City & Borough of Sitka
Electric Department
105 Jarvis Street, Sitka AK. 99835
Telephone: 907-747-4000 Fax: 907-747-3208

Sitka's Power Supply Plan

January 2, 2008

Executive Summary

Major Goals

1. Provide adequate and reliable electric service.
2. Maintain financial integrity
3. Use energy resources efficiently
4. Maintain the lowest electric rates possible consistent with the above goals.

Power Requirements

Sitka's electric System energy requirements grew at less than 1% per year in the decade after the Pulp Mill closure in 1993. At that rate the existing hydroelectric systems would have provided all necessary energy until about 2020. In 2006 we saw a 7% increase and it looks like 2007 energy sales will represent another 5% increase in Sitka's power requirements. About half the growth looks to be driven by increased use of electrical energy for heating because of the tripling of fuel oil cost. The other half was driven by a new fish processor at the Industrial Park and expansion of the other existing seafood processors. More energy was required by supporting services such as freezer container storage and worker housing. The forecast is for continued strong growth in power requirements due to continued high oil prices.

The move to electric heating impacts the energy production capacity of the system, lowering reservoir levels in the spring. The large increase in fish processor loads begins in early summer, the lowest level of our lake reservoirs. At these levels generators produce less power and exhibit frequency stability problems. Below certain lake levels diesel generation is used to maintain stability and to make up for hydroelectric energy shortfall.

Sitka has abundant renewable energy resources. The challenge is to manage the rising demand for electric energy to displace oil while work continues to develop our renewable energy resources (hydro, wind, geothermal) to meet that demand.

Conservation and Demand Side Management

Energy conservation and efficiency measures that can be taken begin at the power plants. We have developed a computer model of the hydroelectric system, using 50 years of historical water records, to evaluate different operating scenarios. Using such techniques we are managing the use of water for power generation to achieve the most efficient use of that water. A water turbine's efficiency varies by as much as 50% depending on how the turbine is loaded. In the past we have not paid too much attention to the efficient use of water as we had more water than we could use; but, those days are over. Now we must pay close attention to managing the use of water to maximize our hydroelectric energy production.

The amount of water will vary seasonally. The maximum water is in the fall of the year when the reservoirs are full. The minimum is in the spring and early summer when the reservoirs are drawn down to their lowest level of the year. Our strategy is to further develop dual-fuel and interruptible electric service for all classes of consumers to enable us to shift loads on a seasonal basis. When the computer model predicts a high risk of diesel generation (particularly in the early summer when the water level in the reservoirs is lowest) then the interruptible loads will be shut-off.

The goal is to minimize the amount of supplemental diesel generated power required to meet Sitka's power requirements. It is far more efficient to burn fuel oil in a 70% to 80% efficient furnace than it is to burn that same fuel in a 35% to 40% efficient diesel generator. This demand-side management will entail promoting dual-fuel heating systems and developing a control system where the interruptible electric heating loads can be remotely switched on and off from the control room of the electric power system.

As Sitka's future power requirements grow to use up the existing hydroelectric energy supply then the interruptible loads may be shut off year-round until new renewable energy resources can be developed and brought on line. When a new renewable energy resource is brought on line, such as the expansion of the Blue Lake Hydroelectric Project to its maximum capacity, then that resource can be immediately utilized by restoring the interruptible loads. This strategy serves the goal of keeping the cost of electric service low as it minimizes the risk of underutilized energy resources that are very costly to build.

At the consumer level, improved weather tightness of buildings, encouraging the use of dual-fuel heating systems, heat pumps and lifestyle changes (smaller heated spaces, lower thermostat settings, smaller cars, walk or bike not drive, etc.) that reduce the amount of energy consumed all serve the goal of conserving energy and using our energy resources efficiently in order to keep the community's total energy costs, as well as carbon emissions, as low as possible.

Educating the consumer on energy use and conservation is an on-going effort. In partnership with the Sitka Conservation Society a series of six brochures were produced in 2007 to help educate consumers on issues such as home heating, water heating, energy consumption of electronics and appliances, personal transportation, energy audits and weatherization as well as Sitka's greenhouse gas emissions.

Historical review of energy use shows that individuals change their use patterns during perceived crisis and then fall back to original patterns within a year or two. Few individuals relate their actions to national or global concerns. Real conservation is effected primarily by a substantial increase in price or by taxation. An example is the effect of the oil crisis of the mid 1970's and how rapidly the US consumer went back to large vehicles. Improvements in efficiency and pollution reduction were used by the consumer to buy larger vehicles, offsetting much of the gain.

