**Questions regarding ERCOT’s marginal loss study**

*1. Please provide the “Annual Generator Revenue Changes by Load Zone” table as shown on page 3, as separated into two individual tables for thermal and renewable generators, as alluded to in paragraph 1 on page 4. (Invenergy LLC)*

A. The annual generator revenue changes reported by the model for the base case and two sensitivities are provided in the following tables, for thermal and renewable generators, respectively:

**Change in Annual Generator Revenue (Thermal, in $M)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Low Gas  Price Case** | **Base Case** | **High Gas  Price Case** |
| Houston Zone | 171.9 | 216.3 | 257.6 |
| North Zone | -218.8 | -328.3 | -412.2 |
| South Zone | 52.5 | 100.3 | 141.9 |
| West Zone | -36.8 | -47.8 | -56.5 |

**Change in Annual Generator Revenue (Renewable, in $M)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Low Gas  Price Case** | **Base Case** | **High Gas  Price Case** |
| North Zone | -4.2 | -4.7 | -4.2 |
| South Zone | -14.2 | -13.5 | -16.0 |
| West Zone | -115.2 | -131.8 | -132.5 |

*2. Please provide the amount of reduction in production of thermal generation in the West and North Load Zones referenced in paragraph 1 on page 4. (Invenergy LLC)*

A. The reduction in production of thermal generation in the West and North Load Zones reported by the model for the base case and two sensitivities are provided in the following table:

**Reduction in Annual Generation (Thermal, in GWh)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Low Gas  Price Case** | **Base Case** | **High Gas  Price Case** |
| North Zone | 6,068.1 | 8,022.4 | 10,249.8 |
| West Zone | 1,390.7 | 1,575.1 | 1,724.4 |

*3. Please confirm that wind generation units in West Texas do not show a reduction in energy production, as stated in paragraph 1 on page 4. Please provide those amounts of production for wind generation units, if possible, for the years 2030 and 2040. (Invenergy LLC)*

A. ERCOT only simulated one future year (2020) in the marginal loss study. For this future year, the model provided the following results for energy production from wind generation units in West Texas:

**Wind Generation in West Texas**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Low Gas  Price Case** | **Base Case** | **High Gas  Price Case** |
| Average Losses (GWh) | 59,519.8 | 59,524.7 | 59,514.8 |
| Marginal Losses (GWh) | 59,536.1 | 59,548.3 | 59,551.0 |

*4. Can the Uplan model used by ERCOT be used to simulate expected system conditions in the year 2030 and the year 2040, in addition to the year 2020 as presented in this study? (Invenergy LLC)*

A. While ERCOT does conduct long-term planning studies (the current Long-Term System Assessment analysis runs through the year 2033), these long-term studies have input assumptions that are not consistent with the study conducted on marginal losses. Adapting these long-term studies to utilize them for a marginal loss study would require significant effort.

*5. Can the model forecast how the generation mix will change, if marginal losses are implemented? (Invenergy LLC)*

A. The Uplan model, with the input data utilized in this study, cannot be used to forecast how the generation mix will change over time.

*6. Will ERCOT please provide the LMP data and dispatch outcomes in an hourly format for the marginal losses study?  We would like to see the data in an Excel, csv, or pdf format. (STEC)*

A. The requested data is being provided in a separate .csv file.

*7. Why did ERCOT choose not choose a high gas case that mirrored the low gas case (e.g. $1 higher for the high gas case)?  What would the outcomes look like for a higher gas case? (STEC)*

A. ERCOT selected the natural gas forecast for the high gas price case based on the gas price forecast assessment and conversations with stakeholders conducted as part of the 2018 Regional Transmission Plan (RTP). The high gas price case forecast was determined to be adequate for this study based on the change noted in the production cost results, as compared to the base case. ERCOT does not know what the impact of a higher gas price would be on the model results.

