B. WHAT HAPPENED

B.1 Chronology of Electrical System Events

B.1.1 Prior to December 2013

On January 11th, 2013, an equipment problem at Holyrood caused the plant to disconnect from the Island Interconnected System.[2] This disturbance resulted in approximately 173,000 Newfoundland Power customers losing electrical service. Service was fully restored to customers by January 13th, 2013. As a result of this system event, the 170 MW generating unit #1 at Holyrood was damaged and unavailable for service for the remainder of the 2012-2013 winter season.[3]

The loss of generating unit #1 at Holyrood reduced available capacity on the Island Interconnected System for the remainder of the 2012-2013 winter season. However, available capacity was sufficient to serve load. The Board approved supplemental capital expenditures of $12.8 million on April 24th, 2013 for refurbishment and repairs to generating unit #1 at Holyrood.[4]

The outages experienced on January 11th, 2013 were longer than what they would otherwise have been due to a lack of blackstart capability at Holyrood.[5] The contingency plan Hydro implemented using the Hardwoods gas turbine to blackstart Holyrood proved to be inadequate in the circumstances experienced on January 11th, 2013. On November 29th, 2013, the Board approved supplemental capital expenditures of approximately $1.3 million for the installation of diesel units at Holyrood for the purpose of blackstart generating units and for the deferral of

[2] The equipment problem at Holyrood involved B1L17 breaker. This breaker would also contribute to a major system disruption on January 5th, 2014. See the response to Request for Information PUB-NLH-045.

[3] The 170 MW Holyrood generating unit #1 represents approximately 10% of Hydro's system generating capacity including purchases. See Attachment A to Hydro's response to Request for Information PUB-NLH-001.

[4] See Order No. P.U. 14 (2013).

[5] *Blackstart* refers to starting a generator without power supply from the electrical system. Blackstart capability at Holyrood was also considered by the Board following a system event in December 1994 after which customer outages were significantly extended due to the lack of blackstart capability. Following the January 2013 system event it was revealed that the blackstart capability installed at Holyrood was no longer operational.

associated lease costs estimated by Hydro to total $5.8 million.[6]

In addition to capital expenditures for refurbishment and repairs to Holyrood generating unit #1 and Holyrood blackstart capability, the Board approved over $12 million in other 2013 capital expenditures for Holyrood.[7]

In January 2013, it was also determined that the Hardwoods gas turbine should only be used in emergency conditions as parts may be near failure.[8] The concerns were identified based upon findings related to the rewind of the stator and rotor in the similar gas turbine plant located in Stephenville.[9] On May 16th, 2013, the Board approved supplemental capital expenditures of approximately $8.0 million to replace the alternator on the Hardwoods gas turbine.[10]

On May 1st, 2013, Newfoundland Power and Hydro held their first of 2 Inter-Utility System Planning and Reliability Committee (the "Committee") meetings of 2013.[11] During the meeting, Hydro indicated that repair work on the Holyrood generating unit #1 was progressing and that the unit was expected to be back in service in July 2013. Hydro also indicated that the Stephenville gas turbine, which was undergoing a planned alternator replacement, was expected to be back in service by the end of May 2013.

In June 2013, while the Stephenville gas turbine was undergoing a planned alternator refurbishment, it was determined that there was deterioration of the insulation blankets on End B

6 See Order No. P.U. 38 (2013). In its November 22nd, 2013 application, Hydro proposed the installation of infrastructure to enable eight 1.825 MW diesel generation units to be leased during the winter months of 2014 up to the time of installation of a new 60 MW combustion turbine. Hydro's proposed capital expenditure was approved with recovery of costs to be determined by the Board in a future order.

7 On February 26th, 2013, the Board approved, in Order No. P.U. 4 (2013), Hydro's 2013 Capital Budget Application, which included capital expenditures of approximately $7 million related to Holyrood. On April 11th, 2013, the Board approved, in Order No. P.U. 12 (2013), supplemental capital expenditures of approximately $5.2 million for the refurbishment of the Marine Terminal at Holyrood.

8 See Hydro's April 24th, 2013 application for approval of a capital project to replace the alternator on the Hardwoods gas turbine.

9 On August 16th, 2012, the Board approved, in Order No. P.U. 25 (2012), a supplemental capital expenditure of approximately $5.2 million to complete a full stator and rotor rewind of the Stephenville gas turbine alternator due to a stator winding fault in December 2011.

10 See Order No. P.U. 20 (2013) Amended.

11 The Committee includes senior operations and engineering management from Newfoundland Power and Hydro. It meets twice a year to consider matters related to system reliability, including reliability targets, system contingency and restoration planning, generation availability and peak load management preparedness.

of the unit. This caused a 20 MW de-rating from the gas turbine's rated output of 50 MW. Hydro initiated steps to obtain replacement insulating blankets in July 2013.[12]

On November 1st, 2013, Newfoundland Power and Hydro held their second Committee meeting of 2013. The availability of generation to meet peak demand on the Island Interconnected System for the 2013-2014 winter season was considered. During the meeting, Hydro indicated that Holyrood generating unit #1 was operational. Hydro also indicated that the Hardwoods gas turbine was on a planned outage to replace the generator and was expected to return to service in mid-December, and that the Stephenville gas turbine would be fully capable by the end of November. The information available at that time indicated that sufficient system generation capacity would be available to meet the peak demand for the upcoming winter as of December 15th, 2013.

Newfoundland Power forecast a peak for the 2013-2014 winter season on its electrical system of 1348 MW.[13]

B.1.2 December 1st, 2013 to January 1st, 2014

Hydro established a seasonal peak of 1501 MW on its electrical system on December 14th, 2013. At the time of peak, Hydro had reductions in available generating capacity with the Hardwoods and Stephenville gas turbines.[14] There were no customer outages as a result of this peak.

Between December 15th and December 25th, 2013, Hydro experienced further generation capacity limitations on the Island Interconnected System. On December 15th, 2013, Exploits generation capacity was reduced by 50 MW and on December 16th, 2013, Granite Canal generating station was reduced by 8 MW. On December 25th, 2013, generating unit #2 at

[12] See Hydro's response to Request for Information PUB-NLH-072.

[13] Newfoundland Power's electrical system accounts for approximately 85% of demand on the Island Interconnected System. See the responses to Requests for Information PUB-NP-002 and PUB-NP-006.

[14] See Hydro's January 8th, 2014 presentation to the Public Utilities Board, *Island Interconnected System Supply Disruptions – January 2 to 6, 2014*. On December 14th, 2013, Hardwoods gas turbine was unavailable for this period and Stephenville gas turbine was reduced to 25 MW.

Holyrood was reduced by 25 MW. These generating capacity reductions impacted Hydro's ability to sustain its contingency reserve criteria during the forecast high demand periods.[15]

On the morning of December 26th, 2013, Hydro made Newfoundland Power aware that the power output of the 150 MW generating unit #3 at Holyrood was de-rated by 100 MW due to failure of a forced draft fan motor.[16] At the same time, Newfoundland Power was informed that the generating capacity limitations on Stephenville and Hardwoods gas turbines were not resolved.

On the evenings of December 29th and 30th, 2013, Hydro requested Newfoundland Power to run its thermal generating units, exercise customer load curtailment, and carry out system voltage reduction to reduce peak loading on the electrical system in response to low system generation reserve margins.[17]

On December 31st, 2013, Newfoundland Power was informed of the load reduction arrangements Hydro had made with Corner Brook Pulp and Paper to provide additional system generating capacity. This load reduction arrangement was first put to use on January 1st, 2014.[18]

Due to its capacity limitations during this period, Hydro determined that there could be difficulty in supplying the required customer demand based on the cold weather forecast and short-term daily customer load forecasts.[19]

[15] See Hydro's response to Request for Information PUB-NLH-002. Contingency reserve criteria refers to the amount of additional generation available to meet demand in the event of equipment damage or capacity reductions.

[16] This was communicated to Newfoundland Power's System Control Centre ("SCC") by Hydro's Energy Control Centre ("ECC") personnel. The following day, Hydro's Vice-President informed Newfoundland Power's Vice-President of Customer Operations and Engineering that the problem with generating unit #3 could take several weeks to correct.

[17] These are routine steps when forecast limitations on the availability of generation to serve customer demand exist. See the response to Request for Information PUB-NP-002.

[18] These load reduction arrangements consisted of capacity assistance from Corner Brook Pulp and Paper of 40 MW during the January 1st, 2014 system peak. See Hydro's response to Request for Information PUB-NLH-002.

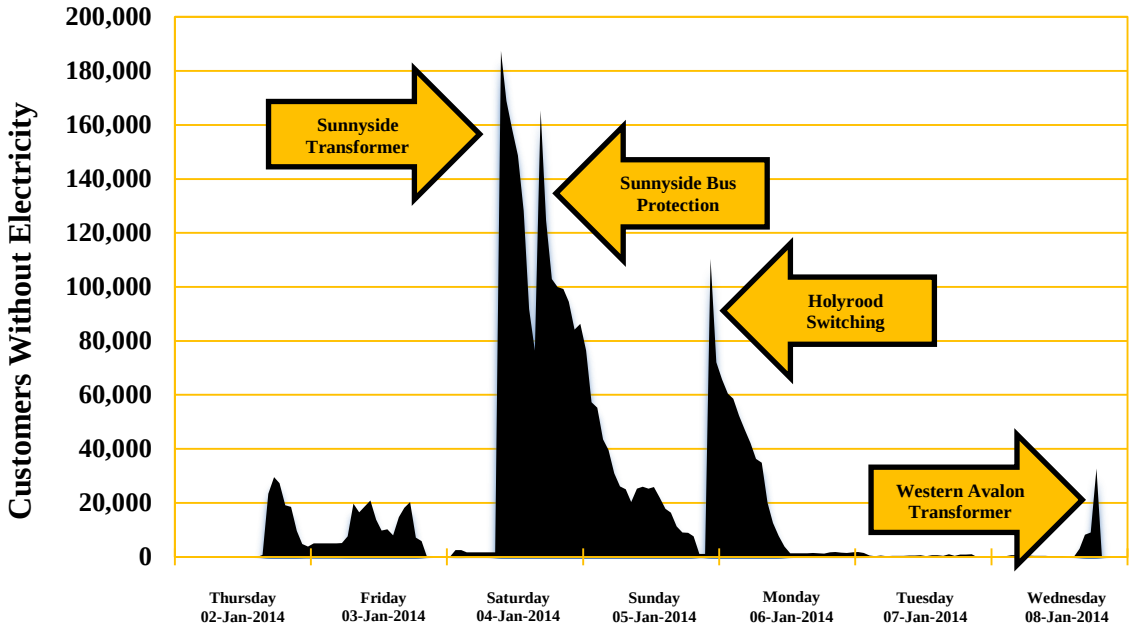
[19] See Hydro's response to Request for Information PUB-NLH-002 and Attachment 1 of Hydro's response to Request for Information PUB-NLH-034.

