Renewable electrical self-sufficiency on islands

There are 17 million people in Europe living on 2500 small islands. Islands are interesting cases to try and meet the electricity consumption entirely from locally available renewable sources.

Consider the case of an island with 2000 inhabitants and year-round average electrical needs of 350 W_{el} / person. We will cover electricity needs by a wind turbine, or a tidal turbine, or a wave power generator.

Data:

The *average* annual wind speed is 6 m/s (on land and sea). The wind turbine's *rated* wind speed is twice the *average* wind speed. The annual electricity generated from a wind turbine corresponds to the turbine running at its *rated* power for an equivalent annual load of 2500 h.

The wind turbine's rated power coefficient C_p is assumed to be 35% and constant over the wind speed operating range, that of the tidal turbine 30%.

The average spring tide peak current is 1.6 m/s, the average neap tide peak current 1.1 m/s; the average *actual* power generated by the tidal turbine is 39% of the average *peak* power generated at these peak tidal currents (cf. derivation in the course slides). The tidal turbine is assumed to operate year-round.

The efficiency of the wave power generator is taken as 70%. The typical amplitude of the waves out at sea around the considered island is 1.4 m. The wave power generator's equivalent annual load for these conditions is taken as 50%.

Questions:

a) Dimension the 3 devices such that <u>each</u> of them (1 wind turbine, 1 tidal turbine, 1 wave power generator) could theoretically supply <u>on its own</u> the total electricity need for the island's inhabitants, on a yearly average basis.

b) What has to be taken further into account, for each of the choices (wind turbine, tidal turbine, wave power generator), to address this case more realistically, i.e. where are the limitations / oversimplified assumptions in each case?