other customers can benefit from partial availability. This concept of partial availability applies in this study to participants which had allocations under Curtailment Tables 7, 9 or 11.

Wacker et al (1989, page 919) also point out other features of energy supply that apply equally to gas. Most customers accept that equipment will fail. Nevertheless, the expectation of continuous supply remains and, to some, it is considered almost a right.

Wacker et al (1989, page 920) elegantly describe the core issue.

> *"Although the cost of improved service is initially borne by the utility, subsequent rate changes transfer this cost to the consumer. Therefore, in the simplest sense, if the aggregate total of all customers' interruption costs is assumed to be a measure of the worth or benefit of service reliability to society, then an optional target reliability level is one in which the marginal cost of incremental improvements in service reliability would result in equal marginal reductions in societal interruption costs."*

For studies of this type, the customer pool is typically broken down into appropriate customer categories or segments, such as residential, industrial, commercial and agricultural. For this study, which only covers gas powered generators, major and large industrial users of gas, the curtailment tables provided readily useable segments.

At best, results of customer surveys provide an accurate reflection of customers' actual or perceived costs associated with supply interruptions. However, as Wacker et al (1989, page 925) point out, simple average or median values of customers' interruption costs may not properly represent the cost incurred by that segment, because a few extreme values can contribute inappropriately to the average cost per interruption. Consequently, customer-reported costs are usually normalised with respect to the customers annual energy consumption ($/GJ) or annual peak demand ($/MDQ in the case of gas).

Wacker et al (1989, pages 925-926) list a number of problems with this normalisation process. The normalisation by maximum demand implies that the maximum cost coincides with maximum use, whereas the maximum costs may be more appropriately related to the activities interrupted, time of day or season. Actual MDQ varies between the customers in a segment, but the $/MDQ is calculated by dividing the sum of the dollar costs by the sum of the MDQs for all participants. In other words, the $/MDQ result will vary between customers, even within a segment. Two ways to minimise these issues are to recruit as many customers as possible into the study, which we have tried to do by having their retailers make the first contact, and to obtain a high response rate, which is why we offered to interview the participants in person.

This study benefited from a number of advantages, including the following:

- a number of VCR studies for electricity have been published overseas
- two VCR studies for electricity have been reported in Victoria by Monash University and Charles River Associates
- a number of the companies which participated in the gas study would also have participated in the 2002 electricity study so they were familiar with the concepts of the study.

For convenience, we refer to the reports prepared by Monash University for the Victorian Power Exchange as the *1997 electricity report,* and the report prepared by Charles Rivers Associates for VENCorp as the *2002 electricity report.*[4]

[4] Full bibliographic details are provided in the section titled *References* on Page 41.

3 THE SAMPLE

This study differed from the previous VCR studies for electricity in the way the sample was arranged. Rather than approaching the companies directly, they were first approached by their gas retailer, which solicited their participation on behalf of VENCorp. VENCorp provided supporting information which described the study and the type of data that would be collected. This approach produced 53 potential participants.

The retailers then forwarded the contact details of the potential participants directly to MMA. We telephoned potential participants and arranged a time and date for an interview. A copy of the survey instrument was sent as an attachment to an email which confirmed the time and date of the interview, so participants could read it and consider their answers in advance.

All interviews were reconfirmed one day before the scheduled date. These measures produced a final response rate of 89% of the sample provided by the retailers, and of 59% for all the organisations in the target groups.

The segments included in this study, the number of companies in each, and the number that participated in the study is shown in Table 3. Note that the participants in the Crucial industrial group also occur under one of the other segments.

Table 3 – Companies in each segment

Segment	Curtailment tables	Number of sites	Number of participants	
			n=	%
Gas powered generators	1, 3 and 5	4[5]	3	75%
Major industrial	2 and 4	14	11	79%
Large industrial	3 and 5	62	33	53%
Total		80	47	59%
Crucial industrial[6]	9	6	5	83%

5 There are four gas powered generators in Victoria, of which two are owned by the same company.
6 This overlaps with the other segments, that is, all participants that were on Table 9 were also on another table.

4 METHODOLOGY

This section describes several methods for calculating VCR and explains the reasons why VENCorp chose its preferred method.

4.1 ALTERNATIVE WAYS OF CALCULATING VCR

This section describes three ways of calculating VCR, and explains the reasons behind VENCorp's choice of a cost normalised per unit of energy not supplied methodology.

At the start of the study, data were available for each customer on:

- their average winter weekday consumption
- their total annual consumption
- their allocations under the curtailment tables
- their industry category.

The overall method used in this study for large industrial customers is known as the direct costs method, which uses the actual economic losses incurred as a result of an interruption to supply. As this study used a hypothetical scenario, the data is based on participants' estimates of likely costs, which include the immediate costs, such as damage to equipment, and the consequential costs, such as the costs to fill orders from other sources of supply.

The essential information obtained from the cost questions is an actual dollar figure associated with each interruption duration. This information can be reported in a number of ways, including:

- costs per interruption
- costs normalised for annual consumption
- costs normalised per unit of energy not supplied.

Each of these is described briefly in the following sections.

Costs per interruption method

The costs per interruption are calculated by averaging the costs reported by all respondents. This is done for each sector and each duration. In the case of this study of gas customers, the sectors are defined by the curtailment tables. However, simple averages of costs are not particularly useful because of the range of sizes of customers within each table. Also, because the supply of gas has been very reliable since 1998, only a few customers had any actual experience of interruptions and the costs that they incurred.

Costs normalised for annual consumption

In the costs normalised for annual consumption method, the normalised costs are calculated by using the annual consumption in GJ.[7] For each duration, the sum of the costs for each sector for each interruption duration is divided by the annual gas consumption of the sector. The results are used to give the cost of interruption as a function of the duration of the interruption. These are called customer damage functions. The customer damage function represents the costs an average customer in that sector would incur per GJ consumed annually. The cost, normalised by annual consumption ($/GJ consumed) is used to estimate the cost of unserved energy, given knowledge of the frequency and duration distributions of outages for the area in question. As the frequency of outages for gas has been very low since 1998, this method was not appropriate because the frequency of interruption for most participants since the Longford outage was zero. The absence of interruptions would make it difficult for participants to provide historical cost data.

Costs normalised per unit of energy not supplied

The cost per unit of energy not supplied uses the dollar costs of the interruption divided by the volume of energy not supplied during the interruption ($/GJ not supplied).

In order to collect the necessary data, participants on Curtailment Tables 2 to 5 only were asked how long it would take for their sites to reduce consumption to nothing.[8] Participants with a Curtailment Table 9 allocation were asked how long their sites would take to reduce consumption to their Curtailment Table 9 allocation. After costs associated with this were collected, they were asked to consider a situation in which all of their gas supply, including their Curtailment Table 9 allocation, was curtailed.

A linear transition from normal consumption to restricted consumption has been assumed in the analysis. Figure 2 illustrates the situation for a site with no allocation under Curtailment Table 9 (the blue line), and one with an allocation under Curtailment Table 9 (the red line).

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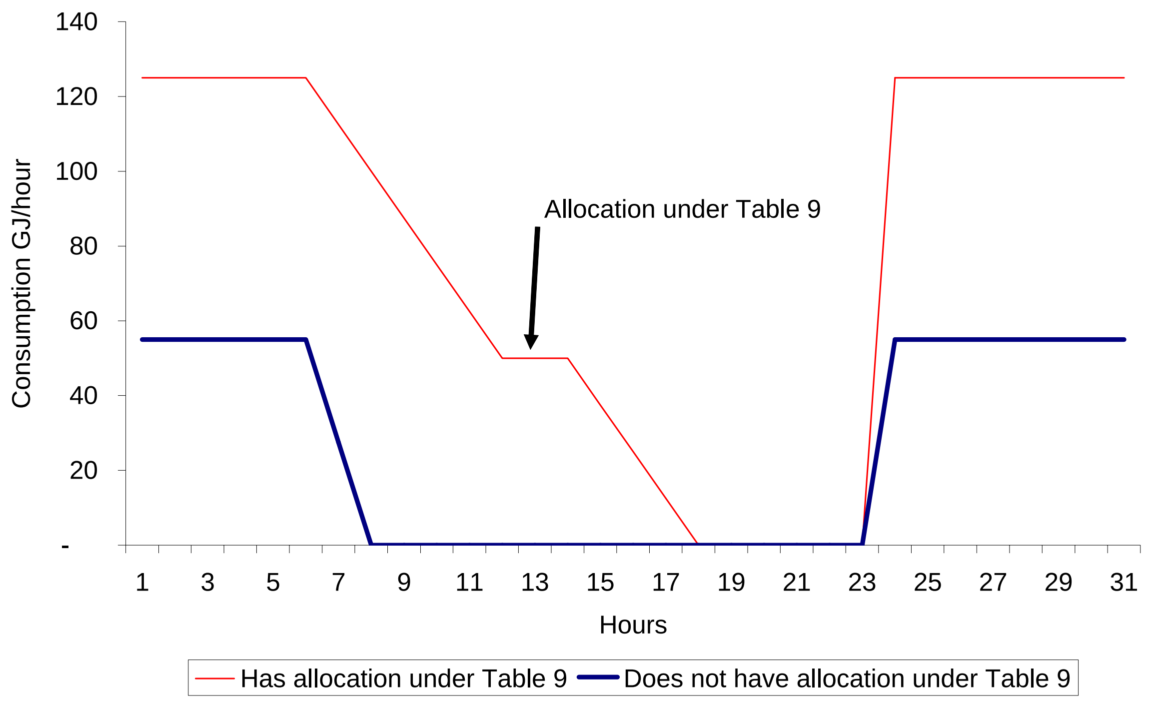
7 They can also be calculated using maximum demand for electricity or maximum hourly quantity for gas but this information was not available.

8 In practice, a mimimum level of gas consumption may be permitted on the grounds of public safety, plant or process safety, health or environmental risk. However, all users must reduce their demand as quickly as possible to the minimum level.

Figure 2 – Schematic view of gas not supplied



4.2 DISCUSSION

After reviewing the alternative methodologies, VENCorp chose the cost per unit of energy not supplied as its preferred methodology for calculating VCR for this study because it would best facilitate the assessment of new investments using the Market Benefits Test. This method is also consistent with that used in the 2002 electricity study.

To help participants in this study estimate their costs, a series of prompts were provided, as follows:

- costs of using alternative fuels
- damage to raw materials
- damage to materials being processed
- damage to finished product in storage
- damage to plant or equipment
- paid staff unable to work
- overtime labour costs to make up lost production
- gross margin on sales foregone from production that can't be made up
- costs to bring business back to normal operation

- loss of profits (gas powered generators only).

Once this information had been collected, the VCR was calculated via the following steps:

- the dollar costs for each respondent for each interruption period were summed ($)
- the costs of all respondents were summed ($)
- the volumes of gas not supplied for all respondents for each interruption period were summed (GJ not supplied)
- the sum of the interruption costs was divided by the sum of the gas not supplied ($/GJ not supplied).

As in the 1997 and 2002 electricity studies, it was assumed that VCR is a function of the duration of the interruption only, so $/GJ not supplied is calculated for each interruption duration, that is, 8 hours, 24 hours and 7 days.

5 THE SURVEY INSTRUMENT

The survey instrument is included in this report in *Appendix 1, Survey instrument* on page 42.

