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Summary of Electricity Production for Lime Village

The original system was built in 1997 with funding from various state grants. It was built around a system from Northern Electric in Vermont. I believe they got their funds from the National Renewable Energy Lab (NREL). Three prototypes were built, and their grant required that one of them be installed in a village. Lime Village Traditional Council (LVTC) applied and was chosen. (Another was set up at NREL in Golden, Colorado). This system featured a 50KWgenerator, a battery bank and a rotary converter, no inverter. When the diesel was running the converter would spin and charge the batteries, and power the town. When the batteries were sufficiently charged the diesel would shut down and the batteries would spin the converter providing power to the town. It worked for a while but the 50KW diesel was oversized and the rubber doughnut shaped clutch between the generator and the converter would fail from too much vibration. After a few replacements we went to straight diesel. Then in 2000, the LVTC got funds for an upgrade from British Petroleum, the Alaska Energy Authority, and the Department of Housing & Urban Development NAHASDA funds. No money came from McGrath Light & Power. They were managing the Lime Village Electric Utility at the time.

Lime Village consumes about 7,000 kilowatt-hours of electricity per month on average though there is significant seasonal variation. About 30 houses, a government center, and 2 commercial buildings (United Utilities, Inc., & State of Alaska Dept. of Transportation) are connected to the community's electrical system. In 2000 Lime Village received a grant to install a photo voltaic (PV) system more panels increasing the capacity from 4 to 12KW to supplement its electrical energy needs (funding from BP, AEA, and HUD). That system consisted of three components:

1. Two diesel generators that produced power when there was limited sunlight. This consisted of two generators: 21kW and a 35kW. This design was for peak loading.
2. A photovoltaic and battery system that would produce and store power when the sun was shining.
3. An inverter system to integrate the PV power, the diesel generators, and the battery bank.

The upgrade provided two new generators 21kW and 35kW. The system got rid of the 50 KW, a new battery bank to replace the old, more PV panels, and a high-tech inverter from an Australian Company with very little US presence. Consequently technical support was very sporadic and expensive. The rotary converter was done away with. This system worked on and off for a period of time until we gave up on it when the battery bank and inverter components failed. The LVTC was left to fund the cost of getting the solar system running again. This became very expensive as a single trip for a consultant to review and determine the cause of the failure was $10,000.00. In addition, the battery bank needs to be replaced every three years. That cost is between $30,000 and $35,000.

The system was designed to be a high penetration system, which means that if the sun was shining and the PV panels were in full production, the intent was to shut down the diesel generator by running on battery power and the inverter. An issue was that the inverter required connection to a separate computer to operate. The computer was connected to an electrical circuit from the inverter. Once the computer shut down the inverter turned off and once the inverter was off the computer had no source of electricity. As well, the inverter was custom-designed with no off-the-shelf replacement parts or standard operating procedures. It was basically ahead of its time, as there are now standard, commercially available inverter designs that can operate as this inverter was designed to do but never did. This system became too expensive to deal with and the solar panels, though producing electricity, were not able to distribute it to the village because of a malfunctioning inverter and battery bank. We thought the battery bank was OK. The inverter never worked properly. One additional product to the PV panels that would increase its efficiency would be to develop a solar tracking system for the panels. The research shows that a tracking would work and increase the solar production 40% to 50%. We have identified that the cost of this tracking system would be $35,000.00 and installation cost of approximately $10,000.00. We have not included this cost in the present report.

With the PV panels a set of new batteries had a 204 amp hour capacity. However, the batteries were undersized and we didn't know this. Because the battery system is not very efficient the recommendation is to by-pass the battery bank and feed the PV electricity directly to the grid. Once we get the new system in place we could charge the battery bank and determine if this system would be a reasonable addition to the existing system.

In 2010 Lime Village received a grant from the Department of Energy to assist them in fixing the problem. A contract was issued to MBA Consulting of Anchorage to determine what was needed to reduce the high cost of electrical production at Lime Village. With diesel fuel cost at $8.00 per gallon and the average cost per kilowatt-hour at $1.50 something needed to be done. MBA focused its work on the size of wiring carrying electricity from the diesel generators to the village and did not have the capacity to determine what was causing the solar power failure. David Mogar from Homer, with assistance from Brian Hirsch, Senior Project Leader - Alaska from National Renewable Energy Laboratory, and Don Wedll from Association of Village Council Presidents, agreed to come out and look at the system. This site review was done and a determination was made that the panels were working but the inverter was out dated and not appropriate for the existing system. Several people in the community confirmed that the inverter had never worked properly and the PV system was compromised as a result. As well, the batteries had not received necessary charging to maintain effectiveness and thus, they were inoperable. It was also determined that only one of the two diesel generators was working. The existing generator that was working had been rebuilt twice and did not appear to have much additional operational life.

The team doing this review, David Mogar, Brian Hirsch, and Don Wedll, believed that the first necessary system improvement was to get properly sized and efficient diesel generators, and then to reduce diesel run-time with a functioning PV and inverter system. Because the solar panels remain intact could generate much of the power needs on sunny days it was determine that the best solution for the electrical power needs of the Lime

Village was to replace the failing diesel generators with high efficiency/low load generators, and upgrade the inverter so that it was not linked to a computer system. It was also determined to by-pass the existing battery storage bank and to feed the solar power directly into the village electrical grid.

We have conducted some analysis of what this change will cost and what savings will be generated from it. The existing generator is a 35 kilowatt generator that has the capacity to meet the electrical needs of the Village; the problem is it is too big most of the time. The smaller generator which is not working initially was designed to run when the electrical need was less, but since it is not working that system is not a solution. The new system of two smaller generators will work on three possible conditions:

1. The lead generator will run to supply the general power needs,
2. Should more power be needed the second generator will start and supply need beyond what the first generator is producing.
3. With the solar panels operating under a new inverter it will reduce the load on the main generator and at peak production the diesel generators will be reduced to essentially idle mode.

The new inverter will match with the switches so that each system will operate and contribute to the electrical supply as needed. There will also be a meter attached to solar panels to determine the solar contribution to the system.

<u>The cost of this new system is:</u>

1. Purchase of two generators and switches $35,000.00
2. Purchase of inverter $16,000.00
3. Installation charges $10,000.00
4. Shipping costs $7,000.00
5. Total costs $68,000.00

<u>The funding to complete this project is:</u>

1. Alaska Energy Association grant $25,000.00
2. Department of Energy grant balance $15,000.00
3. Total funding available: $40,000.00

<u>Additional funding needed to be raised: $19,000.00</u>

The annual expectation in reduced diesel fuel consumption is estimated at 40%. This will save about 3,720 gallons of diesel fuel per year. This would produce a saving of approximately $29,760.00 annually. Once we have real numbers on the solar panel contribution to the electrical production we should be able to conduct further analysis of the savings in consumption of diesel fuel.