The Addressable Solar Market in Connecticut

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Prepared for CEFIA

Abstract

An estimate of the total addressable solar market was conducted for the state of Connecticut. Production values were calculated for a random sampling of sites among all Connecticut counties, and these values were aggregated statewide.

When bounding the economics of a system with a 25-year payback threshold, the total addressable market was calculated to be:

	Total Addressable Market
Size (gW DC)	3.89
Production (gWh/Y)	3,915

While Connecticut is not the sunniest state, the incentive structure available to the homeowner makes solar quite viable. By our calculations, almost a full three quarters of homes in the state are solar viable within that 25-year payback threshold.

The methodology used for this analysis is detailed in this report.

A sensitivity analysis of the effect of the Clean Energy Finance and Investment Authority's rebate level under the Residential Solar Investment Program and the installation cost on solar viability was also conducted and will be reported below.

We also performed an assessment of the total *technical* market (i.e. how much Connecticut residential rooftops could *possibly* produce, irrespective of economic factors), as well as the total possible market for various economic conditions, which we report below. The total technical market is approximately twice the size of the currently addressable market:

	Total Technical Market
Size (gW DC)	6.51
Production (gWh/Y)	6,599.94

Methodology

Geostellar currently has detailed solar information on all counties in Connecticut:

Fairfield	New Haven
Hartford	New London
Litchfield	Tolland
Middlesex	Windham

Because the character of a state can vary from region to region (i.e. housing size, presence of trees, urban/suburban, etc.), separate statistical analyses were

conducted on each county. We focused these analyses on single family homes (either detached or attached).

Dataset

A random sampling of 5,000 residential sites from each county was taken. Owing to variability in data quality as it relates to a property's use class, sites with an identified rooftop area of greater than 400m^2 were excluded from the analysis. It is unlikely that a site that size is truly an example of residential ownership, and large sites will skew the results somewhat. Usually large sites that are characterized as residential are in fact large apartment buildings, as shown in an example below.

Viability

The viability of each site was evaluated. To do this, the roof was examined and a solar PV system was sited.

To accurately size a system one must determine both what *could* be sited and what the desired production *should* be. The former can be calculated from the external datasets we process, but the latter cannot be done without knowing something about the owner's energy use. Because of this, for these types of analyses, Geostellar uses a heuristic sizing algorithm that attempts to place a reasonably sized system, adjusted somewhat for roof size (the assumption being that in general larger houses will have larger energy footprints).

With the system sited, insolation, production, and financial calculations were conducted for each site. A site was considered non-viable if one of the following two conditions were met:

- The roof or shading is such that a system of at least 3kW DC couldn't be sited
- The sited system did not achieve payback within its lifetime (assumed to be 25 years in this analysis).

Connecticut is fairly treed in areas, so this first point is important. As an example, below is a site that, while large, was excluded because of this. The red outline represents the sunniest portion of the roof. Even though this is a winter picture, one can see the abundance of trees that would block direct insolation.

From the statistics of this viability analysis, the size of the addressable market (in number of sites) can be estimated.

Production

The size of the market must also be determined in terms of energy and power. To do this, statistics were gathered on all of the viable sites and estimates of power and energy were made.

Market Estimation

From the above calculations, an estimate of a market's size can be made. The number of viable sites is known, as are the mean power and energy produced. Total size is given by the number of units multiplied by their mean values.

Results

County Results

The following two charts summarize the analysis results for Connecticut. The first shows the statistical averages for the counties; the second the totals for those counties:

County	Resi. Rooftop Sites	Percent Viable	Mean Size (W)	Mean Production (kWh/Y)
Fairfield	107,883	50.72%	6,034	5,662
Hartford	194,144	90.28%	5,885	6,167
Litchfield	52,034	85.46%	5,896	6,139
Middlesex	34,433	87.04%	5,824	5,598
New Haven	161,738	84.90%	5,786	5,533
New London	61,093	63.32%	5,878	5,662
Tolland	26,423	54.18%	6,095	5,414
Windham	21,564	55.50%	6,009	5,429

County	Total Size (gW)	Total Power (gWh/Y)
Fairfield	0.65	611
Hartford	1.14	1,197
Litchfield	0.31	319
Middlesex	0.20	208
New Haven	0.94	974
New London	0.36	346
Tolland	0.16	143
Windham	0.13	117

State Results

The total state market can be estimated by aggregating the above:

Measure	Weighted Average
Viability	71.43%
Size (gW DC)	3.89
Production (kWh/Y)	3,915

Sensitivity Analysis

The economics of a solar installation – specifically the installation costs – are one of the key drivers to solar viability, so it makes sense to examine them parametrically. For this paper we examined the sensitivity of viability to **1)** RSIP rebate levels for the current installation cost (assumed to be $4.50/Watt), **2)** the installation cost for the current rebate, and **3)** the effective installation cost, which is given by the installation cost less the rebate level.

For these analyses we used a blended, average rebate level. The actual rebate as implemented has a two-tiered structure, where the rebate of the first 5kW of system

power has a different value of the second 5kW. For this analysis we used an average rebate level for all sites.

To perform the analysis, 20,000 sites were chosen at random from throughout the state, with calculations performed for each site.

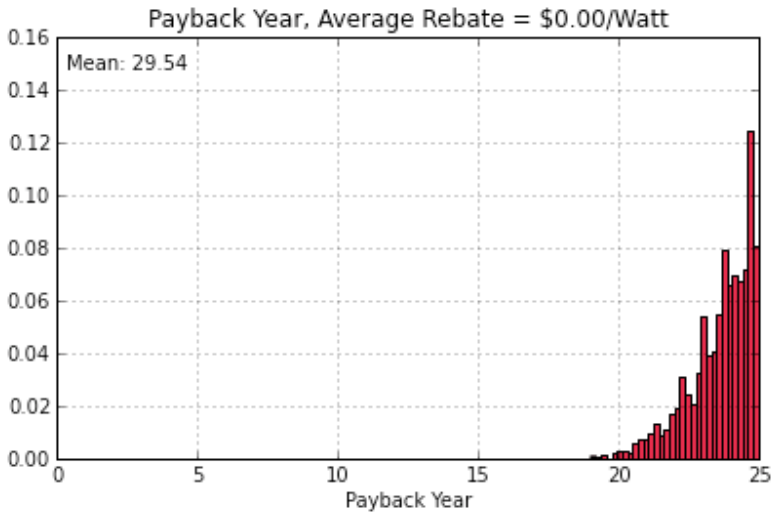
Because we constrained the minimum system size, there is a theoretical maximum, regardless of the economics. By our calculations this maximum is around 74%, which is to say that about 26% of the houses examined couldn't be used for siting a minimum system, regardless of cost.

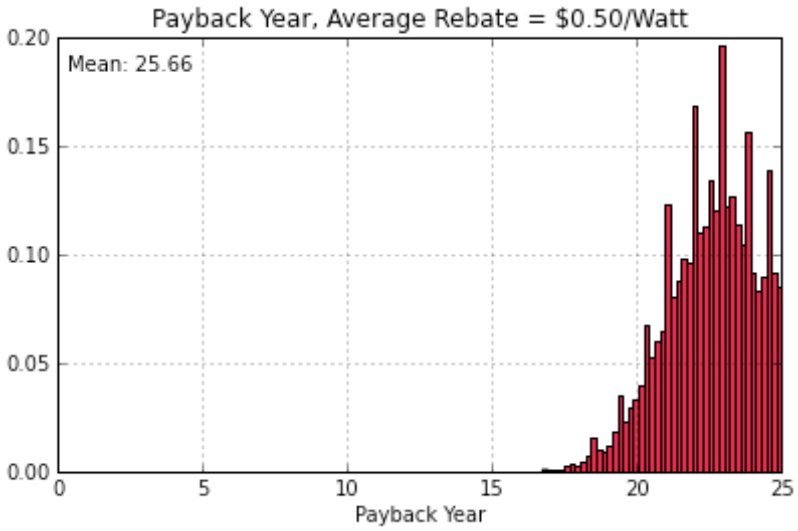
Rebate Level

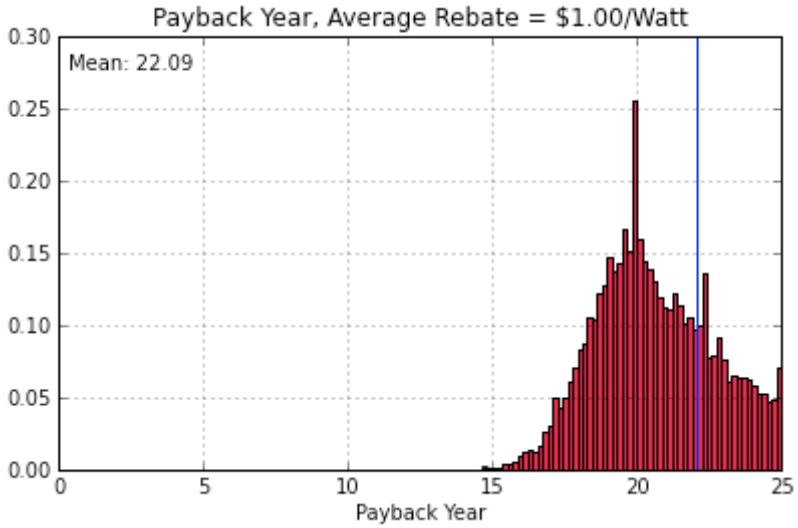
Four levels of average rebate were examined, ranging from $0.00/Watt (i.e., no rebate) to $1.50/Watt (which is close to the current average rebate level). At the lower rebates the viability percentage was low ($0.00/Watt yielded 13.91%), whereas at the higher level it reached the theoretical maximum (70.56%).

