Calculation of Effective Interruptible Power and Examples of its Application

To calculate effective interruptible power, reference power must first be established based on power demand data for peak hours.[1] Data from a single winter period is used. This document will help you understand:

- how the reference power curve is established
- how effective interruptible power is calculated
- how certain rate provisions from the Addendum to the *Electricity Rates Effective April 1, 2023* (the Addendum) influence whether or not you obtain a credit
- why more than one reference curve can be used to identify reference power (concrete examples are given)

Effective interruptible power and demand response credit can only be calculated at the end of the winter period.

[1] Peak hours are all hours between 06:00 and 09:00 and between 16:00 and 20:00 in the winter period excluding Saturdays and Sundays, December 24, 25, 26 and 31, January 1 and 2 and, if they fall within the winter period, Good Friday and Easter Monday (see Article 4.74 of the Addendum to the *Electricity Rates Effective April 1, 2023*).

1. Establishing the reference power curve

Establishing reference power requires the following:

- Calculation of average power demand and average temperature for all days in the winter period
- Calculation of linear regression using average power demand values

1.1 Calculation of average power demand and average temperature

Average power demand is obtained by taking the daily average of all power demand levels recorded by the communicating meters for each peak period. Similarly, average temperature is the average of the outdoor temperatures recorded during peak hours at the weather station closest to the delivery point. For each average power demand calculated, there is an associated average temperature that shares the same date and peak period.

For example, for December 3, an average power demand and average temperature will be calculated for the period from 06:00 to 09:00 (Figure 1). A second average power demand and temperature will be calculated for the period from 16:00 to 20:00.

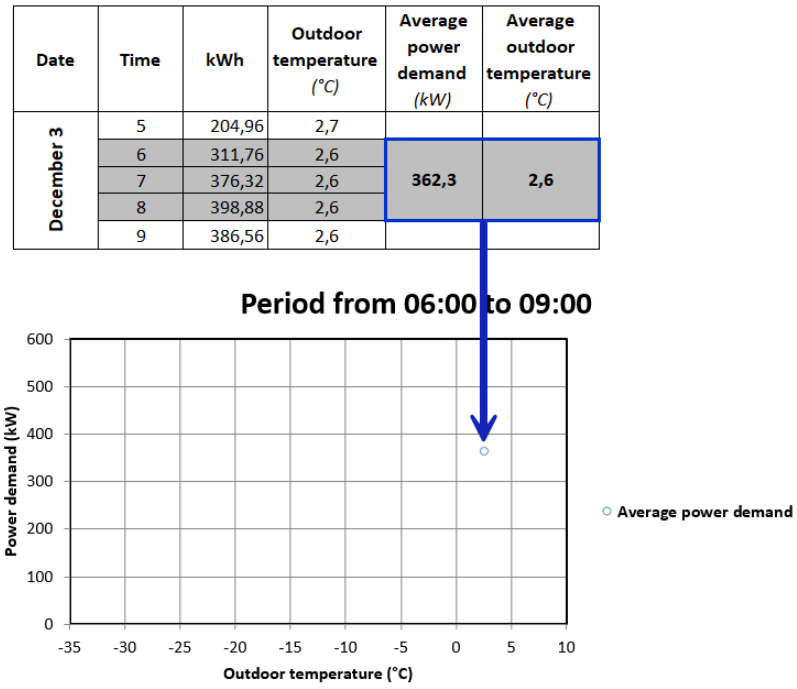

Figure 1: Average power demand associated with average outdoor temperature

These calculations are performed for all days of the winter period[2] (Figure 2).

