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Comments on the Justification of the Eastmain-1-A / Rupert Diversion Project

submitted to the Federal Review Panel and the COMEX, on behalf of the Cree Nations of Nemaska, Waskaganish and Chisasibi

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TABLE DES MATIÈRES

1. Introduction

1.1. Mandate

The Cree Nations of Nemaska, Waskaganish and Chisasibi have asked the Helios Centre to review and comment on the justification presented by the Proponent for the Eastmain 1A-Rupert Diversion Project ("the Project") and related issues.

In sections 2, 3 and 4, we will review and comment on three aspects identified by the Proponent as constituting the justification for the Project: Quebec's needs, energy security (reliability) and exports.

Furthermore, the Directives made clear that the Project's justification must take into account the alternatives available to meet the Project's purpose. In section 5, we will address these alternatives.

Finally, in section 6, we will summarize our conclusions.

1.2. The purpose of the Project

The Proponent has presented two purposes for the Project, describing one as the "main purpose" and the other as the "complementary purpose."

The main purpose is described as follows:

> The Québec power market is the principal market for the output of Hydro-Québec Production, and this market is growing. … To participate in the growth of the Québec power market, Hydro-Québec Production must be able to count on new generating facilities in addition to its existing fleet. This is the main purpose of the Eastmain-1-A/Rupert project. (p. 2-1)

The complementary purpose is described as follows:

> Québec is not Hydro-Québec Production's only market. The division has been active for many years in markets bordering the province, which are also growing. … [A]long with the new sales it hopes to make in Québec, Hydro-Québec Production will be able to increase electricity exports without augmenting interconnection capacity. This is the complementary purpose of the project.

It is important to distinguish between these two purposes, as they imply very different sets of criteria for establishing the project's justification.

The Proponent further indicates that it will market the energy and capacity from the project based on market conditions in and outside Québec, and that its exports will increase during the first few years following commissioning, and then decline as its power sales in Québec grow. However, quantitative information concerning the energy and capacity balance both of the Proponent and of HQ Distribution is provided only through 2014.

1.2.1. Quebec's needs

Insofar as the principal purpose of the Project is to meet Quebec's future power needs, the analysis must address the alternatives available to meet these needs, and their relative costs and benefits. An analysis of this nature calls, either explicitly or implicitly, upon the concepts of integrated resource planning, which seeks to minimize the economic, environmental and social costs to society of meeting its needs for energy services.[1] Once a need has been identified, the project would be considered justified only if "the best scenario for meeting that need includes the proposed Project."[2]

Since, under Quebec's current legislative framework, it is not the Proponent but Hydro-Québec Distribution (HQD) that is responsible for meeting Quebec's power needs, these questions fall under HQD's responsibility. Assuming that this framework will remain unchanged in the coming years, the only issue under the control of HQP is whether or not to offer power and energy to HQD in a future tender.

More specifically, the Proponent argues that with the Project, it will offer power and energy to HQD in future tenders, but that without it, it will have insufficient resources to be able to do so. This presumes, of course, that HQD has unmet needs, and will issue long-term tenders to meet those needs. It also presumes that HQP will indeed participate in such a tender, should it arise.

While the Proponent views the "need" for the Project from the perspective of its own management decisions, the Directives make clear that, insofar as the Project is meant to supply HQD's future needs, its justification must be based on an analysis of those needs and of the alternatives available to HQD.

These issues will be addressed in section 2.

1.2.2. Energy security and reliability

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[1] See J. Litchfield, L. Hemmingway, and P. Raphals. 1994. *Integrated resources planning and the Great Whale Public Review.* Background paper no. 7, Great Whale Public Review Support Office, 115 pp. *(also published in French)*

[2] Directives, p. 12.

A second element of the Project's justification is energy security and reliability. While the Proponent initially denied that the Project had any role in maintaining adequate reserves,[3] in the Supplementary information it acknowledged that it does.[4] Despite this admission, the Proponent still declined to provide the information required in section 2.1.4 of the Directives.

In fact, according to the Proponent, the Project plays an important role in assuring the 15 TWh margin of flexibility it claims is needed to ensure energy security in the face of fluctuating hydraulic inflows. These questions are addressed in section 3.

1.2.3. Export sales

Just as described above with respect to the principal purpose, to justify the Project based on supplying additional export sales, the Directives require first demonstrating that a need exists, and secondly that the best scenario for meeting that need includes the Project. It also requires examining alternatives for this purpose.[5]

The Directives require that the Proponent demonstrate the cost-effectiveness of the Project as a source for additional export sales.[6] However, measuring cost-effectiveness on a strictly economic basis is not sufficient to justify a project such as this. For large projects which impact the lives of many people, environmental assessment processes must also take into account the project's externalities — the environmental and social costs that are borne by others and are not internalized in the project's economics. Thus, analysis of the justification of such a project ultimately involves weighing the expected economic benefits against the expected net environmental and social cost, taking into account the uncertainties associated with these estimates.

With respect to its « complementary » purpose, it appears that whatever power is not purchased by HQD will be sold for export. In reviewing this aspect of the Project's justification, the review bodies must first determine whether or not the Proponent has correctly evaluated the economic costs, benefits and risks of the Project. However, since it is public funds that are involved, it is appropriate for the review bodies to examine the extent to which the Proponent has fully taken into account the Project's potential risks and benefits. Furthermore, insofar as the Project's justification is based on its perceived profitability, it is clearly part of the review bodies' mandate to weigh this profitability against the Project's environmental and social externalities.

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[3] EIS, p. 2-12.

[4] Directives, p. 24.

[5] *Ibid.,* p. 12.

[6] *Ibid.*, p. 14.

It should be noted that, insofar as the project is conceived in terms of export sales — or, more precisely, of sales into a market in which the Proponent has no obligation to serve — the Proponent is under no obligation to provide power for sale. Hence, the "no build" alternative is by definition feasible.

These questions will be addressed in section 4.

2. Meeting Quebec's needs

2.1. HQP's participation in future HQD tenders

Under the functional separation regime created by the Act to Amend the Act respecting the Régie de l'énergie (Bill 116), electricity is provided to consumers throughout the province of Quebec by Hydro-Québec Distribution (HQ-Distribution, or HQD), which is obliged to provide electric power to anyone who so requests in the territory within which it holds exclusive distribution rights.[7, 8] It is entitled by law to a large bloc of energy (heritage pool, or "patrimonial" electricity) provided by Hydro-Québec Production (HQP, the Proponent).

HQD is required by law (s. 72) to file a supply plan every three years, forecasting its needs for electricity. With the exception of very short-term contracts or emergency supplies, all of HQD's supplies must be obtained by public tender (s. 74.1).

HQP is allowed to participate in HQD's tenders, and has done so in the past.[9] However, it is under no obligation to do so.

In the Environmental Impact Statement (EIS), the Proponent wrote that

> Hydro-Québec Production has no statutory obligation to supply electricity to Hydro-Québec Distribution in excess of the heritage pool. It is free to bid in competition with other suppliers in response to future calls for tenders from Hydro-Québec Distribution to meet additional supply requirements.
>
> Moreover, Hydro-Québec Production has made no long-term commitment to supply electricity to Hydro-Québec Distribution beyond the heritage pool and the 600 MW pursuant to Call for Tenders A/O-2002-01 …

[7] This includes all of Quebec, with the exception of those territories served by municipal distribution utilities or by the Coopérative régionale d'électricité de Saint-Jean-Baptiste de Rouville. *Loi sur la Régie de l'énergie (LRÉ),* R.S.Q., C. R-6,01, s. 76.

[8] The *Stratégie énergétique du Québec 2006-2015* published in May 2006 proposed to limit this obligation to 50 MW (p. 25), as discussed below in s. 2.2.1.

[9] HQP won two of the three contracts awarded in 2003 following HQD's tender A/O-2002-01.

> However, once the project is under construction, Hydro-Québec Production intends to participate in new calls for tenders by the Distributor for long-term supplies. If construction commences as planned in the summer of 2006, Hydro-Québec Production will be able to bid for the supply of additional long-term needs starting in 2011. Hydro-Québec Production will not participate in any new calls for tenders by the Distributor for long-term supply until the project is under construction. (EIS, pp. 2-5; underlining added)

In its new Strategic Plan, however, Hydro-Québec further restricts its willingness to participate in future HQD tenders. In the Energy and Capacity Balance on p. 16 of the Strategic Plan, a separate line indicates the « Uncommitted resources available for long-term sales ». This value remains nil until 2012, when the « Margin of flexibility for managing runoff risk and short-term sales » reaches 15 TWh. It only becomes substantial in 2014, when a refurbished Gentilly-2 comes back on line.

This presentation implies that HQP's intention is now to abstain from any long-term sales to HQD that would leave it with a margin of flexibility lower than 15 TWh. Thus, even if the Project were to begin construction as planned, HQP would not participate in a tender for deliveries beginning earlier than 2014.

It is also important to realize that HQP has made no commitment to pass on the relatively low costs of the Project to Quebec consumers, even if it does participate in a tender. In the 2002 tender, HQP's approach was to price its bid just below the prices expected from its combined cycle competitors — low enough to win the contract, but no lower.[10] Thus, HQP's baseload contract is priced at 5.5¢/kWh, even though the power is supplied from LG-2, at a cost of under 1.5¢.[11] HQP has never suggested that it would change this policy. Thus, one should not expect HQD or its clientèle to expect any economic benefits from purchasing power from the Project.

In conclusion, it is clear that HQP has no statutory obligation to offer power to HQD, nor has it made any firm commitment to do so. Rather, assuming that the existing legal and regulatory framework remains in effect, the decision to submit a bid in response to an HQD tender — if and when such a tender is issued — will be made by HQP (i.e., by Hydro-Québec top management) at that time. Based on current policy, it is clear that this decision will be made in order to maximize economic benefits to Hydro-Québec's shareholder. There is thus no certainty that the power from the Project will ever be offered to HQD, or under what terms and conditions.

2.2. HQD's need for additional power and energy

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10 Indeed, HQD justified the reasonableness of HQP's price by comparing it to the price of a new combined cycle natural gas plant in New England. Merrimack Energy, *The Competitive Cost of Power in the Northeast Market*, HQD-2, doc. 4, (June 20, 2003), Régie de l'énergie, R-3515-03.

11 Régie de l'énergie, Décision D-2003-159, p. 17; EIS, p. 2-15.

According to the Directives :

> The Proponents shall first demonstrate that they need new or additional electrical generating capacity and energy resources, and that the best scenario for meeting that need includes the proposed Project.

In the following sections, we will look at HQD's need for additional energy and capacity.

2.2.1. HQD's energy balance

In the original EIS, Table 2-5 showed a need for additional supplies of 9.3 TWh starting in 2011. While no information was provided beyond that date, it seemed appropriate to assume that these needs would continue to grow.

Much has changed, however, since the EIS was originally filed in December 2004. In the updated tables filed just one year later, the additional supplies required by HQD in 2011 had fallen by almost 85% to 1.5 TWh (Volume 1, Annex 1, p. 3). Furthermore, this table shows that additional supplies needed will decline even further in coming years, to 1.1 TWh in 2014, the last year for which information is presented.

There is thus no information available to suggest that HQD has any substantial need for additional energy within its planning horizon.

Also, the *Stratégie énergétique du Québec* made public in May 2006, and of Hydro-Québec's *Plan stratégique 2006-2010* that followed it, introduce policies that will limit growth of HQD's future needs even further.

The load forecast underlying the projected needs in the Updated EIS[12] takes into account Hydro-Québec's proposed *Plan global d'efficacité énergétique 2005-2010.*[13] According to this Plan, HQD would achieve 4.1 TWh of new savings in 2010, and this amount would remain constant through 2014.[14]

Under both the *Stratégie énergétique* and the *Plan stratégique*, Hydro-Québec now intends to achieve 8.1 TWh of energy savings by 2014. This therefore represents 4 TWh of energy savings above and beyond the levels included in the Updated EIS (Tableau B). Thus, all else being equal, instead of needing 1.1 TWh above and beyond identified resources in 2014, HQD will instead have a surplus of 2.9 TWh.

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[12] We will use this term to refer to the EIS, as modified by the Supplementary Information.

[13] *État d'avancement du Plan d'approvisionnement,* Oct. 19, 2005, Appendix III, Supplementary Information (December 2005), p. 17.

[14] Ibid., p. 18.

Another factor that may tend to reduce energy needs is the new government policy with respect to large industrial rates. The load forecast foresees an increase in energy needs from large industrial users of 11.1 TWh between 2004 and 2014.[15] However, two policy choices made in the *Stratégie énergétique* can be expected to reduce this growth, perhaps substantially.

First, the Quebec government will henceforth limit HQD's obligation to serve new loads at 50 MW. In other words, any new loads greater than this amount will be subject to Hydro-Québec's discretion.

Second, the *Stratégie* makes clear that, if authorization is granted, the rates to be offered will take into consideration the resulting economic spinoffs. In the *best of cases*, the new user will be required to pay the regular industrial rate; otherwise, higher rates may be applied, to reflect the additional costs that such new loads create for the system as a whole.[16] This means, of course, that new large industrial users will not benefit from special low rates, as they have in the past. While Hydro-Québec's load forecast documents do not provide enough detail to evaluate the precise consequences of this change, it certainly suggests that the industrial growth will be revised downward in the next annual load forecast update.

Furthermore, the language in the *Stratégie* makes clear that the Quebec government has no intention of renewing the risk and profit sharing contracts under which most of Quebec's aluminum and magnesium smelters operate, but rather intends that these users pay the regular industrial rate (Rate L) in the future. This of course is very bad news for the aluminum industry. As electricity rates in Québec rise, aluminum producers can be expected to reduce their production here (and therefore the power consumption), especially when aluminum prices are low. A similar effect has been observed in recent years in the Pacific Northwest, the other large aluminum smelting region in North America. While no closures are expected in the short term, it is unlikely that there will be new investments to modernize inefficient smelters, and more likely that that these plants may eventually close.

