ERTAC EGU Growth Algorithm Process Elements (Version 2.2)

5/24/2021

Note: Process numbers refer to the box designations on the flowcharts dated 4/17/2017 in the file named “ERTAC Implementation - v2.2.ppt”. The narrative description referred to in this document is the document entitled, “Implementation Outline 122010.doc”. The most recent spreadsheet showing database structures is entitled, “Data Files Needed - v2.2.xlsx”.

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# Preprocessing Steps

## Process PS1: BY CAMD Data

* Use CAMD data for base year data. The base year may be 2007, 2011, or 2012. In future endeavors, the base year will change. Data may be modified as supplied by ERTAC representatives.
* Only reported data will be used to calculate optimal load threshold, max\_ERTAC \_heat\_input\_hourly\_summer, the ERTAC Heat Rate, and the ERTAC Fuel/Unit Type Bin for partial year reporters.
* This step may also encompass pulling in hourly data that has been manipulated by States or MJOs to account for anomalous unit behavior, reporting errors, or other issues in the hourly data.
* This step may also encompass pulling in hourly data from units that do not report to CAMD but for which States or MJOs may have supplied actual hourly CEM data.

## Process PS1.01: Non EGUs

* The states have developed lists of units reporting to CAMD that should not be grown using factors associated with electrical production. These units should be marked as nonEGUs. The code will remove their data from the CAMD input files.

## Process PS1.04: Seasonal Emissions and Controls

* Some units vary their level of control at differing times of the year, in particular NOX rates between ozone season and non-ozone season. This file converts a list of seasonal emission rates into the same format as ertac\_control\_emissions setting them to run during the appropriate days in the future year being processed and then appends them to ertac\_control\_emissions.

## Process PS1.05: Hourly hierarchies

* Three hourly hierarchies need to be created.
* Assignment of the methodology for hour hierarchy is a choice on the Input Variables worksheet so that modelers may choose one of the three options for each ERTAC fuel/unit type bin by ERTAC region.
* For coal, the listing of hours in the base year is by energy demand, ranked by day. Days are ranked according to the value of the peak energy demand for the highest hour in any day. The hours within the day are ranked from 0 to 23. Days are used for coal in the hierarchy ranking rather than hours since coal units generally cannot turn off and on in an hour.
* For combined cycle, the listing of hours in the base year is by energy demand, ranked by 6 hour periods.
* For others, the order is the highest to lowest energy demand hours.
* These rankings are described further in the Implementation Outline.

## Process PS1.06: Partial year reporters

* Some units did not report an entire year’s worth of data to CAMD in the base year. These units’ data could be manipulated to simulate the unreported hourly data. Annual heat input data may be obtained from States, E-Grid or another source. The difference between the BY annual heat input and the reported period’s heat input will be assigned to the hours in the unreported portion of the base year using a flat profile.

## Process PS1.08: Calculations

* After the calculations below are conducted note any net transfers from the demand transfer file for the hour.
* The hour specific growth rate will come from PS3.01.

| Variable | Definition | Calculation |
| --- | --- | --- |
| BYGen (MW-hr) | Sum of the base year (BY) generation for that hour, the particular region, and the ERTAC fuel/unit type bin. | ΣBase year hourly generation for each region and ERTAC fuel/unit type bin. |
| BYRetGen (MW-hr) | For each hour and ERTAC fuel/unit type bin, the BY generation from each unit that has been either retired or curtailed should be summed. | ΣBase year hourly generation from units that are retired or curtailed. |
| FYGen (MW-hr) | The future year generation for that hour and ERTAC fuel/unit type bin, based on the base year's generation and the growth factor. | BYGen\*(1+HSGR/100) |
| FYGrowth (MW-hr) | The amount of generation in MW that is needed to meet the future year demand for that hour, above the 2007 level. May be more or less than 1, depending on growth rates. Also depends on how high the hour is in the hourly hierarchy. | BYGen\*HSGR/100 |

## Process PS1.09: Unit allocation order

* Using base year data and including new units, the unit allocation order for each ERTAC Region and Fuel/Unit Type Bin should be developed.
* Placement of new units should be as described in the narrative using the input variables worksheet information.
* If new generic units are added in other processes (3.5Y.1), then this allocation order will need to be revised.
* The unit hierarchy will be based on base year utilization fractions for each unit in the region and unit/fuel type.
* The new units are assumed to be more efficient and economical to run, and therefore the new units should be very high on the hierarchy.
* Where new units are inserted into the allocation order may be adjusted in the Input Variable worksheet.

