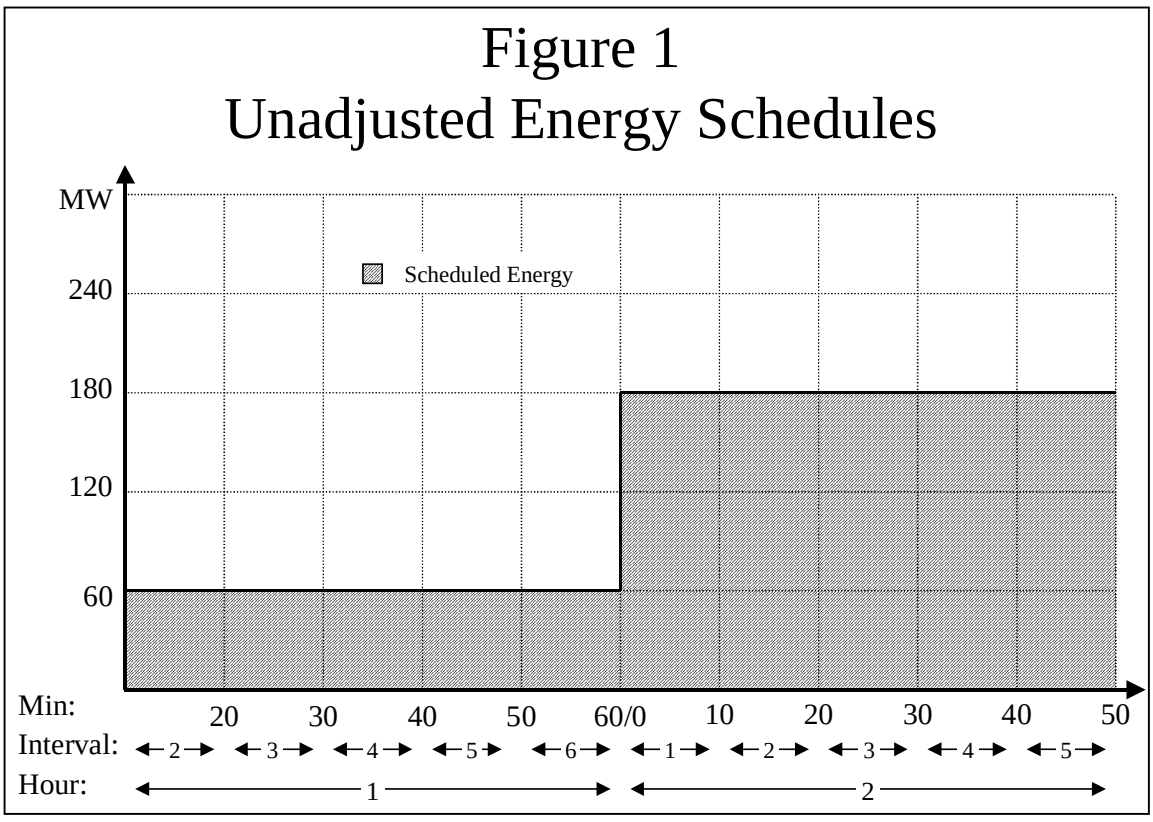
10-MINUTE SETTLEMENT EXAMPLE:
RAMPING ENERGY

Resources must ramp from one hourly schedule to another.[1] A linear 20 minute ramp is consistent with efficient and reliable operation of the ISO Control Area. Under ten-minute settlement, resources will encounter uninstructed deviations, unless a ramping Energy adjustment is made to Energy schedules. This paper uses an example to illustrate how ramping Energy proposed by the ISO provides an incentive for a smooth ramp by eliminating uninstructed deviations that would otherwise be incurred.[2]

NO RAMPING ENERGY

To provide a point of reference, the following illustrates the impact of following a smooth 20 minute ramp with no ramping Energy adjustment. Suppose a resource is scheduled for 60 MWh in Hour 1, and 180 MW in Hour 2, as shown in Figure 1.