In addition to the usual questions in a VCR survey instrument about the costs incurred as a result of an interruption, the questions covered:

- the presence of backup fuels or equipment
- whether dual fuel had been investigated if it was not present
- any recall of being directed to reduce gas consumption since 1998
- the level of impact if the interruption occurred in different months of the year, days of the week or times of the day
- the number of hours required to reduce gas consumption and the reasons for this
- the number of hours required to get the site back to normal consumption levels after an interruption
- the issues that have to be dealt with during an interruption
- the actions that would be taken
- the associated risks
- the effect on staffing
- the potential effects on suppliers.

The questions about the costs of the interruption are based on the following scenario, which was provided by VENCorp.

> *"Imagine that it is a weekday morning on a cold winter's day. Your site is operating as usual at normal capacity. No maintenance work is scheduled and no down time is planned.*
>
> *Around lunchtime someone mentions to you that he or she has just seen a news report about a major incident that may affect gas supplies in Victoria.*
>
> *Your gas retailer contacts you just before 2pm and advises that a gas emergency has been called and that VENCorp, with the authority of the Victorian government, has directed your company to reduce gas consumption immediately. Due care is to be taken to protect equipment, and the safety of staff, while reducing consumption as rapidly as possible. However, loss of product or materials is not an acceptable reason for delaying curtailment. Serious penalties apply to companies that do not comply with the directions.*

Your gas retailer advises that the emergency is serious and that the duration of the interruption is not known. Given previous experience, your retailer advises that it might be 7 to 8 hours, but could go on for 24 hours or longer if the situation cannot be rectified."

When calculating the likely costs, the participants were prompted to consider the following:

- costs of using alternative fuels
- damage to raw materials
- damage to materials being processed
- damage to finished product in storage
- damage to plant or equipment
- paid staff unable to work
- overtime labour costs to make up lost production
- gross margin on sales foregone from production that can't be made up
- costs to bring business back to normal operation.

Gas powered generators were also asked to consider the loss of profits resulting from the interruption to their gas supply.

6 RESULTS

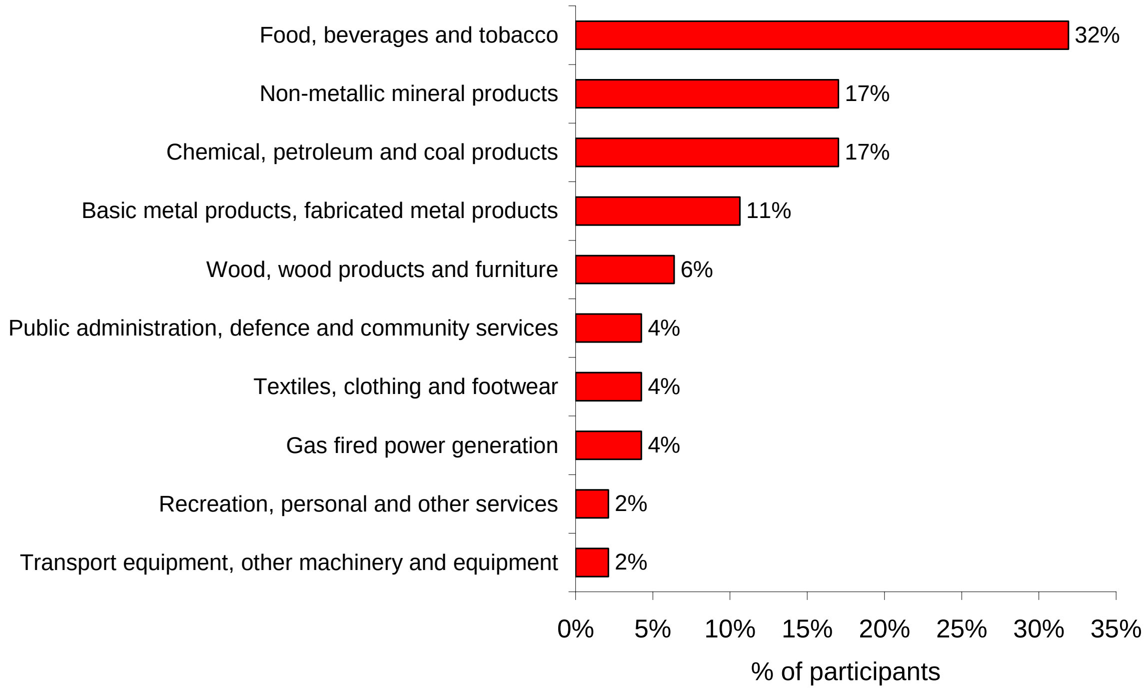
This section of the report describes the results of the analysis under the headings of:

- Characteristics of the participants
- Issues participants would consider during an outage
- Actions participants would take
- Risks to be considered
- Staff management issues
- Likely effects of an outage on suppliers
- The Longford legacy
- Presence of backup fuel or equipment
- History of being directed to reduce gas use
- Time required to reduce gas use
- Volume of gas used after curtailment
- Time required to resume normal gas use
- Volume of gas used after restart notice
- Total costs of interruptions
- Types of costs incurred because of an interruption
- Worst times for interruptions
- Effect on VCR of outages at other times of the year
- VCR for Curtailment Tables 2 to 5
- VCR for Curtailment Tables 7, 9 and 11
- VCR for gas powered generators.

6.1 CHARACTERISTICS OF THE PARTICIPANTS

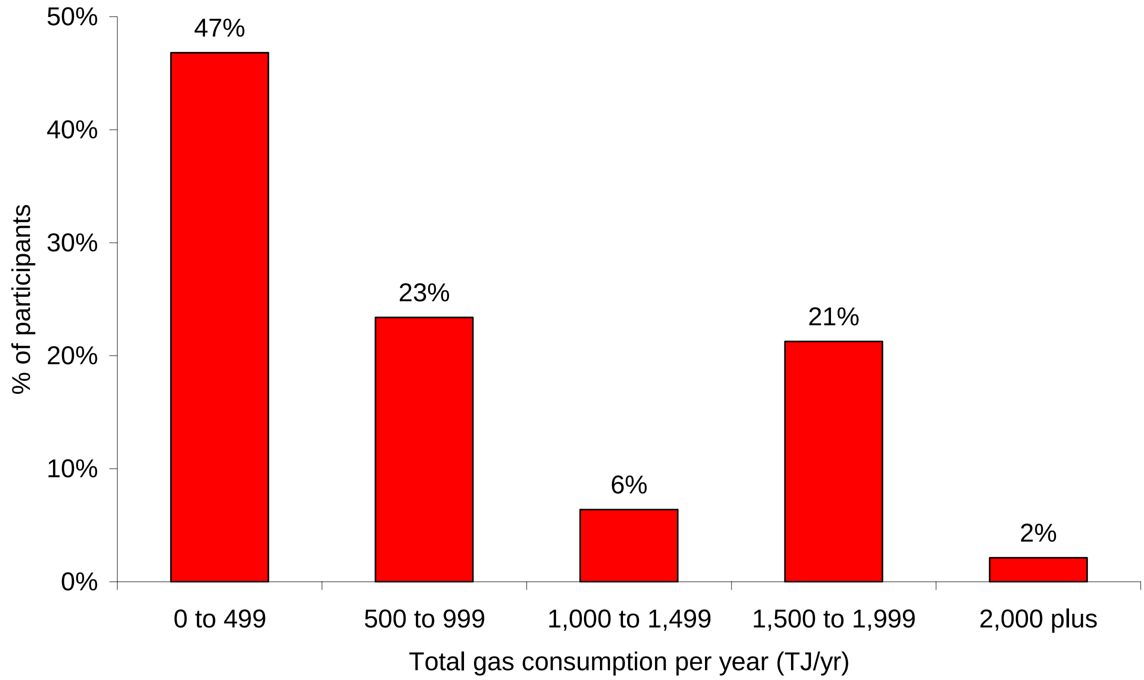
Figure 3 shows a breakdown of the industries represented in this study. Of the 47 participants, nearly one third of the companies were from the food, beverages and tobacco industries (32%). Along with the non-metallic mineral product industry (17%) and chemical, petroleum and coal products industry (17%), these three industries made up approximately two-thirds of the participants. The industries which were least represented were the recreation, personal and other services industry (2%) and the transport equipment, other machinery and equipment industry (2%).

Figure 3 – Industry of participants



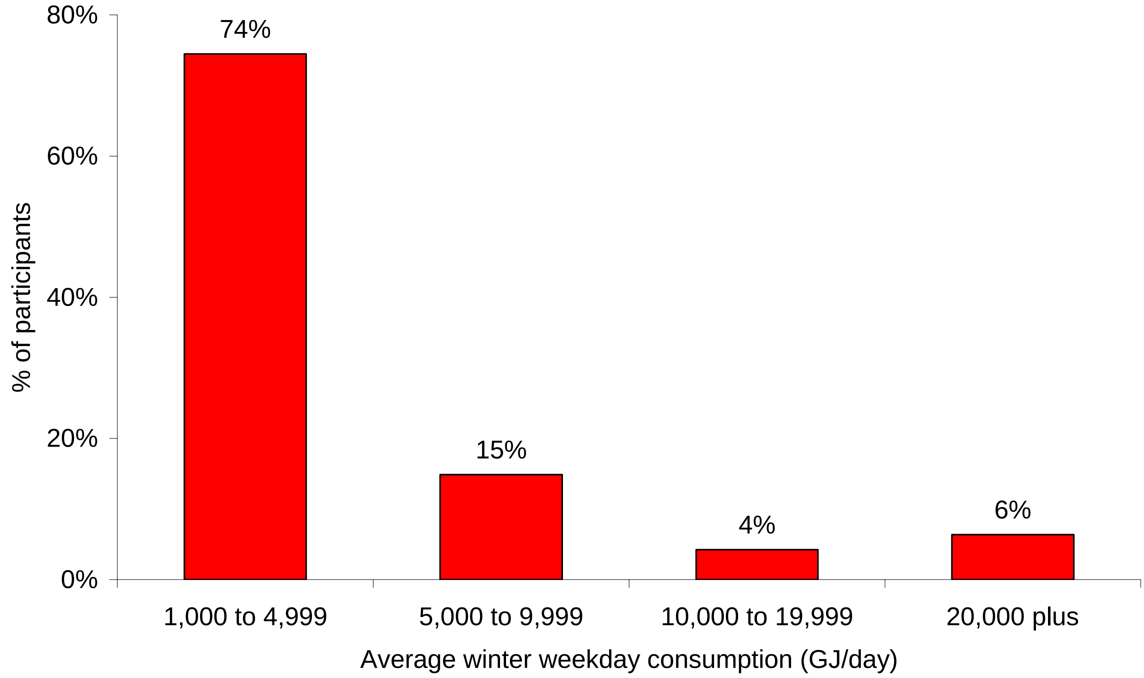
VENCorp supplied data for the annual gas consumption of each participant, in terajoules (TJ), as shown in Figure 4. Nearly half of the participants used from 0 to 499 TJ of gas per year (47%). A further 23% were in the next sub-group, which used from 500 to 999 TJ/year. Only about 2% of participants used 2,000 TJ/year or more of gas.

Figure 4 – Annual gas consumption of participants, TJ



VENCorp also provided data on the participants' average winter weekday consumption of gas, as shown in Figure 5. Nearly three-quarters of the participants used between 1,000 and 4,999 GJ per day.

