

LOWER CHURCHILL PROJECT COST ESTIMATE PROGRESSION 1998 TO 2011

Technical Note

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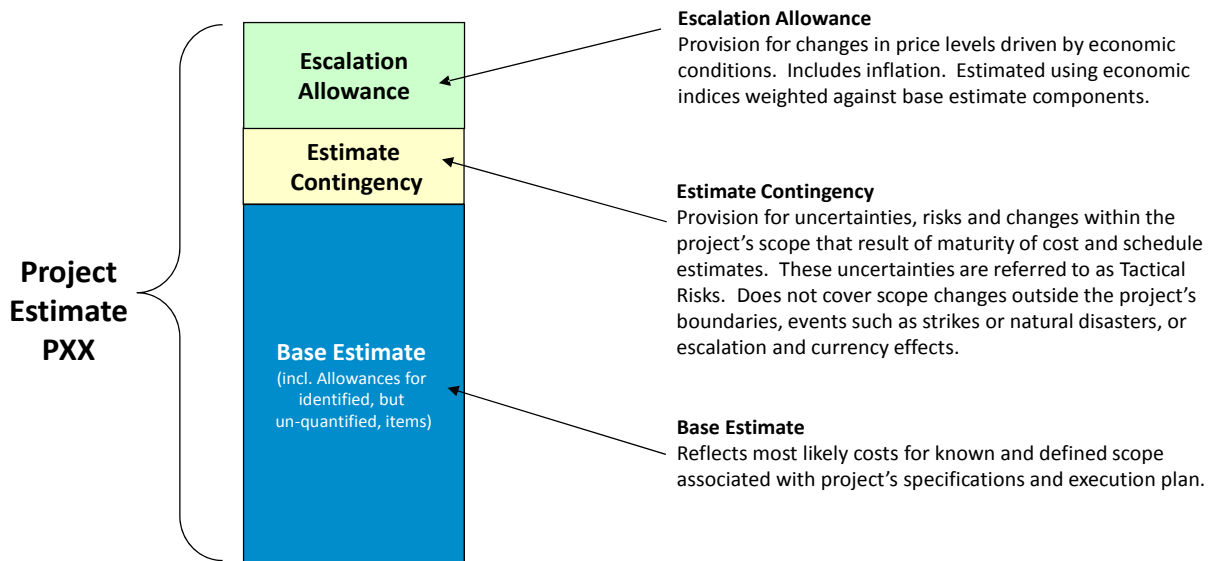
1.0 Purpose

The purpose of this Technical Note is to provide an overview of how the cost estimate for the Lower Churchill Project (LCP) has changed from the 1998 estimate to current Decision Gate 2 (2010) and to present applicable rationale to explain this change.

2.0 Scope

This Technical Note addresses the Base Cost Estimate for each of the Muskkrat Falls Generation Facility (MF) and the Labrador – Island Transmission Link (LIL) projects. It explicitly excludes contingency, escalation, or Interest During Construction (IDC) allowances / provisions, which, when combined with the Base Cost Estimate, provide the total Project Cost Estimate (reference Figure 1).

Figure 1: Project Cost Estimate Components (Nalcor Energy)