B.1.3 January 2-8, 2014

The period of January 2-8, 2014 included continuing generation supply shortages and successive major electrical system disruptions. The generation supply shortages resulted in rotating power outages which caused as many as 33,529 Newfoundland Power customers to be without electricity at one time. The impact of the major electrical system disruptions was more dramatic for Newfoundland Power's customers. They resulted in as many as 187,501 Newfoundland Power customers being without electricity at one time.

Figure 1 shows Newfoundland Power customer outages and major system disruptions for the January 2-8, 2014 period.

Figure 1
Customer Outages & Major System Disruptions
January 2-8, 2014



On the morning of January 2nd, 2014, it was evident that there was an increased likelihood that there would be insufficient generation available to meet the forecast evening peak on the Island Interconnected System. At approximately 2:00 pm on January 2nd, 2014, a public advisory was

made by Hydro to request customers served by the Island Interconnected System to take steps to conserve electricity where possible.[20]

Hydro requested Newfoundland Power to commence rotating power outages shortly after 4:00 pm on January 2nd, 2014. The loss of Hydro's Granite Canal generating station shortly after the planned rotating outages commenced complicated the exercise. Rotating power outages were carried out throughout the day on January 3rd and 5th, 2014, and throughout the morning and afternoon of January 6th and 8th, 2014, respectively.[21]

At the time rotating power outages were commenced on January 2nd, 2014, the demand on Newfoundland Power's electrical system was 1378 MW. This demand was 2.2% higher than Newfoundland Power's forecast of 1348 MW for the 2013-2014 winter season.[22]

Overnight on January 3-4, 2014, a blizzard hit the island portion of the province and affected operations on the Island Interconnected System. To prepare for this severe weather event, Newfoundland Power deployed line crews from the western portion of the island to the Avalon Peninsula.[23] While the response to this severe weather event overlapped with the rotating power outages caused by generation shortfall on the system and the subsequent major system disruptions, actual damage to Newfoundland Power's electrical system was relatively modest.

In total, the blizzard resulted in 2 broken poles, 5 damaged insulators, 1 broken guy wire and 11 incidents of conductor damage on Newfoundland Power's primary distribution system. There were 464 incidents of damage at the secondary distribution system and service level.[24] The

[20] Hydro took the lead on the issuing of public advisories related to the status of the Island Interconnected System throughout the January 2-8, 2014 period.

[21] For details on Newfoundland Power's preparations for rotating power outages please refer to **B.2: Rotating Power Outages**, page 16.

[22] See the response to Request for Information PUB-NP-006.

[23] On January 2nd, 2014, Newfoundland Power line crews travelled from Port-aux-Basques, Stephenville, Corner Brook and Gander to the Avalon Peninsula.

[24] The secondary distribution and service level of Newfoundland Power's electrical system is the portion of the system between distribution transformers and customers' service connections.

capital cost to reinstate the damage on Newfoundland Power's electrical system caused by the blizzard was approximately $100,000.[25]

The impact of this damage accounted for approximately 5.7% of the outage time experienced by Newfoundland Power's customers over the January 2-8, 2014 period. The timing of the blizzard complicated some of the Company's response efforts to the ongoing supply issues of the Island Interconnected System.[26]

Beginning on the morning of January 4th, 2014, a series of major system disruptions occurred on the Island Interconnected System. At approximately 9:00 am, a transformer caught fire at Hydro's Sunnyside Terminal Station. This triggered a near collapse of the Island Interconnected System and caused an outage to approximately 188,000 Newfoundland Power customers. Newfoundland Power began restoring power to customers once Hydro began to re-establish the Island Interconnected System.[27] Prior to Newfoundland Power restoring service to all customers, at approximately 3:30 pm on January 4th, 2014, a second major system disruption occurred at Hydro's Sunnyside Terminal Station. This second disruption resulted in approximately 165,000 Newfoundland Power customers being without service. Following this disruption, Newfoundland Power again began restoring power to customers as Hydro again began to re-establish the Island Interconnected System. Newfoundland Power had substantially restored service to its customers by approximately 8:30 pm on January 5th, 2014.

[25] By comparison, damage caused by a severe winter storm in central parts of the Company's service territory on November 20-21, 2013 required approximately $500,000 in capital expenditures to repair. (See *November 2013 Winter Storm Central Newfoundland*, March 2014 filed March 21st, 2014).

[26] These complications had varying impacts on system operations and customer service. For example, Newfoundland Power's 20 MW Greenhill Gas Turbine was shut down because of lack of fuel for 39.5 hours on January 3-5, 2014 because blizzard conditions closed highway access to the facility for fuel delivery. On the other hand, staffing of Customer Contact Centre operations was unaffected by the blizzard as the Company was able to arrange safe transportation for its employees where necessary.

[27] The January 4th, 2014 Sunnyside Terminal transformer fire resulted in the loss of all 3 Holyrood generating units. Generating units #2 and #3 were brought back online by 1:40 am on January 5th, 2014. Generating unit #1 was brought back online on January 8th, 2014. See Hydro's January 8th, 2014 Presentation to the Public Utilities Board, *Island Interconnected System Supply Disruptions – January 2-6, 2014*.

At approximately 9:30 pm on January 5th, 2014, an electrical fault at Holyrood resulted in loss of supply to over 100,000 Newfoundland Power customers.[28] Power was substantially restored to customers by noon on January 6th, 2014.

A fourth major system disruption occurred at approximately 5:45 pm on January 8th, 2014. At that time, Hydro experienced an overload condition which caused a trip on a transformer at its Western Avalon Terminal Station. This resulted in the loss of supply to approximately 29,000 Newfoundland Power customers in the Trinity-Conception area. In order to restore service, Newfoundland Power reconfigured its transmission system to minimize transformer load at Hydro's Western Avalon Terminal Station.[29] This had the effect of restoring service to customers within approximately ½ hour.

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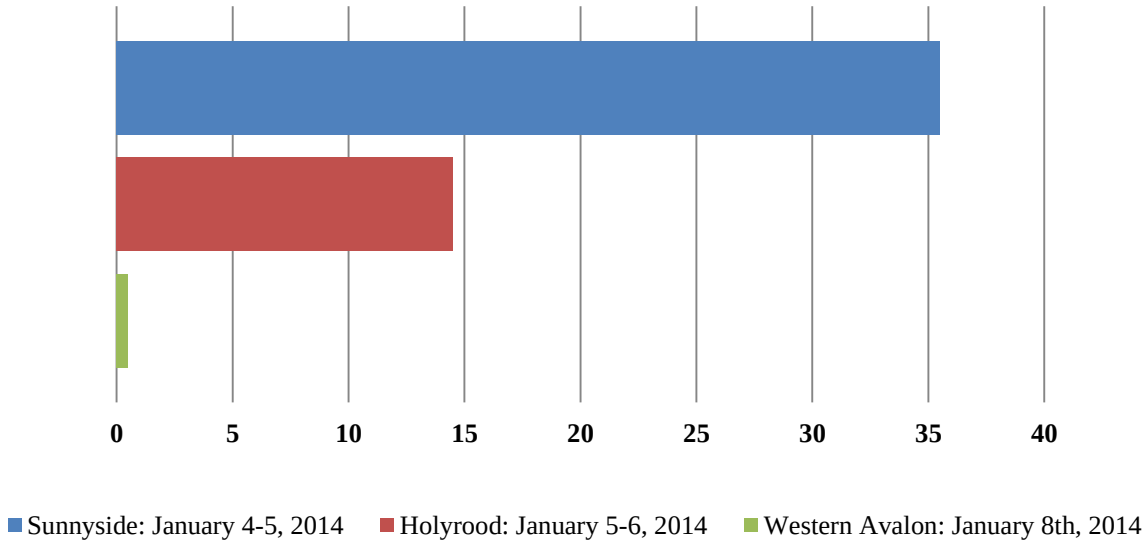
[28] The January 5th, 2014 Holyrood electrical fault resulted in the loss of generating units #2 and #3 (generating unit #1 had not been brought online following the January 4th, 2014 Sunnyside Terminal Station transformer fire). Generating units #2 and #3 were brought back online by 7:17 am on January 6th, 2014. See Hydro's January 8th, 2014 Presentation to the Public Utilities Board, *Island Interconnected System Supply Disruptions – January 2-6, 2014*.

[29] Newfoundland Power's 138 kV transmission line (64L) tripped as the result of the operation of Hydro's transformer overload protection. This caused an immediate overload trip on a second Newfoundland Power 66kV transmission line (86L). See the response to Request for Information PUB-NP-052.

Chart 1 shows the comparative recovery times for the major disruptions on the Island Interconnected System in the January 4-8, 2014 period.[30]

Chart 1
Major System Disruptions
Recovery Time
January 4-8, 2014
(Hours)



It took 35.5 hours to reinstate service to the approximately 188,000 affected customers following the Sunnyside Terminal transformer incident which occurred on January 4th, 2014. It took 14.5 hours to reinstate service to the approximately 100,000 affected customers following the Holyrood electrical fault which occurred on January 5th, 2014. It took approximately ½ hour to fully reinstate service to the approximately 29,000 affected customers following the Western Avalon transformer overload.

The primary contributor to the relatively longer recovery times associated with the Sunnyside and Holyrood incidents was the length of time before Holyrood generation was available.[31]

[30] Recovery time from a major system event is the number of hours from (i) the point when service to Newfoundland Power's customers was interrupted by the major system disruption to (ii) the point when service interrupted by the event was restored.

[31] See footnotes 27 and 28.

Recovery from the Western Avalon incident was quicker because Holyrood generation was unaffected by the incident itself.

Newfoundland Power improved its efficiency in system recovery for major system events from January 2013 to January 2014.[32] Over the past few years, Newfoundland Power has deployed mobile computing in all of its line trucks, implemented a computerized operations dispatch system, and expanded its use of geographic information systems for its vehicles and electrical system assets. This has improved the overall efficiency of the Company's field operations, including its response capabilities to system distress.[33]

When the system disruptions occurred during the January 4-8, 2014 period, Newfoundland Power implemented its normal electrical system restoration procedures, which included communication and coordination with Hydro as generation was re-established and available for distribution.

