

## **ANNEXE 5**

### **Rapport du consultant externe Merrimack Energy Group Inc.**

*The Competitive Cost of Biomass Generated Electricity*

**A/O 2009-01**



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# The Competitive Cost of Biomass Generated Electricity

## 1. Introduction

In April 2009, Hydro-Quebec Distribution (“HQD”) issued a Call for Tenders (A/O 2009-01) for Firm Capacity for a Total of 125 MW and Associated Energy produced by biomass cogeneration in order to meet the long-term electricity needs of its Quebec customers. Based on the Call for Tenders, the electricity must originate from new generating facilities located in Quebec. The Call for Tenders also identified the eligible biomass fuels, which included a wide range of resource options.

Hydro-Quebec Distribution has selected 8 bids for a total of 60.7 MW from the 125 MW Call for Tenders. Deliveries of the power from these projects are required to come on-line no later than December 1, 2012. Hydro-Quebec Distribution has reported that the average price of the winning bids is \$112/MWh (\$2009 Cn), including \$4.00/MWh for transmission costs, with a range of approximately \$90.00/MWh to \$124/MWh in real levelized cost terms.

The Régie de l’énergie (Régie) requires that Hydro-Quebec Distribution undertake a comparative analysis of the cost of power from the bids selected through Call for Tenders A/O 2009-01 relative to the cost of power for similar products from neighboring Northeast markets. Because of widely varying biomass feedstocks and generation/conversion processes, it is difficult to identify “typical” costs for biomass generated energy.<sup>1</sup>

Although it is difficult to conduct a consistent and equivalent evaluation of biomass projects, Merrimack Energy has developed a reasonable approach for conducting the comparative cost assessment required by the Régie. The methodology undertaken by Merrimack Energy assesses the competitive cost of long-term power from the winning bids from the 125 MW Call for Tenders for energy produced by biomass generated electricity with general industry cost data on a real levelized cost basis over a 20 year term. For purposes of the analysis, Merrimack Energy is relying on cost data for biomass energy technology developed for Feed-in Tariff programs in Ontario and Vermont<sup>2</sup> as well as industry studies on the cost of biomass electricity generation technologies.

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<sup>1</sup> This Call for Tenders is complicated further by the requirement that energy eligible for the Call for Tenders must be produced by biomass cogeneration. Thus, the issue of generation/conversion processes are unique to the application which creates difficulties identifying specific benchmark projects.

<sup>2</sup> Feed-in Tariffs obligate retail electric utilities to purchase electricity from eligible renewable energy producers under standardized arrangements specifying prices, terms and conditions. This standardization simplifies the purchase process, provides revenue certainty to generators, and reduces the cost of financing generation projects. The standardized rates are typically reflective of generation costs for a specific renewable technology, including a reasonable return. Feed-in tariff programs are generally promulgated by a utility regulatory commission or through legislation. While Feed-in Tariff programs are being developed in several states in the US, the Ontario Power Authority and the Vermont Public Service Board are in the lead in developing and implementing such programs. Under these programs, one of the key aspects is to

This report will first present a brief description of the Feed-in Tariff programs in Ontario and Vermont, including the tariff rates for biomass in each program. Following will be a brief assessment of the capital and operation and maintenance (O&M) costs for biomass options presented in several recent studies on power generation costs, primarily from US federal and state government sources. In addition, a few of the studies also include an estimate of the levelized costs of power from biomass options as the basis for developing benchmark cost options. Finally, the benchmark costs are developed based on the feed-in tariff rates and the third-party studies to develop a range of benchmark biomass generated electricity costs from which to compare the real levelized cost of the bids selected in Quebec.

## **2. Background**

There are a number of factors that influence the cost of biomass generated electricity. These include the capital cost of the equipment, the cost of financing the project, operation, maintenance, and other administrative costs (e.g. fiscal environment and other taxation), the conversion efficiency, relatively small project size, feedstock availability and cost, transportation costs for delivering the feedstock to the plant site, and any government incentives.

However, since the cost of biomass generation is influenced by feedstock availability and technology,<sup>3</sup> it is very difficult to consistently and equitably compare the economics of various projects since each project has a unique set of local conditions. Unlike other generation technologies, such as combined cycle or combustion turbine facilities that generally have a standard design and fairly consistent cost characteristics, the economics of biomass generation can vary considerably in a number of areas. A presentation of the estimated capital and operation and maintenance costs illustrates the wide variation in the cost of biomass options.

