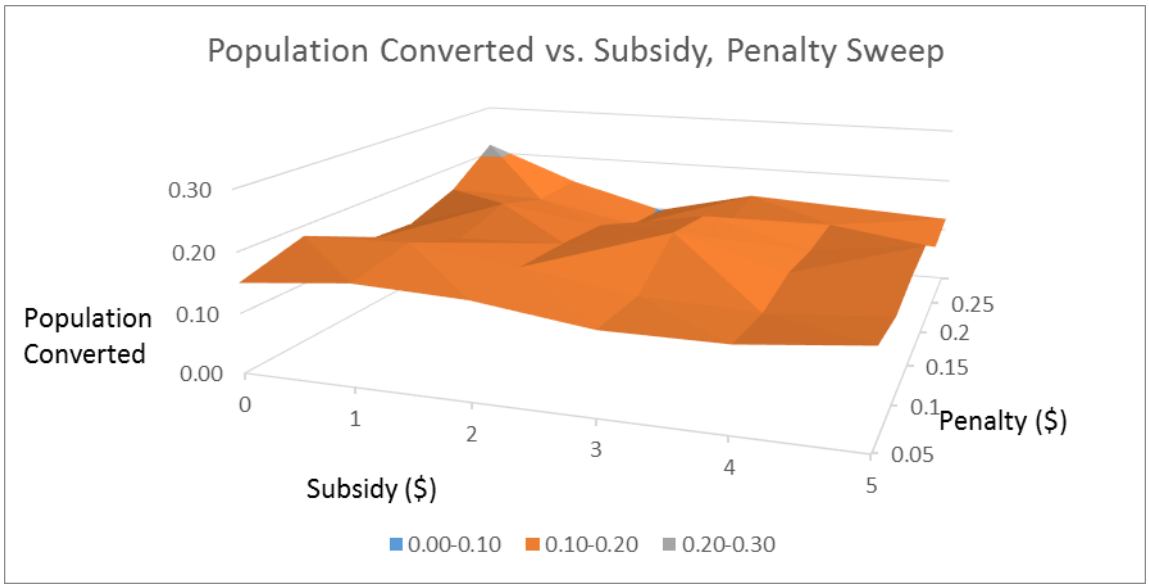
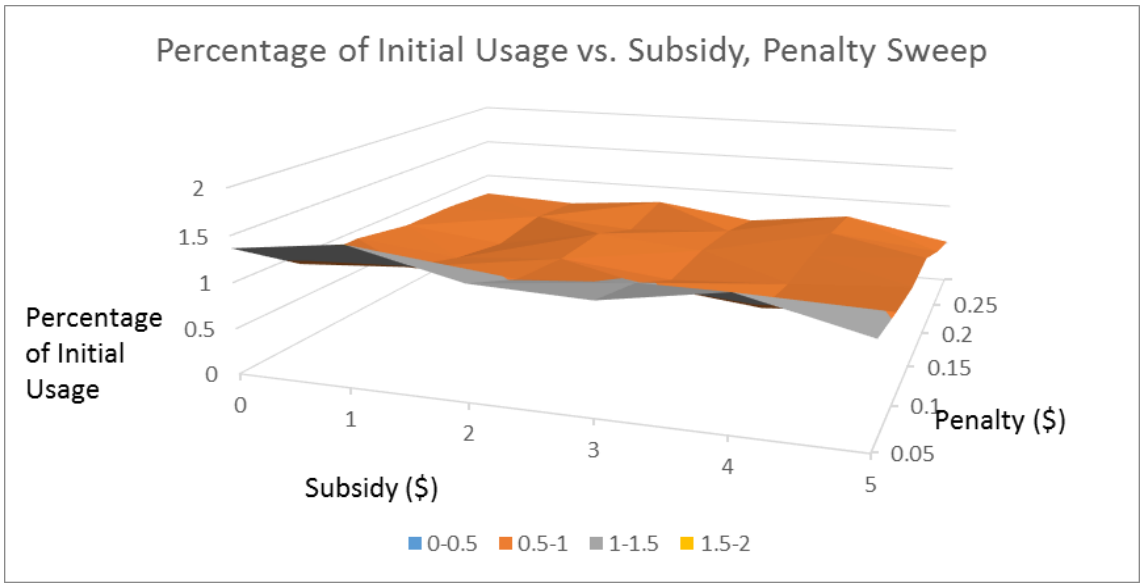
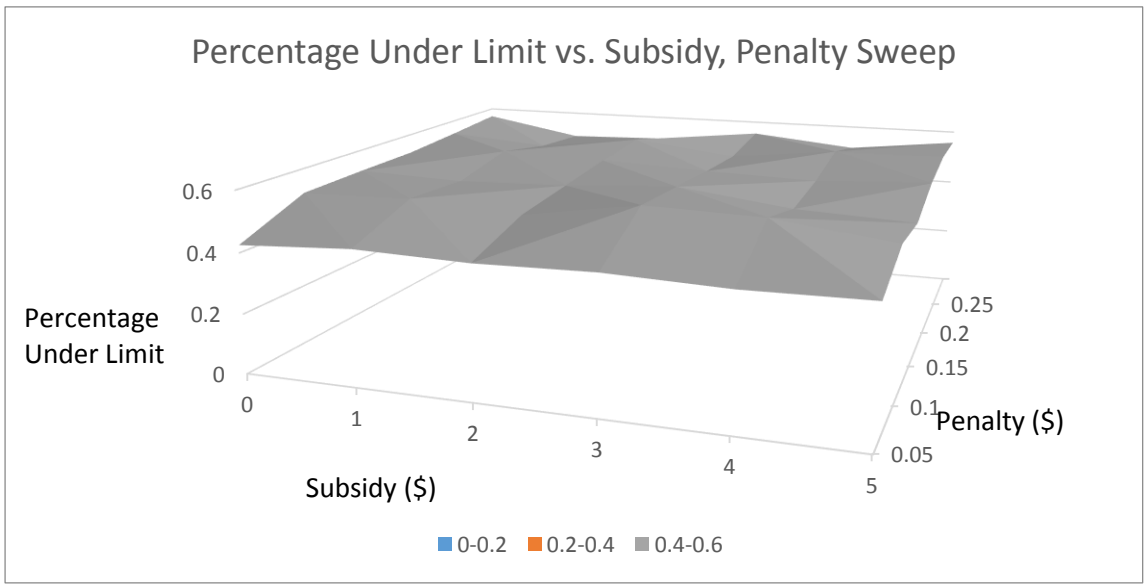
Results