Hydroelectric

The hydroelectric energy available in a given year is dependent on rainfall. Our generation requirements for 2006 were 112,000 MWH (megawatt-hours). Our requirements for 2007 will be about 118,000 MWH. The existing hydroelectric system in a low rainfall year will produce 100,000 MWH, an average rainfall year 123,500 MWH, and a high rainfall year 134,000 MWH. Current cost of diesel generation is about 33 cents per kWH (kilowatt-hours) or $333 per MWH. A shortfall of 10,000 MWH would add about $3.3 million to operating costs causing an electric rate increase of 30%. Development of lower cost alternatives to diesel is imperative to maintain low cost electric power in Sitka.

Many alternatives to expanding power generation alternatives have been explored and are outlined in detail later in the report. Hydroelectric energy is the best alternative. It has a relatively low and predictable cost, has a predictable and well developed regulatory environment, uses very reliable equipment provided and supported by well established large scale industry. The least cost and fastest hydroelectric project is to expand the existing Blue Lake Hydroelectric Project to its maximum capacity. This will entail constructing a new powerhouse containing a third turbine and dam raise at Blue Lake, optimizing the energy producing potential of that reservoir.

Diesel

The only diesel generation is located at Jarvis Street. The plant contains one new Caterpillar unit rated at 4840 kW (kilowatts) and three old modular generators made by Fairbanks Morse rated at 2,000, 2,750 kW, and 2,750 kW. The Fairbanks Morse units are of a 1950 design, prone to failure, and very expensive and difficult to repair. The department will not run them at full rated load since this causes failure. Overall, with all four units operating, the plant can produce 11,400 kW. This rating will not provide full power for the City at any time of the year. Winter daily peaks are 22,500 kW and summer daily peaks run 16,000 kW. Any sustained operation of the plant would lead in short order to failures of the Fairbanks Morse Units. This outdated equipment has been acceptable for very limited hours per year in emergency mode, but in the period between now and new hydro coming on line, we need more reliable diesel capacity for continuous generation requirements and for emergency.

The driving event which could cause a major problem for the City would be loss of the transmission line between Blue Lake and the City in the Heart Lake area, isolating all hydro generation for perhaps 30 days. A full 22,500 kW of Diesel would be needed to cover this problem, costing in the order of 11 million dollars to add 11,000 kW of new diesel capacity to the existing 11,400 kW. A better, more cost effective solution would be adding a 69 kV transmission tie line along the highway from Blue Lake Hydro tying to the transmission line near Thimbleberry Park. This redundant transmission line would reduce the need for diesel at Jarvis to about 12,000 kW. See the section in this report on system reliability.

<u>Wind Energy</u>

We intend to explore the feasibility of wind generated energy for Sitka. Unlike large and expensive hydroelectric projects, wind is scalable. Wind turbines can be added incrementally as needed. The concept for Sitka is that intermittent energy from the wind can be stored in our hydroelectric reservoirs and add to Sitka's firm renewable energy supplies.

Wind is fairly well developed as a technology and equipment is now manufactured and supported by major manufacturers such as General Electric and Siemens. We are beginning studies to better identify sites which would almost certainly be on offshore islands, such as Biorka Island or Legma Island. These sites would require undersea transmission lines of up to 15 miles, adding substantial cost.

The first step in evaluating the potential of wind energy is to install anemometer towers to measure the wind speed and direction over a period of time of not less than one year.

<u>Geothermal Energy</u>

Geothermal would seem to hold great potential for Sitka since we lie in the midst of many fault lines with geothermal springs and the Mount Edgecumbe volcano. The problem is locating a suitable site which can provide long term heat from the earth to meet the City's needs. This seems to be akin to wildcat drilling for oil. It is very possible to spend millions of dollars exploring and drilling, even constructing a power plant, only to discover that the heat source is inadequate in the long term. The Department intends to retain a qualified consultant to conduct an initial survey to assess the risk and evaluate the economics of the exploration and development of geothermal power generation for Sitka. Our initial estimate is that the wholesale cost of geothermal energy will likely be in the range of 12 to 15 cents per kWh to produce, compared to our existing hydroelectric system's wholesale cost of 4 cents per kWh.