## Process PS2: Unit Calculations

* Data from the Unit Availability File will need to be augmented by other data and manipulated in order to develop all data needed for the algorithm.

## Process PS2.01: ERTAC Fuel/Unit Type Bin

* From CAMD data, each unit must have a derived ERTAC Fuel/Unit Type Bin: oil, natural gas-boiler, natural gas-simple cycle, natural gas-combined cycle, or coal.
* For new units, States must provide this data.

## Process PS2.02: Re-calculate base year emission rates

* For every hour of the year recaluate the base year SO2 and NOX emission rates by dividing the total emissions by the heat input for hours with heat input.

## Process PS2.03: Fill missing gross load with steam load

* From CAMD data hours that are missing gross load but have steam load will have steam load converted to gross load by multiplying steam load by .1.

## Process PS2.04: Unit Specific Statistics

* If a standard deviation limit for heat rate, NOX emission rate, or SO2 emission rate is set in the input variables file, calculates the standard deviation for each unit and sets that value in the updated UAF.
* If a minimum or maximum value for heat rate, NOX emission rate, or SO2 emission rate is set in the input variables file, that value is set in the updated UAF.
* Calculates annual, ozone season, and non-ozone season average heat rate, NOX emission rate, or SO2 emission rate for each unit and sets that value in the updated UAF.

## Process PS2.05: Base Year Operating Hours

* Sets the base year operating hours to the hours listed in the CAMD hourly data file.

## Process PS2.06: ERTAC Heat Rate

* The ERTAC Heat Rate is derived from the base year heat input total and the base year MW-hr total. If steam load is reported, a value of 0.1 MW-hr/1000 lbs steam should be used to convert the steam load to MW-hrs.
* For new units, States must provide unit specific data for this value.

## Process PS2.07: Max\_ERTAC\_heat\_input\_hourly\_summer

* To determine this value, the preprocessing steps should pick the higher of the hourly\_base\_max\_actual\_heat\_input, which is pulled from CAMD hourly data, or the max\_unit\_heat\_input, which is pulled from CAMD unit data or provided by States.
* Data from the 860 report will need to be converted from MW to mmbtu/hr.
* For new units, this data must be supplied by States.

## Process PS2.08: Optimal Load Threshold

* The first pass for distribution of the excess generation pool will drive units to no higher than their optimal load threshold.
* For existing units, this value is a percentile (90th is default) of their BY operating hour data.
* For new units, this value mimics the Optimal Load Threshold (in terms of percent utilization) of the unit beneath the new unit in the Unit Allocation Order, developed in PS1.08.

## Process PS2.09: Utilization Fraction

* Units cannot operate every hour of the year at maximum capacity since they need maintenance.
* The UF ensures that units are not over-allocated.
* For existing units, the UF may be set by the State/MJO. Otherwise, it is the higher of the fraction used in the base year calculated from actual CAMD data or the default data found in the input variables worksheet.
* UF is calculated by summing the BY heat input and dividing by the product of 8,760\* the max\_ERTAC\_heat\_input\_hourly\_summer.
* For new units, the UF is supplied by State/MJO personnel or is the default data in the input variables worksheet.

