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Comparison between Deterministic and Probabilistic Methods for Evaluating Grid-Accommodative Wind Power Capacity

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SUMMARY

Large scale integration of wind power brings great challenges to power system planning due to inherent fluctuation and uncertainty. The question of how much wind power can be physically and economically integrated into the power system needs to be answered, and is required as a boundary condition for planning decisions. The index of grid-accommodative wind power capacity (GAWC) is thus proposed to address this problem. It is defined by the maximum amount of wind power capacity that can be integrated into power system, without jeopardizing the reliability and security of power system. Approaches for evaluating GAWC can be categorized into two types: deterministic method and probabilistic method. In deterministic method, GAWC is evaluated by the adequacy of the flexibility of power system and the flexibility requirement needed by each MW of wind power for the worst scenario from the perspective of frequency regulation, peak regulation and spinning reserve. Probabilistic method uses power system operation simulation technique to evaluate year-round wind power accommodation (or curtailment). The probabilistic GAWC is calculated as the maximum capacity of wind power with the wind curtailment less than a certain fraction (e.g. 5%). Comparatively, deterministic GAWC is more widely used by Power Grid Company but with relatively conservative evaluation, while the probabilistic GAWC that fully considers all the possible scenarios of wind power is more credible for practical planning. This paper is oriented to quantify the differences between deterministic GAWC method and probabilistic GAWC method. Both evaluation methods are established in the study. GAWC evaluations for five provincial power systems in China Southern Grid (CSG) are carried out using deterministic method and probabilistic method respectively. From the perspective of system operation, the power system flexibility constrains are modelled, including frequency regulation, peak regulation and reserve constrains. From perspective of generation portfolio, sensitivities to generation flexibility are analysed for both methods. The reasonable wind curtailment ratio for probabilistic GAWC is further discussed.

KEYWORDS

Grid-accommodative wind power capacity (GAWC), probabilistic evaluation, deterministic evaluation, flexibility, wind power

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1. Introduction

With the environmental problem being increasingly serious and fossil fuels drying up, renewable energy is gaining extensive attention and accounting for an increasing percentage of the total electricity generation [1]. In China, for example, the installed wind power has reached 91.4GW by the end of 2013, and is planned to reach 200GW by the end of 2020 [2]. However, the large scale integration of wind power also brings great challenges to power system planning and operation due to the inherent intermittency and uncertainty of wind speed. Extra flexibilities from conventional plant, storage, demand response, and external energy supply will be required to accommodate wind power and guarantee the requested reliability level of power system at the same time [3]. In 2012, over 20 TWh of wind production in China was curtailed, leading to a low utilization efficiency of wind power, because of lacking sufficient flexibility [4]. Therefore, the question of how much wind power can be physically and economically integrated into the power system needs to be answered, and should be further taken as a boundary condition for planning decisions.

Index of grid-accommodative wind power capacity (GWAC) is proposed to denote the maximum amount of wind power capacity that can be integrated into power system without jeopardizing the reliability and security of power system while guaranteeing the revenue of wind power. Given a fixed power system planning and scheduling strategy (unit technical parameters, dispatching objective, etc.), GWAC is essentially determined by the flexibility requirement of wind power and the flexibility supply that the power system can provide. Flexibility requirement is mainly affected by wind power characteristics (wind power generation distribution, diurnal/seasonal pattern, fluctuation characteristic and spatial correlation among wind farms), and load characteristics (peak-valley difference and ramping up/down speed) [5]. From the perspective of flexibility supply, five major types of flexibility are empirically regarded as the main factors determining the GWAC, namely peak-valley regulation capability, frequency regulation capability, load-following capability, spinning reserve capacity and available transmission capacity (ATC) [6].