*8. ERCOT notes that “The lack of production cost savings in the high gas price case is likely due in part to the increased competitiveness of coal fired units, which are more distant from urban load centers, as gas prices increase.”  However, if coal is displacing gas in the high gas price sensitivity, the “Total Annual Generation” table indicates a decrease in load served as coal generation increases which would seem to indicate that system losses decrease as coal generation increases.  Can ERCOT please reconcile these two statements? (STEC)*

A. While the competition between coal and gas generation resources as gas prices rise is a dominant market factor, your question correctly points out that the model output indicates the actual cause may not be this simple. The model shows that implementation of marginal losses creates greater regionalization of the ERCOT energy market.  One example of this regionalization is shown in the start-up cost changes provided in response to question 13 (below).  So while there are market-wide changes in the competitiveness of coal and gas units as gas prices rise, these changes are affected by the greater regionalization (i.e., greater competition within regions of the grid) imposed by the use of marginal losses.

*9. Can ERCOT quantify the marginal loss surplus identified in the study? (STEC)*

A. These results were provided in response to a question from NRG.

*10. How can the marginal loss surplus be allocated without undoing the incentives created by marginal loss implementation? (STEC)*

A. ERCOT does not have an opinion at this time regarding allocation of the marginal loss surplus.

*11. Please provide the modeled changes in generator revenues from ancillary services. (Vistra)*

A. Ancillary service costs and revenues were not assessed as part of this study. The unit commitment requirements to account for ancillary services were not changed across the 6 runs included in the study results.

*12. Please provide the changes to annual unit revenue shortfalls by zone. (Vistra)*

A. The changes to the annual unit revenue shortfalls reported by the model for the base case and two sensitivities are provided in the following table:

**Change in Annual Unit Revenue Shortfall (in $M)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Low Gas  Price Case** | **Base Case** | **High Gas  Price Case** |
| Houston Zone | 4.1 | 1.2 | 4.5 |
| North Zone | 11.4 | 28.7 | 35.0 |
| South Zone | 4.9 | 13.8 | 25.9 |
| West Zone | 1.2 | -0.1 | 0.5 |

*13. Please provide the changes to annual unit startup cost by zone. (Vistra)*

A. The changes to the annual unit startup costs reported by the model for the base case and two sensitivities are provided in the following table:

**Change in Annual Unit Startup Cost (in $M)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Low Gas  Price Case** | **Base Case** | **High Gas  Price Case** |
| Houston Zone | 0.3 | -1.8 | -1.7 |
| North Zone | 5.5 | 22.9 | 35.2 |
| South Zone | 4.1 | 9.4 | 15.6 |
| West Zone | 3.4 | 4.6 | 4.4 |

*14. Please state the margin of error for UPLAN’s modeling results. (Vistra)*

A. ERCOT has not attempted to quantify the internal margin of error for all of the output from the Uplan model.  Over approximately 15 years of using the model for transmission planning studies, we have developed an expectation of approximately 0.05% internal margin of error for production cost results, meaning that we don’t consider the production cost results of different model runs that are within this margin of error to be significantly different.  This error assessment is not an indication of how closely the Uplan model tracks actual system outcomes.

*15. Would it be possible to create tables to show the deltas to revenue and total generation dispatch by zone and technology? (Vistra)*

A. The changes in annual generator revenue and annual generation by zone and technology reported by the model for the base case and two sensitivities are provided in the following tables, respectively:

**Change in Annual Generator Revenue (Low Gas Price Case, in $M)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Houston Zone** | **North Zone** | **South Zone** | **West Zone** |
| Combined-cycle greater than 90 MW | 88.2 | -120.1 | -2.9 | -21.7 |
| Combined-cycle less than or equal to 90 MW | 19.1 | - | 8.6 | -6.0 |
| Coal and lignite | 12.3 | -58.5 | -0.5 | -2.7 |
| Reciprocating engines | - | -1.5 | -2.3 | - |
| Gas steam non-reheat or boiler without air-preheater | 0.5 | -0.1 | - | -0.1 |
| Gas steam reheat boiler | 10.3 | -16.9 | 12.0 | -4.4 |
| Gas steam supercritical boiler | 28.9 | - | - | - |
| Hydro | - | -0.2 | -0.0 | - |
| Nuclear | - | -13.5 | 28.6 | - |
| Simple-cycle greater than 90 MW | 7.1 | -8.3 | 9.4 | -1.0 |
| Simple-cycle less than or equal to 90 MW | 5.5 | -0.1 | -0.5 | -0.9 |
| PhotoVoltaic Generation Resources | - | -0.9 | -0.0 | -11.8 |
| Wind generation Resources | - | -2.7 | -14.1 | -103.4 |
| Other | - | -0.3 | - | 0.1 |