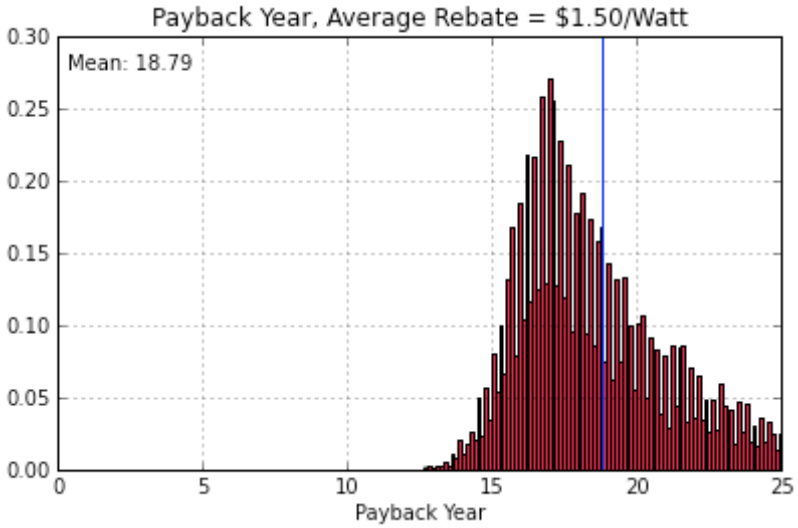
Note that 25 years is considered the usual lifetime of a solar installation, so when a site has a calculated payback longer than that, it should not be assumed that the system will in fact reach payback while still in service. This calculation assumed that the system would continue to produce through payback so that statistics could be gathered, but in reality these systems would probably not continue to perform.

Also note that in this calculation (and elsewhere), discounted cash flows were used to calculate financial performance (the discount rate used was 4.13%).



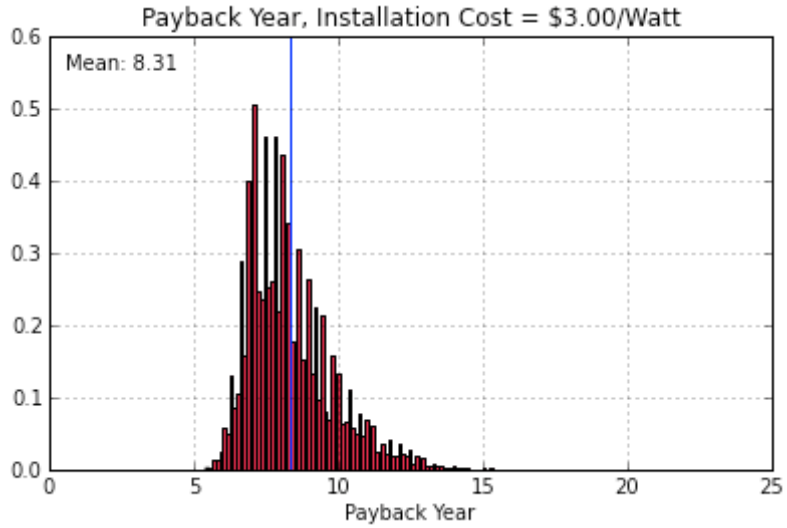

Payback Year, Average Rebate = $0.50/Watt
Mean: 25.66
0.20
0.15
0.10
0.05
0.00
0
5
10
15
20
25
Payback Year

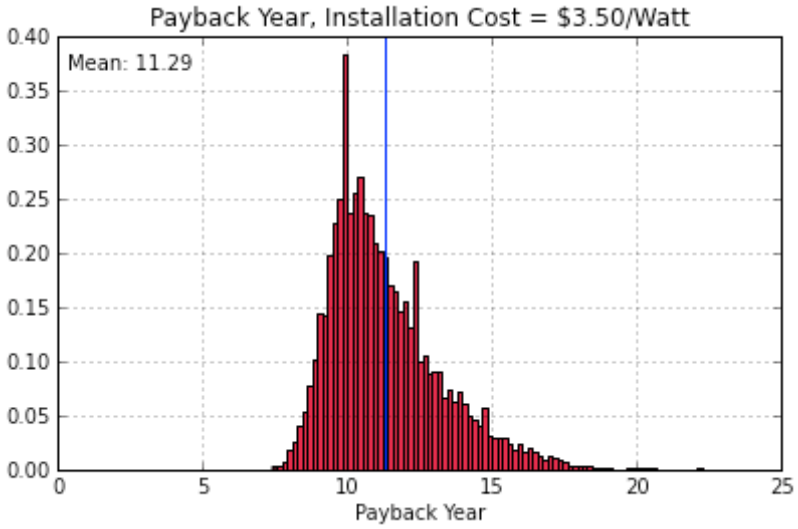

Payback Year, Average Rebate = $1.00/Watt
Mean: 22.09
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
5
10
15
20
25
Payback Year

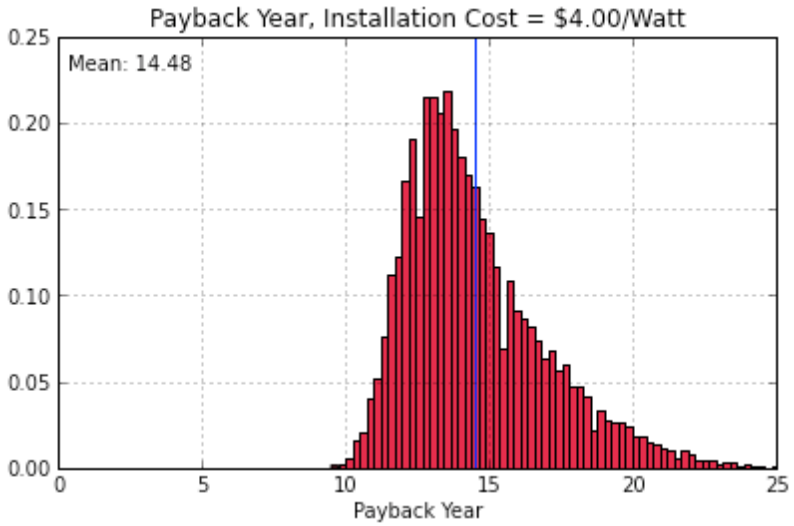

Payback Year, Average Rebate = $1.50/Watt
Mean: 18.79
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
5
10
15
20
25
Payback Year

Installation Cost

For this analysis, installation costs between $3.00/Watt and $4.50/Watt (current install costs) were examined. At the current level of rebate, all installation costs produced reasonable levels of viability (ranging from 71 to 74%):






