**Questions regarding IMM Software to Estimate Benefits of RTC**

*1. Were AS offers for all qualified resources set to $0/MW/h?* (Crescent Power, Inc.*)*

A. Qualification status was not used, as it is protected information and not publishable. However, AS offers for each resource that had sold the AS product in the trailing year from the operating date (as a proxy for qualification status) were set to $0/MWh.

*2*. *Or was it only for resources that didn’t offer in that particular interval?* (Crescent Power, Inc.*)*

A. No

*3*. *Why were they set to $0/MW/h when there’s a history of such offers in the current DAM (already a co-optimized market)?* (Crescent Power, Inc.*)*

A. DAM offers reflect the risk of the unit being offline/out in the interval (and the corresponding exposure to SASM prices). There is no corresponding risk with Real-Time AS Offers, thus the IMM felt that DAM offers were not indicative of marginal costs in a Real-Time Co-optimization world.

*4.* *What is the impact of using historical offer prices instead of $0/MW/h on all results?* (Crescent Power, Inc.*)*

A. The IMM made a very conscious decision to use only open source tools, public data, and published, commented code in the generation of the results. This was done to enable other parties to model different scenarios and assumptions.

*5. Please explain the change in SCED with RTC (assuming no look-ahead) that allows more efficient deployment of NFRC and ramp capacity available in the system.* (Crescent Power, Inc.*)*

A. The choice of whether to carry RRS (and thus reduce system capacity by the NFRC amount) or not is essentially a mixed integer problem. Thus, the RT Co-optimization simulation uses a Mixed Integer Program (MIP) solver to determine the most efficient deployment of NFRC; that deployment is then fed to a Quadratic Program solver (QP) to determine dispatch and prices. Most of the ramp enhancement comes from more efficient utilization of ramp sharing, which tends to move Regulation Up to faster ramping units.

6. *The statements summarizing the findings of the study seem misleading. A more accurate summary is:*

1. *A significant reduction in system congestion rents ~~costs~~ ($257M);*
2. *A significant reduction in AS prices ~~costs~~ (resulting in $155M lower payment by load): and*
3. *A significant reduction in energy prices ~~costs~~ (resulting in $1.6B lower payment by load or approximately $4/MWh reduction in prices)*

 *(Crescent Power, Inc.)*

A. The IMM is comfortable with the summary of findings that it provided.

7. *How much of the $257 million in congestion reduction benefit was attributable to better management of the Houston import limit?* (STEC)

A. The IMM has published detailed results and files that will enable you to determine where all of the congestion changes occurred and to what degree. To find out:

1) For each constraint in the input cdr.00012302.YYYMMDD.csv files, multiply the shadow price of the constraint (column F) by the "math limit" (column H) and divide by 4. This is the original amount of congestion rent caused by that constraint.

2) Next, identify the same constraint in the appropriate "binding\_constraintsYYYYMMDD.csv" file in the results.

3) Again, multiply the shadow price (column I) by the math limit (column F) and divide by 4. This is the congestion rent caused by that constraint in the Real-Time Co-optimization model.

4) Compare the two values to determine the amount of congestion rent change. Then,

5) Determine which constraints are involved in the Houston import and total up the change for those constraints.

8. *The IMM admits that the $1.6 billion reduction in energy costs is likely overstated which seems to indicate that this might be the upper boundary to a reduction in energy costs. Can the IMM provide a likely lower boundary for the reduction in energy costs?* (STEC)

A. To determine a good lower bound for the reduction of energy costs to load would require modeling significant assumptions of behavior changes. The IMM made a very conscious decision to use only open source tools, public data, and published, commented code in the generation of the results. This was done to enable other parties to model different scenarios and assumptions. The behavioral change most likely to have a significant effect on both the energy price (raising it) and the production cost savings (also raising it) is the likely reduced commitment of resources in the face of lower prices. To model this one should be able to simply change the status (column EV in the "60d\_SCED\_Gen\_Resource\_Data-DD-MMM-YY.csv" input file) of the resources that one determined would not have come online to "OFF" and re-run the model per the posted. The accuracy of the congestion modeling would suffer somewhat, as the new commitment might cause congestion that was not originally caught by the RTCA and included in the binding constraints input file, but that would likely be a minor problem.