Figure 1
Unadjusted Energy Schedules



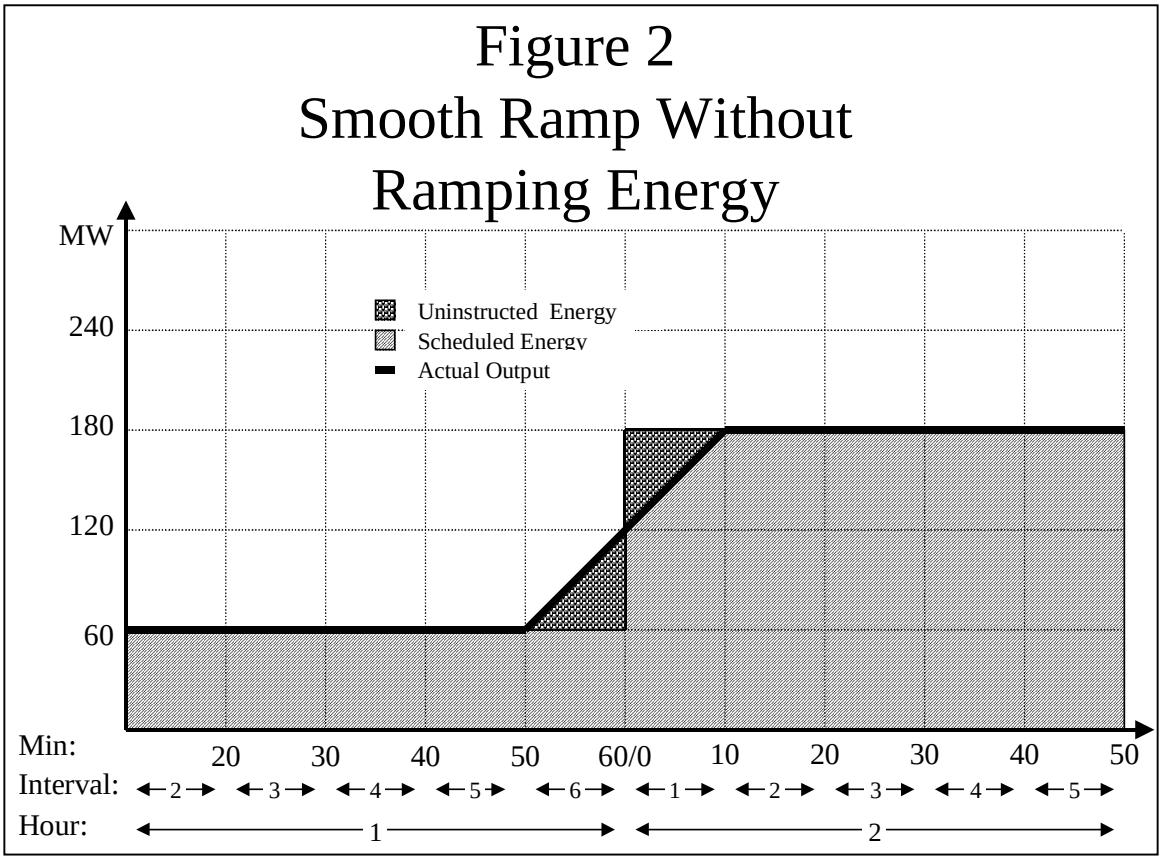
[1] Ramping Energy would apply to resources within the ISO Control Area that are eligible to participate in the Imbalance Energy market.

[2] Uninstructed Imbalance Energy is proposed to be netted based on the deviations of all loads and resources in a Scheduling Coordinator's regional portfolio. For simplicity, this example ignores the impact of netting, and focuses on a single resource.