Approaches for evaluating GAWC can be categorized into two types: deterministic method [7-9] and probabilistic method [10-12]. In this paper, a daily system load profile and a possible wind power generation profile are aggregated and regarded as a possible operation scenario. The system with high penetration of wind power requires generating sufficient various operation scenarios to cover possible operation situations in the future, because of the uncertainty in wind power generation. In deterministic method, some typical (or extreme) operation scenarios are selected and simulated. The deterministic GAWC is evaluated by matching the flexibility supply from power system and flexibility demand required from installed wind power capacity from the perspective of different types of flexibility, e.g. frequency regulation, peak regulation and spinning reserve. In probabilistic method, all the possible operation scenarios are simulated to evaluate wind power accommodation (or curtailment). The probabilistic GAWC is calculated as the maximum capacity of wind power with the wind curtailment less than a certain fraction (e.g. 5%). Comparatively, deterministic GAWC is more widely used by Power Grid Company, however, while the result is relatively conservative. It is suggested that the probabilistic method that fully considers all the possible operation scenarios of wind power and status of power system should be employed in practical planning.

China Southern Grid (CSG) is one of the most complicated power systems in the world. It is composed of five distinctive provincial power systems, namely Guangdong (GD), Guangxi (GX), Yunnan (YN), Guizhou (GZ) and Hainan (HN). In GD provincial power system, current generation mix is flexible and diverse, including conventional thermal units, nuclear plants, gas turbine, hydro power delivered from YN province, pump storage and renewable energy. However, the difference between the peak and off-peak load is very large in summer and causes severe ramping and minimum-load problem for generation units. This challenge is empirically identified to be the weakness in accommodating the planned wind power capacity. Hydro power dominates the generation mix in YN and GX provincial power system. The challenge would be more severe in flood season because of the lack of flexibility that can be provided by hydro plants with heavy water inflow. In GZ provincial power system, coal-fired plants represent a major proportion of the current generation mix and are responsible for peak load regulation and ramping. According to the planning scheme of CSG by 2020, the maximum load consumption is forecasted to reach 235.6 GW, while the total installed power generation capacity and wind power capacity are planned to be 408.8 GW and 44GW respectively. It will be of great importance to evaluating whether the planned wind power capacity can be physically and economically integrated into the power system and identifying the GAWC for each provincial power system.

This paper is oriented to quantify the differences between deterministic GWAC evaluation method and probabilistic GAWC evaluation method. Both evaluation methods are established based on a chronological production simulation platform named GOPT [13]. According to the planning scheme announced by CSG Company, the quantifying amount of GAWC for each provincial power system in CSG is evaluated using both deterministic and probabilistic methods respectively. Considering the distinguishing characteristics among these five provincial power systems, sensitivity of GAWC to generation flexibility from the perspective of generation portfolio is analysed and discussed through comparing their GAWC evaluation results. Moreover, the reasonable wind curtailment ratio for probabilistic GAWC is further discussed.

Section II briefly describes the simulation platform GOPT used for the GAWC evaluation. Section III introduces the deterministic and probabilistic GAWC evaluation frameworks respectively. Section IV outlines the particulars of the planning scheme of CSG by 2020, including the load forecasts, generation mix, wind power data and the tie-line planning for exchanging power. Section V presents the GAWC evaluation results and the sensitivity analysis. Section VI concludes the paper.

2. Assessment Tool: Chronological Production Simulation Platform GOPT

2.1 Overall Framework

The assessment tool used in this paper is part of a power system planning, decision-making and evaluation software package named "GOPT". This software package is designed to chronologically simulate the operation of a power system on a daily basis with hourly resolution. The core of this simulation platform is a daily dispatching simulation model that accommodates various types of units. Fig. 1 illustrates the structure of this simulation platform. Unit maintenance module performs the long term generation maintenance scheduling using classical equal targeted risk criterion. Wind farms operation simulation module reconstructs chronological generation sequence of wind power through modelling the spatial and temporal stochastic characteristics of multiple wind farm generations. The maintenance scheduling and simulated wind power output are used as a boundary condition of daily dispatching simulation module. Utilizing a security constrained UC-ED model, the module schedules the daily operation of all units to minimize the operating cost while considering various constraints. If performed over a long period of time, this day-by-day simulation will cover a sufficient number of scenarios to consider the intermittent and stochastic nature of wind power and provide sufficient statistical data on operational activities.

