CHP Rate Design Considerations based on NYSERDA Data

Presentation to MPSC Standby Rate Working Group by Douglas Jester, 5 Lakes Energy

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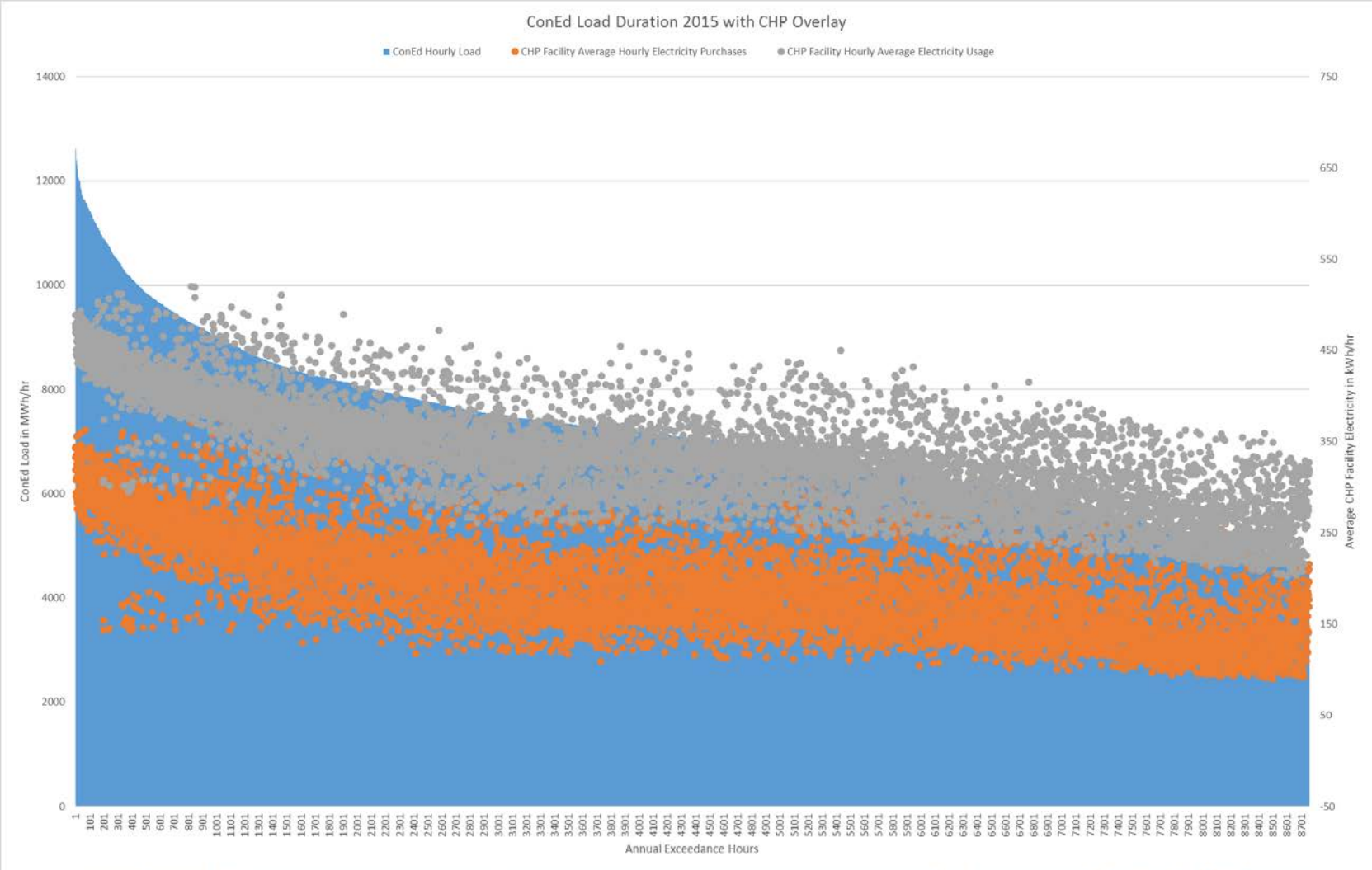
NYSERDA Data