This hourly schedule would be attributed to each 10-minute BEEP Interval as shown in Table 1. If no adjustment for Ramping Energy is made, then following a 20 minute linear ramp would require this resource to undertake uninstructed deviations, as illustrated in Figure 2.[3]

Table 1
Assignment of Hourly Schedules to BEEP Intervals
MWh

Interval	Hour 1	Hour 2
1	10	30
2	10	30
3	10	30
4	10	30
5	10	30
6	10	30
Hourly Total	60	180



[3] The average output in Interval 6 of Hour 1 is 90 MW, and the Energy delivered in that interval is 15 MWh (90 MW X 1/6 hr.). The average output in Interval 1 of Hour 2 is 150 MW, and the Energy delivered in that interval is 25 MWh (150 MW X 1/6 hr.).

Table 2 shows the actual output, by BEEP Interval, consistent with the smooth ramp illustrated in Figure 2.

Table 2
Actual Output Associated with a Smooth Ramp
MWh

Interval	Hour 1	Hour 2
1	10	**25**
2	10	30
3	10	30
4	10	30
5	10	30
6	**15**	30
Hourly Total	60	180

Table 3
Uninstructed Deviations Associated with a Smooth Ramp
MWh

Interval	Hour 1	Hour 2
1	0	**-5**
2	0	0
3	0	0
4	0	0
5	0	0
6	**5**	0
Hourly Total	5	-5

Table 3 then shows the uninstructed deviations associated with following this smooth ramp. The uninstructed deviation in each interval is the difference between the actual output in Table 2, and the schedule attributed to each interval in Table 1.

This result illustrates two extremely important points:

1) Following a smooth ramp unavoidably results in uninstructed deviations if no adjustment for ramping Energy is made.
2) Uninstructed deviations associated with a smooth ramp are always symmetric from one hour to the next, and always net to zero.

NO RAMPING ADJUSTMENT - SETTLEMENT

Ramping involves potentially negative settlement consequences in the absence of a ramping adjustment. First, resources scheduled to provide Spinning Reserve, Non-Spinning Reserve or Replacement Reserve may lose capacity and energy payments. Second, other resources face price risk related to uninstructed deviations associated with ramping.

Whenever an uninstructed deviation is delivered using capacity obligated to be unloaded and available for Ancillary Services, then both the capacity payment

and the associated Energy payment will be eliminated.[4] In the example above, if all unloaded capacity in Hour 1 is obligated to be unloaded and available as Spinning Reserve, then the resource will lose payment for 5 MW of Spinning Reserve in Hour 1, and would not be paid anything for the 5 MWh of uninstructed incremental Energy delivered in that interval. However, in Interval 1 of Hour 2, the resource would still be charged for the 5 MWh of uninstructed decremental Energy.

Even if a resource has no Ancillary Service obligation, the uninstructed deviations associated with following a smooth ramp will impose a price risk on the resource whenever either of the following occurs:[5]

1) Separate incremental and decremental BEEP Interval Ex Post Prices are established, or
2) A single price is established, but that price changes from one interval to the next.

These two scenarios are illustrated in Table 4. In Scenario 1, uninstructed incremental deviations would be paid $25/MWh, and uninstructed decremental deviations would be charged $35/MWh in both intervals. In Scenario 2, uninstructed incremental and decremental deviations would be paid or charged $30/MWh in the 6th interval of Hour 1, and paid or charged $40/MWh in the 1st interval of Hour 2.

Table 4
Energy Pricing Scenarios
$/MWh

Prices	Hour 1 6th Interval	Hour 2 1st Interval
Scenario 1		
Inc Price	35	35
Dec Price	25	25
Scenario 2		
Inc Price	30	40
Dec Price	30	40

Table 5 shows the settlement consequences of following a smooth ramp under these two pricing scenarios.

[4] The "No Pay" program to encourage Ancillary Service compliance originally filed in Amendment 13 will is proposed to become effective when 10-minute settlement is implemented.