That being said, if an entrepreneur is willing to take the risk of exploration for geothermal energy and development of a geothermal generating plant which could deliver energy to our electric system at a cost competitive with other alternatives, we will be interested in buying power from that entrepreneur.

Biomass Energy

The U.S. Forest Service is interested in developing wood as a fuel for space heating and possibly electric power generation. Our assessment is that generating power with wood fuel would be several times more expensive than our other alternatives and a large scale wood fuel supply is not available. Thus we are not interested in pursuing a wood fired generating plant. However, if an entrepreneur is willing to take the risk of developing a wood fueled generating plant and can deliver energy to our electric system at a cost that is competitive with our other alternatives, then we will be interested in buying power from that entrepreneur.

If burning wood could be developed as a practical alternative to electric or oil space heating on a large scale, this could reduce the rate of growth in Sitka's power requirements and perhaps allow deferral of the investment in new renewable resources such as wind turbines, or the Lake Diana hydroelectric project or geothermal.

Reliability

Another very critical area to consider is the overall reliability of the electric system to provide power every moment. Generation equipment failures and failures of the transmission system represent the primary risks to reliable delivery of power to the customers. Considerable financial risk is implied because sustained power outages can deeply affect the business of the City and because running of diesel generators during such emergencies can be very expensive.

Hydroelectric generators are extremely reliable, but because of their unique nature, custom fit to each project. Major repair can take a very long time, up to a year or more. Without ample generation capacity the City could be forced to generate large amounts of power with diesel, a very costly business, which could easily double rates.

On the transmission side, a line break between Blue Lake and the City would put the City totally on diesel, possibly for several weeks until repairs could be made. The current City load is about twice the diesel capacity at Jarvis requiring rolling blackouts and probably a shut down of many businesses for the duration of the problem. The area with the highest risk to the transmission line, meaning the most probable to induce a very long outage of perhaps a month, would be along Heart Lake. It is proposed that a tie line be built between Thimbleberry and the Blue Lake Hydro to substantially reduce this risk. To further bolster reliability, a substation near Thimbleberry would allow much of the load along Sawmill Creek Road to be carried in the case of a failure at the Jarvis Street complex.

A more detailed discussion of reliability and Firm power is offered at the end of this document.

Frequency Stability

The entire generation system was built with the idea that the Pulp Mill at Sawmill Cove would provide frequency control with its steam fired turbines. When the mill closed in 1993 the hydroelectric system alone could just barely operate. Many very dedicated engineers and technical people managed to fine tune the speed governors so that we have just barely acceptable stability but it's a very delicate system to operate and relatively minor events can cause loss of generators or even complete collapse of the system. Although remarkable improvement has been made we are at about the theoretical limit of control. At low reservoir levels the system cannot run stable without a diesel assisting. Blue Lake hydro at this time can never run by itself and so a loss of a generator at Green lake or the transmission line puts a diesel on the line to maintain frequency.

As the load grows and we draw the water levels down more each year, the early summer becomes very frequency critical. Addition of a great deal of fish processing load at this critical time may push the system to require running some diesel as soon as the summer of 2008 for stability. This adds significant operating cost.

Addition of any new generation will attempt to improve this situation. The Blue Lake third turbine design presently incorporates a large surge tank built into the mountain and a more responsive and higher rotating mass turbine.