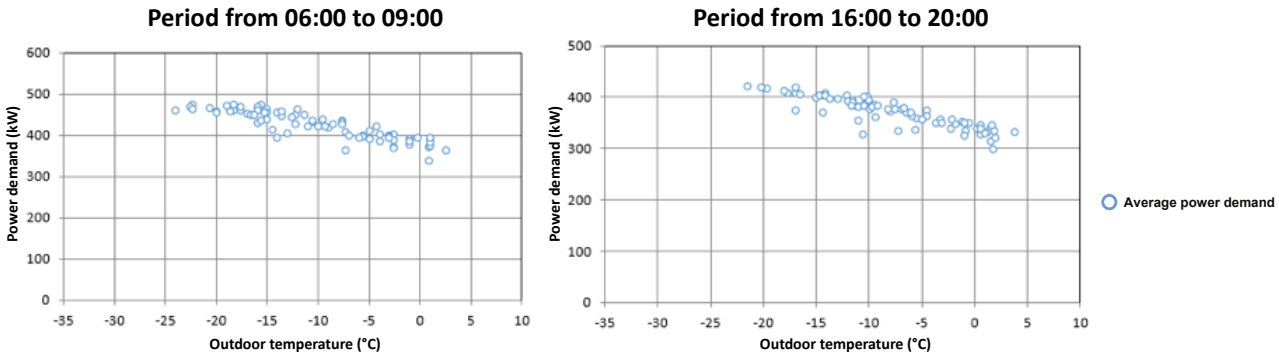

Figure 2: All average power demand values for the winter period

1.2 Linear regression

The linear regression is based on all average power demand values and their associated average temperatures[3]. This linear relationship expresses the impact of outdoor temperatures on the customer's power demand and lets us identify reference power for each critical peak events. Note that outdoor temperature influences the slope of the linear regression (Figure 3). Consequently, if your power demand is only slightly influenced by outdoor temperature, you'll have a linear regression with almost zero slope.

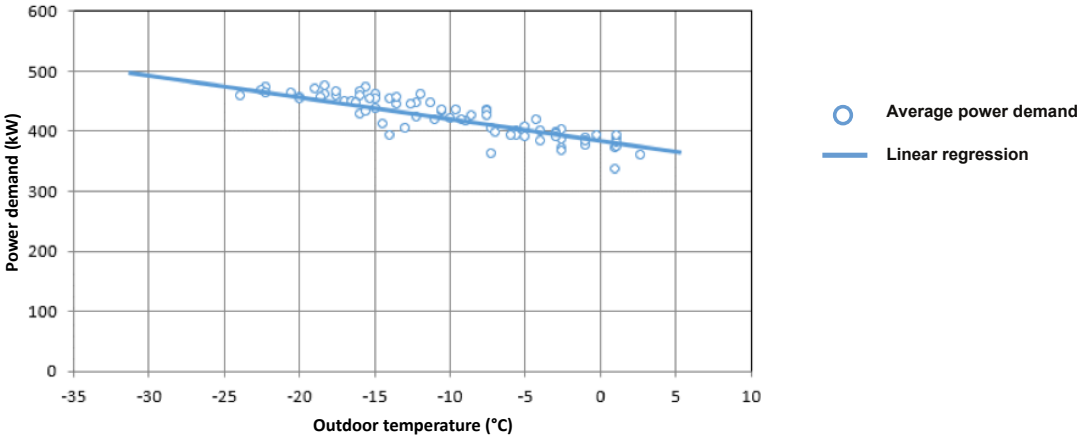

Figure 3: Reference power curve obtained by linear regression of all average power demand values

[2] Not including Saturdays and Sundays, December 24, 25, 26 and 31, January 1 and 2 and, if they fall within the winter period, Good Friday and Easter Monday (see Article 4.74 of the Addendum to the *Electricity Rates Effective April 1, 2023*).

[3] Periods during critical peak events are not included.

1.3 Number of reference curves

For each contract, a separate reference curve is established for the peak periods of 06:00 to 09:00 and 16:00 to 20:00.

In addition, to "... *better reflect the customer's normal consumption profile*,"[4] more than one reference curve may be established for the 06:00 to 09:00 or 16:00 to 20:00 period. In this way, we avoid over- or underestimating the power reduction so that customers can be remunerated fairly. Hydro-Québec has statistical indicators that enable it to identify such service contracts.

For example, there might be one reference curve for Mondays and another for the other days of the week. See Section 4 for more examples.