B.1.4 Post January 8th, 2014

Newfoundland Power did not implement any further rotating power outages beyond January 8th, 2014. However, supply limitations on the Island Interconnected System did present themselves after the January 2-8, 2014 period.[34]

At approximately 11:00 pm on February 17th, 2014, a 230 kV Hydro transmission line tripped due to faulted insulators outside its Western Avalon Terminal Station. This line is one of the two 230 kV transmission lines that transmit power from Central Newfoundland to the Avalon Peninsula.[35] The loss of either line reduces the transmission capacity and increases the risk of a

[32] In the 4 days following the January 11th, 2013 system event resulting from equipment problems at Hydro's Holyrood plant, Newfoundland Power made 798 specific line crew responses to customer outages. In the 4 days following the January 5th, 2014 Holyrood switching event, Newfoundland Power made 862 specific line crew responses to customer outages. In 2013, approximately 40% of the responses were completed in the first 2 days. In 2014, approximately 75% of the responses were completed in the first 2 days.

[33] In 2013, the Company dispatched approximately 60% of all line crew responses to customer outages through computerized dispatch. To March 13th, 2014, approximately 93% of all line crew responses to customer outages were dispatched by computer.

[34] See Attachment 1 to Hydro's response to Request for Information PUB-NLH-034.

[35] TL237 connects the Come by Chance Terminal Station and the Western Avalon Terminal Station. TL203 connects the Sunnyside Terminal Station and the Western Avalon Terminal Station.

supply shortfall on the Avalon Peninsula. When Newfoundland Power became aware of the transmission line outage on the morning of February 18th, 2014, it considered issuing a public advisory to inform customers of the supply vulnerability for the Avalon Peninsula. Hydro made the necessary repairs by approximately 1 pm on February18th, 2014, so no public advisory was issued.

Hydro's daily system status report dated March 2nd, 2014, indicated that Hydro's forecast daily demand was 1500 MW for March 4th through March 6th, while Hydro's current available system supply was 1575 MW.[36] The report also indicated supply limitations at Hydro's Holyrood, Bay d'Espoir, Stephenville and Hardwoods generating facilities.[37] Newfoundland Power issued a public advisory on March 3rd, 2014 to inform customers of the possibility of supply shortages and to request that customers conserve during peak times starting on Tuesday, March 4th and ending on Thursday, March 6th, 2014. At the same time, Newfoundland Power informed its Curtailable Service Option ("CSO") customers of the likelihood that they would be called upon to curtail.[38]

B.2 Rotating Power Outages

B.2.1 General

When Hydro foresees a shortage of available generation on the Island Interconnected System it invokes its 14 step system operating instruction T-001 *Generation Load Sequence And Generation Shortages*.[39] Step 14 in this operating instruction is the request to Newfoundland

[36] On January 10th, 2014, the Board requested Hydro file, by 9:00 am each morning, a report on the status of the Island Interconnected System providing, at a minimum, (i) the previous day peak demand; (ii) the previous day's total available generation from Hydro's sources only; (iii) the previous day's total available generation from all sources and (iv) the forecast peak for the current day. In addition, Hydro was required to report any change in the status of generation capacity serving the Island Interconnected System, including the return to service or increase in rating of any generating unit, the loss of any generating unit from any source for any reason, and any reduction in generation capacity of any unit equivalent to 25% or greater of the unit's capacity.

[37] These limitations included Holyrood generating unit #1 being de-rated from 170 MW to 140 MW; Bay d'Espoir generating unit #6 (75 MW) being unavailable for service; Stephenville gas turbine being de-rated from 50 MW to 38 MW and Hardwoods gas turbine being de-rated from 50 MW to 25 MW.

[38] Newfoundland Power also completed reviews of potential feeder rotation and its critical customer list in preparation for the possibility of rotating power outages at this time. Additional technical and communications staff were stationed at the Company's SCC during peak periods in the event rotating power outages became necessary.

[39] A copy of this system operating instruction is Attachment 1 to Hydro's response to Request for Information PUB-NLH-033.

Power to shed its customer load by rotating distribution feeders. The rotating power outages which were commenced by Newfoundland Power on January 2nd, 2014, were in response to a Hydro request made under this operating instruction.[40]

Newfoundland Power serves approximately 255,000 customers via 306 distribution feeders. A distribution feeder is an electrical circuit which originates in a substation, and along its route connects customer premises to the electrical system. Distribution feeders vary in length, voltage and number of customers served. Some distribution feeders are only a few hundred metres in length while others are over 100 kilometres in length. Some feeders serve only a handful of customers while others serve thousands.

By operation of substation switching equipment, Newfoundland Power's distribution feeders can be disconnected from and reconnected to the electrical system.[41] Rotating power outages are the systematic disconnection and reconnection of distribution feeders, and the customers served by them, to maintain the overall balance of electricity supply and demand where there is a generation shortage. Rotating power outages are sometimes referred to as *rolling blackouts*.

When the possibility of a system wide generation shortfall on the Island Interconnected System became evident on January 2nd, 2014, Newfoundland Power prepared for possible rotating power outages. This included the review of distribution feeders eligible for rotation and the deployment of field staff.

Newfoundland Power commenced rotating power outages at 4:13 pm on January 2nd, 2014. In total, the Company undertook rotating power outages in 5 of the 7 days from January 2-8, 2014. On January 2nd, 2014, the average duration of rotating power outages was 88 minutes. From January 3-8, 2014, the average duration was less than 1 hour.

[40] This request was the first such request made due to an expected system wide generation shortfall on the Island Interconnected System.

[41] For Newfoundland Power, approximately 60% of its distribution feeders can be remotely operated from the Company's SCC located at Mount Pearl. The remaining distribution feeders can only be disconnected from or reconnected to the electrical system by manual intervention at the substation.

Most of the rotating power outages affected Newfoundland Power customers on the Avalon, Bonavista and Burin Peninsulas.[42] This is largely a reflection of the current configuration of the Island Interconnected System. Electrical system demand on the Island Interconnected System is concentrated on the eastern portion of the system. Generation resources, on the other hand, are concentrated on the central and western portion of the system. These features of the Island Interconnected System can present restrictions when there are insufficient generation resources available on the eastern portion of the system.[43]

The maximum number of Newfoundland Power customers which were disconnected at one time as a result of rotating power outages during January 2-8, 2014 was 33,529. This occurred during the evening of January 2nd, 2014 and represents just over 13% of Newfoundland Power's total number of customers. By comparison, the maximum number of Newfoundland Power customers who were without service during the January 2-8, 2014 period was 187,501, or just over 73%. These customers were without service as a result of the major system disruption originating at Hydro's Sunnyside Terminal Station on January 4th, 2014.

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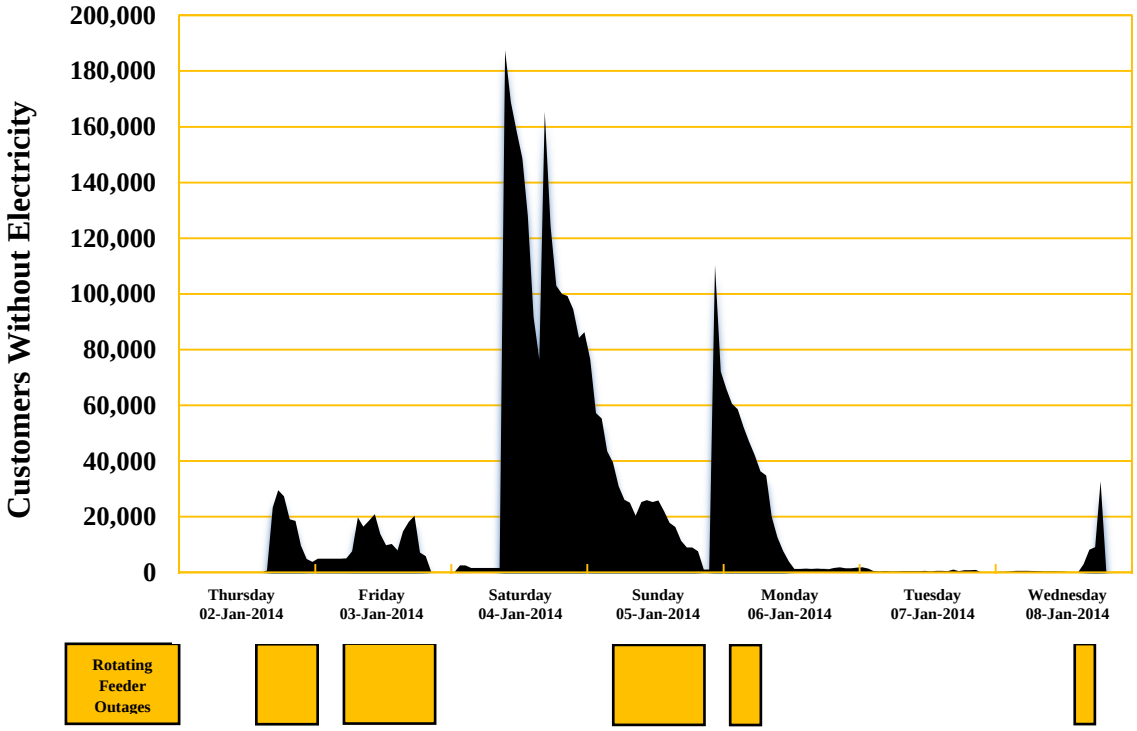
[42] 382 of the 447, or 85%, Newfoundland Power rotating power outages during the January 2-8, 2014 period occurred on the Avalon, Bonavista and Burin Peninsulas.

[43] One such restriction arises when voltage drop occurs as electricity is transmitted over long distances. This restriction is particularly prominent on the Island Interconnected System when generation at Holyrood is not available. The loss of Holyrood generation tends to restrict the capacity of Hydro's 230 kV transmission systems which transmit electricity from the central to the eastern portion of the Island Interconnected System. Such transmission capacity restrictions were encountered during January 11-13, 2013 and January 2-8, 2014.

B.2.2 The Rotating Power Outages: January 2-8, 2014

Figure 2 shows the times in the period January 2-8, 2014 during which Newfoundland Power rotated power supply to its customers.

Figure 2
Customer Outages & Rotating Power Outages
January 2-8, 2014



Newfoundland Power compiled a list of distribution feeders to be considered for feeder rotation based on experience in the January 2013 loss of supply event.[44] This list includes information for each distribution feeder such as peak load, critical customers served, and whether the feeder has remote control capability.[45]

[44] On January 11-12, 2013, Hydro's Holyrood Thermal Generating Station was unavailable for 21 hours. As part of the system recovery from this event, Newfoundland Power implemented limited rotating power outages to its customers. The January 2013 rotating power outages were undertaken in recovery from a major system event as opposed to the rotating power outages during January 2-8, 2014 which were undertaken to respond to a forecast shortage of generation resources on the Island Interconnected System.