While difficult to quantify, this issue could lead to substantial *decreases* in demand for electricity in Quebec.

This situation of course represents a reversal of important trends that have been in place for decades. The causes of this fundamental shift are due, in the first place, to the fact that, on the margin, hydropower is no longer cheap. Future hydropower resources will have costs twice

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[15] *État d'avancement*, p. 10.

[16] The relationship between new loads and system costs is explained in the Avis de la Régie de l'énergie sur la distribution d'électricité aux grands consommateurs industriels (A-2005-01), pp. 46-47.

those of the Project, and 4-6 times as much as the La Grande project; they appear to be of the same order of magnitude as the projected cost of thermal power.[17]

Furthermore, due to the new regime of heritage pool (patrimonial) power, and the great cost differential between patrimonial and post-patrimonial power, rates are now very sensitive to increased load. As noted by the Régie in the Avis quoted earlier, new loads create significant economic costs borne by all. It is in no way surprising that such a sea change will affect industrial development policies.

To summarize, there is thus nothing in the file to indicate any substantial power needs for HQD within its planning horizon, nor is there reason to believe the situation will change in the years thereafter. While the slow, steady growth in Quebec's population and domestic energy use can be expected to continue, this could be more than compensated for if expected industrial growth fails to materialize or if existing energy-intensive industries eventually leave the province.

Furthermore, a number of additional resource options are likely to emerge in the next 5-10 years that will make new long-term tenders even less likely. These include:

- **energy efficiency:** Hydro-Québec Distribution's energy efficiency target has been increased several times since its first *Plan global de l'efficacité énergétique* was filed in 2002. The target went from 1.5 TWh in 2010 (original plan), to 4.1 TWh in 2010 (current version of plan), to 8 TWh in 2015 (*Stratégie énergétique du Québec* and *Plan stratégique 2006-10*). However, the potential is far from exhausted. In 2004, Belliveau et al. identified a cost-effective energy efficiency potential for HQD of 12.6 TWh in 2012.[18] If the substantial increase in electric rates and avoided supply costs were taken into account, the potential would rise considerably higher.

- **distributed generation.** In its decision D-2006-28 issued on February 9, 2006, the Régie de l'énergie for the first time made it possible for consumers to generate electricity to meet their own needs and return surplus energy to the grid. During times when their distributed generation exceeds their consumption, the energy can be returned to Hydro-Québec and "banked" for credit against future consumption. While this pilot program is limited in several respects, there is every reason to believe that, in coming years, it will expand, as it has in many North American jurisdictions. Distributed generation has the potential to substantially reduce the already very modest growth in non-industrial loads in Quebec. In the agricultural milieu, and in rural residential areas, there is already considerable interest in small-scale wind development. Furthermore, the cost of solar

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[17] The cost of the La Romaine project is estimated at 8.1¢/kWh (http://www.regie-energie.qc.ca/audiences/3526-04/RepHQ_DemRensRegie/HQP-3-Doc-1_3526_RepHQP-DemRens-1Regie_19mars04.pdf, pp. 44-450; the average cost of La Grande stations in 2011 will be 1.43¢/kWh (EIS, Table 2-16); thermal power costs are discussed in section 4.2, below.

[18] Belliveau, Neme, Plunkett, Dunsky, *Opportunities for Accelerated Electrical Energy Efficiency in Quebec: 2005-2012,* expert testimony before the Régie de l'énergie, R-3526-04.

cells is expected to decline precipitously in coming years, due to technological improvements, which could for the first time make this a realistic option in Quebec.[19]

2.2.2. HQD's capacity balance

While, as we have seen, HQD has no unmet energy needs through 2014 and perhaps well beyond, it does have capacity needs, ranging from 730 MW this winter to 1350 MW in 2013-14.[20]

A number of alternatives exist to meet these needs:

- **interruptible power.** No growth whatsoever is forecast for the 500 MW of interruptible electricity currently available. There is no doubt that, if an effort is made to broaden this program, it could be expanded considerably. Furthermore, though Quebec is much slower off the mark than Ontario with respect to "smart meters" and time-of-use pricing, one can expect at least some progress to be made over the next decade, which will inevitably result in some reduction in demand at the system peak.

- **energy efficiency.** As noted in section 2.2.1, the forecasts presented in the EIS and the Supplemental Information are based on the *Plan global d'efficacité énergétique*, which forecasts savings of 4 TWh through 2014. The doubling of this objective to 8 TWh under the new *Stratégie énergétique* will inevitably reduce peak power needs as well, since the most potent resources — those affecting the thermal envelope of buildings — directly reduce capacity needs at system peak — which, due to Quebec's high electric heating loads, always occurs during very cold periods — as well as energy needs.

- **wind power.** The capacity balance shows contributions to peak needs of 347 MW for the first tender, and 600 MW for the second one. This is based on the assumption that the balancing (*équilibrage*) contract signed between HQP and HQD in June 2005 remains in effect, and that a similar contract is signed for the 2000 MW tender. Under this type of contract, HQP receives the constantly varying output from the wind turbines, and provides HQD with firm power (24 hours a day, 365 days a year) equivalent to their average output.

  There is good reason to believe that HQD would be better off without such a contract. First, the strong correlation between wind output and demand means that the actual contribution to peak would be greater in most years than the average value provided under the balancing contract. Second, the flexibility mechanism built into the heritage

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[19] Despite Quebec's cold climate, its average level of solar radiation is quite high, superior to that of some tropical cities.

[20] Updated Table B-1.

(patrimonial) contract established under Bill 116 has the unexpected effect of absorbing a great deal of the variability of wind output.[21] Finally, supply contracts with a 100% capacity factor like this one are in fact of limited utility to HQD, as its load curve is far from flat.[22]

While the Régie has given its formal approval to the first balancing contract, it has made it clear that it intends to review the terms and conditions before all but the earliest deliveries begin.[23]

Specifically in terms of HQD's capacity balance, there is considerable literature suggesting that there is greater capacity value in the constantly varying wind output than the amounts provided under the balancing contract.[24]

For all these reasons, it is likely that HQD will obtain more capacity value for its 3000 MW of wind (3500 MW, with the additional 500 MW set aside for municipalities and First Nations in the *Stratégie énergétique*) that the 947 MW indicated here.

- **short-term purchases.** It is important to note that the capacity shortfall in 2014 is only slightly greater than the one last winter. HQD has indicated that the cost of purchasing firm capacity on the US market last winter was only $10/kW.[25] Such purchases remain a realistic and inexpensive option..

- **single-cycle combustion turbines (*turbines à gaz)***. In the event that HQD required peak capacity but not energy, single-cycle combustion turbines (*turbines à gaz*) represent a cost-effective alternative to short-term purchases. They are not subject to the environmental constraints associated with combined-cycle gas turbines (*turbines à gaz, cycle combiné*), like the Suroît project, because they are intended to operate only a few hours per year, during periods of peak demand. In contrast, the Suroît project was intended to operate 85-90% of the time.

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[21] These are the conclusions of a detailed analysis of hourly wind and load data submitted by the author as expert testimony in the Régie proceeding concerning HQD's Supply Plan 2005-2014 (R-3550-04). Raphals, Philip, Implications pour le Distributeur de l'ajout des parcs éoliens en Gaspésie, May 25, 2005. www.regie-energie.qc.ca/audiences/3550-04/Memoires3550/RNCREQ-8_3550 _RapExpertRaphals CORRIGE_14juin05.pdf.

[22] Ibid.

[23] According to the Régie's decision D-2006-27, the agreement must be subject to a new review before it comes up for renewal in 2009. Furthermore, though the question of the need for such an agreement was examined in the hearing on the Supply Plan 2005-14, a decision was deferred until the next supply plan, which will be filed in 2007.

[24] See section 3.2, below.

[25] HQ Distribution, Présentation sur les coûts évités, 12 mai 2006, page 14.

For example, the 428 MW combustion turbine at Bécancour is expected to function only 0.2% of the time, or 17 hours per year. Production figures from the early 1990s confirm this usage pattern for most years.[26]

All-in capital costs for combustion turbines are currently estimated at under US$600/kW.[27] The reliability benefits of locating such facilities near load centres should not be underestimated.

Given all these options, it is clear that HQD's 1350 MW of capacity shortfall in 2013-14 does not contribute in any significant way to the likelihood of its holding long-term tenders for power and energy, or for its need for the Project.

3. Energy security and reliability

3.1. HQP's margin of flexibility

In the absence of the Project, HQP expects to have a « margin of flexibility » of 12.8 TWh in 2014.[28] According to Hydro-Québec's Strategic Plan 2006-2010, released last month, the expected margin of flexibility in 2014, without the Project, will be 14.3 TWh, 1.5 TWh more than the figure in the Updated EIS.[29] It should also be noted that, again according to the Strategic Plan, the La Romaine project will provide 0.4 TWh in 2014, the first year of its commissioning. Within a few years, it will provide 7.7 TWh per year. A project of similar scale is planned for the Petite Mécatina. It can thus be expected that the total surplus (including both the flexibility margin and « available resources ») will increase to over 20 TWh, if not more, by the latter part of the next decade.

This represents thus a significant improvement compared to the situation reported in the original EIS, where HQP's margin of flexibility in 2011 would only have been 6.7 TWh.[30]

Hydro-Québec affirms that it requires a margin of flexibility of at least 15 TWh before it can commit to long-term sales. (EIS, p. 2-9) However, this key term is not defined by the

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[26] Per plant production data are available only through 1995.

[27] ICF Consulting, Avoided Energy Supply Costs in New England, December 23, 2005, p. 63. http://publicservice.vermont.gov/pub/other/aescfullreport2005.pdf.

[28] Updated EIS, Table C-2.

[29] Flexibility margin of 15 TWh + available resources of 7.8 TWh = 22.8 TWh, minus 8.5 TWh from the Project.

[30] EIS, p. 2-9.

Proponent. In order to evaluate the soundness of this affirmation, a clear understanding of the concept is required.

In Hydro-Québec's parlance, margin of flexibility refers to the need for a planned surplus to provide secure supply in the face of runoff that varies substantially from year to year.

> The annual margin of flexibility … must enable HQP to replenish its energy reserves after a period of low runoff, without interrupting firm deliveries.[31]

HQ's runoff is usually modeled as a normal distribution with a standard deviation of about 20 TWh. This means that runoff varies randomly from year to year, such that 98% of the time it falls within two standard deviations (40 TWh) of the long-term average.[32]

How does a hydro utility ensure reliability in the face of such drastic variations in supply? If the utility is highly interconnected, in relation to its own size, it can simply rely on purchases from its neighbours to meet any annual hydraulic shortfall. This is not Hydro-Quebec's situation: its annual domestic demand (around 180 TWh) is many times greater than the import capacity of its interconnections.

In such a situation, in the absence of significant storage, a utility would have to "overbuild" its system to provide, on average, considerably more energy than it requires each year, to avoid shortfalls in years of low runoff. Many hydro systems that do not have significant storage capacity have developed in precisely this way, and thus have significant surplus in most years.

Reservoir storage, however, is designed to reduce or eliminate the need for a planned surplus. There is thus an inverse relationship between the storage capacity in a hydro system and the need for a planned surplus, or flexibility margin.

A report on Hydro-Québec security of supply commissioned by the Régie de l'énergie in 1998 indicated that Hydro-Québec had at that time 171 TWh of useful storage capacity, of which 45-50 TWh was allocated for seasonal storage.[33] That leaves 120 TWh or more of interannual storage, designed precisely to allow water from wet years to be saved for use during dry years.

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[31] Hydro-Québec, *Strategic Plan 2006-2010*, p. 9.

[32] Considerable effort has been dedicated to determining how accurately this simple model reflects actual year-to-year variations. See *Série d'apports énergétiques: Mandat confié en 2005 au groupe d'experts. Résumé et rapports des experts, Novembre 2005.* Most models include some degree of year-to-year correlation. However, this does not materially affect the analysis presented here.

[33] Biggerstaff, Dodge et Mittelstadt (1998), *An Assessment of Hydro-Québec's Security of Supply in Accordance with Their Energy Reliability Criteria*, p. 9. www.regie-energie.qc.ca/audiences/3526-04/SpecialReport_HQ_Confidential_18dec98.pdf. This value has increased since 1998, due the to commissioning of the Sainte-Marguerite-3 project in 2001.

How much surplus production capacity is needed, given Hydro-Québec's interannual reservoir storage capacity? When the utility's reliability criteria were established in 1991, the optimal level of surplus production capacity was determined to be 3.3 TWh, based on projected 1995 load data.[34] However, according to Biggerstaff et al., in 1998 Hydro-Québec determined that a « hydro energy excess » (planned surplus) of 5 TWh was required to meet the 0.35 TWh/year loss of load expectancy.[35]

Why then does Hydro-Québec now insist on the need for a flexibility margin of 15 TWh? It was in the hearings before the Régie de l'énergie concerning the Suroît gas combined cycle plant that Thierry Vandal, then head of HQP, first mentioned his division's interest in developing a planned surplus (« marge de manœuvre ») of 15-18 TWh. The author's testimony before the Régie reviewed Hydro-Québec's approach to maintaining an adequate flexibility margin both in real time (water storage) and in the planning period (planned surplus). It pointed out that, over the long term, this surplus production is inevitably exported, and thus needs to be examined in terms of the costs, benefits and risks of such an export strategy.[36]

While it is generally recognized that societies must unavoidably absorb the environmental externalities that result from meeting their own energy needs, there exists no similar consensus with respect to the environmental externalities resulting from energy exports. In the words of Prof. Arturo Gándara of the University of California,

> [T]he importation of power results in the exportation of its environmental burden, and the exportation of power results in the importation of an environmental burden.[37]

Gándara's article addresses the question of air pollution in Mexico caused by power plants exporting electricity to the United States, but the issue is the same. How do we determine to what extent a society is willing to accept increasing its energy-related environmental burden, when the energy is not to serve its own needs but those of its larger neighbours?

