2005

QUÉBEC AREA

TRIENNIAL REVIEW

OF RESOURCE ADEQUACY

Approved by the RCC on March 8, 2006

Prepared by

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1. EXECUTIVE SUMMARY

1.1. Major Findings

This Québec Triennial Review of Resource Adequacy is submitted to the Northeast Power Coordinating Council (NPCC) and prepared in accordance with "Guidelines for Area Review of Resource Adequacy", document B-8 revised November 29th, 2005. As in the previous review, it shows that the Québec Area has the ability to meet the NPCC reliability criterion for the five year planning period, November 2005 through October 2010.

The information presented covers November 2005 to October 2010 and is based on the Hydro-Québec 2005 load forecast according to the 2005-2014 Procurement plan progress report filed with the Québec Energy Board on October 19th 2005. Related documents can be found at the following internet address:

http://www.regie-energie.qc.ca/audiences/EtatApproHQD/Etat-avancement2005_19oct05.pdf

The peak load forecast for 2005-2006 is set at 36 754 MW, about 1 800 MW higher than forecasted in the previous review. The winter peak load is forecasted to grow at an annual average rate of 0,63% to reach 37 690 MW in 2009-2010. The planned resources is forecasted to grow faster than the load over this period (annual average growth rate of 1,4%). For the 2005-2006 winter peak, the planned resources are 40 658 MW. This is 1 158 MW more than the previous Review. In 2009-2010, the planned resources are estimated to be 42 981 MW, an anticipated increase of 2 323 MW.

The anticipated increase of resources, greater than the anticipated increase of load, is more than sufficient to maintain the planned reserve over the required reserve by more than 1 000 MW on the horizon of the Review. This Review indicates that the required reserve margin varies in a range from 9,3 % in 2005/06 to 10,0 % in 2009/10 to meet the NPCC reliability criterion of a maximum 0,1 day per year of loss of load expectation (LOLE). The planned reserve margin varies in a range from 10,6 % in 2005/06 to 14,0 % in 2009/10.

Québec Energy Board requirements

The Québec Energy Board in its approval of the Procurement plan 2005-2014 states that the Québec Control Area must include interconnection support from neighbouring areas in its resource planning. Beginning in the 2006/2007 winter period, the Distributor will take into account a tie benefit of 500 MW in its planning. This tie benefit from neighbouring areas will probably come mainly from the New York Control Area. The decision of the Québec Energy Board on the Procurement plan 2005-2014, can be found at the following internet address:
http://www.regie-energie.qc.ca/audiences/decisions/D-2005-178.pdf

1.2. Major Assumptions and Results

The following table sets major assumptions and results.

Table I Major Assumptions and Results

Assumptions	Description	
Study period	Winter 2005-2006 to Winter 2009-2010	
Reliability Criterion	LOLE 0,1 day/year : complying with once in 10 years NPCC criterion	
Load Model	8 760 hourly peak load with uncertainty factors	
Program	GE MARS Program	
Load Growth	2005-2006	2009-2010
- Base Case	36 754 MW	37 690 MW
- High Case	37 284 MW	39 314 MW
Required Reserve (% of Total Peak Demand)	9,3 %	10,0%
Resources Additions	2 323 MW through the study period	
Forced Outage Rates	5 years history	
- Hydraulic	1,1 % to 1,8 %	
- Thermal, including nuclear	4 % to 10 %	
Tie benefit	500 MW beginning in 2006-2007 (mainly from NYCA)	
Synchronized Spinning Reserve	minimum amount of 250 MW	
Emergency Operating Procedures		
- Interruptible Load	1 235 MW through the study period	
- Voltage Reduction	200 MW beginning in 2006-2007	
Unit Dependable Maximum Net Capability	see Table A	
Maintenance Schedule	see Table A-1	
Results		
	LOLE Day/year	
	Base Case	**High Case**
2005/06	0,097	0,102
2006/07	0,030	0,036
2007/08	0,035	0,052
2008/09	0,029	0,059
2009/10	0,024	0,072

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3. INTRODUCTION

This resource adequacy review is conducted by Hydro-Québec and submitted to the Northeast Power Coordinating Council (NPCC) in accordance with "Guidelines for Area Review of Resource Adequacy", document B-8 revised November 29th, 2005.

Information presented covers November 2005 to October 2010 and is based on the Hydro-Québec 2005 load forecast included in the 2005-2014 Procurement plan progress report filed with the Québec Energy Board on October 19th 2005.

The report demonstrates that the Québec Control Area is expected to meet the NPCC resource adequacy design criterion (i.e. the frequency of disconnecting non-interruptible customers due to resource deficiencies, on average, no more than once in ten years) for the period 2006 to 2010 under the base case. For the high load forecast scenario, only the year 2005/2006 shows a LOLE slightly over 0,1 day/year.

This is the first Québec Triennial Review under the new NPCC criterion stating the obligation to take into account the internal transmission transfer capabilities. For doing so, the Québec Area has been split into six sub areas (Baie James, Churchill Falls, Manicouagan, Québec Centre, Nicolet-Des Cantons and Montréal).

Hydro-Québec bought a licence for the usage of the General Electric "Multi-Area Reliability System" model (MARS). For technical information see appendix A.

3.1 Previous Triennial Review

The last Québec Triennial Review was submitted November 2002. Based on that review, NPCC concluded that Québec's resource adequacy was in accordance with the NPCC criterion for resource adequacy.

3.2 Comparison of Current and Previous Triennial review

The Québec Control Area has been divided into six sub areas to model the major internal transfer constraints. The values provided in Figure 1 and Table 2 represent the capabilities within the Québec system.

Baie James sub area
This sub area is located in the northwest and includes 15 830 MW of generating capacity from the large James Bay hydro complex (see the first Table in Appendix A). The load in this region is very small. The peak load forecast for the 2005-2006 winter is around 1 150 MW. The transfer capabilities from this sub area to the other sub areas are 15 500 MW.

Churchill Falls sub area
The Churchill Falls sub area has no load and represents Hydro-Québec contractual rights on Churchill Falls hydro generation (5 064 MW).

Nicolet-Des Cantons sub area
The Nicolet-Des Cantons sub area has no load and is used to model the HVDC Phase 2 interconnection and its transfer capabilities within the Québec system and/or imports/exports with the New England Control Area. The values provided in Figure 1 represent the capabilities within the Québec system.