## **3. Cost of Biomass Generated Electricity in Feed-in Tariff Programs**

Feed-in tariffs establish prices at which a seller will be able to sell power to a buyer under a long-term contract. For purposes of establishing this price, utilities or other buyers generally calculate the cost of constructing and operating a renewable energy project plus a reasonable return over the life of the project. In most cases, these prices are established for different technologies and for different size projects. Both the Ontario Power Authority (“OPA”) and the Vermont Public Service Board have established feed-in tariffs for several technologies.

The Ontario Feed-in Tariff program was launched on October 1, 2009. The Ontario Power Authority (“OPA”) has established tariffs for a range of different renewable

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establish the target price at which the utility will purchase the power from the eligible renewable energy producer.

<sup>3</sup> Biomass technologies can include co-firing with coal in coal plants, direct-fire biomass, biomass gasification, and biomass plants for combined heat and power (i.e. cogeneration).

resource options, including biomass. For biomass, tariff rates are based on size, with tariffs established for projects above and below 10 MW. In the OPA program, biomass projects under 10 MW have a tariff rate that starts at \$138/MWh (Cn \$) with 20% of the cost escalating by changes in the Consumer Price Index (“CPI). Tariffs for biomass projects over 10 MW start at \$130/MWh (Cn \$) with 20% of the cost escalating by CPI. The feed-in tariff rates were effective as of September 30, 2009.

The Vermont Public Service Board recently approved new tariff rates for eligible renewable technologies, after having originally developed interim rates. For biomass options, the tariff is established at a levelized rate of \$125/MWh (US dollars). The levelized rate was based on an initial year cost of \$120.80, with 30% of the cost escalating by an inflation index. The Vermont Public Service Board provided a table with annual costs for various renewable energy technologies, including biomass.

The tariff rates for the above programs are used as a primary benchmark for evaluating representative biomass costs in Ontario, New England, and New York.

#### **4. Public Studies on Biomass Costs**

There have been several studies commissioned over the past few years designed to assess the costs of electricity generation from various generation technologies, with a focus on renewable resources. Merrimack Energy has reviewed these studies and presents the results of several studies to highlight the estimated costs of electricity generated by biomass. For purposes of assessing the range of costs, we also present the range of capital and O&M costs assumed in the various studies along with the estimated levelized busbar costs.

##### **Capital Cost**

The capital cost of biomass projects vary widely depending on the technology and process. For example, based on studies and reports the capital costs of biomass power plants range from \$2,500/kW to \$5,000/kW, depending on size and technology.<sup>4</sup>

Table 1 presents a summary of the capital costs for biomass projects from a sample of studies prepared on the costs of various technologies.

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<sup>4</sup> This analysis has focused on direct fire biomass and cogeneration options. Technologies such as co-firing with coal and integrated gasification options were not considered. Co-firing options are estimated to have lower capital costs than other biomass technologies, while gasification technologies would be at the high end of the range presented above.

**Table 1**

**Capital Cost Information for Sample Biomass Projects**

| <b>Study</b>  | <b>Technology</b> | <b>Size (MW)</b> | <b>Cost/kW</b>     |
|---|-------------------|------------------|--------------------|
| Comparative Cost of California Central Station Electrical Generation Technologies Final Report, Dec. 2007 | Biomass           | 25               | \$2,899            |
| US DOE Energy Information Administration Annual Energy Outlook 2009                                       | Biomass           | 80               | \$3,766            |
| International Energy Agency Energy Technology Essentials, Dec. 2007                                       | Biomass Steam     | 5-25             | \$3,000 to \$5,000 |
| California Public Utility Commission GHG Modeling , October 2007  | Biomass           | N/A              | \$3,737            |
| Navigant Consulting 2006 IEPR Committee Workshop on Electricity June 2007                                 | Biomass           | N/A              | \$2,500            |
| Northwest Power and Conservation Council 6 <sup>th</sup> Power Plan, 2009                                 | Biomass           | 25               | \$4,000            |

**Annual Operation and Maintenance Expenses**

In addition to the recovery of capital-related costs, project developers also incur annual operation, maintenance and administrative costs and other operating expenses. Several of the studies referenced above as well as other studies present the estimated fixed and variable O&M costs for biomass options. Table 2 below presents these costs estimates in the first year of the study period. As noted, there is a wide variation estimated for operating costs as well.