- Distributed generation data set accumulated over 10 years.
- Submitted by distributed generation hosts, with varying quality.
- Selected ALL CHP generators in ConEd territory with reasonably complete hourly generation and utility purchase data for 2014 or 2015.
- 19 ConEd customers, including health care, industrial, multi-family residential, retail, educational

CHP Facilities Load Profile



CHP Facility Average Hourly Purchased Electricity

Facility	121	133	166	185	203	211	227	236	252	312	166	181	185	203	211	227	252	312	345
Year	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2015	2015	2015	2015	2015	2015	2015	2015	2015
1CP	6033	472	263	304	0	1910	201	414	546	22	65	202	245	369	1056	235	605	25	276
4CP	6096	453	149	215	151	1253	177	258	483	23	138	206	213	346	904	186	616	25	263
12CP	3991	406	107	111	135	819	150	214	419	28	82	163	150	221	752	120	465	23	179
Energy	2312	189	78	106	117	650	109	160	300	25	62	101	107	153	655	91	351	25	158
Peak Energy	2847	324	83	117	148	691	118	196	337	25	63	130	120	188	698	101	382	26	161
Off-peak Energy	2146	146	77	102	108	637	106	149	289	25	61	92	103	142	641	87	341	25	157
Winter Peak Energy	1921	304	79	79	118	566	96	181	298	27	51	115	100	150	661	78	311	27	134
Summer Peak Energy	4769	363	89	195	209	941	162	228	414	23	85	158	156	263	770	147	522	23	214
Demand	11269	945	460	355	534	2018	314	655	627	77	467	454	310	546	1636	316	721	80	335
CPP Energy	6217	474	151	182	210	939	187	391	510	22	93	202	232	360	889	173	609	25	248

CHP Facility Average Hourly Total Electricity

Facility	121	133	166	185	203	211	227	236	252	312	166	181	185	203	211	227	252	312	345
Year	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2015	2015	2015	2015	2015	2015	2015	2015	2015
1CP	12738	1018	553	367	238	1908	299	648	655	53	516	330	382	614	1118	283	643	60	276
4CP	12897	1008	509	352	377	1322	290	492	598	55	476	446	352	592	1037	284	646	59	272
12CP	9722	858	476	250	370	943	245	430	510	63	427	413	253	462	913	225	504	60	222
Energy	8150	681	405	195	349	774	205	309	395	53	384	333	204	394	830	198	390	52	199
Peak Energy	8990	836	430	220	379	819	218	360	431	58	400	394	224	428	875	210	422	58	202
Off-peak Energy	7888	633	397	187	340	759	201	293	383	52	379	313	198	383	816	195	380	51	198
Winter Peak Energy	7751	801	410	190	352	714	192	337	387	62	377	373	192	388	846	187	353	60	179
Summer Peak Energy	11559	905	468	282	435	1029	269	406	520	52	443	436	284	508	933	256	556	52	246
Demand	14503	1154	571	390	586	2018	317	680	737	79	588	614	392	645	1635	322	748	79	337
CPP Energy	13004	1025	509	342	431	1089	293	602	626	55	487	464	345	584	1017	279	645	58	271