Manicouagan sub area
This sub area, in the northeast, includes 8 400 MW of generating capacity and receives the Churchill Falls (5 064 MW) generation. Its load is mainly driven by large industrial users. The Manic-Outardes complex (7 800 MW) is located in this sub area. The peak load of this sub area is 1 835 MW. The transfer capability from this sub area to the Québec Centre sub area is 11 600 MW.

Québec Centre sub area
This sub area includes the Lac St-Jean, Gaspésie, Québec City and Trois-Rivières regions. The peak load is 9 130 MW and the generating capacity is 1 600 MW. This sub area can receive 13 500 MW from the James Bay sub area and 11 600 MW from the Manicouagan sub area. The transfer limit between Québec Centre and Montréal is 17 900 MW.

Montréal sub area
This sub area, in the south west of Québec, includes the Montréal, Outaouais, and Estrie regions. The peak load is 24 015 MW, more than 65 % of the total load and the generating capacity is 6 270 MW.

Figure 1 Québec Internal Transmission Transfer Capabilities at 2005/2006 Peak (in MW)

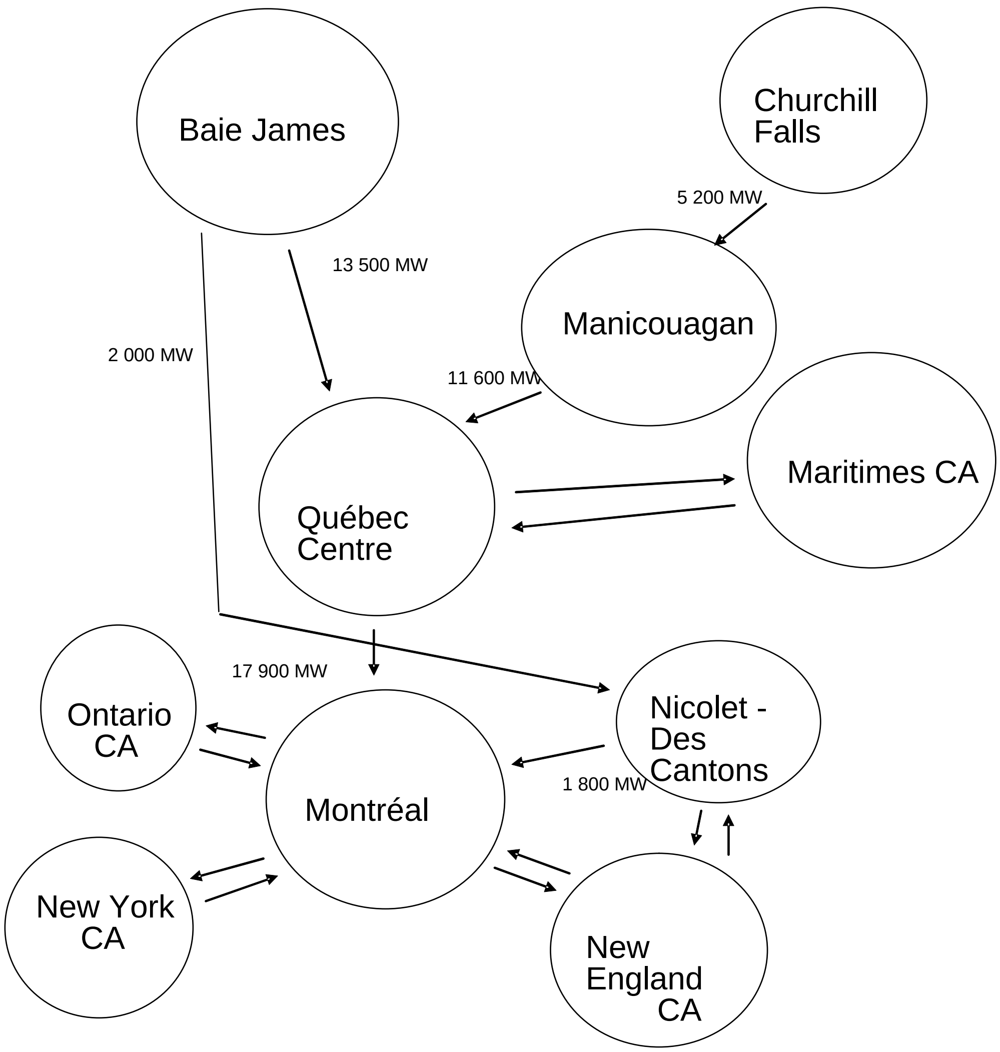


Table 2 Québec Internal Transfer Capacities

Sub area		Capacity			
Sending	Receiving	MW	# of circuits	Kv Voltage	Type of current
Churchill	Manicouagan	5 200	3	735 Kv	Alternative
Manicouagan	Québec Centre	11 600	5	735 Kv	Alternative
Québec Centre	Montréal	17 900	8	735 Kv	Alternative
Baie James	Québec Centre	13 500	6	735 Kv	Alternative
Baie James	Nicolet-Des Cantons	2 000	1	450 Kv	Direct
Nicolet-Des Cantons	Montréal	1 800	1	450 Kv	Direct

3.2.1 Load

The observed peak load for the winter 2004-2005 was 35 830 MW reached on December 20th, 2004 at 6 pm, including 874 MW of firm sales to neighbouring areas. This annual peak load was 1 240 MW greater than forecasted in the previous Review for the same period. A strong economic activity and a robust residential sector are the main reasons explaining the peak load increase.

In the 2002 Review, the 2005-2006 winter peak load forecast was 34 960 MW and 35 240 MW for the 2006-2007 winter peak (see Table 3 and Figure 2). In the current review, the 2005-2006 winter peak load forecast[1] is set at 36 754 MW and grows at a annual average rate of 0,63 % to reach 37 690 MW by 2009-2010. The load forecast is higher than the last Triennial Review but growth is slower.

For the 2005-2006 winter period, the peak load demand is forecasted to be 36 754 MW, about 1 800 MW higher than the 2002 Triennial Review's forecast for the same period. This higher load is mainly driven by Québec's economic performance since 2002. Some major industrial loads have been added since the last Triennial Review. Also, the residential sector has experienced high growth since 2002. The housing construction hit an annual record high in 2004. Moreover, since 2004, the high prices of alternative energies have put pressure on electricity demand for heating purposes.