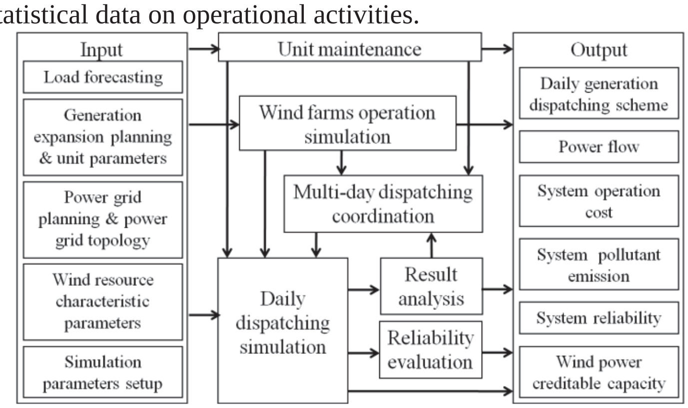

Fig.1 Framework of the power system chronological production simulation platform

Applying this chronological production simulation platform to evaluate the GAWC of a power system has two advantages. 1) Sufficient operation scenarios of wind farms can be generated from the wind farms operation simulation module to represent the uncertainty and intermittency of wind power and overcome the barrier of lacking wind farm generation data. 2) Daily dispatching simulation module carries out a realistic simulation of system operation by incorporating a UCED model, and thus can consider all the types of flexibility constraint simultaneously and provide more comprehensive results, e.g. the amount of curtailed wind power. The following paragraphs briefly describe both modules.

2.2 Wind Farms Operation Simulation

This module produces simulated chronological outputs for multiple wind farms using stochastic differential equation as proposed in [14]. From the perspective of wind speed simulation, the probability distribution of wind speed is assumed to follow two-parameter Weibull function. Based on the statistical results of historical data, spatial and temporal correlations among different wind farm generations are identified and modelled. Then stochastic differential equation is applied to generate stochastic wind speed sequence considering the seasonal and diurnal patterns. The simulated wind speeds are converted to wind power outputs using a typical piecewise cubic function to represent wind turbine output characteristics. The reliability of wind turbines and the wake effect in the wind farms are also taken into account.

2.3 Daily Dispatching Simulation

This key part of the simulation platform determines the daily dispatch for each unit using a security constrained UCED model. The objective is to minimize the total system operating cost, including the fuel, start-stop and load shedding cost as well as the penalties for wind curtailment and water spillage. The operation constraints include load-generation balance equation, reserve constraints, limits of daily energy production of hydro and pumped storage units, limits of the output of each generator and wind power curtailment, generation ramp rate limits and transmission lines constraints.

3. Grid-Accommodative Wind Power Capacity Evaluation Framework

3.1 GAWC evaluation framework

The structures of both deterministic and probabilistic GAWC methods are illustrated in Fig.2. Firstly, wind farms operation simulation module in GOPT is applied to generate sufficient wind power generation scenarios. Meanwhile, scenarios of system load are generated by historical load data. Then daily system load profiles and the daily wind power scenarios are combined to form the system operation scenario set used by GAWC evaluation. The daily dispatching simulation is conducted using the typical operation scenarios. GAWC evaluation is conduced one by one. For deterministic method, only typical and extreme operation scenarios are selected for the sake of simplicity. On the contrary, in the probabilistic method, 365 daily operation scenarios over the whole year are selected to approximate the various operation situations in the future. Detailed procedures of both methods are described in the following paragraphs.