## Process PS2.10: Proxy Generation

* For coal fired new units, proxy generation is a straight percentage of the max\_ERTAC\_heat\_input\_hourly\_summer value. The percentage may be adjusted in the input variables worksheet.
* For non-coal new units, the proxy generation is based on the percent utilization of the first existing unit just beneath the new non-coal unit in the unit allocation hierarchy. Therefore, for non-coal new units, this value may change hourly.

| Variable | Definition | Calculation |
| --- | --- | --- |
| Proxy % (%) | The % of the unit maximum generation capacity at which a new unit is assumed to be running. | For coal units, the default is 50%, which may be adjusted in the Input Variables worksheet. For other units, the Proxy % must be calculated as noted in the implementation outline. For non coal units, hourly proxy % will change for every hour. |
| ProxyGen (MW-hr) | The hourly generation level at which a new unit is assumed to be running. | Unit max generation for the hour \* Proxy % for the hour |

## Process PS3.01: Growth Rates

* Based on the annual growth factor, the peak growth factor, and the given transition points, the preprocessor needs to develop the hour specific growth rates.
* The transition from peak to non-peak growth rates may be linear or exponential. At this time, the code only provides the linear transition option.

| Variable | Definition | Calculation |
| --- | --- | --- |
| HSGR (%) | The hour specific growth rate. This value is calculated based on 4 data points: the hour’s hierarchy rank, the peak growth rate, the non-peak growth rate, and an input variable in the form of a calculation or function that relates the three previous data points. | n/a: from Growth Rates Table |

# Algorithm Steps

## Process 1: Confirm valid data from preprocessor

* Ensure for each region and fuel unit type bin there are 8,760 hours of data in the calc\_hourly\_base file and raise an error if that is not the case.

## Process 3: Calculations

* Calculations below are needed for each hour of the year, for each region and ERTAC fuel/unit type bin.

| Variable | Definition | Calculation |
| --- | --- | --- |
| TotalProxy (MW-hr) | The sum of all the proxy generation for all new and curtailed units in that hour, region, year, and ERTAC fuel/unit type bin. | ΣProxy generation of all new units in the future year. |
| AFYGrowth (MW-hr) | The adjusted future year growth is the future year growth with the sum of all proxy capacities subtracted. This ensures that new and curtailed units will be allotted some generation in the future year. | FYGrowth-TotalProxy |
| AFYGR (%) | The adjusted future year growth is the amount of growth that will be applied to all existing operating units in the future year. This number may be less than 1. | AFYGrowth/(BYGen-BYRetGen) |
| ExGenPool (MW-hr) | Excess generation pool is the amount of generation needed to be allocated every hour after the AFYGR is applied to every unit operating in the base year generation data. This generation is the sum of additional generation from each unit that is beyond any capacity limitation on that unit. | Summed from the algorithm. |

## Process 3.5: Power capacity deficit check

* Since hours with highest demand requirements are evaluated first, after the top hours are calculated, the algorithm should be able to determine if more capacity to meet future year demand is needed.
* After a certain number of hours, which is an input variable called the deficit review hour, the program should evaluate whether or not enough capacity exists to satisfy demand.
* This step checks the sum of future projected generation and net demand transfers.

## Process 3.5aY.1: Available Capacity Check during Grown Generation Allocation

* This process will be used to meet the highest capacity demand deficit in the hours previously processed. A demand cushion may be applied (a multiplication factor to inflate or deflate the highest capacity demand deficit), as listed in the Input Variable worksheet. The default demand cushion is 1.0.
* The needed capacity is recorded so that generation deficit units (GDUs) can be added later.

## Process 4: Growth factor check

* Check whether the adjusted future year growth factor indicates excess new capacity and document if so.

## Process 4N.1 and 4.2: Assigning “proxy” generation to new units

* New units in the Unit Availability File that did not operate in the base year and therefore do not have CAMD data but are expected to be operating in the future year must have generation assigned to them.
* These new units are expected to be very efficient and therefore are expected to be very economical to operate.
* Each hour, they will be initially assigned a certain amount of generation, their proxy load, as described in the implementation outline. These units will still need to have their annual generation totals tracked so that they don’t exceed the Max \_annual\_ERTAC\_UF for that ERTAC fuel/unit type bin.
* If future projected generation is less than the total proxy generation adjust the total proxy generation down so new units are not assigned too much generation.
* Initially the algorithm will be designed to assume that new units will be fully operational at the start of the future year. Future enhancements may want to allow for units to begin operating commercially in the midst of a future year.

