Preliminary Review of SO_2 Emissions at Newfoundland & Labrador Hydro's Holyrood Generating Station

July 2002

HYDRO
THE POWER OF COMMITMENT

This brief is provided without prejudice and is not intended to represent Newfoundland & Labrador Hydro's (Hydro's) final position on its preference for addressing SO_2 emissions from its facilities, in particular the Holyrood Generating Station. A more in-depth response is currently in preparation, which will outline Hydro's position on this issue.

1. Introduction

The Newfoundland & Labrador Department of Environment (NLDOE) is considering implementing new Air Pollution Control Regulations in the near future. As these regulations will impact on the operation of Hydro's Holyrood Generating Station, Hydro has been studying the effects of their implementation. Hydro's mandate is to provide its customers in Newfoundland and Labrador with least cost, reliable power and energy, consistent with sound practices including such things as environmental considerations. In fact, Hydro's commitment to the environment is one of the key factors in most, if not all its decisions.

It was Hydro's aim to have a report prepared that would fully explore the cost of mitigating SO_2 emissions and that would include recommendations that would meet the objectives of NLDOE as well as those of Hydro in balancing cost with environmental considerations. As the study proceeded, however, it became apparent that there are many ways for Hydro to reduce emissions at Holyrood but no obvious "best" way. Therefore, it was decided to submit this preliminary report, outlining some of the pertinent concerns, in hopes of developing a consensus on a methodology that satisfies the concerns of all parties involved.

2. Annual Variations in Hydro and Thermal Generation

Hydro is the prime supplier of electrical energy on the Island, accounting for 81% of the Island's net capacity with most of Hydro's generating capability being hydro-electric. From 1973, when the Holyrood Thermal Plant started producing significant amounts of thermal energy, to the end of 2001, approximately 76% of the energy produced by Hydro for the Island Interconnected System was hydro-based with the other 24% being thermal-based. However, Figure 1 shows that there were large variations from year to year. For example, in 2000, Hydro's hydro-electric production was 84% of the total but only 65% in 2001.

This variation is due to the availability of water in Hydro's hydro-electric reservoirs, which varies with the amount of precipitation and runoff. Figure 2 shows the inflows (converted to energy values) for Hydro's 50 years of hydrological records for all of Hydro's large plants and Figure 3 shows the distribution of inflows for the same period. The average inflow from 1950 to 2001 was 4,278 GWh, with a standard deviation of 608 GWh. This indicates that 68 percent of the time, annual inflows will be between 3,669 GWh and 4,886 GWh and outside that range the other 32 percent of the time. Hydro refers to the electrical energy that can be produced with average annual inflows is referred to as the "average water year".

It is important to note that reservoir inflows do not directly correspond with hydraulic production on a year-to-year basis. This is because Hydro has large storage reservoirs, which are used to regulate the level of hydraulic production. In particular, water is stored to ensure that the hydro-electric generating plants can produce a minimum amount of energy through a repeat of the lowest inflow sequence, a 3 ½ year period from 1958 to 1961. This is necessary so that all firm demand for electrical energy can be met under all known hydrological conditions. Therefore, Holyrood's output is affected by reservoir storage levels, in addition to inflows.

3. SO_2 Emissions

The primary source of SO_2 emissions by Hydro is the Holyrood Thermal Generating Station. As was previously stated, Hydro meets its generation requirements from both hydro and thermal generating sources. Hydro-electricity is utilized to supply as much load as possible while ensuring Hydro can get through a multi-year, low inflow period and the remaining energy requirements are almost entirely met by thermal electricity produced at Holyrood.

The variability of hydro-electric generation and power system energy demand from year to year leads to variations in the amount of thermal energy produced in any given year and thus in the amount of SO_2 produced. Since 1988, when the agreement for Hydro's 25,000 t SO_2 cap was signed, SO_2 output has averaged 15,951 t annually but has ranged from a low of 8,582 t in 1994 to a high of 25,900 t in 1989. In 1991, as a result of a forecast that SO_2 emissions could exceed 25,000 t in an "average water year", Hydro reduced the sulphur content in its fuel specification from 2.8% to 2.2%. Since that time, hydraulic production has been well above the average and therefore, emissions have not approached the 25,000 t cap. As can be seen in Figure 2, 2001 was the first year since 1991 with below average hydraulic production and as a result, the SO_2 emissions in 2001 saw a significant increase.