[4] From the definition of reference power in Article 4.74 of the Addendum to the *Electricity Rates Effective April 1, 2023*.

2. Calculating effective interruptible power

Establishing effective interruptible power requires the following:

- Calculation of real power demand
- Calculation of associated reference power
- Calculation of power reduction
- Calculation of effective interruptible power

2.1 Calculation of real power demand

Real power demand is obtained by averaging all power demand values recorded during a critical peak event.[5] In Figure 4, real power demand is represented by the red circle.

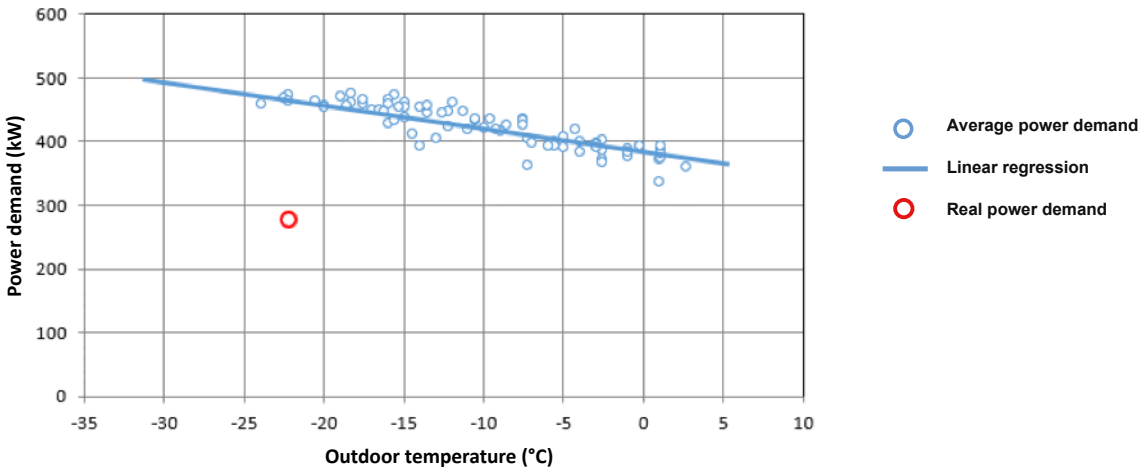

Figure 4: Real power demand during a critical peak event

[5] The same method is applied for each critical peak event.

2.2 Calculation of reference power

We can determine reference power[6] during a critical peak event by using the linear regression that represents the normal consumption profile and the average outdoor temperature during the event. In Figure 5, the reference power is represented by the red X.

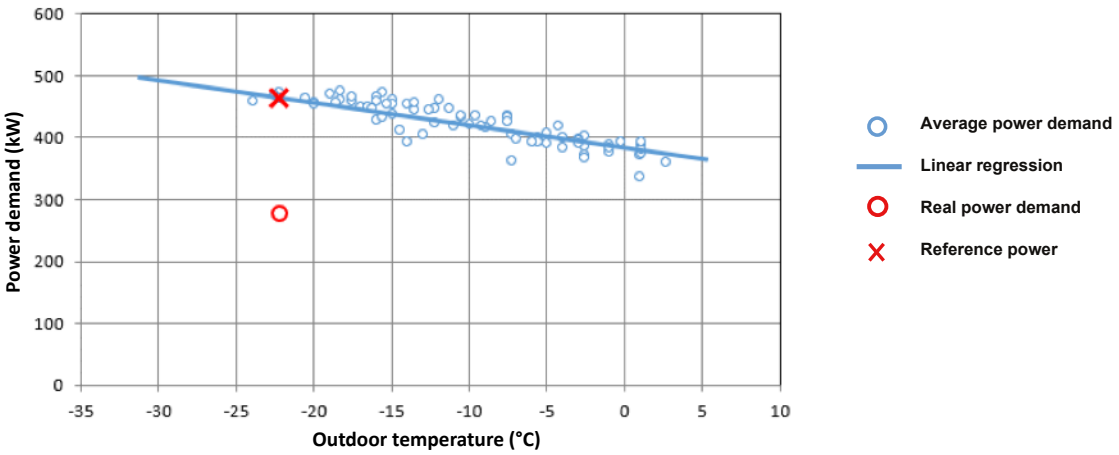

Figure 5: Reference power for a critical peak event

[6] A reference power is determined for each critical peak event.

