

Electric Distribution System Losses
On
Matinicus Isle Plantation, ME



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Summary:

The Matinicus Plantation Electric Company (MPEC) is a small, municipally-owned utility that provides electric service to the residents of Matinicus Island, a 720-acre island located about 18 miles southeast of Owls Head, Maine. Due to the island's remote location, MPEC relies entirely upon on-island diesel generation to service its customers. MPEC includes three charges on each customer's bill, one for delivered electricity, at a flat rate of \$0.26/kWh, a fuel charge, which reflects each customer's share of the total monthly fuel costs, and a \$15.00 meter charge.

The purpose of this study is to quantify the cost to MPEC associated with distribution system losses in an effort to help maximize the efficiency of the electric grid and minimize any unnecessary delivery charges. The cost of these "lost" kilowatt-hours is absorbed by MPEC in the form of lost revenue, and its customers in the form of excess fuel charges. Using monthly data compiled by MPEC from January 2003 to October 2014, this study finds that:

1. Meticulous record keeping by MPEC presents a unique opportunity to evaluate the efficiency of the Matinicus distribution system.
2. The demand for electricity on Matinicus has increased.
3. The efficiency of the MPEC distribution system has decreased.
4. The efficiency of on-island generators has decreased.
5. Distribution system losses are increasing due to increasing demand for electricity and decreasing distribution system efficiency.
6. Total generation is increasing due to increasing demand for electricity and increasing distribution system losses.
7. Fuel consumption is increasing due to increasing demand, increasing distribution system losses, and decreasing generator efficiency.
8. The amount of fuel used to generate electricity lost in the distribution system is increasing, due to decreasing generator and distribution system efficiency.
9. The price of fuel has increased.
10. The cost of fuel is volatile and generator efficiency is variable.
11. The cost to customers for fuel used to generate "lost" electricity is increasing due to increasing distribution system losses, decreasing generator efficiency, and increasing fuel prices.
12. The cost to customers for fuel used to generate "lost" electricity is volatile due to the variability of generator efficiency and volatility of fuel costs.
13. The total cost to MPEC for generating 572,386 kWh of "lost" electricity from 2003 to 2013 was \$151,396.10.
14. The total cost to customers for 61,844 gallons of fuel used to generate "lost" electricity on Matinicus from 2003 to 2013 was \$113,222.52.
15. **The total cost associated with distribution system losses on Matinicus from 2003 to 2013 was \$264,618.62.**

Given these findings, this study concludes that distribution system losses represent a significant cost to MPEC, and recommends steps that could be taken to address the issue.

Background:

The Matinicus Plantation Electric Company (MPEC) is a municipally-owned utility that provides electricity to residents of Matinicus, a 720-acre island located roughly 18 miles southeast of Owls Head, in Knox County, Maine. The island has a year-round population of about 30, with a summer population of about 100. The main industry on Matinicus is lobster fishing, and it is home to several artists and writers.¹

MPEC is run by a board consisting of the island's assessors, and has three part-time employees. It currently serves about 150 customers, and has a meter attached to every service point. Municipal buildings are metered, but not billed, and the power station's consumption is also metered. For the purposes of this study, municipal buildings and the power station are not distinguished from paying customers.

Matinicus is too far from the mainland with too small of a customer base for an economically-feasible Submarine High Voltage Direct Current (HVDC) cable. Therefore, MPEC relies entirely upon on-island diesel generators to meet demand. The fuel supplied to these generators is shipped from the mainland, and MPEC is billed the cost of fuel plus a delivery premium on each gallon they receive. This premium, coupled with high operating costs and a small customer base, means that Matinicus has some of the highest electricity rates in the country.

MPEC customers receive two charges on their electricity bills. One is for delivered power, and is a flat rate of \$0.26.45/kWh. This covers all operating costs, as well as \$1.00/gallon of fuel. The second rate is a "fuel charge" which is expressed in the following formula:

$$\text{Monthly fuel charge (\$)} = \frac{\text{Individual kWh consumption}}{\text{Island kWh consumption}} * ((\text{Fuel cost per gallon} - 1) * \text{Total fuel consumption})$$

This charge allows MPEC to cover its fuel costs over \$1.00/gallon.

Purpose:

The purpose of this study is to quantify the costs associated with distribution system loss on Matinicus. Two types of direct costs are assessed:

1. Lost revenue from kWh generated but not consumed. This cost is absorbed by MPEC.
2. Fuel charges on excess fuel needed to generate kWh that are not consumed. This cost is absorbed by customers.

This study does not assess indirect costs or externalities.

Method: The data used in this survey come from two separate sources; monthly data meticulously collected by Paul Murray at the power station, dating back to January 2003, and monthly customer records recorded by Bill Hoadley, also

¹ <http://islandinstitute.org/matincus.php>

dating back to January 2003. Both of these records go back further, but a ten-year timeframe was the most manageable and useful for the purposes of this survey.

Monthly power station records included the following information that was used for this study:

1. Total Generated (kWh): The amount of energy generated at the power station in a given month.
2. Total Billed (kWh): The amount of electricity consumed by paying MPEC customers in a given month.
3. Station (kWh): The amount of electricity consumed by the power station in a given month.
4. Town (kWh): The amount of electricity consumed by municipal buildings in a given month.
5. Efficiency (%): The ratio of electricity consumed to electricity generated in a given month.
6. Losses (kWh): The amount of electricity generated minus the amount of electricity consumed in a given month.
7. Fuel Used (gallons): The amount of fuel used in a given month.
8. Heat Rate (kWh/gallon): The ratio of kWh generated to gallons used. Indicates generator efficiency.

