MEMO

Subject: Levelized Cost of Energy of variant 8.2 for Hollandse Kust (west)
Date: 1 November 2018

Introduction

BLIX Consultancy & partners recently performed a study to investigate the Levelized Cost of Energy (LCoE) of different variants for the wind farm site boundaries of the roadmap 2030 areas. For wind farm zone Hollandse Kust (west) (HKW), variant 8 is currently under consideration by the working group. On the 25th of October, RVO requested BLIX to perform an additional LCoE calculation for variant 8, with an adapted location of the TenneT platform for the northern wind farm site. This memo describes the results.

Wind farm layouts

Figures 1 and 2 show the original wind farm layout of variant 8 (left) and the modified variant (defined as variant 8.2 - right). In variant 8.2, the substation is located more towards the south, at the new location defined by TenneT. This requirement causes the following changes for the wind farm layout:

1. A new export cable corridor is defined near the new substation location in the south. Three turbines are moved from the new export corridor to the previous export corridor area in the north.
2. The infield cable length and number of crossings increase as a result of the new configuration.

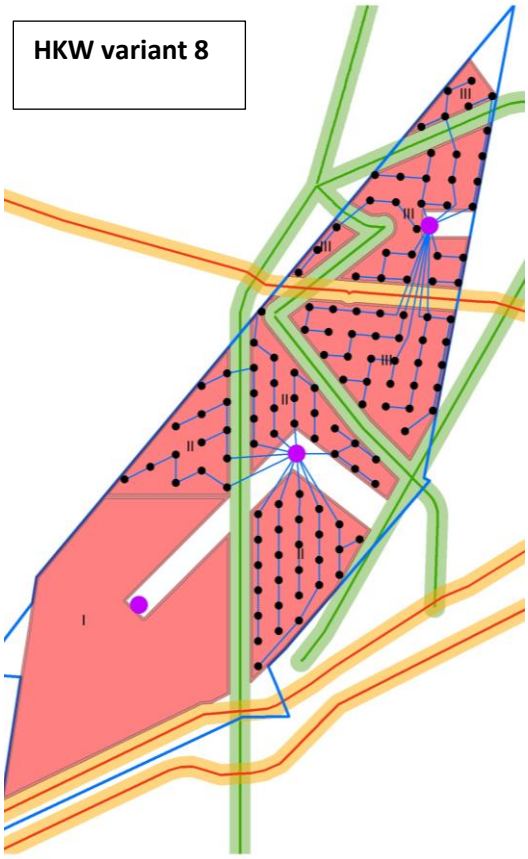

Figure 1: wind farm layout of variant 8

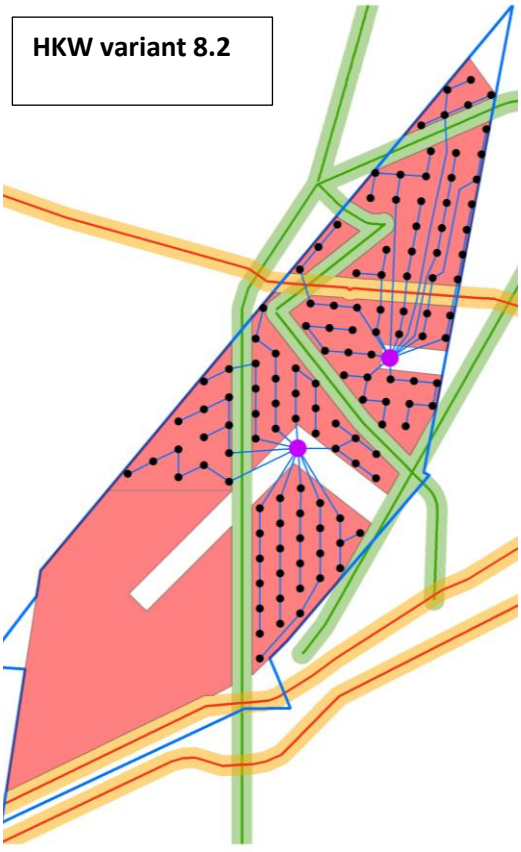

Figure 2: wind farm layout of variant 8.2

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Yield

The results of the yield calculations are shown in Table 1. The following can be observed:

- The wind farm density and spacing of both variants are equal
- The wake effects of variant 8.2 are comparable with the wake effects of variant 8 (0.1% difference)
- The infield cable length of variant 8.2 is slightly longer (203km instead of 195km)
- Variant 8.2 will require two more cable crossings

Table 1: Wind farm layout and yield characteristics of Hollandse Kust (west) variant 8 and variant 8.2

Variant	HKW ref	HKW var 8	HKW var 8.2
Number of turbines [-]	126	126	126
Minimal turbine spacing [x D]	7D	6.5D	6.5D
Density [MW/km^2]	6.2	8.8	8.8
Mean wind speed at hub height [m/s]	10.2	10.2	10.2
Gross annual yield [GWh/y]	8,132	8,133	8,130
Wake effects [%]	8.2	11.1	11.0
Net annual yield [GWh/y]	6,879	6,677	6,678
Net annual yield per WTG [GWh/y]	54.6	53.0	53.0
Total infield cable length (km)	239	195	203
Total crossings	18	11	13
Average foundation depth [m]	26.7	26.5	26.5

Costs

The resulting LCoE is shown in Table 2. This table shows the differences relative to the reference alternative.

Table 2: LCoE of Hollandse Kust (west) variant 8 and variant 8.2

Wind farm zone	HKW ref	HKW var 8	HKW var 8.2
Site description	*Reference lay-out*	Var 4 whereas area on south is excluded	Var 8 with modified substation
Capacity (MW)	*1,512*	1,512	1,512
Wake Losses		36.02%	35.2%
LCoE impact wake losses		**3.33%**	**3.25%**
IAC cable length		-18.53%	-15.31%
LCOE impact cable losses		**-0.29%**	**-0.28%**
IAC cable length		-18.53%	-15.31%
Number of crossings		-38.89%	-27.78%
LCoE impact array cable costs		**-0.34%**	**-0.28%**
Average water depth		-1.03%	-0.99%
Foundation costs		-0.25%	-0.24%
LCoE impact foundation costs		**-0.05%**	**-0.05%**
Net LCoE impact		**2.68%**	**2.71%**

The following conclusions are drawn:

- For variant 8.2, the lower wake effects reduce the LCoE very slightly.
- For variant 8.2, the additional cable length slightly increases the LCoE by higher cable losses and costs for cables.
- For variant 8.2, the larger number of crossings slightly increases the LCoE.
- The net effect of these changes is that the LCoE increases with 0.03% (from 2.68% to 2.71%) compared to variant 8. This is smaller than the uncertainty of the applied approach. Therefore, the difference is considered negligible.

Conclusion

The difference in LCoE of variant 8.2 compared to variant 8 is concluded to be negligible.