Figure 5 – Average winter weekday consumption of participants, GJ



Respondents were asked about the potential impacts a gas interruption would have on their business in terms of:

- issues participants would consider during an outage
- actions participants would take
- risks to be considered
- staff management issues
- likely effects of an outage on their upstream suppliers.

The results for these questions are described in the following sections, before dealing with the financial effects of outages.

6.2 ISSUES PARTICIPANTS WOULD CONSIDER DURING AN OUTAGE

Respondents' comments about the main issues resulting from a gas interruption included:

- having to shut down operations (11 comments)
- the need to meet safety requirements or regulations (10 comments)
- sequencing the shut down of different areas of production (9 comments)
- discontinued or reduced supply to customers (8 comments)
- loss of product in process or wastage of unprocessed product (8 comments).

The following quotes illustrate their concerns with these issues and their implications:

> *"Shutting down the ethane plant. Safety is the first issue."*

> *"The shutting down process. Making the plant safe."*

> *"We would do a safe controlled shut down. The pilot lights would go off and the stoves would be turned off."*

> *"A safe ramp down, particularly in the melting area."*

> *"The shut down of machinery. The sequence of stopping parts of the plant. Health and safety issues. The community impact is a big issue, the vapours and smells. The flare may need to get bigger."*

> *"Failure to meet customer delivery requirements."*

"The continued use of gas in the four gas incinerators and flare stack to burn off non-condensable gases and comply with EPA requirements. Contacting customers in Australia and overseas to advise them that orders may be delayed."

"Damage of the product in the kiln or dryer."

"If we lose gas, we have to sell the milk to other dairy companies. If they also have gas problems, then we dump it. We ask if other dairies can take it, if the answer is no, we ask the farmers who keep milking their cows to dispose of it at the farm."

6.3 ACTIONS PARTICIPANTS WOULD TAKE

The types of actions that businesses would take in response to a gas interruption included:

- sequencing the shut down of different areas of production (20 comments)
- converting machinery to use alternative fuels (12 comments)
- finishing processes or running at a reduced load, if possible (6 comments)
- having or following shut down procedures (5 comments)
- notifying regulatory or government bodies (4 comments)
- notifying the highest level of management (4 comments)
- shutting down operations (4 comments).

The following quotes illustrate some of the sequences of actions that would be required:

"Halt the brewing, stop further brews, run the packaging lines right out of the pasteurisers (which need steam), and bring in a diesel conversion plan."

"Continue to reduce heat until the product was cleared. Shut down the furnace and processing."

"Call the management team together and tell them, "Don't panic!" Find LPG tanks and burners for the furnace. We are in curtailment Table 9 for the furnace. Think about switching everything else off."

"Activate emergency shut down procedures."

"Follow the procedures for a controlled shut down in the … bake ovens."

"We could hold up the kiln, but we still need to feed in a little gas to keep up the temperature until the firing is finished."

"Write to the EPA and tell them we are going to an alternative fuel and that we need licensing [permission] for the higher emission diesel plant."

"We would set up the furnace to handle diesel firing and reduce any structural damage. We would also notify the EPA, as diesel causes more emissions."

6.4 RISKS TO BE CONSIDERED

When respondents were asked about the risks involved as a result of a gas interruption, the mostly commonly mentioned risks were:

- general financial loss (14 comments)
- vapours/higher emissions/dangerous waste (13 comments)
- potential damage/malfunctions (9 comments)
- no safety issues (8 comments).

"The business shut down causes financial loss."

"There are no health and safety risks if it is done according to existing procedures. There is a risk of losing customers and of losing production."

"Losing heat out of the furnace and causing structural damage."

"Milk disposal is an environmental risk."

"Financial loss, in terms of down time cost and lost production costs, especially for exports."

"The risks associated with the change over to equipment, for example the malfunction of the control system."

"If we stop immediately, there is a risk of the unstripped product entering tanks open to the atmosphere. That would result in a breach of our EPA licence conditions, and have a potential impact on employee health and safety."

6.5 STAFF MANAGEMENT ISSUES

Methods for managing staff in the event of a gas interruption included:

- standing down some or all staff (17 comments)
- asking staff to take rostered days off [RDOs] or holidays or keep them on standby (14 comments)

- managing staff in general, for example putting staff on alternative duties (10 comments)
- mobilising everyone or particular staff to deal with the situation (8 comments)
- no staffing issues (8 comments).

"We would lay off staff in the areas closed down. It may require additional staff in the engineering and maintenance areas, as well as security resources."

"We would stand down staff over the duration of the interruption."

"If it was for a day, we would put the staff on alternative duties. If it was longer, we would ask people to take holidays."

"Temporary labour re-distribution and re-balance. Stand down some employees."

"Nothing unusual. They are well trained to manage a shut down. We don't need extra staff for these things."

"It is not a problem in normal hours. If it was out of hours, we would have to call staff back in."

"Staff would be required to take compulsory leave for the duration of the shut down."

"No change."

6.6 LIKELY EFFECTS OF AN OUTAGE ON SUPPLIERS

Respondents were asked whether or not any of their suppliers were likely to be affected by a gas interruption and, if so, how this would affect their own business. The most common responses were:

- some suppliers would be affected (14 comments)
- packaging would be affected (9 comments)
- no effect upstream (8 comments)
- rely on just-in-time supply/not much stock (5 comments).

"Food and beverage suppliers to the complex would be affected."

"It would affect the glass manufacturer, because we are on a just-in-time supply."

"Packaging – [the packaging manufacturers] are on just-in-time supply for packaging. They would be out of packaging in a couple of days."

"Upstream would not be overly affected."

"Milk supplies will be seriously affected. Other suppliers, for example for packing material, boxes, bags and pouches [would also be affected]."

"There are suppliers of raw materials and packaging that would be affected."

"The problem may begin to hurt after about 24 hours as our internal stock is run down."

"There would be no impact on suppliers."

Respondents also talked about the effects a gas interruption would have on customers downstream. Responses included:

- it would have an impact on customers downstream (8 comments)
- downstream customers rely on just-in-time supply/don't have a lot of stock (3 comments)
- downstream customers have some storage (2 comments).

"It would have a significant impact on downstream customers."

"Customers rely on just-in-time delivery, so they may close down."

"It wouldn't affect upstream suppliers, but downstream would not be able to ship product to builders."

"Customers have some stock, but they are getting towards just-in-time, so we may lose some customers."

"Downstream – construction and retail – would have some storage."

6.7 THE LONGFORD LEGACY

Many respondents mentioned the effect the Longford explosion in 1998 had on their business. For a small number of companies, it had little or no effect:

"When Longford went down in September, it was not a bad time for us compared to the summer period."

"We have never been interrupted, even during Longford. We got gas from Culcairn in New South Wales and operated at full level."

If these companies were not able to operate at full capacity during this period, they could at least run on a limited basis:

"During the Longford outage, we were allowed to run on a limited basis on a day by day basis. We have a generator, and it was enough power to get the cans out of the cooker and keep running the cool rooms."

For others, however, any outage had serious effects and the negative impacts of the Longford explosion are still relatively fresh in their minds:

"Any interruption that shuts the site, even for a few minutes, will mean a significant loss in production for five to six days. A short unplanned outage would crash the plant with a significant risk of extensive secondary damage. A half shut down of the plant would take 24 to 36 hours to accomplish in safety."

"Gas is critical to the operation of business as we are (a) tourist destination which directly and indirectly employs (a large number of) Victorians. This was shown in the Longford incident in 1998, which had a major negative impact on the business."

Opinion is divided as to whether an event such as Longford could happen again. One respondent felt that there are now more points of supply, so it is unlikely to happen again. Others said that more backup to Longford is still required or that an incident like Longford is unforeseeable:

"Need to ensure there is backup to Longford available, for example, the underground storage, and more reserve stocks. There should be enough in reserve to carry everyone through."

"Reliability is better now we have more points of supply than just Longford. There are fairly firm AMDQs here, so reasonable security. With extra fields it will be even more reliable, for example SEA Gas. The days of a Longford style thing are fairly remote with the way they have linked up the pipeline."

"Obviously, there is the unforeseeable, like Longford."

Several respondents were unhappy with how the Longford explosion was handled. They felt that better communication between all parties was needed and stressed the importance of being able to obtain accurate and up-to-date information:

"During the Longford outage, there was no contactability. There were no call centres – absolutely no contact. We were stuck with a retailer who was getting information off the radio, the same as I was getting."

"During Longford, [VENCorp] were very dictatorial and arrogant. It ended up being a whole lot of puff."

"They didn't know what they were doing. The retailer tried to help, but they couldn't get any information."

"In 1998, no-one knew what we did, and no-one seemed to care. All we needed was someone to have a compassionate ear and let us keep operating at a reduced level, but no-one would listen. We even contacted the Premier's Department."

"It is essential to get accurate and timely information, so we can make the right decision."

"We would like to think the gas industry could have the same sort of forum for large users as Powercor has organised with milk companies to see how the industry could be more collaborative. If any industry is going to survive, it needs to understand how each interacts with all the others. You need to have frank discussions and forums to have the discussions."

Another aspect was that some companies were seen to have 'gotten away' with using gas and were not punished, while others did the right thing:

"They threatened penalties and to cut people off. One big company in the area didn't cut production, and they weren't penalised. The whole thing was a sham, particularly as nothing happened to them. There was a fear of a bit of a backlash from the public. The handling of it was pathetic."

"It was a mockery what went on. The ones that ignored the rulings to stop using gas got away scot-free."

Another respondent felt that the residential sector should have borne more of the impact than the industrial sector:

"The hardship on the employers was unnecessary and unfair. It was wrong that people lost their income. They should have curtailed residential, rather than industry. I'm sure people would rather have a cold shower than see people lose their wages."

The Longford explosion resulted in many businesses either using alternate fuels during the period of curtailment, or at least investigating their use:

"Three days after Longford we began to put diesel kits on all burners, but we have no diesel storage on site. We used a diesel tanker and refilled every three hours during Longford."

"During Longford, we used diesel for the … bake. They are large ovens which are gas fired. But we don't hold any fuel."

"We investigated diesel after Longford, but it was too costly to put in alternate fuel burners."

"During Longford, we changed our boilers to diesel so we had the ability to change quickly. We have now changed the boilers, so using diesel would be problematic but LPG is still a possible option."

"During Longford, we bought a synthetic natural gas plant, which we still own. However, it would only allow us to operate below capacity and it never got commissioned as it was delivered

after the crisis. Synthetic natural gas is produced from LPG. It produces 90 GJ/hour, but we use 170 GJ/hour."

6.8 PRESENCE OF BACKUP FUEL OR EQUIPMENT

Table 4 shows that 64% of the sites did not have any backup fuel or equipment for their gas equipment. Twenty-two percent could make use of diesel, 8% could use LPG, 8% could make use of electric equipment and 2% could draw on other fuels.

Table 4 – Backup fuel or equipment[9]

Fuel	% of respondents n=47
Diesel	22%
LPG	8%
Other electric	8%
Other	2%
None	64%

However, most sites did not maintain stocks of these fuels and, even if the fuels were available, could not continue to operate. For example, of the eight sites with some LPG-fired equipment, two could run indefinitely, one could continue to operate for 24 hours and one for eight hours. The remaining four could not continue to operate without natural gas. For the sites with some diesel-fired equipment, two could run for a week or longer, two for more than one day and the rest for less than one day. For the sites with electric backup equipment, two could operate indefinitely, one for a day, and the others for less than a day.