Monthly customer bill records included kWh consumption and fuel charges, which were used to calculate average monthly fuel prices.

The data was aggregated, graphed, and analyzed to identify trends and quantify costs.

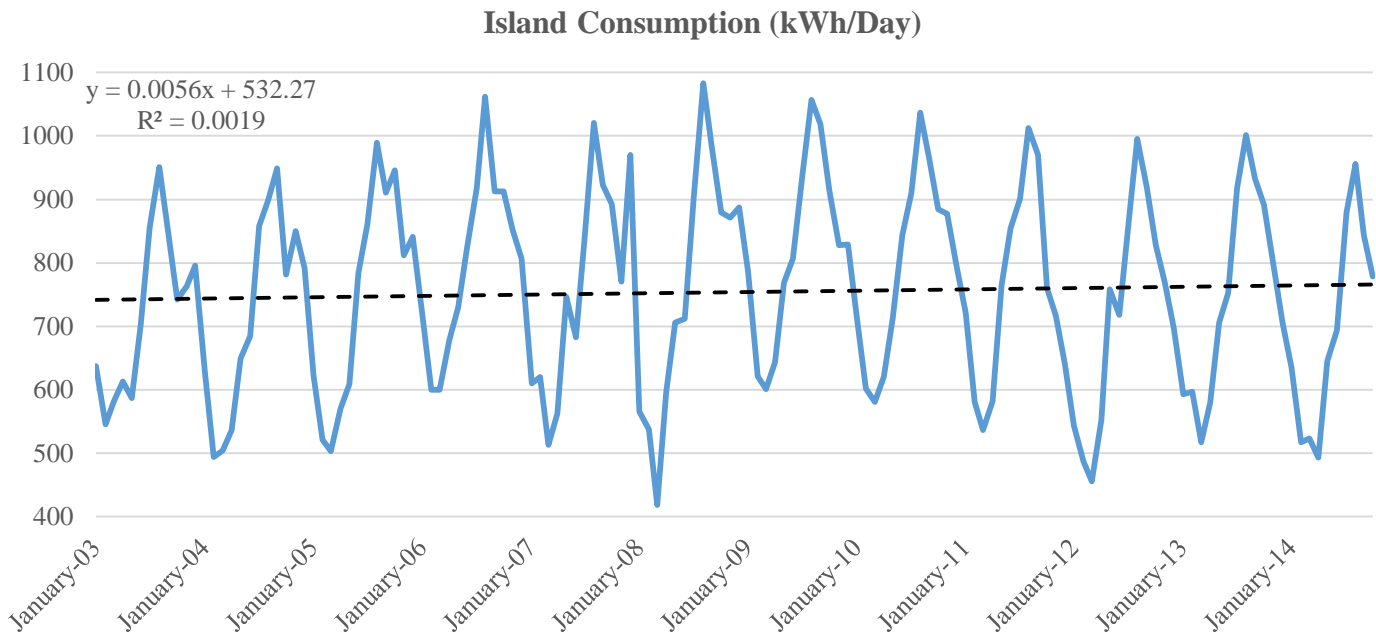
Findings:

From January 15, 2003, to October 15, 2014, the following findings are indicated.

Meticulous record keeping by MPEC presents a unique opportunity to evaluate the efficiency of the Matinicus distribution system.

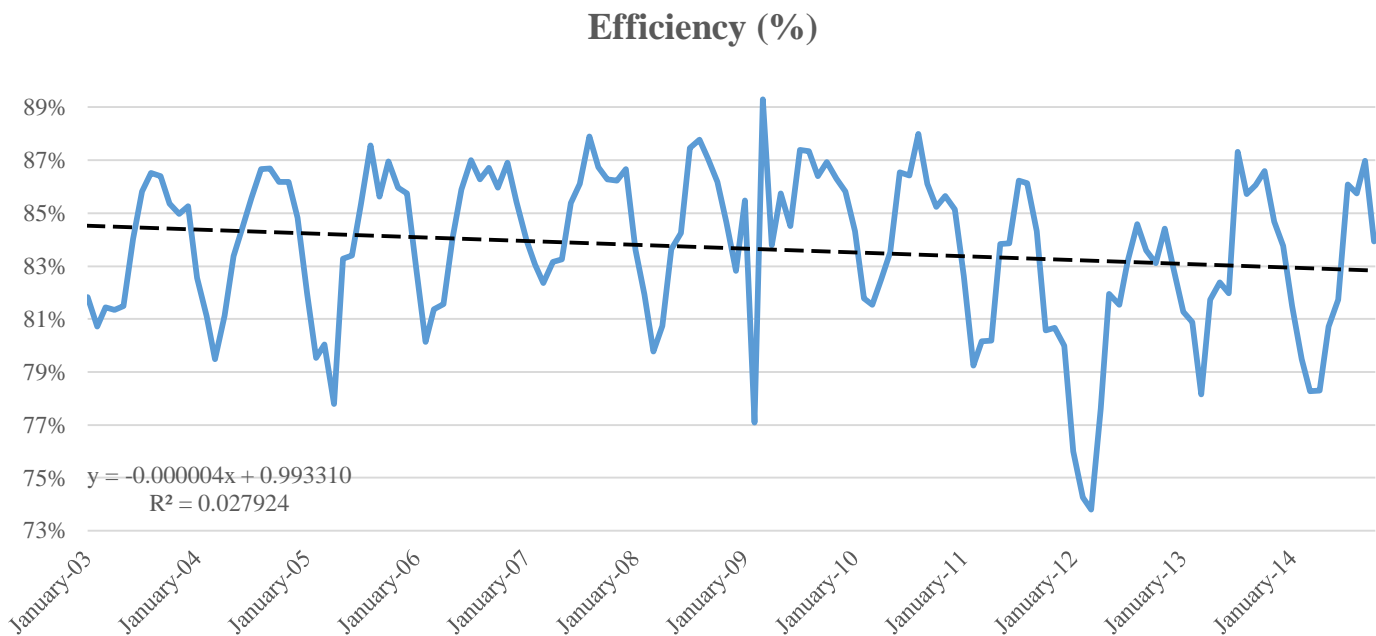
MPEC system operator Paul Murray has made a habit of recording monthly generation information at the island power house, including number of kWh's generated, number of kWh's sold, total losses, distribution system efficiency, and generator heat rate. This information, combined with monthly billing information provided by Bill Hoadley, the MPEC bookkeeper, has allowed for a comprehensive assessment of the Matinicus distribution system. Without that information, it would be very difficult and expensive to assess this issue.