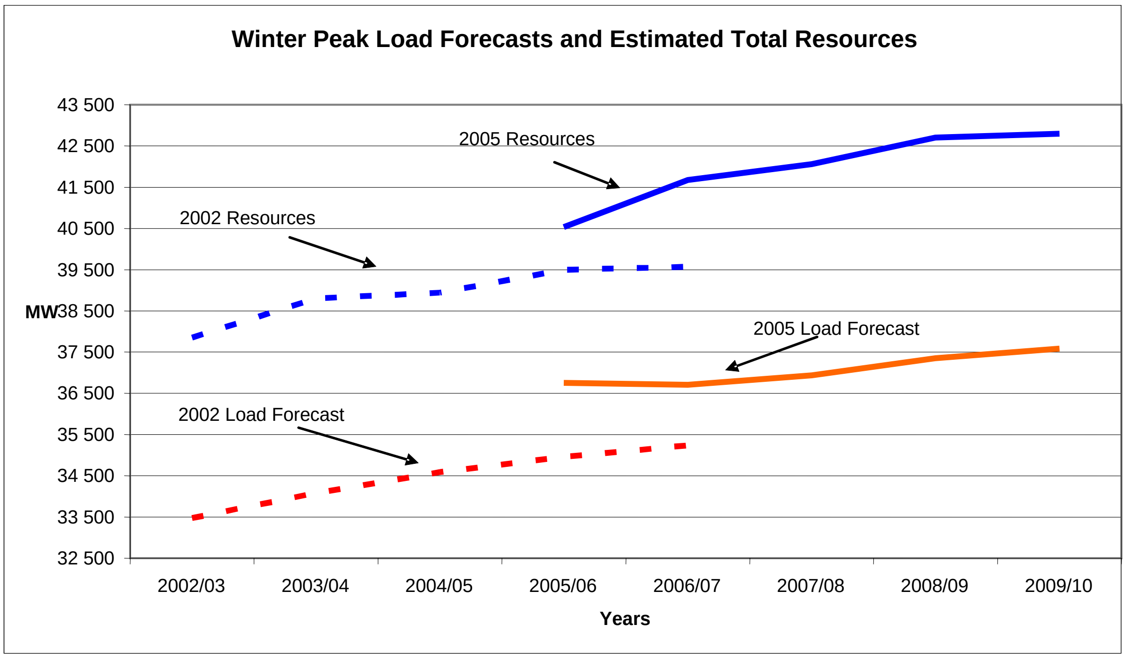
[1] *Hourly chronological load profiles are developed based on the weather profiles of the 30 year period (1971 to 2000) and the economic and demographic load forecast parameters for the year modeled. By shifting the weather profiles by up to ± 3 days, a total of 210 load profiles are derived. Our load forecast is the arithmetical average of these 210 annual hourly load forecasts.*

Table 3 Comparison of Annual Peak Load Forecasts[1] (MW)

Load Forecast			
Year	**Triennial 2002**	**Triennial 2005**	**Difference**
2002/03	33 480		
2003/04	34 080		
2004/05	34 590		
2005/06	34 960	36 754	1 794
2006/07	35 240	36 813	1 573
2007/08		37 038	
2008/09		37 454	
2009/10		37 690	
Average growth rate	1,3%	0,63%	

[1] Annual peak load forecast includes firm exports but does not take into account interruptible power shaving.

Figure 2 Winter Peak Load Forecasts and Estimated Total Resources in MW



3.2.2 Resources

The planned resources for the 2005-2006 winter peak are 40 658 MW. This is 1 158 MW more than the previous Review. The resources are planned to grow to 42 981 MW for the 2009-2010 winter peak, an average annual growth rate of 1,4 %. By 2010, the resources are expected to have increased by 2 323 MW. The increase in resources is 1 387 MW more than the anticipated increase in peak load for the same period. The new resources come mainly from new generation facilities in Québec that will add 2 283 MW of capacity during the period. The in-service of new hydro equipment and upgrades of existing hydro equipment account for nearly 1 500 MW of the capacity increase. New thermal generation represents nearly 600 MW of additional capacity almost exclusively coming from the Bécancour cogeneration generating station of 547 MW (see Table 4).

All government authorisations have been received and the construction is in progress in all of those generating stations. No construction delays are expected so there is no uncertainty related to the in-service date. Regarding the upgrading of various generating stations, some projects can be delayed, done sooner or modified.

Table 4 Capacities addition in Québec between 2005/06 and 2009/10 in MW [2]

	2005/06	2006/07	2007/08	2008/09	2009/10
Outardes-3 Reequipment	75	150	150	150	150
Outardes-4 Reequipment	14	28	42	56	56
Mercier		32	32	32	32
Eastmain-1		320	480	480	480
Péribonka				340	340
Rapides des Cœurs				77	77
Chute Allard				57	57
Upgradind various stations	10	62	150	270	373
TransCanada Energy (Bécancour)		547	547	547	547
Biomasse (Montréal sub area)		20	36	36	36
Cogeneration (Montréal sub area)				8	8
Independent Power Producer	20	28	91	127	127
Total Cumulative New Generation	119	1 187	1 528	2 180	2 283

[2] : these capacity additions exclude the Sainte-Marguerite 3 return to full capacity in October 2006.

These figures do not include the wind power capacities. In 2006, Hydro-Québec will undertake studies to evaluate the peak capacity contribution of wind power. In 2009-2010, the wind power installed capacity is estimated at 1 336 MW. The forecasted wind power installed capacity is approximately 3 500 MW for 2013-2014.

Table 5 Comparison of Estimated Total Resources[3]

Resources Forecast			
Year	Triennial 2002	Triennial 2005	Difference
2002/03	37 850		
2003/04	38 800		
2004/05	38 940		
2005/06	39 500	40 658	1 158
2006/07	39 570	41 987	2 417
2007/08		42 334	
2008/09		42 825	
2009/10		42 981	
Average growth rate	1.1%	1.4%	

[3]Resources include purchases and interruptible power shaving.

The Rocher Grand-Mère, Toulnustouc and Sainte-Marguerite 3 hydraulic generating stations have been put in service as forecasted in the previous review. Installed capacity is similar to the previous review forecast. One of the two units at the Sainte-Marguerite 3 hydroelectric generating station will be out of service for the 2005-2006 winter period due to a significant maintenance extension. This station will be back at full capacity (882 MW) before the 2006-2007 winter period.

For the 2005-2006 winter period, Hydro-Québec Distribution bought more than 900 MW from neighbouring areas. Transmission capabilities have been secured at the same time.

