

# The wind power injection limitation for Cherry Grove substation

- **Introduction**

Three cases: 2011summer, 2011winter, 2020summer(forecasting data) power flow of the four area surrounding south Carolina power system including Santee cooper, SCE&G, Duke power, and CPLE(figure1) are analyzed for injection limitation, the system violation results are listed; The system operation violation, including voltage violation(above1.05p.u.and below0.95p.u) and the power overrating at the transmission lines(above95%), which needs to be paid attention due to this amount wind injection are be listed below(comparing with the base power flow case);

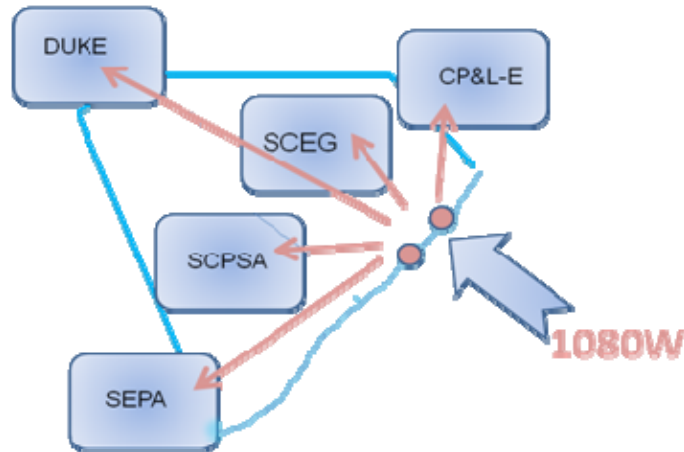


Figure 1 the system analyzed

The Cherry Grove substation which is a distribution switching station has been equalized to the Nixons Crossroads bus in the power flow cases downloaded from [www.scrtp.com](http://www.scrtp.com), the Nixons bus number is 312811in the base cases, so the wind power would be injected into Nixons bus to check the limitation;

- **The wind farm layout in the simulation**

The wind farm is consisted of wind generator, and step up transformers, as well as the submarine cable. GE3.6MW DFIG generator model is chosen, and wind generator has its own step-up transformer with voltage level of 4.16/34.5KV the power reaches to collecting point and then 34.5/115KV step-up transformer is used before the wind farm connected into the South Carolina power system.

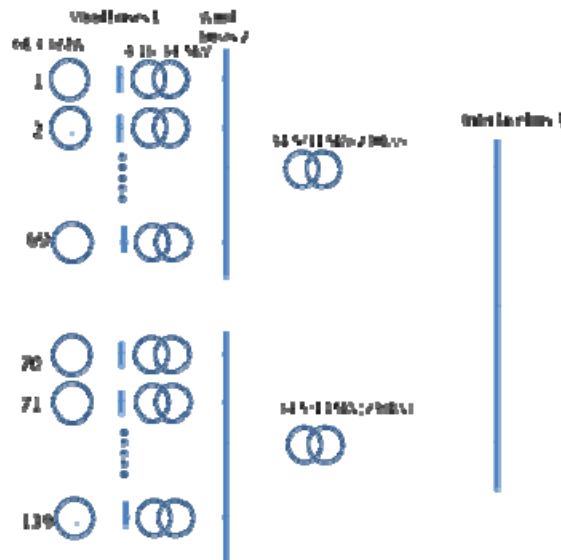


Figure 1 the layout of wind farm in simulation

● **The results analysis**

1. For 2011 summer power flow case,  $93 \times 3.6\text{MW} = 334.8\text{MW}$  is the limitation, the voltage violation (above 1.06 and below 0.94) because of the injection of 334.8MW wind power into the Nixon bus(312811) are listed below:

BUS# X-	- NAME --	X BASKV	AREA	V(PU)	V(KV)
306070	FISHNG C	6.6000	342	1.0722	7.077
306106	8PARKWOD	500.00	342	1.0615	530.74
306107	8PL GRDN	500.00	342	1.0621	531.04
306168	1TIGER	44.000	342	1.0656	46.885
306195	ANDERSON	100.00	342	1.0617	106.17
306337	1PISGAH	44.000	342	1.0621	46.733
306349	1GTFALL2	44.000	342	1.0669	46.943
306363	ANDER 1	1.0000	342	1.0635	1.063
370491	3HARDEE	46.000	343	0.9207	42.350

Table 1 BUSES WITH VOLTAGE GREATER THAN 1.0600 and BUSES WITH VOLTAGE LESS THAN 0.9400

And the power overrating (95%) because of the injection of 334.8MW wind power into the Nixon bus (312811) are listed below, the first transmission line loading will increase from 98.6% to 99.4%, which needs to pay attention to:

FROM BUS#	NAME	BASE KV	AREA #	TO BUS#	NAME -	BASE KV	AREA #	RATING MW	LOADING MW	PERCENT %
311451	1CROSS2	22.000*	344	312710	6CROSS	230.00	344	584.0	580.5	98.6-99.4
311470	13JEFFH6	13.800	344	312789	3JEFF	115.00*	344	11.5	11.1	96.2

Table 2 BRANCH LOADINGS ABOVE 90.0 % OF RATING SET A

2. For 2011 winter power flow, the bus injection can go as far as  $379 \times 3.6\text{MW} = 1364.4\text{MW}$ ;
3. For 2020 summer power flow, the bus injection can go as far as  $379 \times 3.6\text{MW} = 1364.4\text{MW}$ ;
4. Due to the 2011 summer power flow (heavy loaded) restraint, the limitation of injection at bus 312811 Nixon is 334.8MW, beyond that the power flow would blow up.