The demand for electricity on Matinicus has increased.



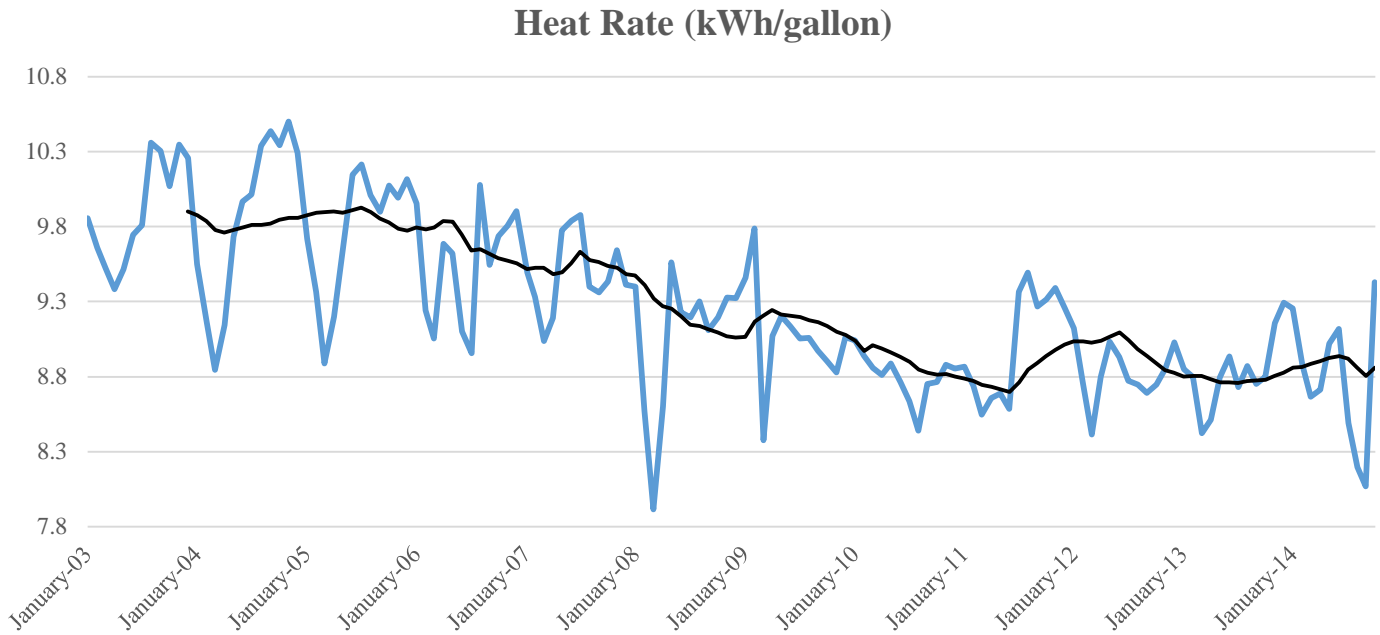
The consumer demand for electricity on Matinicus has increased at a rate of about 2 kWh a year since 2003.

The efficiency of the MPEC distribution system has decreased.