## Process 5: Initial growth of existing units to future year

* Multiply the BY operational input/output of each existing unit by AFYGR. For 4Y.2, the growth rate is < 1 so that generation decreases. For 5, the growth is >1 so that generation increases and there may be an excess generation pool.
* Some units will have steam load rather than MW-hrs. Those units will need to have steam load converted to MW-hrs.
* If include Heat Input Zero Grossload (HIZG) is set to true and the assigned generation is 0, but there was heat input in the base year, bring forward the heat input and emissions to the future year.

## Process 6: Initial capacity check

* For each unit, there are a variety of capacities that need to be consulted with each calculation.
* There are short term maximum generation/capacity values for every unit, which the hourly assigned generation cannot exceed. For example, this would be the max\_ERTAC\_heat\_input\_hourly\_summer.
* There are also annual capacities for every unit, since units cannot be operated 100% of the year due to maintenance and repair concerns. A unit’s annual utilization fraction is calculated by using the capacity factors assigned in the Unit Availability File (field name max\_annual\_ERTAC\_UF). If a unit’s annual utilization fraction is reached, no more generation can be assigned to that unit in any of the following hours. Generation above that limitation would go in the excess generation pool.
* States may manipulate annual capacities to account for future year limitations in the field named Unit\_Annual\_Capacity\_Limit. This field is for units with future year capacity constraints that were not in place in the base year. Such units are identified by a “Y” in the field named Capacity-Limited\_Unit\_Flag. The behavior exhibited when this functionality is used can behave oddly so results should be scrutinized.
* At this point, the algorithm may need to use heat rates to facilitate conversion of maximum rated heat input capacity of units, expressed as mmbtu/hr, and generation, expressed as MW-hr.

## Process 7: Utilization of the unit

* For hourly generation, a unit may be allotted generation up to its max\_ERTAC heat\_input\_hourly\_summer capacity. The unit may be allotted more generation the next hour even if this hourly capacity for the previous hour has been reached.
* Each unit may be allotted up to its annual capacity or utilization fraction, number of hours allowed to operate, and its hourly rates. After the unit has used up its annual capacity, hour cap, or utilization fraction, no more generation for the rest of the year may be assigned to it.
* It should be noted that if large numbers of units reach their annual capacity or operational hour caps and the system as a whole does not have enough capacity to account for units that are curtailed in a later hour in the hierarchy problems can arise with disappearing generation. It is vital that users check to ensure that the proper number of GDUs with the right size were created and that the growth rate was honored by checking the excess generation pool column in calc\_generation\_parms.csv
* Future iteration of the coding could possibly allow trading between peak and annual hour capacities for each unit.

## Process 8: Summing the ExGenPool for that hour, ERTAC fuel/unit type bin, and region

* After each existing unit is grown using the AFYGR, any unit that is above any maximum capacity must have its generation set back to the maximum capacity (either hourly or annual), and the additional generation should be added to the Excess Generation Pool (ExGenPool).
* If an hour has generation in the ExGenPool, it will be assigned to units in the hierarchy after all hours are grown using the AFYGR.
* Use of the unit specific heat rate for conversion purposes between heat input and generation output will be critical.

## Process 8.1: Available Capacity Check for Excess Generation Pool

* This process will be used to determine if capacity is available to allow for the allocation of excess generation.
* There are slightly flaws in this portion of the algorithm, if units have reached their annual capacity limit or annual operating hour cap at a later hour than that being checked this will still be considered available for receiving excess generation inflating the capacity that is available.
* The needed capacity is recorded so that generation deficit units (GDUs) can be added later.

## Process 8.2: Checking if the end of the hour hierarchy has been reached for the initial growth round

* Rather than assigning generation from hour 1 to hour 8,760, the algorithm assigns generation in order of highest demand to lowest demand. This way, units will receive generation in a manner that is more representative of how units would choose to dispatch in reality. If a unit has a limitation on capacity, this method also ensures that the unit would operate on the highest demand days rather than other days.
* To determine the order in which hours are allotted generation, three methods are used, one for coal, one for combined cycle, and one for all other unit/fuel types. See Process PS1.04.
* The algorithm will assign hourly growth to each hour of the year using the AFYGR and will calculate the necessary ExGenPool for each hour of the year. All hours of the year will be grown with the AFYGR before any generation from each hour’s ExGenPool is distributed.