2.3 Calculation of power reduction

The power reduction is obtained by subtracting real power demand from reference power for the event in question. The power reduction cannot be less than zero and is calculated for each critical peak event. In Figure 6, the power reduction is represented by the symbol ΔP.

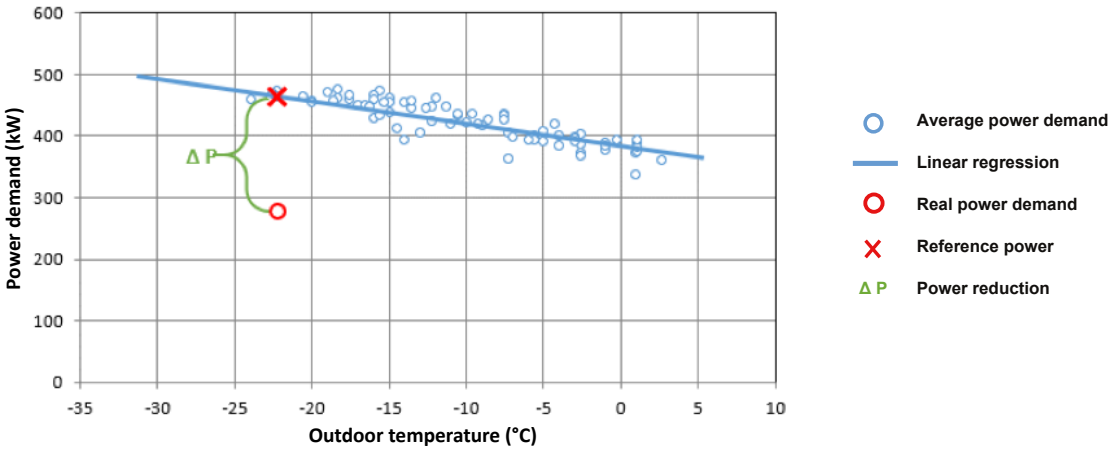

Figure 6: Power reduction for a critical peak event

2.4 Calculation of effective interruptible power

Effective interruptible power is obtained by averaging power reductions during critical peak events in the winter period. Failure to reduce power demand during one critical peak event does not result in a penalty under the DR option, but it will affect the effective interruptible power calculated for the entire winter period.

Table 1 presents an example of the calculation of effective interruptible power.

Note that some credits under certain provisions of the Addendum may not be applied even though the effective interruptible power is not zero. See Section 3 for more information.

Critical peak event		Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	**Period**			
January 5	06:00 to 09:00	464.1	311.1	153.0
January 5	16:00 to 20:00	371.3	292.2	79.1
January 19	06:00 to 09:00	449.6	334.8	114.8
February 12	06:00 to 09:00	455.6	324.7	130.9
February 15	06:00 to 09:00	463.3	340.6	122.7
			Effective interruptible power (kW):	**120.1**

Table 1: Calculation of effective interruptible power

3. Impact of certain articles of the Addendum on granting of credit

Under certain provisions of the Addendum, there may be no credit applied to the bill at the end of a given winter even though the effective interruptible power is not zero.

3.1 Termination of demand response option

Under Article 4.81 of the Addendum, this option ceases to apply the day after Hydro-Québec is notified to that effect by the customer, and no credit is granted. However, this provision does not apply to customers who terminate their contract during a winter period.

3.2 10-kW threshold

Article 4.80 of the Addendum states "*No credit is granted if the effective interruptible power is less than 10 kilowatts.*" In the example in Table 2, there is a power reduction for each critical peak event; however, the effective interruptible power is below the 10-kW threshold. On the customer's bill, the effective interruptible power will be shown and no credit will be issued.