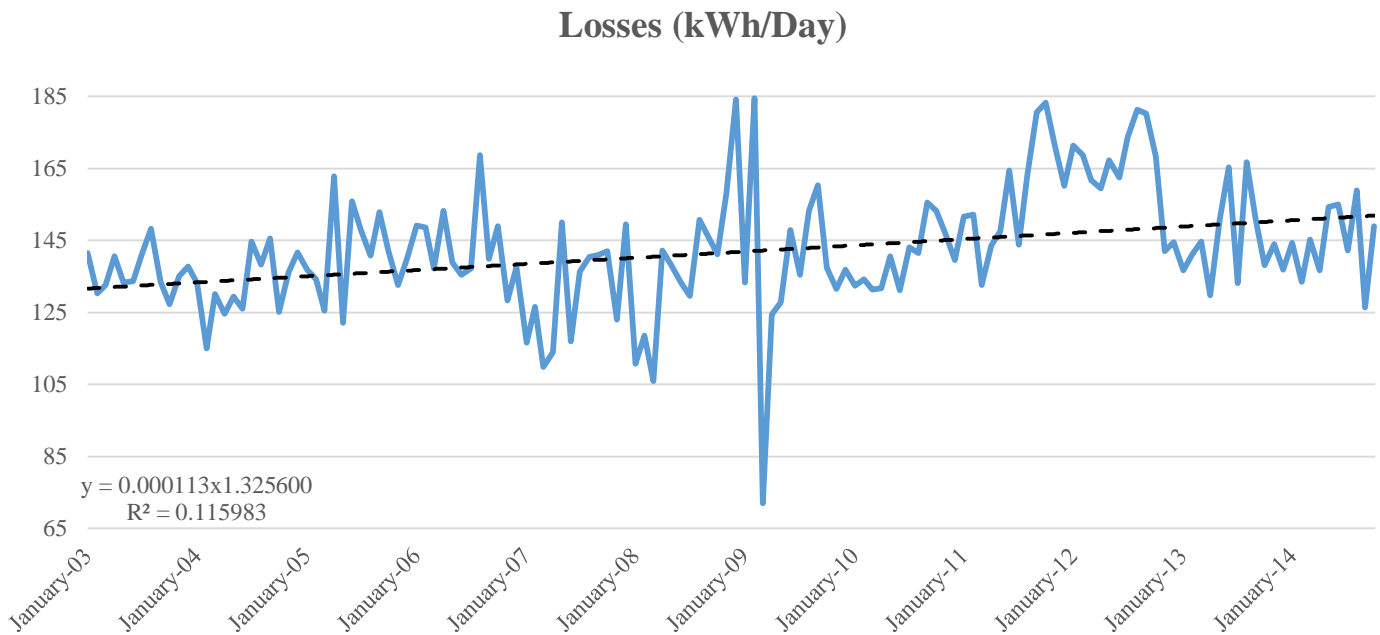
The efficiency of the MPEC distribution system has decreased steadily since 2003 at a rate of about .146 % per year.

The efficiency of on-island generation has decreased.



The efficiency of on island generators, as measured by the heat rate, shows a general downward trend.

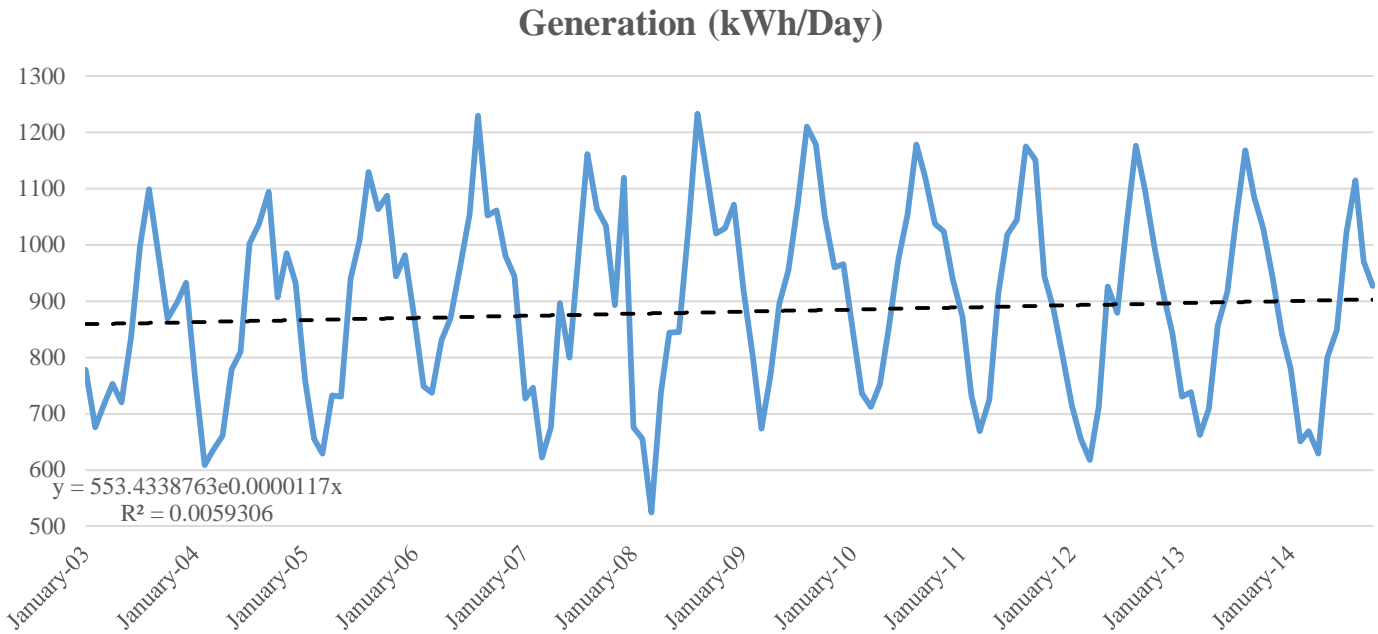
Distribution system losses are increasing due to increasing demand for electricity and decreasing distribution system efficiency.