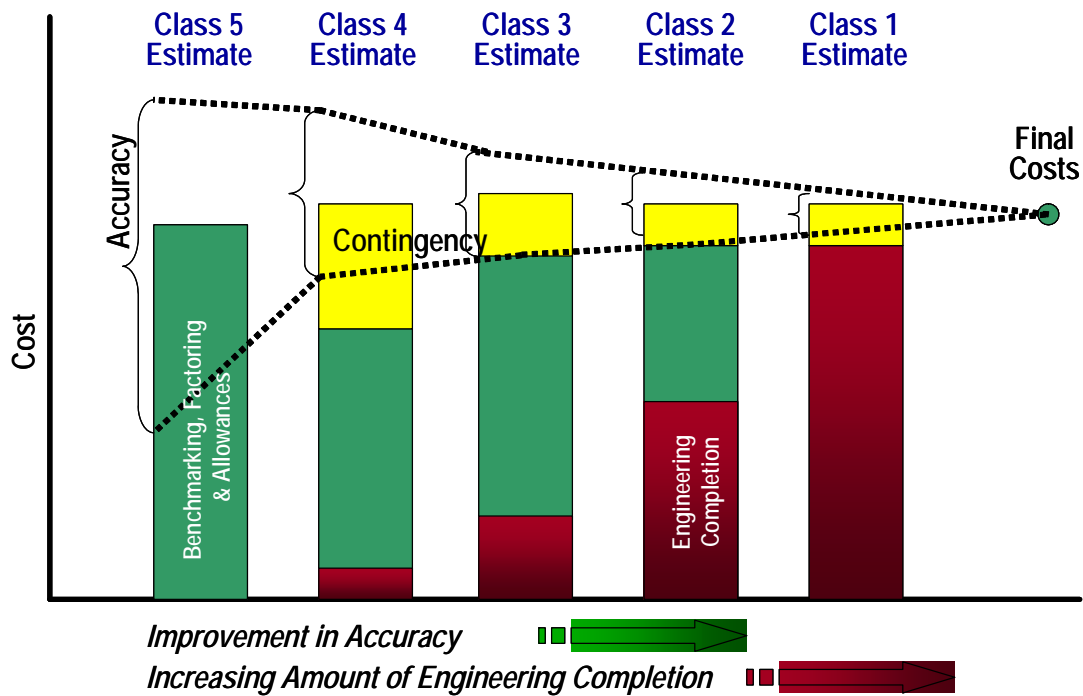
3.0 Definitions

<u>Term</u>	<u>Definition</u>
Base Estimate	Reflects most likely costs for known and defined scope associated with the project’s specifications (i.e. basis of design) and execution plan.
Decision Gate	A Decision Gate is a predefined moment in time where the Gatekeeper has to make appropriate decisions whether to move to the next stage, make a temporary hold or to terminate the project. The option to recycle to the current stage is considered an undesirable option unless caused by changes in business conditions.
Escalation	Provision for changes in price levels driven by economic conditions, including inflation.
Estimate Contingency	Provision made for variations to the basis of an estimate of time or cost that are likely to occur, and that cannot be specifically identified at the time the estimate is prepared, but experience shows will likely occur. Contingency does not cover scope changes outside the project’s boundaries, events such as strikes or natural disasters, or escalation and currency effects.
Gatekeeper	The person responsible for making the decision at the Decision Gate of the Gateway Process.
Gateway Phase	Refers to the period between Decision Gates during which the Project Team completes various work activities in order to produce Key Deliverables required to move the Project forward.
Tactical Risk	Refers to risks associated with the base capital cost estimate as a result of uncertainties with the four components of the estimate: (1) project definition / scope, (2) construction methodology and schedule, (3) performance factors, and (4) price. It excludes escalation and inflation.

4.0 Basis of Estimate

During the lifecycle of all projects, such as the LCP, it is typical for the capital cost estimate to evolve as the project definition matures, as illustrated in Figure 2. Cost estimates for both MF and LIL projects have followed a similar progression from the late 1990’s to present. During this time further technical and execution studies have revealed new insights, constraints, and opportunities that must be considered in the selection of final design layouts, execution strategies, and construction schedules, all of which have led to the ultimate determination of a cost estimate.

Figure 2: Cost Estimate Maturity Model (Nalcor Energy)



Nalcor has adopted the recommended estimating practices of the Association for Advancement to Cost Engineering (AACE) International for use in planning the development of the LCP. AACE International is recognized within the engineering, procurement and construction industry as the leading authority on cost estimating standards, practices and methods. AACE International’s Cost Estimate Classification System, shown in Figure 3, provides guidelines for applying the general principles of estimate classification to project cost estimates. Nalcor Energy has leveraged AACEI’s Cost Estimate Classification System to map the level of estimate maturity required for each of the gate decisions within Nalcor’s Gateway Process.

TECHNICAL NOTE: Muskrat Falls Generation Facility and Labrador – Island Transmission Link Cost Estimate
Progression from 1998 to Decision Gate 2

Figure 3: AACEI Cost Estimating Classification System (Reference AACE International Recommended Practice No. 17R-97)

	<i>Primary Characteristic</i>	<i>Secondary Characteristic</i>			
ESTIMATE CLASS	DEGREE OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical +/- range relative to index of 1 (i.e. Class 1 estimate) ^[a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 ^[b]
Class 5	0% to 2%	Screening or feasibility	Stochastic (factors and/or models) or judgment	4 to 20	1
Class 4	1% to 15%	Concept study or feasibility	Primarily stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget authorization or control	Mixed but primarily stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or bid/tender	Primarily deterministic	1 to 3	5 to 20
Class 1	70% to 100%	Check estimate or bid/tender	Deterministic	1	10 to 100

Notes: [a] If the range index value of "1" represents +10/-5%, then an index value of 10 represents +100/-50%.
[b] If the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

The current capital cost estimates for MF and LIL projects were prepared for the purposes of Decision Gate 2 (DG 2), and are commensurate with the level of technical and execution detail available (i.e. reflect the latest project definition arrived at from the completion of engineering studies and field investigations). The MF project is based upon Variant 10, Scheme 3b layout which includes a radial gate spillway, and temporary diversion through the spillway structure in lieu of temporary diversion tunnels as had been contemplated with Variant 7 in 1998.