The most frequently mentioned reasons for not installing dual fuel equipment were related to costs (24 mentions), including:

- the fuels were too expensive (10 mentions)
- both the installation costs and the fuel costs were too expensive (10 mentions)
- installing or converting equipment to use dual fuels was too expensive (4 mentions).

Supply issues were the next most frequently mentioned reasons (14 mentions), including:

- the difficulty of obtaining the quantities required (10 mentions)

[9] The percentages add to more than 100% because some sites used more than one form of backup fuel or equipment.

- the gas supply is adequately reliable and an alternative is not justified (3 mentions)
- the supplies of other fuels were not reliable enough (1 mention).

Other reasons for not installing dual fuel equipment included:

- the difficulty or impossibility of converting equipment (4 mentions)
- the lack of space for equipment and for storing fuel (3 mentions).

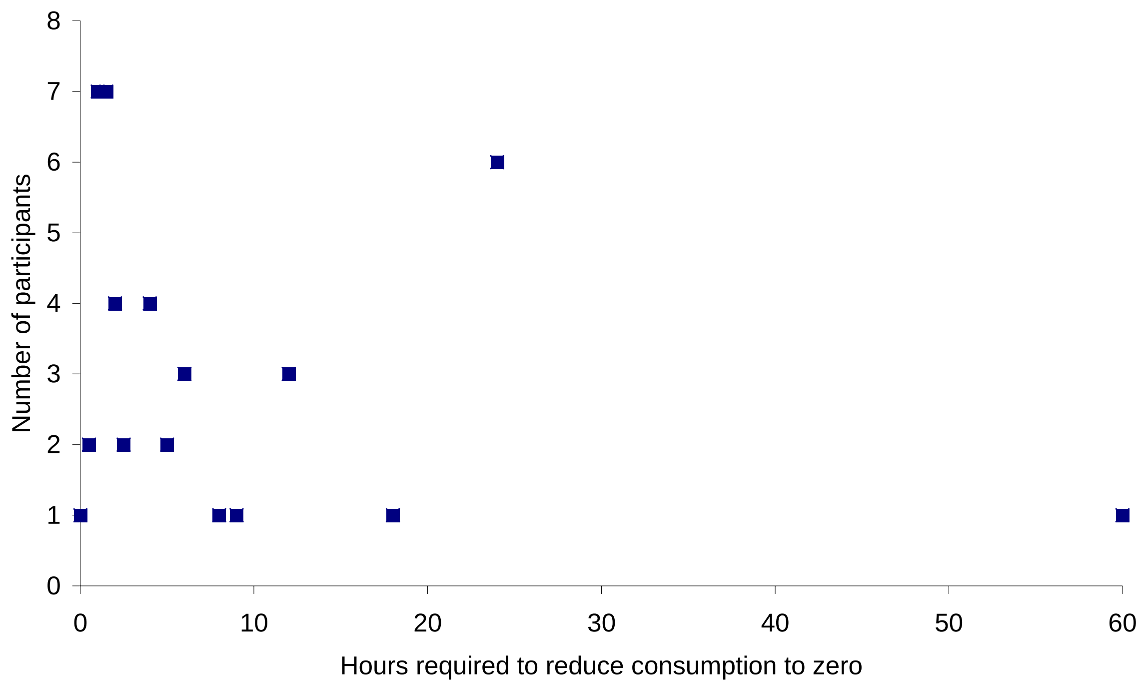
6.9 HISTORY OF BEING DIRECTED TO REDUCE GAS USE

Only one site reported that it had been asked to reduce gas consumption since the Longford explosion in 1998. The request was believed to have been caused by the failure of a compressor in the Western District, but the site was still able to operate at reduced capacity.

6.10 TIME REQUIRED TO REDUCE GAS USE

Participants were asked, *"How many hours would it take for your site to reduce its gas consumption to zero (or to its allocation under Curtailment Table 9)?"* Figure 6 shows that most sites reported that they would be able to shut down within ten hours. There is another spike at 24 hours, where a number of companies thought that it would take them about a day to wind down their operations. The longest requirement was for 60 hours.

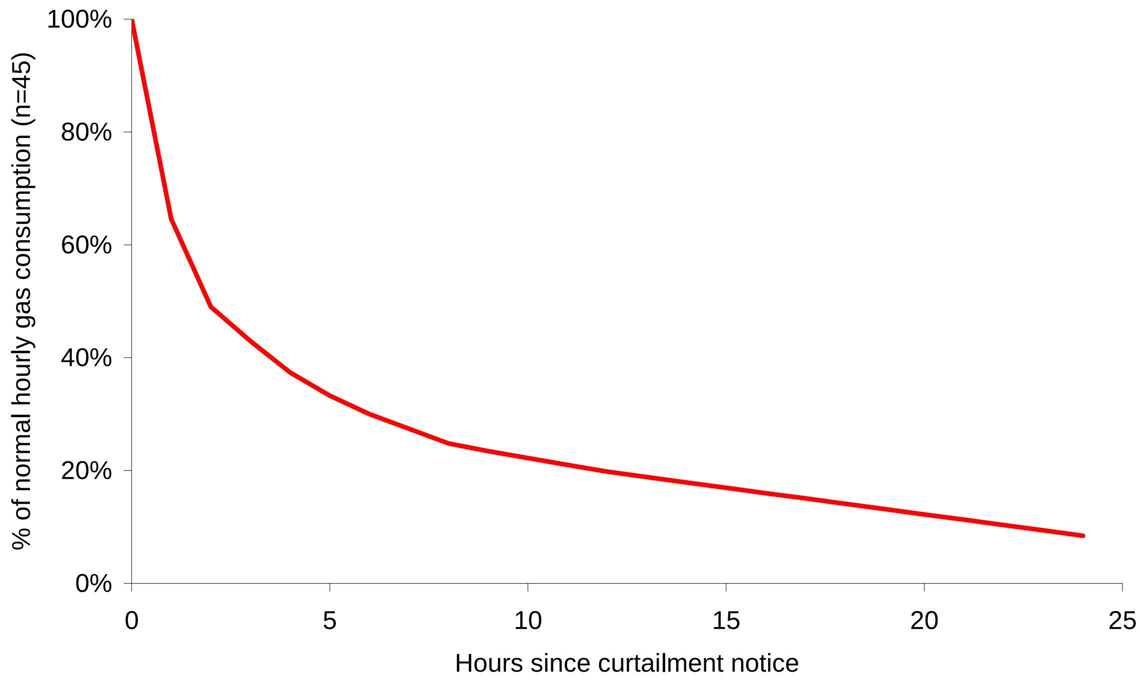
Figure 6 – Time taken to reduce gas use



6.11 VOLUME OF GAS USED AFTER CURTAILMENT NOTICE

Figure 7 shows the volume of gas that respondents indicated that they are likely to use as they shut down their operations after a curtailment notice affecting Curtailment Tables 2 to 5. It is based on their average winter weekday consumption per hour and the length of time they expect to require to shut down their operation once they have been notified. The data does not include the gas fired generators, even though some of them have allocations under Curtailment Tables 2 to 5. Figure 7 suggests that gas consumption will decrease rapidly during the first three hours, and then reduce more slowly until about 10 hours after the curtailment notice. After 10 hours, the rate of reduction in gas consumption would be almost linear. In percentage terms, the data indicate that gas consumption will halve in two hours and drop to 25% in eight hours.

Figure 7 – Volume of gas consumed after the curtailment notice



6.12 TIME REQUIRED TO RESUME NORMAL GAS USE

Participants were also asked, *"Once you are told that you can start using gas again, how many hours would it take until your site was back to its normal consumption levels?"* Figure 8 shows that most sites reported that they would be back operating at normal levels within 20 hours. Once again, there is a peak at around 24 hours, where a number of participants said it would take them about a day to resume operating. There is also a tail on the right hand side of the graph, which reflects a small number of participants whose businesses would need from approximately 35 hours up to nearly 140 hours to resume normal operations after a gas interruption.

Figure 8 – Time taken to resume normal operations

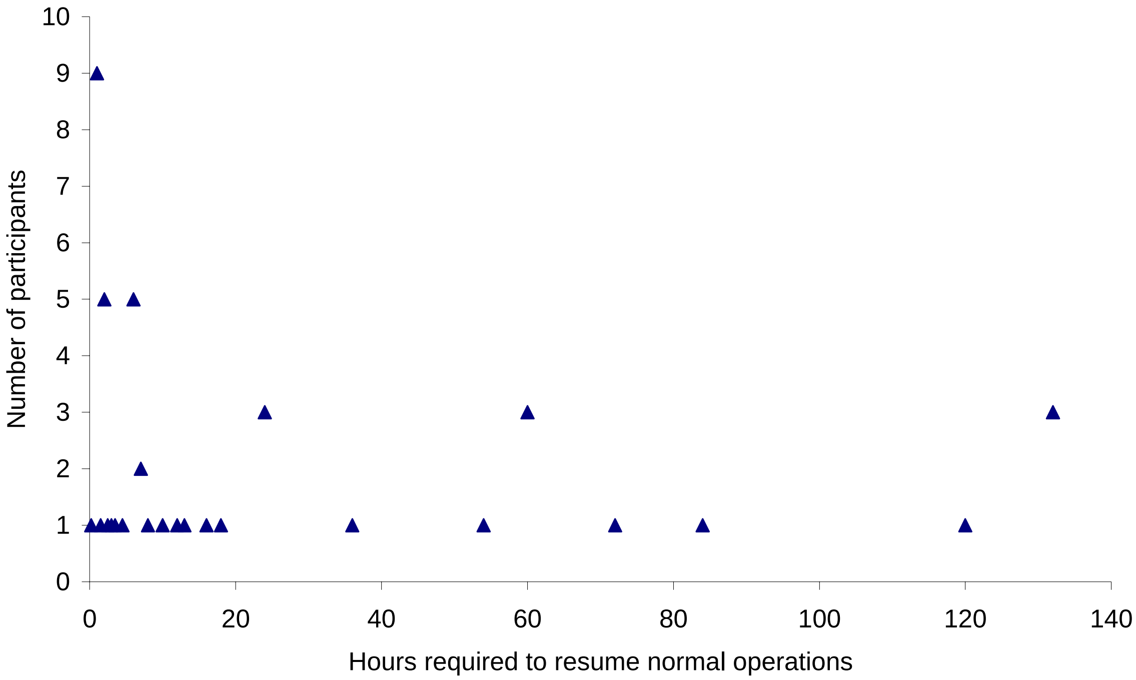
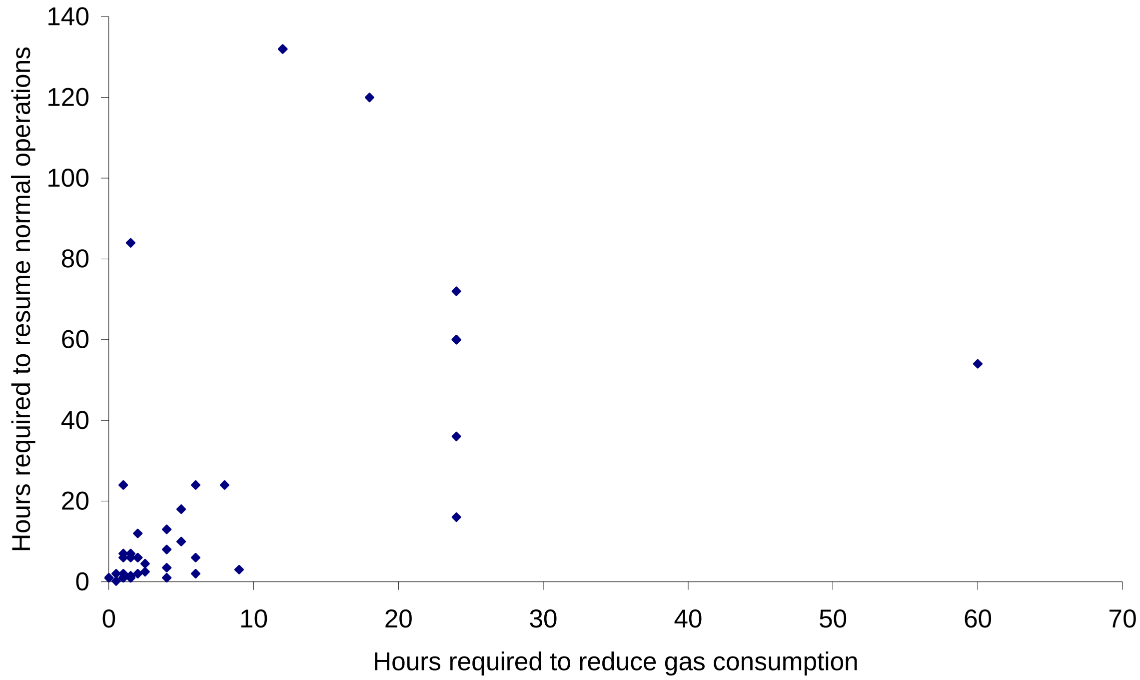