[45] Distribution feeders with remote control capability can be turned on and off from the Company's SCC without needing to have personnel on site at the substation. Remote control of feeders also includes the ability to remotely adjust safety protection settings, as may be required when cold load pick-up or other abnormal conditions are anticipated.

Prior to implementing rotating power outages, the distribution feeder list was reviewed for accuracy and was prioritized to minimize impact of feeder rotation to critical customers. Critical customers included, but were not limited to, hospitals, fire and police stations, seniors' homes, and water pumping stations.

In total, 247 of Newfoundland Power's 306 distribution feeders were considered eligible for rotating power outages. Not all of the eligible feeders were necessarily included in the rotation of power outages for technical or operational reasons. For example, particularly large feeders with higher loads were more difficult to rotate due to a combination of their relative size and the effect of cold load pickup.[46] The Company tried to ensure that distribution feeders were not disconnected multiple times.

The list of distribution feeders considered for rotation was adjusted based on operating experience and consultation with customers and other stakeholders. For example, following the system disruption associated with the Sunnyside transformer fire on January 4th, 2014 and after communication with municipalities, the Company modified the feeder rotation list to exclude feeders serving community warming centres and fuel supply depots.[47]

Newfoundland Power tried to limit rotating power outages to one hour during the period January 2-8, 2014. A one-hour target was thought to be a reasonable compromise of customer inconvenience and the technical complications associated with rotating power outages, including cold load pickup.

During the first day of rotating power outages on January 2nd, 2014 Newfoundland Power and Hydro discussed each feeder rotation immediately prior to implementation. Following a review

[46] See footnote 54 for information on cold load pickup. Other technical reasons for excluding distribution feeders from rotating outages would include the location of available generation and customer demand (see page 18, lines 1 to 7). For these reasons, more rotating outages were required on the Avalon Peninsula than were required in, say, Western Newfoundland. Operational reasons would include resource limitations. For example, Newfoundland Power might choose not to rotate an outage to a small rural distribution feeder without remote control capability where the rotation would require a dispatch of technical or line resources for a relatively small system impact.

[47] A total of 59 of Newfoundland Power's 306 distribution feeders were designated critical feeders for the purposes of the events from January 2-8, 2014.

on January 3rd, 2014, it was determined by Newfoundland Power that the discussion of which feeders were to be rotated between control centres was extending the length of customer outages. As a result of this review, it was agreed that, beginning on January 3rd, 2014, Newfoundland Power would monitor system frequency and voltage, and carry out the rotating power outages within agreed maximum load change thresholds.[48] Coordination with Hydro was to be limited to determining when to start and when to cease rotating power outages.

Table 1 shows the date, time, and number of distribution feeder rotations completed together with the average duration of customer outage from January 2-8, 2014.[49]

Table 1
Rotating Outages
Feeder Rotations and Duration
January 2-8, 2014

Date	Time	Feeder Rotations	Average Duration (minutes)
January 2, 2014	4:13 pm to 10:46 pm	77	88
January 3, 2014	6:57 am to 7:36 pm	141	44
January 5, 2014	7:23 am to 8:29 pm	158	54
January 6, 2014	5:17 am to 10:48 am	39	47
January 8, 2014	3:23 pm to 5:42 pm	32	25

On January 2nd, 2014, the average duration of rotating power outages was 88 minutes, which was materially in excess of the Company's one hour target. From January 3rd, 2014, Newfoundland Power was able to achieve an average duration of rotating power outages of less than one hour.[50] The improvement in effectiveness of Newfoundland Power's efforts reflected a combination of better management of the process and experience.[51]

[48] System frequency and voltage levels at Hydro's supply points to Newfoundland Power are indications of the matching of system load to available generation.

[49] Table 1 does not include the outages which occurred as a result of the various system events described in footnote 27.

[50] On January 2nd, 2014, 14 of 77, or just over 18%, of rotating power outages lasted for 2 hours or more. From January 3-8, 2014, 6 of 370, or just under 2%, of rotating power outages lasted for 2 hours or more.

[51] A primary component of improved management of the process was the result of a review of the coordination process between Newfoundland Power and Hydro on January 3rd, 2014 which is described in more detail in the response to Request for Information PUB-NP-020.

Table 2 shows the number of Newfoundland Power customers which were affected by rotating power outages from January 2-8, 2014.

Table 2
Rotating Outages
Number of Customers Affected
January 2-8, 2014

Date	Time	Average	Maximum	Total
January 2, 2014	4:13 pm to 10:46 pm	17,777	33,529	73,925
January 3, 2014	6:57 am to 7:36 pm	8,150	17,254	90,587
January 5, 2014	7:23 am to 8:29 pm	11,203	21,889	93,744
January 6, 2014	5:17 am to 10:48 am	4,760	14,222	36,136
January 8, 2014	3:23 pm to 5:42 pm	6,292	11,047	32,931

On January 2nd, 2014, the maximum number of Newfoundland Power customers which were disconnected from the system at any point in time was 33,529, or just over 13% of Newfoundland Power's total number of customers.[52] On January 8th, 2014, the maximum number of Newfoundland Power's customers which were disconnected from the system at any point in time due to rotating outages was 11,047, or just over 4% of Newfoundland Power's total number of customers.[53]

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[52] 33,529/255,618 = 0.1312, or 13.1%.
[53] 11,047/255,618 = 0.0432, or 4.3%.

Table 3 shows the number of times that individual Newfoundland Power customers were exposed to rotating power outages from January 2-8, 2014.

Table 3
Rotating Outages
Number of Times Customers Affected
January 2-8, 2014

		Times Affected		
Date	**Time**	**1**	**2**	**3**
January 2, 2014	4:13 pm to 10:46 pm	73,925	4,564	-
January 3, 2014	6:57 am to 7:36 pm	90,587	44,219	6,953
January 5, 2014	7:23 am to 8:29 pm	93,744	57,944	4,919
January 6, 2014	5:17 am to 10:48 am	36,136	-	-
January 8, 2014	3:23 pm to 5:42 pm	32,931	-	-

On January 2nd, 3rd and 5th, some Newfoundland Power customers had their electrical service disconnected and reconnected more than once as part of the Company's rotating power outages. One of the primary reasons for this was the length of time over which rotating power outages were required to maintain the balance of the supply and demand on the Island Interconnected System. On each of these 3 days rotating power outages were required from periods of 6 ½ hours to 13 hours. In addition, most of the rotating power outages were required to be undertaken on the Avalon Peninsula which has 160 distribution feeders. So the pool of the available distribution feeders for rotating power outages was limited. Increases in the number of critical feeders due to requirements such as service to warming centres further reduced the pool of distribution feeders available on January 5th, 2014.

B.2.3 Field Operations

When it became evident that there could be rotating power outages as a result of a supply shortage on January 2nd, 2014, Newfoundland Power made preparations and deployed its operations staff accordingly. These preparations included:

(i) deploying field operations staff to a number of the Company's substations to ensure that un-automated distribution feeders could be manually disconnected and reconnected if necessary;

(ii) positioning generation maintenance personnel at thermal and hydro plants to ensure their reliable operation;

(iii) readying electrical maintenance personnel to respond to any equipment damage; and

(iv) preparing line crews and technologists for localized trouble on transmission and distribution lines and *cold load pickup* issues.[54]

One of the challenges in matching supply and demand in a power rotation process is that larger amounts of load must be disconnected to enable the reconnection of previously disconnected distribution feeders. For Newfoundland Power, demand at reconnection could be as high as twice that at disconnection.[55] To enable the reconnection of a distribution feeder which was disconnected with 10 MW of customer load could require the disconnection of distribution feeders with as much as 20 MW of customer load. This type of situation presented itself repeatedly during the January 2-8, 2014 period.

Another technical challenge in a power rotation process is the risk of overloading electrical equipment and conductors. Relays which serve to protect substation equipment will operate to protect that equipment in circumstances of increased demand.[56]

[54] 26 line crews were in the field on January 2nd, 2014 when rotating power outages commenced. *Cold load pickup* is simply the additional electrical demand which presents itself when a disconnected feeder is reconnected. The electrical demand which can be expected upon reconnection will be higher than that which existed at disconnection. This is the result of a lack of diversity of demand at the time of reconnection. Prior to disconnection, a distribution feeder normally has a degree of diversity (randomness of electrical devices on at any given time). When that distribution feeder is disconnected and later reconnected, or "picked up", this diversity is lost (all electrical devices are on at the moment of reconnection). This serves to increase the demand on the feeder at the moment of reconnection from what it was at the moment of disconnection.

[55] This is consistent with broader electrical engineering observations (see, for example, *Stepwise Restoration of Power Distribution Network under Cold Load Pickup*, Kumar, Gupta and Gupta, IEEE, where it is estimated that post-outage demand is up to 2 to 5 times diversified load.)

[56] Electrical system relays are typically set to operate under normal electrical system operating conditions. Readjusting settings on relays which protect electrical equipment in circumstances of electrical system distress requires application of engineering judgment. For example, overload conditions on a substation transformer may be acceptable in certain circumstances depending on the duration of the overload condition, the impact of the overload on the transformer, and ambient temperatures.

Field engineering options are available to address potential overload conditions on distribution feeders. Firstly, feeder restoration can be accomplished by sectionalizing the feeder into multiple smaller loads and reconnecting those loads sequentially. Secondly, a part of the load served by the distribution feeder may be capable of being offloaded onto an adjacent feeder. [57] Thirdly, temporary adjustments to protection settings on substation equipment may be available.[58] Distribution system overload conditions caused modest damage to Newfoundland Power's electrical system during the January 2-8, 2014 period.[59]

There were 9 substation breakers or reclosers which failed to operate correctly during the rotating power outages during January 2-8, 2014. These failures prolonged the duration of customer outages. The majority of the failures were due to the cold temperatures affecting the operating mechanisms. In each of these cases, field staff was dispatched and either made required repairs immediately or completed switching to temporarily transfer the customers to another distribution feeder while the repairs were completed.[60] Overall, during the rotating power outages over the January 2-8, 2014 period Newfoundland Power's breaker and recloser operations were successful 99% of the time.[61]

B.2.4 The Issue of Advance Customer Notice

The rotating power outage protocol adopted by Newfoundland Power in the period from January 2-8, 2014 was intended to maximize the use of available supply. As customer demand approached the limit of available generation, small blocks of customer load were rotated off and on the electrical system so that, to the extent practicable, the load matched *all* available

[57] Sectionalizing and offloading distribution feeders occurred frequently throughout the January 2-8, 2014 period.