At DG 2, the LIL project reflects a smaller HVdc system than envisioned in 1998 (320 kV versus 400 kV), with the HVdc converter located at MF rather than Gull Island.

Additional detail on the differences in definition of the projects (i.e. Project Definition) is contained in Section 7.1.

The DG 2 cost estimate is founded in all technical, execution, and market intelligence related studies / investigations completed to-date, and explicitly leverages the extensive engineering studies and execution planning completed during the period of 2007 – 2009, referenced as Gateway Phase 2 within Nalcor's Gateway Process. The estimate's principal purpose was to support the evaluation and selection of the potential development scenarios for the LCP.

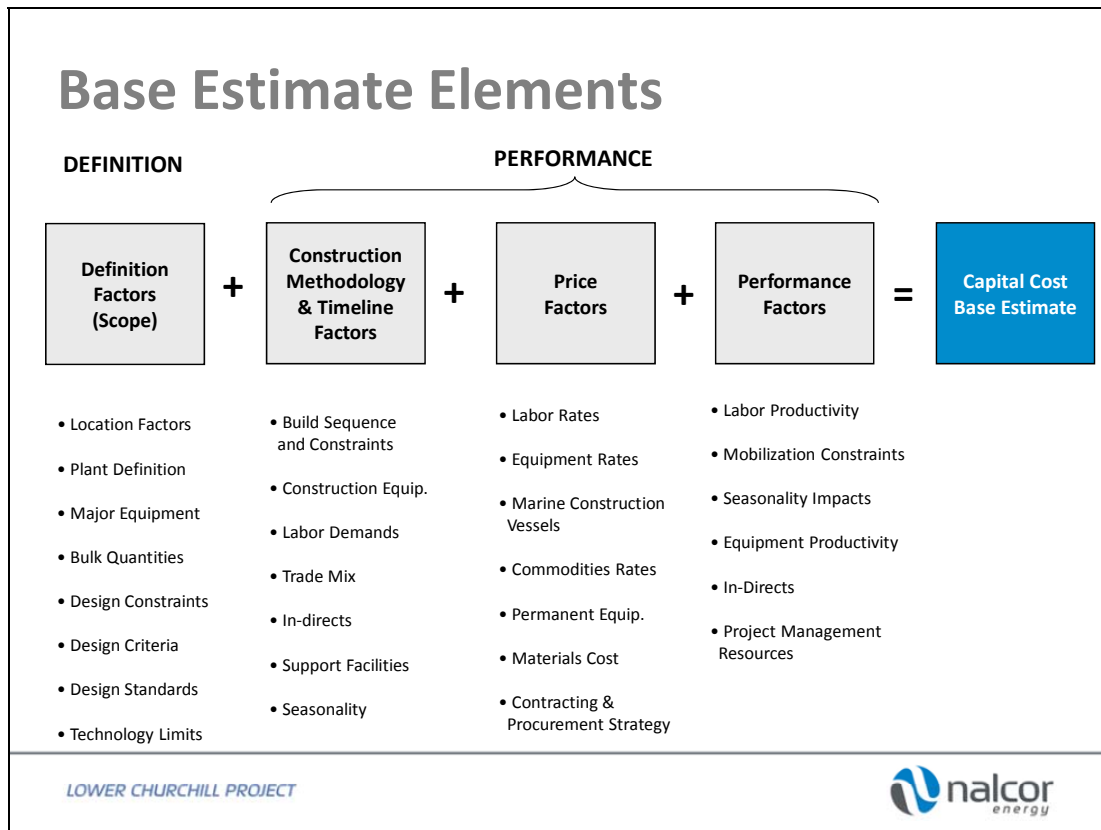
This DG 2 cost estimate reflects the key timelines and sequences, and execution approach as documented in the project execution plan, which indicates early works

construction commencing in Spring 2012 following release from Environmental Assessment and ends with commissioning of the final turbine/generator unit and thus full power in May 2017. Nalcor considers this cost estimate to be commensurate with a AACE International Class 4 estimate, thereby meeting the requirements of DG 2 of Nalcor’s Gateway Process.

5.0 Approach and Methodology

The Decision Gate 2 capital cost estimate is based on a combination of bottom-up estimating using four (4) estimate components shown in Figure 4 below for areas of the plant where detailed definition exists. In addition factored adjustments were made from the larger 450 kV Labrador – Island Transmission Link which had been developed as a bottom-up estimate to support the current 320kV overland transmission component. This estimate had leveraged extensive feasibility work undertaken in the period of 2007 – 2010 were made, as well as the 1998 Teshmont studies.

Figure 4: Capital Cost Estimate Elements (Nalcor Energy)



The latest construction methods, engineering technologies and market intelligence are critical to ensuring that the estimate contains current information. To that end, a number of external parties have been engaged to provide engineering studies, scope

definition, estimating and construction experience, and market data for inclusion in the estimate.

