WIND AND SOLAR REPORT

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By Supply Adequacy Working Group

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION	COMMENTS
5/16/2017	Derek Hawkins	Draft	For review at the May 23rd SAWG Meeting

CONTENTS

EXECUTIVE SUMMARY

BACKGROUND

The Supply Adequacy Working Group (SAWG) maintains, coordinates, and implements Criteria related to generation in Southwest Power Pool (SPP). One task of the SAWG is to monitor and establish criteria for the rating of generating units within SPP and report results to the Markets and Operations Policy Committee (MOPC). During the course of the Generation Working Group (GWG) activities over the last few years, there has been a need to perform analysis on an ad-hoc basis using operational data to support changes to the SPP Criteria. The following report aims to review operational data that may support current accreditation methodologies or indicate a need to further assess accreditation methodologies.

FINDINGS

At this time, the SAWG recommends that changes be considered for SPP Planning Criteria Section 7.1.5.3.(7), which contains the approved methodology for establishing the net capability of wind and solar facilities for capacity accreditation purposes. The SPP Planning Criteria presently requires the capability for wind and solar resources to correspond to the top 3% load hours by month of the Load Serving Entity. The value used for accreditation is the output at the 60% confidence factor for those peak hours.

Discussions were raised about the longevity of this methodology and whether or not it could remain reliable at increasing levels of wind and solar penetration. There was approximately 7,350 MW of nameplate capacity analyzed for this report while there is already over 16 GW registered in SPP. With a higher percentage of the overall capacity mix coming from variable resources, there is concern that the risk to reliability is higher if that capacity is unavailable during peak loading conditions. Further evaluation may be needed in the future to consider alternative methods for accreditation such as the Effective Load Carrying Capability (ELCC) calculations.

The SAWG and SPP Staff reviewed analyses of the output of wind generation in SPP over various peak periods since 2011. Since wind generator output is not highly correlated to peak temperatures in SPP, the number of peak hours evaluated in SPP's accreditation methodology and the number of years utilized significantly impacts the accreditation results. Also, generation from wind resources is not consistent with the standard "normal" distribution or "bell curve", and is instead more variable. Therefore, monitoring smaller amounts of data, such as only 3% of peak load hours per month, results in more volatile and less consistently accurate capacity accreditation for wind resources. The larger the sample of data (more hours and more years), the more stable and robust the accreditation results appear to become. As a result, if the current accreditation methodology continues to be used, it is recommended that the SAWG provide recommendations in the near future on this issue.

SPP staff observed both summer and winter time periods for this analysis although the current SPP Planning Criteria also allows a single annual capability based on the month that corresponds to the Load Serving Entity's (LSE) peak load hour. It was noted that this could create a gap in planning for the SPP Balancing Authority (BA) peak, which typically occurs in the summer season. The analysis

shows that resource accreditation can vary widely from summer to winter seasons and create a potential gap for the SPP BA when an LSE's annual capability is based on winter load hours. The SAWG will consider whether or not to address this with changes to the current methodology. Another option that the SAWG may consider is the evaluation of individual resource output as it corresponds to SPP BA load. This report contains calculations based on the LSE's load as well as SPP BA load for comparison purposes.

While discussing the wind and solar data, other considerations were raised for further analysis. The group recommended further analysis of data to determine if there is a need to set caps on the levels of variable generation that can be counted for capacity. This type of evaluation would be valuable soon as companies are planning well out into the future and have the added complication of meeting renewable portfolio standards. This information has just been made available for the LREs in SPP's footprint for the summer of 2017, and the SAWG has begun evaluating it. Finally, the SAWG may explore the possibility of expanding the capacity accreditation methodology further to include additional resource types as applicable.

While reviewing this report, SAWG members also noted that it was not possible for them to replicate the data used in this report in order to confirm the results. In the future, SPP Staff will endeavor to develop analyses that can be replicated and confirmed by Members in order to provide needed transparency. Changes to the accreditation methodology could also help provide this additional level of transparency.

METHODOLOGY AND RESULTS

SCOPE AND METHODOLOGY

This report focuses on the historical performance of wind and solar generation during peak load hours. The following will provide more details about the input data.