Construction is underway on different sites that amount to nearly 1 000 MW of hydraulic capacity (Eastmain-1, Péribonka, Chutes Allard and Rapides-des-Coeurs). Hydro-Québec Production has a rehabilitation program for its generation equipment. More than 350 MW will be added over the next four years following specific upgrading projects.

TransCanada Energy is completing the construction of its 547 MW natural gas cogeneration unit in Bécancour.

4. RESOURCE ADEQUACY CRITERION

4.1 Statement of Québec Resource Adequacy Criterion

The Québec system is planned in accordance with the NPCC resource adequacy criterion. This represents a change compared to the previous Review. The LOLE is now expressed in day per year instead of hours per year. Because the previous Québec reliability criterion was in accordance with the NPCC's reliability criterion, this change is more a wording variation neutral as an assessment of Québec's electric system.

Québec's reliability criterion is the same as the NPCC resource criterion, which reads:

> "Each Area's probability (or risk) of disconnecting any firm load due to resource deficiencies shall be, on average, not more than once in ten years. Compliance with this criteria shall be evaluated probabilistically, such that the loss of load expectation (LOLE) of disconnecting firm load due to resource deficiencies shall be, on average no more than 0.1 day per year. This evaluation shall make due to allowance for scheduled outages and derating, forced outages and deratings, assistance over interconnections with neighbouring Areas and Regions, transmission transfer capabilities, and capacity and or load relief from available operating procedures."

4.2 Details on the application of the criteria

The criterion used in Québec resources planning is a Loss of Load Expectation (LOLE) of 0,1 day per year using an hourly load model.

Due to the shape of the Québec load, most of the expected deficiencies occurs in the expected peak load month of January.

Load control procedures will be supplemented with 200 MW of voltage reduction as a modeled emergency operating procedure. Some tests have been made during the 2004-2005 winter period and others will take place during the 2005-2006 winter period to confirm a 200 MW voltage reduction capacity.

Interruptible load over the considered period is 1 235 MW.

A minimum amount of synchronized spinning reserve of 250 MW is required to ensure safe operation of the system. Load shedding will be implemented to prevent the spinning reserve from dropping below that value. Therefore, this capacity is not considered available to supply the load. The minimum spinning value is the same as in the 2002 Review.

Table 6 Emergency Operating Procedures

Step	Procedure	Effect	MW value
1	Interruptible Load	Load Relief	1,235
2	Thirty-minutes reserve to zero	Allow operating reserve to decrease	500
3	Voltage Reduction	Load Relief	200
4	Ten-minutes reserve to zero	Allow operating reserve to decrease	750(4)

(4) : the ten-minutes reserve is 1,000 MW, but 250 MW of spinning reserve must be available at all time.

4.3 Statement of Required Reserve

For resource planning, the "Patrimonial contract" which includes a peak load of 34 342 MW, requires 3 100 MW of reserve based on simulations using the previous FEP model (see Appendix C). For comparison purposes, an analysis evaluated the required reserve for the "Patrimonial Contract" with the GE MARS model. This model evaluated the required reserves to be 3 130 MW at 0,1 day per year of LOLE.

The resource requirements are the result of a complete Loss of Load Expectation (LOLE) evaluation done year by year for the power system which meets both the energy and capacity criteria. The resource capacity adequacy may vary from one year to another depending on the system characteristics such as:

- the load forecast and the load hourly chronological shapes over the years;
- the type, the size and the commitment dates of the new resources;
- the existing and future generating unit availability (scheduled maintenance and outages rates).

As can be seen in Table 7, for the planning years 2005-2006 through 2009-2010, total resource requirements are expressed as a percentage of the annual peak load.

The resource requirements are 9,3 to 10,2 % higher than the annual peak load and are mostly supplied by available and committed generation and firm purchases. It shows that planned resources are more than adequate to abide by Québec reliability criterion.

4.4 Comparison of Québec and NPCC Resource Reliability Criteria

Québec's reliability criterion is the same criterion as the NPCC criterion.

4.5 Recent Reliability Study

Resource requirements are evaluated every year, pertaining to the normal yearly planning process to integrate the latest information such as demand forecast, the available capacity, the new firm purchases and sales contracts.

Hydro-Québec Distribution has the obligation to demonstrate its reliability to the Québec Energy Board in November of each year. The Québec Energy Board asks that the reliability be demonstrated over the NPCC procedure. For more details about the requirements of Québec Energy Board, see the following internet addresses:

http://www.regie-energie.qc.ca/audiences/decisions/D-2002-169.pdf

http://www.regie-energie.qc.ca/audiences/decisions/D-2005-178.pdf

The Québec Area fully participates in the different NPCC Working Groups that regularly conduct reliability studies in which the Québec system is modelled. These studies show that the Québec Area complies with the NPCC adequacy reliability criterion. The last NPCC Multi-Area Winter Assessment has been conducted with Québec's six sub areas representation.

5 RESOURCE ADEQUACY ASSESMENT

5.1 Proposed vs. Required Resources for the Base Case Load Forecast

Based on the 2005 load forecast, Table 7 depicts the required reserve and the planned reserve values for the 2005-2010 period, expressed as a percentage of the total annual peak demand which includes firm demand and exports.

The planned resources include the installed capacity, firm purchases and the interruptible power shaving. Total reserves are higher than required reserves throughout the considered period.

The Required Reserve margin is 9,3% in 2005/06 and 10,0% for 2009/10 of the annual peak load. This is the same required reserve margin as in the previous review. The internal transfer capabilities are not a constraining factor. The transmission planning is done under full NPCC criteria. The maintenance program can be adapted to various conditions without repercussion on its reliability.

Table 7 Comparison of Planned and Required Reserves (Base Case)

	Planned Resources	Annual Peak Load	Planned Reserves		Required Reserves		LOLE
	MW	MW	MW	%	MW	%	(Day/year)
2005/06	40658	36754	3904	10,6%	3424	9,3%	0,097
2006/07	41987	36813	5174	14,1%	3431	9,3%	0,030
2007/08	42334	37038	5296	14,3%	3642	9,8%	0,035
2008/09	42825	37453	5372	14,3%	3837	10,2%	0,029
2009/10	42981	37690	5291	14,0%	3781	10,0%	0,024

Planned and committed capacity includes existing hydro and thermal plants, scheduled improvements to existing capacity and also committed additions of generating facilities. Firm purchases include purchases from Alcan (a private electric producer in Québec), Churchill Falls Corporation Limited (CFLCo), New Brunswick Power, Québec's independent power producers and short term purchases.