## Process 9: Capacity Needed Check

* Determine if capacity was determined to be needed due to grown and proxy generation not being allocated and if so begin the process to create Generation Deficit Units (GDUs).
* If capacity was available after all grown and proxy generation was allocated determine if capacity is potentially needed to allocate the excess generation pool and if so begin the process to create Generation Deficit Units (GDUs).

## Process 9Y.1: Log Deficit Generation Hours

* Before a GDU is added log generation statistics for all hours including how much capacity was lacking in hours in which GDUs were required for.
* Note: the lacking capacity calculation does not accurately calculate the lacking generation in cases where unit curtailment leads to units hitting the annual capacity cap or annual operation hour cap. This occurs if the cap is encountered when assigning grown, proxy, or excess generation.

## Process 9Y.2: Insertion of GDUs

* New unit(s) will be added using sizes supplied in the input variables file and as described in the Implementation Outline.
* Data for the GDU must be gathered and inputted into the Unit Availability File.
* If the GDU is the 10,000th added for a region/fuel unit type bin no more GDUs are created and a warning is issued.

## Process 9Y.3: Recalculation of the unit allocation order

* When a GDU is created, the unit allocation order must be recreated to account for this unit. The GDU also will receive proxy generation, which will necessitate the recalculation of the TotalProxy, AFYGrowth, and AFYGR.

## Process 9a: Checking for negative demand transfers

* For every hour run a check to see if any demand transfers transferred away more generation was projected in each hour for the region and fuel unit type bin being projected. If so raise an error preventing the code from progressing.

## Process 10.5: Allocation

* After all hours of the future year are grown using the AFYGR, then the ExGenPool for each hour must be distributed to units able to increase hourly generation.
* Page 3 only needs to be performed for hours that have an ExGenPool.

## Process 12 and 14Y.2: Checking for the unit optimal load threshold

* Each unit in the unit availability file will have an optimal load threshold assigned to it. For the first pass of generation distribution from the excess generation pool, units should only receive generation from the pool if they are not yet operating at their optimal load threshold.
* If they are at or above their optimal load threshold, they get no additional generation assigned to them in the first pass.
* Annual capacity limits and max ERTAC UFs must also be checked to ensure that additional hourly generation is assigned to units with the ability to accept the additional generation.
* The cumulative operating hours are also checked to determine if the next hour would put the unit beyond the cap on number of hours the unit can operate.
* The algorithm must keep track of total annual generation for each unit to check annual capacity limits and the max ERTAC UFs. This information would be a good report data to determine how close each unit gets to the annual capacity (stress on system).
* Unit optimal load threshold defaults are calculated based on a percentile rank of the unit’s base year operation. The default for this value is 90th percentile of the hourly generation for that unit. This default may be changed in the input variable spreadsheet. Also, a State may choose to set a unit-specific unit optimal load threshold. For new units, the new unit optimal load threshold should mimic the unit optimal load threshold (as percent utilization) calculated for the unit beneath the new unit in the unit allocation hierarchy.
* This algorithm allows the excess generation to be distributed in two passes. Future modifications to the algorithm may distribute the generation in more than two passes.

## Process 16: Allocating generation and checking on a unit’s maximum rated capacity

* If there is still generation in the pool after distribution of the energy to all units up to the units’ optimal thresholds, the generation will be distributed in a second pass.
* The second pass will allot generation up to a unit’s maximum rated capacity.
* Some units may be at maximum rated capacity before any generation is assigned from the pool due to the application of the AFYGR in process box 5. These units do not receive any generation from the pool beyond their maximum hourly rated capacity.
* Units may be at the annual capacity or the utilization fraction, in which case that unit also does not receive any additional generation.
* The Unit Availability File also has a Unit Optimal Minimum Load Threshold. This is currently not being used. A future enhancement would use this value to turn off units dropping below this threshold on days when generation is expected to decrease and reassign the generation from those units to other, more frequently used units. This may be a future enhancement of the algorithm.