The MF project cost estimate has been developed using the most current information available, using site layouts and quantities contained in reports MF1010 Review of Variants, MF1050 Spillway Design Review, MF1080 Review of Construction Camp Layout, Infrastructure and Operation and MF1090 Review of Access Roads and T&W Bridge. This is the first bottom-up estimate that has been completed for the Variant 10, Scheme 3b design layout.

For estimating purposes the project has been broken down into a series of logical contract packages for construction of various components, for supply and installation of major packages such as turbine/generator units, dams, and for service and support facilities. The estimates for the various contract packages have been developed from the point of view of a contractor. The estimates for the specific contract packages have been developed by applying the costs of materials, labor and equipment to the required volume or amount of materials, quantities, and construction equipment. Each subcontract includes a separate evaluation of the contractor's indirect costs. Indirect costs such as accommodations and site services have been estimated in detail for Muskrat Falls. Support facilities have been included in the estimate, including accommodation facilities and equipment repair facilities.

Historical as-built productivity rates for concrete, formwork, tower erection and conductor stringing have been considered in the development of the estimate. Labor rates are competitive with other East Coast megaprojects, and construction equipment hourly cost were calculated from first principles, using current market prices for new equipment, diesel fuel, repairs, etc.

Estimates for permanent plant equipment (e.g. turbines, submarine cable, transmission towers, insulators, converter stations, transformers) have been based upon recent quotations received from manufacturers, while prices for key construction consumables (e.g. rebar, explosives, etc.) have been obtained from vendors.

Contractor's overhead and profit has been added to the subtotal of direct and indirect costs.

The Base Cost Estimate has been linked with the project schedule in order to produce cost flows for all major commodities and equipment in-place (reference Figure 5). Using a similar approach, the linkage of the Base Cost Estimate and Project Schedule has facilitated the production of labor histograms for each major occupational area (reference Figure 6)

Figure 5: Estimation of Capital Cost Flow (Nalcor Energy)

TECHNICAL NOTE: Muskrat Falls Generation Facility and Labrador – Island Transmission Link Cost Estimate
 Progression from 1998 to Decision Gate 2