The planned resources provide reliable and continuous electricity service over the currently forecasted levels of load through the end of 2010.

5.2 High Load Forecast

Table 8 Québec Annual Peak Load Forecast[5]

Planning Year	High Load Forecast	Average Load Forecast	Difference
2005/06	37 288	36 754	534
2006/07	37 509	36 813	696
2007/08	38 069	37 038	1 031
2008/09	38 699	37 453	1 246
2009/10	39 319	37 690	1 629
Average Growth Rate	1,33%	0,63%	

[5] Annual peak load forecast includes firm exports but does not take into account interruptible loads shaving.

Table 9 Planned Resources, Annual Peak Loads, Planned Reserves and LOLE (High Case)

	Planned Resources	Annual Peak Load	Planned Reserve		LOLE (Day/year)
	MW	MW	MW	%	
2005/06	40 658	37288	3370	9,0%	0,102
2006/07	41987	37509	4478	11,9%	0,036
2007/08	42334	38069	4265	11,2%	0,052
2008/09	42825	38699	4126	10,7%	0,059
2009/10	42981	39313	3668	9,3%	0,072

Except for the **year** 2005/06, the LOLE for the High Case scenario is under 0,1 day per year. If the high case load scenario should materialize, Québec will be able to access additional resources from neighbouring areas in a very short period of time.

5.3 Contingency Plans

The total planned resources will be sufficient to meet both base and high case load assumptions. In addition, Québec, at the appropriate time, can purchase resources from external markets.

Table 10 shows Québec's typical import capability at peak time by system. These numbers do not account for transmission unavailability.

Table 10 Maximum-Import Capability at Peak (MW)

Neighboring Area	Synchronous	HVDC	Radial	Total
CF(L)Co[6]	5 200			5 200
Ontario			500	500
New-Brunswick		785		785
New York		1 000		1 000
New England		690		690
Total	**5 200**	**2 475**	**500**	**8 175**

(6) : Churchill Falls (Labrador) Corporation Limited

6 PROPOSED RESSOURCE CAPACITY MIX

6.1 Planned Resources Capacity Mix

Québec is mainly a hydroelectric generation system. The breakdown by type is shown in Figure 3 for the 2006-2007 winter period. Hydropower represents 93 % and thermal generation 7 %.

Hydropower relies on adequate water inflows to reliably meet the annual energy consumption. To assess its energy reliability, Hydro-Québec developed an energy criterion that states that sufficient resources should be available to go through sequences of 2 or 4 years of low inflows having a 2% probability of occurrence. Hydro-Québec must demonstrate three times a year to the Québec Energy Board its ability to meet this criterion.

The Québec Area will have close to 1 336 MW of wind power installed capacity in 2009-2010 winter period.

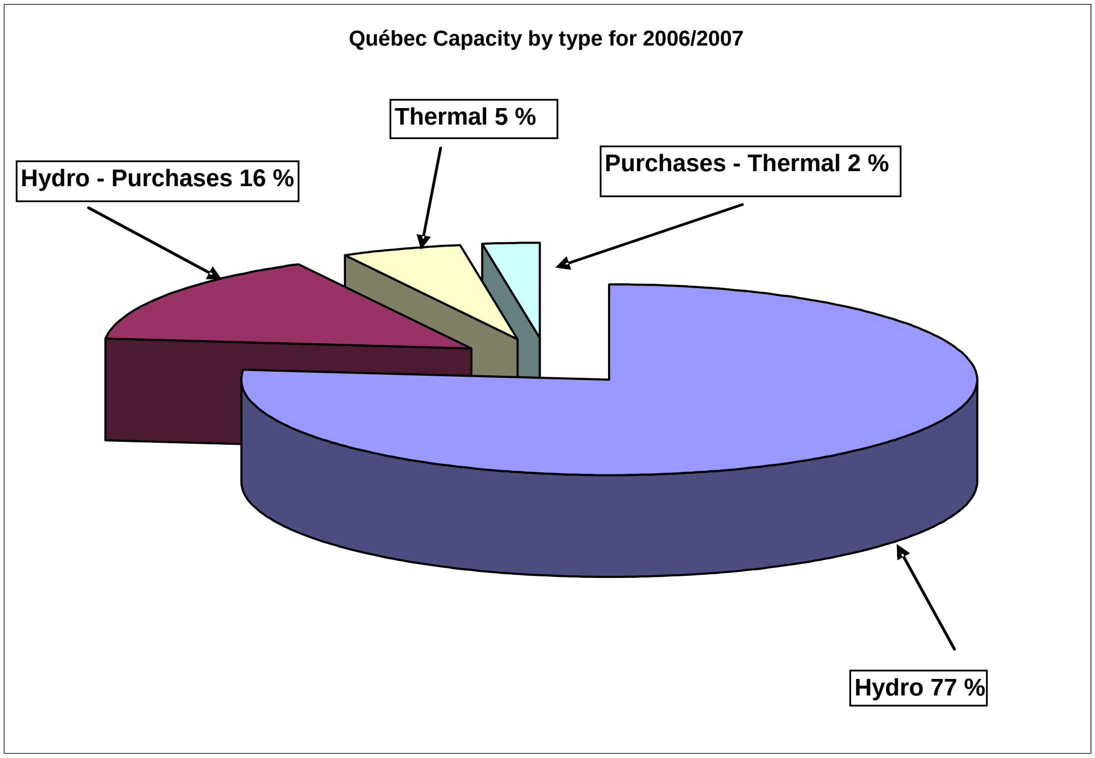
The contribution of wind power capacity is not included in this review. Hydro-Québec Distribution will analyse wind power contribution during peak and off peak periods and evaluate its capacity and energy contributions. Wind technology is planned to be operational over different Québec winter peak conditions that can be severe (wind, temperature and duration).

6.2 Reliability Impact of Resource Capacity Mix

Hydro-Québec's energy requirements are mostly produced by hydro generating stations, which are located on different river systems scattered over a large territory. The major plants are backed by multi-year reservoirs (water reserves lasting more than one year). Québec's system can rely on those multi-year reservoirs and on some other non-hydraulic sources, including fossil generation, allowing it to cope with inflow variations.