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[34] For a detailed account of these criteria and their development, see Raphals, Philip, *La sécurité des approvisionnements patrimoniaux dans le cadre du Plan d'approvisionnement,* expert testimony filed at the Régie de l'énergie in the file R-3470, phase II, April 23, 2002.

[35] Biggerstaff et al., p. 22, relying on Hydro-Québec (1990) La fiabilité énergétique et la planification des équipements de production and Hydro-Québec (1992) Vice présidence planification du réseau, *Impacts de la révision des critères de fiabilité en puissance et en énergie*.

[36] Philip Raphals, Testimony before the Régie de l'énergie, R-3526-04, Notes de présentation, 17 mai 2004. www.regie-energie.qc.ca/audiences/3526-04/MemoiresParticip3526/Memoire_CentreHelios_23avr04.pdf.

[37] Arturo Gándara, "United States-Mexico Electricity Transfers: of Alien Electrons and the Migration of Undocumented Environmental Burdens," *Energy Law Journa*l, Vol. 16, No. 1 (1995).

The author's testimony concluded as follows:

> On peut en conclure que le projet de construire une surcapacité, au-delà des engagements d'HQP, de 15 à 18 TWh par année est un mégaprojet qui mérite un examen détaillé quant à ses risques et bénéfices potentiels sur le plan financier, et de ses implications environnementales. Avec respect, je crois que la simple affirmation qu'un tel surplus est optimal n'est pas suffisante. La détermination du niveau optimal d'une telle marge de manœuvre — qui équivaut à une décision sur la rentabilité et de l'acceptabilité d'un grand nombre de projets à risque — requiert un débat plus élargi.[38]

In its recommendation to the Minister of Natural Resources in this file, the Régie retained the essence of this analysis. It wrote :

> Selon les experts Biggerstaff, Dodge et Mittelstadt, dans rapport de 1998, historiquement, Hydro-Québec planifiait croissance de son parc de façon à maintenir une marge manoeuvre de 5 TWh alors que le Producteur cherche augmenter jusqu'à 18 TWh au cours des prochaines années.
>
> RECOMMANDATION NO 7
>
> Au cours de la prochaine année, Hydro-Québec déposera auprès de la Régie une étude sur l'impact à la hausse de la marge de manoeuvre de 5 TWh à 18 par le Producteur en tenant compte des dernières données climatiques et conditions du marché.

It should come as no surprise that Hydro-Québec did not follow the Régie's recommendation in this regard. Since the adoption of Bill 116 in June 2000, which exempted HQ-Production from the Régie's oversight, HQP has jealously guarded its independence from the Régie, with the single exception of the Suroît hearing which, it must be recalled, was convoked in response to a request of the Minister of Natural Resources.

It is surprising, however, that Hydro-Québec has not used other fora, such as the present one, to make a fuller case as to the desirability of constituting such a massive reserve for export. It has failed to do so. It does, at least, acknowledge that this energy making up the flexibility margin will ultimately be exported.[39] However, it has not presented any explicit justification for the choice of 15 TWh — as opposed to 5, or 10, or 20 TWh — nor has it provided any detailed analysis of the costs, benefits and risks of such a strategy. Given the very large sums involved, as well as the very significant environmental and social externalities resulting from this policy, this is an important oversight.

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[38] Raphals, *op. cit.*

[39] Line labelled "Flexibility margin for managing runoff risk and short-term sales" in chart.

It could be argued —Tables E-1 and E-2 of the Promoter's Supplementary Responses point in this direction — that a very large flexibility margin is needed in order to maintain reliability in the event of an adverse hydraulic sequence. According to these tables, which present a scenario in which runoff for the 4-year period 2006-09 is 98 TWh below average (the worst scenario which is likely to occur 2% of the time), the energy available for short-term export in the absence of the Project is just 5.9 TWh in 2014.

First, it should be noted that this scenario creates no significant danger. While imports are required in the period 2006-2010 (which is in any case prior to the proposed commissioning dates), reservoir levels at January 1 have recovered to their starting levels by 2014.

Second, it is important to situate this scenario within HQP's management strategy which consists of maintaining reservoir levels on May 1 (typically the low-point of the year) at around 60 TWh.[40] These same charts show Nov. 1 levels (the high-point of the year) of about 120 TWh, which is just 70% of the useful storage capacity of 171 TWh mentioned above.

In the 1998 report quoted above, which was commissioned by the Régie and only made public in 2004, Biggerstaff et al. questioned this approach. They pointed out that Hydro-Québec's policy of operating its reservoirs in the lower half of their operating range leads to a double loss of efficiency, both through the loss of head and of turbine efficiency.

> **Impact of Lower Reservoir Levels on Production Efficiency.** The Hydro-Québec reservoir system has been operating in the lower half of its operating range during much of the 1990s, due in part to low inflows and in part to its non-firm sales strategies. It should be pointed out that operating continuously in this range results in forgoing a significant power of the systemès energy potential at the storage projects themselves. Operating in the bottom half of the reservoir means an energy loss due to a lower generating head. Furthermore, turbines are typically designed to operate most efficiently at the heads that would occur in the middle to upper portion of the reservoir's operating range. While all of this is presumably acounted for in the economic model which drives Hydro-Québec's day-to-day sales strategy, a policy that leads to prolonged operation in an inefficient operating range needs to be carefully monitored.[41]

[40] See pages 6 and 7 of Hydro-Québec's most recent bi-annual filing at the Régie, http://www.regie-energie.qc.ca/audiences/CriteresFiabilite/HQ_CriteresFiab_AnnexA-B_25mai06.pdf. It should be noted that, until recently, Hydro-Québec refused to divulge information of this type, arguing that it was sensitive information that, if divulged, would seriously prejudice Hydro-Québec's commercial relationships. After several years of wrangling over this issue, the Régie finally required these filings of HQ-Distribution in its October 2005 decision D-2005-178, at pages 12-13 (http://www.regie-energie.qc.ca/audiences/decisions/D-2005-178-e.pdf).

[41] Biggerstaff et al., p. 26.

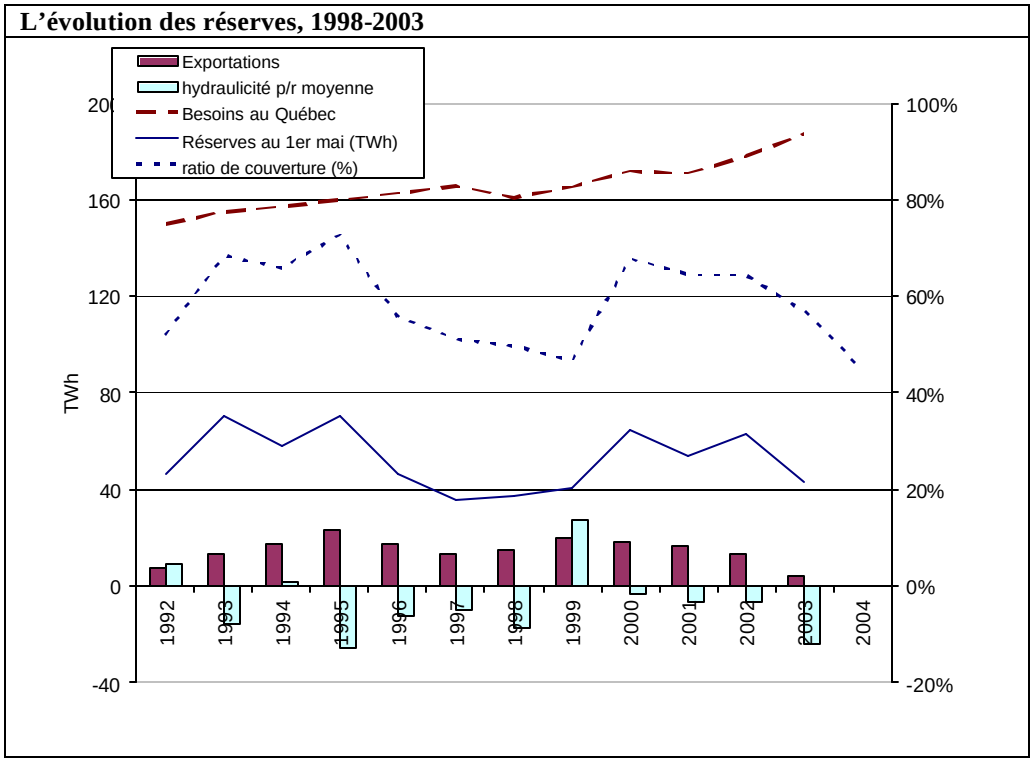
It should also be noted that foregoing the use of a large part of the storage capacity of Hydro-Québec's large reservoirs in effect means that the environmental cost associated with the creation of that capacity was for nought.

The Proponent argues that the critical low reservoirs levels experienced in 2004 demonstrate that the 8-TWh margin of flexibility then in place was inadequate. The following graphs, drawn from the author's testimony in the hearing on the Suroît project, demonstrates the fallacy in this argument.[42]

The first graph shows hydraulic inflows (light bars), net exports (dark bars), and two measures of reservoir levels (reserves at May 1, solid line; and the "coverage ratio," which Hydro-Québec states should exceed 65%, dotted line[43]). Note that, for the years 1993 through 1998, net exports were substantial, despite the fact that runoff was far below normal. As a result, the coverage ratio fell to under 50% in 1999.

[42] Philip Raphals, La contribution du projet Suroît à la sécurité des approvisionnements en électricité d'Hydro-Québec Production, April 23, 2004. Régie de l'énergie, Avis de la Régie de l'énergie sur la sécurité énergétique des québécois à l'égard des approvisionnements électriques et la contribution du projet Suroît, R-3526-03.

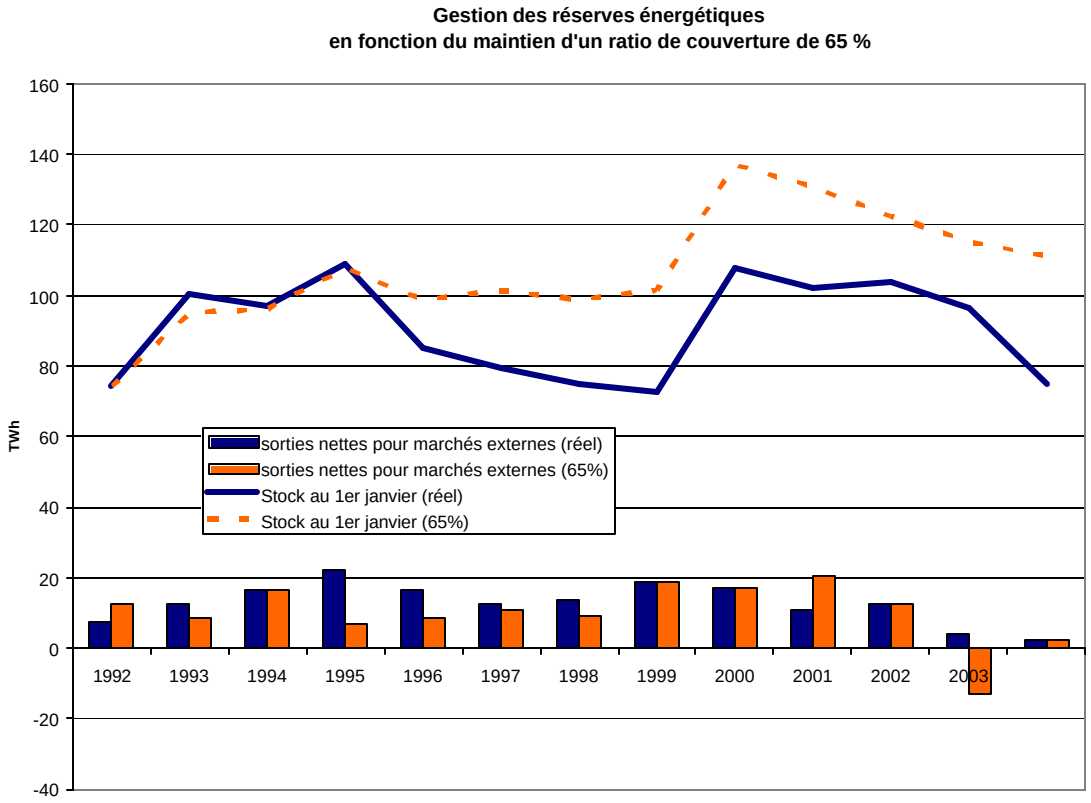
[43] The coverage ratio is defined as volume of stored energy on January 1 divided by the volume of firm sales for the year.



While the strong runoff in 1999 helped matters considerably, net exports again greatly exceeded runoff in 2000-2002, again driving the coverage ratio down to almost 40%, producing the critical low storage measures mentioned by the Proponent.

The following graph shows, in contrast, what would have occurred had Hydro-Québec taken care to export only its true hydraulic surplus, taking account of variations in runoff, throughout this period.

Here, the dark bars represent actual net exports (the same as in the preceding graph), whereas the light bars represent the export levels allowed in order to respect the 65% coverage rule. The solid line represents actual reservoir levels on May 1 of each year, and the dotted line represents the modelled May 1 levels resulting from respecting the 65% coverage rule at all times.