[58] Sectionalizing or offloading feeders and adjusting relays may require the dispatch of engineers, technologists or line crews to the field. When this is required, it will tend to extend the duration of customer outages.

[59] Newfoundland Power experienced no damage to primary distribution conductor resulting from increased loads associated with cold load pickup. Less than 30 distribution transformers were damaged during the period January 2-8, 2014 due to increased load associated with cold load pickup. Newfoundland Power has approximately 60,000 distribution transformers on its electrical system.

[60] As a result of these breaker and recloser failures, Newfoundland Power inspected every breaker and recloser on the Avalon Peninsula on January 6-7, 2014 to reduce the risk of further failures compromising customer service.

[61] There were 447 distribution feeder rotations completed in the period January 2-8, 2014. (9/(447 x 2) = 0.01).

generation.[62] Using this protocol there was practically no margin between the amount of generation available and the customer load on the system.

As an alternative approach to rotating power outages Newfoundland Power could have attempted to provide all customers affected with advance notice of the timing and location of rotating power outages. Providing customers with advance notice would necessarily have involved planning to remove blocks of customer load based upon the *forecast* peak load and generation for the planned rotation period. Under this approach, the timing and magnitude of the supply shortfall would need to be forecast hours in advance. Using this forecast, a schedule would be developed to address the anticipated shortfall. The schedule would identify groups of distribution feeders with sufficient load to rotate such that demand would not exceed supply, with an appropriate allowance for forecast error.[63]

For the period January 2-8, 2014, Newfoundland Power is not in a position to estimate the number of additional customers that would have been off the system had customers been given advance notice of outages. This is largely due to the significant destabilizing events which occurred on the Island Interconnected System through this period and would have effectively prevented the giving of advance notice.[64] But, conceptually, it seems clear that scheduling rotating power outages so prior notice to customers is given will result in a greater number of customers being affected by the outages.[65]

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[62] The determination of which distribution feeders were rotated off and on the electrical system was guided by real-time monitoring of system frequency and voltage levels. System frequency for the Island Interconnected System provides an indication of the balance of electrical demand and supply on a system wide basis. Voltage levels measured at delivery points will provide an indication of the balance of electrical demand and supply on a local geographical basis. Together, system frequency and voltage levels provide an indication, in engineering terms, of how many and which distribution feeders can be rotated off and on the electrical system at any point in time.

[63] The identified groups of distribution feeders would have to (i) include sufficient load to accommodate forecast error in the system peak, (ii) include the individual distribution feeder loads identified for rotation, and (iii) accommodate the dynamic and uncertain system circumstances which exist in an environment where there is insufficient supply.

[64] See **B.1: Chronology of Electrical System Events,** page 10 for a description of the series of major system disruptions which occurred during the January 2-8, 2014 period. Events of this magnitude create a level of instability on the Island Interconnected System that effectively precludes any realistic capability of scheduling rotating customer outages with advance notice.

[65] The conceptual basis for this conclusion is more fully described in the response to Request for Information PUB-NP-048.

B.3 Customer Communication & Response

B.3.1 Background

B.3.1.1 General

Utility customer communication and response is most critical in situations of electrical system distress. For Newfoundland Power, these situations typically occur as a result of severe weather damage to transmission and distribution systems.[66] In each year, Newfoundland Power usually experiences 1 or 2 major electrical system outages. These major electrical system outages serve as real-time tests of Newfoundland Power's customer service capabilities.

Newfoundland Power communicates with its customers by a variety of means. They include telephonic, digital and mass media based communications. The Company's operational processes aim to ensure that information provided to customers is responsive, accurate and timely, regardless of the customer's choice of communication channel.

Following major electrical system outages it is usual for Newfoundland Power to review its communication and customer service response to identify areas of potential improvement. The Company's customer communications performance in the period January 2-8, 2014 was improved as a result of changes made during 2013 to the Company's operational processes largely as a response to the electrical system events caused by equipment problems at Hydro's Holyrood plant on January 11th, 2013.[67]

B.3.1.2 The 2013 Customer Service Improvements

Newfoundland Power reassessed some key aspects of its customer service response in major electrical system outages following the electrical system events of January 11-13, 2013. This reassessment resulted in changes to customer communication technology, overall outage response processes, and human resource deployment.

[66] These severe weather events typically include ice storms, blizzards, hurricanes and tropical storms. Ice storms and blizzards occur in the winter; hurricanes and tropical storms occur in autumn. Newfoundland Power's operational protocol for response to severe weather events is described in the response to Request for Information PUB-NP-028.

[67] On January 11-12, 2013, Hydro's Holyrood Thermal Generation Station was unavailable for 21 hours. The reinstatement of electrical service to Newfoundland Power's customers following this outage was not concluded until January 13th, 2013. The events of January 11-13, 2013 are described more fully in **B.1: Chronology of Electrical System Events**, page 6.

Following the January 2013 outage, Newfoundland Power's Customer Contact Centre phone capacity was increased by over 25%.[68] Enhancements were made to facilitate more advanced telephone message handling.[69] In addition, improvements were made to permit quicker mobile phone access to outage information.[70] During this time, Newfoundland Power also deployed upgrades to its website to permit improved customer access to outage related information.[71]

To improve the timeliness, accuracy and consistency of customer communications during major electrical system events, Newfoundland Power established a team referred to as the *communications hub*. The communications hub is comprised of a mixture of operations, customer relations, communications and information services employees. The communications hub is responsible for the assembly, update and dissemination to key employees of information relating to outage status and restoration.[72]

To increase the pool of employees available to communicate with customers through a major electrical system event, the Company identified additional employees for service in the Customer Contact Centre.[73] The employees identified included employees in human resources, finance, conservation, regulatory, information services and audit functions.

[68] This contributed to a reduction of unanswered calls during the January 2-8, 2014 period by approximately ¾ compared to those experienced by customers during the January 11-13, 2013 period.

[69] One enhancement was establishment of an overflow menu to eliminate the "busy tone". When all trunks to the Contact Centre are busy, instead of receiving a busy tone, the overflow menu provides customers with the ability to indicate if their call is a public hazard. If so, the customer is routed to an agent through capacity reserved for public hazard calls. If the call is not a public hazard, the customer is asked to refer to the website for the most recent outage information or to try calling again.

[70] Prior to these improvements, unrecognized phone numbers (primarily cellular phone numbers) accessed St. John's area outage information by default. A new menu system was developed that prompts these particular callers for their calling area so that they receive outage information for their area.

[71] This included an interactive outage map, list of known customer outages and informational messages, such as outage status. The upgrades also permitted the Company to modify its website during response to major system events so that specific customer messaging for outages (i.e., the safe use of generators) could be exclusively run. Finally, enhancements included an application to permit customers to report outages online. Development of the interactive outage map was commenced prior to January 2013.

[72] This includes information from company sources, such as the Customer Contact Centre, SCC and Field Operations. It also includes information gathered from a diverse array of external sources, including customers, Hydro, fire and emergency services, department of transportation, municipalities, critical suppliers (i.e., fuel and food suppliers), school districts and seniors' homes.

[73] During major electrical system events and restoration, Newfoundland Power's Customer Contact Centre operates on an around-the-clock basis. During the January 11-13, 2013 electrical system event, Newfoundland Power encountered shortages of qualified employees available to answer customer inquiries.

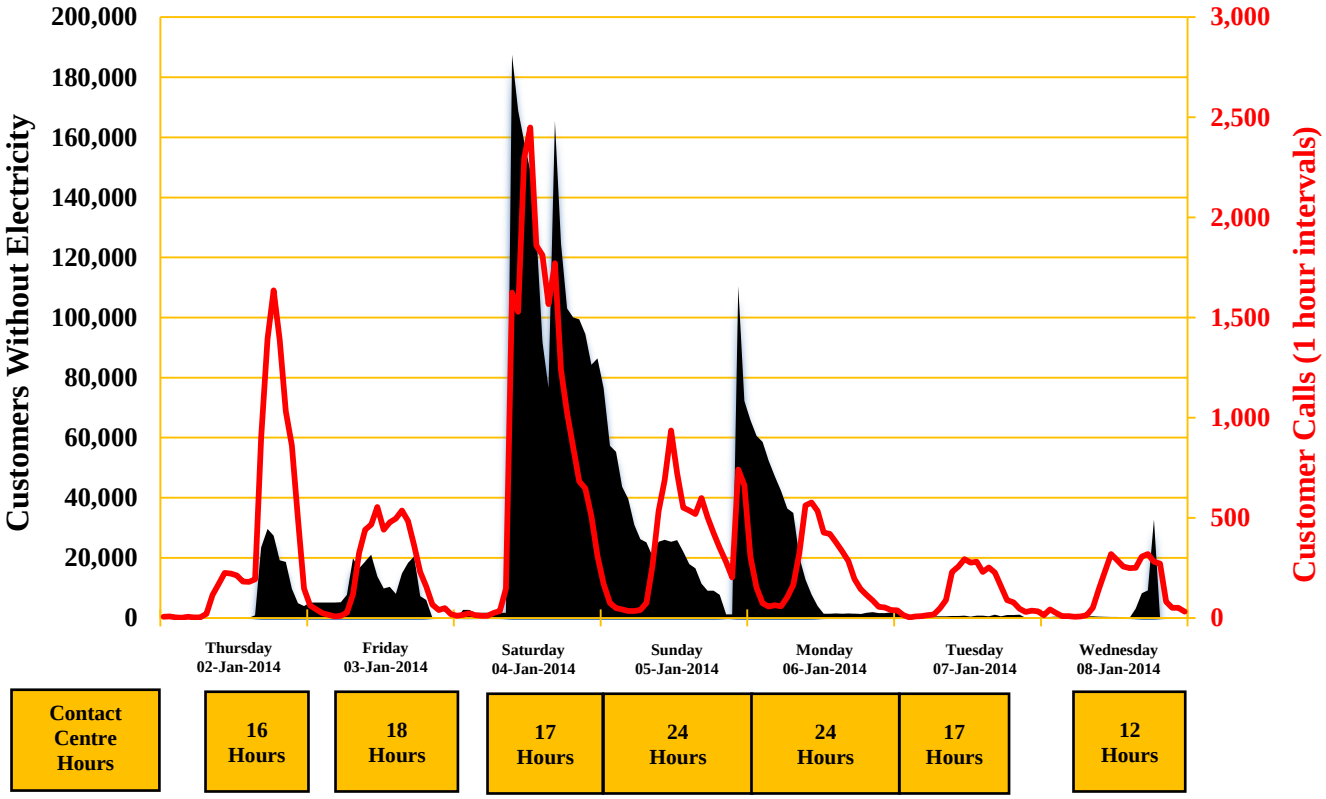
In August 2013, prior to the 2013/2014 hurricane season, the Company conducted a storm scenario test day in order to evaluate the improvements made in the aftermath of the January 2013 outage.