CHP Effects on Facility Average Hourly Electricity

Facility	121	133	166	185	203	211	227	236	252	312	166	181	185	203	211	227	252	312	345
Year	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2015	2015	2015	2015	2015	2015	2015	2015	2015
1CP	-6705	-547	-290	-63	-238	2	-98	-234	-109	-31	-450	-128	-137	-245	-62	-48	-39	-35	-1
4CP	-6801	-554	-360	-137	-226	-69	-113	-235	-115	-32	-339	-240	-139	-246	-133	-99	-30	-35	-9
12CP	-5731	-452	-368	-139	-235	-125	-95	-216	-91	-35	-345	-250	-103	-241	-162	-106	-39	-37	-43
Energy	-5837	-493	-327	-89	-232	-124	-97	-149	-95	-28	-323	-232	-97	-241	-175	-108	-39	-28	-41
Peak Energy	-6142	-512	-347	-103	-231	-129	-100	-163	-94	-33	-337	-265	-104	-240	-177	-109	-40	-32	-41
Off-peak Energy	-5742	-487	-320	-85	-232	-122	-96	-144	-95	-27	-318	-222	-95	-241	-174	-107	-39	-26	-41
Winter Peak Energy	-5830	-497	-331	-110	-233	-149	-96	-156	-89	-35	-325	-258	-92	-238	-185	-109	-43	-33	-45
Summer Peak Energy	-6790	-541	-379	-88	-226	-88	-107	-178	-106	-29	-359	-278	-128	-244	-163	-110	-34	-29	-32
Demand	-3235	-209	-111	-36	-52	0	-3	-25	-110	-2	-121	-160	-82	-99	1	-6	-27	1	-1
CPP Energy	-6787	-551	-358	-160	-221	-149	-105	-211	-116	-33	-395	-262	-113	-225	-128	-105	-36	-33	-23

Empirical Rate Design

- Assume cost drivers (e.g. 4CP, 12CP) are valid but not usable as billing determinants
- Assume a set of usable billing determinants (e.g., demand, energy, etc.)
- Assignment of costs to individual customers with least error can be found by regressing each cost driver (dependent variable) against the set of billing determinants
- Billing determinant coefficient * average value of billing determinant/average cost driver = % of cost driver to allocate to billing determinant

Empirical Rate Design

- Stepwise regression to simplify
  - Remove insignificant billing determinants
    - Not predictive hence not fair
  - Remove billing determinants with small cost allocations
    - Not material, so simplify
  - Remove billing determinants with ”wrong sign”
    - Indicates collinearity between billing determinants leading to perverse price signals

Empirical Rate Design

- Can do regression within class or across classes, if same cost drivers and billing determinants available in all classes.
- Within-class regression sensible if and only if classification variable adds information about cost causation.

ConEd CHP
12CP of Purchased Electricity

Adj R^2 = 0.928092885	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Off-peak Energy	-3.43815E-05	2.55568E-05	-1.3453	0.199916	-8.91954E-05	2.04324E-05	-65.58624699	-14.60%
Winter Peak Energy	0.000401521	8.48318E-05	4.733145	0.00032	0.000219575	0.000583468	155.5500961	34.63%
Summer Peak Energy	0.000794695	0.000249082	3.1905	0.006543	0.000260468	0.001328922	284.0876736	63.24%
Demand	-0.005446809	0.032537921	-0.1674	0.86945	-0.07523371	0.064340091	-6.340734098	-1.41%
CPP Energy	0.002674333	0.00195625	1.367071	0.193154	-0.001521407	0.006870073	85.26308816	18.98%

Adj R^2 = 0.932885798	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Off-peak Energy	-3.32297E-05	2.38023E-05	-1.39607	0.183013	-8.3963E-05	1.75037E-05	-63.38897369	-14.11%
Winter Peak Energy	0.000399381	8.10997E-05	4.924561	0.000183	0.000226521	0.000572241	154.7207346	34.44%
Summer Peak Energy	0.000778038	0.000220819	3.523416	0.003072	0.000307373	0.001248702	278.1328868	61.91%
CPP Energy	0.002620476	0.001866048	1.404292	0.180599	-0.001356911	0.006597863	83.5460217	18.60%

Adj R^2 = 0.93702592	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Winter Peak Energy	0.000301631	4.21185E-05	7.161466	2.26E-06	0.000212343	0.000390918	116.8521731	26.01%
Summer Peak Energy	0.000566537	0.00016535	3.426292	0.003463	0.000216011	0.000917063	202.5256261	45.08%
CPP Energy	0.004189177	0.001533357	2.73203	0.014769	0.000938606	0.007439749	133.5593536	29.73%