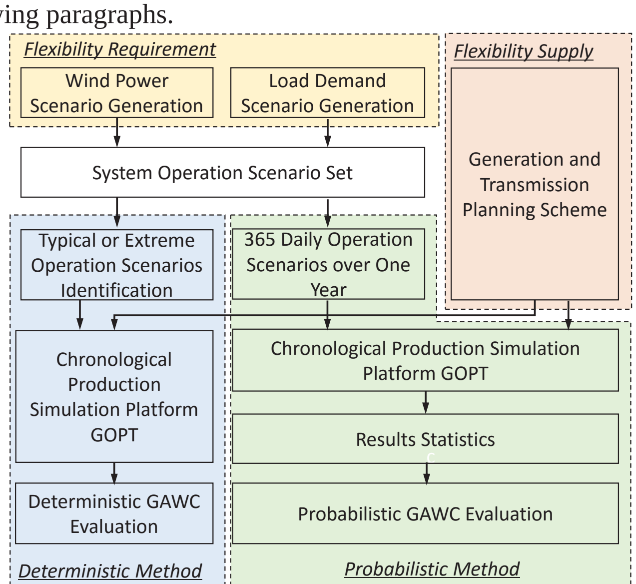

Fig.2 Grid-accommodative wind power capacity evaluation framework

3.2 Deterministic GAWC evaluation methodology

The whole deterministic GAWC evaluation model is presented in Fig.3. Firstly, three critical load scenarios (the day with maximum load, minimum load and maximum peak-valley difference respectively) and two typical wind power scenarios (negative correlation with load and positive correlation with load) are selected and crossly combined to form six typical operation scenarios. Then, these typical scenarios are simulated using GOPT, and the most critical scenario for each type of flexibility is identified. For peak-regulation flexibility, the scenario with highest peak-regulating ratio (PRR), which is defined as the ratio of the outputs in peak hour to the start-up capacity for the conventional controllable units, is regarded as the representative critical scenario. For reserve flexibility, the scenario with lowest reserve-scheduling ratio (RSR), which is defined as the ratio of the scheduled reserve in peak hour to the start-up capacity for the conventional units, is regarded as the representative critical scenario. For frequency-regulation flexibility, the maximum load day and minimum load day are both regarded as the critical scenarios. Afterwards, each of the critical scenario is simulated repeatedly with increasing wind power capacity until there is wind power curtailment. The maximum installed wind power capacity without wind power curtailment is regarded as GAWC for the corresponding type of flexibility. The minimum value of GAWC among all of the type of flexibility is regarded as deterministic GAWC. The associated flexibility type is the identified as the short-bar factor of the power system to accommodating wind power.

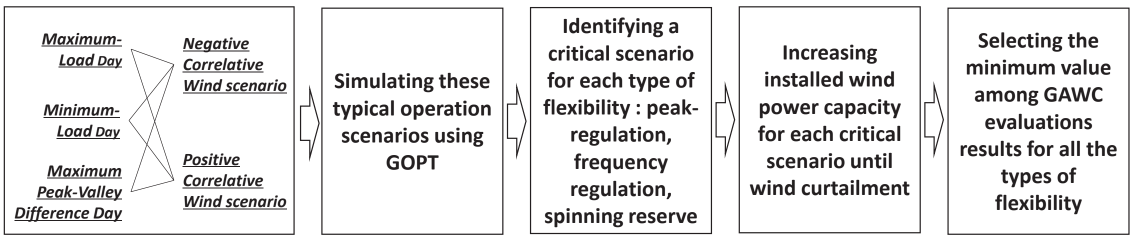

Fig.3 Flow chart of deterministic Grid-accommodative wind power capacity evaluation method

3.3 Probabilistic GAWC evaluation methodology

The whole probabilistic GAWC evaluation model is presented in Fig.4. Firstly, hourly chronological wind power outputs and load curves are combined to form 365 daily operation scenarios to approximate the various operation situations in the future. Then, a day-by-day operation simulation over the whole year is performed using simulation platform GOPT. The year-round wind curtailment is counted to quantify the performance of wind power accommodation in this study. The acceptable ratio of wind curtailment is pre-defined, i.e. 5%. After that, increase the installed wind power capacity and perform the year-round simulation process over and over until the ratio of wind spillage reach the pre-defined value. The maximum wind power capacity with wind curtailment less than the pre-defined value is regarded as the probabilistic GAWC.

