Summary of the Above Cases (listed on http://egpreston.com)

In all the cases the microgrid has 150 homes. This number of houses was selected to best match the output of a 1.5 MW wind generator. Of course the size of the system could be scaled to any number of houses. The intent is to design each system to be as independent of the larger grid as possible. Each house has two EVs (electric vehicles) with 50 kWh batteries for a range of 100 miles of city driving for each fully charged vehicle. Each home is assumed to annually use about 12500 kWh plus another 12500 kWh for the EVs for a total of 25000 kWh per home annually. The EVs are assumed to be bi-directional power sources, being able to both receive power from the microgrid and deliver power to the microgrid in all cases. The microgrid consists of an undergound distribution system connecting the houses as well as the power sources local to the microgrid. All the costs for the distribution system, metering, etc that are the same for each of the above cases are not included in these calculations. The purpose of this analysis is to simply compare the cost and reliability of different types of power sources. Here are the findings:

Case 1 has 10 kW of rooftop solar fixed panels at each house and a 1.5 MW wind generator for the whole neighborhood. The up front cost of the solar and wind per household is $90,000. This system will suffer occasional power deficiencies if operated as a standalone system. The interconnection costs for backup power from a larger grid were not estimated.

Case 2 replaces the rooftop solar panels with a centralized tracking solar system of size 750 kW. This saves each homeowner about $45,000 in up front costs and raises the question – why are we installing rooftop solar when the centralized solar system is so much more cost effective? This system suffers the same problem as case 1 in that there will be occasional power deficiencies.

Case 3 looks at three ways to improve the reliability. #1 adds more battery storage and more renewable capacity to charge up those batteries and costs $100,000 more per household. However, this is still not a completely reliable system. #2 connects all microgrids in the US together with a massive investment in new transmission lines to gain reliability. The cost and environmental impacts are found to be impractical and the time to get approval and construct all the lines could take many years. #3 looks at installing backup generation at the microgrid instead of interconnecting. This is equivalent to firing up a put-put generator when solar and wind fail to produce enough power. The types of fuels discussed are oil, gas, coal, and nuclear. All of them are reliable, except they are deviations from our desire to be dependent only on 100% renewable power.

Case 4 looks at the cost of CCS carbon capture and sequestration and finds that it adds about 16 cents per kWh to the cost of coal generation, making coal unattractive as a base loaded source of power. Case 4 also shows that a 1 MW coal plant beside our subdivision eliminates the need for any solar or wind power at all and it would be the lowest cost if not for the CCS cost. With CCS coal looks no more economical than our 100% renewable plans, although the 100% coal is quite a bit more reliable than the 100% renewable plan, because the coal generator can run 24/7.

Case 5 looks at adding a small 300 kW nuclear plant beside the subdivision. It is air cooled and fits in a single homeowner lot. It silently runs for 30 years on a single fuel load and requires little maintenance. The wind generator is eliminated and the central solar is retained. The system is reliable. The EV batteries are lightly used, allowing them to last longer. No new transmission lines are needed. This plan has a $45,000 up front cost to each homeowner.