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California Energy Commission
Dockets Office, MS-4
Re: Docket No. 16-BSTD-06
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Re: 16-BSTD-06 Docket: 2019 Time Dependent Value of Energy

To CEC Staff and Commissioners:

This letter is sent into the record to correct an error and spreadsheet posted July 29th.

- I had proposed adding demand factors based upon peak capacity allocators. This reflects the regional demand associated with T&D (transmission and distribution).
- After for holding further discussions, with a number of people including Brian Horii and Snuller Price at E3, for system peak demand, we are really more interested in demand factors based upon statewide generation peak demand. This more closely reflects the demand forecasts conducted by others including the CEC.
- Since the peak demand is statewide there is a string of 8,760 numbers regardless of climate zone for each period of analysis (15 year and 30 year).

TDV Demand Factors

The TDV demand factors are used to calculate system peak demand reductions from various measures. These hourly demand factors are multiplied by the hourly electric loads from an annual building simulation and then added up over the course of year to yield the system peak demand impact of the simulated load. Two building simulations are compared: a base case simulation without the energy efficiency measure(s) of interest and a proposed case that includes the energy efficiency measure(s) of interest. The demand savings from a given measure is simply the base case demand minus the proposed demand. These demand factors have been used in previous Title 24 proceedings to quantify the demand impact of the various efficiency proposals. The calculation does not replace the TDV calculations as TDV is used to calculate the present valued cost savings to the consumer resulting from the energy savings of various efficiency measures.

I contacted Brian Horii at E3 to discuss how to calculate generation demand factors, DFg, for the 15 year and 30 year analyses that are used to determine the cost effectiveness of building code upgrade proposals. The demand factors are based on the hourly generation capacity allocation factors that are one component of costs used to build up the TDV costs. Because there are a number of hours during which statewide system loads are near the system peak, several hours

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have a relatively high probability of being the peak hour that results in a loss of load (LOLP). As documented on the TDV spreadsheet:[1] *"TDV Capacity Values use E3 RECAP model to calculate month/hour/day-type LOLP under base case scenario. Values are allocated to individuals hours using TDV weather year - load weighted temperature days above 90 degrees receive value."* The hourly capacity allocation factors are the relative probabilities of a given hour being the peak hour. If these hourly allocation factors are summed up over 8,670 hours in a year they sum to 1.0. Most hours have allocation factors of 0. In 2020, there are 287 non-zero hours and by 2030 there are 254 non-zero hours.

Steps for Creating Hourly Generation Demand Factors, DFg.

1. Collect hourly generation capacity allocation factors from the "CapAlloc" tab of the "TDV_2019 Update_model_7_20.xlsb" spreadsheet. There are 8,760 hourly capacity allocation factors for each climate zone. Most of these allocators are zeros.
2. "CapAlloc" tab has precalculated hourly capacity allocation factors for the time period 2020 to 2060. Years between 2020 and 2030 are linearly interpolated from the 2020 and 2030 data. Years after 2030 use the 2030 data.
3. Take the average over the period of interest. For generation demand factors used with the TDV factors for the 15 year period of analysis the results are averaged over the 2020 - 2034 time frame. For generation demand factors used with the TDV factors for the 30 year period of analysis the results are averaged over the 2020 – 2049 time frame.
4. Verify that the resulting 15 year and 30 year demand factors sum up to 1.0

I recommend that the generation demand factors are added to the TDV files so hourly simulation software can directly calculate peak demand impacts as well as TDV impacts. I have attached a sample MSExcel spreadsheet file with the needed data.

Results

All the demand factors add up to 1 as they should. Since the 2020 and 2030 generation capacity allocation factors can shift over time, the number of non-zero average demand factors increases. This reflects the broadening of the possible period of peak demand. This is indicating that the time of peak demand is changing over time and thus the number of hours that could be the time of system peak is greater but correspondingly the probability of any particular hour being the peak hour is decreasing as the annual sum of the peak demand factors must still be 1.0. The count of non-zero demand factors increases to 290 hours per year as compared to the 287 hours of non-zero generation capacity allocation factors for 2020 and 254 non-zero hours in 2030.