The foregoing is meant to provide some insight into the variability as well as the short-term unpredictability of hydraulic production. While Hydro can forecast, with reasonable accuracy, the long-term average hydro-electricity that can be produced and thus the amount of thermal electricity that will be needed to fill the remainder of Hydro's customers' needs, for any given year the thermal production can vary significantly due to the unpredictability of inflows. A very important point to remember, however, is that Hydro has a mandate to produce sufficient electricity to supply its customers' firm requirements. Therefore, in a year with low hydro-electric production due to low inflows, it does not have the option of reducing thermal production to lower SO_2 emissions. In addition to efforts to maximize plant efficiency and optimize the hydro/thermal dispatch, further SO_2 emission reductions can only be obtained by reducing the amount of sulphur in the fuel burned, without investing in a multi-million dollar capital program, and this low sulphur fuel comes at a premium. The next section will examine some methods of setting emissions limits.

4. Setting Emissions Limits

As noted in the previous section, Hydro, by the nature of its generating plant portfolio must utilize Holyrood to fully supply its customers' firm requirements, and therefore to limit its emissions in any given time period, without investing in a multi-million dollar capital program, it would have to vary the sulphur content of the fuel.

The regulator (NLDOE) can limit emissions by either or a combination of setting an upper limit on the amount of sulphur in the fuel burned or by setting a cap on the amount of emissions for a given time period, annually or longer.

If an upper limit on the amount of sulphur in the fuel burned is set lower than the 2.2% Hydro specifies now, overall average SO_2 emissions will be reduced but the annual amount actually produced at Holyrood will still vary greatly. If an annual limit on emissions is important, Hydro may still exceed this limit in some years depending on the total production and "cap" if it does not at times buy even lower sulphur fuel. In low thermal production years, however, Hydro could be spending money to reduce emissions even though it would be far below the annual cap.

If a cap is set, the additional amount paid by Hydro to reduce emissions will depend on the length of the time period covered by the cap, assuming a multi-year cap is acceptable, and the upper limit of sulphur content in the fuel. An annual cap will mean that in high thermal production years, Hydro will pay extra to meet the cap, but may not be able to compensate for these additional costs from reduced costs in low thermal production years. A cap, incorporating a longer time period for averaging, such as a five-year running average cap, would reduce the effects of the annual thermal/hydro production variations and thus reduce costs (thereby lessening the rate variations to consumers) but would lead to a greater variation in annual emissions.

5. Preliminary Results

In analyzing the implications of the methods outlined in the previous section on Hydro's cost of operations, the combination of emissions caps of varying time periods and fuel sulphur content limits along with the short-term unpredictability of annual thermal production requirements over the next number of years must all be considered. Other factors include Hydro's changing annual energy production requirements. As well, a final complication is that these factors are not independent of each other: changing one changes the effect that another has on the final results. For example, the effect of a 20,000t cap varies with different allowable upper limits on the amount of sulphur allowed in fuel.

Some preliminary numbers to indicate the impact follow. These are subject to refinement in further analysis.

The incremental cost of moving from 2.2% to 1.8% sulphur fuel for various hydro/thermal splits without cap implications would be $13.1 million over a 5-year period, for the current forecast, or an average of $2.6 million annually. For the firm sequence (worse case scenario) the cost would be $20.5 million over a 5-year period, or an average of $4.1 million annually.

A cap that applies, regardless of the hydraulic situation i.e. not tied to the average water year, annually or on a five year rolling basis will increase the cost at both 2.2% or at 1.8% sulphur fuel limits.

Hydro is reluctant at this point to indicate additional costs of all the various permutations and combinations, but for purposes of illustration in the firm sequence (worse case) period, the additional cost of a fixed cap of 25,000 tonnes with no relief for low inflow periods could be as high as $21.2 million over a five year period with the 2.2% sulphur fuel continued and as high as $40 million with a 20,000 tonne cap and 1.8% maximum sulphur fuel. There are of course other scenarios to explore and Hydro could benefit from any indication of the more important issues that the regulator would offer for our further consideration.

In concluding this update, and in order to finalize our report/comments to NLDOE, Hydro is seeking a more concise indication of the priorities of NLDOE. This would aid in refining the analysis of the numerous alternative approaches that might be suggested or recommended by Hydro to addressing those priorities as well as assisting in achieving a mutually agreeable target with a clear understanding of exactly what the target means in all situations under which Hydro will be expected to operate.