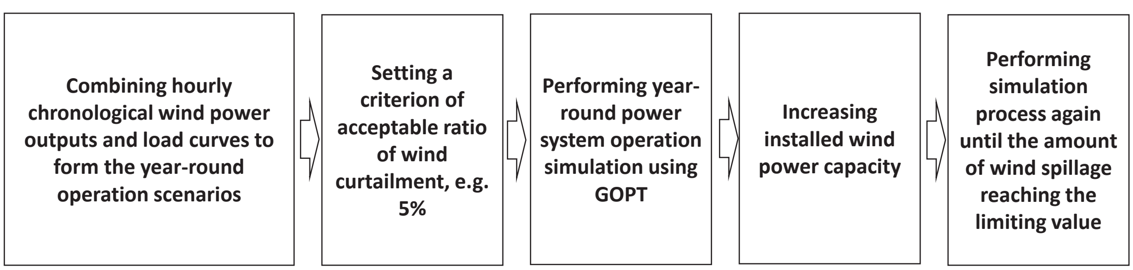

Fig.4 Flow chart of probabilistic Grid-accommodative wind power capacity evaluation method

4. Data Resource: Planning Scheme of China Southern Grid by 2020

The evaluations of GAWC for the five provincial power systems in CSG are conducted based on one of the electric power planning scenarios for CSG in 2020. The basic parameters used are shown in the following paragraphs.

4.1 Load forecasts

The load curves for each provincial power system in CSG in 2020 are generated based on the long term load forecasts for 2020 and the historical load profiles of 2013. Table I illustrates the long term load forecasts in CSG for 2020, including the total amount of electricity consumption and the maximum load demand. Moreover, the seasonal and diurnal characteristics of load curve are provided in Fig.5. The typical normalized daily load curves for summer and winter for each province are shown on the left, while the normalized seasonal load curves are shown on the right.

TABLE I
LONG-TERM LOAD FORECASTS IN CSG FOR 2020

	GD	GX	YN	GZ	HN	CSG
Electricity Consumption / TWh	667	205	265	183	39	1368
Maximum Load / GW	125.8	37.2	42.8	33.1	7.1	235.6

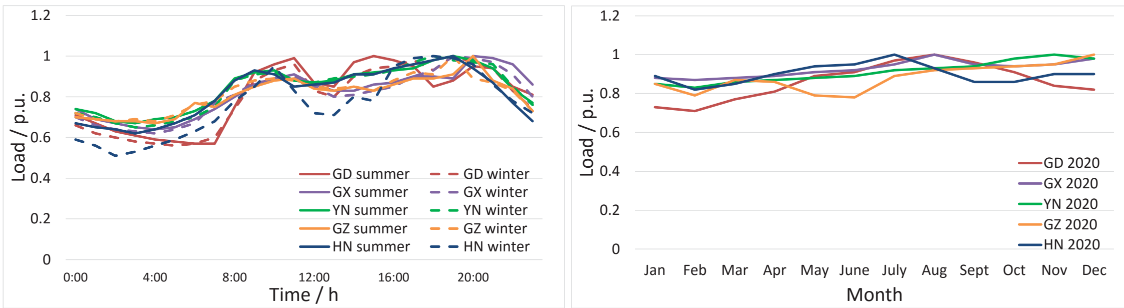

Fig.5 Seasonal and diurnal typical load curves in 2020

4.2 Generation expansion planning

Table II lists the capacities from different types of generation which are planned to be in service in CSG by 2020. Coal and hydro units will make a major proportion of the generation mix. Wind power will reach over 10% in the total generation capacity. Pumped storage is introduced to increase the peak-regulation flexibility only in both GD and HN provinces. Hydro power is dominant in generation mix occupying over 70% in YN. Hydro units are incapable to alter their outputs to balance the load and wind variations and will thus intensify the wind spillage problem in flood season. In GX and GZ, hydro and coal-fired units nearly occupy all the generation capacity except renewable energy. In the dry season, coal-fired plants serve as the base load, and hydro plants are mainly responsible for balancing the variations of load and wind, vice-visa in the flood season, namely summer.