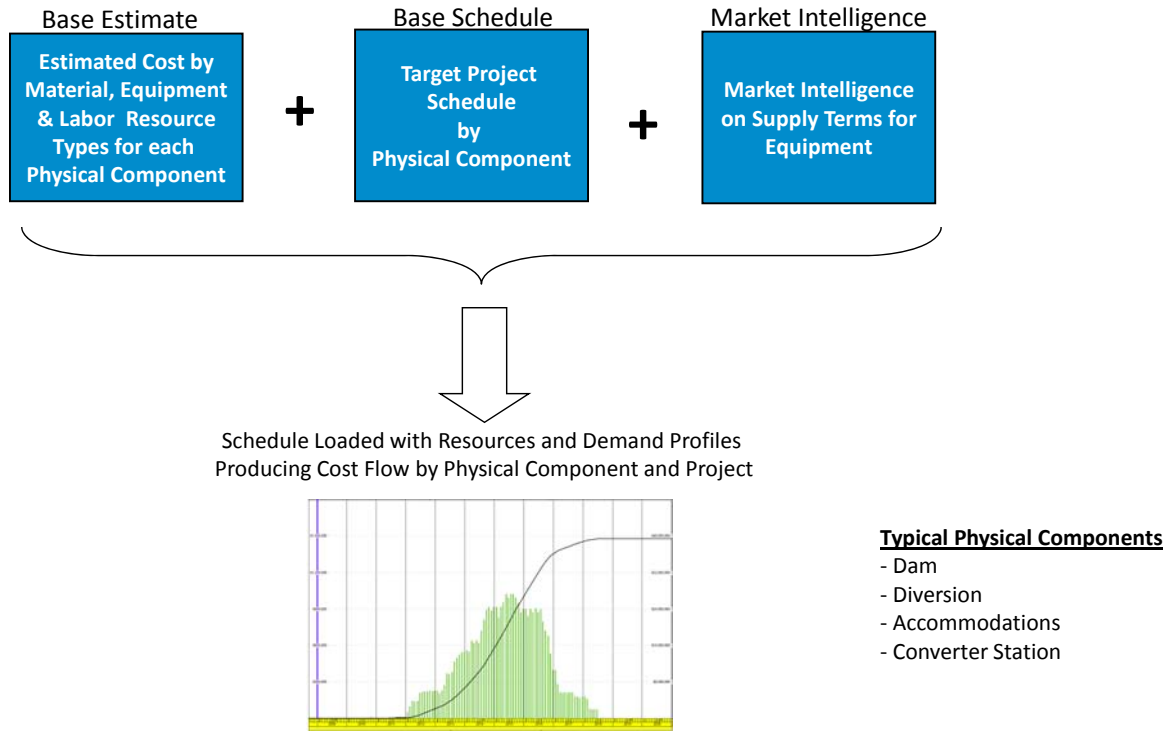
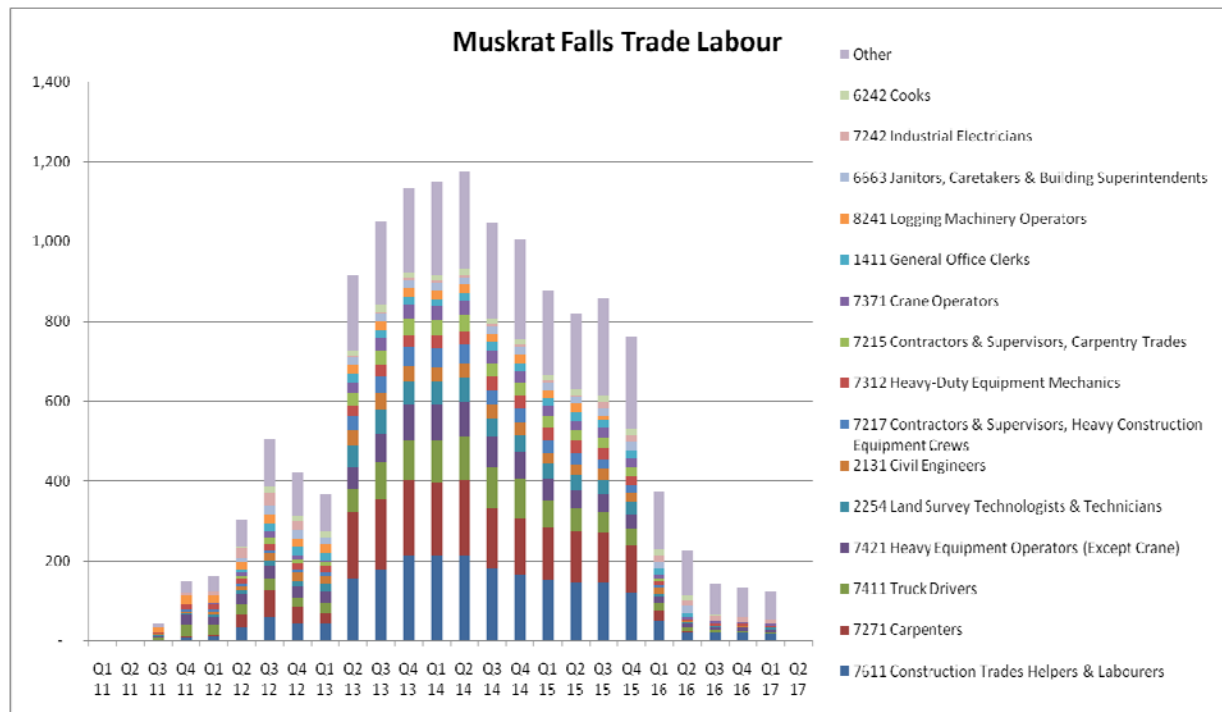


Figure 6: Histogram of Muskrat Falls Trade Labor (Nalcor Energy)



TECHNICAL NOTE: Muskrat Falls Generation Facility and Labrador – Island Transmission Link Cost Estimate Progression from 1998 to Decision Gate 2

6.0 Estimate Comparison

Table 1 presents a summary comparison of the base capital cost between 1998 and DG 2. From this comparison it is evident that the MF project cost estimate has increased substantially more than that for the LIL project. This is largely due to the fact that while the production capacity of the MF project has remained constant at 824 MW and 4.9 TWh of energy, the LIL project represents a scaled-down version of the 1998 basis. Further details of changes in key technical parameters as well as contributors to the cost delta are provided in Section 7.0.

Table 1: Estimate Summary Comparison

	<u>1998</u>	<u>DG 2</u>	<u>Increase</u>	
Muskrat Falls Generating Facility	\$ 965.2	\$ 1,972.9	\$ 1,007.7	104%
MF to Churchill Falls AC Transmission	See Note 3	\$ 233.1	\$ 233.1	-
Labrador - Island Transmission Link	\$ <u>1,302.0</u>	\$ <u>1,616.0</u>	\$ <u>314.0</u>	24%
Totals	\$ 2,267.2	\$ 3,822.0	\$ 1,554.8	

Notes:

1. 1998 Estimate extracted from Final Feasibility Study completed by SNC-Agra published January 1998. All costs are in June 1998 CDN \$.
2. DG2 estimate are in January 2010 CDN \$.
3. The 1998 developed assumed the connection of the MF plant with the HVdc Converter located at Gull Island. The two 230 kV AC transmission lines were excluded from the cost estimate, while the AC transmission link between CF and Gull Island was included in the capital cost for Gull Island.
4. The 1998 estimate for the LIL Project produced by Teshmont was premised upon the HVdc Converter being located at Gull Island.
5. These numbers represents the Base Cost Estimate prior to contingency, escalation and IDC.