Lawn Subsidy ($)	Penalty ($)	Population Converted	Percentage of Initial Usage	Percentage under Limit
0	0	0.15	1.365211232	0.405
0	0.05	0.18	0.889179014	0.55
0	0.1	0.13	0.899709105	0.48
0	0.15	0.12	0.791512463	0.545
0	0.2	0.15	0.785891288	0.5125
0	0.25	0.22	0.731191135	0.5425
1	0	0.17	1.511524209	0.43
1	0.05	0.19	0.967173711	0.5425
1	0.1	0.15	0.767953486	0.5425
1	0.15	0.18	0.651004281	0.5675
1	0.2	0.15	0.743337756	0.535
1	0.25	0.15	0.674135947	0.545
2	0	0.16	1.227011349	0.4075
2	0.05	0.16	0.948394098	0.555
2	0.1	0.16	0.869181425	0.54
2	0.15	0.15	0.885991554	0.55
2	0.2	0.11	0.65987464	0.5575
2	0.25	0.10	0.78385823	0.515
3	0	0.14	1.18085055	0.4625
3	0.05	0.13	1.02731142	0.5475
3	0.1	0.19	0.732735904	0.545
3	0.15	0.18	0.779499882	0.5325
3	0.2	0.13	0.742566033	0.5425
3	0.25	0.14	0.614845357	0.5575
4	0	0.14	1.384539553	0.3925
4	0.05	0.13	0.883859322	0.595
4	0.1	0.14	0.805329657	0.5225
4	0.15	0.13	0.823901417	0.53
4	0.2	0.14	0.814852511	0.485
4	0.25	0.13	0.767040039	0.5625
5	0	0.16	1.08096071	0.4225
5	0.05	0.14	0.970115295	0.49
5	0.1	0.15	0.886872598	0.5475
5	0.15	0.16	0.90180865	0.5425
5	0.2	0.11	0.681386192	0.54
5	0.25	0.12	0.518505309	0.5875


Population Converted vs. Subsidy, Penalty Sweep
Population Converted
0.30
0.20
0.10
0.00
0
1
2
3
4
5
Subsidy ($)
0.25
0.2
0.15
0.1
0.05
Penalty ($)
0.00-0.10
0.10-0.20
0.20-0.30


Percentage of Initial Usage vs. Subsidy, Penalty Sweep
Percentage of Initial Usage
2
1.5
1
0.5
0
0
1
2
3
4
5
Subsidy ($)
0.25
0.2
0.15
0.1
0.05
Penalty ($)
0-0.5
0.5-1
1-1.5
1.5-2