TABLE II
GENERATION EXPANSION PLANNING IN CSG BY 2020

	GD	GX	YN	GZ	HN	CSG
Hydro	8.42	17.25	80.35	20.15	0.93	127.1
Pumped Storage	7.28	0	0	0	0.6	7.88
Coal	74.14	23.54	18.03	40.61	5.2	161.52
Gas	33.47	0.17	0	0	0.72	34.36
Nuclear	18.64	4	0	0	1.3	23.94
Wind	13.46	6.26	13.4	9.33	1.56	44.01
Solar	4.00	0.15	1.96	0.05	1.05	7.21
Others	0.13	1.51	0	1.14	0.05	2.83
Total	159.54	52.87	113.74	71.28	11.41	408.85

In China, hydro resources are rich in west such as YN, GX and Three Gorges, while the dominant load consumption centre is located in GD, accounting for about 50% of the total electricity consumption in CSG. Hence, the project of sending electricity from the west to the east is carried out. The electricity delivery plan of 2020 is summarized in Table III. The inter-regional electricity delivery follows a pre-defined protocol, which includes a series of agreed power-delivery curves.

TABLE III
PLANNING OF SENDING ELECTRICITY FROM THE WEST TO THE EAST

	Capacity (GW)		Capacity (GW)
Send to GD	45.08	Send to GX	7.44
1)From YN province	23.5	1)From TSQ plant	0.84

2)From GZ province	8.0	2)From YN province	6.0
3)From the region except CSG	8.58	3)From GZ province	0.6
i)From LT plant	2.1	Send to the surrounding except CSG from YN	1.15
ii)From SX plant	3.0		
iii)From LYJ plant	1.8	Send to the surrounding except CSG from GZ	3.0
iv) From TSQ plant	1.68		

4.3 Wind power data

Wind farms are grouped into several wind regions according to their locations. Basic wind speed distribution parameters of each wind region and correlation coefficients between regions are calculated according to historical wind resource parameters. Table IV shows the operation simulation results for each provincial power system in CSG.

TABLE IV
GENERATION EXPANSION PLANNING IN CSG BY 2020

		GZ	GX	YN	GZ	HN
Installed Wind Power Capacity /MW		13457	6264.5	13402	9232.1	1558.2
Available Utilization Hour / h		2019.0	2149.0	2299.0	1907.0	1831.4
Minimum Output Ratio		3.8%	1.9%	1.2%	2.2%	1.0%
Maximum Output Ratio		54.8%	61.0%	71.0%	58.9%	62.7%
Average Output Ratio		23.0%	24.5%	26.0%	21.8%	20.91%
Seasonal Feature	Wet Season	39%	48%	32%	51%	42%
	Dry Season	61%	52%	68%	49%	58%
Diural Feature	Daytime	49%	42%	43%	45%	52%
	Night	51%	58%	57%	55%	48%

4.4 Operation simulation settings

1) Each province is modelled as a single-node system, without considering the intra-regional transmission capacity limits. The inter-regional electricity transmission is fixed by pre-defined delivery curve.

2) Since the proposed operation simulation methodology is designed to simulate dispatching under normal conditions, forced outages of conventional units are not considered. It should be noted that yearly unit maintenance is performed before simulating daily operation.

3) Water spillage and wind curtailment are both considered in the simulation. The corresponding penalties are both set as 0 RMB/MWh, while the wind curtailment is prior to the water spillage. The penalty of load shedding is set as 10000 RMB/MWh.

5. Results and Discussions

The deterministic GAWC and probabilistic GAWC for the five provincial power systems in CSG are shown in Table V and Table VI, respectively. It should be noted that wind power will be curtailed in flood season in YN and GX province with any penetration of wind power. Hence, the criterion of GAWC evaluation is adapted to guarantee that no wind will be curtailed in dry season for both evaluation methods.

TABLE V
DETERMINISTIC GAWC EVALUATION OF CSG IN 2020

(MW)	GD	GX*	YN*	GZ	HN
Peak-regulation limits	6000	5000	19500	4400	820
Flexibility-regulation limits	35939	32973	72109	35947	2700
Reserve capability limits	25000	10000	20000	24000	2141
GAWC evaluation result	6000	5000	19500	4400	820
GAWC / Maximum load	4.77%	13.44%	45.56%	13.29%	11.55%

* No matter what penetration level of wind power is, wind power will be curtailed in flood season in YN and GX province. The critical scenario for evaluating GAWC is selected among those operation scenarios in dry season.