Critical peak event		Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	**Period**			
December 15	06:00 to 09:00	44.2	36.8	7.4
January 14	06:00 to 09:00	44.3	40.1	4.2
January 14	16:00 to 20:00	38.2	25.3	12.9
January 25	06:00 to 09:00	43.8	37	6.8
January 25	16:00 to 20:00	38.1	28.5	9.6
January 26	06:00 to 09:00	45.2	33.0	12.2
February 3	06:00 to 09:00	43.1	34.2	8.9
February 4	06:00 to 09:00	43.2	33.2	10.0
February 15	06:00 to 09:00	44.8	32.4	12.4
February 15	16:00 to 20:00	38.5	30.3	8.2
February 23	06:00 to 09:00	44.0	31.1	12.9
February 24	06:00 to 09:00	43.7	33.5	10.2
			Effective interruptible power (kW):	**9.6**
			Credit:	**$0**

Table 2: Calculations for a contract where effective interruptible power does not meet the 10-kW threshold

If your effective interruptible power frequently remains below 10 kW, consider the winter credit option for small-power customers or a Flex rate.

3.3 No power reduction for more than four critical peak events

Under Article 4.80 of the Addendum, "*if no power demand reduction is noted during more than 4 critical peak events in a given winter period while the service contract is active, Hydro-Québec reserves the right not to grant any credit to the customer.*" The example in Table 3 shows that despite an effective interruptible power above the 10-kW threshold, no credit is applied because the number of events with no power reduction exceeds the limit of four.

Critical peak event		Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	**Period**			
December 15	06:00 to 09:00	788.2	801.1	0.0
January 14	06:00 to 09:00	811.3	499.1	312.2
January 14	16:00 to 20:00	401.2	402.2	0.0
January 25	06:00 to 09:00	812.8	815.0	0.0
January 25	16:00 to 20:00	658.1	661.2	0.0
January 26	06:00 to 09:00	809.2	499.0	310.2
February 3	06:00 to 09:00	813.1	814.2	0.0
February 4	06:00 to 09:00	808.2	496.5	311.7
February 15	06:00 to 09:00	810.8	814.2	0.0
February 15	16:00 to 20:00	646.5	652.7	0.0
February 23	06:00 to 09:00	811.0	814.4	0.0
February 24	06:00 to 09:00	810.7	811.1	0.0
			Effective interruptible power (kW):	**77.8**
			Credit:	**$0**

active contract

Table 3: Contract with no power reduction for more than four critical peak events

In the event a customer terminates their contract during the winter, that customer will of course not be able to contribute to critical peak events occurring while their contract is inactive. The power reduction for each of these events will be set to 0 kW and will be included in the calculation of effective interruptible power. However, these peak events will not be counted as "no reduction" events, and a credit will therefore be granted. For example, in Table 4, the customer's contract was terminated on February 10. Despite five events with no power reduction, this customer is entitled to a credit because only peak events occurring when the contract was active (one event in this case) are considered.

Critical peak event		Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	Period			
December 15	06:00 to 09:00	788.2	497.8	290.4
January 14	06:00 to 09:00	811.3	499.1	312.2
January 14	16:00 to 20:00	401.2	402.2	0.0
January 25	06:00 to 09:00	812.8	498.7	314.1
January 25	16:00 to 20:00	658.1	401.1	257.0
January 26	06:00 to 09:00	809.2	499.0	310.2
February 3	06:00 to 09:00	813.1	494.4	318.7
February 4	06:00 to 09:00	808.2	496.5	311.7
February 15	06:00 to 09:00	0.0	0.0	0.0
February 15	16:00 to 20:00	0.0	0.0	0.0
February 23	06:00 to 09:00	0.0	0.0	0.0
February 24	06:00 to 09:00	0.0	0.0	0.0
		Effective interruptible power (kW):		**176.1**
		Credit:		**$12,507.50**

active contract up to February 10

inactive contract

Table 4: Calculations for a contract terminated by the customer during the winter period

In Table 5, the customer also terminated the contract on February 10. The four events with no power reduction that occurred after the end of the contract are not considered; however, five such events occurred while the contract was active. As a result, no credit is given.