1. Resources with at least 3 years of operational data were included in this analysis. For example, the resource must have data for the 2014 summer season to be included. Also, output data dating back to 2011 was used where available. This resulted in approximately 7,350 MW of nameplate capacity of wind resources being analyzed for this report, which is less than half of the total wind resources in the SPP footprint today.
2. Next, the resources are associated to a legacy Balancing Authority:
    a. Starting with the Market Participant, some are easily mapped to the legacy BA.
    b. Others can be attributed based on other factors such as naming convention, etc.
    c. Finally, the remaining resources were assigned based on location.
3. Identify the top 3% of peak load hours in the month of the annual peak for each legacy BA during the summer and winter months from 2011-2016. Repeat this for the SPP BA load as well.
4. Resource output data was linked to the applicable legacy BA peak load hours as a percentage of their nameplate capacities. This step was also repeated for the SPP BA load.

It should be clarified that the wind and solar production values used in this report already take into consideration: 1) forced outages or failure to start; 2) curtailments due to both reliability and economic reasons although during high load hours curtailments are expected to be low; and 3) weather related events.

RESULTS

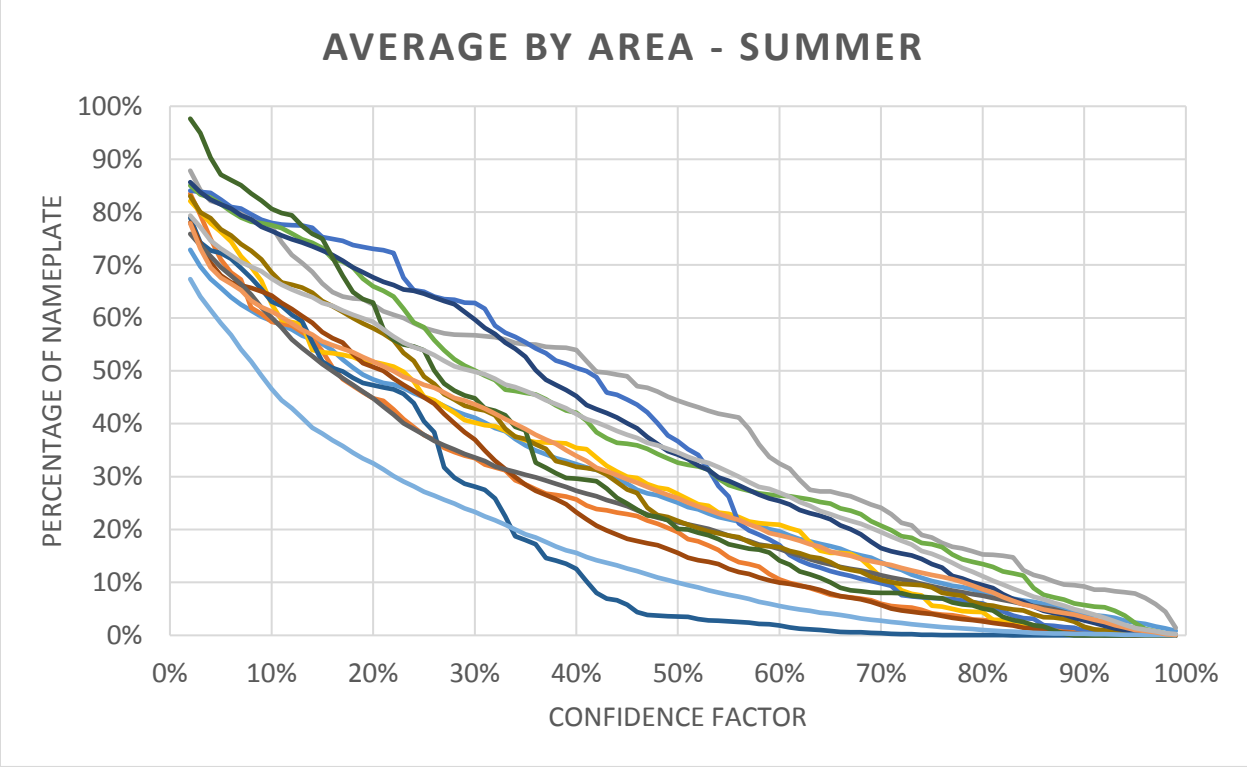
WIND ACCREDITATION BASED ON LEGACY BALANCING AUTHORITY AREA LOAD

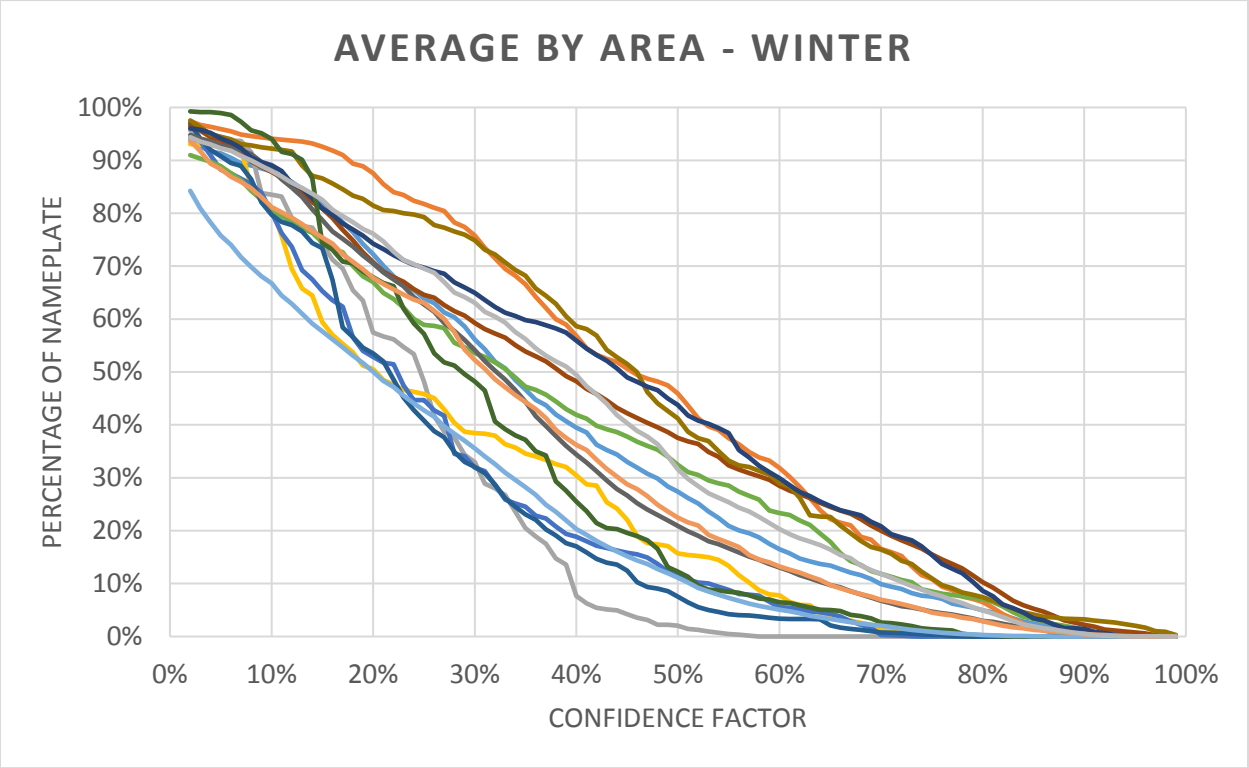
The following table displays the aggregated results by each legacy BA area. The percentage is calculated by summing the MWs for each area and dividing by the sum of the nameplate maximum values for each area. The average amongst the areas at the 60% confidence factor during the summer months was 18.2%, which is a MW-weighted value.

AREA	AVERAGE AT 60% CF SUMMER	AVERAGE AT 60% CF WINTER	AVERAGE ON-PEAK VALUES (2014-2016) SUMMER	AVERAGE ON-PEAK VALUES (2014-2017) WINTER
Area 1	19.9%	18.1%	26.0%	49.5%
Area 2	11.7%	31.8%	24.7%	51.2%
Area 3	32.6%	0.0%	53.3%	0.4%

Area 4	20.9%	7.8%	15.3%	10.8%
Area 5	17.5%	5.6%	27.3%	26.3%
Area 6	26.2%	22.5%	39.8%	18.4%
Area 7	1.5%	2.5%	25.9%	46.0%
Area 8	10.3%	29.1%	12.9%	39.6%
Area 9	16.0%	13.1%	23.1%	48.2%
Area 10	16.5%	28.3%	32.4%	25.9%
Area 11	28.9%	35.4%	74.4%	52.6%
Area 12	14.2%	6.7%	34.3%	6.8%
Area 13	8.1%	7.1%	9.4%	40.2%
Area 14	19.7%	14.3%	40.3%	27.5%
Area 15	30.0%	22.4%	30.7%	29.7%
All	**18.2%**	**17.4%**	**27.5%**	**38.8%**

The following two charts show the aggregate resource outputs for each area across all confidence factors for summer and winter.