More specifically, in our model, we limited net exports to levels that allowed Hydro-Québec to respect its 65% coverage ratio in each year. Following this management rule would have led to substantially lower net exports in 1995, and to a less extent in 1996-98. In 2001, net exports would have been substantially higher than they actually were; however, imports would have been necessary in 2003 to ensure adequate storage levels.

The conclusion of this modeling exercise is clear: had Hydro-Québec limited its net exports to its actual hydraulic surplus throughout this period, the critical low reservoir levels experienced in 2004 would never have occurred. The reason for this crisis was therefore *not* an inadequate planned surplus, but the decision of Hydro-Québec's management (at the time) to continue high levels of discretionary exports in the face of a sustained period of very low runoff.

As we noted above, the margin of flexibililty, or planned surplus, represents the *average* level of short-term exports the system can support. In any given year, however, the actual exportable surplus will depend on actual hydraulic inflows. No matter how high the planned surplus, it is still possible to create low reservoir conditions, if exports exceed the exportable surplus (inflows minus firm requirements) over several years.[44]

[44] It is important to note that a similar crisis occurred in the late 1980s, for similar reasons: in the mid 1980s, runoff was low but exports remained high, far beyond the actual hydraulic surplus. Indeed, it was

It is impossible to review this historical record without wondering if the "average runoff level" against which annual runoff variations are measured is not overstated. As shown by the light bars in the first graph, above, runoff was below average for all but one of the years 1992-2003.

To respond to this concern, Hydro-Québec last year once again asked a team of hydraulic experts to review this question. Their unanimous conclusion was that the average value has not varied. Based on this conclusion, it is possible to affirm that a margin of flexibility of 10 TWh is indeed sufficient to produce average net exports of 10 TWh per year.[45] Actual export levels will have to vary from year to year, however, depending on actual inflows, in order to maintain adequate reliability of the generation system.

To summarize :

- The traditional flexibility margin of 5 TWh is more than adequate for reliability purposes, if HQP makes use of its existing reservoir storage and limits net exports to its actual hydraulic surplus;
- Insofar as stored water represents an asset that is not producing income, managers may prefer to keep reservoir levels as low as possible. However, the combination of operating reservoirs below their design levels and of maintaining exports at high levels without regard to actual inflows creates real risks with respect to energy reliability.
- Even without the Project, HQP's energy balance will be sufficient to provide, on average, 10-12 TWh of exportable surplus each year, while maintaining a fully reliable energy supply.

There is thus no energy reliability problem in the absence of the Project. Rather, the new policy of requiring a 15-TWh margin of flexiblity, as opposed to the 5-TWh margin used in the past, is in fact designed to favour exports, not reliability. An analysis of this policy is presented in section 4.

It is disturbing to note that the Government of Québec nevertheless affirms that, "The completion of this project is essential in order to secure the electricity supply of the Québec population" (*Energy Strategy*, p. 12). The same assertion was made with respect to the Suroît project but, after careful examination by the Régie de l'énergie, it was found not to be the case. A similar review for the Eastmain 1-A/Rupert Diversion project would lead to a similar conclusion.

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to avoid a repetition of this crisis that Hydro-Québec instituted new reliability criteria in the early 1990s. See note 35, above.

[45] See note 32, above.

3.2. HQP's capacity balance

According to the updated Tables D-1 and D-2, HQP's excess capacity in 2013-14 will be 1284 MW with the Project, and 391 MW without it, [46] taking into account all applicable reserve requirements. This demonstrates that HQP does not need the Project for resource adequacy (capacity reliability). Indeed, the Project merely contributes to a capacity surplus which, as we shall see below, has no significant economic value. Furthermore, the capacity balance understates the surplus in that it does not take into account any capacity value at all for the almost 4,000 MW of wind power that will be installed in its system by 2014.[47]

It goes without saying that, due to the intermittent nature of wind power, the full nameplate capacity of wind turbines cannot be considered to be available resources for the purposes of establishing resource adequacy. Nevertheless, it is far from obvious that this enormous wind power production has no capacity value at all.

While much of this wind power will be sold to HQD, balancing contracts have been signed for 990 MW and are contemplated for the remaining wind power to be developed. For wind facilities covered by such contracts, whatever capacity value these facilities have would accrue to HQP rather than HQD, as it is HQP that will receive their output on an hour-to-hour basis.

> Although wind turbines may be idle due to a lack of wind at times of a utility's peak demand, there is a statistical probability that they will be available, especially if there are multiple turbines dispersed geographically. In this, wind turbines are no different from conventional power plants. No generating plant operates 100% of the time, and no power plant is 100% dependable during peak loads.[48]

A report prepared for the California Energy Commission describes the widely accepted methodology for evaluating the capacity value of intermittent resources, known as *effective load carrying capability* (ELCC). This approach measures a power plant's capacity contributions based on its impact on system reliability. It takes into account not only the average availability of a power plant (which may be 85% for a thermal plant, or 30% for a wind plant), but also the probability that it will generate during the system peak.

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[46] The version of Table D-2 filed during the hearings reduces this second value to 332 MW, due to a) increasing from 600 to 700 MW the provision for balancing the 2000 MW of wind power currently in tender, and b) reducing from 130 to 90 MW the category "réserve et restrictions pour ajouts de production."

[47] This includes the 212 MW currently in service, the 200 MW currently under construction by SkyPower at Rivière-du-Loup, the 990 MW for which contracts were awarded following the first HQD tender, the 2000 MW expected under the second HQD tender currently in progress, and the 500 MW reserved for communities and First Nations, announced in the recent *Stratégie énergétique du Québec*.

[48] Paul Gipe, *Wind Energy Comes of Age,* Wiley and Sons (2005).

Using real data from California, the study found that the wind parks in Altamont, San Gorgonio and Tehachapi had capacity values ranging from 23% to 31% of their nameplate capacities, depending on the assumptions made concerning hydropower.[49]

> Capacity credit is a measure of the contribution that intermittent generation can make to reliability. It is usually expressed as a percentage of the installed capacity of the intermittent generators. There is a range of estimates for capacity credits in the literature and the reasons for there being a range are well understood. The range of findings relevant to British conditions is approximately 20 - 30% of installed capacity when up to 20% of electricity is sourced from intermittent supplies (usually assumed to be wind power). Capacity credit as a percentage of installed intermittent capacity declines as the share of electricity supplied by intermittent sources increases.[50]

These conclusions are entirely consistent with those presented by Hydro-Québec in a study published in 1995.[51] That study reviewed hourly wind data from the Gaspésie, in relation to hourly loads, and found capacity values of up to 49% of installed capacity.[52]

Assuming 30% capacity value for the 4000 MW to be installed by 2014 would add 1200 MW to HQP's capacity balance. The result would be to raise the capacity level without the Project well above the level that HQP has presented *with* the Project.

However, unlike surplus energy, surplus capacity has no real economic value. Recall that surplus capacity means the ability to generate more power at system peak than is needed by firm power clients. Given the size of Quebec demand compared to Hydro-Québec's other firm power customers (limited to Vermont Joint Owners and Cornwall Electric), in practice that means any generating capacity in excess of firm needs on the coldest days of the winter.

Quebec's neighbouring systems, however, generally have more than sufficient capacity to meet their own winter peaks, because their summer peaks are even higher. Therefore, while HQP can

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[49] California Wind Energy Collaborative, *California Renewables Portfolio Standard: Renewable Generation Integration Cost Analysis: Phase III: Recommendations for Implementation,* pp. 20-21. http://www.energy.ca.gov/reports/500-04-054.PDF

[50] U.K. Energy Research Centre, *The Costs and Impacts of Intermittency: An assessment of the evidence on the costs and impacts of intermittent generation on the British electricity network* (2006), p. v. www.ukerc.ac.uk/component/option,com_docman/task,doc_download/gid,550/

[51] Roger Lambert et Jocelyn Marcotte, Hydro-Québec, *Évaluation de la valeur en puissance d'un parc d'éoliennes incluant l'effet de corrélation entre le vent et la demande,* Association canadienne de l'électricité, mars 1995.

[52] Depending on the parameters used to extrapolate from the height at which wind measurements were taken (10 metres) to hub height (then assumed to by 30 metres, though hub heights of 80 m are now common).

sell all the surplus energy (kWh) it can generate, it cannot sell its surplus peak capacity (MW). Thus, for example, while Hydro-Québec had several thousand MW of surplus capacity in the early 1990s, following the commissioning of La Grande phase 2, it was never able to sell this surplus capacity. There is thus no reason to believe that any benefits will flow from the surplus system capacity resulting from the Project.

4. Exports

As noted earlier, the Directives require that, for each of the purposes of the Project, the Proponent must demonstrate the need for additional resources, and that the best scenario for meeting that need includes the Project. It further requires that:

> The documentation provided shall include all information and material necessary to assure a high standard of analysis and review, including data, hypotheses, sources, models and methodologies used, which shall be transparent and reproducible.[53]

It is important to emphasize that, with respect to exports, none of the information provided concerning external markets can be said to meet this standard. This problem was already noted in our report on the Conformity of the original EIS prepared at the request of the Federal Review Panel in March 2005 :

> Or, le tableau 2-10 cite comme source « Hydro-Québec Production – estimé interne ». Aucune documentation n'a été fournie à son appui. Il est donc impossible d'analyser ces estimations ni d'évaluer leur bien-fondé. Elles ne sont ni transparentes ni reproductibles.[54]

We also noted that the EIS provided no analysis of the effects a higher valued Canadian dollar might cause,[55] and that it failed to provide any information concerning « monthly estimates of peak and off-peak bulk prices as well as whatever indicators the Proponents use to reflect the volatility of short-term peak prices », as required by the Directives.

None of these problems were resolved in the Updated EIS. In the following sections, we will review the information available concerning the anticipated costs and revenues resulting from the development of the Project for purposes of off-system sales.

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[53] Directives, p. 12.

[54] Raphals, Philip. *Projet Eastmain-1-A / dérivation Rupert: Rapport sur la conformité de l'étude d'impact,* March 18, 2005, p. 15. www.ceaa-acee.gc.ca/010/0001/0001/0017/001/1092/1-a-comex.pdf.

[55] The EIS presumed an exchange rate of $0.80; the current value is some 12.5% higher ($0.90).

4.1. Project costs

Project costs and the economic assumptions used to develop them were not updated in the Supplemental Information. However, a number of changes have occurred since December 2004 that would tend to increase the unit cost of the Project.

- **interest rates.** It is well known that, for capital intensive resources like hydropower, financing costs represent a very large portion of the total cost, and that their unit costs are thus very sensitive to interest rates. North American real interest rates were at historically extremely low levels following the attacks on the World Trade Center in 2001, and the low prime rate in 2004 still reflected this influence. However, interest rates are starting to return to more normal levels, and there is every reason to believe that this trend will continue.

  More specifically, the prime rate was 4.25% in December 2004 when the EIS was issued. It has now increased to 6%, and further increases are expected. It is thus likely that the actual borrowing costs, both for capitalized interest indicated in Table 2-11 of the EIS (which was not updated in the Supplemental Information) and for the long-term financing of the construction costs, will be greater than those presented in the EIS.

- **royalties.** According to the recent *Stratégie énergétique* of the Quebec government, Hydro-Québec will henceforth pay water use rights for its hydroelectric generation. It is estimated that these charges will add approximately a quarter of a cent per kWh[56] to the costs of the Hydro-Québec's generation, including the Project.

4.2. Export revenues

It is above all in the estimation of future export revenues that the shortcomings of the EIS with respect to the information requested as well as the transparency and reproducibility of the calculations are most flagrant.

The information presented in the original EIS is limited to the following table:

[56] $2 billion over five years, for annual generation of about 180 TWh.

Table 2-10: Market prices (US¢/kWh, except Ontario - C¢/kWh)

	2005	2006	2007	2011 (HQP estimate)
PJM - Western Hub	5.82	5.43	5.23	5.75
New-York - Zone A New England – Mass Hub	5.85 7.00	5.56 6.55	n.a. 6.35	5.75 6.75
Ontario (C¢/kWh)	6.95	6.93	n.a.	7.50

Source : 2005-2006-2007: Megawatt Daily, Thursday October 7, 2004, page 4. – daily peak period on the market (16 hours a day – 7:00-23:00, weekdays, 12 months) ; 2011: Hydro-Québec Production – internal estimate

This table was updated and slightly expanded upon in the Supplementary Information with the following table:[57]

Table 11-1: Proponent's 2011 market prices (US¢/kWh, except Ontario: C¢ /kWh)

	Market price[a] (1)	Wheeling charges / losses and congestion[b] (2)	Price at the border (3) = (1) - (2)	Project unit cost at the Québec border[c] (4)	Unit gain (5) = (3)- (4)
PJM – Western Hub	7.50	– 0.28	7.78	4.54	3.24
New York – Zone A	7.50	– 0.58	8.08	4.54	3.54
New England – MassHub	8.00	0.73	7.27	4.54	2.73
Ontario (C¢/kWh)	8.15	Not significant	8.15	5.67	2.48

a. Daily market peak hours (16 hours per day, from 7 a.m. to 11 p.m., weekdays, 12 months).

b. From the Québec border to the load centre: includes transmission providers' charges, market entry costs, and losses and congestion. Depending on market conditions, losses and congestion may yield credits (i.e., negative values).

c. Including Québec wheeling charges and associated losses.

A number of comments can be made with respect to these tables.

- **exchange rates.** The estimates of export profitability in the EIS are based on an exchange rate of US$0.80 per $CA. Table 11-1 uses the same unit cost in $US (US$04.54/kWh) as that used in the original EIS (p. 2-11), and hence implicitly uses the same exchange rate. At current rates of approximately US$0.90 per $CA, the Project's unit cost in $US would be $05.10/kWh, or 12.5% higher than the values in the table.