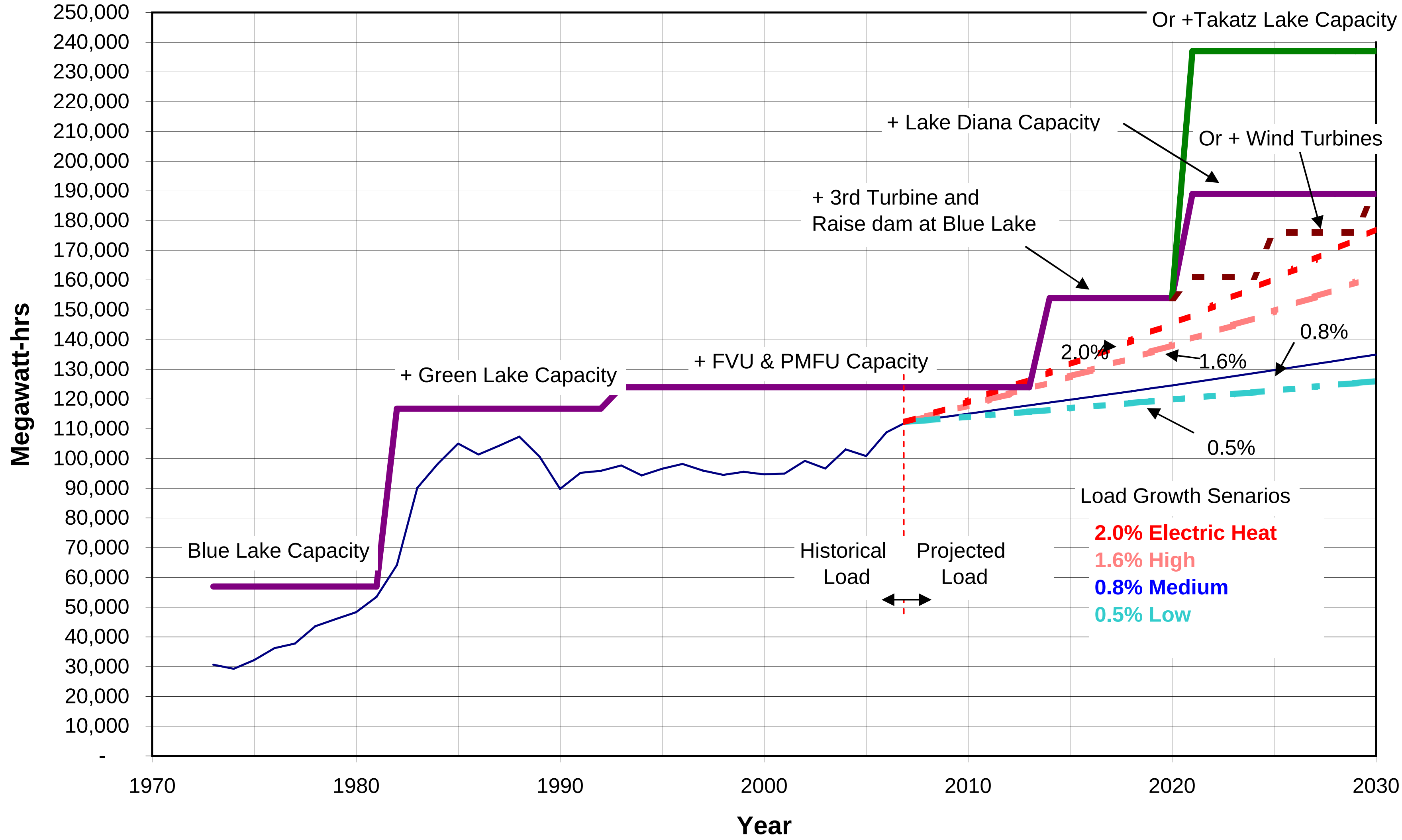
Future Loads and Generation Requirements

The attached chart shows projected energy requirements and the effect of various projects on satisfying these needs. This chart is based on a power requirements study done in 2005. The growth has been much greater in the last two years and we feel may continue growing faster than previously predicted.

This chart assumes that the Blue Lake Third Turbine and Dam Raise are added first. The Lake Diana curve adds to the energy provided by the upgraded Blue Lake Project. The Takatz curve adds to the upgraded Blue Lake Project, assuming Lake Diana is not built.

Wind and other alternative curves are added to the upgraded Blue Lake Project assuming neither Lake Diana nor Takatz have been built.

Historical and Projected Total Energy Requirement (1973-2030) with Generation Capacity



<u>Impact of Generation Choices on Electric Rates</u>

On the following chart projected costs of several options are combined to predict impact on electric rates until 2030. These costs are shown as if no inflation occurs, in present value of money. The exception is the cost of fuel oil which is escalated at 5% per year. The cost or even availability of fuel oil in future decades is impossible to determine but increased global demand, inevitable global production decrease, and carbon taxes related to decreasing greenhouse emissions would seem to indicate that fuel oil would be a poor choice to supply future needs.

<u>Existing System</u> -- If existing equipment is used and no major investment made in additional generation then the cost of power is predicted to begin to rise sharply about 2015 when the existing hydro is totally utilized and all growth must be supported by diesel. The abrupt dip in price is the year the Green Lake bonds are paid off, reducing annual cost by about 4 million dollars. This cost drop is rapidly offset by increasing use of diesel.