WIND ACCREDITATION BASED ON SPP BA LOAD

This section provides an alternative observation to the accreditation methodology using SPP's load. In the table below, the Percentage of Nameplate at 60% is a MW-weighted value where the average by resource is the simple average of each resources accreditation percentage. Using SPP load, the percentage of nameplate at the 60% confidence factor in summer is 23.7%, which is higher than the 18.2% from above.

	PERCENTAGE OF NAMEPLATE AT 60% CF SUMMER	AVERAGE BY RESOURCE SUMMER	PERCENTAGE OF NAMEPLATE AT 60% CF WINTER	AVERAGE BY RESOURCE WINTER
SPP	23.7%	19.9%	16.0%	13.8%

The following table shows the variability across the single peak hours for the past three years. In the past, this data has been interpreted to highlight the need for a multiple year approach to resource accreditation.

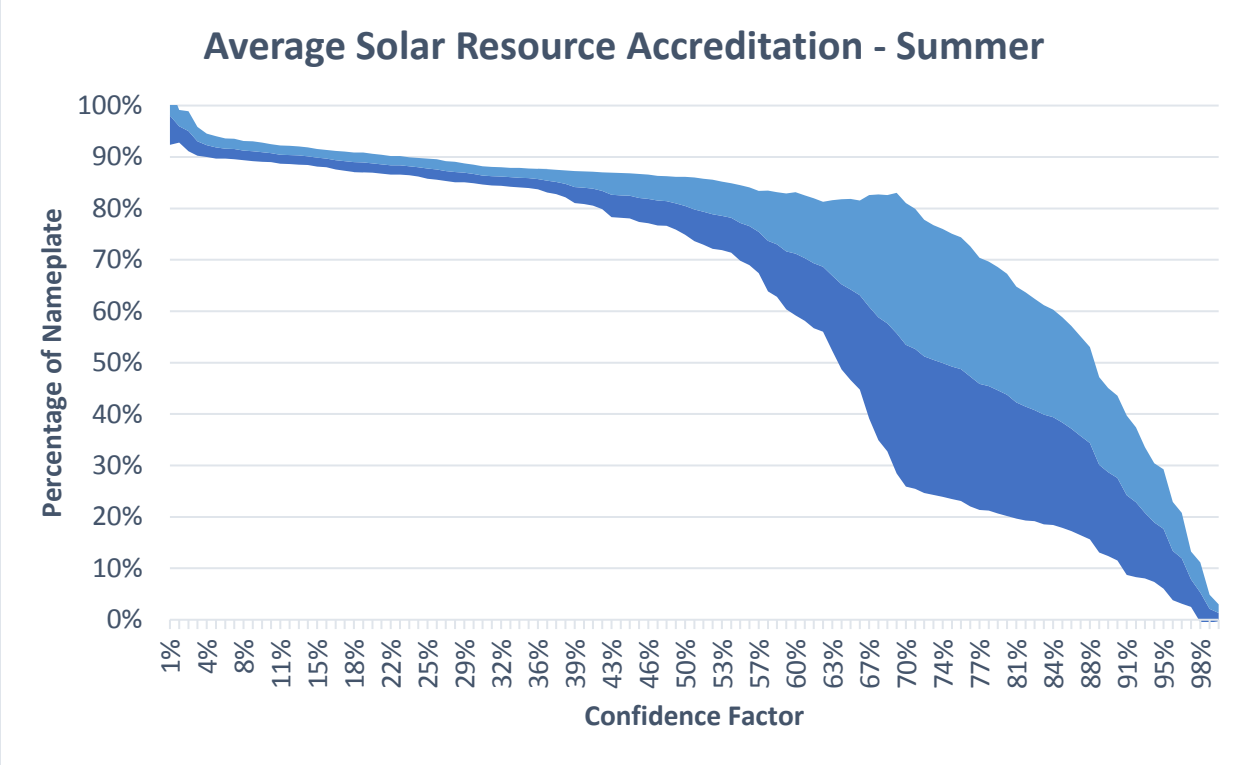
ON-PEAK PERCENTAGES FOR SPP	2014	2015	2016