7.0 Rationale for Change

The change in the estimate capital cost for the MF and LIL projects can be primarily attributed to the following two items:

1. Changes in Project Scope / Definition
2. Rising Construction Costs

TECHNICAL NOTE: Muskrat Falls Generation Facility and Labrador – Island Transmission Link Cost Estimate
Progression from 1998 to Decision Gate 2

7.1 Changes in Project Scope / Project

There are several key design differences between the 1998 design and the DG 2 plan as listed in Tables 2 and 3, each of which influence Element 1 – Project Definition of the Base Cost Estimate (reference Figure 4).

Table 2: Key Design Parameters influencing Capital Cost of MF Project

Parameter	1998	DG 2
Layout	Variant 7	Variant 10, Scheme 3b
Power Generation Capacity	824 MW	824 MW
Energy Production	4.9 TWh	4.9 TWh
Number and Size Turbines	4 x 216 MW	4 x 216 MW
Type of Turbines	3 Propeller + 1 Kaplan	4 Kaplan
Switchyard Step-up Voltage	230 kV	345 kV
Temporary Diversion Scheme	2 Diversion Tunnels	Spillway
Main Dam	RCC with Rubber Dam	RCC with Fixed Crest
Powerhouse	Center of River Channel	South Bank
Spillway	3 vertical gates	4 radial gates
Access	North Spur + Bridge	South Side Access Road
Construction Accommodations	1215 persons	1500 persons

Table 3: Key Design Parameters influencing Capital Cost of LIL Project

Parameter	1998	DG 2
Operating Voltage	400 kV	320 kV
System Capacity	800 MW	900 MW
Number of Submarine Cables	3 off	3 off
Submarine cable route	40 km	35 km
Overland Transmission Length	~1100 km	~1050 km
Design Reliability Return Period	1/50 years	1/ 50 years

It is difficult to quantify these changes without substantial forensic comparative analysis; however, all things being equal, these design changes would result in a lower cost estimate for the LIL project and a higher cost estimate for the MF project compared to the 1998 estimate. Fundamentally these Project Definition changes impact a primary input to the Base Cost Estimate – quantities.

It is important to note that the DG 2 plan is based upon development of Muskrat Falls prior to Gull Island. This results in the requirement to extend interconnecting ac transmission links from Muskrat Falls through to Churchill Falls, an additional distance of

TECHNICAL NOTE: Muskrat Falls Generation Facility and Labrador – Island Transmission Link Cost Estimate Progression from 1998 to Decision Gate 2

approximately 200 km, and include for the switchyard expansion at Churchill Falls. This adds an incremental cost in excess of \$200 million (2010 CDN).

Unlike the 1998 estimate, the current DG 2 estimate includes provisions for the environmental process, aboriginal affairs, habitat compensation, owner's cost, and construction insurance.

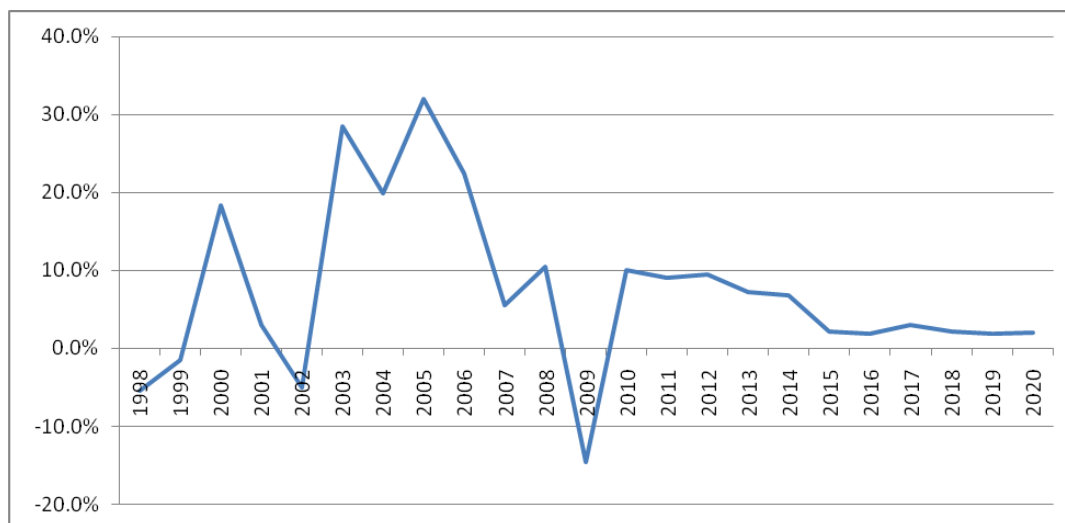
7.2 Rising Construction Costs

Likely the largest contributor to the change in the estimated base cost for the MF and LIL projects results from the third estimate element, Price Factor, shown in Figure 4. The Price Factor includes the cost for materials, equipment, labor and other items upon which the estimate is comprised. Generally industry indices indicate a doubling of construction costs since the late 1990's. If this trend were applied to the 1998 estimate, it would largely explain the incremental cost increase.