Payback Year, Installation Cost = $4.00/Watt
Mean: 14.48
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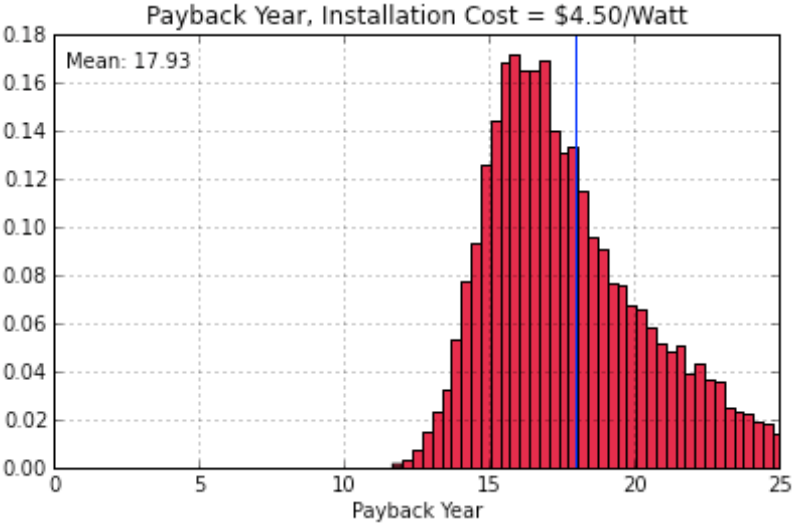
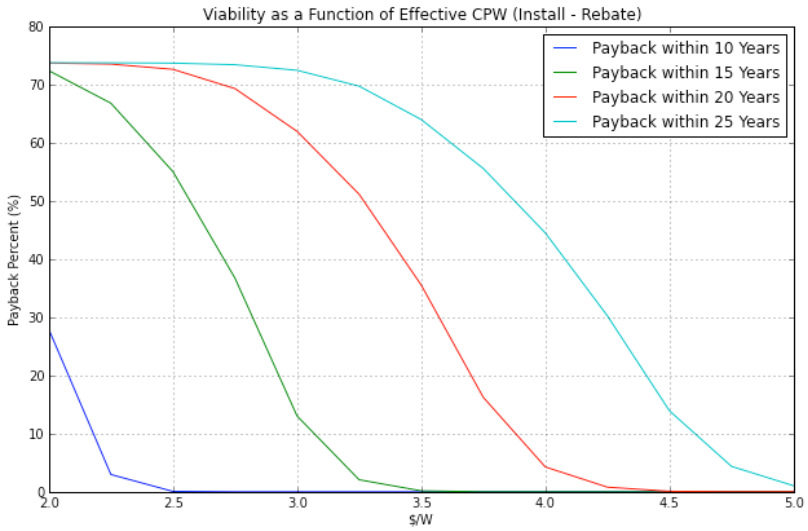
0.20
0.15
0.10
0.05
0.00
0
5
10
15
20
25
Payback Year


Payback Year, Installation Cost = $4.50/Watt
Mean: 17.93
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
5
10
15
20
25
Payback Year

Effective Installation Cost

Because the CT rebate is an upfront deduction in cost, it has the net effect of lowering the effective installation cost. An analysis of the sensitivity of this effective cost was conducted, examining viability as a function of this cost:



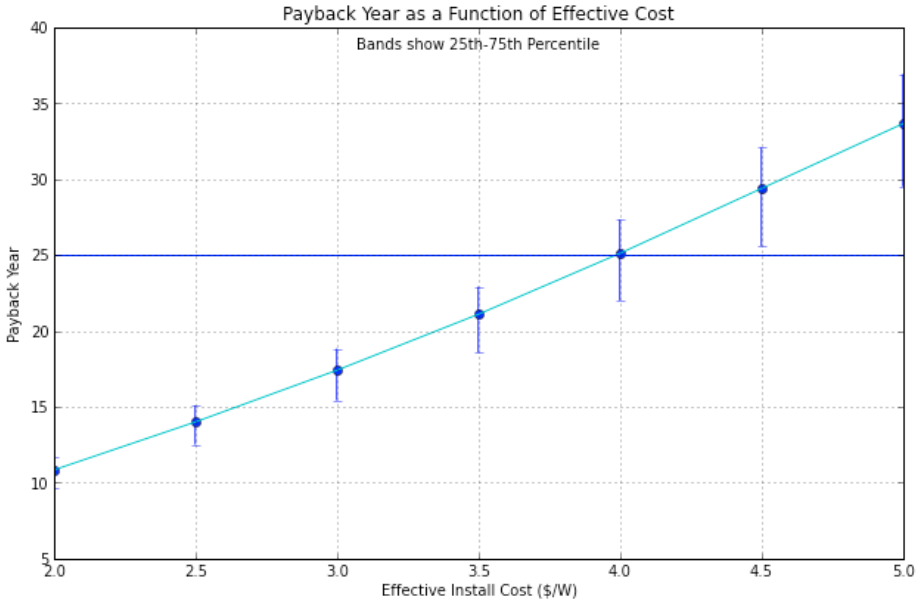
This chart shows the percentage of systems that achieve payback for various installation costs. Twenty-five years is considered the useful lifetime of a solar system, but we have also included contours for earlier payback targets should earlier payback goals be explored.

As can be seen in the chart, the viability at 25 years holds close to its maximum value until the effective installation cost reaches about $3.00/Watt. Thus, for the current installation cost of $4.50, if one desires to maximize viability one would structure the rebate to be about $1.50/Watt (which is close to its current value, so the incentive is well designed). If installation costs were to drop – say, to $3.50/Watt – then the same effect could be achieved with an incentive of $0.50/Watt.

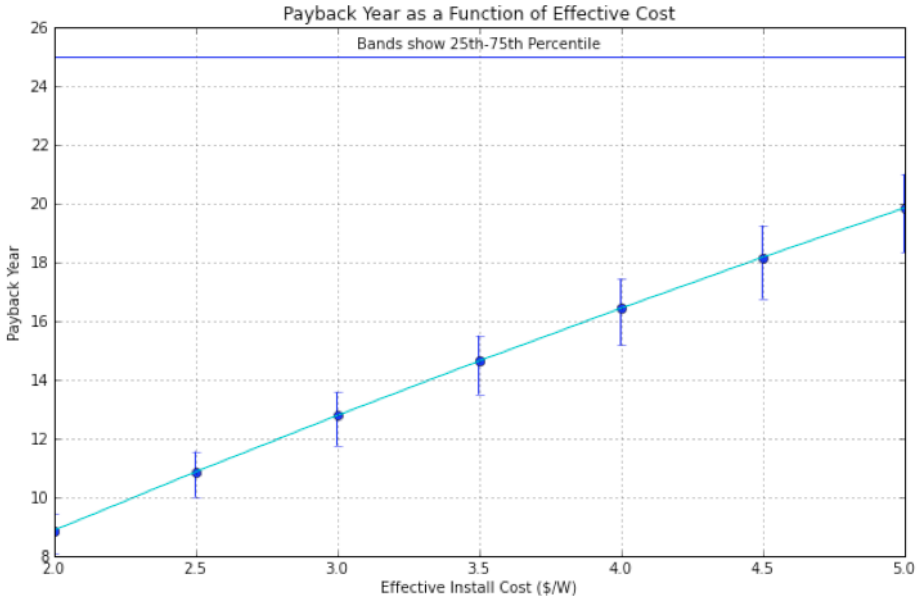
(Note that for these calculations the Federal Investment Tax Credit is assume to be active, and a utility rate of $0.15/kWh was used.)

A slightly different take on the data is shown below, where the payback year as a function of effective installation cost is shown. The error bars show the distribution of payback years between the 25th and 75th percentile. As an example, at $3.50/W most systems will achieve payback by year 25, whereas for $4.00/W only about 50% of them do. These data are evocative of what effect various levels of rebates have on homeowners. If a policy goal of, say, ensuring that 75% of homeowners can achieve payback with their system, then an effective installation cost of about $3.75 would be a target. The first chart calculates payback assuming a discount rate of 4.13%, whereas the second chart does not discount future cash flows (and thus presents a simple payback analysis).

Discounting Future Cash Flows



Simple Payback



Technical Market Potential

An analysis was also conducted that characterizes the total technical market – how much energy can possibly be produced given the rooftop analyses performed.

To conduct this analysis, each county was examined and the average maximum size and production was determined. This number was used along with the total rooftop

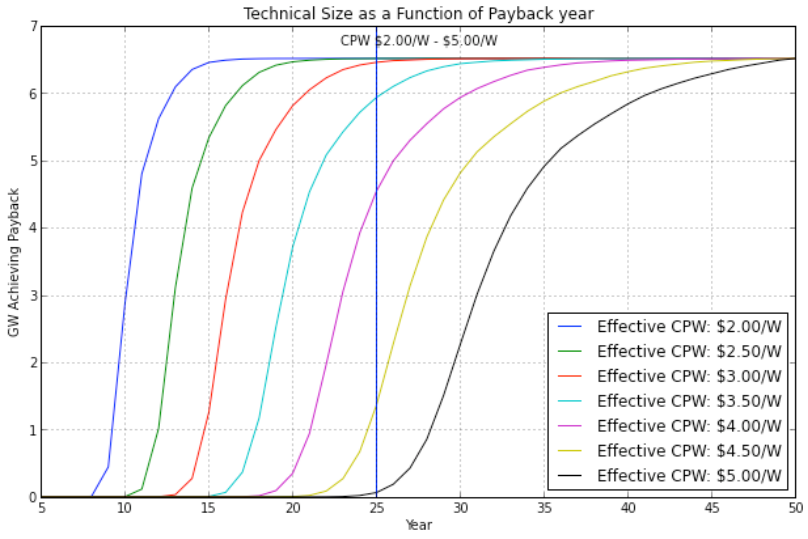
numbers to ascertain how much energy could possibly be produced. These data are summarized below:

County	Average Size (kW-DC)	Average Produced (mWh/y)	Rooftops	Total (gW)	Total gWh
Fairfield	6.79	6.26	107,883	0.73	674.87
Hartford	12.17	12.73	194,144	2.36	2,471.65
Litchfield	12.45	12.94	52,034	0.65	673.53
Middlesex	10.54	10.88	34,433	0.36	374.74
New Haven	10.21	10.6	161,738	1.65	1,714.8
New London	6.65	6.33	61,093	0.41	386.86
Tolland	7.5	6.46	26,423	0.2	170.75
Windham	6.97	6.16	21,564	0.15	132.75

Market Indicator	Total Market
Size (gW DC)	6.51
Production (gWh/Y)	6,599.94

As can be seen above, the total potential for CT, irrespective of market factors, is almost twice the addressable market calculation. This begs the question: What market conditions will allow as much of the technical potential to be realized as possible?