I compared the 2016 demand factors used in the calculation peak demand for the 2016 Title 24 standards to the new 2019 demand factors proposed for the 2019 Title 24 standards. It should be noted that the demand factors are for reporting the generation demand savings from the energy efficiency measures proposed for Title 24; this is not used to calculate cost-effectiveness, for that the TDV PV$ are used for that calculation. There are 250 hours which have non-zero demand factors for the 2016 standards demand calculations and there are 290 hours which have non-zero demand factors for the proposed 2019 demand calculations.

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[1] See bottom (cell A8763) of the "CapAlloc" tab of the "TDV_2019 Update_model_7_20.xlsb" spreadsheet

Figure 1 illustrates the timing of the 2016 and 2019 peak demand factors by date. The 2016 factors are the stippled blue columns and the 2019 demand factors are the solid red columns. It is readily apparent that the peak days are very similar between the 2016 and 2019 demand factors.

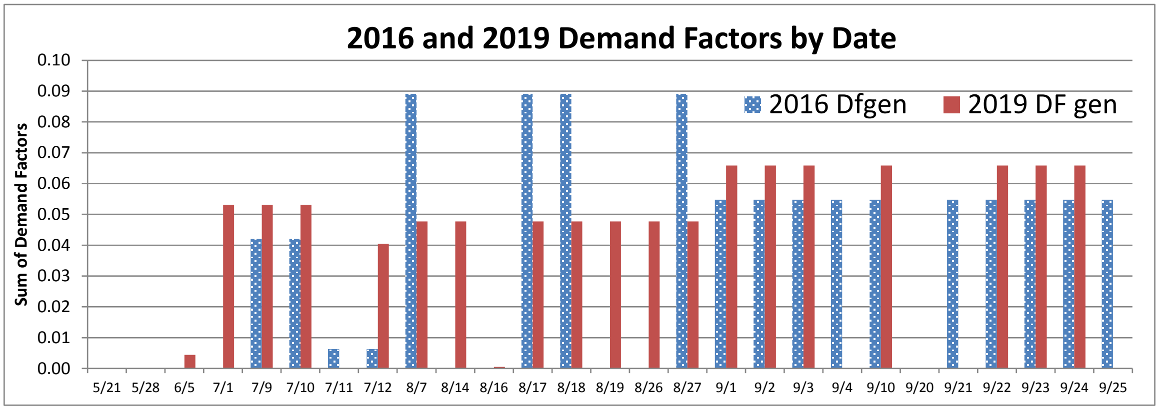

Figure 1: 2016 and 2019 Generation Demand Factor Summary by Date

Figure 2 plots the sum of demand factors by hour of day. It should be noted that the hour numbers reflect the time beginning hour time, so hour 0 is from midnight to 1 and hour 23 is from 11 pm to midnight. Also these values are in terms of Pacific Standard Time and not Pacific Daylight Time. Since these times primarily occur in the summer, the clock times should reflect Pacific Daylight time so for the 2019 demand factors, the hour with the greatest sum of peak demand factors, hour 18 (6 pm to 7 pm PST), corresponds to the scheduled hour of 7 pm to 8 pm Pacific Daylight Time (clock time).

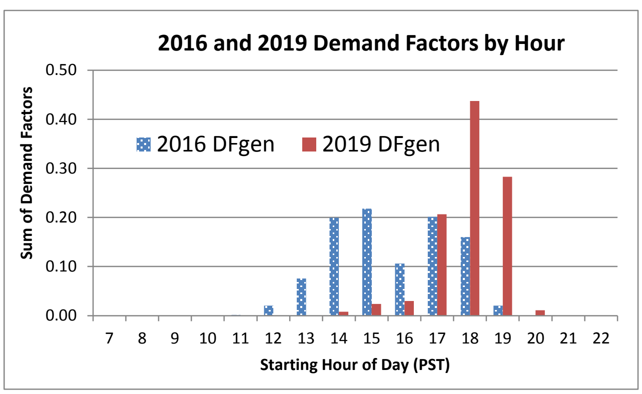

Figure 2: 2016 and 2019 Generation Demand Factor Summary by Time of Day

As compared to the 2016 demand factors, these have shifted several hours later on in the day. This reflects that the TDV calculation of generation capacity allocators for the fossil fueled generation system occurs after subtracting off renewable generation provided mainly by solar photovoltaic systems. This shifts the generation peak to later on in the day as renewables are generating power in the period centered around solar noon. As a result the shift of demand factors to early evenings is representative of how many fossil fueled power plants are avoided by changes in the standard.[2] It should be noted that this methodology results in most of the generation system peak demand being after the normal operating hours of many commercial building types including offices.