Figure 3 Capacity Generation by Type for winter 2006/2007

Percent of total



Appendix A

Description of Resource Reliability Model

A. Description of Resource Reliability Model

A.1.1 Load Model

A.1.1.1 Description of Load Model

MARS employs an 8760 hours chronological zonal load model. The load model currently used is based on the demographic, economic and energy conditions, which are most likely to materialise.

A 1.1.2 Load Forecast Uncertainty

Load forecast uncertainty was determined by analysing Québec's internal load over the 1971 to 2000 period.

A 1.1.3 Loads of interconnected entities within the Area

The loads and resources of interconnected entities within the Area that are not members of the Area were not considered.

A 1.1.4 Demand Side Management

Industrial interruptible load amounts to 1,235 MW.

A 1.2 Resource Unit Representation

A 1.2.1 Unit Rating

The following Table provides a listing of the existing capacity of Hydro-Québec Production system as of January 2006.

Table A

Existing Capacity as of January 2006

Station	Number of Units	Dependable Maximum Net Capability in January - MW
1 - Hydroelectric Power Plant		
Outaouais River		
Rapide 7	4	46
Rapide 2	4	47
Rapide des Quinze	6	87
Rapide des Îles	4	132
Première Chute	4	111
Bryson	3	59
Chute des Chats	4	86
Hull 2	4	19
Paugan	8	183
Chelsea	5	149
Rapides Farmers	5	93
Carillon	14	600
Rivière des Prairies	6	35
Subtotal Outaouais	**71**	**1647**
St.Lawrence River		
Beauharnois(*)	36	1098
Les Cèdres	18	38
Subtotal St.Lawrence	**54**	**1136**
St-Maurice River		
Rapide Blanc	6	214
Trenche	6	292
Beaumont	6	260
La Tuque	6	178
Grand-Mère	9	0
Rocher-de-Grand-Mère	??	219
Shawinigan 2 et 3	11	354
La Gabelle	5	125
Subtotal St-Maurice	**49**	**1642**
Bersimis River		
Bersimis 1	8	901
Bersimis 2	5	717
Subtotal Bersimis	**13**	**1618**
Ste-Marguerite River		
SM3	2	297
Subtotal Ste-Marguerite	2	297
Aux-Outardes River		
Outardes 4	4	680
Outardes 3	4	972
Outardes 2	3	434
Subtotal Aux-Outardes	**11**	**2086**

Station	Number of Units	Dependable Maximum Net Capability in January - MW
1 - Hydroelectric Power Plant (cont'd)		
Manicouagan River		
Hart Jaune	3	42
Manic 5	12	2454
Manic 3	6	1172
Manic 2	8	1047
Manic 1	3	183
Toulnustouc	2	465
McCormick	7	354
Subtotal Manicouagan	**41**	**5717**
La Grande River		
Brisay	2	361
LA 2	2	296
LA 1	6	860
LG 4	9	2650
LG 3	12	2432
Robert Bourassa	16	5452
LG 2A	6	1989
LG 1	12	1232
Subtotal La Grande	**65**	**15272**
Stations < 30 MW	40	96
TOTAL HYDRAULIQUE	**346**	**29511**
2 - Thermal Plant		
Oil		
Tracy	4	600
Gas Turbines		
Cadillac	3	162
La Citière	4	280
Bécancour	4	436
Nuclear		
Gentilly 2	1	627
TOTAL Thermal Plant	**16**	**2105**
TOTAL Hydro-Québec Production	**362**	**31616**

A 1.2.1.1 Definitions

The capacity definitions used in reliability evaluation are as follows:

- Hydroelectric Generating Stations of 50 MW and above

Dependable Maximum Net Generating Capability (DMNC) is defined as the net output a unit can sustain over a specified period modified for month limitations and reduced by the capacity required for station service or auxiliaries. The DMNC must be sustainable for a minimum of two consecutive hours. The proper use of the reservoirs usually makes this capacity available daily. DMNC varies monthly.

- Hydroelectric Generating Stations less than 50 MW

These generating stations are the run-of-river plants. DMNC is based on operational historical generation.

- Thermal Generating Stations

DMNC is defined as the net output a unit can sustain over a two consecutive hour period. DMNC varies monthly subject to ambient temperature change.

A 1.2.1.2 Procedure for Verifying Ratings

The power station ratings are based on annual maximum net output tests conducted between November and February of the following year. The procedure is in conformity with :

- NERC Reliability Standards TOP-002-00 and VAR-001-00;
- NPCC Guide B-09;
- NPCC Procedure C-07.

A 1.2.2 Unit Unavailability Factors

A 1.2.2.1 Unavailability Factors Represented

Québec represents forced outage rates, planned outages, maintenances outages, and restrictions (hydraulic, electrical and mechanical). With the forced outage rates of the Hydro-Québec generating stations we determine the State Transition Rates for each unit of the generating station.

- Forced Outages Rates

The generating unit parameter used is the unit forced outage rate (FOR). The FOR serves as an estimate of the transition rates in the studied period.

FOR = Time in Forced Outage / (Time on Forced Outage + Time on Service).

- Maintenance

2006 schedules for planned outages are used. The monthly volumes are comparable to historical volumes shown in the following table.

Table A.1
Typical % Maintenance for Hydro Units

Month	Maintenance for the year 2006-07
January	0,4%
February	0,4%
March	4,4%
April	13,7%
May	17,7%
June	22,5%
July	24,9%
August	17,1%
September	21,6%
October	10,5%
November	5,3%
December	0,4%

A 1.2.2.2 Source of Outage Factors

Unit outage data is based on historical data for the years 2000-2004. Hydro units that do not have a complete 5-year history for unscheduled outages were given an outage rate equal to the historical average of hydraulic units in Québec.

A 1.2.2.3 Maturity Considerations

No separate immature-mature unavailability factors are used in this Québec Triennial Review.

A 1.2.2.4 Tabulation of Unavailability Factors

Forced Outages Rates (FOR)

Type of equipment	FOR
Hydraulic	1,1 to 1,8 %
Thermal	4 to 9 %

A 1.2.3 Purchase and Sale Representation

Purchases

The purchases of UCAP from other Control Areas and sales of UCAP to other Control Areas are shown in Table A.2.