Critical peak event		Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	**Period**			
December 15	06:00 to 09:00	788.2	801.1	0.0
January 14	06:00 to 09:00	811.3	499.1	312.2
January 14	16:00 to 20:00	401.2	402.2	0.0
January 25	06:00 to 09:00	812.8	815.0	0.0
January 25	16:00 to 20:00	658.1	661.2	0.0
January 26	06:00 to 09:00	809.2	499.0	310.2
February 3	06:00 to 09:00	813.1	814.2	0.0
February 4	06:00 to 09:00	808.2	496.5	311.7
February 15	06:00 to 09:00	0.0	0.0	0.0
February 15	16:00 to 20:00	0.0	0.0	0.0
February 23	06:00 to 09:00	0.0	0.0	0.0
February 24	06:00 to 09:00	0.0	0.0	0.0
			Effective interruptible power (kW) :	**77.8**
			Credit :	**$0**

active contract up to February 10

inactive contract

Table 5: Calculations for a contract terminated by the customer during the winter period with no power reduction during more than four critical peak events while the contract was active

4. Examples of contracts with several reference curves

To "*better reflect the customer's normal consumption profile*,"[7] more than one reference curve may be established for the 06:00 to 09:00 or 16:00 to 20:00 period for certain contracts. In this way, we avoid over- or underestimating the power reduction so that customers can be remunerated fairly. Hydro-Québec has statistical indicators that enable it to identify such contracts.

Four sample contracts are presented below. They are differentiated by their sector of activity and by their hours of operation during the week and during the winter period. Despite these many differences, the same methodology was applied, namely the establishment of more than one reference power curve to "*... better reflect the customer's normal consumption profile*."[8]

[7] Excerpt from the definition of reference power in Article 4.74 of the Addendum to *Electricity Effective on April 1, 2023.*

[8] Idem.

4.1 Bank branch

A bank branch's business hours generally vary according to the day of the week and time of year. This customer has some business days ending at 16:00 and others ending at 20:00. The following reference curves were therefore established:

- Curves 1-AM and 1-PM: days the branch is open until 16:00
- Curves 2-AM and 2-PM: days the branch is open until 20:00

Note that the customer does not have to provide Hydro-Québec with its business hours. Our consumption analysis tools can identify days that have different hours.

The reference curve used for each of the critical peak events is shown in Table 6. Curve 1-PM was not used to identify a reference power since no critical peak events occurred between 16:00 and 20:00 on days when the branch was open until 16:00.

Critical peak event		Reference curve	Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	Period				
January 17	06:00 to 09:00	1-AM	58.8	16.6	42.2
January 20	06:00 to 09:00	2-AM	53.3	16.6	36.7
January 21	06:00 to 09:00	2-AM	54.4	18.8	35.6
February 14	06:00 to 09:00	2-AM	56.6	13.3	43.3
February 14	16:00 to 20:00	2-PM	53.3	30.0	23.3
				Effective interruptible power (kW) :	**36.2**

Table 6: Calculation of reference power for a bank branch

In this example, by using multiple reference power curves, we avoided underestimating the interruptible power, which would have been only 35.3 kW if just one curve had been used.

4.2 Plant

This plant begins operating on Monday morning and shuts down on Friday afternoon. The following reference curves were therefore established:

- Curves 1-AM and 1-PM apply Mondays only (startup day, which is different from the other days)
- Curves 2-AM and 2-PM apply Tuesdays, Wednesdays and Thursdays
- Curves 3-AM and 3-PM apply Fridays (shutdown day)

The reference curve used for each of the critical peak events is shown in Table 7. Curves 1-PM and 2-PM were not used to identify a reference power.