Distribution system losses are increasing exponentially, as a function of increasing demand for electricity, and decreasing system efficiency. It would be expected that losses would increase as consumption increases, however, due to decreasing

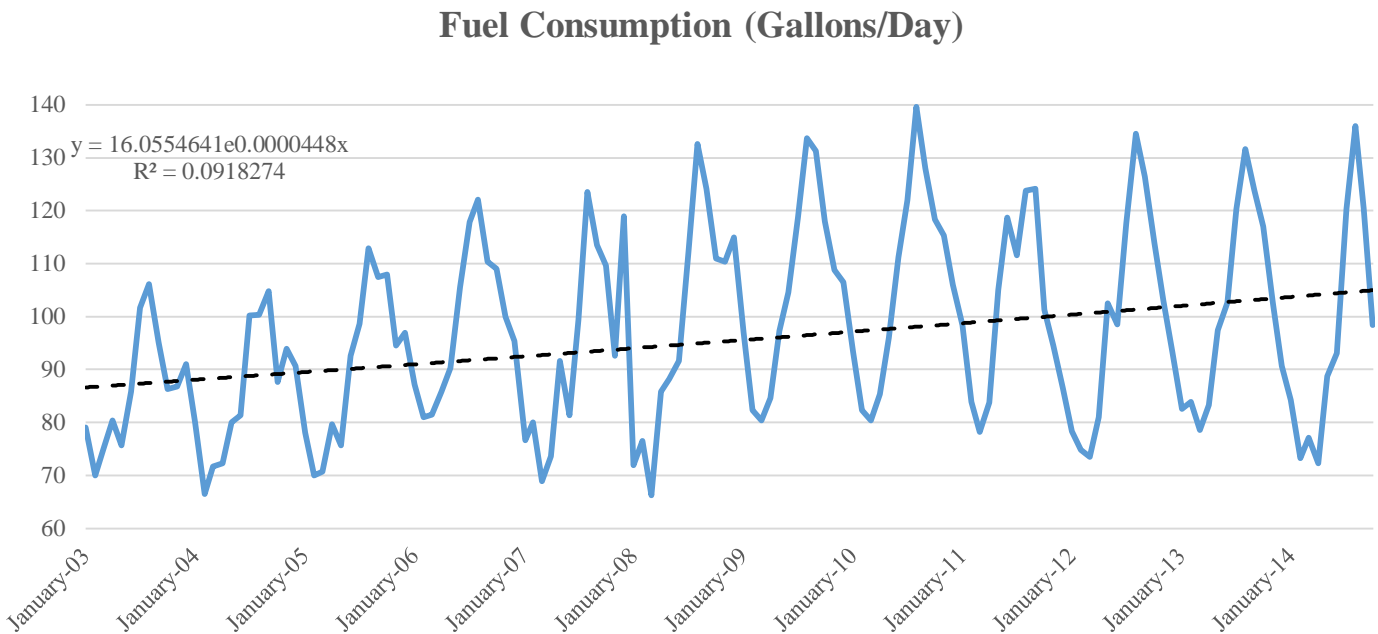
system efficiency, they are also increasing as a portion of total generation. Put another way, distribution system losses are becoming a larger slice of a growing pie.

Total generation is increasing due to increasing demand for electricity and increasing distribution system losses.



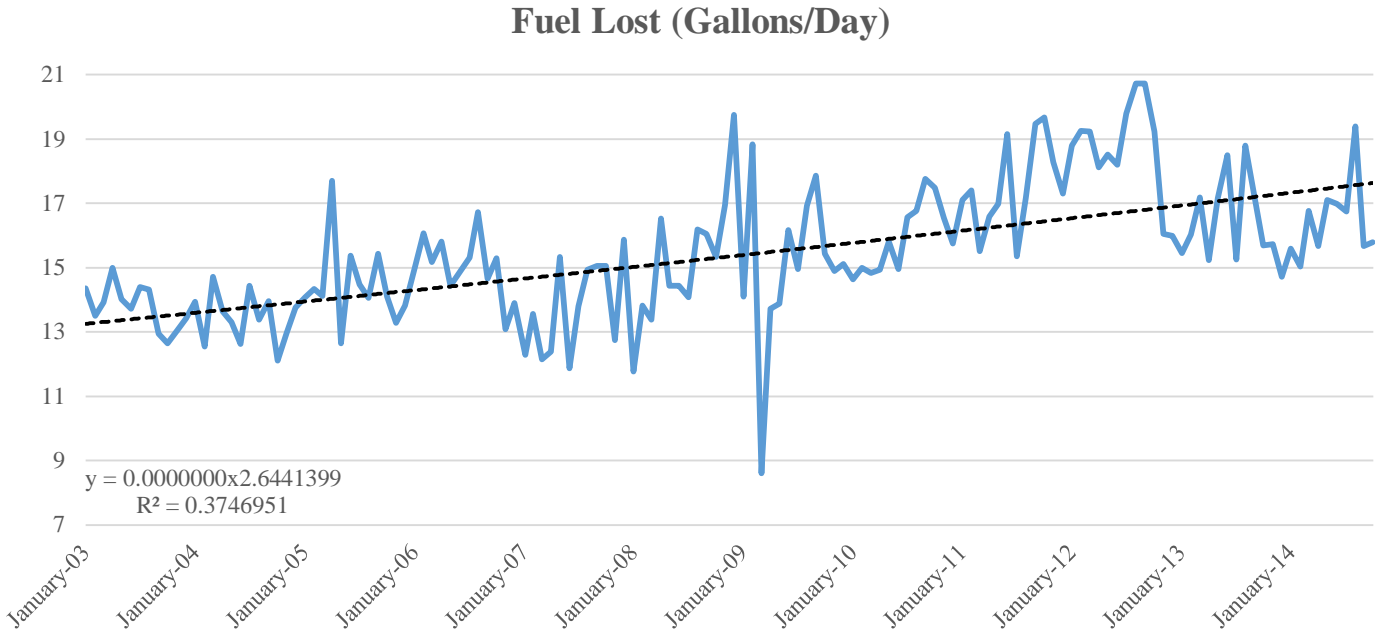
Total generation is increasing exponentially due to increasing electricity demand and increasing system losses.

