Designing a DC Micro grid with renewable energy on the Andaman Islands

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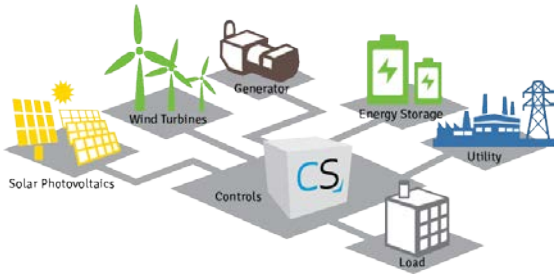
The world today stands at a cross roads when it comes to energy and electrical grids. A large part of the world's population still lacks access to reliable working electricity 24 hours a day. Much of this is in remote and poor parts of the world. In the 20th century, large centralized AC grids have been the norm to provide people with electricity. But for remote parts of the world including island communities this have been problematic, because of the difficulty and high cost of extending the main AC grid to them. With the introduction of large amounts of renewable energy into our grids in combination with the increasing use of DC appliances inside our homes, the idea of using DC instead of AC as the main way for transmission and distribution in the form of isolated microgrids has gained traction. To test this a DC based micro grid with solar PV have been modelled on a remote island called Rutland Island, part of the Andaman Islands in India.

The method used was to dimension two different microgrid designs based on two different scenarios. The first one was a design A, dimensioned after the current electrical consumption of the island community at Rutland Island. The second one was design B, dimensioned after the average per capita Indian electrical consumption.

The two designs had similar components with the big factors being cables, DC/DC converters, batteries and short circuit breakers. The main difference being that A used lead-acid batteries and B used lithium-ion batteries. Comparing them the factors looked at was efficiency, losses, short circuit currents and cost. Design A was smaller and had 1/3 of the solar PV than design B but both had similar battery energy storage size.

The layout at Rutland was such that a large part of the Island is currently uninhabited with a few main settlements. So in this stage of the project only 26 houses was included with all of them having the same load, based on how a normal household consumes electricity. The grid used a 2-phase design with one battery controlling each phase at 350V.



The conclusion of the study was that for a DC microgrid of this size, cables are an important aspect if you look at the losses. For safety, accurate breakers are needed because of the high short circuit currents that can arise in direct current transmission.

When including costs, DC/DC converters and batteries was concluded to be the most important components, especially if aiming for the future design with Lithium-ion batteries instead of Lead-acid. Both components are still expensive, but with their increasing use, especially Lithium-ion batteries in the car industry, prices should come down. For the grid on Rutland Island the study recommended to aim for the future and use a larger grid design with Lithium-ion batteries.