ConEd CHP
4CP of Purchased Electricity

Adj R^2 = 0.927836953	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Off-peak Energy	2.16049E-05	4.774E-05	0.452552848	0.6578042	-8.07873E-05	0.000124	41.21353464	6.44%
Winter Peak Energy	-0.000202998	0.000158466	-1.281023499	0.22099947	-0.000542873	0.0001369	-78.64186344	-12.29%
Summer Peak Energy	0.001822518	0.000465284	3.917002484	0.001549055	0.000824584	0.0028205	651.5139153	101.85%
Demand	0.097034208	0.060780752	1.596462771	0.132704514	-0.03332754	0.227396	112.9593601	17.66%
CPP Energy	-0.002612171	0.003654271	-0.714826897	0.486465859	-0.010449802	0.0052255	-83.28123332	-13.02%

Adj R^2 = 0.932637795	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Winter Peak Energy	-0.00014114	7.80217E-05	-1.808989241	0.090536976	-0.00030744	2.516E-05	-54.67801461	-8.55%
Summer Peak Energy	0.00197271	0.000317347	6.216255826	1.65132E-05	0.001296301	0.0026491	705.2044907	110.25%
Demand	0.089628394	0.056963609	1.573432523	0.136470555	-0.031786663	0.2110435	104.3381122	16.31%
CPP Energy	-0.003484931	0.003020551	-1.153740191	0.266659321	-0.009923082	0.0029532	-111.1065672	-17.37%

Adj R^2 = 0.936790067	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Winter Peak Energy	-9.93198E-05	6.98016E-05	-1.422887403	0.173974017	-0.000247293	4.865E-05	-38.47667247	-6.02%
Summer Peak Energy	0.001697299	0.00021126	8.034168538	5.24691E-07	0.001249448	0.0021452	606.7505232	94.86%
Demand	0.06500002	0.053356339	1.218224903	0.240798183	-0.048110364	0.1781104	75.66775528	11.83%

Adj R^2 = 0.940446323	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Winter Peak Energy	-0.000134671	6.43811E-05	-2.091786336	0.051775931	-0.000270504	1.161E-06	-52.17195112	-8.16%
Summer Peak Energy	0.00194553	5.65629E-05	34.39589292	3.70373E-17	0.001826193	0.0020649	695.4882194	108.73%

Adj R^2 = 0.943577371	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Summer Peak Energy	0.001829753	1.27049E-05	144.0190388	5.13982E-29	0.001803061	0.0018564	654.1003313	102.26%

ConEd CHP
12CP of Combined Cases (Purchased and Total)

Adj R^2 = 0.969535524	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Off-peak Energy	4.32576E-06	1.84295E-05	0.234719	0.815877	-3.3E-05	4.18E-05	14.79355996	2.17%
Winter Peak Energy	0.000334525	5.9839E-05	5.590417	3.23E-06	0.000213	0.000456	237.9919709	34.94%
Summer Peak Energy	0.000241529	0.000177965	1.357169	0.183938	-0.00012	0.000604	130.2446151	19.12%
Demand	0.078609996	0.010523584	7.469888	1.38E-08	0.0572	0.10002	100.3594991	14.74%
CPP Energy	0.004325018	0.001576838	2.742842	0.009767	0.001117	0.007533	194.8619541	28.61%

Adj R^2 = 0.970431276	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Winter Peak Energy	0.000346652	2.97632E-05	11.64701	2.05E-13	0.000286	0.000407	246.6197735	36.21%
Summer Peak Energy	0.000270862	0.000124932	2.168075	0.037244	1.7E-05	0.000525	146.0623739	21.45%
Demand	0.078336346	0.010312448	7.59629	7.97E-09	0.057379	0.099294	100.0101364	14.68%
CPP Energy	0.004117095	0.001286242	3.200871	0.002967	0.001503	0.006731	185.4940713	27.23%

