











performance. On the other hand, the original blade has higher mechanical and electric motor losses, and its actual generated output is less than that of the improved blade although the low speed shaft power of the former is greater than that of the latter.

## CONCLUSION

In general, the aerodynamic performance of the improved blade is inferior to that of the original blade; however, it has great potential for improvement in the following aspects:

- (1) Improvement in optimization algorithm. Harp\_opt optimizes the curve segments of steady state power; however, because the working condition of blade with small tip speed ratio accounts for low weight, optimization results will not seek in the direction of higher  $C_p$ ;
- (2) Limited by technological conditions, it needs to adjust geometrical shape, and separately optimize the twist and chord length of blades and other parameters;
- (3) Airfoil selection. New blades select DU93-W-210 airfoil. However, it is hard to make high  $C_p$  of small tip speed ratio using the airfoil, so it considers to use NACA21 airfoil for improved design.

## CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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