**Change in Annual Generation (Low Gas Price Case, in GWh)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Houston Zone** | **North Zone** | **South Zone** | **West Zone** |
| Combined-cycle greater than 90 MW | 2,657 | -3,494 | 74 | -878 |
| Combined-cycle less than or equal to 90 MW | 636 | - | 256 | -252 |
| Coal and lignite | 363 | -1,612 | -15 | -83 |
| Reciprocating engines | - | -51 | -67 | - |
| Gas steam non-reheat or boiler without air-preheater | 0 | 1 | - | - |
| Gas steam reheat boiler | 334 | -561 | 426 | -149 |
| Gas steam supercritical boiler | 1,014 | - | - | - |
| Hydro | - | - | 1 | - |
| Nuclear | - | -1 | 265 | - |
| Simple-cycle greater than 90 MW | 142 | -348 | 345 | -28 |
| Simple-cycle less than or equal to 90 MW | 80 | -2 | -29 | -1 |
| PhotoVoltaic Generation Resources | - | - | 0 | 7 |
| Wind generation Resources | - | 3 | 209 | 16 |
| Other | - | -11 | - | 3 |

**Change in Annual Generator Revenue (Base Case, in $M)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Houston Zone** | **North Zone** | **South Zone** | **West Zone** |
| Combined-cycle greater than 90 MW | 125.6 | -234.3 | 5.5 | -26.5 |
| Combined-cycle less than or equal to 90 MW | 18.1 | - | 24.7 | -5.4 |
| Coal and lignite | 55.9 | -55.0 | 8.4 | -12.3 |
| Reciprocating engines | - | -0.6 | -1.3 | - |
| Gas steam non-reheat or boiler without air-preheater | -1.6 | 2.9 | - | -0.2 |
| Gas steam reheat boiler | 4.6 | -13.3 | 4.7 | -1.6 |
| Gas steam supercritical boiler | 15.8 | - | - | - |
| Hydro | - | -0.2 | -0.1 | - |
| Nuclear | - | -14.4 | 42.4 | - |
| Simple-cycle greater than 90 MW | -0.9 | -13.8 | 15.9 | -0.9 |
| Simple-cycle less than or equal to 90 MW | -1.3 | 0.2 | -0.0 | -1.0 |
| PhotoVoltaic Generation Resources | - | -1.1 | -0.0 | -14.0 |
| Wind generation Resources | - | -2.6 | -13.4 | -117.8 |
| Other | - | -0.8 | - | 0.1 |

**Change in Annual Generation (Base Case, in GWh)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Houston Zone** | **North Zone** | **South Zone** | **West Zone** |
| Combined-cycle greater than 90 MW | 3,359 | -6,790 | 444 | -949 |
| Combined-cycle less than or equal to 90 MW | 496 | - | 753 | -190 |
| Coal and lignite | 1,641 | -496 | 335 | -374 |
| Reciprocating engines | - | -16 | -31 | - |
| Gas steam non-reheat or boiler without air-preheater | -28 | 79 | - | - |
| Gas steam reheat boiler | 109 | -343 | 122 | -43 |
| Gas steam supercritical boiler | 436 | - | - | - |
| Hydro | - | - | 1 | - |
| Nuclear | - | 1 | 252 | - |
| Simple-cycle greater than 90 MW | -30 | -460 | 480 | -19 |
| Simple-cycle less than or equal to 90 MW | -49 | 4 | -12 | -0 |
| PhotoVoltaic Generation Resources | - | - | 0 | 5 |
| Wind generation Resources | - | 4 | 279 | 24 |
| Other | - | -10 | - | 4 |