To address this question the potential market as a function of payback year was examined for a variety of effective installation cost (gross cost less rebates received), but there is one caveat to this analysis: no assumptions were made as to site consumption. For this analysis as much solar as was possible was sited at each location examined, with no assessment of electricity consumption made. The results of this analysis are presented below:



1 CT Solar Market
2

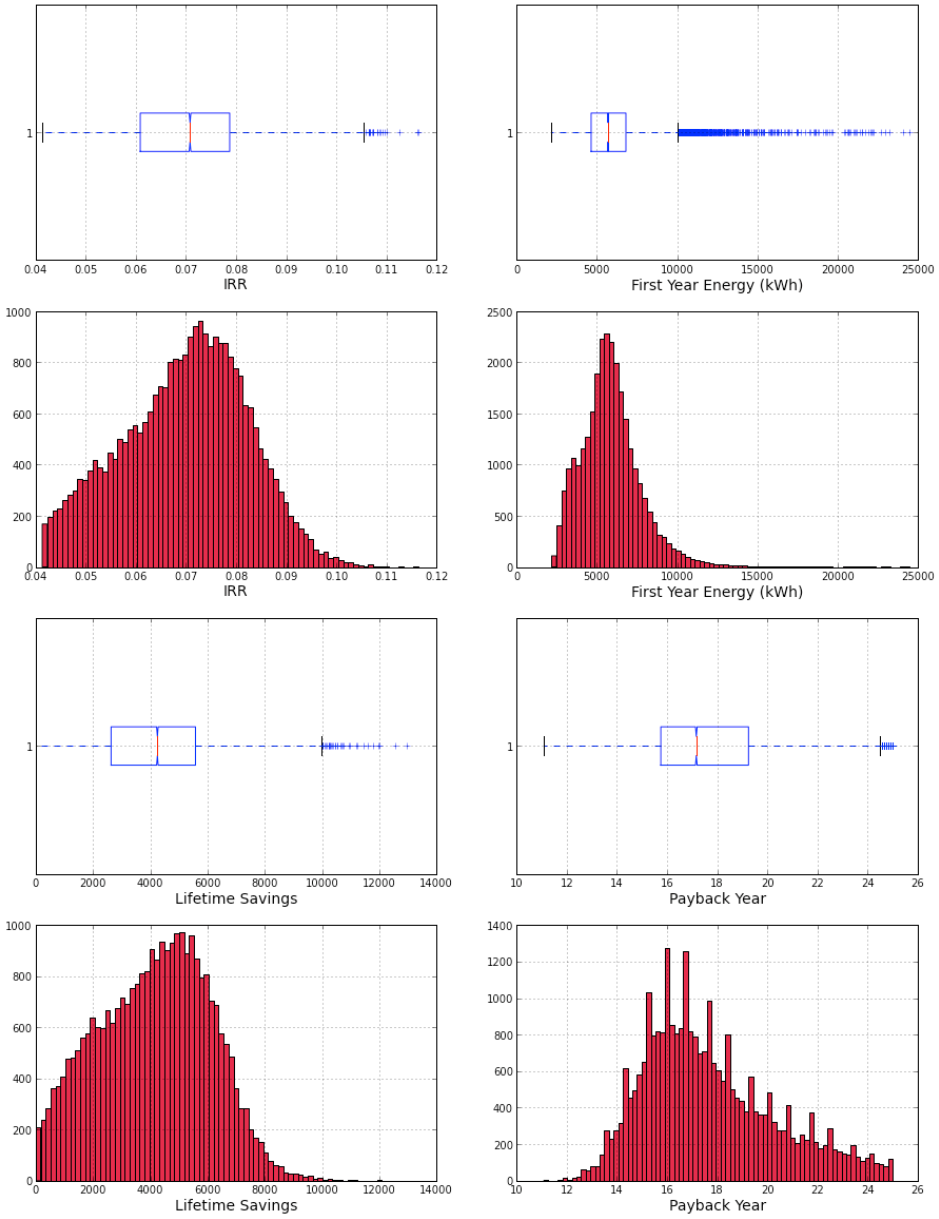
This figure is somewhat complicated, so an explanation is in order.

If we look at the $2.00/W effective installation line (dark blue), approximately 3 GW of solar achieves economic payback by year 10, and most systems achieve payback by year 15 (all lines approach 6.51 GW asymptotically, which is the maximum potential calculated above). Through effective installation costs of $3.00/W, most systems will achieve economic payback by year 25, which is normally considered the life of a solar system. Somewhere around $4.25/W, only 50% of the systems achieve payback by year 25, and at $5.00/W virtually no systems achieve payback by this year.

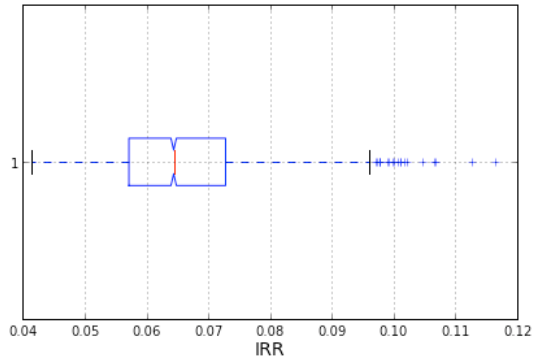
The calculations for production follow these numbers, so that, for example, at $4.25/W only about ½ of the total production calculated will be produced by economically viable systems.

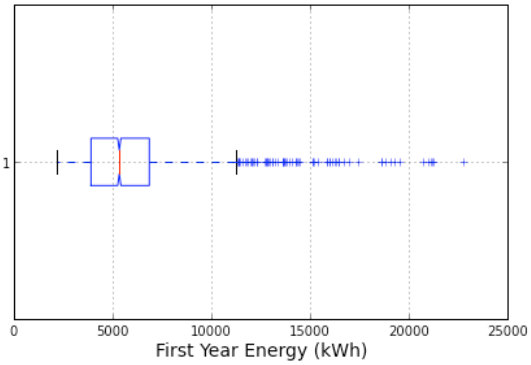
Appendix: Detailed State and County Data

