



Day-Ahead System Load Distribution Factor Improvement

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Day-Ahead System LDFs Improvement Overview

- Perform Day-Ahead hourly load forecast for each of the 23 sub-LAPs within the CAISO system
- Adjustment factors, one for each sub-LAPs for each hour are determined on the basis of the sub-LAPs DA load forecast.
- Adjustment factors are used to adjust DA system LDFs under the current approach so that the total LDFs within each sub-LAP will reflect sub-LAP forecast loads relative to each other.
- The adjusted DA system LDFs are fed to the market system to run DA market.

Sub-LAP Day-Ahead Hourly Load Forecast

- Currently, CAISO production system is set up to perform DA load forecast for 10 load forecast zones
- Load forecast model is based on neural network and auto regression and moving average methodologies
- Weather forecast and actual load and weather data of pre-specified lag time are fed to the load forecast model to perform load forecasting
- Sub-LAP DA load forecasting is on “indirect” basis through the load forecast of the 10 load forecast zones
- Using the 2009 and 2010 hourly load data of sub-LAPs and load forecast zones through statistical approach, the CAISO identifies for each sub-LAPs, a group of LF zones to be best correlated with

Sub-LAP Day-Ahead Hourly Load Forecast cont

- For each sub-LAP, a functional mapping from the load(s) of the identified forecast zone (group of forecast zones) to the sub-LAP load is determined on the basis best fit between the historical hourly load data of the sub-LAP and the forecast zone.
- In market operation, using the forecast loads of forecast zones, the forecast load of each sub-LAP is determined by applying the pre-determined functional mapping of the sub-LAP to the forecast load(s) of its corresponding forecast zone (group of forecast zones).

Proposed Adjustments of DA LDF from Current Production System by Example

- A system consisting two sub-LAPs A and B with sub-LAP A comprised of Nodes 1 and 2 and sub-LAP B comprised of Nodes 3 and 4.
- Normalized LDFs from current production system adaptation method are given in the table below
- LDF values implies that ratio of the two sub-LAP loads be 7 : 3

Node Name	LDF
N1 (Sub-LAP A)	0.4
N2 (Sub-LAP A)	0.3
N3 (Sub-LAP B)	0.2
N4 (Sub-LAP B)	0.1

Proposed Adjustments of DA LDF from Current Production System by Example cont

- Forecasted loads of sub-LAPs are 80MW for sub-LAP A and 20MW for sub-LAP B
- Adjustment factors are $8/7$ for sub-LAP A and $2/3$ of sub-LAP B. Each sub-LAP specific adjustment factor is applied to all nodes of the sub-LAP.
- Final LDFs after adjustments are listed in the table on the left. The adjusted LDFs are normalized.

Node	Adj LDF
N1	$0.4 * 8/7 = 0.457$
N2	$0.3 * 8/7 = 0.343$
N3	$0.2 * 2/3 = 0.133$
N4	$0.1 * 2/3 = 0.067$

Load Forecast Zones and Sub-LAPs

Forecast Zones

- PGE-BA
- PGE-NBA
- SCE-INLAND
- SCE-COASTAL
- SDGE-NET
- NCPA
- MSSA_ANHM
- MSSA_RVSD
- MSSA_VERN
- SVP

Sub-LAPs

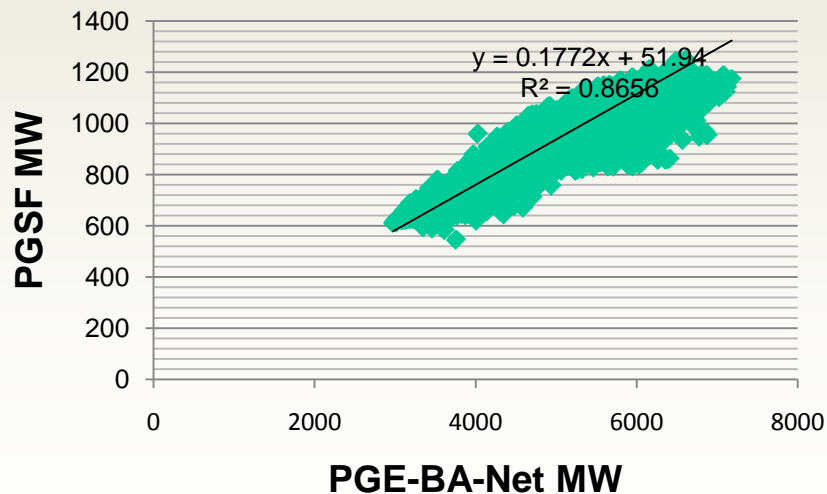
- PGCC
- PGEGB
- PGF1
- PGFG
- PGHB
- PGLP
- PGNB
- PGNC
- PGNV
- PGP2
- PGSA
- PGSB
- PGSF
- PGSI
- PGSN
- PGST
- SCEC
- SCEN
- SCEW
- SCHD
- SCLD
- SCNW
- SDG1

Note: Forecast loads of PGE-BA, PGE-NBA, SCE-INLAND and SCE-COASTAL include the loads of MSS within the forecast zones.