[57] Supplemental Information, v. 1, p. 21.

Many analysts are predicting further appreciation in the Canadian dollar, which would further erode the Project's profitability.

- No methodology was presented in detail or even vaguely described with respect to the market price projections. The first table simply identifies the source as "Hydro-Québec Production – internal estimate"; no source at all is provided for the market prices in the second table.

- No information is provided with respect to the comparison of peak and off-peak prices, or the indicators used by the Proponent to reflect the volatility of short-term peak prices.[58]

- In the first table, 2011 prices were estimated to be very similar to those of 2006. In the second table, these estimates were increased by 30% for PJM and New York Zone A, and by 19% for New England – Mass Hub. No explanation was provided for these increases, nor were they even mentioned in the accompanying text. This represents a very serious weakness in the documentation, as the estimated profitability of the Project depends directly on the forecast market prices in neighbouring regions.

- In the second table, a new column is added for "Wheeling charges / losses and congestion", which is supposed to represent the additional charges from the Quebec border to the load centre. It is remarkable that negative figures are presented for both PJM and New York Zone A (West). An explanatory note is provided, which reads: "Depending on market conditions, losses and congestion may yield credits (i.e., negative values."

  While it is indeed true that, under certain conditions, negative values may be in effect, it is extraordinary to assert that these values will *on average* be negative. While point-to-point transmission charges are not normally levied on imports, there are real losses between the Quebec border and load centres, which must inevitably be compensated for one way or another. Furthermore, transmission pathways to these load centres are frequently congested, which normally leads to a loss of value for supplies upstream of the congested interface.

  In the absence of any references or further explanation, the column of Table 11-1 detailing "wheeling charges / losses and congestion" is simply not credible.

As noted above, the Updated EIS makes no reference whatsoever to any market studies or projections on which to base its price forecasts. While it is well beyond the scope of this report to carry out a market projection study or survey existing ones, we wish to call the Review Bodies' attention to one such report that is pertinent to their deliberations.

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[58] Directives, p. 14.

A consortium of New Energy electric utilities periodically commissions a study of avoided supply costs in New England, for the purposes of evaluating their energy efficiency programs. Since the restructuring of the New England electric system into a competitive marketplace, these avoided cost studies are based projections of future market prices, rather than of future generation costs. The most recent study, carried out by ICF Consulting and published in December 2005, is based on in-depth, hour by hour modeling of the New England electric and natural gas supply systems.

The sponsors of the study, known as the Avoided Energy Supply Component (AESC) Study Group, includes a broad spectrum of electric and gas utilities or their representatives from Massachusetts, New Hampshire, Vermont, Rhode Island, Connecticut, and Maine.[59]

ICF describes its methodology as follows:

> This analysis utilizes a detailed and integrated fundamentals modeling approach combined with actual market data to estimate the supply costs considered to be avoidable. To provide projections of wholesale or spot market fuel market prices and wholesale energy and capacity prices, ICF utilized a fundamentals based modeling approach for the gas and power wholesale or spot markets. ICF further estimated the costs considered avoidable for retail power market services and gas services through estimating actual cost expenditures for these services. Avoided costs for other fuels were estimated in conjunction with the natural gas market analysis. Transmission and distribution avoidable costs were considered under the electricity sector portion of this analysis. To project wholesale market conditions going forward, ICF relied on the combination of the NANGAS® natural gas market model to forecast delivered to New England market pricing and the IPM® power market model to forecast near- and long-term power market conditions. IPM® considers the entire time horizon (2005 – 2040) to determine the optimal distribution and use of generation and transmission resources including the potential retirement, retrofitting, or addition of capacity. Similarly, NANGAS® is a fundamentals based model capturing reservoir level detail on the supply side and reflecting the demand side fundamentals through sectoral demand estimates and representation of the North American pipeline system.[60]

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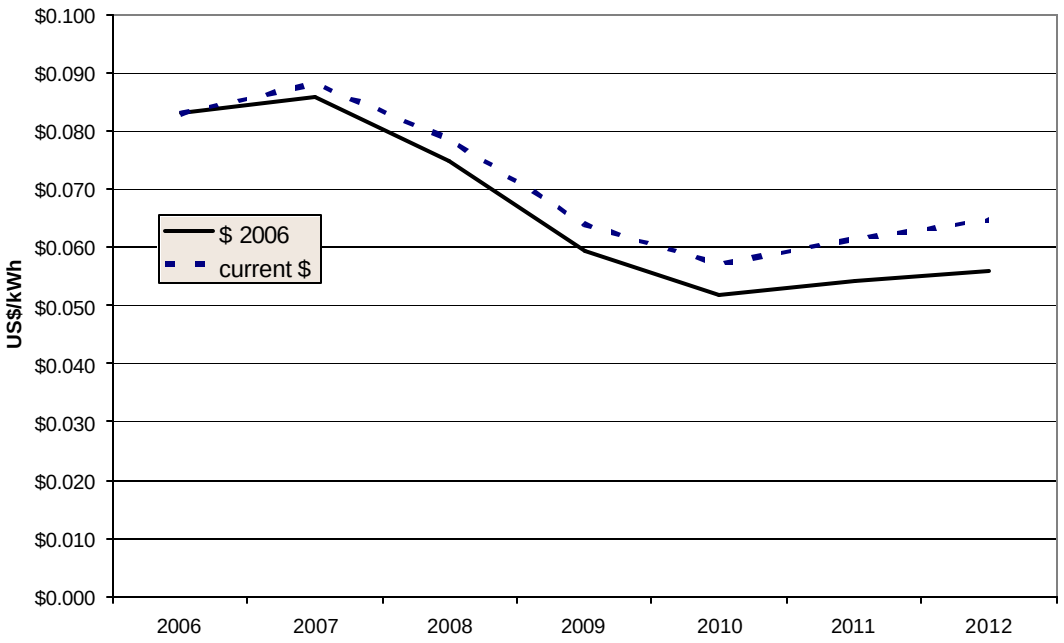
[59] The sponsors of this project include: Berkshire Gas Company, Keyspan Energy Delivery New England (Boston Gas Company, Essex Gas Company, and Colonial Gas Company), Cape Light Compact, National Grid USA (Massachusetts Electric Company, New England Gas Company, NiSource Inc., NSTAR Electric & Gas Company, Northeast Utilities (Western Massachusetts Electric and Public Service of New Hampshire), Unitil (Fitchburg Gas and Electric Light Company, United Illuminating, Concord Electric Company and Exeter & Hampton Electric Company), the State of Maine, and the State of Vermont. Additional members of the Study Group include Connecticut Energy Conservation Management Board, Massachusetts Department of Telecommunications and Energy, Massachusetts Division of Energy Resources, Massachusetts Low-Income Energy Affordability Network (LEAN) and other Non-Utility Parties, New Hampshire Public Utilities Commission, and Rhode Island Division of Public Utilities and Carriers.

[60] ICF Consulting, see note 27.

The following graph shows the ICF's forecast avoided costs for Massachusetts, for the years 2006 through 2020. Values are shown in current dollars, and so are comparable to those in the Proponent's tables.[61]

Mass. wholesale electricity prices, from ICF Study



It is of course striking to note that ICF forecasts substantial price **decreases** over the next five years. Broadly speaking, this reflects the view that current extremely high levels of natural gas prices are unsustainable, because they are well above the marginal production costs of new gas supplies.[62] This logic, widely held in the forecasting community, suggests that gas (and oil) prices will retreat from their current high levels by around 40%, before beginning to gradually increase once again.[63]

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[61] Since the purpose of the ICF study is to estimate avoided costs, these figures include both generation and transmission costs. However, transmission costs are addressed separately in the Proponent's tables. The generation-only values are not provided by ICF, but they would by necessity be lower than the figures presented here.

[62] If built, the Liquefied Natural Gas (LNG) terminals currently under review in Québec and elsewhere in the Northeast would drive gas prices lower still.

[63] ICF Consulting, p. 28.

As Northeast market prices for electricity are largely driven by the price of natural gas, which is on the margin during virtually all peak hours and many off-peak hours there, ICF projects that real wholesale electricity prices will **decline by 38%** relative to their 2006 levels, by 2010. Electricity prices are then expected to increase gradually, but still not to return to current real levels before the end of the study period (2040).[64]

As with any projection, there is of course considerable uncertainty in relation to these figures, and other forecasters may well disagree. However, we are dealing here with a study which fully meets the criteria set forth by the Review Bodies in the Directives. It includes all information and material necessary to assure a high standard of analysis and review, including data, hypotheses, sources, models and methodologies used. It is transparent and reproducible. Furthermore, it is accepted and used by most electric utilities in the American Northeast. It thus should be accorded considerably more credibility than the back-of-the-envelope projections provided by the Proponent.

4.3. Profitability of the Project for export sales

In section 2.6.2 of the EIS, the Proponent argues that failure to carry out the Project would result in a lost margin of $151 million in the first complete year of operation. This figure is based on the estimated export revenues minus the estimated unit cost of the Project, or 7.6 – 5.5 = 2.1 cents per kWh exported.

As we have seen, a number of factors exist which tend to narrow this spread from both directions. The costs are underestimated due to:

- the very substantial increase in interest rates since the date of the EIS, which will inevitably lead to higher financing costs, both during construction and in the long term, and
- the new obligation to Hydro-Québec pay royalties for the hydraulic rights for all hydropower generation, which would apparently add close to 1¢/kWh to the unit cost.

At the same time, the revenues appear to be overestimated, due to:

- unsupported projections of price increases, compared to well-supported projections of price decreases in the timeframe at issue;
- unsupported assertion that wheeling charges, losses and congestion charges are on average negative for PJM and New York; and

[64] More broadly, it is clear that an export strategy imports the risk profile of natural gas prices. If gas prices go up, export profitability increases; if they do not, export profitability declines.

- the very substantial appreciation of the Canadian dollar, which at current levels reduces the value of each dollar of export revenue by 12.5%, not to speak of additional appreciation that could well occur before construction is completed.

Based on the information currently available, it is impossible to make a serious estimate of the profitability or the risks associated with developing the Project for purposes of off-system sales. Instead, we are left with the simple statement that: "The Proponent believes that all reasonable export scenarios are profitable. "[65] With respect, this is not a sufficient basis on which to base a decision.

In the same paragraph, the Proponent emphasizes that:

> The proponent … reiterates that it assumes all business and financial risks related to the project, including those in markets outside Québec.

Were the Proponent a private company, and were it engaged in a business that created no significant externalities, this affirmation would be sufficient to address the question of project justification. However, it is not the proponent's private capital that is at risk, but public funds. Indeed, regardless of the accounting treatment accorded to them, any losses incurred by the Proponent will be borne by the taxpayers of the province of Québec. As there is no other public process in place to review the soundness of this very large investment, it is entirely appropriate that the Review Bodies require a demonstration of profitability, rather than a simple affirmation that the proponent assumes all risks.

Secondly, there is little doubt that the Project will be accompanied by significant environmental and social externalities. Insofar as the Project's primary justification is the profitability of its export sales — and this certainly seems to be the case, given the conclusions reach in section 2 — its justification comes down to a weighing of future profits to be gained by Hydro-Québec and its shareholder, the Quebec government, against present harm to be borne by the affected Cree communities and the Quebec environment in general.

In such a context, a serious demonstration of profitability and of absence of risk is required. The Proponent has clearly failed to meet even the most generous burden of proof in this regard.

5. Alternatives

It is clear from the opening sentence of the justification section of the Directives that the Proponent needs to consider the alternatives to the Project:

> In this section of the Impact Statement, the Proponents will have to present ht epurpose of and the need for the Project as well as the alternatives to the Project

[65] EIS, p. 2-12.

> considered, before analyzing the proposed alternative means of carrying out the Project. (p. 11; underlining added)

Furthermore, the concluding section of the chapter is entitled, "Alternatives to the Project." It begins:

> The alternatives to a project are defined as functionally different ways of addressing the need for the Project. For each of the final purposes described previously, the Proponents will have to describe the relevant alternatives. The Proponents shall:
>
> - identify the alternatives to the Project for each of the four purposes previously outlined;
>
> - establish criteria making it possible to identify the costs and direct and indirect benefits at the environmental, economic and technical levels;
>
> - show that the Project is a reasonable approach to the identified needs;
>
> - where applicable, identify the alternative to the Project that is preferred based on the comparative analysis of the costs and the benefits at the environmental, social, economic and technical levels. (p. 15)

Additional details are provided for each of the four potential purposes described in the Directives (heritage pool electricity, additional needs of HQD, export sales and energy reserves).

The Proponent addressed these requirements in section 2.6 of the EIS. This section devoted four (4) pages to describing alternatives for meeting domestic demand (s. 2.6.1), and four (4) paragraphs to the "Impact of failing to carry out the project on additional sales outside Quebec."

Following their conformity review, the Review Bodies addressed seven additional questions to the Promoter that concerned alternatives to the Project (questions 17-23). On January 20, 2006, we provided the Review Bodies with comments on the Supplementary Information that identified serious lacunae in the responses to six of these seven additional questions. In several cases, the Proponent did not even try to answer the question. For example, Question 22 asks the Proponent to describe Quebec's cogeneration potential, but the response does not even mention that potential.

Our comments concluded as follows, with respect to alternatives:

> Selon le rapport précité [see note 54], aucune des exigences de la Directive concernant les solutions de rechange n'a été respectée adéquatement, et cette carence constituait une lacune majeure [note omitted]. De toute apparence, les questions 17 à 22 des Demandes de renseignements additionnels avaient pour but de remédier ce défaut.