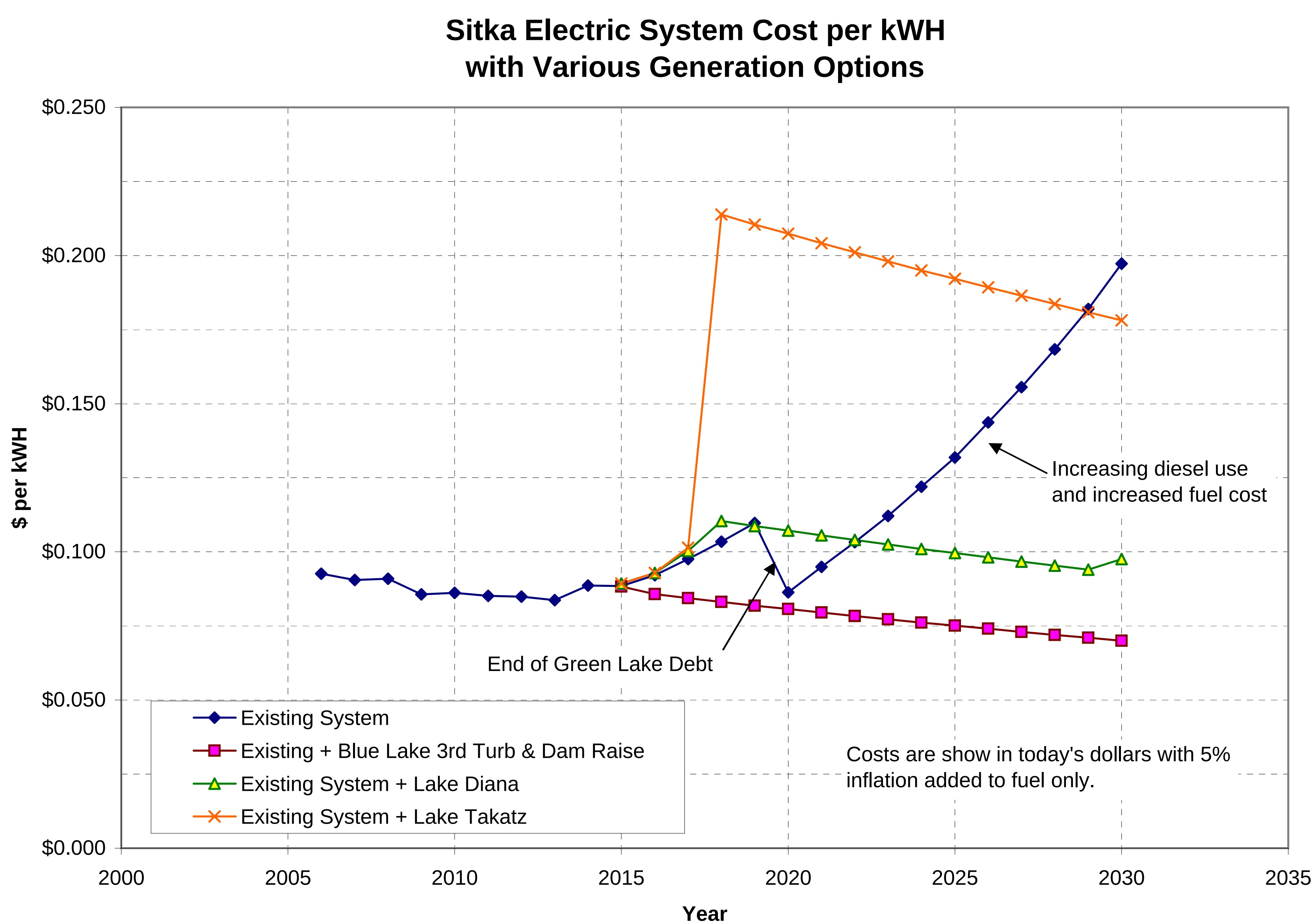
Add Blue Lake Third Turbine and Raise Blue Lake Dam – This project would add about 10 MW (megawatts) of capacity and as much as 34,000 MWH of energy to the system, depending on the final height of the dam. This appears to be the best overall plan. The cost is relatively low at about $50 million and it comes on line about the time that generation with diesel would be rapidly escalating. By borrowing enough money to build the improvements and pay off the remaining Green Lake Bond, there is virtually no bump in rates and over time, in real terms, the rates go down. This option also greatly improves the frequency stability and reliability of the system.