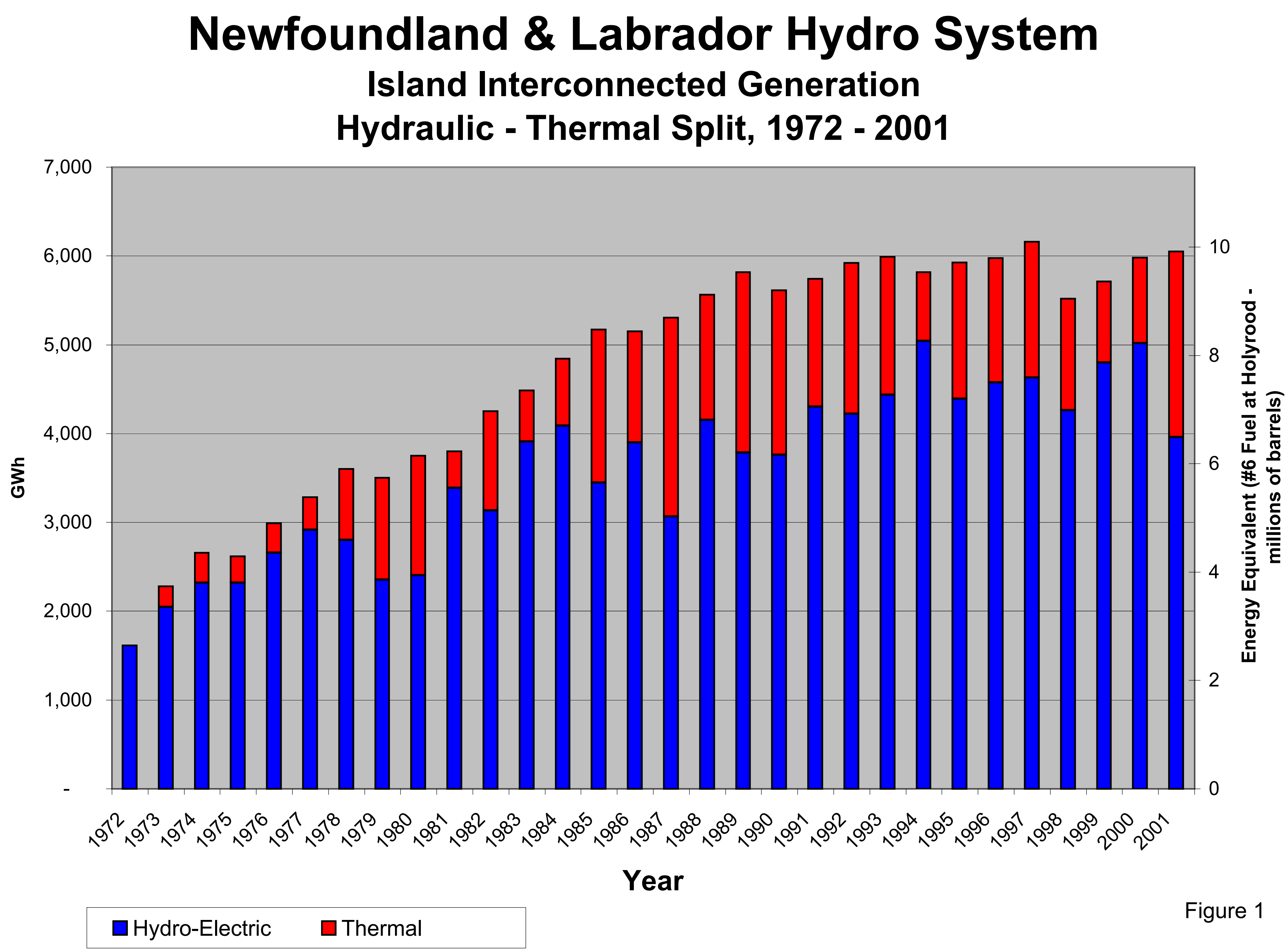

Newfoundland & Labrador Hydro System
Island Interconnected Generation
Hydraulic - Thermal Split, 1972 - 2001
GWh
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
Energy Equivalent (#6 Fuel at Holyrood - millions of barrels)
10
8
6
4
2
0
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Year
Hydro-Electric
Thermal