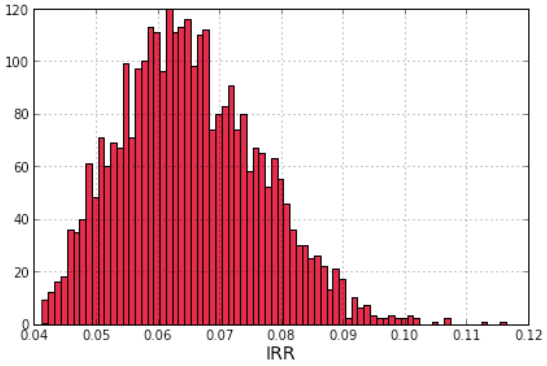
State Wide Statistics

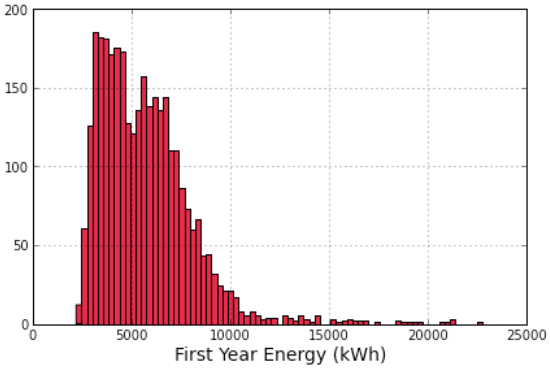


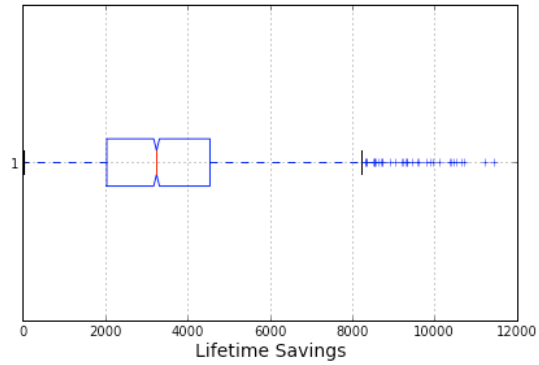
New London County

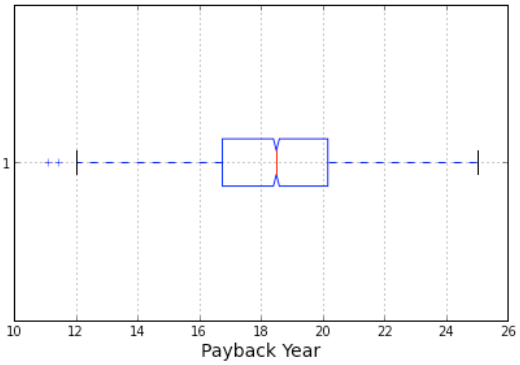


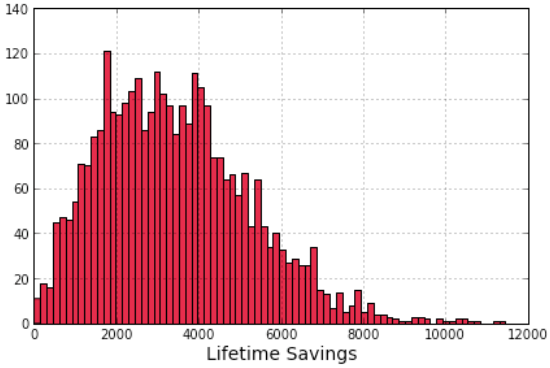


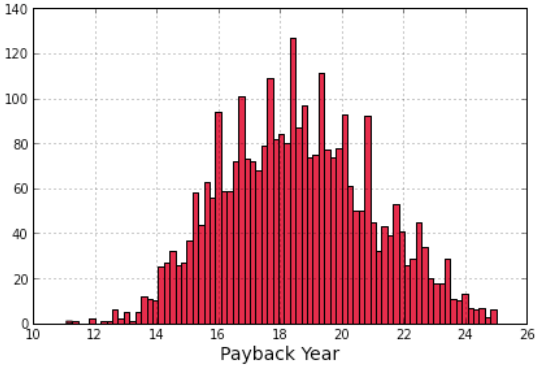




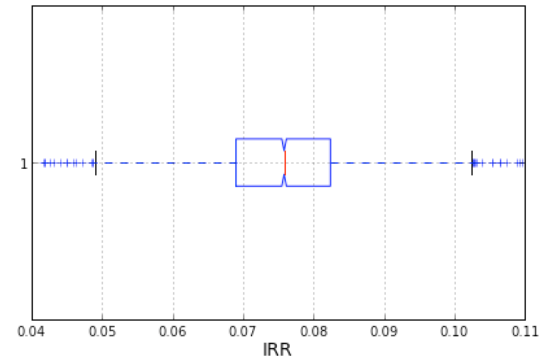


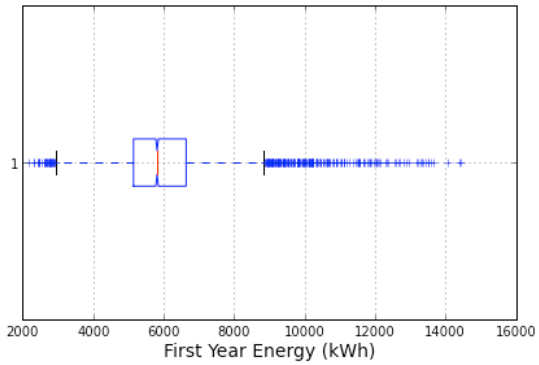


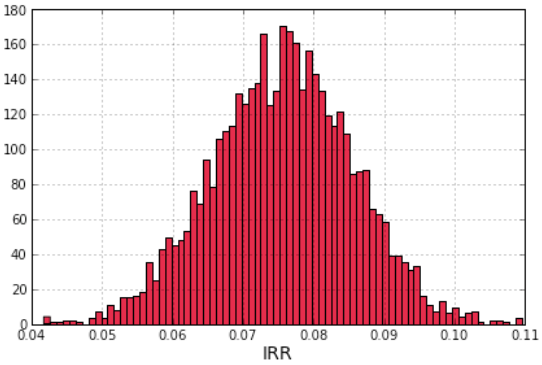


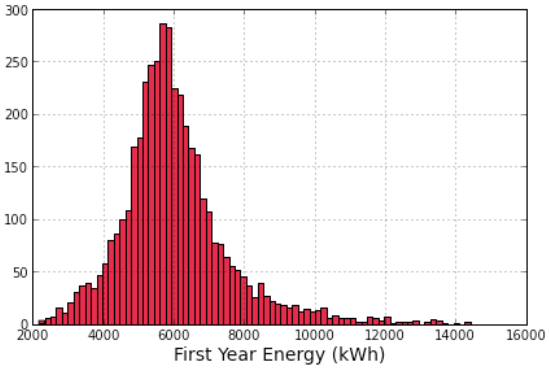


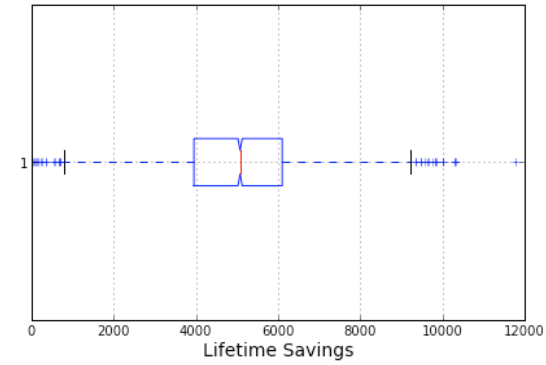
New Haven County

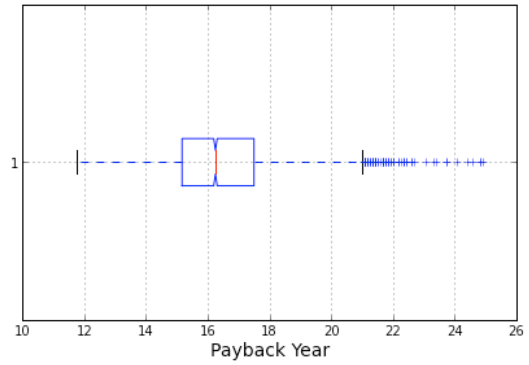


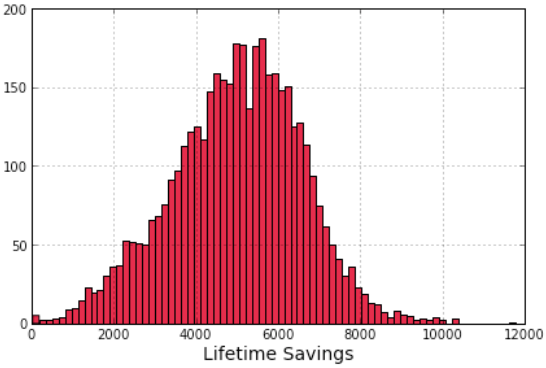