Figure 9 combines the data on the time required to reduce consumption and the time required to resume normal operations. This further illustrates the pattern in which most companies can reduce consumption within 10 hours, and resume normal operations within 24 hours. However, the companies that will take a long time to reduce consumption are not necessarily the ones that will take longest to resume operations.

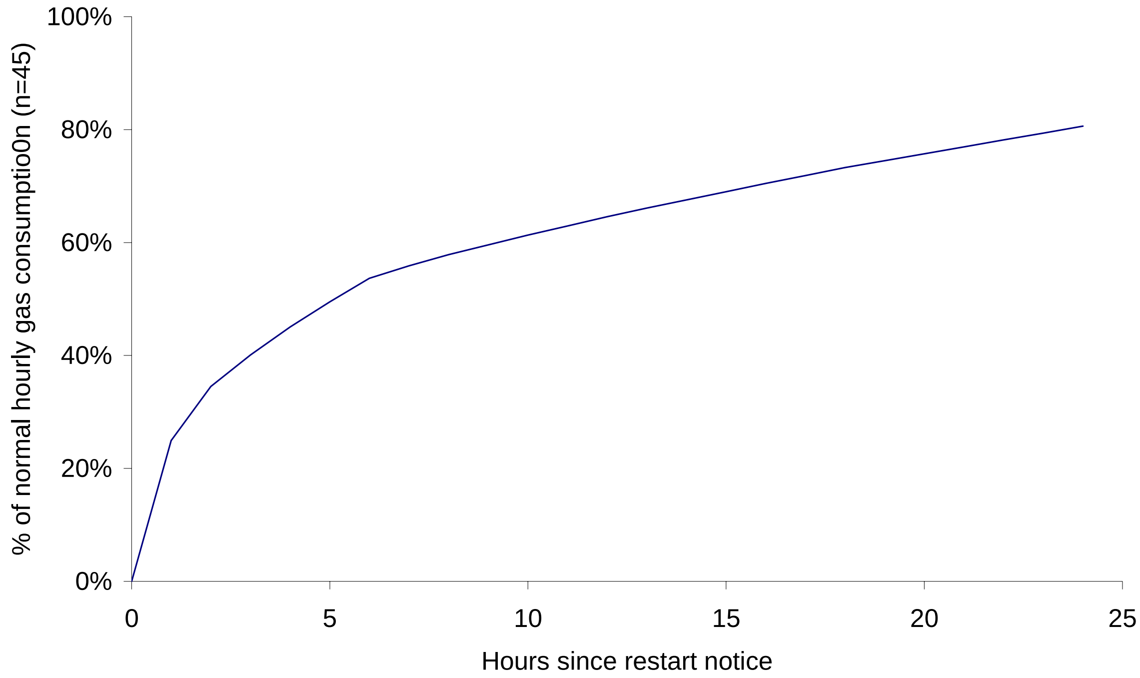
Figure 9 – Time to reduce gas use against time to resume normal operations



6.13 VOLUME OF GAS USED AFTER RESTART NOTICE

Figure 10 shows the volume of gas that participants expect to be consuming after they are notified that they can start using gas normally again. The steps in the curve occur at one hour and six hours because a number of participants gave these times as the number of hours that they would need to reach normal operations. Consumption of gas will be about half the normal rate five hours after notification and reach 75% of normal after 19 hours. After 24 hours it will be 80% of normal consumption.

Figure 10 – Volume of gas consumed after restart notice



6.14 TOTAL COSTS OF INTERRUPTIONS

The anticipated total costs that would be incurred by participants as a result of an interruption to the gas supplied under Curtailment Tables 2 to 5 varied, as shown in Table 5.

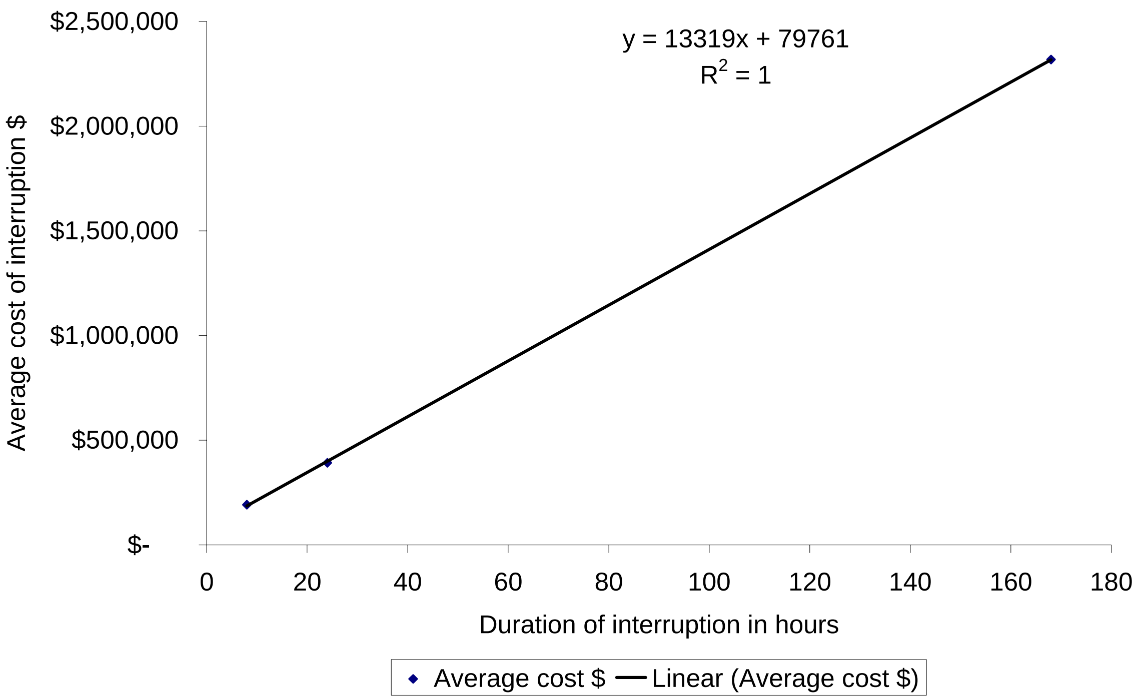
Some participants expected to incur no costs for the eight and 24 hour interruptions, and the lowest expected cost for the seven day interruption was $4,400. The highest expected costs ranged from $1.2 million for the eight hour interruption to $24.3 million for the seven day interruption. Given this variability, the averages provided a useful guide to the trend in costs for longer durations. The average cost for the eight hour interruption was $192,000. This figure doubles to $393,000 for the 24 hour interruption and increases by a factor of 13 to $2.3 million for the seven day interruption. Figure 11 shows that this trend to rising average costs over time is effectively linear.[10]

[10] However, few of the participants described this linear pattern, which only becomes apparent when all the data is averaged.

Table 5 – Lowest, highest and average costs reported

Length of interruption	Lowest cost $ n=44	Highest cost $ million n=44	Average cost $ n=44
8 hour	$0	$1.2 million	$192,000
24 hour	$0	$1.6 million	$393,000
7 day	$4,400	$24.3 million	$2,318,000

Figure 11 – Trends in average costs by duration of interruption



6.15 TYPES OF COSTS INCURRED BECAUSE OF AN INTERRUPTION

Participants were prompted to consider a range of categories of costs when they calculated the effects of an outage. Table 6 summarises the number of participants who allocated costs to each category, and their average cost. For all durations, the most frequently nominated costs were loss of gross margin on sales foregone, damage to materials being processed and paid staff unable to work. The items in the Other category included:

- loss of research materials
- transport of perishable raw materials to other processors
- laundry costs

- penalties for non-delivery
- freight liabilities
- preparations to use diesel
- clean up costs.

Table 6 – Cost by category

Category	8 hours		24 hours		7 days	
	n=	Average $	n=	Average $	n=	Average $
Cost of alternative fuels	10	207,610	11	226,180	14	941,812
Damage to raw materials	6	36,000	7	230,571	8	1,395,000
Damage to materials being processed	18	58,000	18	71,333	19	95,737
Damage to finished product in storage	-	-	-	-	1	N.A.[11]
Damage to plant or equipment	-	-	-	-	1	N.A.
Paid staff unable to work	17	71,265	20	215,800	21	996,352
Overtime labour costs to make up lost production	9	10,844	10	16,800	9	53,222
Loss of gross margin of sales foregone	19	151,263	20	260,650	24	1,749,708
Costs to bring business back to normal operation	14	16,493	17	51,888	19	158,416
Total of other costs	6	119,167	10	115,000	12	711,250

6.16 WORST TIMES FOR INTERRUPTIONS

Participants were asked to nominate the worst month of the year, day of the week and time of the day for an interruption, and Figure 12, Figure 13 and Figure 14 show the results. The lower blue sections in each graph represent the organisations which reported that there was no worst month, day or time, respectively.

Figure 12 shows that the worst months are during spring and summer between October and March. This peak is composed of companies in rural centres which process milk, fruit and vegetables.