B.3.2 Customer Inquiry and Response

B.3.2.1 Overview

Figure 3 shows (i) Newfoundland Power customer outages, (ii) the number of customer calls received (in 1 hour intervals) and (iii) the hours of operation of the Company's Customer Contact Centre during the period of January 2-8, 2014.

Figure 3
Customer Outages & Customer Calls
January 2-8, 2014



The Customer Contact Centre received typical volumes of customer calls (i) prior to the commencement of rotating power outages at 4:13 pm on January 2nd, 2014; (ii) on January 7th, 2014; and (iii) prior to the recommencement of rotating power outages at 3:23 pm on January 8th,

2014. Customer calls to Newfoundland Power were highest on the evening of January 2nd, 2014, when rotating power outages were commenced by the Company, and immediately after the major electrical system disruptions of January 4th and 5th.[74]

Newfoundland Power's Customer Contact Centre was in operation until midnight on each of January 2nd and 3rd, 2014. The extended hours were necessary to respond to customer inquiries related to the rotating power outages during the peak evening periods in each of those days. From 7:00 am on January 4th until 5:00 pm on January 7th, the Customer Contact Centre was operating on a continuous basis. This was required to respond to customer inquiries following the major electrical system disruptions and the subsequent electrical system restoration periods.[75] The Customer Contact Centre also operated from 6:00 am to midnight on January 8th, 2014.

B.3.2.2 Customer Response

Table 4 shows a summary of customer contacts received by Newfoundland Power via telephone, email and website from January 2-8, 2014.

Table 4
Customer Contacts
January 2-8, 2014

Source	Number
Customer calls	139,335[76]
Emails	240
Website visits	947,215[77]

[74] Shortly after the commencement of rotating power outages at approximately 4:15 pm on January 2nd, 2014, Hydro's Granite Canal hydroelectric plant went out of service. This materially increased the number of customers affected by rotating power outages.

[75] On January 3rd and 4th, 2014, blizzard conditions were experienced across Newfoundland Power's service territory. The Company arranged safe transportation for staff as necessary to ensure the commencement of Customer Contact Centre operations by 6:00 am on January 4th, 2014.

[76] Newfoundland Power did not record how many customer calls to the Customer Contact Centre were related specifically to *rotating power outages*. Instead, the Company simply coded calls related to all aspects of the electrical system events as *outage calls*.

[77] The peak periods of web site visits occurred on January 4th, 2014 (approximately 219,000 visits) and January 5th, 2014 (approximately 200,000 visits).

During this period, Newfoundland Power's website was visited 947,215 times or approximately 87% of total contacts via these media. By comparison, Newfoundland Power received approximately 1 million visits to the Company's web site during the full year in 2013. During the January 2013 supply outage event, there were approximately 156,500 visits to the Company's website.[78]

Customer telephone calls to Newfoundland Power's Customer Contact Centre accounted for approximately 13% of contacts via these media. The 139,335 telephone calls received compares to the 194,564 telephone calls received during the January 2013 outage event.

Table 5 shows a summary of Newfoundland Power's response to telephone inquiries received from January 2-8, 2014.

Table 5
Telephone Response
January 2-8, 2014

Source	**Number**
Contact Centre Agent	25,792
IVR[79]	80,475
Unanswered Calls	33,068
Total	**139,335**

A total of 33,068 customer telephone calls received by Newfoundland Power during the period January 2-8, 2014 were unanswered. This represented approximately 24% of the total calls

[78] Increased customer website visits is consistent with recent patterns of customer contact with Newfoundland Power (see, for example, Newfoundland Power's 2013/2014 General Rate Application, Company Evidence, pages 2.6 to 2.8). Increased website contact, particularly via mobile device, is also reflective of the fact that mobile devices become the most convenient way for many customers to contact the Company when their electrical service has been disrupted. Finally, improvements to website outage content and mobile device accessibility undertaken in 2013 likely contributed to increased website traffic during January 2-8, 2014.

[79] IVR, or Interactive Voice Response, is an automated response which enables customers to access information regarding service by choosing from a menu via their telephone keypad.

received by the Customer Contact Centre during this period. This compares to over 50% of telephone calls unanswered during the January 2013 supply outage event.[80]

Table 6 shows a summary of the customer response to Newfoundland Power's social media efforts from January 2-8, 2014.

Table 6
Social Media
January 2-8, 2014

Source	Number
New Twitter followers	6,561
Facebook page likes	4,119

During the January 2-8, 2014 period, Newfoundland Power acquired approximately 6,600 new Twitter followers.[81] In addition, the Company's Facebook page was *liked* by just over 4,100 people. During the January 2013 supply outage event, Newfoundland Power acquired approximately 400 new Twitter followers.[82] Newfoundland Power did not have a Facebook presence in January 2013.

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[80] See Table 7, 101,171/194,564 = 0.5200, or 52%. The reduced unanswered call rate over January 2-8, 2014 is likely attributable to a combination of customer service improvements undertaken in 2013, particularly, increased Customer Contact Centre phone capacity, enhancements to facilitate more advanced message handling (i.e., a message directing customers to the company website instead of a standard telephone busy tone) and improvements to website outage content and mobile device accessibility.

[81] Newfoundland Power now has over 17,000 Twitter followers.

[82] This is an estimate. Newfoundland Power was experimenting with expanded use of social media during the January 2013 system event and did not keep reliable records of its experience.

Table 7 shows a comparative summary of key customer response data for the January 2013 and January 2014 supply outage events.

Table 7
Comparative Customer Service Statistics
Supply Outage Events
January 2013 & January 2014

	2013	2014
Customer Calls	194,564	139,335
Answered by Agent	9,610	25,792
Answered by IVR	83,783	80,475
Unanswered	101,171	33,068
Website Visits	156,506	947,215

The customer response data indicates that for the period January 2-8, 2014, Newfoundland Power answered a greater proportion of customer calls than during the January 2013 supply outage event. In addition, the Company website played a substantially more significant role in customer response for the period January 2-8, 2014 than it did during the January 2013 supply outage event.

B.3.2.3 Communications

Hydro took the lead on the issuing of public advisories related to the status of the Island Interconnected System throughout the January 2-8, 2014 period.[83] Hydro indicated to Newfoundland Power on January 2nd, 2014 that Newfoundland Power should not speak to the status of Hydro's generation and requested all media calls received by Newfoundland Power should be forwarded to Hydro. Newfoundland Power did not have access to real-time or forecast information relating to the status of most of Hydro's generation.[84]

At approximately 2:00 pm on January 2nd, 2014, a public advisory was made by Hydro to customers served by the Island Interconnected System "…to avoid unnecessary electricity usage and reduce their consumption as much as possible from 4:00 p.m. to 8:00 p.m. on Thursday,

[83] Newfoundland Power typically had no influence over the content of Hydro's media advisories throughout the January 2-8, 2014 period. Newfoundland Power received a copy of the 2:00 pm media advisory on January 2nd, 2014 by retrieving it from Hydro's website.

[84] See ***C.1.2: Current Transparency of System Operations***, page 50, line 22, *et. seq.*

January 2, 2014 and from 7:00 a.m. to 10:00 a.m. on Friday, January 3, 2014."[85] At approximately 9:00 pm on January 2nd, 2014, a further public advisory was made by Hydro indicating, in part, that "Temperatures and winds for tomorrow morning are forecast to result in colder weather than this evening, so rotating outages are highly likely for the peak period from 7:00 a.m. to 10:00 a.m. and possibly later."[86]

Newfoundland Power used mass and digital media to send broader messages to its customers concerning the status of events during January 2-8, 2014.

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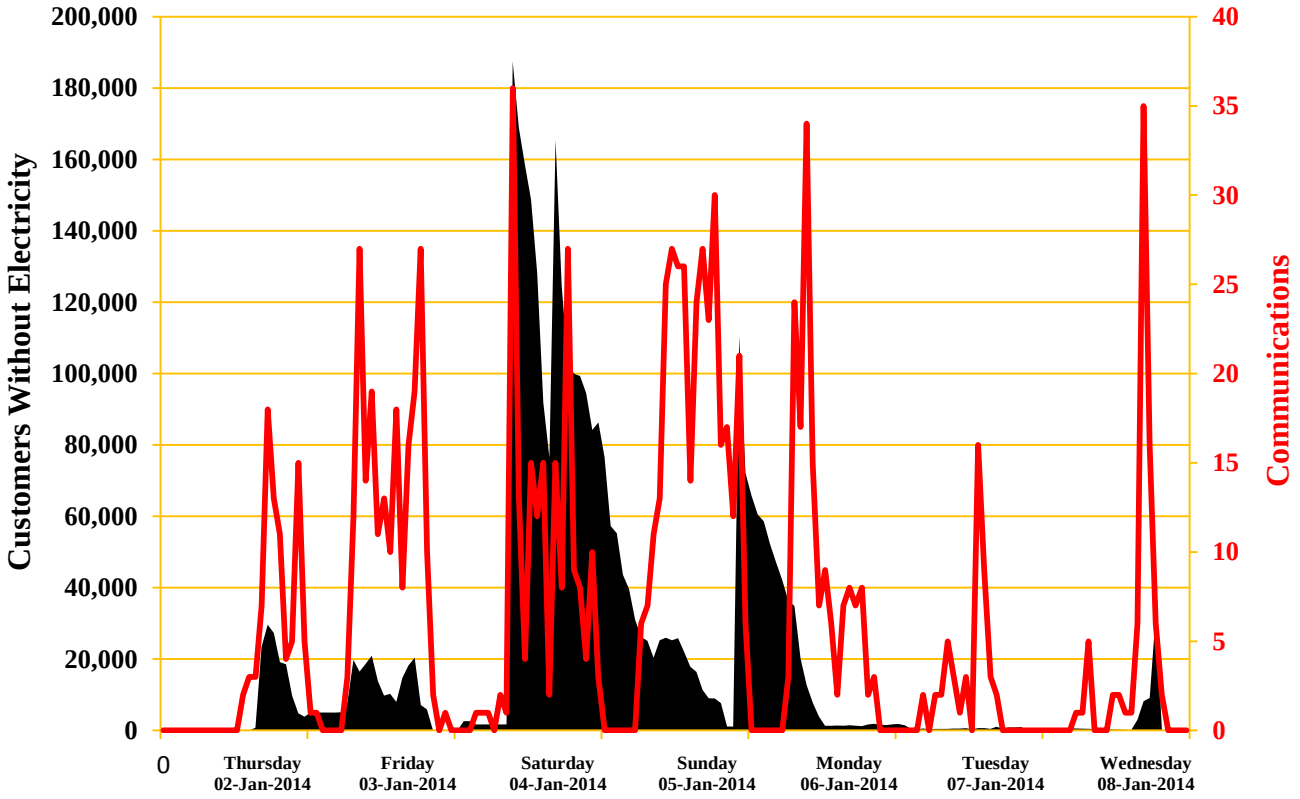
[85] The public advisory is Attachment 1 to Hydro's response to Request for Information PUB-NLH-020.

