Discussion Paper on Flexiramp and Virtual Bidding
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The flexiramp constraint is currently modeled in FMM. The modeling of the flexiramp constraint in the binding interval of FMM should be having the effect of raising FMM prices for energy and ancillary services to the extent that it causes resources to be scheduled down out of merit to provide ramp in the binding interval, with other resources dispatched higher than they otherwise would be.

Conversely, however, the modeling of the flexiramp constraint in the advisory intervals can lower FMM prices during intervals with potential price spikes, by committing additional generation.

These effects are occurring today and have been impacting FMM prices since the implementation of the FMM market in early 2014. While the CAISO has generally been procuring less flexiramp since early 2014 than in the prior years, the flexiramp constraint still has a non-zero shadow price in many hours of the FMM.[1] These positive shadow prices reflect hours when the flexiramp constraint is raising both energy and ancillary service prices in FMM, relative to what they would otherwise be, given the unit commitment.

The impact of the flexiramp constraint on FMM prices relative to day-ahead market prices is complex to evaluate because the flexiramp constraint not only changes the schedules in the FMM in a way that raises FMM prices relative to the day-ahead market, it also potentially changes the unit commitment in a way that lowers FMM prices relative to the day-ahead market. The design is intended to reduce overall production costs, and generally also reduce FMM prices, but empirically assessing the overall net effect of the two effects would be difficult without very detailed and resource intensive analysis.

DMM data in the quarterly reports tends to show that there has been net virtual supply offers in the day-ahead market in the past year, [2] which would be consistent

1. See, for example. California ISO Department of Market Monitoring, Q3 2015 Report on Market Issues and Performance, Nov 16, 2015, Table 2.4 p. 37.
2. See, for example. California ISO Department of Market Monitoring, Q3 2015 Report on Market Issues and Performance, Nov 16, 2015, Figure 1.14, p. 26.
3. See, for example. California ISO Department of Market Monitoring, Q3 2015 Report on Market Issues and Performance, Nov 16, 2015, Figure E-1 p. 3, Figures 1.1, 1.2 and 1.3 pp. 9-10.

with FMM prices that are lower than day-ahead market prices. [3] This relationship between day-ahead and FMM prices could conceivably be a result of resources committed in RTPD to meet the flexiramp constraint, but it is more likely due to resources being committed through other processes, such as long start units in RUC.

This is something that could be empirically analyzed by examining how much capacity that is on line in real-time that did not receive a day-ahead market schedule is:

a) Long start capacity committed in RUC;
b) Capacity committed through exceptional dispatch or other processes other than either the IFM, RUC or RTPD;
c) Capacity committed in RTPD, potentially committed as a result of the flexiramp constraint.

This analysis is something that would be valuable to carry out not just to understand the impact of the flexiramp constraint but also to understand what is causing uplift, as one could calculate the uplift costs due to the commitment of each of these categories of capacity.

These effects of the flexiramp constraint will be largely unimpacted by the introduction of the flexiramp product, which affects the modeling of the flexiramp constraint in RTD rather than in RTPD.

One potential impact of implementing the flexiramp constraint in RTD with the introduction of the flexiramp product is that it is possible that more ramp will be available in the binding interval of RTPD at lower cost than is the case in the current design because the initial positions of generation resources when RTPD initializes will reflect resources being dispatched down in RTD to provide the flexiramp product. I believe this impact will likely be extremely small if not non-existent because RTPD initializes so far in advance of the binding interval.

However, these effects are difficult to fully evaluate because there may be features of the RTPD initialization based on the RTD solutions at t-42.5 that cause the effect of actual unit positions and dispatch instructions at t-42.5 to impact the RTPD solution when the system is ramp constrained, reducing both RTD and RTPD prices for a given ramp target. If this is the case, implementation of the

flexiramp product may reduce the cost of ramp in RTPD and somewhat reduce FMM prices for energy and ancillary services, given the target and unit commitment.

Because the introduction of the flexiramp constraint in RTD will likely have little or no effect on FMM prices and schedules, it will not directly impact the level of virtual bidding, which depends on the difference between day-ahead market and FMM prices absent the virtual bids. Moreover, if the introduction of the flexiramp product somewhat impact FMM prices by causing the FMM and real-time dispatch to operate more efficiently, that is a good thing, regardless of how it impacts of level of virtual bids.

The introduction of the flexiramp product is likely to somewhat raise RTD prices during non-price spike intervals but should more than offset this impact on average power prices by reducing the frequency of power balance violations in RTD, leading to a net reduction in RTD prices. RTD prices currently tend to exceed day-ahead and FMM prices during the hours ending 17-19, which are also the hours in which the flexiramp constraint tends to have a positive shadow price, i.e. binds and schedules resources out of merit to create ramp which is not actually available in real-time. [4]

Changes in the flexiramp target in RTPD will, however, have a potential impact on FMM prices. There are two factors that could cause the flexiramp target to change with implementation of the flexiramp product. First, better methods of estimating ramp needs could lead to improved targets. This would be independent of flexiramp product implementation. Second, the implementation of the flexiramp product in RTD will mean that more ramp will actually be available in RTD, given the same target in RTPD, which should lower the need for flexiramp in RTPD and allow flexiramp targets to be set at a lower level while achieving the same reduction in power balance violations.

The reason that implementation of the flexi ramp product is expected to increase the supply of ramp in RTD for a given target level is that the shadow price of flexiramp in RTPD is set by out of merit schedules in RTPD that provide additional ramp to meet the target. This ramp capability provided by the out of merit schedules in RTPD is not actually available in RTD in the current implementation, however, because generation is not actually dispatched out of

4. See, for example. California ISO Department of Market Monitoring, Q3 2015 Report on Market Issues and Performance, Nov 16, 2015, Figure 1.3 p. 10 and Figure 2.4 p. 37.

merit in this manner to create ramp in RTD. This out of merit dispatch in RTD will not occur until the flexiramp product is implemented. Hence, any time there is a positive shadow price of ramp in RTPD in the current design, there is likely to actually be a shortage of ramp relative to the target in RTD.

This situation tends to require that the CAISO set a higher target than would otherwise be needed to meet ramp needs in order to cause additional generation to be committed, which is the only factor that changes the amount of ramp actually available in RTD under the current implementation. With the implementation of the flexiramp product, there should be an increase in the amount of ramp that is actually available in RTD for any given level of the flexiramp target, allowing an eventual reduction in the target.

Overall, the implementation of the flexiramp product will not directly impact FMM prices. While the implementation of the flexiramp product might allow reductions in the flexiramp target that would reduce FMM prices given the unit commitment, such a reduction in the target would also reduce the need commit units to provide ramp, which would tend to raise FMM prices. Reducing the production cost of meeting load while prices do not materially rise or fall would tend to reduce uplift costs as well as production costs. The bottom line is that implementation of the flexiramp product should reduce production costs and any impact on the level of virtual bidding would be an indirect impact attributable to increased market efficiency, which might either increase or decrease the level of virtual bids.