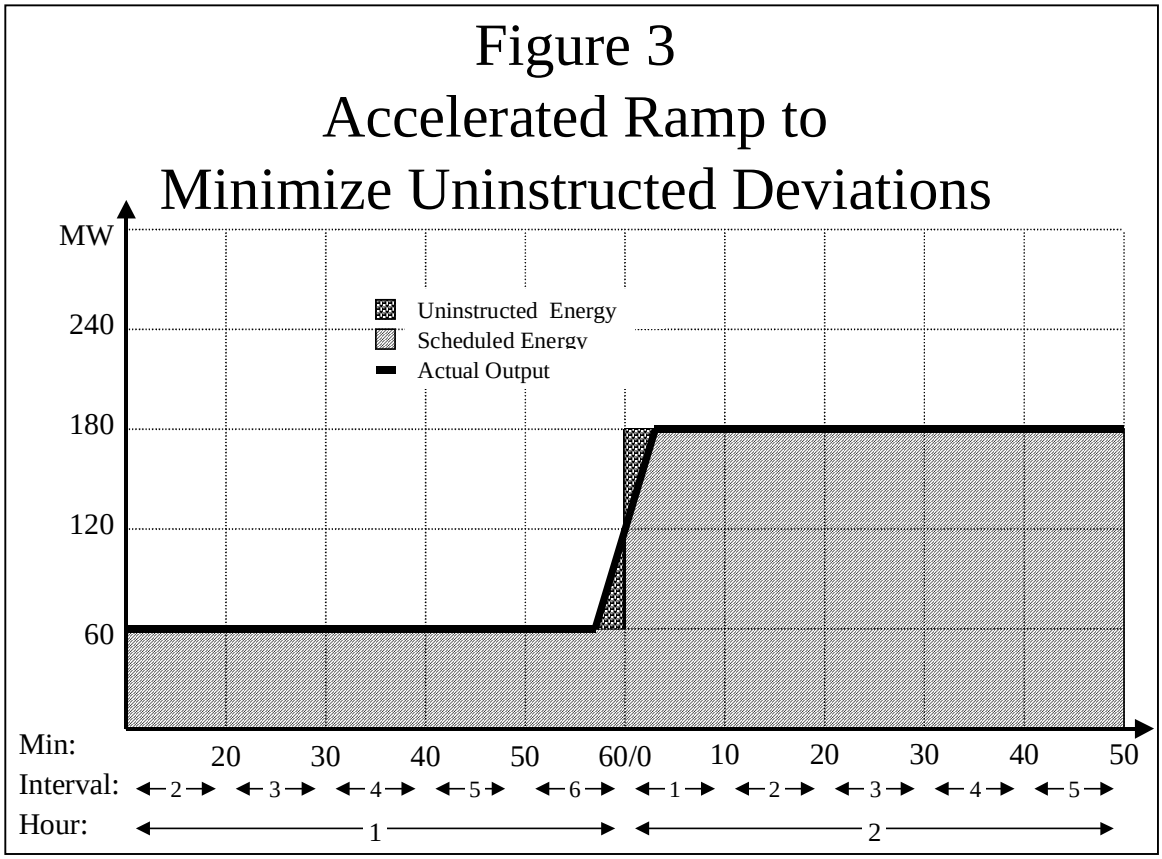
[5] An essential element of the proposal for 10-minute settlement is that uninstructed net incremental deviations are proposed to be paid the dec price, and uninstructed net decremental deviations charged the inc price. This element of the proposal assures that the marginal cost of accommodating uninstructed deviations is used to price those deviations on a net system basis.

The net charges shown in Table 5 illustrate the price risk that would be imposed on a resource that follows a smooth ramp. Although it is possible that a net payment could be earned, if the prices in Scenario 2 were reversed, the uncertainty with respect to settlement consequences of following a smooth ramp represents risk that resource owners would seek to minimize.

Table 5
Settlement of Uninstructed Ramping Deviations
(20 Minute Ramp)

	Hour 1 6th Interval	Hour 2 1st Interval	Net Payment (Charge)
Uninstructed Deviation MWh	5	(5)	
Scenario 1 Results			
Price $/MWh	25	35	
Payment (Charge) $	125	(175)	**(50)**
Scenario 2 Results			
Price $/MWh	30	40	
Payment (Charge) $	150	(200)	**(50)**

Figure 3 illustrates one potential strategy to minimize this risk that is available to fast ramping resources. Such resources might elect to ramp very quickly to minimize uninstructed deviations.