Adj R^2 = 0.971017323	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Winter Peak Energy	0.000250514	4.36044E-05	5.745155	1.67E-06	0.000162	0.000339	178.2239347	26.17%
Summer Peak Energy	0.00016044	0.00020085	0.798803	0.429792	-0.00025	0.000568	86.51726816	12.70%
CPP Energy	0.008886061	0.001817161	4.89008	2.24E-05	0.005197	0.012575	400.3579542	58.78%

Adj R^2 = 0.971815108	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Winter Peak Energy	0.000283124	1.52449E-05	18.57173	5.01E-20	0.000252	0.000314	201.4238328	29.57%
CPP Energy	0.010325014	0.000237707	43.43585	1.07E-32	0.009843	0.010807	465.1893802	68.30%

ConEd CHP
4CP of Combined Cases (Purchased and Total)

Adj R^2 = 0.969420425	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Off-peak Energy	2.65065E-05	3.26175E-05	0.812647	0.422245	-3.99E-05	9.287E-05	90.64882844	10.07%
Winter Peak Energy	-0.00019144	0.000105906	-1.80766	0.079783	-0.000407	2.403E-05	-136.1981736	-15.12%
Summer Peak Energy	0.001513049	0.000314972	4.803764	3.29E-05	0.000872	0.0021539	815.9130991	90.61%
Demand	0.126264037	0.018625162	6.779218	9.93E-08	0.088371	0.1641572	161.1982719	17.90%
CPP Energy	-0.0006654	0.002790766	-0.23843	0.813024	-0.006343	0.0050125	-29.97913895	-3.33%

Adj R^2 = 0.970319362	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Off-peak Energy	3.08754E-05	2.66071E-05	1.16042	0.253961	-2.32E-05	8.495E-05	105.5899619	11.73%
Winter Peak Energy	-0.00019853	0.000100231	-1.98071	0.05576	-0.000402	5.165E-06	-141.2393598	-15.68%
Summer Peak Energy	0.001442901	0.000110885	13.01256	9.25E-15	0.001218	0.0016682	778.0855697	86.41%
Demand	0.124758322	0.01727711	7.221018	2.35E-08	0.089647	0.1598696	159.2759616	17.69%

Adj R^2 =0.971157036	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Winter Peak Energy	-9.5145E-05	4.61504E-05	-2.06163	0.046731	-0.000189	-1.45E-06	-67.6892622	-7.52%
Summer Peak Energy	0.001520209	8.90785E-05	17.06594	1.53E-18	0.001339	0.001701	819.7741326	91.04%
Demand	0.116997598	0.01600887	7.308298	1.54E-08	0.084498	0.1494973	149.3680315	16.59%

Adj R^2 = 0.971926171	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Average Contribution	% Cost Allocation
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Summer Peak Energy	0.001339791	1.73652E-05	77.15379	1.39E-41	0.001305	0.001375	722.4836186	80.23%
Demand	0.145813826	0.008149592	17.89216	1.69E-19	0.129286	0.162342	186.1570202	20.67%

ConEd CHP
Empirical Rate Design Conclusions

- CHP Class (Purchased Electricity)
  - 12CP Cost Factors should be allocated to (at most) winter peak energy (26%), summer peak energy (45%), and critical peak energy (29%)
  - 4CP Cost Factors should be allocated to summer peak energy (100%)
- Combined C&I&CHP Classes (Purchased and Total Electricity)
  - 12CP Cost Factors should be allocated to winter peak energy (30%) and critical peak energy (70%)
  - 4CP Cost Factors should be allocated to summer peak energy (80%) and customer demand (20%)
- These can be further simplified without significant loss of cost allocation precision

Recommendations to SRWG

Based on analysis of data about ConEd's CHP customers, rate design for standby and supplemental power for Michigan CHP customers should be based only on billing determinants as follows:

- Off-peak Energy (energy costs only)
- Winter Peak Energy (energy and transmission)
- Summer Peak Energy (energy, transmission, and capacity)
- and, perhaps, Critical Peak Period Energy

- No distinction between standby and supplemental power appears warranted.

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