## Process 19-23: Calculating spinning reserve

* Following the allocation of generation ensure that enough capacity exists, accounting for demand transfers, for each hour in aggregate across all of the fuel/unit type bins in a region.
* The spinning reserve capacity should be equal to the capacity of the largest unit operating in that hour in the region.
* If the reserve capacity is less than the capacity of the largest unit raise a flag.

## Process 26: Calculation of emission rates

* ***Note: This CO2(e) has not yet been implemented.***
* Extract base year emission rates for NOX, SO2, and CO2(e) for that hour from CAMD data.
* For new units supplied by States, the emission rates will be supplied in the Controls and Emissions file.
* Only controls that begin after the base year will be applied, except in runs where the base year and future year are equivalent.
* For GDUs inserted by the program to meet generation requirements, default emission rates should be calculated. These emission rates should be the 90th percentile of NOX, SO2, and CO2(e) rates in lbs/mmbtu for that ERTAC fuel/unit type bin and region. These facilities will need PSD permits, at a minimum, and therefore will be subject to BACT and will be very clean. Assuming they are the 10th percentile cleanest units should be a conservative estimate. This value may be varied in the Input Variables worksheet.
* If unit level emission rates for other criteria pollutants exist in the Controls and Emissions file for a particular unit, the future year emissions of those pollutants should be calculated on an hourly and annual basis.

## Process 26.5: Addition of controls

* ***Note: This section has not yet been implemented.***
* This applies control efficiency or controlled emission rates to units that States believe will be controlled by the future year date.

## Process 27: Criteria pollutant policy check

* Units in states and or groups of states subject to a cap in the state or group listing files for a particular pollutant should have their emissions summed.

## Process 27.5: Assignment of “generic” emissions controls

* ***Note: This section has not yet been implemented.***If the TR caps are not met after application of all known controls provided by States, then additional controls must be applied. These are called “generic” controls.
* Assignment of generic controls should be performed as described in the Implementation Outline.

## Process 29 and 30: Climate change checks

* ***Note: This section has not yet been implemented.***
* These are informational. No “controls” are assigned to meet climate change requirements, nor are additional EE/RE programs assumed to be put in place. Another run may be created using updated growth factors adjusted for RPS and other programs not included in AEO. A comparison could be made by state personnel of CO2(e) emissions. However, the model will not generate “generic” CO2(e) reductions to meet cap levels.
* Needed are lists of units, caps, and what accord the units belong to.

# Reporting Processes:

## PS1.06: Partial Year Reporters

* The data used for partial year reporters should be provided for review and quality assurance purposes.
* Data should include unit IDs, annual heat input provided by states that choose to use this functionality, heat input reported to CAMD, and locations.

## PS1.03 and PS2.08: Report on outliers from edit checks

* These reports need to flag units with data outside edit check parameters and explain what the parameters are.

## PS1.09 and PS2.09: Outputs for use in the algorithm

* These output files should also be able to be edited by States so that data can be corrected or adjusted.

## Process 4Y.1: Reporting of excess generation in a region, by State, for an ERTAC Fuel/Unit Type Bin

* Amount of unused capacity in MW for each region, for each hour of the year, for each ERTAC fuel/unit type bin where existing units are predicted to generate less power than in the base year.
* Minimum data in the report are the hours, the ERTAC fuel/unit type bin, the region, the hour specific growth rate (HSGR), the AFYGR, the base year generation, and the AFYGrowth.
* A condensed, overview version of this report will be needed for State review and potential inclusion in SIP TSDs.

## Process 19.1: Generation capacity demand deficit report

* Sorted by region, ERTAC fuel/unit type bin, and hour. Should detail the amount of any demand deficit. For every hour for every region where there exists a demand deficit, there should be a record in this table.
* This report will be a key notification to regions and states.
* The model must assure adequate generation in the future year, so information in the deficit report will be used to evaluate the new “generic” units assigned to a region and unit/fuel type. This report will document the creation of generic generating units as described in the Implementation Outline.
* Data in the report needs to include region, unit/fuel type, region’s total capacity as run in the model, the percent capacity increase needed, the hour specific growth rates, peak and annual growth rates, the location of the new generic units, the size of new generic units, the top 10 facilities of that unit/fuel type, capacity of the top 10 facilities, and the county location of those facilities. Location of the top 10 facilities to receive new units may be set as part of the Input Variables spreadsheet.
* Creation of generic generating units to meet demand deficits will necessitate the reordering of the unit hierarchy in Process 3.6 and will affect the excess generation pool since the new generic unit will receive proxy generation as noted in Processes 4.5 and 4Y2.
* For units in the UAF and the Control and Emissions File, this report should detail the amount of mass from units in the BY that was not able to be grown due to lack of important fields.