Fuel consumption is increasing due to increasing generation and decreasing generator efficiency.



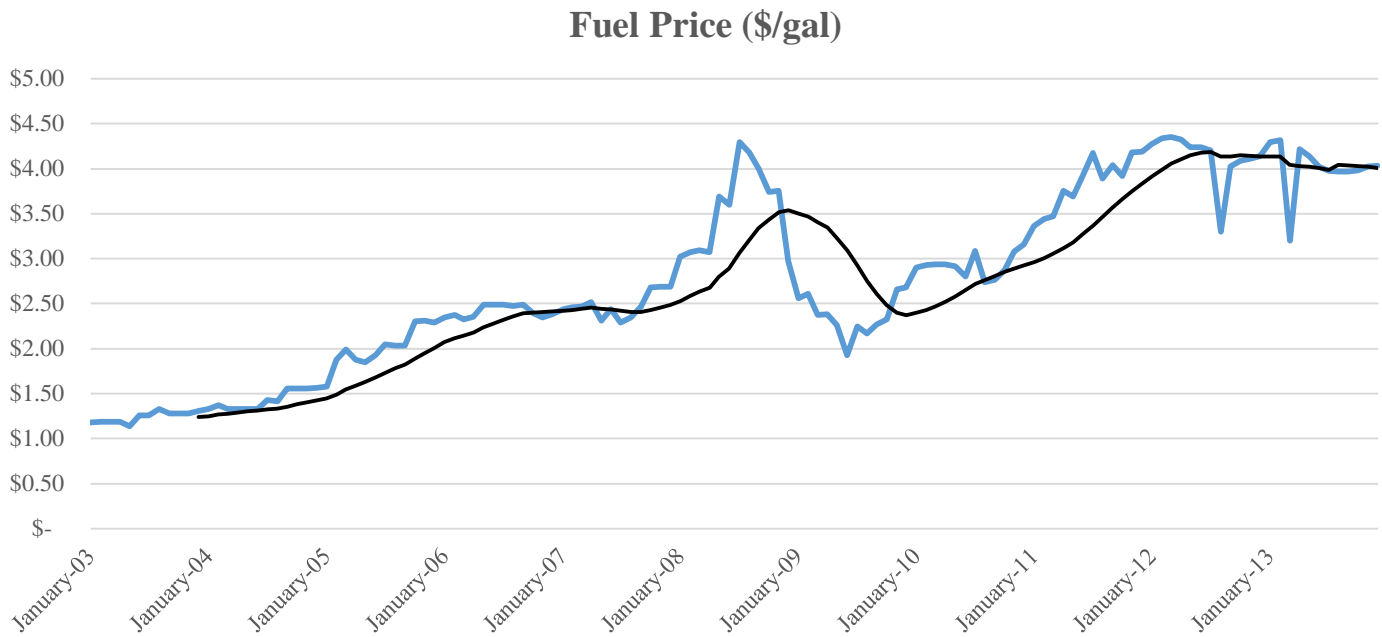
Average daily fuel consumption is increasing exponentially as a function of increasing generation and decreasing generator efficiency. Due to the high volatility of generator efficiency, some volatility is built into this function.

The amount of fuel used to generate electricity lost in the distribution system is increasing, due to decreasing generator and distribution system efficiency.



The amount of fuel used to generate electricity lost in the distribution system is increasing, due to decreasing generator and distribution system efficiency. There is variability built into this figure, due to the variability of generator efficiency.

The price of fuel has increased.



Matinicus diesel prices have risen slightly in the last ten years, and have, unsurprisingly, closely mirrored regional diesel prices.² Factors effecting fuel prices are many and mysterious, and prices are volatile.

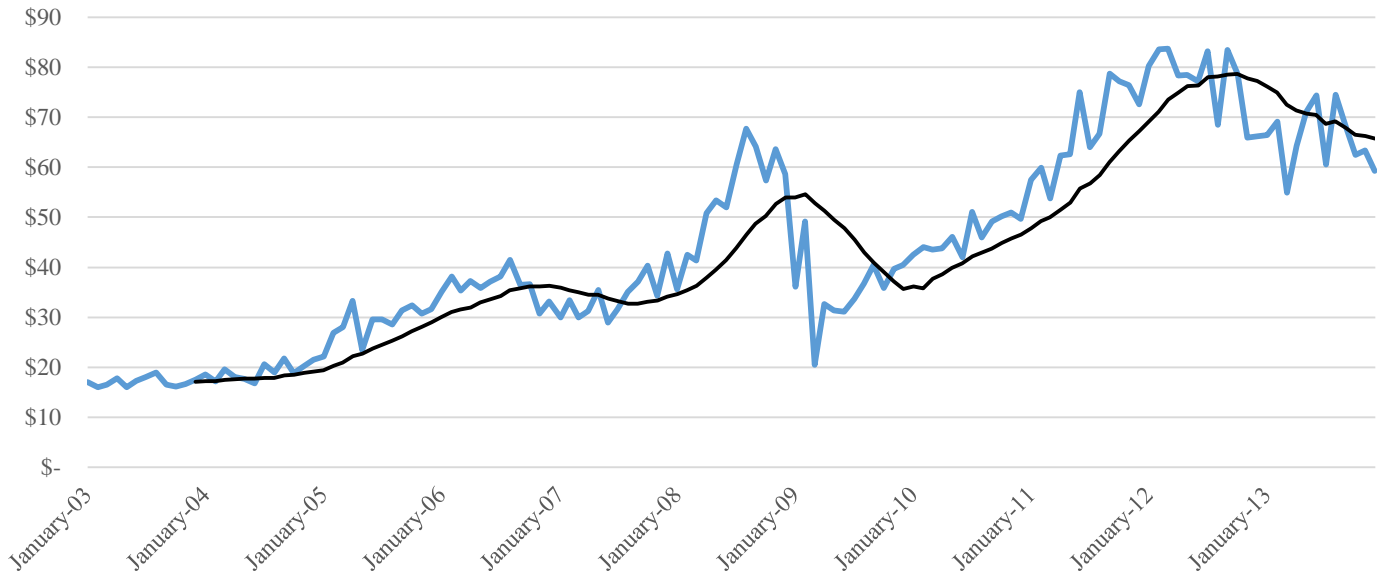
The cost of fuel is volatile and generator efficiency is variable.