**Change in Annual Generator Revenue (High Gas Price Case, in $M)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Houston Zone** | **North Zone** | **South Zone** | **West Zone** |
| Combined-cycle greater than 90 MW | 137.1 | -307.4 | 25.2 | -24.0 |
| Combined-cycle less than or equal to 90 MW | 17.3 | - | 31.6 | -1.6 |
| Coal and lignite | 99.9 | -61.4 | 18.8 | -27.8 |
| Reciprocating engines | - | -0.3 | -0.9 | - |
| Gas steam non-reheat or boiler without air-preheater | -2.2 | 0.5 | - | -0.2 |
| Gas steam reheat boiler | 3.9 | -11.8 | 4.6 | -0.9 |
| Gas steam supercritical boiler | 11.9 | - | - | - |
| Hydro | - | -0.3 | -0.1 | - |
| Nuclear | - | -14.0 | 43.9 | - |
| Simple-cycle greater than 90 MW | -5.0 | -18.0 | 18.8 | -1.2 |
| Simple-cycle less than or equal to 90 MW | -5.2 | 0.0 | -0.0 | -1.0 |
| PhotoVoltaic Generation Resources | - | -1.1 | -0.0 | -14.5 |
| Wind generation Resources | - | -2.0 | -15.9 | -118.0 |
| Other | - | -0.7 | - | 0.0 |

**Change in Annual Generation (High Gas Price Case, in GWh)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Houston Zone** | **North Zone** | **South Zone** | **West Zone** |
| Combined-cycle greater than 90 MW | 3,655 | -8,910 | 1,016 | -773 |
| Combined-cycle less than or equal to 90 MW | 465 | - | 911 | -47 |
| Coal and lignite | 2,866 | -490 | 629 | -863 |
| Reciprocating engines | - | -8 | -17 | - |
| Gas steam non-reheat or boiler without air-preheater | -23 | 13 | - | - |
| Gas steam reheat boiler | 82 | -274 | 110 | -20 |
| Gas steam supercritical boiler | 290 | - | - | - |
| Hydro | - | - | 0 | - |
| Nuclear | - | 1 | 40 | - |
| Simple-cycle greater than 90 MW | -75 | -582 | 559 | -22 |
| Simple-cycle less than or equal to 90 MW | -89 | 0 | -16 | -0 |
| PhotoVoltaic Generation Resources | - | - | 1 | 5 |
| Wind generation Resources | - | 7 | 318 | 36 |
| Other | - | -5 | - | 1 |

*16. Would it also be possible to create an alternate outage scenario based off of closing 1% of the North and West Coal and Combined Cycle units? (Vistra)*

A. ERCOT is able to conduct additional model simulations, but would prefer to wait until the Commission has time to consider what additional runs would be informative.

*17. How does the modeling ensure that losses for both average loss and marginal loss dispatch is accurately calculated? Is an AC power flow performed to determine actual flows from generation dispatch patterns of each case and then flows on lines for the AC power flow case used to calculate losses? (Shams Siddiqi)*

A. In completing this study, ERCOT staff relied on the software tool to provide an informative assessment of the impact of marginal loss implementation. Although ERCOT staff spent a significant amount of time reviewing and vetting the model output across hundreds of simulation runs, the results of the study have not been verified using an independent method of calculation.

*18. Has ERCOT run ACOPF to determine the inaccuracies of their model in terms of dispatch, prices, and total losses? If not, is there a way for ERCOT to determine the harm done to resources if ERCOT’s method of modeling marginal losses were implemented (e.g. ERCOT’s model is likely to greatly exaggerate the marginal loss impact of electrically distant resources from the distributed load reference bus compared to ACOPF)? (Shams Siddiqi)*

A. ERCOT has not conducted an AC Optimal Power Flow analysis to verify the output of the Uplan model. The Uplan model is not the tool that would be used to implement marginal losses in Security-Constrained Economic Dispatch (SCED). Validation of SCED changes can be addressed during implementation discussions in the event the Commission decides to implement marginal losses.