Percentage Under Limit vs. Subsidy, Penalty Sweep
Percentage Under Limit
0.6
0.4
0.2
0
0
1
2
3
4
5
Subsidy ($)
0.25
0.2
0.15
0.1
0.05
Penalty ($)
0-0.2
0.2-0.4
0.4-0.6

Parameter Sweep

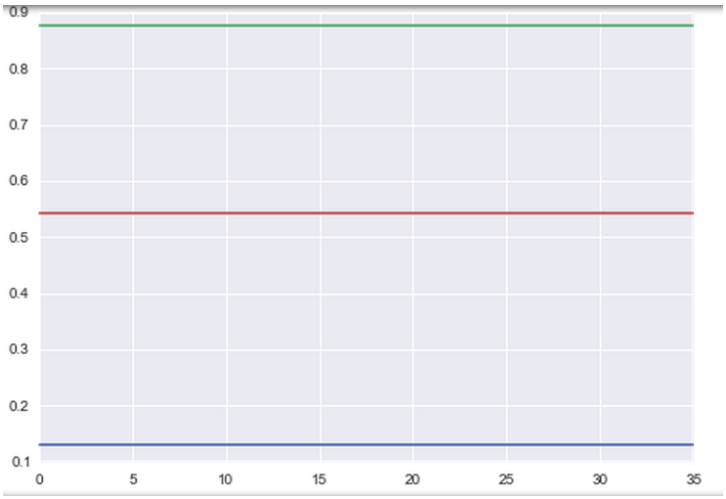
The above graphs show the effects of the parameter sweep on subsidy level and penalty, and the corresponding changes to the state variables. Reasonable subsidy levels of 0 to 5 dollars were put in place (those match LA county high and low prices per square foot), and reasonable penalties of 0-25 cents per gallon above the limit are also swept.

Looking at the population converted, it is somewhat difficult to discern a trend but there are some “hotspots” where the number of converted lawns converted is highest. The max peak is at minimum penalty and max subsidy, and there is a slight trend where the overall area is higher as subsidy approaches 5 dollars per square foot. Another peak is right around the middle of the parameter sweeps, and also at the lowest levels. This suggests that overall higher subsidy leads to more converting, but the “hotspots” at do not necessarily follow this trend as the interaction between the two policies is having an effect. This is an important takeaway for policy makers as these programs are often times set without accord, and various pricing schemes should be thought of more holistically in the future.

When looking at the percentage of initial usage, there is a very clear relationship between penalty and usage. Usage is very high when penalty is at zero, and in some cases goes up. This is because the elasticity issue under minimal penalty actually sees some houses tend to increase usage. This may seem like a problem in the model, but it is actually an interesting result as this is a fairly realistic budget flexibility, and if there is no incentive and no sense of urgency, it is quite possible that households may increase their water consumption over the period. There is slight relationship between lawn subsidy and total reduction, it is in the expected direction as higher subsidy yields lower usage, but this is not a very strong relationship. Here is seems clear that penalties are having a much stronger effect than subsidies.

Looking at the percentage of households who make it over 20% reduction over the period, there is a fairly clear and positive relationship with penalty, but no discernable trend with lawn subsidization. This is likely due to the random nature of conversion that is more correlated with income effects than subsidy.

The important takeaways from the sweeping process are that penalties are seemingly much more effective and reliable than subsidies, as consumer’s budgets are much more inelastic with response to cost addition than cost savings. Income effects also moderate lawn conversion uptake, and this is most likely applicable to other technologies as well.



This graph is supposed to represent the changes in total population percentage under the 20% reduction goal (red), the percentage of initial usage (green), and percentage of lawns converted (blue) as it changes over time. I cannot seem to get my count step right, I can tell that it is indeed changing at each step but am somehow not able to capture this graphically. It is not that important for the understanding as the parameter sweep is more informative, but it would have been nice to be able to see this over time instead of just what it is after 36 months.

The findings of this model are fairly robust and in line with a lot of energy reduction and resource conservation economic thinking. Investigating the carrot and the stick and the interplay between the two, it seems clear that penalty programs have the most predictable results, and that the effectiveness of subsidy programs is often dependent on

myriad factors and enhanced by the presence of penalty systems. Policy takeaways are that these programs should be thought of in conjunction, and as penalties rise, subsidized options for usage reduction become more appealing to consumers. Looking at Los Angeles, carrot and no stick, Santa Monica, the reverse, and the areas in between gives a good picture of Los Angeles County and California as a whole where there are many mixes of programs. It seems clear that Santa Monica is more likely to reach its goal of 20% reduction by 2020, and Los Angeles may have to implement more stringent policies if it hopes to do the same. These lessons are applicable to the broader state and the rest of the arid Southwest.