Table A.2
Purchases and Sales in MW

	2005/06	2006/07	2007/08	2008/09	2009/10
Purchases					
- New York CA	759				
- Maritimes CA	200	200	200	200	200
- Québec	150				
TOTAL	1 109	200	200	200	200

	2005/06	2006/07	2007/08	2008/09	2009/10
Sales					
- New England CA	329	329	329	329	329
- Ontario CA	154	154	154	154	154
- Québec	336	336	336	336	336
TOTAL	819	819	819	819	819

Churchill Falls Corporation Limited (CFLC0)

The capacity purchases are represented according to the contracts between Hydro-Québec and CFLCo.

For 2005 and after, Québec has access to 5 064 MW during winter and from 2 900 to 4 200 MW during the rest of the year. For each month, the capacity of the generating station is reduced by 89 MW above its forced outage rate.

Alcan

Alcan has its own generating facilities in Québec. Some of its loads are connected to the TransÉnergie system and are included in the internal load forecast. Hydro-Québec Production has signed some capacity purchase contracts with Alcan, but these contracts are reduced by 222 MW during the winter period to account for availability constraints.

Maritimes CA

Québec has a purchase contract of 200 MW of peaking capacity from 2002 to 2011.

Independent Power Producers in Québec

In 2005-2006, the purchase contracts from Independent Power Producers amount to 620 MW. For the upcoming years, there will be an additional 120 MW available from these producers. During summer 2006, a 547 MW natural gas cogeneration unit will be put in service in the Montréal sub area (Bécancour) and 44 MW of additional cogeneration and biomass generation will be put in service over the 2006 to 2008 period.

Short term purchases

For the winter period 2005-2006, the Distributor bought 759 MW of capacity from New York Control Area and 150 MW of capacity from interconnected entity within the Area that is not a member of the Area.

Sales

Québec has two firm export contracts. One contract is with New England Control Area (329 MW losses included). This export contract is delivered through the Highgate interconnection (225 MW capacity), the Derby Line (50 MW capacity) and the NEPOOL Phase I (690 MW capacity). The second contract is with the Ontario Control Area (154 MW losses included).

Hydro-Québec Production has a compensation agreement (336 MW) with an industrial customer operating a hydro generating station in Québec.

A 1.2.4 Retirements

No retirement is planned for the period covered by this review.

A 1.3 Interconnected Systems

Neighbouring systems are not modeled in this review. The 500 MW tie benefits capacity from 2006-2007 to 2009-2010, mainly from New York CA, is an assumption derived from the NPCC Tie Benefits studies.

The following Table shows the Québec import capability during peak load period.

Table A.3
Maximum-Import Capability at Peak (MW)

Neighboring Area	Synchronous	HVDC	Radial	Total
CF(L)Co[6]	5 200			5 200
Ontario			500	500
New-Brunswick		785		785
New York		1 000		1 000
New England		690		690
Total	**5 200**	**2 475**	**500**	**8 175**

(6) : Churchill Falls (Labrador) Corporation Limited

A 1.4 Modeling of Limited Energy Resources

For most hydro generating stations, energy limitations are considered by using a different value of dependable maximum generating capability (DMNC) for each month accounting for the effect of the reservoir level variation on the net head and the generating cooling water temperature.

Unlike hydro generating stations with reservoirs, the run-of-river Beauharnois and Les Cèdres generating stations are operated in parallel on the Saint-Lawrence River. Their capability depends on water availability and varies according to seasons. Also, during ice formation, capacity output must be reduced. Ice formation restrictions are also modeled for all generating stations where it applies.

A 1.5 Modeling of Interruptible Resources

Québec models 1 235 MW of interruptible power contracts with industrial customers. The required reserves include deterministic reserves associated with the operational constraints of these resources.

A 1.6 Modeling of all Resources

No uncertainty is modeled over the in-service date of the planned generating stations. Available capacities of each station are modeled with latest available data. Maintenance, restrictions and outages are taken into account.

A 1.7 Others Assumptions

The TransÉnergie system and its maintenance and up-grade programs, included in this Review, have been submitted and approved by the NPCC.

A 1.8 Reliability Impacts of market Rules

The Québec capacity purchases contracted through request for proposals are secured by procedures put in place with the neighbouring NPCC's Control Areas.

Appendix B

Description of FEPMC Reliability Model

Appendix B Description of FEPMC Reliability Model

Hydro-Québec also developed a Reliability Model called FEPMC. It uses the same concept as the GE MARS program which consists in sequentially comparing total available resources with hourly loads for each hour but it does it over a number of annual load shapes instead of just one for GE MARS.

FEPMC uses sequential Monte Carlo simulation to model the availability of generating units over the total number of annual load shapes simulated. For each unit, the model generates a random availability profile based on its last five year average forced outage rate. Units can either be fully available or forced out. Scheduled maintenance is developed externally based on planned outages. Total resource capacities are developed from these profiles for each sub area. The total capacity for the system is compared to the hourly load. If the system is deficient or if the surplus is below a defined value (used to reduce calculation time), the model will then determine the resource capacities and local loads for each sub area. Taking into account the transmission transfer capabilities, FEPMC then determines the quantity of locked-in capacity in each of these sub areas. FEPMC assumes that local load for all sub areas other than the main load sub area (Montréal sub area) will never be higher than the resource capacity for that sub area. The model will then reduce the capacity of the system by the quantity of locked-in capacity.

If the system is deficient after these steps, the program calls on the available emergency operating procedures to prevent load shedding, still taking into account the transmission transfer capabilities. If loss of load still occurs and the current hour is the daily peak load, the program records that it has experienced a loss of load for that day.

After recording the result for the current hour, the program proceeds to the next hour. This continues for each hour of each annual load shape with as many replication as needed to reach convergence. After the simulation is complete, the program computes the LOLE, and other reliability indices.

Description elements that are different than the ones in Appendix A are addressed below. Results obtained with FEPMC are shown at the end of this appendix and are compared to the GE MARS results.

B 1.1 Load Model

B 1.1.1 Description of Load Model

The system load is represented in the simulation model by specifying an hourly load cycle for the study period. The simulation model assumes that the load changes discretely every hour and is constant throughout the hour.

Climatic uncertainty is modeled by recreating each hour of the 30 year period 1971 through 2000 under the current load forecast conditions of the study period. Moreover, each year of historic data is shifted up to ± 3 days to gain information on extreme conditions that occurred during a weekend for example. Such an exercise generates a set of 210 different demand scenarios.

B 1.1.2 Load Forecast Uncertainty

Even perfectly knowing the weather conditions, the load forecast carries a structural uncertainty caused mainly by demographic and economic parameters that affect the total energy in the study period. This forecast uncertainty is modeled by generating three equally probable load levels for each load profile.