[2] See p. 18. Section 3.1.2 "Generation Capacity Avoided Costs" in E3. *Time Dependent Valuation of Energy for Developing Building Efficiency Standards: 2019 Time Dependent Valuation (TDV) Data*

Demand Factor Next Steps

So all this data is in one place, the calculated demand factors for both the 15 year and 30 year period of analyses have been merged with the TDV factors. The TDV factors are from the MSExcel file *"TN212728 20160810T134951 Results of the 72016 version of the 2019 TDV.xlsx"* and this new merged file with both TDV and demand factors is given the name "2019CalBldEffStdTDV7-20-16wDFgen.xlsx".

I recommend that the CBECC-com and CBECC-res software incorporate both the TDV factors and the system demand factors so annual building simulations of hourly electrical loads can be directly used to calculate annual electric TDV kBtu and annual average system peak demand. This would reduce the effort needed to calculate peak demand impacts of various measures. Alternatively, the hourly electrical consumption results from these simulation programs can be exported and separately post-processed with these demand factors to yield the demand impacts.

Modelling of Electric Heat Pump Water Heater in Electrification Example

During the TDV presentation on July 15, 2016, E3 had also presented a number of scenarios on the impacts of the new 2019 TDVs.[3] This included a discussion of how a heat pump water heater would compare to the default water heater, a tankless gas fired water heater with an energy factor of 0.82.

The presentation indicates that the comparison heat pump water heater (AO Smith HPTU 50N) has an energy factor of 3.6, when in actuality it is listed with the CEC as a 3.24 EF heat pump water heater in the CEC's Appliance efficiency database.

The manufacturer lists the energy factor in three different modes as follows:

Energy Factor:

3.61 (Efficiency Mode)

3.24 (Hybrid Mode)

0.93 (Electric Mode)

Efficiency mode is with the electric resistance element in the water heater locked out. Hybrid mode uses the heat pump to generate hot water but will turn on the electric resistance element if the water temperature in the tank is too low (maintaining amenity for the user). Electric mode is the energy factor when only the resistance element is used.

The water heaters are shipped in hybrid mode and thus the CBECC-com software models the water heater in hybrid mode. Thus it is more accurate to describe this heat pump water heater as a 3.24 EF water heater.

Sources and Inputs July 2016. http://docketpublic.energy.ca.gov/PublicDocuments/16-BSTD-06/TN212524_20160801T120224_2019_TDV_Methodology_Report_7222016.pdf

[3] http://docketpublic.energy.ca.gov/PublicDocuments/16-BSTD-06/TN212440_20160725T110215_E3_2019_TDV_Lead_Commissioner_Workshop_Presentation.pdf

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It is also worth noting that the water heater selected is one that has been tested in accordance with NEEA Advanced Water Heater Specification.[4] This more comprehensive test procedure better captures the details of how a HPWH operates, providing detailed data so that the CBEEC-res program can more accurately simulate water heater operation. If the heat pump water heater had not been tested to this detailed specification, the water heater performance would have been more conservatively modeled in CBECC since less information is known regarding actual performance.

The end result is for a similar type of heat pump water heater with a 3.6 EF in hybrid mode, the TDV energy results would be approximately 10% lower and would show the heat pump water heater being equivalent or lower TDV energy consumption than the tankless gas water heater in most climate zones (except perhaps CZs 1, 3, 5 and 16).

I would like to acknowledge the assistance I received from Brian Horii and Snuller Price at E3 and Marc Hoeschele and Bill Dakin at Davis Energy Group.

Sincerely,

Jon McHugh, PE

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[4] Formerly known as the Northern Climate Specification. For more details see: http://neea.org/docs/default-source/northern-climate-heat-pump-water-heater-specification/northern-climate-specification.pdf?sfvrsn=18