> Or, comme le démontre la section 2 du présent rapport, les réponses fournies par les Promoteurs à ces questions sont inadéquates. Il s'en suit que les informations soumises par les Promoteurs à ce jour sur la question des solutions de rechange du Projet le sont également. Cela est vrai pour chacune des finalités qui font partie de la justification du Projet, dont notamment la vente d'énergie post-patrimoniale à Hydro-Québec Distribution (identifiée par les Promoteurs comme la première raison d'être du Projet) et pour la vente en exportation (identifiée par les Promoteurs comme sa raison d'être complémentaire). …
>
> À notre avis, l'absence des informations adéquates sur les solutions de rechange pour l'ensemble des finalités qui font partie de la justification du Projet constitue une lacune majeure qui devrait être rectifiée avant de procéder à l'étape d'audiences publiques.[66]

The Review Bodies' decision to proceed to public hearings despite these failures in no way relieves the Proponent of its responsibility to provide a full and coherent justification for the Project. It is regrettable that the Proponent did not treat the Review Bodies' Supplementary Questions — which were already quite limited, given the impressive number of serious lacunae identified with respect the Directives — with more respect.

5.1. Alternatives for meeting Quebec demand and for guaranteeing energy security

In the preceding pages, we have demonstrated that the Project cannot be justified either based on Québec's future energy needs (identified by the Proponent as the Project's principal purpose) or on the basis of securing Québec's energy supply (margin of flexibility, reliability). Thus, we will not take the time to address the failings of the EIS with respect to the alternatives for these purposes.

Instead, we will limit our comments to the alternatives available with respect to the « complementary » purpose of the Project, supplying off-system sales.

5.2. Alternatives for supplying export sales

In the EIS, the Proponent in effect argued that there are no alternatives to the Project with respect to its complementary purpose of allowing Hydro-Québec to increase export (off-system) sales without increasing interconnection capacity.[67] In this section, we will look at four possible

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[66] Raphals, P. *Projet Eastmain 1-A/dérivation Rupert: Complément de l'étude d'impact sur l'environnement — Commentaires concernant la justification du projet,* le 20 janvier 2006.

[67] EIS, pp. 2-1, 2-19 and 2-20.

alternatives: the no-build option, other large hydroelectric projects, wind power and additional imports.

5.2.1. No build option

As noted above, with the exception of its two long-term export contracts (about 310 MW to Vermont Joint Owners, and 45 MW to Cornwall Electric), the Proponent is under no obligation to provide power for off-system sales. Hence, the "no build" alternative is by definition feasible.

It must be acknowledged that the Government of Quebec's new *Energy Strategy* anticipates signing new long-term export contracts. However, it makes clear that exports will depend on the quantities of electricity available, and that any new long-term export agreements would have to be signed *before* the construction of new hydropower facilities to serve them.

> With regard to outside markets, our exports will depend primarily on how much electricity is produced in excess of demand in Québec, including industrial demand. Surplus electricity could be sold at market prices or under agreement with neighbouring jurisdictions. The agreements would be signed before the construction of the new hydroelectric facilities. (p. 16)

It is thus clear that the export sales to be served by the Project will be short-term sales, at market prices.

In the *Energy Strategy*, the Government of Québec bemoans the trend of recent years whereby net electricity exports have fallen from 22 TWh in 1995 to 1.5 TWh in 2004.[68] However, as explained in detail in the author's report prepared for the Régie's hearings on the Suroît project, this sudden decline in export volumes was the result of critically low reservoir levels, which in turn were the result of Hydro-Québec's failure to modulate its export sales in response to a many years of low runoff. As demonstrated above, had Hydro-Québec been more prudent in its export sales during the late 1990s, it could have continued to sell its exportable surplus (actual hydraulic surplus minus domestic needs) on an ongoing basis, without its water supplies every reaching dangerously low levels.[69]

Indeed, looking forward, HQP continues to have a margin of flexibility (planned surplus) well in excess of its historical levels. According to Hydro-Québec's *Strategic Plan 2006-2010*, it already has an exportable surplus of 10-12 TWh, based on average runoff conditions, which it

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[68] Energy Strategy, p. 20.

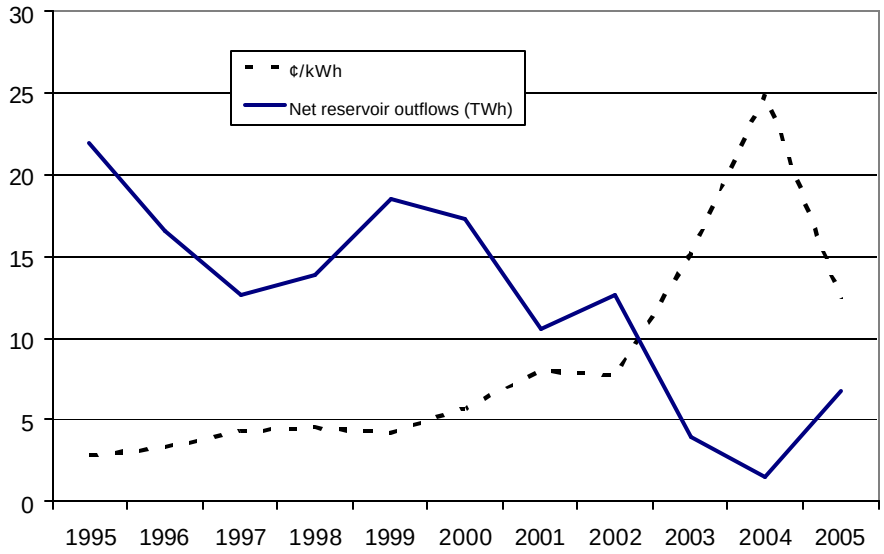
[69] Philip Raphals, La contribution du projet Suroît à la sécurité des approvisionnements en électricité d'Hydro-Québec Production, note 42. See also page 18, above.

will continue to enjoy into the future, even without the construction of the EM-1/Rupert Diversion Project.[70]

Thus, even in the absence of the Project, Hydro-Québec can return to its historical export levels, and can take advantage of lucrative opportunities in neighbouring markets. Indeed, it is important to realize that the profitability of Hydro-Québec's exports is not closely tied to the volumes of its net exports. On the contrary, over the last ten years, there has been a clear *inverse* relationship between net export volumes and average unit price.

In 2004, when net exports were only 1.5 TWh, the average export price reached over 25¢/kWh. In 2005, when net exports increased to 6.7 TWh, the average export price fell to 12.4¢/kWh. In contrast, in the mid-1990s, when net exports reach as high as 22 TWh, the average export price was well under 3¢/kWh, as shown in the following graph.[71]

Net exports vs. avg. export price



Upon reflection, there is nothing surprising about this relationship. Since the late 1990s, Hydro-Québec has engaged more and more in buy-sell (purchase for resale) transactions, taking advantage of the restructuring of the electric systems in the Northeast, whereby huge volumes of electricity are bought and sold on an hourly market, with prices that vary in relationship to hourly demand and supply curves. When prices are low (e.g. in the middle of the night), HQP imports energy to meet domestic demand (under the heritage contract, which gives it full discretion as to the source of the energy provided), saving the water it would otherwise have

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[70] Hydro-Québec, Strategic Plan, p. 16.

[71] Data from EIS, Table 2-9 and *Energy Strategy,* p. 20.

used to meet that demand. When prices are high (e.g. during morning and evening rush hours, on hot days, etc.), it can then turbine that saved water for export.

Through this type of transaction, and by focussing these sales on the highest-priced hours, HQP can realize very significant export profits that in no way depend on maintaining an exportable hydraulic surplus. In contrast, exporting 15 TWh of hydraulic surplus in a year requires exporting, on average, almost 2000 MW every hour of every day (or almost 4,000 MW, if exports are limited to peak hours[72]). It is of course still possible to try to increase sales during peak price periods. But, in order to physically export that quantity of energy, HQP must inevitably sell considerable volumes during lower-priced periods. Beyond a certain point, as the volume to be exported increases, HQP's sales would have to extend into off-peak periods when prices can be quite low.

It is thus clear that, all else being equal, as export volumes increase, unit revenues must decrease. For this reason, it is far from obvious what level of additional export revenues would result from increasing HQP's exportable surplus. As noted in s. 4.2, above, HQP has failed to present any price forecasts, and the one relied upon by 20 utilities in the U.S. Northeast forecasts substantial price *decreases* over the next 5-10 years. The Proponent has failed to present any serious analysis of the potential benefits and risks of the Project. In any case, there is certainly no reason to believe that the average price at the margin in any way resembles the extraordinarily high average export prices realized during the years when HQP's export volumes were severely limited, due to low runoff.

5.2.2. Other hydroelectric projects

While no mention is made of them in the Updated EIS, other large hydro projects clearly represent an alternative to the Project for the purposes of increasing export sales.

> The Government intends to launch major hydroelectric projects totalling 4,500 MW between now and 2010. Québec has enough remaining hydroelectric potential to meet this objective, and the projects will help to fully secure the electricity supply of the Québec population. They will also create significant extra capacity to attract new wealth-creating industries and increase the volume of electricity exports.[73]

Both the *Energy Strategy* and Hydro-Québec's *Strategic Plan* set out an objective of 4500 MW in new large hydro projects, above and beyond the Eastmain-Rupert Project. These include the

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[72] In Quebec energy planning, peak hours usually refer to the 300 hours of greatest demand ("la fine pointe). In U.S. energy markets, the term "peak period" usually is defined as extended from 8 am to 10 pm on work days (Monday through Friday or, in some jurisdictions, Monday through Saturday).

[73] *Energy Strategy,* p. 14.

La Romaine project (1500 MW), the Petite Mécatina Project (1500 MW), and another large project to be identified.[74]

Furthermore, the *Energy Strategy* proposes an innovative approach to accelerate these developments. The approach consists of developing a "portfolio" of projects at the same time, and proceeding with environmental assessments of all of them, thereby advancing commissioning dates by several years.

> By 2010, Hydro-Québec will have in its possession the agreements and environmental authorizations needed to complete projects totalling 4,500 MW. This will give Québec a "portfolio" of hydroelectric projects to meet increased demand in Québec as well as in neighbouring jurisdictions. If the market conditions are favourable, as early as 2010, Québec could begin the construction of major hydroelectric projects totalling 4,500 MW, or construct only some projects if conditions are less favourable – for example, if the export market has changed. This approach allows for the development of more resources at a faster pace, while managing the risks associated with projects of this scope.[75]

This enormous bloc of power and energy should thus be available by 2015, just a few years after the proposed commissioning date for the Project, and therefore represents a realistic alternative to it. It must again be emphasized that neigher Hydro-Québec nor the government of Québec has ever explained how it intends to maintain a high average price for its exports once the volume to be sold exceeds the amount that can be sold during peak periods.

5.2.3. Wind power

A number of interveners have raised the prospect of a major wind development as an alternative to the Project. Interveners and Proponent alike seem to agree that a wind development of some 2500 to 2700 MW would produce annual energy equivalent to the Project, and that wind resources of that magnitude exist within the Cree territory.

The Proponent's first response was to point out that wind power is very different from hydropower, where "nous avons la manette".[76] It is obvious, of course, that large hydropower has advantages for system management that wind power does not. However, potential alternatives to the Project do not need to precisely reproduce all of its characteristics; rather, they need to meet the Project's purpose (here, additional energy for export sales), without compromising the reliability of the Hydro-Québec system.

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[74] *Strategic Plan,* p. 17.

[75] *Energy Strategy,* p. 16. It is interesting to note that the Government here recognizes risks related to the export market, discussion of which is curiously lacking in the EIS.

[76] Transcription, v. 22, May 3, 2006, p. 28.

Many of the arguments raised by the Proponent in response to the proposed wind alternative fail to stand up to critical scrutiny. We will explore these arguments in the following sections.

5.2.3.1. Low temperatures

In his presentation to the Review Bodies, M. Patrick Arnaud presented low temperatures as an important constraint for wind power development in the Cree territory:

> The second restriction is that we're in a northern country and as we were able to note, some people in the Cree communities talked to us about temperatures that often go below -30 in the wintertime, as a result wind towers face a problem of very low temperatures. We re not claiming that there are no solutions, the solutions exist. However, they're currently being studied and the studies are being sped up, nonetheless it is a constraint that we need to recognized and you'll recognize it's a double constraint in that when it's very, very cold, one has to heat the wind towers to make sure that they continue to be operational, that means you have to heat the wind towers that is, use electricity to heat them, that is a constraint. Nonetheless, we do believe that very soon, we will able to achieve the required temperatures,-20, -30 will be able to solve this.[77] (underlining added)

These problems are not as serious as M. Arnaud suggests. This issue was addressed by Søren Krohn, an internationally respected wind expert who now is part of HQ Distribution's team managing the 2,000 MW tender, in his testimony last year before the Régie de l'énegie regarding wind options for off-grid communities.[78]

According to Mr. Krohn's testimony:

- Icing is a much more important problem than cold temperatures for wind turbines. Icing is generally much more of a problem in the Gaspésie than in Nunavik.
- Low operating temperatures are usually not a major problem, as cold climate packages that are now available for temperatures down to -30ºC include heated gearboxes, heated generators, heated electronics and heated hydraulics systems. The energy spent for heating purposes is typically only 2-3% of the total annual energy production of the turbine.

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[77] *Ibid.*

[78] Søren Krohn, Wind-Diesel Systems in Nunavik and other Autonomous Grids, Régie de l'énergie, R-3550-04, May 25, 2005, http://www.regie-energie.qc.ca/audiences/3550-04/Memoires3550/RNCREQ_KrohnReseauxAutonomes_3550_25mai05.pdf.

