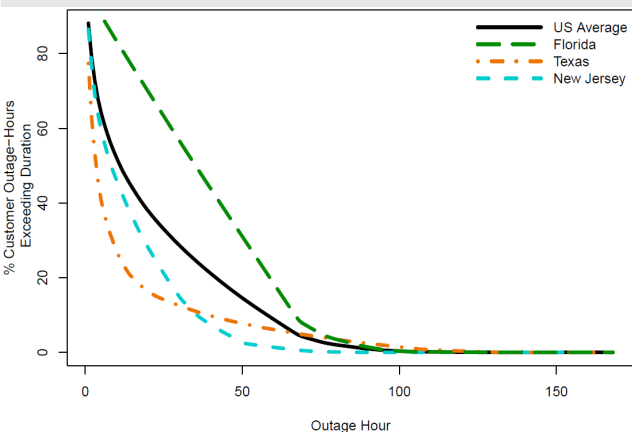


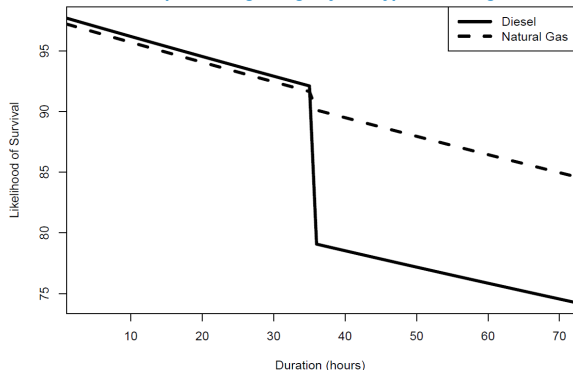
## Goals Of Project

- Estimate the reliability of diesel and natural gas backup generators.
- Compare how differences in fuel security between diesel and natural gas affects backup generator reliability for long-duration outages.
- Model the economics of using backup generators to provide additional services.
- Compare the economics of diesel and natural gas backup generators.

Customer outage-hour distributions by region.



Likelihood of backup surviving outage by fuel type and outage duration.



## Additional Customer Services

In addition to reliability benefits, backup generators may:

- Allow a facility to switch to an interruptible rate tariff.
- Reduce energy and demand charges.
- In restructured markets generators can sell into wholesale markets.
- Reduce coincident peak charges.

More frequent operations also reduces failure likelihoods.

## Case Studies

- We gathered outage data, cost data, rate tariffs, generator reliability data, and reliability of fuel supply data from a variety of sources.
- We compare the reliability and economic benefits of a backup diesel system with 36 hours of on-site fuel and a natural gas system installed in Florida, Texas, and New Jersey, to provide backup power and grid services to a supermarket.

Failure rate estimates for various backup generator configurations

Failure Type	Point Estimate	Lower Range	Upper Range
FTS (Backup Only)	0.67%	0.33%	1.34%
FTS (Grid Services)	0.15%	0.08%	0.3%
FTR/MTTF (Backup Only)	0.172% / 580 hr	0.086% / 1156 hr	0.346% / 279 hr
FTR/MTTF (Grid Services)	0.086% / 1160 hr	0.043% / 2312 hr	0.173% / 578 hr
Diesel Fuel Supply	36 hr	18 hr	72 hr
Failure of Resupply (Diesel)	14%	7%	28%
FFS (NG Long-Duration)	1.5%	0.75%	3%

Reliability estimates by fuel type and region

Region	Diesel Reliability (%)	Natural Gas Reliability (%)	Difference
U.S. Average	94.7	97.3	2.6
Florida	90.1	95.5	5.4
New Jersey	97.2	98.2	1.0
Texas	97.3	98.3	1.0

Net Present Values by region and by fuel type

Generator Type	Diesel			Natural Gas		
	TX	FL	NJ	TX	FL	NJ
CAPEX + O&M (\$/kW)						
Region						
CAPEX + O&M (\$/kW)						
Revenues/savings (\$/kW)	\$968	\$1,380	\$3,064	\$1,091	\$1,380	\$3,153
Fuel cost for (\$/kW)	-\$187	\$0	-\$341	-\$199	\$0	-\$272
NPV (\$/kW)	-\$425	\$175	\$1,518	-\$513	\$25	\$1,476

## Calculating Generator Reliability

Generators can fail due to:

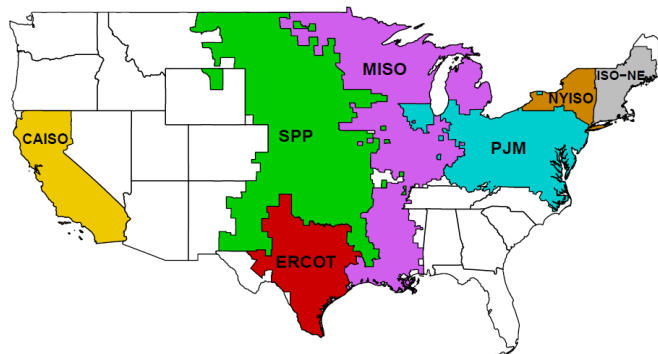
- Failure to Start (FTS)
- Failure to Run (FTR)
- Failure of Fuel Supply (FFS)

The likelihood of each failure type varies with outage length and fuel supply.

Many Power outages are short duration, but some can last for several days.

When calculating reliability, the distribution of outage durations, and the type of fuel used need to be considered.

Map of Restructured markets in the United States



## Main Findings

- Due to lower rates of fuel supply failure during long duration outages, natural gas generators can provide higher reliability than diesel generators.
- Generators which provide grid services can significantly reduce net costs, or even provide net positive revenues.
- Due to lower capital costs, diesel generators tend to be cheaper than natural gas generators, even after accounting for the lower fuel costs of natural gas
- Differences between fuel types are relatively modest. Additional considerations may determine investment choice.