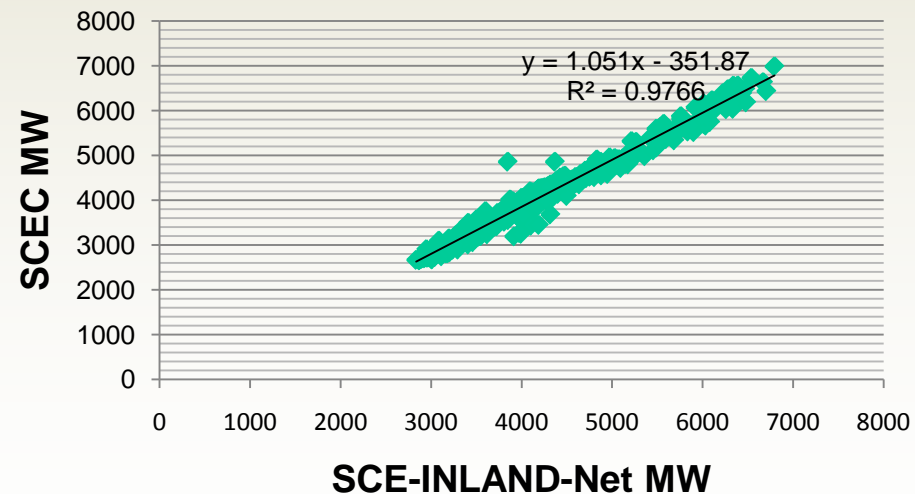
Examples of Best Fit Linear Mapping from Forecast Zone to Sub-LAP by Regression

- Following two regression plots are generated using more than ten thousand hourly load data points between April 2009 and June 2010.

PGE-BA-Net → PGSF



SCE-INLAND-Net → SCEC



Best Fit Linear Maps for all Sub-LAPs in the Prototype Implementation

	Intercept	NCPA	PGE-BA-NET	PGE-NBA-NET	SCE-INLAND-NET	SCE-COASTAL-NET	SDGE-NET
PGCC	9.7527	1.5464					
PGEB	-48.2438		0.2627	0.0726			
PGF1	-383.2097			0.2810			
PGFG	-3.0800		0.0611	0.0087			
PGLP	313.5267			0.1559			
PGNB	-0.0209		0.0828				
PGNC	21.4981	0.3444					
PGNV	-39.3049			0.0699			
PGP2	0.0206		0.1374				
PGSA	-74.2386			0.1215			
PGSB	98.1067		0.2961				
PGSF	51.7025		0.1772				
PGSI	-12.7249			0.0448			
PGSN	30.8474		-0.0081	0.0110			
PGST	-51.0538			0.1178			
SCEC	118.2632				0.8902		
SCEN	-0.4000				0.1875		
SCEW	207.6283					0.5877	
SCHD	144.1043				0.0749		
SCLD	-104.3653				0.1139		
SCNW	73.1547					0.1217	
SDG1	-4.9925						0.9717

Proposed Performance Metric for LDF Adjustments

- Use the after-the-fact state estimation (SE) hourly load of different sub-LAPs as reference.
- Calculate the sub-LAP based distribution defined as the ratio between the sub-LAP load and the total system load. Distributions for each hour are separately calculated for a) adjusted DA LDFs, b) original DA LDFs prior to adjustment and c) after-the-fact SE load.
- Performance metric is based on absolute deviation of the sub-LAP based distribution value of the DA LDFs from the distribution value of after-the fact SE load. Specifically, it is the absolute difference of the sub-LAP based distribution between the DA LDFs and the after-the-fact SE load of each sub-LAP, summing over all sub-LAPs.

General Results of Prototype Implementation

- Prototype implementation has been tested for about 3 weeks.
- Absolute deviation of the performance metric for a given hour ranges from 2% to 10% for original DA LDFs prior to adjustment
- For any given day, adjusted LDFs may not outperform the original LDF for all hours. However, over the entire day, adjusted LDFs reduce the absolute deviation between 25 to 50% in averaging over all hours for most days.
- On rare occasions, improvement of adjusted LDFs can be as high as 60% and also as low as about 5% pending on the accuracy of the original LDFs.

