Designing a Rooftop Solar + Wind + Electric Vehicle 100% Renewables Microgrid.

Let's consider a 100% renewables microgrid power system consisting of:

1) a single 1.5 MW wind generator located near a residential subdivision,
2) 10 kW of solar fixed rooftop panels on each home,
3) two EVs at each home with 50 kWh battery storage in each EV,
4) each home will use 25,000 kWh annually for electrical home use + transportation.

The wind generator costs about \$2/watt or \$3 million. The wind generator will be able to supply about 4000 MWh annually if the capacity factor is about 30%, which is typical. This microgrid might be able to operate independently from the larger grid if their location has enough wind and sunshine, such as Midland, Texas. Most customers will need to get their wind power from remote and windy locations that can produce energy at the lowest \$/kWh cost.

The rooftop solar panels cost \$7/watt or \$70,000 per house and produce an amount of energy of (10 kW)(.77 DC-AC converter eff)(.15 annual capacity factor)(8760 hours/yr) = about 10,000 kWh. The .77 is my EE friend's new 4.4 kW system which produces 3.4 kW AC power.

The remainder of the energy must come from the wind generator, which is 15,000 kWh per home. In order to have some reserve, we should double the wind available energy as a part of the microgrid interconnection in which our renewables must also serve others so that we can draw power from other microgrids. Therefore, for estimating how many homes the 1.5 MW wind generator can serve, let's be conservative and assume that each home will need 30,000 kWh wind (double the 15,000). This means that our microgrid can serve a total of 4,000,000 kWh wind/30,000 kWh per home = 133 homes. Let's round it off to 150 homes. The wind generator cost per home is therefore \$3e6/150 = \$20,000 which seems reasonable.

Each home will have two EVs in which most of the time one EV is active in driving locally and the other one remains parked in the garage most of the time. Each EV contains a 50 kWh battery, which has a range of about 100 miles for city driving. Each EV charges at 220 or 240 VAC with a 10 kW load or 45 amps and can get a full charge in less than 5 hours and are charging when possible. These EVs are likely to cost about \$40,000 each because of the large battery storage capacity and the battery cost of \$10,000 for the electronics plus (0.4)(50,000) for the batteries = \$30,000 total and then another \$10,000 for the rest of the car.

The EVs are critical to storing energy for times when there is no wind and no solar, especially for an independent standalone microgrid system. The homeowner will need to be aware at all times of the charge state of the batteries and plan their daily activities around the power that is available from their batteries, their microgrid, and what's available from the larger grid (if any).

The total homeowner cost of this system is \$70k solar + \$20k wind = \$90,000 which should be affordable to most homeowners. The annual cost financed at 6% annual interest rate for 25 years is A = (90)(.06)(1.06^25)/(1.06^25-1) = \$7040. The levelized energy cost is 704000 cents/yr / 25000 kWh = 28 cents per kWh just for the wind and solar renewable power investment cost.

The 1500 MW wind generator is sized appropriately to simultaneously charge 150 EVs. The solar panel at each house is also sized appropriately to charge one EV at the house. A EV could supply 1 kW power for up to 50 hours for backup power when there is no solar or wind.