Add Lake Diana to the Existing System – Lake Diana would have about 6.5 MW of capacity installed and provide 34,000 MWH. At this time Lake Diana looks to be a difficult project to license taking a long time to work around environmental and land use issues. We have included an analysis to show the impact of the project if it were allowed to proceed normally. In about 2014 the use of diesel begins to have a large impact on rates until the Lake Diana Project comes on line in 2018. Beside the higher cost of Lake Diana, $110 million, there are added costs of supporting an on site crew, road, dock, building and housing, maintenance, as well as transportation costs. The Blue Lake improvements look far better as a next step, but Lake Diana from an engineering standpoint is the next logical project if the load continues to grow.

Add Takatz Lake to Existing System – This is a very large project with probably 25 MW installed and producing 92,000 MWH. Current estimates are that final cost would be about $318 million with $19 million per year added as debt service. There are very high annual operating costs involved because the facility is on the opposite side of the island, a full crew would need to live on site and aircraft as well as boat support would be needed.

Takatz is too large for the Sitka Power System in the foreseeable future. It has been discussed bringing a tie line to Baranof Island and selling the surplus energy but even with Takatz fully utilized the cost is still 22 cents per kWH. There are probably hydro projects much larger and much less expensive closer to the energy export market loads.

Alternatives such as windpower and geothermal energy are not developed enough to include in this analysis but first reviews would put wind roughly financially even in cost per kWh generated with the proposed Blue Lake expansion and Geothermal much more risky and expensive than wind or the Blue Lake expansion.


Sitka Electric System Cost per kWH
with Various Generation Options
$ per kWH
$0.250
$0.200
$0.150
$0.100
$0.050
$0.000
2000
2005
2010
2015
2020
2025
2030
2035
Year
Increasing diesel use
and increased fuel cost
End of Green Lake Debt
Existing System
Existing + Blue Lake 3rd Turb & Dam Raise
Existing System + Lake Diana
Existing System + Lake Takatz
Costs are show in today's dollars with 5%
inflation added to fuel only.

Generation Options in More Detail

Blue Lake Third Turbine

The Blue Lake Hydroelectric Project was built about 1960 with major participation by the Sitka Pulp Mill. At the time the entire City load peaked at about 3,000 kW and it was hard to justify building a project with more than 6,000 kW. The engineers and City officials of the time did a very commendable job in designing and constructing the project so that it could be expanded. Provision for a third turbine was provided in the piping and the license included an ultimate raise of the dam another twenty ft. The dam was constructed to support additional height.

The 1959 vintage Blue Lake Hydroelectric plant runs harder than originally designed, 7,000 kW, rather than 6,000 kW nameplate rating, and about 800 kW was added at the campground and 600 kW at the mill filter plant. The facility including the two small hydros can run virtually all the time and still not use all the water in an average or better rain year. The third turbine will give us the ability to use water that would have spilled, better manage the Blue Lake reservoir and the Green Lake reservoir, and improve overall efficiency with more modern equipment and reduced loss in the penstock.

After much study and preliminary design work the third turbine for Blue Lake is envisioned as a separate powerhouse containing a new 11 MW turbine designed to run most efficiently at about 8 MW. This new unit will provide higher efficiency, making better use of available water, providing more rotating mass to enhance frequency stability of the system. Preliminary work indicates the need for a surge tank within the mountain combined with a tunnel tap for the new powerhouse to take full advantage of power and frequency capability. The extra 11 MW of capacity will allow the system to better maintain system reliability in case of other generator or transmission line failures.

Blue Lake Dam Raise

The power we can extract from water is related directly to the head, or the vertical height difference between the generator and the surface of the reservoir. Presently this net head is about 327 ft. with the dam built to spill at elevation 342. We hope to be able to raise the dam to a spill elevation of about 425 ft, which would increase the available head from 327 to 410. The higher dam does not provide more water but reduces the amount of water spilled and each gallon of water can produce 25% more energy.

Our intent is to maximize the height of the dam to use the Blue Lake water to it's fullest potential, which would be realized with an elevation 425' spill height.

From and engineering standpoint all the power plant equipment and pipeline must be checked to assure it can stand the higher operating pressures. It is assume some modifications will be necessary. The dam construction is being reviewed to determine the actual structural and seismic height limits. The dam was originally designed and built for future increases in height.