## Process 19.5: Generation report

* The stakeholder report on generation needs to list each unit in the region and ERTAC fuel/unit type bin, as well as base year and future year generation data.
* # of hours in the year when generation exceeded optimal thresholds in base year and future year.
* # of hours in the year where units were driven up to their maximum threshold.
* Units and the rank-ordered hour of the year where a unit is driven to optimal threshold, max hourly capacity, and annual capacity.
* Data from the Unit Availability File describing physical limitations of the unit such as optimal threshold, and maximum threshold. Data from the growth file such as hour specific growth rate. For each unit, the mmbtu allocated and MW generated from base year to future year.
* Sorted by region, ERTAC fuel/unit type bin, state ID, county ID, ORIS facility ID, and unit ID.
* Will not contain every hour of the year.
* Should be sortable by unit, ERTAC Region, and ERTAC Fuel/Unit Type Bin

## Process 23Y1: Generation capacity reserve deficit report

* This is a very important report, however, it will not trigger the creation of generic combined cycle units in a region. That process may be part of a future enhancement, but for this iteration, deficits for reserve capacity will only generate reports.
* Information in the report is hour of year, region, amount of capacity needed to meet reserve requirements (% and MW), the location of the top 10 facilities that are combined cycle/natural gas units in the region, and neighboring region’s utilization as compared to capacity. This will allow a comparison between regions to determine if reserve capacity could be bought.

## Process 23.5Y1: Hourly generation database by unit

* The database should include each region, each ERTAC fuel/unit type bin, each hour, heat input data and generation data for both the base year and the growth year, and the total amount of excess generation distributed for that hour. Data will be used by some MJOs to create the hourly inventory data for each unit.
* Every hour for every unit with no generation or heat input, the database should contain zeros so that there is a complete year for each unit.
* Data should be in heat input (mmbtu) and MW to facilitate emissions calculations.
* A summary table should also be included to show annual changes from base year to future year in heat input for each unit.
* A separate summary table by state and by region should also be supplied to show growth.
* BY generation by hour, across the board growth, and excess generation by hour for each ERTAC Region and ERTAC Fuel/Unit Type Bin.

## Process 27.5B: Criteria pollutant control equipment installation report

* State level report that will show a comparison of cap versus estimated emissions.
* This report prints out the units that must have additional control equipment installed beyond the state specified controls to allow the area to demonstrate compliance with policy caps. The report should contain the particular area’s pollutant cap, how far over the cap are the calculated emissions, which units received what controls, and the new total calculated emissions level.
* For each ERTAC Region, the report should also detail existing units that will be receiving State specified controls.

## Process 28: SIP Report and AQ modeling database

* For SIP purposes, the report should detail by State each unit’s BY annual and seasonal heat input, generation, and emissions; FY annual and seasonal heat input, generation, and emissions; the regional annual and seasonal caps for SO2 and NOX under which the unit operates; and the FY annual and seasonal SO2, CO2, and NOX totals for that state and region. Also, the report should include monthly total values for heat input, generation, and emissions for ozone season calculations. The timeframe for the ozone season would be set for each region in the input variables spreadsheet.
* The database needs to have hourly data for each unit for modeling purposes. Like 23.5Y1 plus for each unit SO2, NOX, and CO2, and any other pollutants that can be calculated based on information in the control and emissions file.

## Process 29N and 30N and 31: Climate change cap exceedance reports and compliance report

* **Not yet operational**
* The report should list the climate change cap values.
* The report should also list the amount a region is over the climate change cap values in the future year. The report should be done by state, by climate change program, and should also provide emission totals for CO2 by program codes (Midwest Accord and RGGI).