11 Data not presented because of small sample sizes.

Figure 12 – Worst month of year

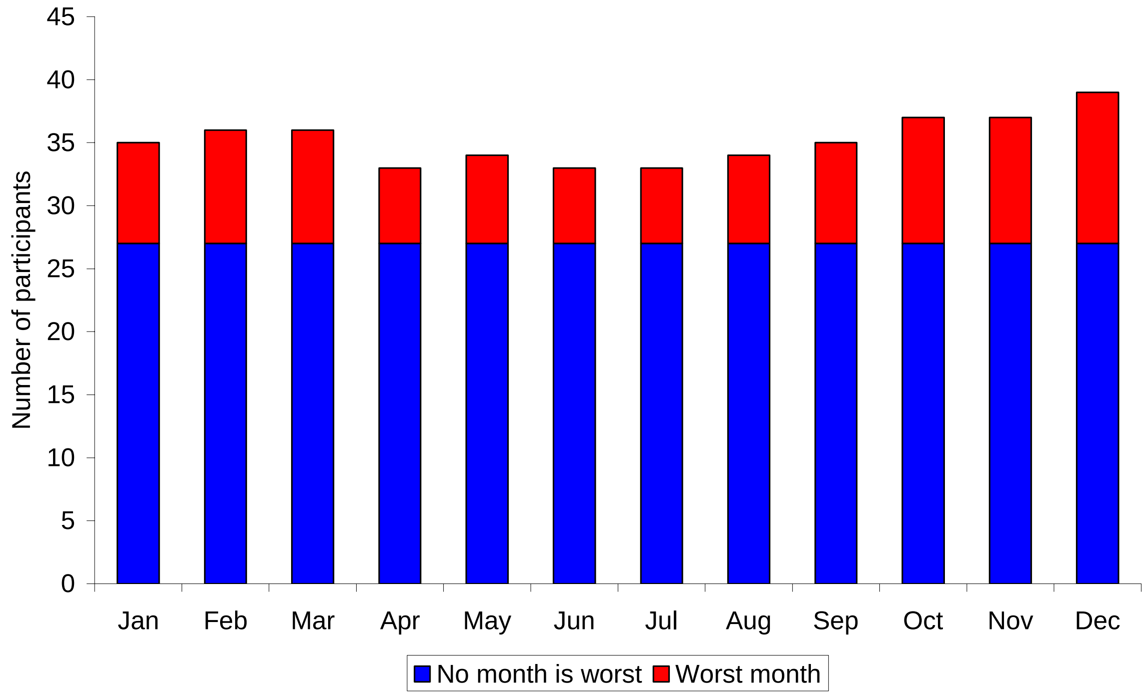


Figure 13 shows that the worst days of the week are Monday, Tuesday and Friday, however, the differences are slight.

Four of the six participants who nominated Monday or Tuesday were manufacturers and the other two were in public administration. Four of the seven participants who nominated Friday were manufacturers, two were in public administration and one was in recreation.

Figure 13 – Worst day of week

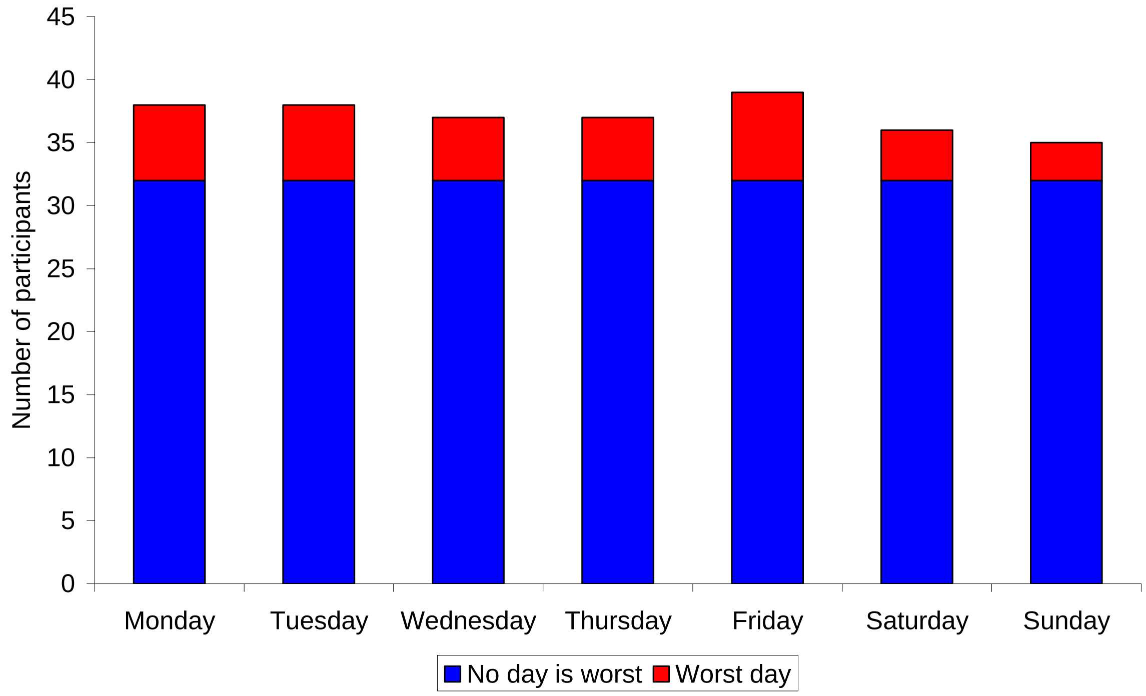
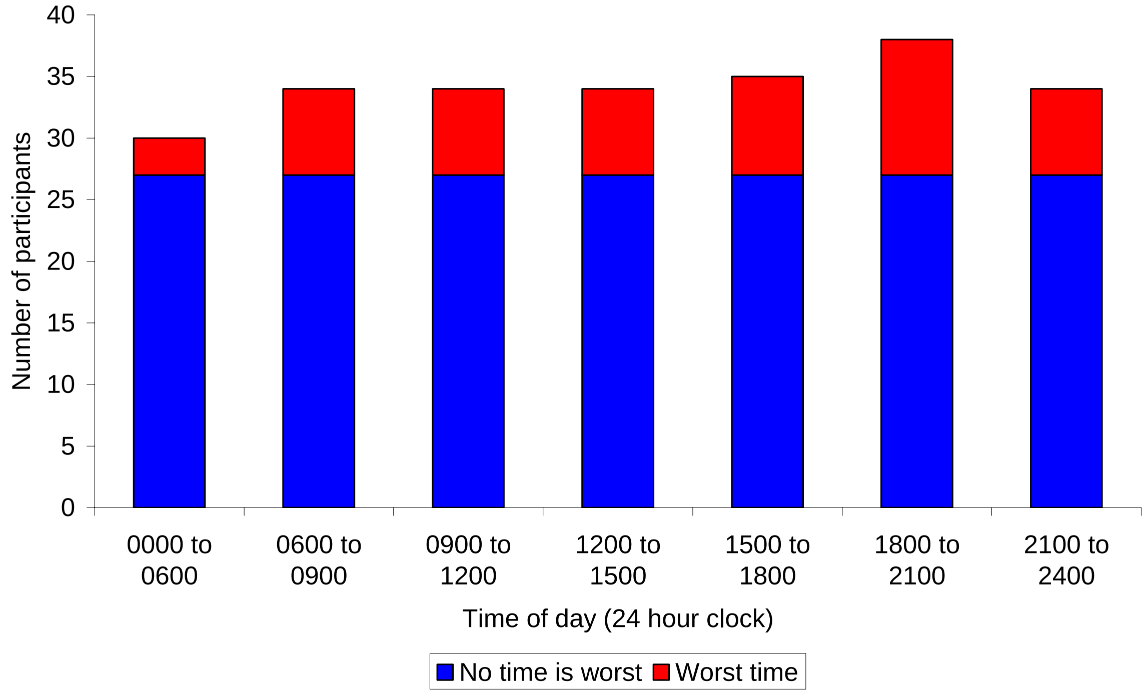


Figure 14 shows that the worst time of the day for gas to be interrupted is in the evening between 1800 hours and 2100 hours. Five of the eleven participants who nominated this time were milk, fruit or vegetable processors, and two were gas powered generators.

Figure 14 – Worst time of day



6.17 EFFECT ON VCR OF OUTAGES AT OTHER TIMES OF THE YEAR

If the scenario had been in midsummer, during the peak processing periods for fruit, vegetables and milk products, the value of VCR would have been much higher for these firms.

The following quotes illustrate this point:

> *"For a workday in November, transport costs would double, and work in progress would double because more milk is being processed."*
>
> *"Costs in peak times would be 2.5 times that of winter off-peak season."*
>
> *"In the summer peak, the cost for transport would be millions immediately, even for the eight hour interruption."*
>
> *"The impact in summer would be ten times the costs in winter. The baked beans are going to hold, but the fruit won't."*
>
> *"The impact in the summer processing season would be ten times higher."*
>
> *"Summer is the worst time. The costs would be much higher as we use a much higher volume of gas."*

The midwinter scenario was chosen by VENCorp because the demand on the distribution system is usually highest in midwinter. However, midwinter is not the worst scenario for many companies. Melbourne-based companies tend to work all year round, but companies processing food in regional centres tend to have a summer peak that falls between October and March. We recommend that future studies of VCR for gas either ask the participants to nominate the worst time of year for their operation, or specify a day in December.

6.18 VCR FOR TABLES 2 TO 5

Forty-five of the participants had allocations of gas under Curtailment Tables 2 to 5. Two participants did not provide any cost data. Four participants also had allocations of gas under Curtailment Tables 7, 9 or 11, so these allocations were subtracted from their allocations under Curtailment Tables 2 to 5, on the assumption that they would still receive this gas. Two participants were glass manufacturers whose unusual characteristics result in very high VCRs, so they have been excluded from this analysis. The result for the analysis of the VCR of this gas under Curtailment Tables 7, 9 and 11 is dealt with in the next section.

The analysis of the available data for Curtailment Tables 2 to 5 is summarised in Table 7. The total cost incurred for the eight hour interruption was $6.4 million, rising to $14.6 million for 24 hours and $86.2 million for the 7 day interruption.

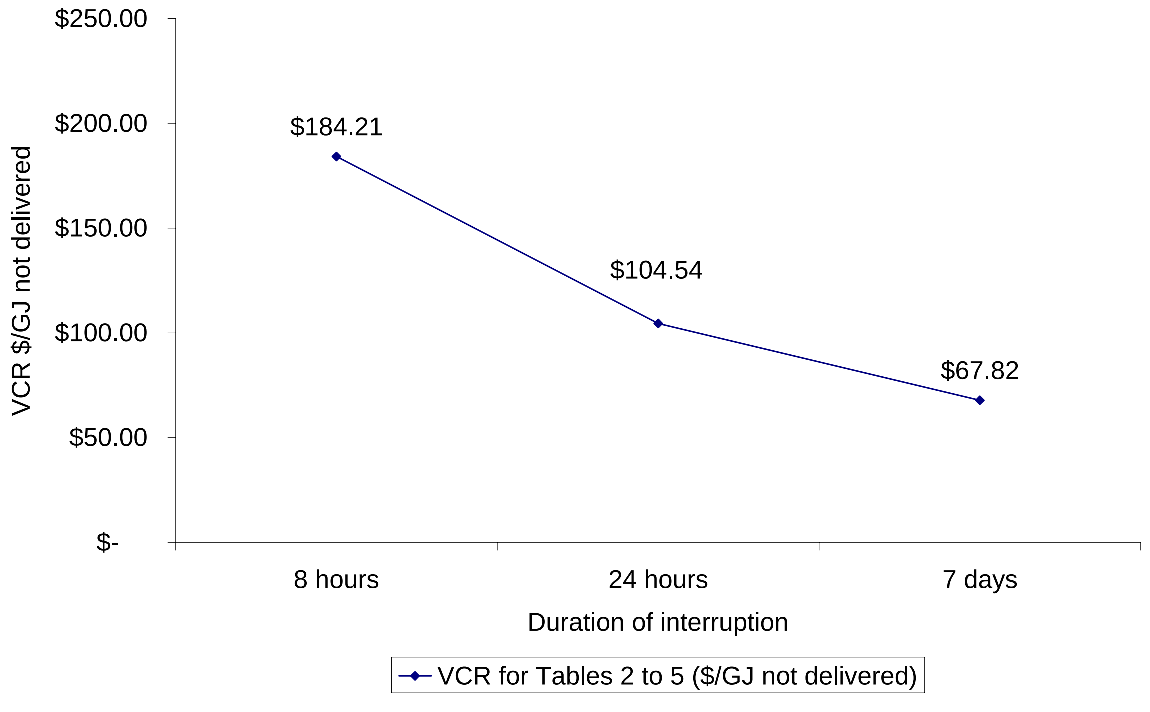
The method used to calculate the volume of gas not delivered is described in *Appendix 2, Technical note on the calculation of the gas not delivered* on page 50.