From an environmental standpoint, the area surrounding the lake must be evaluated for impact of raising the lake. Most of the lake is almost vertical on the sides and raising the water level would have little consequence. The primary inlet stream of the lake, however, is critical trout habitat and this must be fully evaluated.

The dam raise provides much better generation capacity from the hydro units and provides more capacity at what was the summer low water period.

Improvement of Blue Lake would not require increase in system operating staff, a substantial cost advantage over other projects considered.

Lake Diana

This high lake, 1728 ft. elevation, has been considered as a potential hydroelectric site for many decades. It appears to have a potential to produce about 34,000 MWH with approximately a 6 MW turbine installed. The current plan is to tunnel beneath the lake to draw the water, minimizing visual impact, and build the powerhouse near the head of the Redoubt valley. The access road and underground transmission line would be run from Salmon Creek near the Green Lake Hydroelectric plant, along Salmon Lake, and then along the Redoubt drainage.

From an engineering standpoint the project is practical, although fairly expensive, $95 million, and somewhat difficult to maintain. Lake Diana would require more maintenance staff and perhaps operators residing on site. It adds road maintenance, a dock, and support buildings at the end of Silver Bay. The third turbine and dam raise project at Blue Lake is far easier and less expensive as a next step, about $50 million with little additional operating costs.

From an environmental and permitting standpoint Lake Diana is very difficult. The Lake itself lies just within the South Baranof Wilderness area and the project could probably not be licensed unless the wilderness boundary was changed. This has been done for other projects but is a difficult political process that could take decades.

Because of its high altitude the project uses very little water but preliminary engineering indicates that the best economic and environmental choice is to build the powerhouse in the Redoubt drainage, moving the water presently spilled from the lake into the Crawfish Inlet, Lake Ekaterina drainage, into the Redoubt drainage. The impact on the very successful salmon runs of Redoubt Lake would need extensive evaluation.

The routing through the Salmon Lake area would bring road access to the area and even though much of the road follows a historic corduroy road, it still passes through old growth forest and considerable study would need to be done to determine the best balance of routing.

At this time we have completed enough field work to assure that this project is viable, and we intend to collect stream flow information which is critical to final evaluation.

Every reasonable effort should be made to stream gauge the lake outlet and perhaps stream gauge Redoubt creek and Lake Ekaterina to gather basic data for evaluating this renewable energy resource in the future.

Takatz Lake

This potential hydroelectric project is located near Warm Springs on the Chatham side of Baranof Island. It has been stream gauged and studied in considerable detail. We have brought construction estimates up to date but have done no field work at this time. The current estimate is $240 million to build the hydroelectric project and $60 million to build a transmission line from Takatz Lake to Sitka. There is a long term Federal Power land reservation already set up for the project and the City owns the property to build the project. The major engineering problem would appear to be a viable transmission line design and routing across the island. This has not been examined carefully in the past. A road across the island, in which a transmission line could have been buried, seems now to be unlikely.

Overall Takatz is too large project for Sitka to afford at this time, particularly when we have better immediate options.