Critical peak event		Reference curve	Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	Period				
January 17	06:00 to 09:00	3-AM	801.1	0.0	801.1
January 20	06:00 to 09:00	1-AM	773.3	829.9	0.0
January 21	06:00 to 09:00	2-AM	748.8	789.9	0.0
February 14	06:00 to 09:00	3-AM	811.1	0.0	811.1
February 14	16:00 to 20:00	3-PM	575.5	576.6	0.0
				Effective interruptible power (kW) :	**322.4**

Table 7: Calculation of reference power for a plant

In this example, by using multiple reference power curves, we avoided overestimating the interruptible power, which would have been 340.7 kW if just one reference curve had been used.

4.3 Ski hill A (snowmaking)

This contract is for electricity to be used in snowmaking at a ski hill.[9] Snowmaking varies over the course of the season, and consumption on days without snowmaking is zero. The following reference curves were therefore established:

- Curves 1-AM and 1-PM apply on all snowmaking days
- Curves 2-AM and 2-PM apply on days with no consumption

The customer stopped production before the last two critical peak events but was still able to participate in the first three events. Table 8 indicates which reference curve was used for each of the critical peak events. Curve 1-PM was not used to identify a reference power.

Critical peak event		Reference curve	Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	Period				
January 17	06:00 to 09:00	1-AM	1,883.3	207.7	1,675.6
January 20	06:00 to 09:00	1-AM	1,873.3	215.5	1,657.8
January 21	06:00 to 09:00	1-AM	1,877.7	219.9	1,657.8
February 14	06:00 to 09:00	2-AM	0.0	0.0	0.0
February 14	16:00 to 20:00	2-PM	0.0	0.0	0.0
				Effective interruptible power (kW) :	**998.2**

Table 8: Calculation of reference power for snowmaking (ski hill A)

In this example, by using multiple reference power curves, we avoided overestimating the interruptible power, which would have been 1,522.4 kW if just one reference curve had been used.

[9] The service contract nevertheless remains active throughout the winter period.

4.4 Ski hill B (snowmaking)

This contract is also for electricity to be used in snowmaking at a ski hill.[10] The following reference curves were established:

- Curves 1-AM and 1-PM apply on all snowmaking days
- Curves 2-AM and 2-PM apply on days with no consumption

Unlike the ski hill in the previous example, this customer stopped production before the first critical peak event.

Table 9 indicates the reference curve used for each of the critical peak events. Reference curves 1-AM and 1-PM were not used to identify a reference power.

Critical peak event		Reference curve	Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	Period				
January 17	06:00 to 09:00	2-AM	0.0	0.0	0.0
January 20	06:00 to 09:00	2-AM	0.0	0.0	0.0
January 21	06:00 to 09:00	2-AM	0.0	0.0	0.0
February 14	06:00 to 09:00	2-AM	0.0	0.0	0.0
February 14	16:00 to 20:00	2-PM	0.0	0.0	0.0
				Effective interruptible power (kW) :	**0.0**

Table 9: Calculation of reference power for snowmaking (ski hill B)

In this example, by using two reference power curves, we avoided overestimating the interruptible power, which would have been 217.2 kW if just one reference curve had been used.

[10] The service contract nevertheless remains active throughout the winter period.

However, if the critical peak events had occurred prior to December 17, that is, before the winter snowmaking shutdown, reference curves 1-AM and 1-PM would have been used, as indicated in Table 10.

Critical peak event		Reference curve	Reference power (kW)	Real power demand (kW)	Power reduction (kW)
Date	Period				
December 9	06:00 to 09:00	1-AM	1,883.3	207.7	1,675.6
December 10	06:00 to 09:00	1-AM	1,873.3	215.5	1,657.8
December 13	06:00 to 09:00	1-AM	1,877.7	219.9	1,657.8
December 16	06:00 to 09:00	1-AM	1,880.0	212.2	1,667.8
December 16	16:00 to 20:00	1-PM	1,876.6	214.4	1,662.2
				Effective interruptible power (kW) :	**1,664.2**

Table 10: Calculation of reference power for snowmaking at ski hill B (hypothetical situation)

In this example, by using multiple reference power curves, we avoided underestimating the interruptible power, which would have been only 217.2 kW if just one curve had been used.

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