**Table 2**

**O&M Costs for Biomass Options**

| <b>Study</b>  | <b>Fixed O&amp;M \$/kW-year</b> | <b>Variable O&amp;M \$/MWh</b> |
|---|---------------------------------|--------------------------------|
| Comparative Cost of California Central Station Electrical Generation Technologies Final Report, Dec. 2007 | \$134.72                        | \$3.11                         |
| US DOE Energy Information Administration Annual Energy Outlook 2009                                       | \$64.45                         | \$6.71                         |
| California Public Utility Commission GHG Modeling Oct 27, 2007  | \$54.04                         | \$3.19                         |
| Navigant Consulting 2006 IERP Committee Workshop on Electricity, June 2007                                | \$130.00                        | \$3.00                         |
| Northwest Power and Conservation Council 6 <sup>th</sup> Power Plan, 2009                                 | \$180.00                        | \$3.70                         |

## 5. Methodology/Approach

To assess the competitive cost of biomass generated electricity relative to the selected bids, Merrimack Energy has relied upon the two sets of data identified above to compare the cost of biomass generated electricity to the bids selected through the Call for Tenders.<sup>5</sup> These include:

- (1) Compare the real levelized cost of biomass generated electricity based on the levelized cost of biomass generated electricity from Feed-in Tariff programs in Ontario and Vermont;
- (2) Calculate the real levelized cost of biomass generated electricity based on the levelized cost of power as reported in studies on the cost of power from electric generation technologies

In all cases, the levelized costs estimated have all been adjusted to 2009 and converted to Canadian dollars to ensure all options are placed on a level playing field.

The results of the levelized cost analysis and real levelized cost analysis are reported on Table 3.

**Table 3 Real Levelized Cost of Biomass Options**

| Program/Study/Reort  | Levelized Cost<br>2009<br>\$/MWh<br>(Cn \$) | Real Levelized Cost<br>\$/MWh<br>(Cn \$) |
|--|---|--|
| Ontario Power Authority Feed-in Tariff Program   |   |  |
| <10 MW   | \$138                                       | \$119.42                                 |
| >10 MW   | \$130                                       | \$112.49                                 |
| Vermont Feed-in Tariff Program   | \$133.75                                    | \$115.46                                 |
| Comparative Cost of California Central Station Electrical Generation Technologies Final Report December 2007 | \$123.74                                    | \$103.52                                 |
| US DOE Energy Information Administration Annual Energy Outlook   | \$115.33                                    | \$96.48                                  |
| Northwest Power and Conservation Council 6 <sup>th</sup> Power Plan  | \$139.67                                    | \$116.84                                 |
| Average  | \$130.08                                    | \$110.70                                 |

<sup>5</sup> All options are compared based on 2009 dollars and include an adjustment for the exchange rate between US and Canadian dollars. We have used an adjustment of 1.07 Canadian dollars per US dollar.



## 6. Analysis Results

As noted, the average real levelized price of the bids selected through the Call for Tenders process was \$108/MWh (excluding the transmission costs in Quebec).<sup>6</sup> The average real levelized cost of the bids selected is significantly lower than the prices established in the feed-in tariff programs in Ontario and Vermont and is slightly lower than the average of the feed-in tariffs and studies analyzed. In addition, all bids selected, with one exception, are competitive with or lower than the real levelized rates for biomass included in the Ontario and Vermont feed-in tariff programs.

## 7. Conclusion

As illustrated in this analysis, the average cost of the portfolio of selected bids (not including transmission costs) is generally competitive with the analysis of biomass generated electricity costs based on the Feed-in Tariff programs in Ontario and New England as well as the costs from power generation technology studies. While it is very difficult to accurately compare the economics of biomass projects due to the unique nature of the project and locational factors, the competitive options presented offer reasonable metrics based on the feed-in tariff rates and other studies and reports on biomass that have been used in other states and jurisdictions.

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<sup>6</sup> Since the other options represent busbar costs only, it is appropriate to remove the transmission costs associated with the bids selected to ensure a consistent assessment (Hydro-Quebec TransEnergie reimburses the switchyard costs up to a maximum applicable amount).