Firm Power and Impact of Generation Equipment Loss

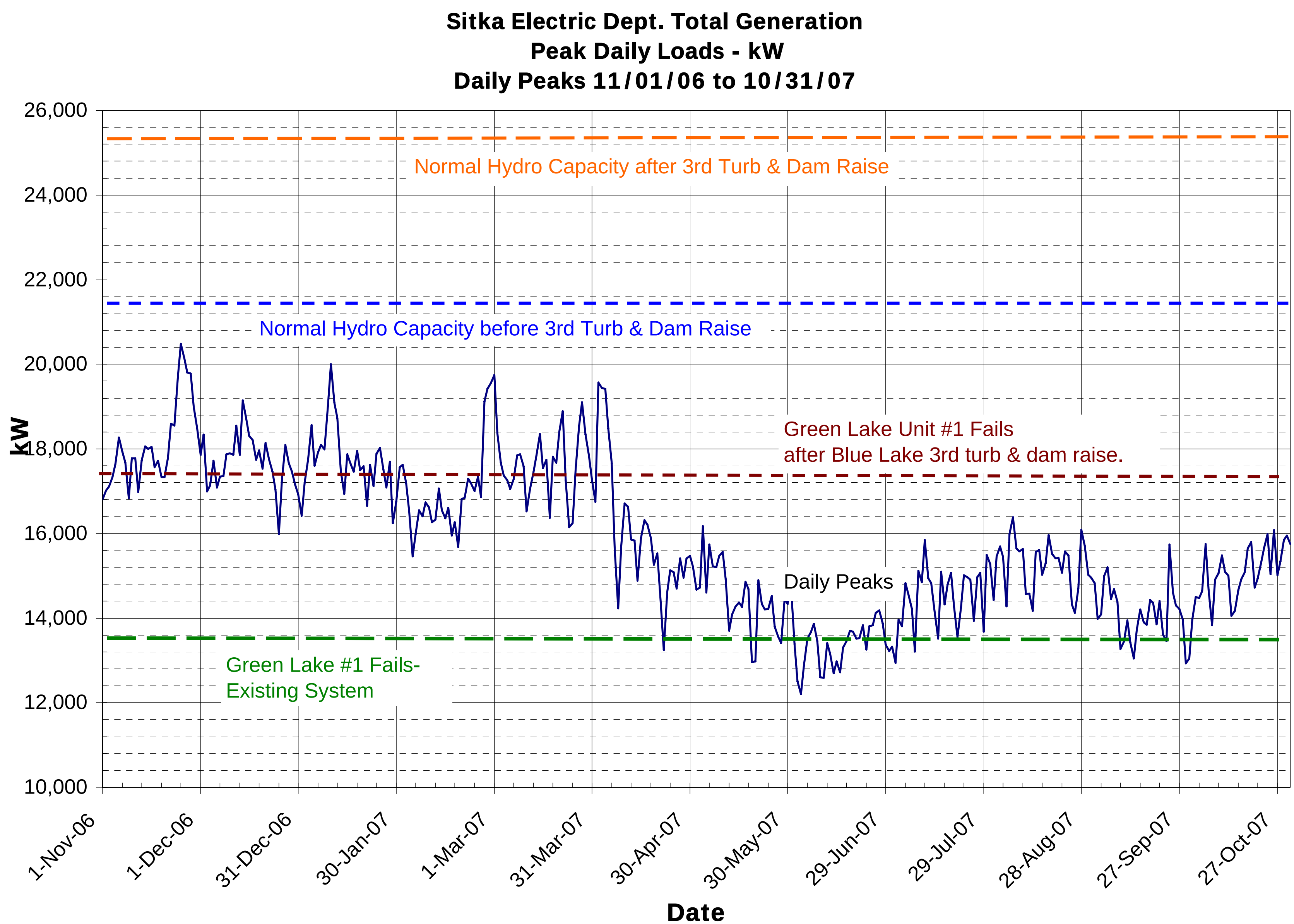
Various equipment failures will have impacts on the ability for the electric system to meet City load requirements. Some of those more serious scenarios are listed below:

System Conditions	Hydroelectric Capacity in kW	
	Before BL Unit #3	After BL Unit # 3
With All Generators Working	21,400 kW	25,400 kW
Failure of Green Lake Unit #1	13,400 kW	17,300 kW
Failure of Blue Lake Unit #1	18,050 kW	24,800
Failure of Transmission between Green Lake and Blue Lake	5,400 kW 16,800 kW w/diesel	9,400 kW 20,800 kW w/diesel
Failure of Transmission between Blue Lake and Jarvis Substation	11,400 kW diesel	11,400 kW diesel

On the following page a graph shows the daily peak loads experienced by the system from 1 November 2006 until October 31 2007 which includes the additional fish processor loads added in 2007.

We have shown normal hydro capacity in kW before and after the proposed Blue Lake Third Turbine and Dam Raise. We have also shown the effect of a failed Generator at Green Lake Hydro.

The capability to carry load is dependent on the lake reservoir elevations which are lowest in May and June. A failure of a Green Lake unit in early summer with fish processor load operating would require a great deal of diesel to make up the difference.


Sitka Electric Dept. Total Generation
Peak Daily Loads - kW
Daily Peaks 11/01/06 to 10/31/07
Normal Hydro Capacity after 3rd Turb & Dam Raise
Normal Hydro Capacity before 3rd Turb & Dam Raise
Green Lake Unit #1 Fails
after Blue Lake 3rd turb & dam raise.
Daily Peaks
Green Lake #1 Fails-
Existing System
kW
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
1-Nov-06
1-Dec-06
31-Dec-06
30-Jan-07
1-Mar-07
31-Mar-07
30-Apr-07
30-May-07
29-Jun-07
29-Jul-07
28-Aug-07
27-Sep-07
27-Oct-07
Date