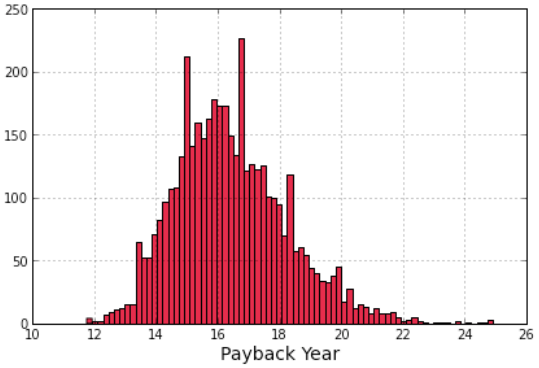




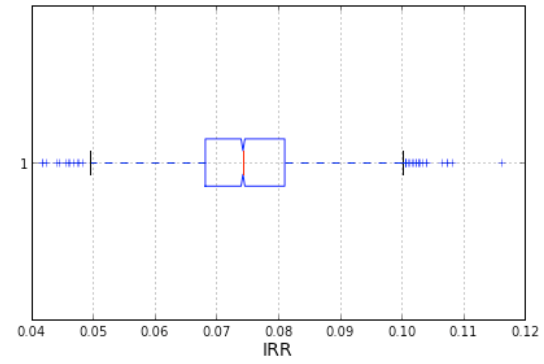


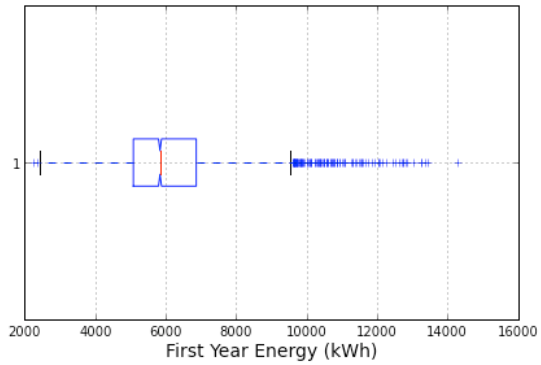


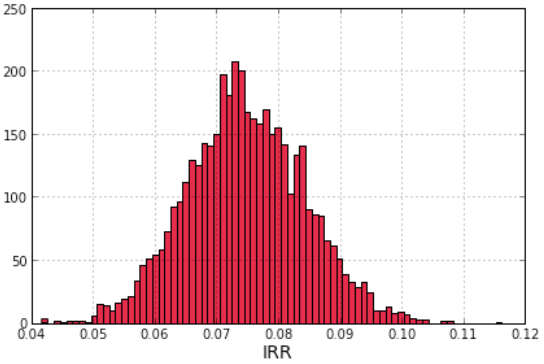


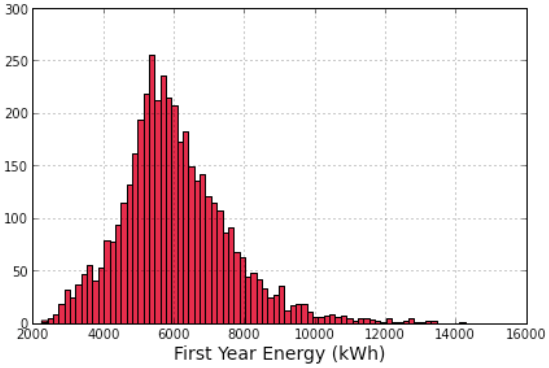


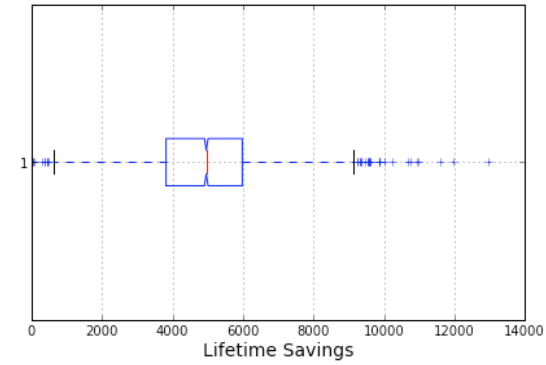
Middlesex County

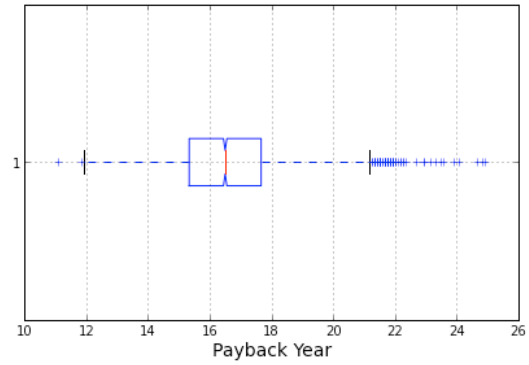


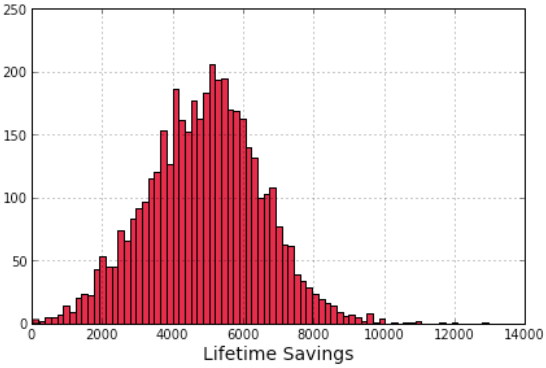


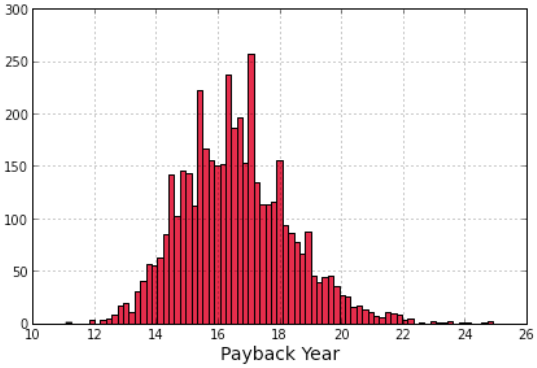




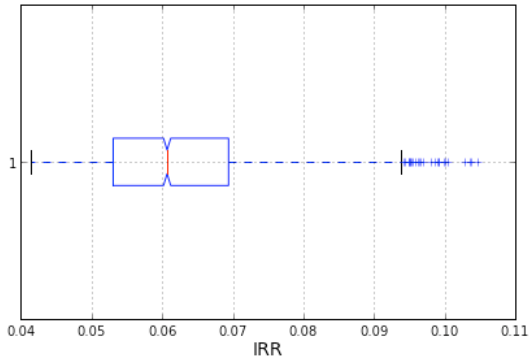


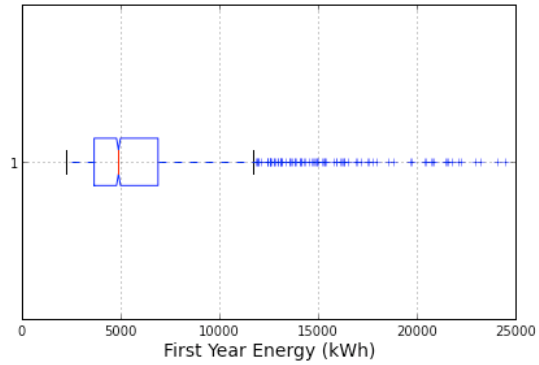


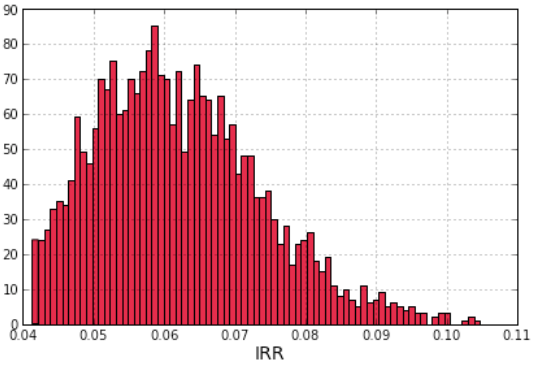


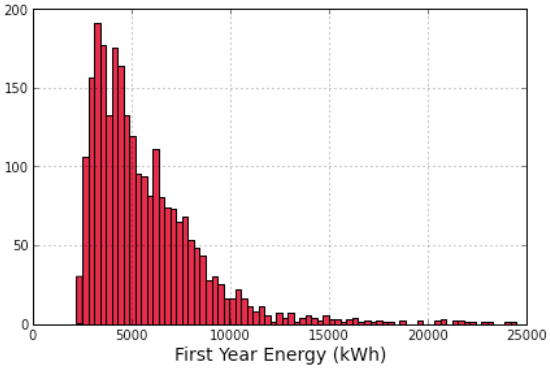


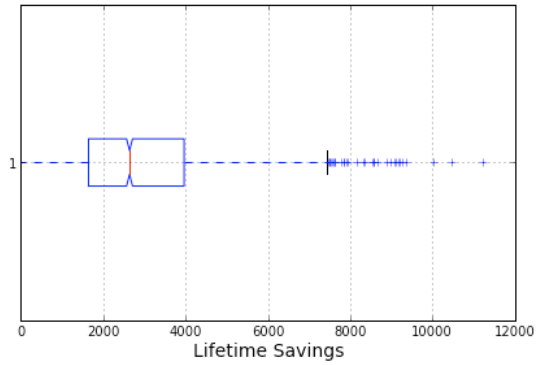
Fairfield County