Since the 1998 estimate, global construction costs have risen significantly, in particular labor and material prices. These increases are heavily influenced by several industry-specific factors, including capital investment intentions, construction labor costs, engineering services, material costs, and construction equipment costs.

Figure 7 illustrates the annual percentage change in capital investment levels in the Canadian process industries since 1998 with forecasts to 2019. Also of note are the very large growth rates for the 2003 to 2007 period, followed by the drop in 2009. These growth rates are consistent with forecasts produced by the Construction Sector Council (CSC), which predicts steady moderate growth in construction investment over the 2011-19 timeframe.

Figure 7: Canadian Process Industry Capital Investment Annual Percent Change (1998-2019)



Source: IHS Global Insight, Q1 2010 forecast

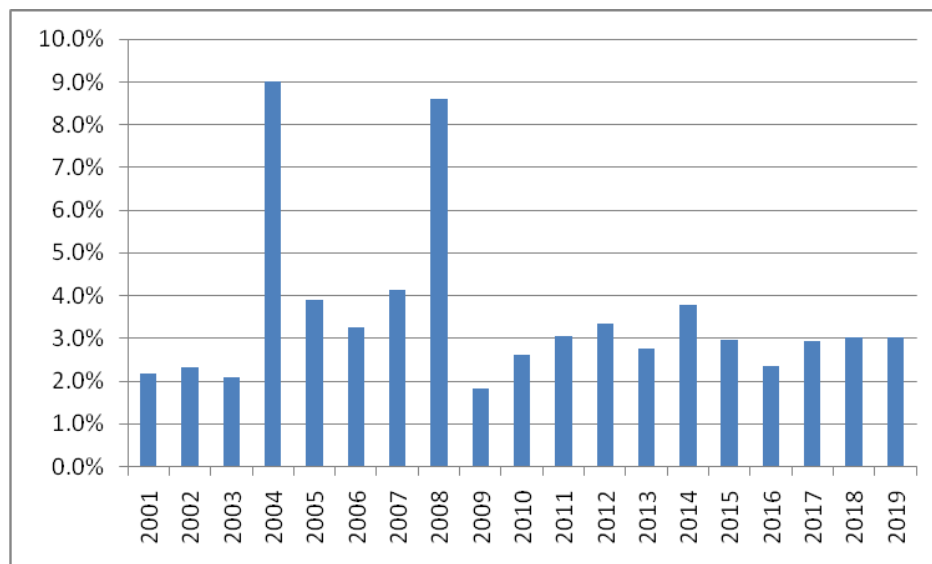
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The Canadian Process Industry includes the following industrial sectors:

<u>ISIC¹</u>	<u>Sector</u>
2A	Energy Mining
311	Food
341	Paper & Products
351	Industrial Chemicals
3529	Chemical Prods, not elsewhere classified (nec)
353	Petroleum Refineries
354	Petroleum & Coal Prods
355	Rubber Products
356	Plastic Products, not elsewhere classified (nec)
361	Pottery, China etc
362	Glass & Products
37	Primary Metals
381	Metal Products
3821	Engines & Turbines
3822	Agricultural Machinery
3841	Shipbuilding & Repair
3842	Railroad Equipment
3845	Aircraft
4	Electricity, Gas & Water

The pattern of annual change in growth in capital investment levels is closely correlated to the price index which best measures price changes in the construction industry as a whole. As Figure 8 illustrates, the period from 2004 to 2008 had significant price increases, with a much smaller increase in 2009 with a more stable long term price increase expected to 2019.