TABLE VI
PROBABILISTIC GAWC EVALUATION OF CSG IN 2020

(MW)	GD	GX	YN	GZ	HN

Probabilistic GAWC evaluation result	65664	8000	20000	7271	5000
Wind curtailment ratio over a year	5%	20.32%*	13.29%*	5%	5%
Utilization hour of wind farms	1921.93	1712.26	1994	1805.42	1745.23
Utilization hour of thermal units	2820.93	2844.11	2831	4315.82	3231.56
GAWC / Maximum load	52.2%	21.5%	46.7%	22.0%	70.4%

* No matter what penetration level of wind power is, over 5% wind generation will be curtailed in flood season in YN and GX province. The criterion of GAWC is changed as guarantying no wind to be curtailed in dry season.

According to the results of deterministic GAWC evaluation, peak-regulation flexibility is identified as the most critical factor for all of the provincial power systems, while frequency-regulation flexibility is the most abundant. Grid-accommodative wind power penetration ratio (GAWP), which is defined as the ratio of GAWC to the maximum load, is proposed to evaluate the relative capability to accommodate wind power for a power system. Neglecting YN and GX province, GD has the largest GAWC by 6000 MW, but with the least GAWP by 4.77%. This observation indicates that GD province is the main load consumption centre and thus has the biggest capability to accommodate wind power. However, the severe peak-regulation problem tremendously limits its performance on accommodating wind power. More capacity of flexible devices, such as pumped storage or gas turbine, is suggested in the planning by 2020. For YN province, every type of flexibility is abundant in dry season because of the hydro-dominant generation mix. The GAWP of YN in dry season is up to 45.56%.

According to the results of probabilistic GAWC evaluation under the criterion of 5% accepted wind curtailment ratio, GD province has the largest GAWC by 65664 MW, while the corresponding utilization hour of thermal units only reaches 2821 h. The results indicate that thermal units can be adapted to provide abundant flexibility to compensate for the fluctuation in the wind power and facilitate the accommodation, from the perspective of long-term operation. The associated GAWP reaches 52.2%. For the coal-fired dominant power system, e.g. GZ province, the GAWP is just 22%. For hydro-plant dominant system, e.g. YN province, the GAWP can reach 46.7% when requiring no wind curtailed in dry season. However, the corresponding wind curtailment ratio reaches 13%, indicating considerable wind power will be curtailed in flood season. Consequently, the wind power should be send out in flood season to avoid spillage, and fluctuating electricity from other provinces can be sent in to take full use of the redundant flexibility in dry season.

Comparing the GAWC evaluation results of both methods, the GAWC with deterministic method is always much less than that with probabilistic method. In deterministic method, only typical critical scenarios are considered, thus the short-bar factor of a power system for accommodating wind power can be easily identified. However, these critical scenarios occur with low probability. Therefore, it will be more reasonable to tolerate the wind curtailment in some extreme situations and evaluate the performance of wind power accommodation from the perspective of accumulative long-term operation. In probabilistic method, yearly accumulative curtailed wind power is selected to reflect the performance on wind power accommodation. Hence, the impact of extreme situation decreases rapidly and the result of GAWC increases dramatically.

Fig.6. illustrates the distribution of wind curtailment under different wind power capacities in HN province by 2020, indicating that the curtailed wind energy is only concentrated in several extreme scenarios. Table VII shows the yearly operation simulation results of GD under different installed wind power capacities. With the increasing penetration of wind power, the wind curtailment ratio will also rapidly increase, while the utilization hour of wind farms and thermal units will gradually decrease. Obviously, the probabilistic GAWC evaluation result is very sensitive to the pre-defined criterion of accepted wind curtailment ratio.