In combination, these two sources of data give VCRs of $184.21 for the eight hour interruption, $104.54 for the 24 hour interruption and $67.82 for the 7 day interruption, as shown in the customer cost function in Figure 15.

Table 7 – VCR for Curtailment Tables 2 to 5

Duration of interruption	Sample	Total costs incurred ($)	Total gas not delivered (GJ)	VCR for Curtailment Tables 2 to 5 ($/GJ not delivered)
8 hours	n=41	$6,412,100	34,810	$184.21
24 hours	n=41	$14,643,075	140,075	$104.54
7 days	4=41	$86,194,674	1,270,990	$67.82

Figure 15 – Customer cost function for Curtailment Tables 2 to 5



6.19 VCR FOR TABLES 7, 9 AND 11

Five of the participants in this study had allocations of gas under Curtailment Tables 7, 9 or 11. One of the five did not provide any cost data. A second participant indicated that it would change to an alternative fuel at relatively low cost, and so did not provide cost data.

The remaining three provided data on the likely costs that they would incur if their allocations under Curtailment Tables 7, 9 or 11 were not available.

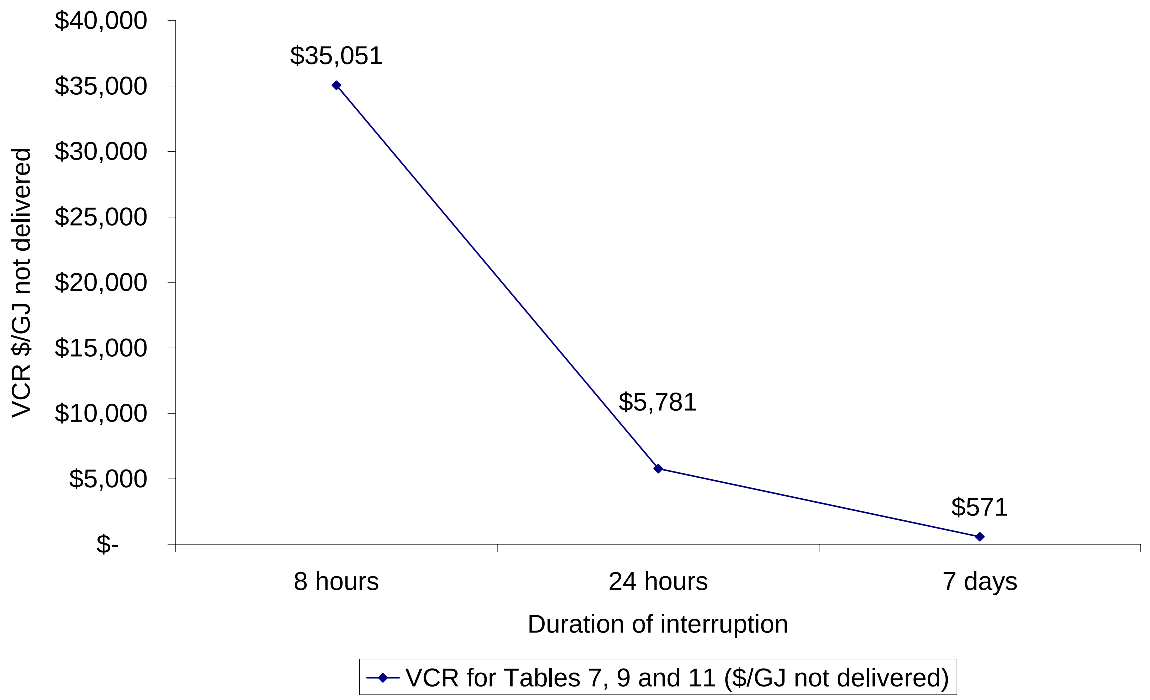
The result of the analysis of the available data are summarised in Table 8, and show a VCR that declines as the duration increases. The high cost for the eight hour curtailment occurs because some of the participants in this sample expect to incur large capital costs if they cannot use gas continuously. While these costs are similar for the 24 hour and 7 day interruptions, they are spread over a larger volume of gas, so the VCRs are lower. Given the small sample, and its possible unrepresentativeness, we recommend that these results be viewed as indicative at best.

Table 8 – VCR for Curtailment Tables 7, 9 and 11

Duration of interruption	VCR for Curtailment Tables 7, 9 and 11 (n=3) $/GJ not supplied
8 hours	$35,051
24 hours	$5,781
7 days	$571

Figure 16 shows the shape of the customer cost function.

Figure 16 – Customer cost function for Curtailment Tables 7, 9 and 11



6.20 VCR FOR GAS POWERED GENERATORS

In view of the highly variable value of gas powered generators' electricity output in the National Electricity Market, the value of gas to generators is itself highly variable. In addition, demand for electricity is likely to fall during a major gas outage as many industrial sites shut down because they cannot use gas.

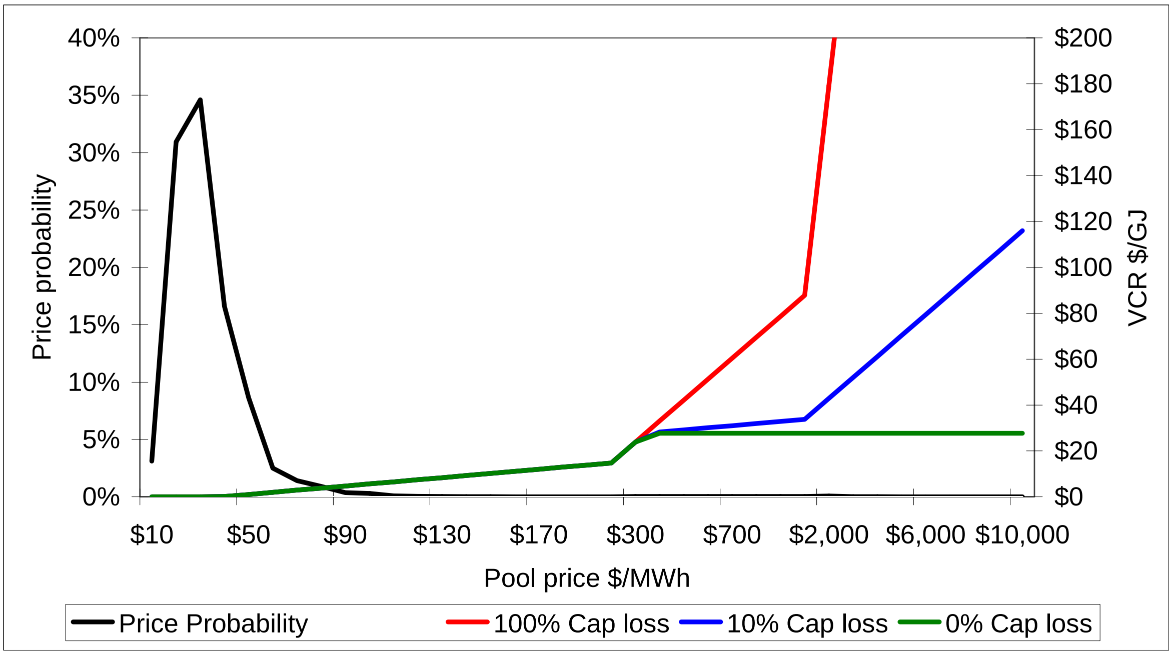
The value of gas to generators is also contingent upon whether they have a back-up fuel available and whether they are able to generate at full capacity on back-up fuel. The three gas-fired generators that took part in this study, of the four taking gas from the Principal Transmission System, are all able to use diesel (distillate) fuel in the event gas is not available and maintain stocks of diesel on site. A loss of capacity of up to 10% was reported, as well as the need to reduce output during a fuel switch over. The generators also have varying ability to effect a cold-start on diesel fuel. In the following analysis it is assumed that those requiring it would be granted the right to use a small volume of gas to start up.

The variation of generator's VCR as a function of pool price is illustrated in Figure 17, for three hypothetical generators that have no capacity loss on diesel fuel (0%), a 10% capacity loss and a 100% capacity loss, i.e. no back-up fuel. The VCRs have been calculated on the basis of marginal loss of profit per GJ of gas not delivered. A gas price of $3.50/GJ has been assumed for each generator and backup distillate is assumed to be available at $1.25/litre, its current price, equivalent to $31.25/GJ. The VCR for a generator with no capacity loss is capped at the fuel price differential of $27.75/GJ, whereas the VCR for a generator with a capacity loss of 10% would reach almost $120/GJ at a pool price of $10,000/MWh and VCR for a generator with no back-up fuel would reach approximately $800/GJ. It is noted that the VCR for the three cases is the same up to a pool price of $300/MWh, below which generation on diesel is not profitable.

The high values illustrated have a low probability of occurring however, as is evident from the price probability distribution displayed in Figure 17. Average VCRs, based on average prices received by generators during 2004, with and without diesel backup fuel, have been estimated for all four gas-fired generators taking gas from the Principal Transmission System. The estimates use the above gas and diesel prices and publicly available information on each generator's levels of generation and prices received during 2004. Assumptions regarding generator heat rates are consistent with MMA's NEM models. All the assumptions and analyses in this section are consistent with information received from the three generators that were interviewed.

The VCRs for generators with diesel backup have been calculated using details of the pool prices received in each half hour in 2004, assuming that the generators would run only when they actually ran on gas or when generation on diesel would have been profitable. The loss of profits in the without- diesel cases are reduced by the profits generated on diesel, which have a significant impact on the VCRs, as shown in Table 9.

Figure 17 – Generator VCR as a function of electricity pool price



This approach assumes that pool prices are not changed by the non-availability of gas. This assumption does not affect the cases without diesel backup because the VCR is simply a measure of the loss of profit that would have been made at the prices that applied when gas was available. For the cases with diesel backup, allowing for a change in prices would probably further reduce VCR, because pool prices would most likely increase, resulting in a reduction in the loss of profits for generators.

Table 9 - VCR for gas powered generators

	2004 Average	2004 Summer	2004 Winter	Worst Case
Gas powered generators' pool price ($/MWh)	$57.08	$70.57	$43.15	$10,000.00
VCR without distillate backup ($/GJ)	$1.77	$2.93	$0.54	$790.70
VCR with distillate backup ($/GJ)	$0.97	$1.74	$0.16	$27.75

It is noted that while the VCR for generators has the potential to be extremely high, the actual average pool prices received by generators are significantly lower than the $10,000/MWh price cap, consequently the average VCRs are very much lower than VCRs for other gas users.

7 SUMMARY OF RECOMMENDATIONS

Based on the results of this study, we recommend for future studies of VCR that:

- the survey instrument for customers under Curtailment Tables 2 to 5 either ask the participants to nominate the worst time of year for their operation, or specify a day in December.