Neither the price of fuel, nor the efficiency of Matinicus generators is closely correlated with any linear or exponential trend, which indicates volatility.

² http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2DXL0_PTE_R1X_DPG&f=M
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The cost to customers for fuel used to generate “lost” electricity is increasing due to increasing distribution system losses, decreasing generator efficiency, and increasing fuel prices.

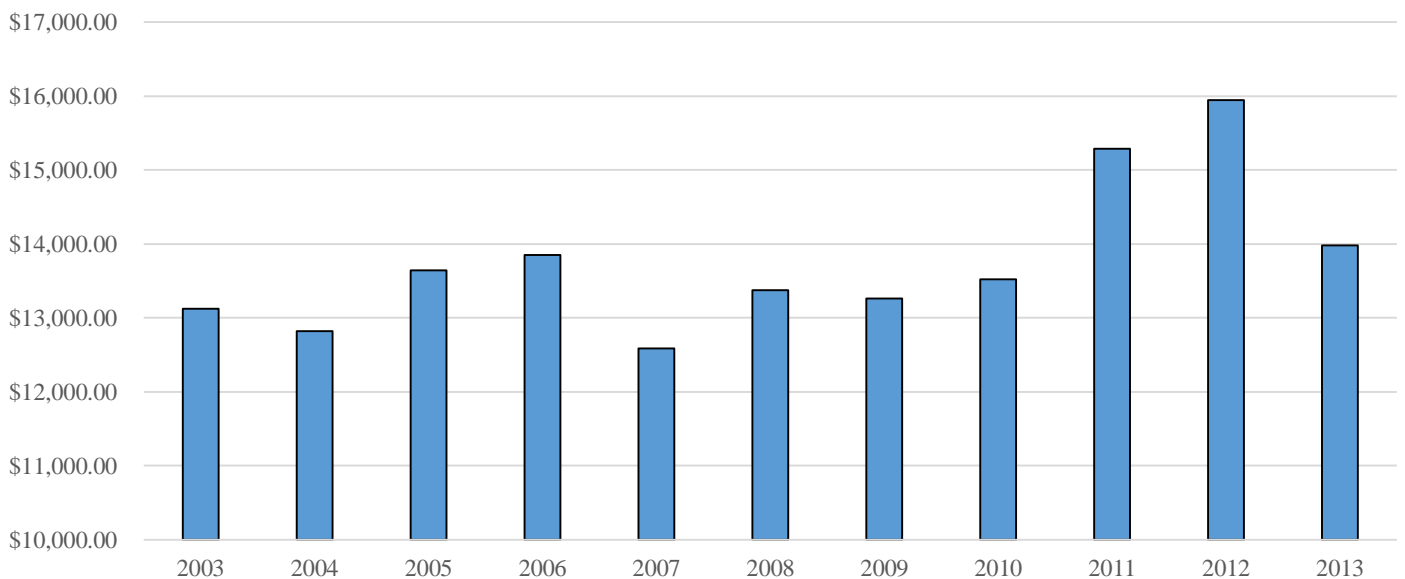
Lost Fuel Cost (\$/Day)



Increasing fuel prices, decreasing generator efficiency, and increasing distribution system loss have increased the amount of money spent on fuel used to generate lost electricity. This cost, minus \$1.00/gallon, is passed on the customers through the fuel charge. The other \$1.00/gallon is absorbed by MPEC. There is volatility built into this figure due to the volatility of fuel prices and generator efficiency.

The total cost to MPEC for generating “lost” electricity from 2003-2013 was \$151,396.10.