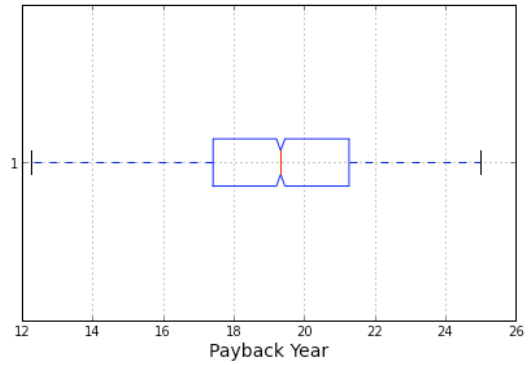


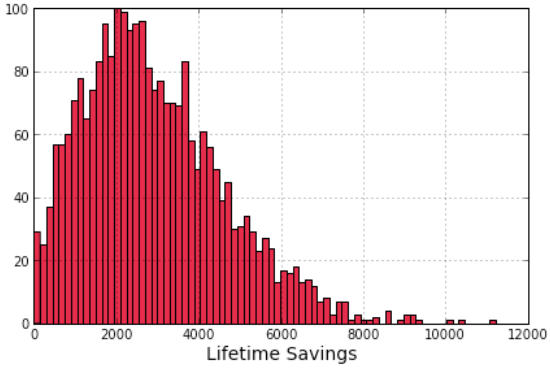


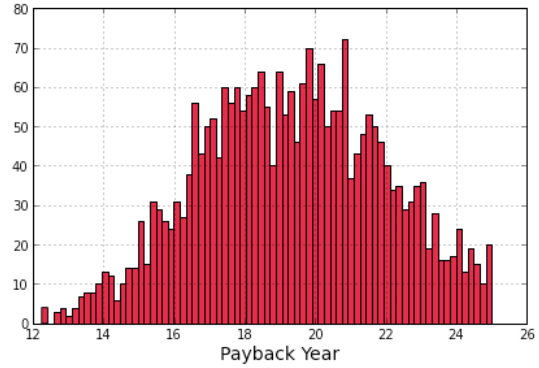




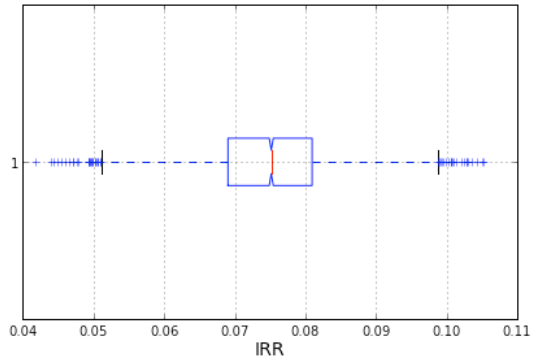


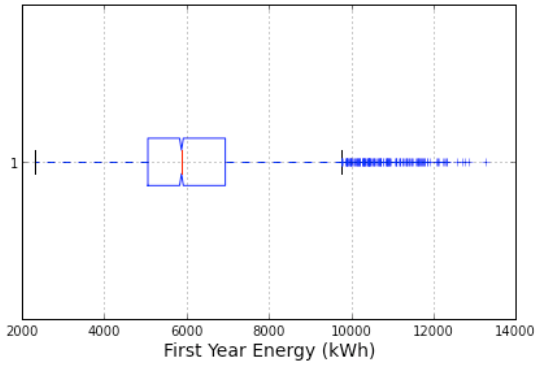


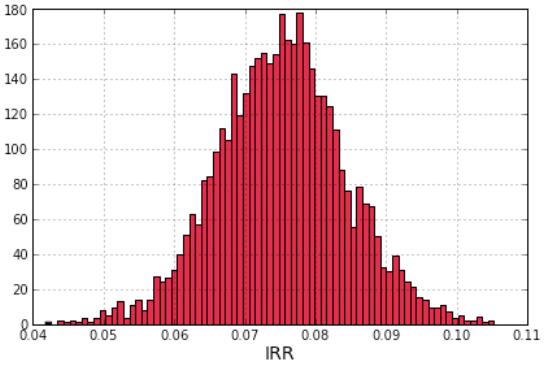


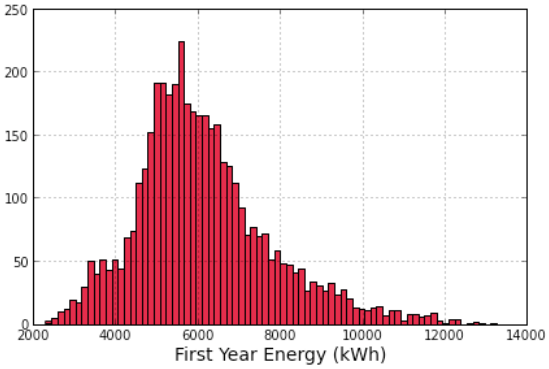


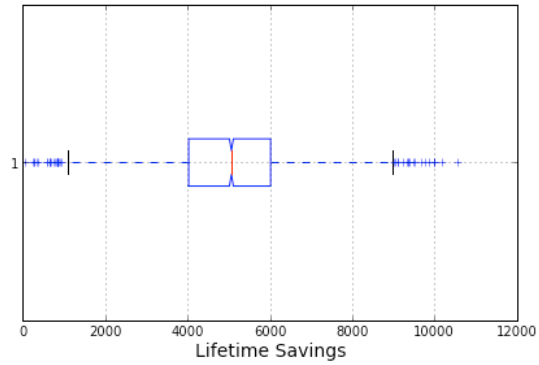
Litchfeild County

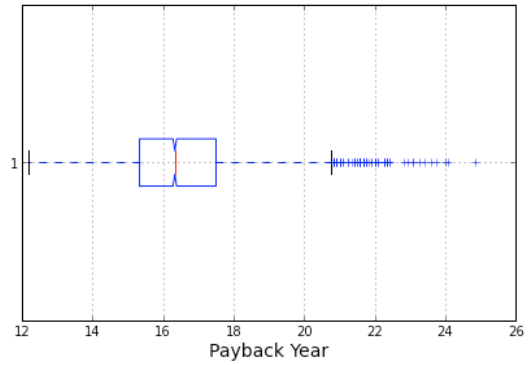


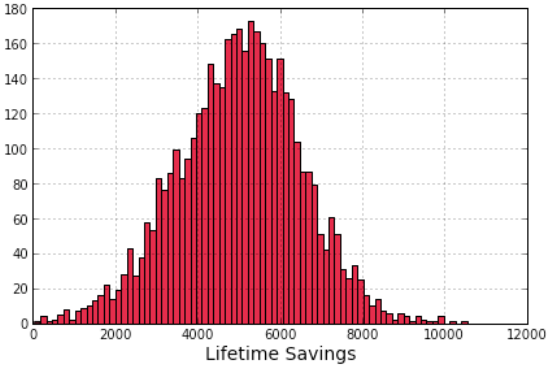


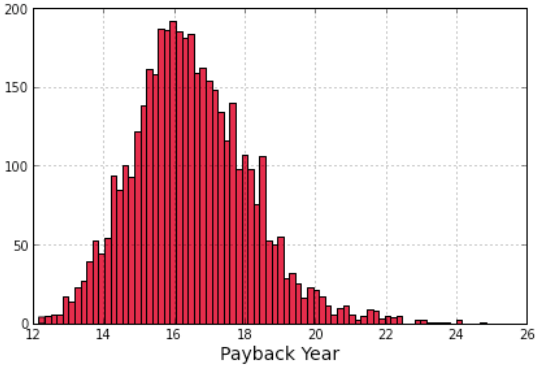




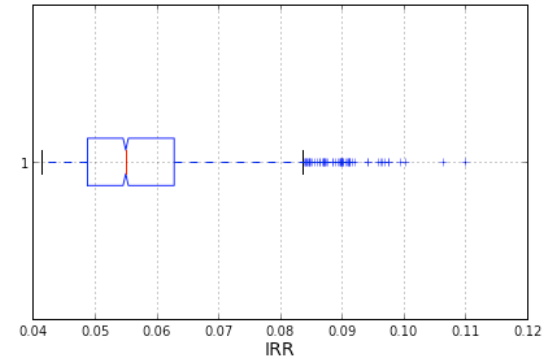


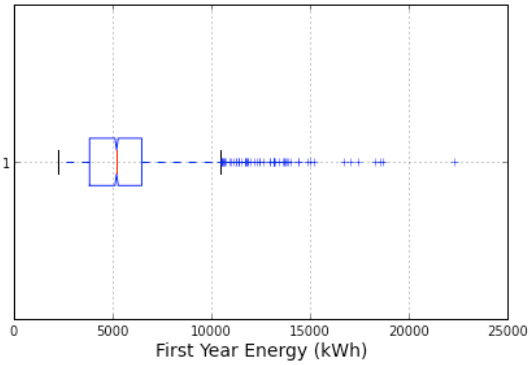


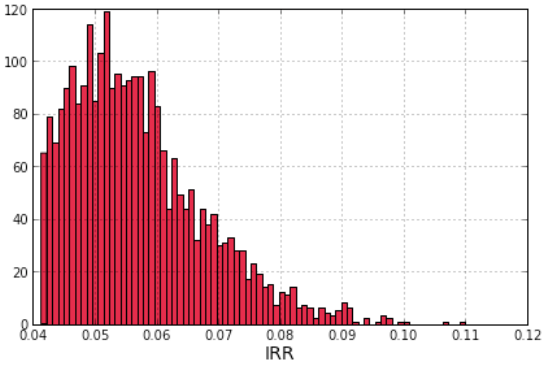