Summer	50%	24%	52%
	2014-2015	**2015-2016**	**2016-2017**
Winter	81%	7%	37%

SPP Staff notes that these results are not necessarily consistent with those from an analysis of all wind resources in SPP. In such studies, provided by Members, average capacity factors for wind resources are higher in the winter than in the summer. SPP Staff will continue to evaluate this issue and discuss it with the SAWG in future reports.

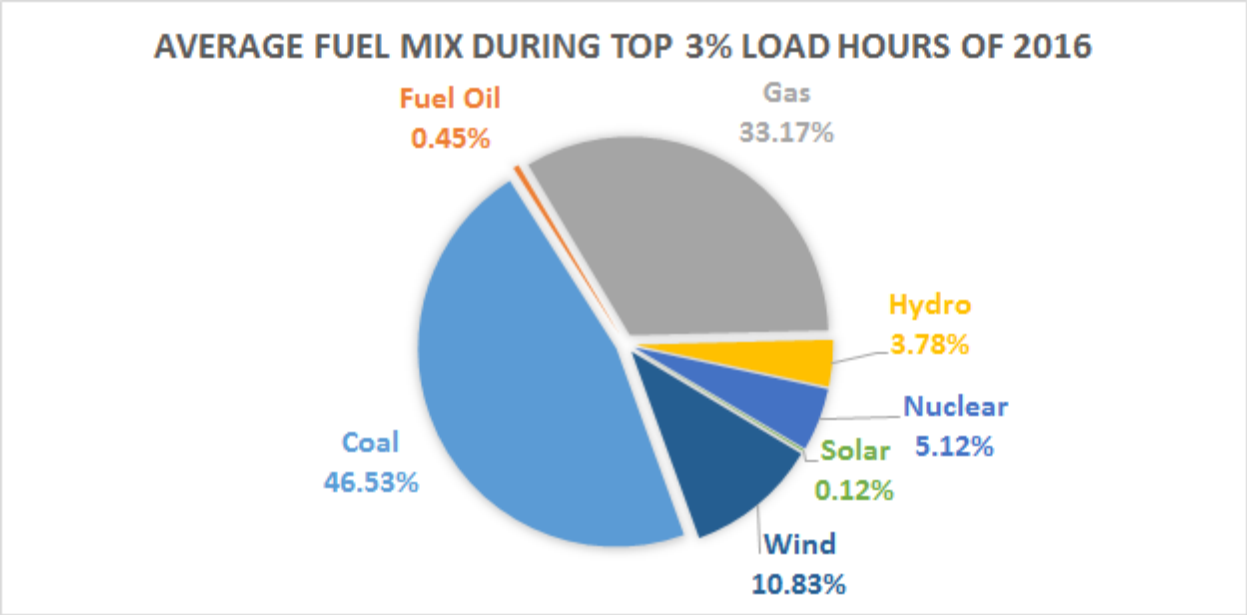
SOLAR ACCREDITATION

Solar accreditation was only reviewed briefly as the level of solar resources in SPP is much lower than wind. The graph below shows solar resources holding their output higher into the confidence factor according to SPP's accreditation methodology. The potential variability in accreditation appears to begin increasing at around the 40% Confidence Factor level, reaches a maximum at around 70% Confidence Factor, then slowly reduces in variability until a 0% Capacity Factor is reached at the 100% Confidence Factor level. The SAWG believes that continued monitoring of solar resource accreditation is warranted



FUEL MIX ANALYSIS

This chart shows the average fuel mix during the peak load hours of 2016.


AVERAGE FUEL MIX DURING TOP 3% LOAD HOURS OF 2016
Fuel Oil
0.45%
Gas
33.17%
Hydro
3.78%
Nuclear
5.12%
Solar
0.12%
Wind
10.83%
Coal
46.53%