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APPENDIX 1, SURVEY INSTRUMENT FOR MAJOR INDUSTRIAL CUSTOMERS

EFFECTS OF INTERRUPTIONS TO THE GAS SUPPLY ON YOUR BUSINESS

Revised 27 July 2005

Version 15

McLennan Magasanik Associates has been asked by VENCorp to calculate the effects of interruptions to the gas supply on businesses operating in Victoria. You have probably heard about the survey from your gas retailer.

As you are aware, VENCorp holds information concerning your annual gas consumption which is to be used by McLennan Magasanik Associates in the Gas VCR Study. Please be assured that the consumption information together with your responses will be treated in the strictest of confidence. Individual company information is to be aggregated and will not be identifiable in any reports.

Your experience with interruptions to your gas supply in the past

Gas retailers typically give their customers a minimum of 48 hours' advance notice for planned interruptions to your gas supply. But this isn't always possible as interruptions are sometimes caused by unpredictable events. These are **unplanned gas interruptions** and can vary from hours to days. The impacts on gas users can range from minor inconvenience, like having to delay activities, to a loss of more tangible nature, such as the shutting down of a manufacturing operation or retail business.

We have assumed that electricity is still available during the interruption.

A1 Does your business (or the building in which it is located) have any backup fuel or equipment to maintain operations in the event of gas interruptions? *[Please tick one box only]*

- ❑ No *[Please skip to Question A3]*
- ❑ Yes *[Please continue to Question A2]*
- ❑ Don't know *[Please skip to Question A5]*

A2 Please tick one or more of the boxes below to indicate the type of backup fuel or equipment your business (or the building in which it is located) has, and enter the number of hours for which it can carry the load.

- ❑ LPG _______________hours *[Please skip to A5]*
- ❑ Diesel _______________hours *[Please skip to A5]*
- ❑ Other equipment, eg electric _______________hours *[Please skip to A5]*
- ❑ Other, please list _______________ _______________hours *[Please skip to A5]*

A3 Has your organisation investigated dual fuel for this location?

- ❑ No *[Please skip to Question A5]*
- ❑ Yes *[Please continue to Question A4]*
- ❑ Don't know *[Please skip to Question A5]*

A4 What were the reasons for not installing dual fuel equipment?

A5 To the best of your memory, how many times has your location been directed to reduce its gas consumption since 1998, the year of the Longford explosion? Just prior to the Longford explosion in September 1998 there was a blockage caused by ice in the Longford plant in June 1998, which also reduced the supply of gas temporarily.

[Enter number of unplanned gas interruptions] ☐

A6 When was your site last directed to reduce its gas consumption? [ ]

A7 Thinking about how long those unplanned gas interruptions lasted when you were told to reduce your gas consumption, how many of them lasted …

Up to 8 hours	
For more than 8 hours and up to 24 hours	
For more than 24 hours and up to 7 days	
Longer than 7 days	
Don't know	

A8 Excluding those occasions you were directed to reduce your gas consumption, does this site routinely use fuels other than natural gas, electricity and fuels for vehicles?

- ❑ No
- ❑ Yes
- ❑ Don't know

A9 Thinking about the type(s) of business activities carried out at this location, would the impact of a gas interruption vary with the time of day, the day of the week or month of the year in which the interruption occurred? *[Please tick one box only]*

- ❑ No, the impacts are pretty similar whenever a gas interruption occurs *[Please skip to section B0 The impacts of gas interruptions on your business]*
- ❑ Yes, the level of impact does depend on when the interruption occurs *[Please continue to Question A10]*

A10 For your business activities at this location, what would be the worst possible **month(s)** for a gas interruption to occur? *[Tick no month is worst, or one or more months]*

- ❑ No month is worst
- ❑ January
- ❑ February
- ❑ March
- ❑ April
- ❑ May
- ❑ June
- ❑ July
- ❑ August
- ❑ September
- ❑ October
- ❑ November
- ❑ December

A11 What **day(s) of the week** would be the worst possible time for a gas interruption to occur in your business at this location? *[Tick no day is worst, or one or more days]*

- ❑ Monday
- ❑ Tuesday
- ❑ Wednesday
- ❑ Thursday
- ❑ Friday
- ❑ Saturday
- ❑ Sunday
- ❑ No day is worst

A12 What would be the worst possible **time(s)** for a gas interruption to occur? *[Tick no time is worst, or one or more times]*

- ❑ 6am to 9am
- ❑ 9am to 12 noon
- ❑ Noon to 3pm
- ❑ 3pm to 6pm
- ❑ 6pm to 9pm
- ❑ 9pm to midnight
- ❑ Midnight to 6am
- ❑ No time is worst

B0 The impacts of gas interruptions on your business

Imagine that it is a weekday morning on a cold winter's day. Your site is operating as usual at normal capacity. No maintenance work is scheduled and no down time is planned.

Around lunchtime someone mentions to you that he or she has just seen a news report about a major incident that may affect gas supplies in Victoria.

Your gas retailer contacts you just before 2pm and advises that a gas emergency has been called and that VENCorp, with the authority of the Victorian government, has directed your company to reduce gas consumption immediately. Due care is to be taken to protect equipment, and the safety of staff, while reducing consumption as rapidly as possible. However, loss of product or materials is not an acceptable reason for delaying curtailment. Serious penalties apply to companies that do not comply with the directions.

Your gas retailer advises that the emergency is serious and that the duration of the interruption is not known. Given previous experience, your retailer advises that it might be 7 to 8 hours, but could go on for 24 hours or longer if the situation cannot be rectified.

B1 What are the main issues that your company will have to deal with?

B2 What actions would you take?

B3 What are the risks?

B4 What about staffing?

B5 This interruption may affect some of your suppliers if they are based in Victoria and if they have to reduce their gas consumption at the same time. Are any of your suppliers likely to be affected and, if so, how will this affect your business at this location?

Assume your company started to reduce its gas consumption at 2pm, for example, by holding a brief meeting of managers and key staff.

I1. How many hours would it take for your site to reduce its gas consumption to zero (or to its allocation under Table 9)?

I2. What are the reasons why it takes this long?

I3. Once you are told that you can start using gas again, how many hours would it take until your site was back to its normal consumption levels?

In question C1, assume that your retailer contacts you and says that you can start using gas after 8 hours, that is 10pm for the first column.

Assume that your retailer contacts you at 2pm on the following day for the 24 hour interruption.

Assume that your retailer contacts you a week later for the 7 day interruption.

C1 If a gas interruption occurred without warning on a weekday morning in mid-winter and you were told to reduce gas consumption, what would be the cost in dollars to your business at this location? Please estimate your costs in dollars for each of the durations shown in the box below.

Here are possible impacts your business might experience …	If you were told you could start using gas again after …		
	8 hours	24 hours	7 days
Costs of using alternative fuels			
Damage to raw materials			
Damage to materials being processed			
Damage to finished product in storage			
Damage to plant or equipment			
Paid staff unable to work			
Overtime labour costs to make up lost production			
Gross margin of sales foregone from production that can't be made up			
Costs to bring business back to normal operation			
Loss of profits (gas powered generators)			
Other *[Please describe]* ______________________			
Other *[Please describe]* ______________________			
Other *[Please describe]* ______________________			
Total			

C2 What method does your organisation use to calculate costs for an event like this?

C3 If the worst time for an interruption at your location is not a weekday morning in mid-winter, how would costs differ if your site was told to reduce consumption at its worst time?

Your comments or suggestions

C4 Finally, if there are any comments you would like to make about the effects of interruptions to your gas supply, please use the space below.

Thank you for taking the time to complete this survey.

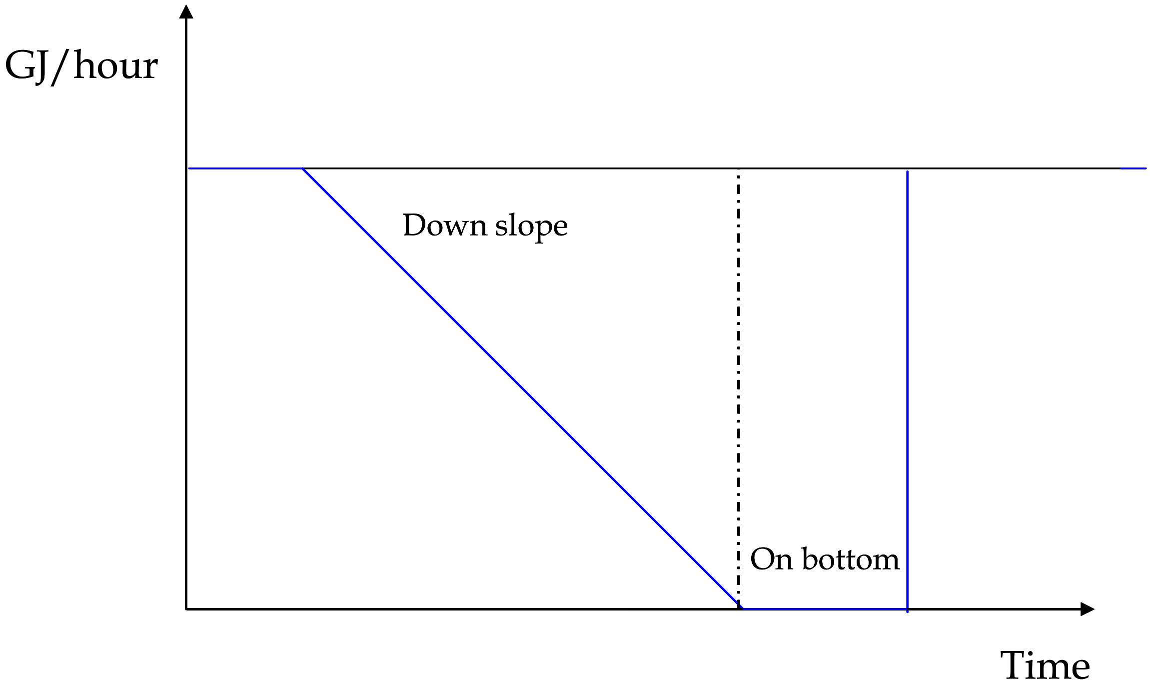
The information you have provided will help to ensure an economical and reliable gas supply to all Victorians.

APPENDIX 2, TECHNICAL NOTE ON THE CALCULATION OF THE GAS NOT DELIVERED

The volume of gas not delivered was calculated for each participant for the three scenarios, that is, an eight hour interruption, a 24 hour interruption and a seven day interruption.

For convenience, consumption during the interruption was conceptualised as consisting of two stages: a down slope and a flat segment on the bottom, as shown in Figure 18. This approach is similar to the approach used in VENCorp's market modelling.

Figure 18 – Example 1, participant reaches zero consumption



The down slope consisted of the time taken to reduce gas consumption to zero. As the rate at which gas consumption could be curtailed was assumed to be linear, the volume of gas not consumed in the down slope was the number of hours multiplied by the hourly consumption divided by two. This is the area of the triangle shown to the left in Figure 18.

Some of the participants stated that they would not reach zero consumption in the eight hour and 24 hour interruptions, as illustrated in Figure 19. In these cases, it was assumed that they would reduce their consumption steadily until they were told that they could resume normal operations. For example, for the eight hour interruption, the level of consumption at the turning point was calculated as eight divided by the time required to reach zero consumption, multiplied by the GJ/hour of average winter weekday consumption. This was used to calculate the area of the triangle in Figure 19.

Figure 19 – Example 2, participant does not reach zero consumption