Figure 1

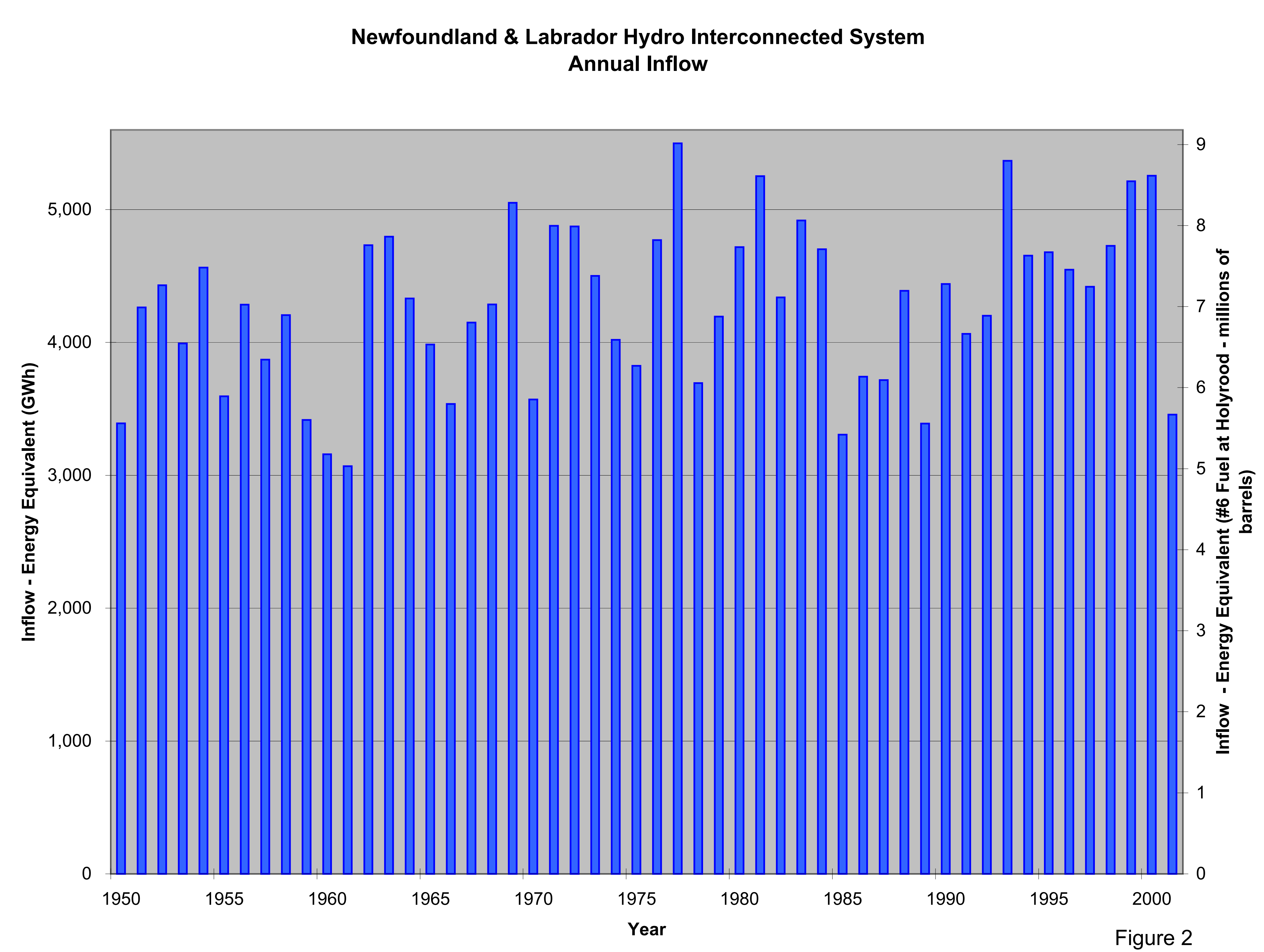
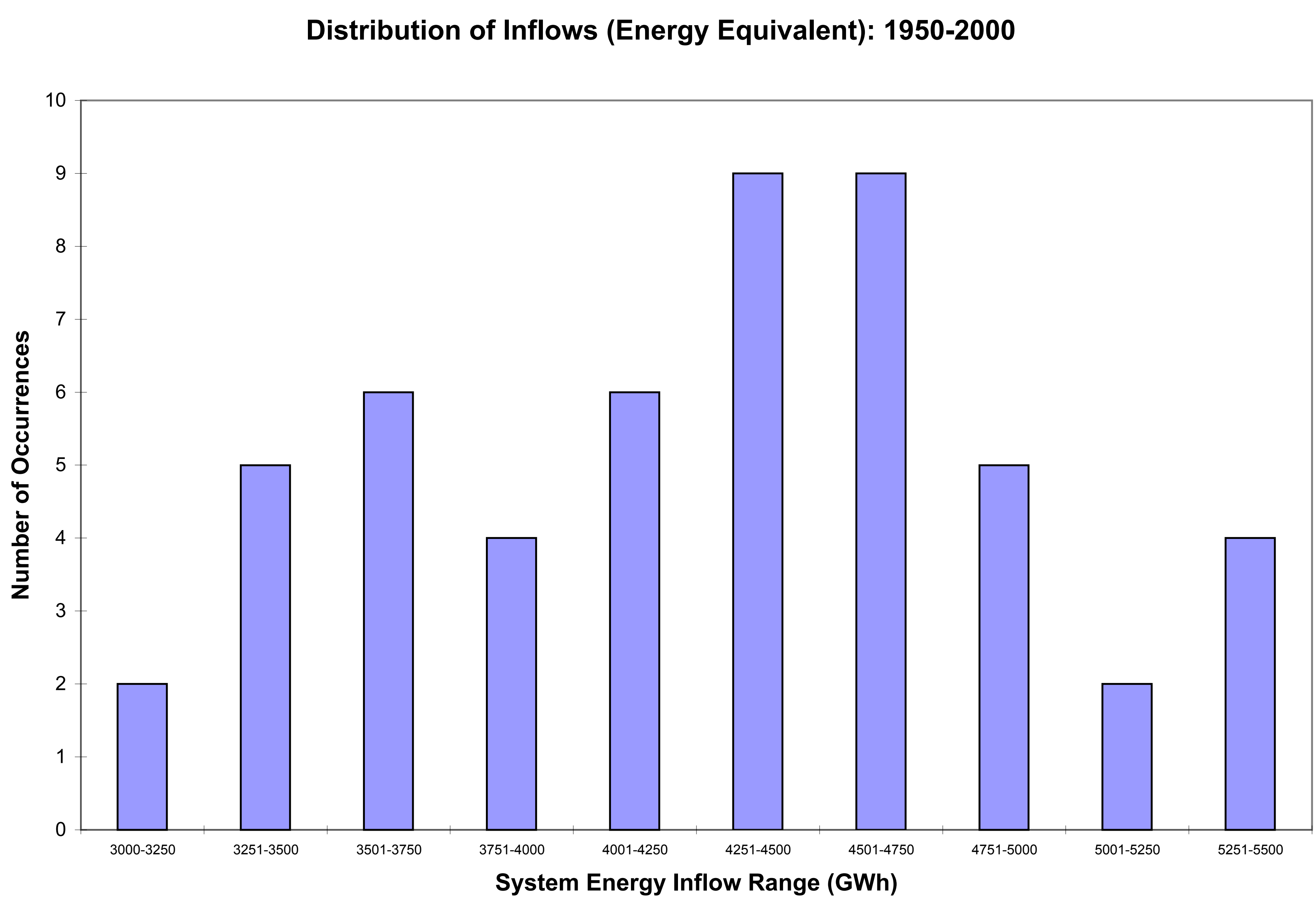

Newfoundland & Labrador Hydro Interconnected System
Annual Inflow
Inflow - Energy Equivalent (GWh)
0
1,000
2,000
3,000
4,000
5,000
Inflow - Energy Equivalent (#6 Fuel at Holyrood - millions of barrels)
0
1
2
3
4
5
6
7
8
9
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
Year

Figure 2



Distribution of Inflows (Energy Equivalent): 1950-2000
Number of Occurrences
0
1
2
3
4
5
6
7
8
9
10
3000-3250
3251-3500
3501-3750
3751-4000
4001-4250
4251-4500
4501-4750
4751-5000
5001-5250
5251-5500
System Energy Inflow Range (GWh)

Figure 3