TABLE VII
PROBABILISTIC GAWC EVALUATION OF GD IN 2020

Installed wind power capacity	13457	20000	30000	400000	50000	60000	70000
Available wind power	271.707	403.818	606.279	807.636	1009.55	1211.45	1413.36
Utilized wind power	269.676	400.271	598.723	792.306	980.965	1160.66	1333.93
Curtailed wind power	2.031	3.547	7.556	15.33	28.58	50.799	79.435
Wind curtailment ratio	0.75%	0.88%	1.25%	1.90%	2.83%	4.19%	5.62%
Utilization hour of Wind farms	2004	2001.35	1995.74	1980.76	1961.93	1934.43	1905.61
Utilization hour of gas turbines	2089.7	2090.32	2084.1	2087.37	2091.37	2078.02	2069.68
Utilization hour of thermal units	4262.99	4074.89	3776.08	3487.8	3205.49	2935.28	2671.53

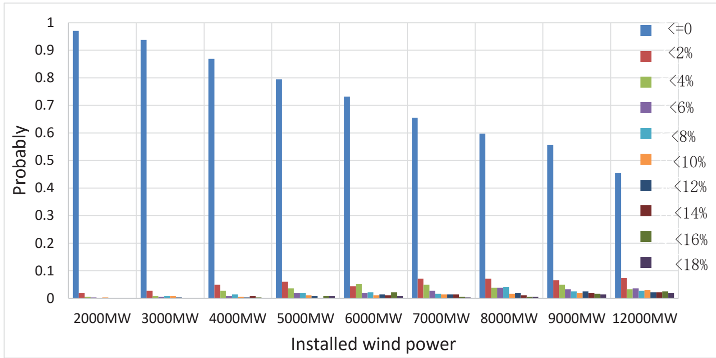

Fig.6 Wind curtailment distribution under different penetration of wind power in HN province

Moreover, the reasonable accepted wind curtailment ratio is discussed in this study. Although integration of wind power will reduce the operation cost for a power system, which can be regarded as the benefit of wind power accommodation, the installation of wind power requires large investment cost. Then, there exists an optimal installed wind power capacity to maximize the net revenue. Fig.7. shows the benefit-cost analysis of HN province under different wind power capacities. If the reasonable accepted wind curtailment ratio (corresponding 5000MW of wind power capacity) is 5%, the matched yearly investment cost for per kW wind power should be around 350 ￥.

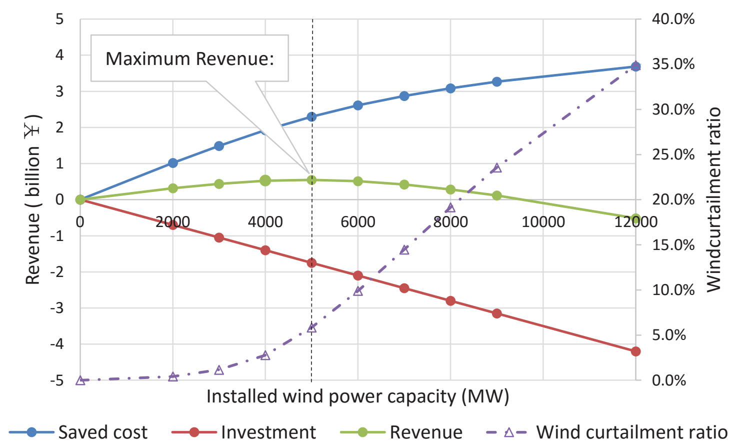

Fig.7 Benefit-cost analysis of HN province under different wind power capacities

6. Conclusions

In order to quantify the differences between deterministic GAWC method and probabilistic GAWC method, this paper establishes both evaluation methods and carries out GAWC evaluations for five provincial power systems in CSG respectively using deterministic method and probabilistic method. The results of deterministic GAWC evaluation indicate that peak-regulation flexibility is the most critical factor limiting the accommodation of wind power for every provincial power system in CSG. The GAWC with deterministic method is much less than that with probabilistic method, because it only considers the most critical scenarios occurring with low probability. The case study on YN province also demonstrates that the curtailed wind energy just is concentrated in several extreme scenarios. The probabilistic GAWC evaluation result is proved to be very sensitive to the pre-defined criterion of accepted wind curtailment ratio. Moreover, the reasonable wind curtailment ratio is discussed in this study using a cost-benefit analysis method, taking HN provincial power system as example. The results show that the yearly investment cost for per kW wind power should be around 350 ￥, if setting 5% reasonable wind curtailment ratio in the probabilistic GAWC.

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