- Extremely low temperatures tend to coincide with low wind speeds in arctic and sub-arctic areas. Based on a spot check of wind speed and temperature for Inukjuak in 2004-05, only 0.5% of annual energy production would have occurred during hours where the temperature was below -30°C. Thus, losing some production capacity during the periods of most extreme cold would likely have little effect on overall turbine performance. Furthermore, the great distance separating the Cree territory from Québec's load centres means that it is unlikely that the coldest hours in the territory would coincide precisely with the coldest hours in Montreal.

Thus, while the low temperatures seen in the Cree territory do reduce productivity, and hence increase unit costs, by 2-3%, they do not in themselves create any significant obstacle to development.

5.2.3.2. Balancing service (*équilibrage)*

Much of the Proponent's criticism of the wind alternative relate to its supposed need to provide balancing service (*équilibrage*). Hydro-Québec's comments in this regard are misleading in several respects.

In his comments on May 3, 2006, Patrick Arnaud said:

> And this makes it possible for the Distributor who signed a contract with a client whether this be a residential or industrial client, to tell that client: "Well, you're asking for so many kilowatthours continuous (*continu*) for so many years, I am in a position to supply you with this, partially thanks to my wind farms and with the contract that I have signed with the Producer who is going to do, what we term balancing." (p. 31)

In fact, about the only clients who require *continuous* power are aluminum and magnesium smelters. For the vast majority of HQD's clients, their power use varies over time. The challenge for the Distributor is to meet these constantly varying loads as efficiently as possible.

Whether or not the variability of wind power helps or hinders HQD in this task is an important and difficult question. Insofar as there is a correlation between wind power production and hourly demand, it would *not* be in HQD's interest to exchange that variable power for baseload power at level equal to just one-third of the capacity the wind turbines can deliver.

Indeed, in our review of 2004 hourly data mentioned earlier, we found that the Gaspé wind parks would have produced on average 37% of their installed capacity during the 10 hours of greatest demand in year.[79]

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[79] Régie de l'énergie, R-3550-04, Plan d'approvisionnement 2005-2014 d'Hydro-Québec Distribution, Engagement #1 du RNCREQ. http://www.regie-energie.qc.ca/audiences/3550-04/Audi-JUIN-

A Hydro-Québec study carried out in 1995 confirmed the existence of a strong correlation between wind production and Quebec demand. Its abstract reads as follows:

> Le présent document résume l'étude de la valeur de puissance d'un parc d'éoliennes incluant l'effet de la corrélation entre la demande hivernale et les alés du vent. Cette corrélation est réelle dans un réseau tel que celui d'Hydro-Québec. En effet, le chauffage électrique contribue en grande partie à la demande d epointe hivernale et est d'avantage sollicité quand il vente. L'analyse est basée sur un historique de 32 ans de mesures horaires de vitesses de vent et de demande simulée. Il en résulte que la valeur en puissance est nettement supérieur à la puissance moyenne produite en hiver, après considération des facteurs de perte.[80]

The authors conclude that the true capacity value of a wind park would vary from 41% to 49% of the installed (nameplate) capacity, depending on the height of the nacelle.[81]

Furthermore, as noted earlier, the heritage (or "patrimonial") contract under which HQP supplies HQD with most of its power needs has built into it a very significant degree of flexibility. According to our study of 2004 hourly data, this flexibility is sufficient to absorb much of the variability in the output of a 1,000 MW of wind power. For the 10 peak hours in 2004, this effect would have increased their capacity value from 37% to 44%.[82]

M. Arnaud's conclusion that supplying this balancing function costs money is clearly drawn from the current context whereby HQP supplies this service to HQD, the purchaser of the wind power. The situation would be very different, however, if HQP itself were to purchase the wind power for resale, which is the scenario that would constitute an alternative to the Project.

When HQP purchases wind power, as it currently does from Axor (Le Nordais), from 3Ci (Mont Copper) and from Northland (Mont Miller), there is no such balancing service provided.[83] Instead, the ever varying power from the wind farms are integrated into HQP's total generation

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3550/PiecesAUDI-Interv/RNCREQ_3550_RepEng1_14juin05.pdf. In fact, the reason the wind turbines would not have produced at full capacity during all these hours was because the wind strength exceeded the design specifications of the turbines.

[80] Roger Lambert et Jocelyn Marcotte, Hydro-Québec, *Évaluation de la valeur en puissance d'un parc d'éoliennes incluant l'effet de corrélation entre le vent et la demande,* Association canadienne de l'électricité, mars 1995.

[81] These calculations were based on a nacelle height of 30 m. Given that modern wind turbines use a nacelle height of 80 m, the upper value is the most relevant.

[82] Engagement #1 du RNCREQ, see note 37.

[83] This energy is added to the "purchases" section of HQP's energy balance, presented in the Strategic Plan (p. 16); no provision is made for balancing service for these projects in the capacity balance.

portfolio, which it manages in real time to meet its obligations under the heritage contract and its firm export contracts, and to make additional export sales in the short-term market. For the same reason, no balancing service would be required if HQP were to purchase the output of a 2,700 MW wind megaproject in the Cree territory.

While no balancing service would be required, it is still important to ask whether the variability of the wind output might disrupt HQP's ability to meet its firm power commitments to HQD, to VJO and to Cornwall.[84] It is of course impossible to fully respond to this question without access to a great deal of information concerning the management of HQP's generation fleet that has not be made public. However, given the radial nature of the Hydro-Québec transmission system and the fact that the proposed wind megaproject would be located in a region that produces a very significant part of Québec's energy supply, the problem is much less complicated than it would otherwise be.

Unlike nuclear or thermal generating stations, production levels at hydropower stations can be ramped up or down extremely rapidly. Insofar as the output of the generating stations of the La Grande system can be modulated to smooth or eliminate the fluctuations of the wind turbines,[85] there is little technical difficulty in maintaining a stable level of power flows on the 735 kV lines connecting hydro-wind generating system in the La Grande area to the rest of Hydro-Québec's transmission system.

There is, however, a possibility that using the ramping capability of the La Grande system to absorb the variability of the Cree wind output might reduce HQP's ability to track HQD's ongoing load fluctuations. This question cannot be answered without careful modelling on the part of HQP. To date, there is no indication that Hydro-Québec has undertaken the studies required to address this question.

It is certainly not the case, however, that in order to operate 2,775 megawatts of wind power in the Cree territory, HQP would have to "install" 975 megawatts of balancing power,[86] as M. Arnaud suggests. This would only be true if the 2,775 MW of wind power were accompanied by a firm power and energy contract for 975 MW. This simplistic assumption in no way properly represents the dynamic effects that would result from this addition.

5.2.3.3. Transmission needs

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[84] As short-term sales can be made with advance notice of less than an hour, this variability would affect short-term export sales only marginally, if at all.

[85] Assuming, that is, that the resulting flow modifications downstream of the turbines do not create unacceptable environmental impacts.

[86] Transcription, v. 22, May 3, p. 42.

A related issue concerns the need for new transmission capacity to accomodate such a wind development. M. Arnaud suggests that the proposed wind park would require building a new 735 kV line to transport the power. Once again, the statement reflects a refusal to recognize the important benefits that would be obtained by HQP as a result of integrating the operations of its hydro and wind generators.

First, it should be recalled that there must exist at least 888 MW of available capacity on the existing high voltage lines in order to accommodate the proposed Project, and probably more. Secondly, the La Grande project currently operates at a capacity factor of just over 60%, which means that a great deal of transmission capacity is available much of the time.

Thus, the concern about transmission capacity is only relevant during peak periods. To address this, let us compare the behaviour under peak conditions of the system resulting from building the Project, versus that resulting from building 2,700 MW of wind power in its place. We will assume that HQD needs all the power the region can provide, and that the hydro system is functioning at 100%. There are three possibilities:

- If the wind system is producing exactly 888 MW (35% of its installed capacity), the system will behave exactly as it would have with the Project.

- If the system is producing more than 888 MW, HQP will be able to deliver even more peak power than it could have with the Project, up to the cold-weather capacity of the transmission system. Beyond that point, HQP will have to reduce generation at one of the hydro stations,[87] saving water for later use. The combined output will still be equal to or greater than it would have been with the Project.

- If the wind system is producing less than 888 MW, HQP will not be able to provide as much power from the region as it could have with the Project. This shortfall will have to be made up elsewhere in the system. For the alternatives in this regard, see section 3.2, above.

Thus, even without the addition of a new high voltage line, the only condition that remains problematic is the one where peak-hour wind production is less than 35% of installed capacity.

How often will this be the case? Our hourly wind data from the Gaspésie in 2004 suggest that generation would have exceeded this level about 50% of the time. However, the true value will vary, for a number of reasons. As winter is considerably windier than summer, the percentage of *winter* hours with less than 35% production can be expected to be even lower. Furthermore, due

[87] The situation would, of course, be different if the wind production were not produced or purchased by HQP. Then, the wind developer would be competing with HQP for access to the existing transmission capacity. HQP would then have no interest in reducing its generation at peak, unless it were properly compensated.

to the vast size of the Cree territory, and the fact that the regions of high wind potential are spread over a wide area, geographic diversity will tend to smooth the production curve. That said, given the availability of low cost of capacity options, discussed above in section 3.2, it is safe to conclude that adding a new 735 kV line would under no circumstances constitute the most economic solution. It is thus highly misleading to suggest that the cost of such a line should be added to the cost of the wind alternative, as did M. Arnaud in the hearing of May 3, 2006.[88]

The fact remains, however, that a large wind development of this type cannot provide the same level of firm capacity as the Project would provide. It has not been demonstrated, however, that the Proponent has a need for this firm capacity. On the contrary, as discussed above in section 3.2, HQP is already forecasting a capacity surplus without the Project, and there is no economic value to surplus capacity in Québec.

Thus, while a large wind development would not provide service equivalent to that provided by the Project, based on the information in the record, it would appear that the difference is of no real importance, as a) HQP has surplus capacity for all years for which it has provided data, and b) low-cost alternatives are available in the event a capacity shortfall should arise.

5.2.3.4. Saving water

According to M. Arnaud's presentation, a Cree wind megaproject would not even allow HQP to save water.

> Et qu'est-ce qui se passe quand on appelle, quand on appelle l'énergie éolienne, c'est-à-dire quand le réservoir doit fournir de l'eau pour l'énergie éolienne, cette eau elle quitte le réservoir. Alors, les gens pensent qu'ici on a économisé de l'eau dans nos réservoirs, mais quand il n'y a pas de vent, cette eau qu'on a économisée on la ressort. Donc, utiliser nos éoliennes qu'on met sur le réseau pour l'instant pour remplir nos réservoirs, c'est pratiquement pas possible et nos réservoirs ils ont des limites.
>
> Alors, ce que je voulais vous montrer par ce petit graphique c'est que nos réservoirs on peut les utiliser pour équilibrer de l'éolienne, mais il y a des limites, et n'oublions pas que chaque fois qu'on stocke de l'énergie ou on stocke de l'eau dans nos réservoirs parce qu'on a utilisé des éoliennes, quand il ne vente pas cette eau il faut la redonner, il faut la rendre. Alors, ça c'était un peu l'explication de la gestion des réservoirs.[89]

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[88] Transcription, v. 22, p. 45.

[89] Verbatim, v. 22, May 3, 2006, pp. 35-36.

It is difficult to make sense of this explanation. First, while it is true that serving new firm load with wind power does indeed require some form of backup, this does not mean that water that has been stored thanks to wind generation must be given back. Adding wind power without adding additional load clearly does result in increased water storage (assuming that storage capacity is available[90]), which can then be used to supply additional export sales.

Hydro-Québec insists that it cannot provide that backup without building new hydropower installations. However, the inherent flexibility of the existing hydro system can provide such backup without modification and, up to a certain point, without impinging on regular operations. Where that point is — how much wind power HQP's 35,000 MW of hydropower can support — can only be determined by or with the close cooperation of HQP. As noted earlier, to the best of our knowledge, no such study has been completed, or even undertaken.

It is important to emphasize that this is a very different question than the wind integration limits of the transmission system, which are the subject of a report commissioned by the Quebec Ministry in 2005. Carried out by the consulting firm RSW, Inc., the report seeks to evaluate the amount of wind power from each region of Quebec that could be successfully integrated into the transmission system without compromising voltage and frequency stability, the ability to maintain charge during low load periods, etc. However, given the complexity of the issues and the limited time given them to complete the study, its authors limited themselves to confirming that Hydro-Québec's assumptions are « not unrealistic ».[91] They did not actually carry out the detailed analyses necessary to fully respond to these questions, nor did they review the many detailed studies of this nature carried out in the U.S. and Europe.[92]

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More recently, Yves Filion, president of TransÉnergie, has acknowledged that the 10% limit which the RSW study attributes to TransÉnergie was not in fact the result of any detailed study carried out by the utility, but rather reflected a policy decision made by the government.[93] M. Filion further indicated that this was a preliminary estimate that would probably increase over time. In his May 3 presentation, M. Arnaud agreed (p. 41).

5.2.3.5. Exporting wind power

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[90] Given the very low reservoir levels favoured by HQP in recent years, there is little risk of spill.

[91] RSW Inc., *Évaluation de la capacité d'intégraiton du réseau intégré d'Hydro-Québec au regard de l'ajout de parcs de production d'électricité à partir d'énergie éolienne,* June 2005.

[92] Discussed in European Wind Energy Association, *Large Scale Integration of Wind Energy in the European Power Supply: Analysis, Issues and Recommendations*, http://www.ewea.org/fileadmin/ewea_documents/documents/publications/grid/051215_Grid_report_summary.pdf.

[93] Forum québécois de l'électricité, May 2006.

While wind power almost certainly is at a cost disadvantage in relation to the Project, it is likely to produce superior export revenues. Renewables Portfolio Standards (RPS) are in effect in several Northeast states (Maine, Massachusetts, Rhode Island, Connecticut and New York), which require distributors to include a minimum percentage of eligible renewable generation in their supplies. These policies create a price premium for eligible generating resources. Most of these states exclude large hydropower from the list of eligible renewables, but all include wind power.