[86] Hydro's public advisories tended to refer to high electricity loads. Only 1 of the 5 Hydro public advisories issued over the January 2-8, 2014 period actually referred to the reduced generation availability on the Island Interconnected System.

Figure 4 shows (i) Newfoundland Power customer outages and (ii) outbound Company communications during the period January 2-8, 2014.[87]

Figure 4
Customer Outages & Communications
January 2-8, 2014



Over 100 media interviews on radio, television and in newspapers were completed by Newfoundland Power as part of its mass media efforts to keep customers informed of the status of electrical system events, including rotating power outages. Digital media included 598 website postings and 302 original social media posts. Of these digital media messages, just over 50% related to the rotating power outages undertaken by Newfoundland Power.[88]

[87] The communications depicted in Figure 4 include Newfoundland Power public advisories, media interviews, website postings and social media posts.

[88] While electrical system outage status was the primary theme of Newfoundland Power's communications, electricity conservation and safety, particularly customer generator safety, were also prominent themes.

In addition to its media efforts, Newfoundland Power conducted outreach to key stakeholders through the January 2-8, 2014 period. This included daily updates with mayors of larger affected municipalities on the coordination of conservation and safety measures. It also included arrangements for adding distribution feeders serving municipal *warming centres* to Newfoundland Power's critical feeder list for the purpose of rotating power outages. Daily updates with executive and senior management of the school system on issues ranging from conservation measures to school scheduling were also undertaken. Increased commercial customer conservation was encouraged through direct contact with commercial customers and outreach to business organizations such as the St. John's Board of Trade.

Newfoundland Power participated in the Government Power Outage Response Committee.[89] This committee developed a joint mass media (radio and newspaper) campaign focused on customer electricity conservation during peak periods on the Island Interconnected System. The campaign commenced on January 6th, 2014 and concluded on January 11th, 2014.

Finally, Newfoundland Power participated in 6 joint press conferences during the January 2-8, 2014 period. These joint press conferences were undertaken with representatives of Hydro, Fire and Emergency services and the Premier of the province.[90]

B.3.2.4 Customer Communications Feedback

In February 2014, Newfoundland Power conducted a survey of its customers to obtain feedback on the effectiveness of the Company's communications during the January 2-8, 2014 period.[91]

[89] The Government Power Outage Response Committee also included a representative for Hydro and 2 representatives for the Government of Newfoundland and Labrador. The committee was formed on January 5th, 2014 during a meeting with the Premier, other government officials and Hydro.

[90] One of the joint press conferences (2:30 pm, January 3rd, 2014) included representatives from Newfoundland Power, Hydro, and Fire and Emergency Services. Two of the joint press conferences (2:00 pm and 6:00 pm, January 4th, 2014) included representatives from Newfoundland Power and Hydro. Two of the joint press conferences (12:30 pm, January 5th and 1:00 pm, January 7th, 2014) included the Presidents of Newfoundland Power and Nalcor/Hydro and the Premier of the Province. One of the joint press conferences (12:30 pm, January 6th, 2014) included the President of Newfoundland Power and the Premier of the Province.

[91] The survey was a random telephone survey of 400 Newfoundland Power customers resident in the eastern Newfoundland areas most affected by the system events of January 2-8, 2014 (the Avalon, Bonavista and Burin Peninsulas). Customer data was collected during February 6-10, 2014 and survey results have a margin of error of ± 5% at a 95% confidence interval (19 times out of 20).

The survey results will be used to improve Newfoundland Power's communication efforts during future major electrical system events.

Based upon this communications feedback, it appears that radio is a favored media source for customer information in periods of electrical system distress. This indicates that the Company should further pursue partnerships with local radio stations to provide regular outage updates with customers.[92]

Newfoundland Power's website was the digital communications source preferred by customers. It was also more popular than television or print media. This indicates that the Company should pursue website improvements to provide more customer friendly information related to system outages. Social media tended to be preferred by younger customers and is growing in popularity. This indicates that Newfoundland Power should increase its efforts in social media communications in future situations of electrical system distress.[93]

The survey results indicated that many Newfoundland Power customers conserved electricity during the January system interruptions. Over 70% of the Company's customers indicated that they turned off lights, however, less than half turned off electric heat or made the conscious decision to wash clothes or dishes in off peak hours. This indicates that increased communications emphasis on customer conservation in situations of electrical system distress is warranted.

The results of Newfoundland Power's survey of its customers will be incorporated in future communications in situations of electrical system distress.

[92] Newfoundland Power already has such partnerships; however, the degree of customer reliance on radio as a source of information indicates further development of such partnerships is warranted.

[93] Media outlets also access Newfoundland Power's social media as a source of information for reporting purposes. This reinforces a continued Company focus on social media during major outages or system interruptions.

B.4 Inter-Utility Coordination

B.4.1 Routine Operational Coordination

Hydro's ECC operates an energy management system that monitors and controls Hydro's generation and bulk transmission systems. The ECC's primary functions are the economic dispatch of generation and ensuring the balance of electrical system supply and demand for the Island Interconnected System.[94] Newfoundland Power's SCC, operates a supervisory control and data acquisition system that monitors and controls Newfoundland Power's generation, transmission and distribution systems. Both Newfoundland Power's SCC and Hydro's ECC are staffed 24 hours a day, every day of the year.

The energy management system in Hydro's ECC is linked to the supervisory control and data acquisition system in Newfoundland Power's SCC.[95] This link provides each utility with near real-time information concerning the other's electrical operations on the Island Interconnected System.[96] Communication and coordination between Newfoundland Power's SCC and Hydro's ECC is continuous and is the central feature of daily operational coordination on the Island Interconnected System. Newfoundland Power's SCC and Hydro's ECC ensure that routine daily electrical system operations such as generation dispatch and line and equipment switching are performed on a safe and reliable basis.

Newfoundland Power and Hydro coordinate scheduling of work on their respective systems for 2 basic reasons. One is to ensure that one utility's actions will not unnecessarily affect the other utility's provision of service to its customers.[97] The other is to ensure that the *joint* actions of the

[94] Newfoundland Power is responsible for the availability of its generation resources which includes approximately 97.5 MW of hydroelectric generation and approximately 41.5 MW of thermal generation; however, this represents less than 10% of the available generation resources on the Island Interconnected System. Each morning, Newfoundland Power's SCC informs Hydro's ECC of the availability of Newfoundland Power's generation.

[95] This link meets the *Inter-Control Centre Communications Protocol* of International Electrotechnical Commission IEC 60870-6.

[96] The operational information available between utilities via this link is not comprehensive. It does include status of some critical equipment and some generation. (See **C.1: Public Policy Context**, page 47).

[97] For example, Hydro routinely schedules maintenance of its 66/138kV radial transmission system from Bottom Brook to Port aux Basques when customer load in the Port aux Basques area is low, and Newfoundland Power's local and mobile generation is available. This coordination ensures service continuity to Newfoundland Power's customers on the southwestern portion of its service territory during Hydro's maintenance activities, which typically take 3-5 days to complete.

two utilities are undertaken in a way which is least disruptive to the reliable delivery of electricity to customers.[98]

Coordination of planned outages on the Island Interconnected System requires a high degree of communication and cooperation which is coordinated by Newfoundland Power's SCC and Hydro's ECC. General oversight of the communication and cooperation between utilities is provided by the Committee.

Newfoundland Power's SCC and Hydro's ECC are central to the utilities' response to major electrical system events. Such events include damage caused by severe weather events, failure of major system components, and loss of supply. When responding to major electrical system events, Newfoundland Power's SCC and Hydro's ECC work together to re-establish normal operations on the electrical system in a controlled and orderly fashion. Hydro's ECC operators typically take a lead role in informing Newfoundland Power's response to major electrical system events via the SCC.[99]

Newfoundland Power's SCC relies upon Hydro's ECC to keep it updated on system demand on the Island Interconnected System.[100] Similarly, Newfoundland Power's SCC relies upon

[98] For example, in 2012 Newfoundland Power relocated its mobile generation to enable scheduled maintenance of its 138kV radial transmission system serving the Baie Verte Peninsula with minimal disruption of service to customers. Hydro has a 138kV radial transmission system in the area which is supplied by the Newfoundland Power 138kV radial transmission system. Hydro coordinated its maintenance of its system in the same area for the same time. The coordination ensured that the overall disruption of electrical service to both utilities' customers was minimized.

[99] Examples of the type of information provided by Hydro's ECC which would inform Newfoundland Power's response to a major electrical system event would include (i) the amount of Hydro generation capacity available on the Island Interconnected System, (ii) the status of the bulk transmission system, and (iii) the operating condition of major electrical system components such as power transformers and breakers. The availability and quality of this information is critical to effective system restoration efforts. For some major weather events where damage is more localized and is not system wide, the information provided by Hydro's ECC will be less critical to Newfoundland Power's response efforts on an ongoing basis.

[100] Newfoundland Power's SCC monitors electrical demand on *Newfoundland Power's* electrical system on a real-time basis. Newfoundland Power does not have information on the Island Interconnected System electrical demand on a real-time basis; however, Newfoundland Power's electrical system accounts for approximately 85% of demand on the Island Interconnected System.

Hydro's ECC for information concerning the availability of system generation resources on a timely basis.[101]

Newfoundland Power's electrical system is programmed so that, whenever system demand or availability of generation requires, customer load will be shed to protect the integrity of the Island Interconnected System.[102] Following such an event, Hydro's ECC cooperates with Newfoundland Power's SCC to ensure that customers disconnected from the system are reconnected to the system quickly while maintaining system integrity.