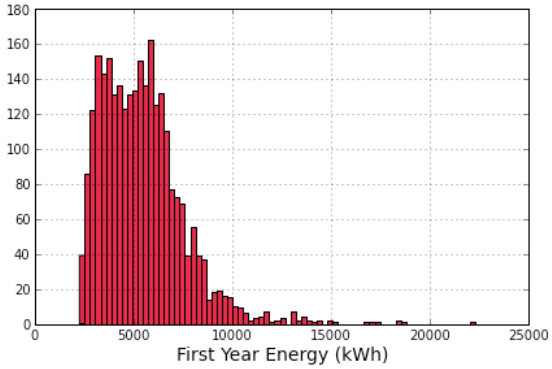


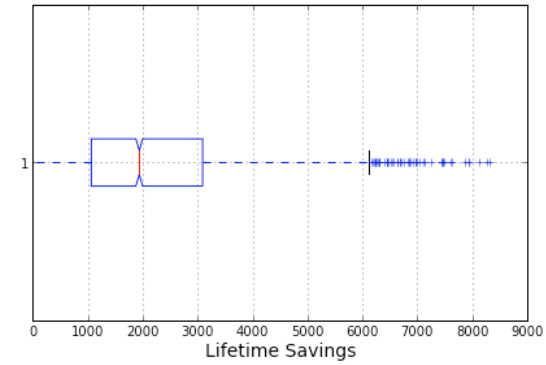
Tolland County

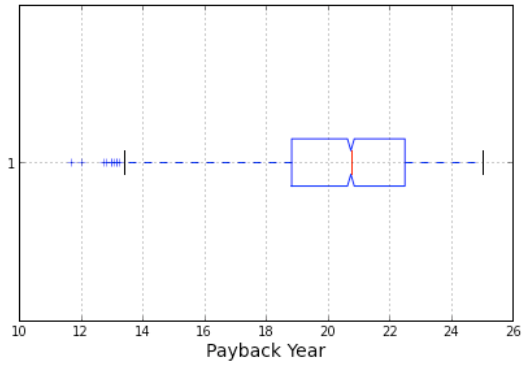


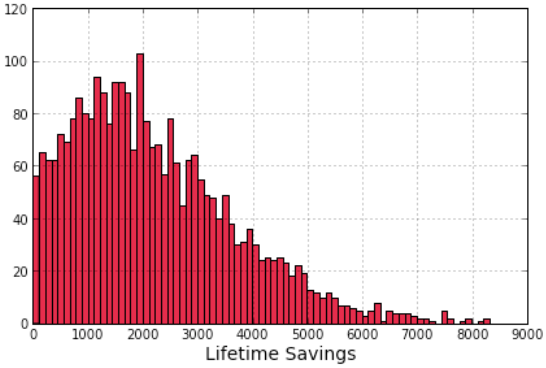


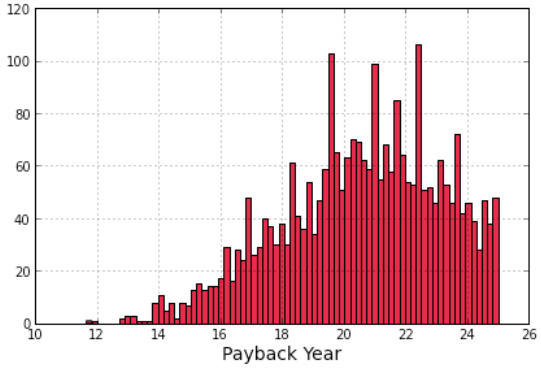




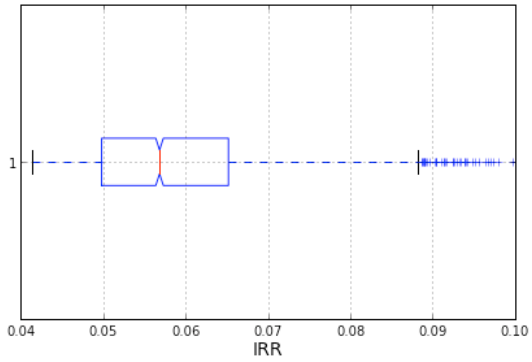


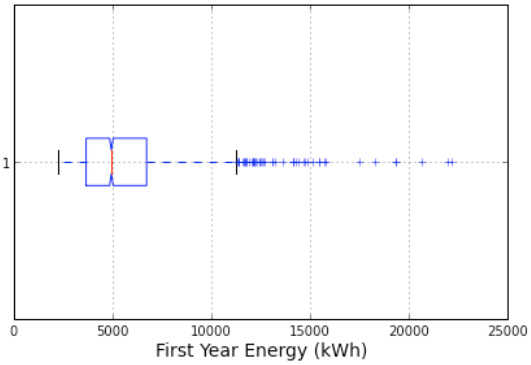


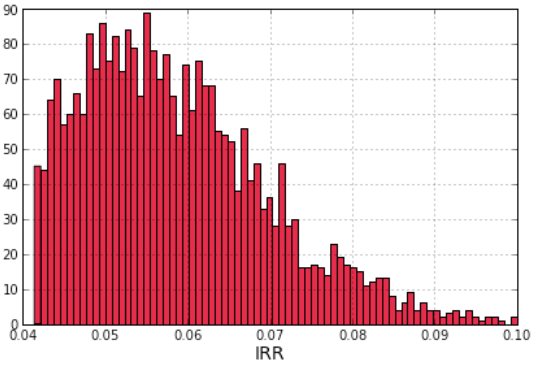


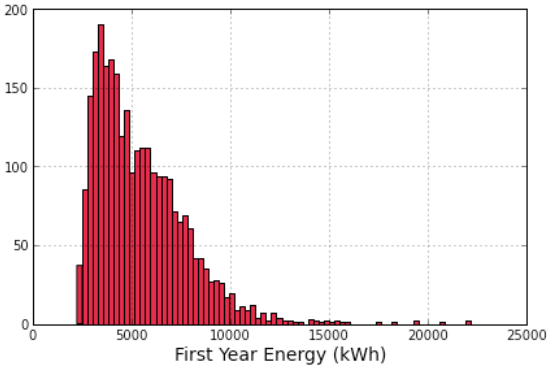


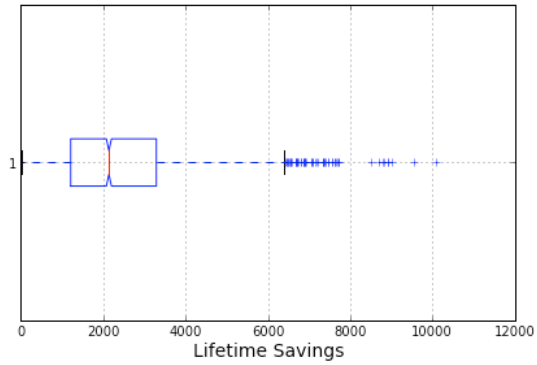
Windham County

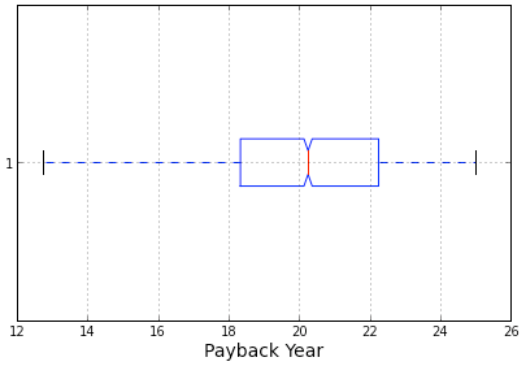


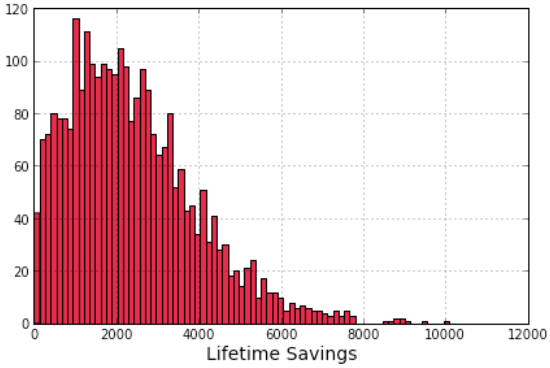


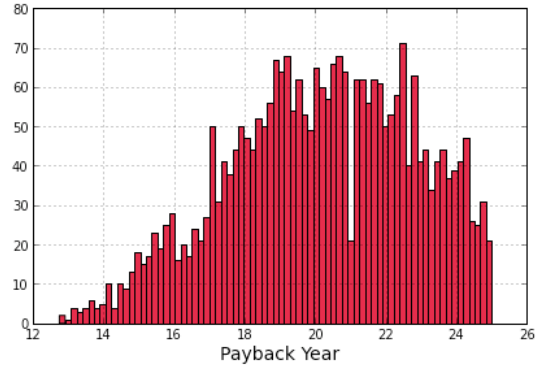












Hartford County