This means that, insofar as HQP can transmit wind power into these states, it can probably obtain a superior price than it can for the rest of its generation portfolio. Furthermore, in some states, renewable energy certificates (RECs) can be substituted for actual renewable generation. That is, these states allow utilities with an RPS obligation to purchase the environmental attributes of renewable generation (RECs) without the renewable energy actually being transmitted into their markets.[94]

To the extent that it can comply with eligibility and tracking requirements, HQP could thus simply sell the RECs from its wind power generation into the Northeast RPS market, while selling the actual kilowatthours to other buyers.[95] In this way, it could still obtain a premium for its additional wind power generation, while avoiding the at times onerous arrangements required for direct sales.

5.2.4. Additional imports

There is one last alternative energy source that could be used to replace the energy that the Project would have provided for the purpose of allowing additional exports: additional imports.

While this option might at first glance seem tautological, it is entirely legitimate, because the underlying purpose of HQP is not to export electricity *per se*, but to earn revenues from so doing. As we have seen above, HQP's per-kWh profits have been greatest when the volume of its own generation available for export has been lowest. As the *Energy Strategy* pointed out:

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[94] See *Northeast RPS Compliance Markets: An Examination of Opportunities to Advance REC Trading,* published jointly by the Clean Energy States Alliance, New Jersey Board of Public Utilities, Office of Clean Energy and the Center for Energy, Economic and Environmental Policy, October 12, 2005. http://www.cleanenergystates.org/library/Reports/Northeast_RPS_Analysis_Final.pdf

[95] The North American Association of Issuing Bodies (NAAIB) is a voluntary association of certificate tracking systems, regulators and interested market participants that are vested in preventing double-counting and promoting harmonization among REC tracking systems in North America. The NAAIB's "best practices" to avoid double-counting can be found at www.resource-solutions.org/policy/naaib/docs/FinalWGDecisionDraft-NAAIB_Double_Counting_best_practices9.pdf.

> Net export revenue has decreased less than the actual quantity of electricity exported, because Hydro-Québec has been able to sell its electricity on export markets at a higher price than it has had to pay for its imports. (p. 20)

In the ongoing debates about the proper level of electric rates in Québec, we have become used to thinking of the "market price" of Québec electricity as its opportunity cost — the amount that kilowatthour could fetch on the U.S. market. In just the same way, we can also think of the "market cost" of electricity as the "opportunity cost" that would have to be paid to *acquire* it in the U.S.

At any given time and location, the market cost and price are of course the same. However, given the ability to use the existing reservoir system to defer purchases or sales, they are in fact very different.

In order to make available a given amount of energy for export, there are therefore two ways for HQP to obtain it: generate it, or purchase it.[96] The alternatives to generating this energy via the Project therefore include, as well as other ways to generate it, the possibility of purchasing it.

There is no question that HQP could greatly increase its purchases. Given approximately 5,000 MW of interconnections, and given that approximately 50% of the hours in the year are off-peak, HQP could in theory purchase more than 20 TWh of off-peak energy per year.

The question, of course, is one of price. Just as HQP seeks to focus its export sales on the highest-price hours, it seeks to focus its purchases on the lowest-priced hours. A review of hourly price distribution in the Northeast markets is beyond the scope of this study. However, it stands to reason that HQP's purchases could be increased, perhaps substantially, and still allow a significant margin between purchase and resale (export) prices.

The EIS is silent on this topic. No information is provided that would allow the Review Bodies to judge the quantity of energy that could be purchased at a cost similar to that of the Project. There is thus no reason to believe that, should HQP wish to increase its short-term sales beyond the average level of 10-12 TWh/yr provided by its margin of flexibility without the Project, it could simply increase its off-peak purchases accordingly. It should be noted that this option would only be needed for a few years, until the La Romaine Project and/or the Petite Mécatina Project come on line.

6. Summary and conclusions

6.1. Summary of findings

[96] HQD, of course, could also save it, by helping or persuading its customers to reduce their consumption, but HQD is not the Project Proponent, nor is it a participant at this time in the export market.

According to the Directives and the EIS, the justification of the Project must be analyzed with respect to three potential purposes: meeting Québec's future energy needs, maintaining energy security, and supplying additional export sales.

With respect to each of these purposes, we have reached the following conclusions:

Meeting Québec's future energy needs

- According to its most recent planning documents, HQD has no additional energy needs to be met for the for duration of its planning period, and it does not intent to hold any long-term tenders in which HQP could offer the energy produced by the Project.
- If HQD meets the energy efficiency targets set for it in the Quebec government's most recent *Energy Strategy,* it will have surplus energy to dispose of by 2014. Indeed, the *increase* in energy efficiency objectives announced in the recent *Energy Strategy* alone amount to 50% of the energy that would be produced by the Project, on an annual basis.
- Other factors that may well reduce HQD's needs over the next ten years include:
    - the government's decision to no longer offer reduced rates for energy-intensive industries, which will probably reduce forecast industrial load growth, and may eventually lead to plant closures,
    - the gradual increase in distributed generation, due to gradual elimination of regulatory barriers, the rising price of electricity, and the declining cost of wind and solar generating equipment,
    - further increases in energy efficiency objectives.
    - HQD currently shows a need for additional capacity of up to 1300 MW, during the planning period. This is not a major constraint, as short-term capacity purchases are available during the winter for only $10/kW (2005$). Alternatives to meet this need include:
    - increasing the amounts of interruptible power under contract,
    - capacity gains from the existing and planned energy efficiency programs,
    - single-cycle combustion turbines near load centres.

We therefore conclude that there is no need for the Project, with respect to Quebec's future energy needs.

Energy security and reliability

- The "margin of flexibility" that plays such a large role in Hydro-Québec's discourse about the Project is in fact a planned surplus that, together with energy stored in Hydro-Québec's interannual reservoirs, contributes to providing a secure and reliable energy supply.

- The experts commissioned in 1998 by the Régie de l'énergie to study the security of Hydro-Québec's energy supply confirmed that the historical level of 5 TWh for this margin of flexibility is still adequate to maintain a secure energy supply. They also seriously questioned the soundness of Hydro-Québec's policy of maintaining reservoirs at very low levels in order to increase profitability.

- The low reservoir levels in 2004 were not caused by too low a margin of flexibility, but by Hydro-Québec's failure to limit its exports to its actual hydraulic surplus in the preceding years of very low runoff. Doing so would have meant lower exports in several years, but would have avoided the critically low reservoir levels experienced in 2004. Even with a larger margin of flexibility, a crisis can be created by exporting more energy than inflows allow.

- In its *Avis* on the contribution of the Suroît project to Quebec's energy security, the Régie de l'énergie recommended a thorough public review of the consequences of increasing the margin of flexibility to 15-18 TWh. No such public review was ever held.

- Even without the Project, HQP has sufficient capacity to meet its obligations through 2014 (the last year for which projections were provided). Indeed, HQP has surplus capacity, even without the Project. This capacity surplus would be even greater if it properly accounted for the the capacity value of its windpower suppliers. Excess capacity, however, has little if any economic value.

We therefore conclude that there is no need for the Project, with respect to Quebec's energy security.

Exports

- As there is no need for the Project with respect either to Quebec's needs or its energy security, the only remaining justification advanced by the Proponent is to supply additional export sales.

- The documentation presented in support of the Proponent's profitability estimates is woefully inadequate.

- The cost information presented is understated due to:

    - the very substantial increase in interest rates since the date of the EIS, which will inevitably lead to higher financing costs, both during construction and in the long term, and

- the new obligation to Hydro-Québec pay royalties for the hydraulic rights for all hydropower generation, which would apparently add close to 1¢/kWh to the unit cost.

- At the same time, the revenues appear to be overestimated, due to:
  - unsupported projections of price increases, compared to well-supported projections of price decreases (from a detailed modeling study carried out on behalf of a consortium of electric utilities in New England) in the timeframe at issue;
  - the unsupported assertion that wheeling charges, losses and congestion charges are on average negative for PJM and New York; and
  - the very substantial appreciation of the Canadian dollar, which at current levels reduces the value of each dollar of export revenue by 12.5%, not to speak of additional appreciation that could well occur before construction is completed.

- Based on the information currently available, it is impossible to make a serious estimate of the profitability or the risks associated with developing the Project for purposes of off-system sales.

Alternatives

- The Directives require the Proponent to examine the alternatives to the Project for each of its purposes.

- Seven of the 23 questions addressed to the Proponent by the Review Bodies with respect to the Project's justification in their conformity report concerned alternatives to the Project. Six of the seven responses were inadequate.

- As the alleged need for the Project in order to meet Quebec's future needs and to provide for its energy security are without foundation, we have not addressed the alternatives for these purposes.

- The Proponent has in effect argued that there are no alternatives to the Project with respect to its complementary purpose of allowing Hydro-Québec to increase export sales without increasing interconnection capacity. We have identified three possible alternatives: the no-build option, other large hydroelectric projects and wind power.

- **the no-build option.** The no-build option is *a priori* feasible, in that Hydro-Québec is under no obligation to increase its off-system sales. Even without the Project, exports will increase to their historic levels of 10-12 TWh per year, assuming average runoff.

- Historically, average exports prices are declined when export volumes increased, and vice versa. It is illusory to expect the very high average export prices of the last few years to continue, once exports return to their historic levels.

- **other large hydro projects.** Hydro-Québec has now confirmed its intention to proceed with 4,500 MW of additional large hydro development, on an accelerated timetable. The first of these projects is expected to begin generating electricity as early as 2014. These projects thus constitute a viable alternative to the Eastmain 1A/Rupert Diversion Project for the purposes of increasing export sales. Indeed, it is far from obvious how Hydro-Québec will be able maintain export prices at acceptable levels, given the enormous amounts of energy it expected to be exporting 10-15 years from now.

- **wind power.** The Proponent acknowledges that a bloc of energy equivalent to that of the Project could be produced by developing some 2,700 MW of wind power in the Cree territory. At the same time, it argues that wind power is in no way an alternative to the Project. Its arguments, however, do not stand up to critical scrutiny:

  - Low temperatures are a much less serious problem for wind turbines than is icing, which is much more common in the Gaspé than in the Cree territory. Existing cold climates packages are effective down to -30ºC, and reduce annual energy production by only 2-3%.

  - Balancing service is unnecessary insofar as HQ Production is the purchaser of the wind power. As the Cree wind project would be located in the same region as the La Grande system, with more than 15,000 MW of installed hydropower capacity, the ramping capability of those power plants would almost certainly be sufficient to maintain stability in the power flows on the high-voltage lines connecting that region to the rest of Hydro-Québec's transmission system. Whether or not so doing would affect HQP's ability to track load variation in Quebec can only be determined through detailed modeling of the hydro system. To date, there is no indication that Hydro-Québec has undertaken the studies required to address this question.

  - For similar reasons, there is no need to construct a new high-voltage line, as long as HQP is willing to modulate its hydro output in relation to wind generation and the capacity of the existing lines. During most hours, and even during most peak hours, the hydro-wind system would produce as much power as would the Project. For the peak hours in which the wind output was less than 888 MW (35% of its installed capacity), however, additional capacity would be required from elsewhere in the system to match the Project's performance.

- **Additional imports.** There is no question that Hydro-Québec could increase its purchases (imports) for resale, perhaps substantially, and still allow a significant margin between the purchase and resale prices. No information has been presented as to the

relative costs of additional purchases compared to the costs of the Project or the other altneratives mentioned here.

There is thus no reason to believe that, should HQP wish to increase its short-term sales beyond the average level of 10-12 TWh/yr provided by its margin of flexibility without the Project, it could simply increase its off-peak purchases accordingly. It should be noted that this option would only be needed for a few years, until the La Romaine Project and/or the Petite Mécatina Project come on line.

6.2. Concluding comments

In the EIS and in its public statements about the Project, Hydro-Québec has insisted that its primary purposes are to meet Quebec's future energy needs and to ensure its energy security. However, our review of the information submitted to the Review Bodies and of other public information demonstrates that, for these purposes, there is no need for the Project.

The one remaining purpose described by the Proponent is to supply additional export sales. While there is no doubt that the Project would indeed accomplish this purpose, many questions remain as to the real profitability of this export strategy. To make a convincing case in this regard would require careful analysis of the expected evolution of the electric system in the Northeastern United States over the next decades — which itself is subject to profound uncertainties — as well as scenarios for the exchange rate of the Canadian dollar. Furthermore, it would have to take into account the consequences of varying levels of exports sales not only on the average price that can be obtained, but also on the hourly price itself.[97]

That said, it must be acknowledged that the proposed Project's unit costs appear to be low when compared to other generation alternatives, though they are quite high in relation to Hydro-Québec's current average generation costs. However, it appears that the Project will bring with it substantial environmental and social impacts, which will be borne primarily, though not exclusively, by the Cree communities situated in the Rupert River basin and at the mouth of the La Grande River.

Given the lack of need for the Project in terms of Quebec's energy needs and its energy security, the only justification for the Project is economic. In the end, the justification of the Project comes down to weighing the expected profits (taking into account all the uncertainties described above) against these environmental and social costs. No attempt has been made to express these in monetary terms, nor is it appropriate to do so. This does, of course, mean that these costs do not exist, or that they should be ignored in the decision-making process. Weighing these very real costs against an expectation of monetary gain, which itself is subject to many uncertainties, is the unenviable task currently before the Review Bodies.

[97] As the hourly price depends on both the supply and demand price curves, significantly increasing imports from Quebec will tend to depress the market price from what it would otherwise have been.