When forced outages have occurred with Hydro's generation and Newfoundland Power's customers lose service, the Company's SCC and Hydro's ECC cooperate to take the available steps to restore service.[103]

B.4.2 Forecasting and Supply Planning

Newfoundland Power's and Hydro's respective forecasting personnel communicate on an ongoing basis. These discussions typically focus on the comparability of Newfoundland Power's energy and demand forecasts and Hydro's long range island load forecasts. Periodically, changes to Newfoundland Power's forecasts are made, either to update forecast methodology or to ensure the information provided is responsive to Hydro's requirements. In all cases, these changes are agreed between the two utilities.[104]

At least once each year, usually in the spring, Newfoundland Power provides Hydro with a 5-year forecast of its overall annual and monthly energy and peak load requirements (the "Energy

[101] The link between Hydro's ECC and Newfoundland Power's SCC provides Newfoundland Power with information on total Hydro supply online (with detail on thermal generation (Holyrood and gas turbines)). The link does not provide any information on Hydro's generation which is available but not serving demand. Newfoundland Power does not have real-time access to information concerning the reserve margins available on the Island Interconnected System.

[102] This is the most common response to an imbalance of supply and demand on the Island Interconnected System. For a description of how Newfoundland Power's underfrequency load shedding system operates to restore the balance between electricity supply and demand, see the response to Request for Information PUB-NP-022.

[103] Following a forced customer outage due to sudden loss of Hydro generation, Hydro will typically inform Newfoundland Power of the generation availability on a real-time basis to assist in restoration of service. See ***B.4.3: January 2-8, 2014***, page 41 for a description of coordination during the January 2-8, 2014 period.

[104] See the response to Request for Information PUB-NP-012 for information on changes to Newfoundland Power's load forecasting methodology.

and Demand Forecast"). The Energy and Demand Forecast is used by Hydro in developing its own forecast of energy and winter peak demand for the Island Interconnected System.[105]

Each year Newfoundland Power also provides Hydro with a forecast of winter peak demand and annual energy requirements for each of the interconnections where Newfoundland Power takes supply from Hydro.[106] This forecast is used to assess the capacity of system equipment at each of the points of supply.

Newfoundland Power does not actively participate in the assessment of either (i) the adequacy of existing generation resources to meet forecast loads on the Island Interconnected System or (ii) future generation alternatives for the Island Interconnected System.[107]

B.4.3 January 2-8, 2014

During the period January 2-8, 2014, there was ongoing coordination and frequent communication between Newfoundland Power's SCC and Hydro's ECC.

Following the morning peak on January 2nd, 2014, Newfoundland Power informed Hydro that its evening peak load could reach or exceed 1,375 MW. Hydro advised Newfoundland Power that, in light of this information, there was likelihood that there would be insufficient generation available to meet the evening peak. This was the first time that Newfoundland Power and Hydro had to coordinate the response to a forecast generation shortfall on the Island Interconnected System.[108]

On January 3rd, 2014, the second day of rotating power outages, an opportunity was recognized to improve the coordination process between Newfoundland Power and Hydro that shortened

[105] For greater detail on this forecast please see the response to Request for Information PUB-NP-006.
[106] Newfoundland Power takes power supply from Hydro at 24 metering points. These 24 metering points are at 21 locations.
[107] Supply planning for the Island Interconnected System is described in **C.1: Public Policy Context**, page 47.
[108] The level of interaction between Newfoundland Power's SCC and Hydro's ECC from this point was consistent with previous responses to major electrical system events as described at page 39, lines 9 to 15.

customer outages. This also reduced the impact of cold load pickup and ensured more customers were served by the available generation capacity.[109]

Throughout the January 4-8, 2014 period, a number of major system disruptions occurred on the Island Interconnected System. After these disruptions, Newfoundland Power implemented its normal electrical system restoration procedures, which included communication and coordination with Hydro as generation was brought back online and was available for distribution. During the period, Hydro indicated the amount of load Newfoundland Power could add to the Island Interconnected System. The amount of load varied from 5 MW to 100 MW but was typically made available in 20 MW increments.[110]

Throughout the January 2-8, 2014 period, Hydro called upon Newfoundland Power to dispatch its hydroelectric and thermal generating units.[111] During the period, Newfoundland Power's hydroelectric generation availability averaged approximately 88 MW each day and its thermal generation availability averaged approximately 27 MW each day.[112]

B.5 Assessment

The chronology of system events associated with the supply issues and power outages of December 2013 – January 2014 on the Island Interconnected System indicates that:

1) The generation supply issues experienced during January 2014 had certain similarities to the generation supply issues experienced during January 11-13, 2013. In both cases, equipment problems at Holyrood resulted in large numbers of Newfoundland Power customers being without service in winter conditions. Following the January 2013

[109] See the response to Request for Information PUB-NP-020.

[110] A typical distribution feeder winter load is approximately 10 MW. 20 MW increments were practical because they would provide enough capacity for Newfoundland Power to reconnect a typical distribution feeder during rotating power outages. See ***B.2.3: Field Operations***, page 23.

[111] A request to Newfoundland Power to maximize (i) hydro production and (ii) thermal production are steps 2 and 8, respectively, on Hydro's 14 step system operating instruction T-001 *Generation Loading Sequence and Generation Shortages*. (See Attachment 1 to Hydro's response to Request for Information PUB-NLH-033).

[112] Newfoundland Power's average thermal generation availability was substantially reduced due to the 20 MW Greenhill Gas Turbine being unavailable for 39.5 hours on January 3-5, 2014 because of the inability to arrange fuel delivery during blizzard conditions.

outage, available generation on the Island Interconnected System was reduced for the balance of the winter season.

2) The impacts on Newfoundland Power's customers resulting from the generation supply issues and power outages experienced during January 2014 were primarily the result of a combination of (i) insufficient available generation on the Island Interconnected System during the period January 2-8, 2014; (ii) a blizzard from January 3-4, 2014; and (iii) a series of major system disruptions from January 4-8, 2014. The series of major system disruptions had the most severe customer impacts. The blizzard had the least severe customer impacts.

3) Newfoundland Power's electrical system was robust and performed reasonably well during the period. The resilience of the Company's transmission and distribution systems resulted in minimal blizzard damage to the electrical system. Newfoundland Power's electrical system performed well in both the recovery from the series of major system disruptions and the implementation of rotating power outages during the period. The Company's generation resources provided reasonable support to the Island Interconnected System throughout the December 2013 – January 2014 period.

A review of rotating power outages undertaken by Newfoundland Power in response to the supply issues and power outages of December 2013 – January 2014 on the Island Interconnected System indicates that:

1) The average duration of rotating power outages experienced by affected Newfoundland Power customers on January 2nd, 2014 was 88 minutes and the average duration during January 3-8, 2014 ranged from 25 to 54 minutes. The reduced average duration of customer outages reflected improvements in implementation made following the initial experience on January 2nd, 2014.

2) Newfoundland Power did not provide its customers any specific advance notice of rotating power outages that would affect them. The provision of specific notice would

require more customers to be without service than otherwise would be the case. During much of the January 2-8, 2014 period major system disturbances destabilized the Island Interconnected System to such a degree that the provision of specific notice would have been practically impossible for much of the period.

A review of customer communications and response to the supply issues and power outages of December 2013 – January 2014 on the Island Interconnected System indicates that:

1) Newfoundland Power's customers did not receive timely or complete information relating to the insufficiency of available generation on the Island Interconnected System commencing January 2nd, 2014. Two hours before the commencement of rotating power outages on January 2nd, 2014, Newfoundland Power's customers were simply advised of the need to conserve electricity. Customers were not informed of the vulnerability of the Island Interconnected System or the likelihood of power outages later in the day.

2) Customer service improvements implemented by the Company in 2013 as a result of the generation supply issues experienced in January 2013 provided improved levels of customer service response during January 2-8, 2014. Newfoundland Power's Customer Contact Centre was operational for virtually all of the period.

3) Further improvements in customer service are achievable.

   Increased availability to Newfoundland Power of real-time and forecast data on the Island Interconnected System will enable the Company to improve the extent of meaningful information it can provide to its customers relating to the forecast adequacy of generation supply to meet demand.

   Improving information conveyed through mass media, particularly radio, and postings to the Company website should improve overall customer communication regarding outages.

An assessment of further possible improvements in the Company's telephonic response capabilities during outages may also yield tangible customer service benefits. Newfoundland Power is considering the potential of rerouting Customer Contact Centre telephone overflow to third party call centres in emergency situations.

A review of operational coordination between Newfoundland Power and Hydro, including that during the supply issues and power outages of December 2013 – January 2014 on the Island Interconnected System, indicates that:

1) Routine operational coordination between Newfoundland Power and Hydro is reasonable. The events of December 2013 to January 2014 on the Island Interconnected System were not routine.

2) January 2nd, 2014 was the first time that Newfoundland Power and Hydro had to coordinate the response to a forecast generation shortfall on the Island Interconnected System. Operational coordination between the utilities permitted rotating power outages to be carried out when overall system stability permitted. Newfoundland Power implemented rotating power outages to respond to generation shortfalls on 5 of the 7 days in the January 2-8, 2014 period.

On a broader basis, the supply issues and power outages of December 2013 – January 2014 clearly raise issues concerning current supply planning and bulk system operations on the Island Interconnected System. The assessment of these issues on reliability of supply for Newfoundland Power and its customers requires consideration over both near-term and longer-term time horizons.

Over the near-term, the reliability of Hydro's thermal generation resources, particularly Holyrood, is critical. In both January 2013 and January 2014, Holyrood reliability was a prominent vulnerability for the Island Interconnected System. Whether and how that vulnerability might be minimized in the future is a key near-term consideration.

Further, the series of major system disruptions which occurred on the Island Interconnected System in January 2014 raise potential questions concerning the adequacy of protection and control at the bulk system level. Protection and control systems are intended to operate in a way that isolates defective or malfunctioning electrical equipment and prevents widespread system impacts. The series of major system disruptions during January 2-8, 2014 suggest that protection and control systems may not have operated as they should.

Over the longer-term, different considerations will apply. The proposed decommissioning of Holyrood generation is a central consideration. Holyrood is the key generating station on the eastern part of the Island Interconnected System. The eastern part of the system is also the location of the largest and fastest growing loads. Following the commissioning of the Labrador in-feed and the Maritime link virtually all of the key generating resources serving the Island Interconnected System are proposed to be located outside the eastern part of the system. It is not clear how long-term reliability and security of power supply will be maintained at that time.

Greater backup generating capacity on the eastern part of the Island Interconnected System would have likely reduced the electrical system and customer distress experienced in January 2014. Whether increasing backup generating capacity on the eastern part of the Island Interconnected System will be necessary to ensure long-term reliability and security of power supply is also a key consideration.