In Figure 3, the resource is assumed to ramp over five minutes instead of 20 minutes. This reduces the amount of uninstructed deviations by 75%, which reduces the price uncertainty and therefore the risk.

Table 6 shows these results. Ramping quickly would partially mitigate the price risk of uninstructed deviations (if no ramping Energy adjustment is made). However, such a practice is inconsistent with reliable, efficient system operations. An incentive for such behavior would be inappropriate.

Table 6
Settlement of Uninstructed
Ramping Deviations
(5 Minute Ramp)

	Hour 1 6th Interval	Hour 2 1st Interval	Net Payment (Charge)
Uninstructed Deviation MWh	1.25	(1.25)	
Scenario 1 Results			
Price $/MWh	25	35	
Payment (Charge) $	31.25	(43.75)	**(12.50)**
Scenario 2 Results			
Price $/MWh	30	40	
Payment (Charge) $	37.50	(50.00)	**(12.50)**

In summary, without a ramping Energy adjustment:

1) A resource that uses capacity obligated to be available for an Ancillary Service to ramp between hourly schedules risks both capacity and energy payments.
2) Resources without Ancillary Service obligations would still incur uninstructed deviations associated with ramping, which introduces price risk.
3) Since uninstructed deviations are priced at the marginal cost in each BEEP Interval, uninstructed incremental deviations may be less valuable than uninstructed decremental deviations, and following a smooth ramp may therefore result in a net cost.
4) Those resources that can ramp in less than 20 minutes can mitigate (but not eliminate) their risk by following an accelerated ramp that would reduce the volume of uninstructed deviations. This incentive is inconsistent with reliable and efficient operation of the ISO Control Area.

PROPOSED RAMPING ENERGY ADJUSTMENT

Based on these results, the ISO is proposing a ramping Energy adjustment to schedules attributed to the first and sixth interval of every hour. The amount of this adjustment is shown in Table 7. The amount of the ramping

Table 7
Ramping Energy
Adjustments
MWh

Interval	Hour 1	Hour 2
1	0	**5**
2	0	0
3	0	0
4	0	0
5	0	0
6	**-5**	0
Hourly Total	-5	5

Energy adjustment exactly offsets the uninstructed deviations associated with following a smooth ramp that were shown in Table 3.

Table 8 revises the schedules attributed to each BEEP Interval (from Table 1) to include the ramping Energy adjustment. When matched against the actual output shown in Table 2, the revised interval schedules shown in Table 8 are identical, meaning that no uninstructed deviations result. The Energy schedule in Table 8, as adjusted by Ramping Energy, is increased by 5 MWh in Hour 1, and decreased by 5 MWh in Hour 2. The total schedule across the two hours has not been changed.

Table 8
Schedules Adjusted by Ramping Energy
MWh

Interval	Hour 1	Hour 2
1	10	**25**
2	10	30
3	10	30
4	10	30
5	10	30
6	**15**	30
Hourly Total	65	175

Why are no prices specified for Ramping Energy?

The impact of the proposed ramping Energy adjustment is simply to redefine the schedule in a way that encourages a smooth ramp. Deviation from a smooth ramp will result in uninstructed deviations that will be priced accordingly.

In summary:

1) The ramping Energy adjustment is effectively a symmetric change in the schedule attributed to the sixth interval of one hour and the first interval of the next hour.
2) The adjustments are equal and opposite, without exception, resulting in no net increase or decrease in Energy.
3) The adjustments eliminate the uninstructed deviations associated with following a smooth ramp.
4) Since a smooth ramp involves no uninstructed deviation, there is no risk that "No Pay" will eliminate Energy and capacity payments.
5) With the ramping Energy adjustment, a resource that fails to follow a smooth ramp will face uninstructed deviations and the associated price risk.