B 1.2 Resource Unit Representation

B 1.2.2 Unit Unavailability Factors

B 1.2.2.1 Unavailability Factors Represented

Units can either be fully available or forced out. FEPMC does not model partial outages.

B 1.2.3 Purchase and Sale Representation

Refer to Appendix A for purchases and sales volumes. Only modeling differences are discussed below.

<u>Churchill Falls Corporation Limited (CFLC0)</u>

A contingency of 89 MW takes into account units forced outages.

<u>Alcan</u>

No deterministic reserves are taken on those purchases since the contractual constraints are modeled (yearly total number of interruptions, the interruption duration, the daily available period). The purchases are firm and are backed by Alcan's system resources and interruptible loads.

<u>Independent Power Producers in Québec</u>

An average contingency of 20.0 % to 14.6 % from 2006 to 2010 is taken into account on the capacity contribution from independent power producers. The percentages of contingencies per type of generation are based on historical generation data.

B 1.4 Modeling of Limited Energy Resources

The St-Maurice River Complex consisting of 8 power stations is an energy limited system. It can peak for a certain number of hours but afterwards it needs to lower its output to adjust its reservoirs. These limitations are modeled in FEPMC.

B 1.5 Modeling of Interruptible Resources

The Demand Side Management program consists of industrial loads that can be interrupted. Specific constraints apply to the different interruptible loads, for example the yearly total number of interruptions, the interruption length, the daily available period. These constraints are modeled in FEPMC and are part of the emergency operating procedures.

B 1.7 Others Assumptions

At the Beauharnois generating station, ice cover formation has a significant impact on capacity availability during a period of approximately two weeks. The start of the cover formation varies yearly depending on weather conditions. The timing uncertainty is modeled by applying the actual pattern of capacity restrictions to the days the ice cover was formed on each of the 30 years (1971 through 2000).

B 1.9 Results Comparison between FEPMC and GE MARS Models

The small differences in results obtained with both models are due to the modeling differences listed above. In terms of required reserve (MW and % of load), these differences are not significant.

Table B1 - Base Case

Year	FEPMC			GE MARS		
	Required Reserve		LOLE (days per year)	Required Reserve		LOLE (days per year)
	MW	% of January Peak Load		MW	% of Annual Peak Load	
2005/06	3453	9,5	0,094	3 424	9,3	0,097
2006/07	3482	9,5	0,025	3 431	9,3	0,030
2007/08	3674	10,0	0,028	3 642	9,8	0,035
2008/09	3867	10,4	0,023	3 837	10,2	0,029
2009/10	3882	10,4	0,026	3 781	10,0	0,023

Table B2 - High Load Forecast

	LOLE (days per year)	
	FEPMC	GE MARS
2005/06	0,138	0,102
2006/07	0,042	0,036
2007/08	0,050	0,052
2008/09	0,051	0,059
2009/10	0,087	0,072

Appendix C

Adequation Analysis between FEP, FEPMC and MARS Models

Appendix C Adequation Analysis between FEP, FEPMC and MARS Models

The LOLE, loads and resources shown in this Review have been modelled with the MARS model. Analysis has been done to evaluate the capability of this model to assess the reliability of the Québec electric system.

For a validation analysis of the MARS model as an adequate tool to assess the Québec system reliability, we reproduced the "Patrimonial electricity" contract assessment of reliability.

The assessment of reliability evaluated with the FEP model and under specific conditions, shows a required reserve associated with the "Patrimonial Contract" of 3 100 MW for a load of 34 342 MW and an 2,4 hours per year of LOLE.

In the MARS model, the characteristics of the Québec's system have been modelled and the required reserve evaluation comes out to 3 130 MW. In the FEPMC model, the required reserve is at 3 166 MW.

The following table shows the principal statistics.

Table C.1

	Models		
	FEP	**MARS**	**FEPMC**
Load			
- "Patrimonial Electricity" (1)	**34 342**	**34 342**	**34 342**
Supply			
-Installed Capacity	31 692	31 566	31 758
-Maintenance/Restrictions	-1 362	-1 213	-1 366
-Available Capacity	30 330	30 353	30 392
-Purchases	6 604	6 604	6 610
-Interruptible Load	515	515	507
TOTAL SUPPLY (2)	**37 449**	**37 472**	**37 509**
Required Reserves			
-Deterministic Reserves	1 067		
-Uncertainty Reserves	2 038		
-Total Required Reserves	3 105		
Observed Reserves (2 - 1)	**3 107**	**3 130**	**3 166**
LOLE	2.4 hours/year	0.1 day/year	0.1 day/year

Appendix D

Legal Framework of Québec Electricity Market

Appendix D Legal Framework of Québec Electricity Market

Since the adoption of the Law 116 by the Québec government in June 2000, Hydro-Québec Distribution (the Distributor) has the responsibility to satisfy Québec electric needs. This law has addressed the functional splitting of Hydro-Québec by establishing 4 divisions and introduced competition in the supply market. To fulfill its obligations, the Distributor inherited an annual volume of patrimonial energy fixed to 165 TWh, supplied by Hydro-Québec Production (the Producer). In capacity, the patrimonial contract established the maximum at 34,342 MW. The Producer must also provide an associated reserve sufficient to cover the reliability criterion for that patrimonial load. The characteristics of the patrimonial electricity are fixed by a Québec government decree. The patrimonial contract is characterised by a load duration curve of 8,760 hourly values.

Beyond the patrimonial contract, the Distributor has the obligation to proceed with call for tenders to acquire new supply.

The law on Québec Energy Board obligates, every three year, the Distributor to produce a Procurement plan describing the characteristics of the contracts it must sign to satisfy Québec's market additional needs. The Distributor must also produce a follow up of the Procurement plan each year. The last Procurement plan submitted by the Distributor, in November 2004, to the Québec Energy Board can be found at the following address:

http://www.regie-energie.qc.ca/audiences/3550-04/index3550.htm

New Supply Sources and Commercial Agreements

Since 2002, the Distributor has proceeded to 4 public long term call for tenders in accordance to government decrees for specific sources of supply. The first one was not associated with a specific type of generation. The last three ones concern electricity produced by biomass, wind power and cogeneration. A fifth one is in process since October 2005 regarding the acquisition of wind energy generated by 2 000 MW of installed capacity.

To satisfy its short term needs, the Distributor proceeds regularly to short term call for tenders.