Figure 8: Price Index, Industrial Structures Montreal (V44176034.Q) (IHS Global Insight)

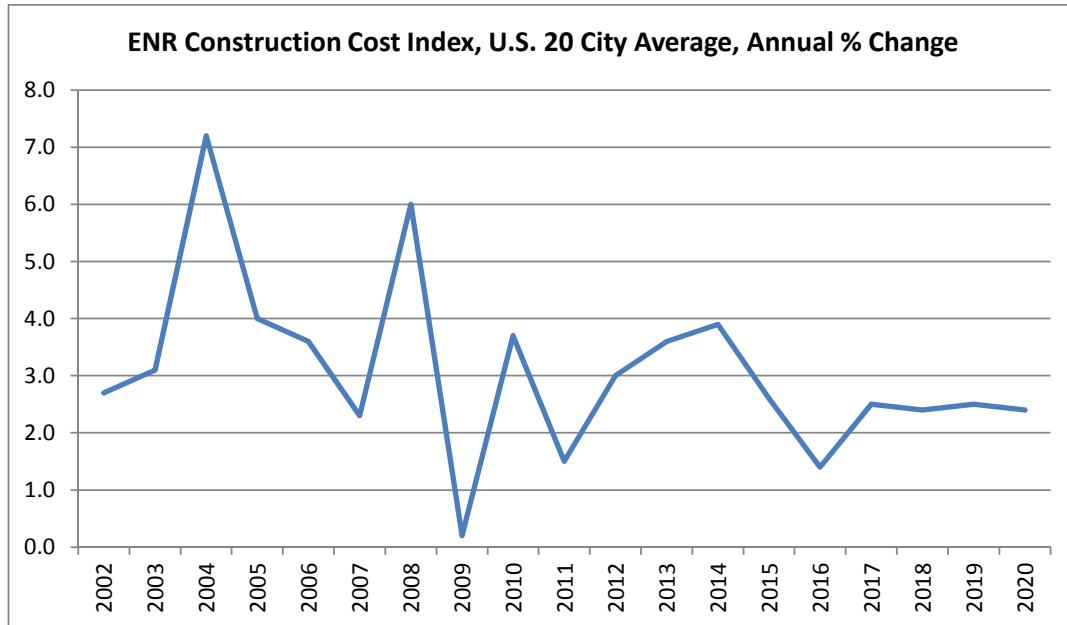


¹ International Standard Industrial Classification

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ENR Construction Cost Index exemplifies how construction cost has increased in North America since the 1990's, a similar trend as we have seen in the LCP cost estimates.

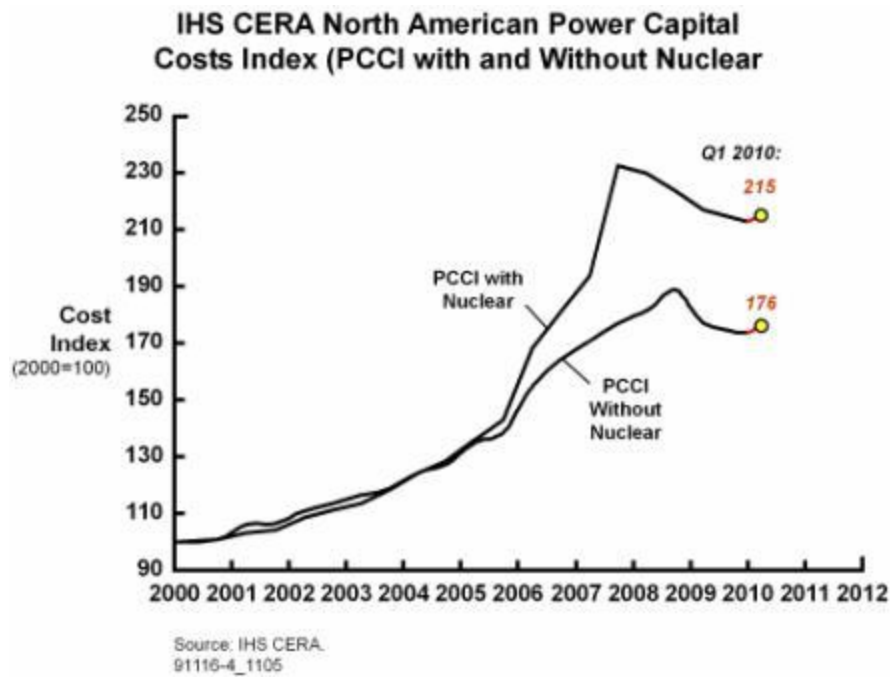
Figure 9: ENR Construction Cost Index



An additional reference point for overall cost increases specific to the power industry is the Cambridge Energy Associates (CERA) power capital cost index. This custom index uses Global Insight indices to track the costs of equipment, facilities, materials and personnel (both skilled and unskilled) used in the construction of a geographically diversified portfolio of more than 30 power generation construction projects (coal, gas, wind and nuclear) throughout North America. Figure 10 illustrates the change in this index from 2000 to 2010.

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Figure 10: IHS CERA North American Power Capital Costs Index



Finally, PowerAdvocate produces an overall cost index for transmission line construction is shown in Figure 11. This index distills all cost elements driving overall construction cost into one curve.

Figure 11: PowerAdvocate’s Transmission Construction Cost Index