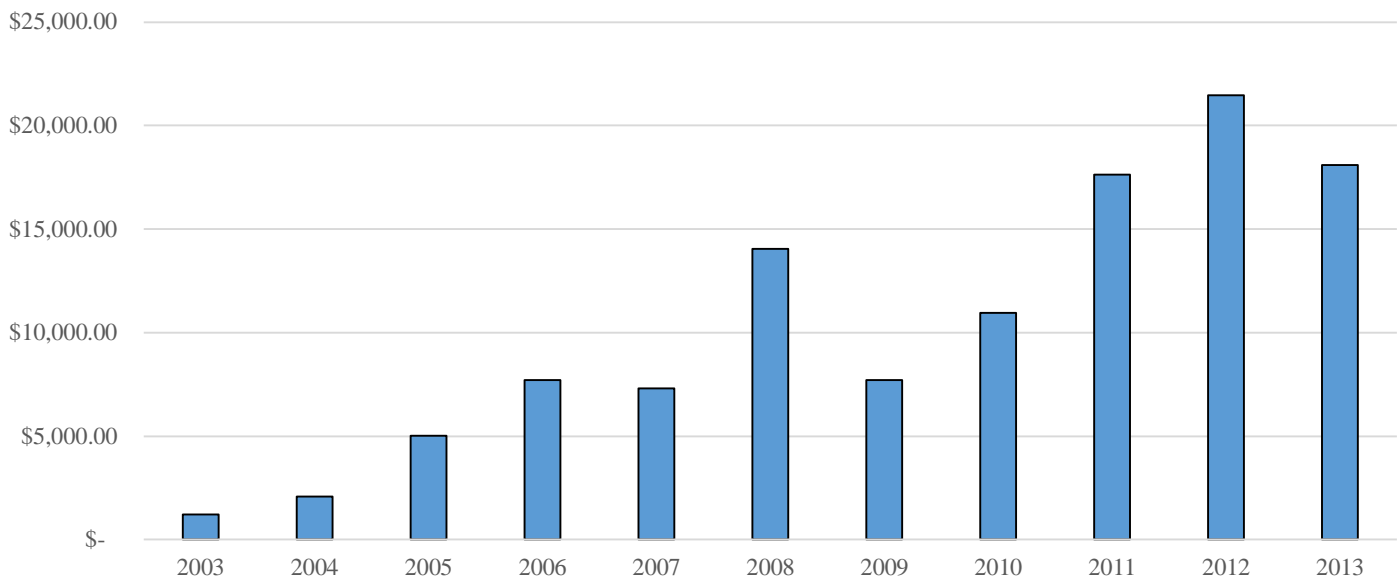
Annual Lost Revenue (\$)



MPEC assigns a value of 26.45 cents to each kWh generated, which includes \$1.00/gallon of fuel and all operating expenses. Ascribing that value to kWh generated but not consumed shows that MPEC is losing anywhere from \$12,000 to \$16,000 a year in revenue due to line loss, and has lost a total of \$151,396.10 over the ten year period from 2003 to 2013.

The total cost to customers for 61,844 gallons of fuel used to generate “lost” electricity on Matinicus from 2003 to 2013 was \$113,222.52.

Annual Fuel Charge for Lost Electricity (\$/Year)



Through the fuel charge, MPEC passes on their fuel costs (minus \$1.00/gallon) to their customers. The fuel charge takes into account all of the fuel used in a given month, so fuel used to generate “lost” kWh are still included in customer’s bills. This cost has increased drastically in the last ten years due to rising fuel costs, decreasing generator efficiency, and increasing distribution system losses.

The total cost associated with distribution system losses on Matinicus from 2003 to 2013 was \$264,618.62.

When added together, the total cost to customers and the total cost to MPEC attributed to line loss from 2003 – 2013 is \$264,618.62.

Conclusion:

The cost of distribution system loss on Matinicus is significant and growing. Decreasing distribution system efficiency, decreasing generator efficiency, and increasing fuel costs all contribute to this problem. While the recent drop in diesel fuel prices may provide some temporary cost relief to MPEC and its customers, it is just that: temporary. Prices will almost certainly rise, the U.S. Energy Information Administration’s short term outlook predicts that on-road diesel prices

will hit the \$3.00 mark by November 2015.³ However, while diesel prices are almost completely out of MPEC's control, distribution system and generator efficiency are both well within the scope of issues that can be dealt with directly by MPEC.

The decline of efficiency in the on-island diesel generators is the result of numerous factors including age, the amount of use at any given time, and other general maintenance issues. While there are a number of ways to address these kinds of problems, the USDA grant submitted by MPEC is ultimately aimed at increasing generator efficiency significantly. The status of this application should determine to what degree MPEC goes after generator efficiency. If the application is not approved, additional steps should be taken to address the issue, if it is, it will probably be sufficient to address the issue in the near term. Furthermore, energy efficiency on the customer side can lower the amount of fuel used, an issue that I am working with MPEC to address.

Distribution system efficiency is an issue that every utility deals with, and it is a significant and growing problem for MPEC. The next step to take is figuring out exactly what is contributing to the problem. This can probably be accomplished with existing Island Institute and MPEC resources, at little to no cost to MPEC. There are at least two steps that can be taken immediately to accomplish this task:

1. Evaluate each transformer on the island, once in the winter when loads are low, and once in the summer when loads are high, to visually inspect it, and take infrared photos of the primary and secondary connections, as well as the core, to see if anything is running hot, or is visibly corrupted. The Island Institute has an infrared camera available, and the only cost to MPEC would be the time their employee must take to go around and assist with this process (i.e., operating bucket truck, etc.). This work has already happened to some degree on Monhegan, and has proven to be beneficial.
2. Use historical customer meter data along with powerhouse data to identify which loads increase distribution system loss. Utilize spatial data analysis (GIS) to identify problem areas and areas and inform next steps. This can all be done by me, at no cost to MPEC, over the course of my fellowship, using Island Institute software and MPEC bills (which I am already able to access.)

Thank you for the opportunity to work in your community. I look forward to doing more with MPEC and Matinicus in the very near future. If you have any questions or comments, please do not hesitate to contact me via email or phone.

³ <http://www.eia.gov/forecasts/steo/>