Sample Performance Results for a Given Hour

On 8/25/2010 HE10

	Sub-LAP Based Distribution			Deviation from SE Load	
	Adj LDF	Orig LDF	SE Load	Adj LDF	Orig LDF
PGCC	0.01755	0.01727	0.01653	0.00115	0.00083
PGEB	0.05599	0.05236	0.05873	-0.00307	-0.00715
PGF1	0.05608	0.05212	0.05400	0.00234	-0.00211
PGFG	0.01185	0.01140	0.01215	-0.00034	-0.00084
PGLP	0.05021	0.05057	0.04883	0.00154	0.00195
PGNB	0.01341	0.01287	0.01350	-0.00010	-0.00070
PGNC	0.00400	0.00379	0.00354	0.00052	0.00028
PGNV	0.01490	0.01392	0.01342	0.00167	0.00057
PGP2	0.02195	0.02076	0.02211	-0.00018	-0.00152
PGSA	0.02571	0.02451	0.02734	-0.00183	-0.00318
PGSB	0.05213	0.05155	0.05475	-0.00294	-0.00359
PGSF	0.03218	0.03161	0.03141	0.00086	0.00023
PGSI	0.00922	0.00880	0.00993	-0.00080	-0.00127
PGSN	0.00240	0.00237	0.00262	-0.00025	-0.00029
PGST	0.02582	0.02507	0.02709	-0.00142	-0.00226
SCEC	0.16324	0.16759	0.16990	-0.00746	-0.00259
SCEN	0.03566	0.03375	0.03416	0.00169	-0.00045
SCEW	0.14051	0.14712	0.13627	0.00475	0.01218
SCHD	0.01828	0.01890	0.01824	0.00005	0.00074
SCLD	0.01975	0.01987	0.01931	0.00049	0.00063
SCNW	0.02990	0.03007	0.02883	0.00120	0.00139
SDG1	0.09075	0.09522	0.08885	0.00212	0.00715
Total	0.89151	0.89151	0.89151	Abs Total	0.03677

Sample Performance Results in for a Given Day

On 8/25/2010 all 24 hours

	Hourly Abs Dev	
	Adj LDF	Orig LDF
HE 1	0.04051	0.05798
HE 2	0.03885	0.05021
HE 3	0.03734	0.04418
HE 4	0.03485	0.03823
HE 5	0.03225	0.03577
HE 6	0.03014	0.03212
HE 7	0.02943	0.02891
HE 8	0.02568	0.03290
HE 9	0.02550	0.04064
HE 10	0.03677	0.05189
HE 11	0.04636	0.06208
HE 12	0.05933	0.07378
HE 13	0.06891	0.08405
HE 14	0.07471	0.08896
HE 15	0.07164	0.09872
HE 16	0.06857	0.10160
HE 17	0.06859	0.10283
HE 18	0.06600	0.10089
HE 19	0.06450	0.09715
HE 20	0.05812	0.08166
HE 21	0.05109	0.07125
HE 22	0.04707	0.06647
HE 23	0.04476	0.06189
HE 24	0.04127	0.05860
Average	0.04843	0.06512

Improvement of the Day

$$= 1 - 0.04843/0.06512$$

$$= 0.2563 \text{ (or 25.63\%)}$$

Daily Improvements over the Past Several Weeks

	Daily Average Abs Dev		Improvement
	Adj LDF	Orig LDF	
8/9/2010	0.01932	0.03343	42.20%
8/10/2010	0.02298	0.02683	14.38%
8/11/2010	0.03236	0.04060	20.30%
8/13/2010	0.01436	0.02938	51.12%
8/14/2010	0.02789	0.02919	4.45%
8/16/2010	0.03266	0.05629	41.98%
8/17/2010	0.03139	0.07191	56.35%
8/18/2010	0.04132	0.09911	58.31%
8/19/2010	0.03280	0.04927	33.44%
8/20/2010	0.01984	0.02691	26.27%
8/21/2010	0.03844	0.07802	50.73%
8/23/2010	0.04171	0.05883	29.10%
8/25/2010	0.04843	0.06512	25.63%
8/26/2010	0.04019	0.06428	37.47%
8/27/2010	0.02964	0.05572	46.81%
8/28/2010	0.04366	0.05943	26.54%