

Regulation Market Concepts – Benefits Factor Calculation

The business rule for resource specific benefits factor calculation is detailed in Section 3.2.7 of M-11: Energy & Ancillary Services Market Operations - <http://pjm.com/~media/documents/manuals/m11.ashx>

The Benefits Factor Curve models the rate of substitution between traditional RegA and dynamic RegD resources. It also limits the amount of RegD MW that can be procured for the optimal mix of RegA and RegD resources for system control. Both RegA and RegD raw MWs are translated into Effective MWs that are used to meet the Regulation Requirement. Resource specific Benefits Factors are calculated for all eligible RegD resources. The Benefits Factor for all RegA resources is 1.

Resource Specific Benefits Factor Calculation Steps with Numerical Example

1. Calculate Performance Adjusted MW

$$\text{Performance Adjusted MW} = \text{Capability MW} * \text{Historical Performance Score}$$

The Capability MWs are the raw MW offers submitted on the Regulation Offers page in Markets Gateway.

Resource	Offer Type	Signal Type	Capability MW	Performance Score	Performance Adjusted MW
A	Economic	D	50	0.90	45
B	Economic	D	50	0.75	37.5
C	Self-Scheduled	D	50	0.80	40
D	Self-Scheduled	D	50	0.50	25
E	Economic	D	50	0.99	49.5
F	Economic	D	50	0.85	42.5

Sample Calculation:

$$\text{Performance Adjusted MW}_{\text{Resource A}} = 50 \text{ MW} * 0.90 = 45 \text{ MW}$$

2. Calculate Initial Adjusted Total Offer Cost

$$\text{Total Offer (\$)} = \text{Regulation Capability Offer (\$)} + \text{Lost Opportunity Cost (\$)} + \text{Performance Offer (\$)}$$

The Regulation Capability Offer and the Regulation Performance Offer are entered on the Regulation Offers page in Markets Gateway. The Lost Opportunity Cost is a calculated value based on forgone revenue when a resource is dispatched uneconomically in order to provide regulation service.

$$\text{Adjusted Total Offer (\$)}_{\text{initial}} = \frac{\text{Total Offer (\$)}}{\text{Historical Performance Score} * \text{Benefits Factor}}$$

(Assume BF = 1 for this step of the Benefits Factor Calculation)

Regulation Market Concepts – Benefits Factor Calculation

Resource	Offer Type	Signal Type	Reg MW	Performance Score	Performance Adjusted MW	Total Offer	Initial Adjusted Total Offer
A	Economic	D	50	0.9	45	\$0.00	\$0.00
B	Economic	D	50	0.75	37.5	\$0.00	\$0.00
C	Self-Scheduled	D	50	0.8	40	\$0.00	\$0.00
D	Self-Scheduled	D	50	0.5	25	\$0.00	\$0.00
E	Economic	D	50	0.99	49.5	\$1.00	\$1.01
F	Economic	D	50	0.85	42.5	\$2.00	\$2.35

Sample Calculation:

$$Adjusted\ Total\ Offer\ (\$)_{Resource\ F_initial} = \frac{\$2.00}{0.85 * 1} = \$2.35$$

3. Rank Resources

Put resources in ascending rank order based on Initial Adjusted Total Offer and calculate the cumulative Performance Adjusted MW. RegD resources with Initial Adjusted Total Offer equal to zero will be ordered using the resource specific historical performance score as a tie-breaker.

Resource	Offer Type	Signal Type	Reg MW	Performance Score	Performance Adjusted MW	Total Cost	Initial Adjusted Total Offer	Cumulative Performance Adjusted MW
A	Economic	D	50	0.9	45	\$0.00	\$0.00	45
C	Self-Scheduled	D	50	0.8	40	\$0.00	\$0.00	85 = (45+40)
B	Economic	D	50	0.75	37.5	\$0.00	\$0.00	122.5 = (45+40+37.5)
D	Self-Scheduled	D	50	0.5	25	\$0.00	\$0.00	147.5 = (45+40+37.5+25)
E	Economic	D	50	0.99	49.5	\$1.00	\$1.01	197 = (45+40+37.5+25+49.5)
F	Economic	D	50	0.85	42.5	\$2.00	\$2.35	239.5 = (45+40+37.5+25+49.5+42.5)

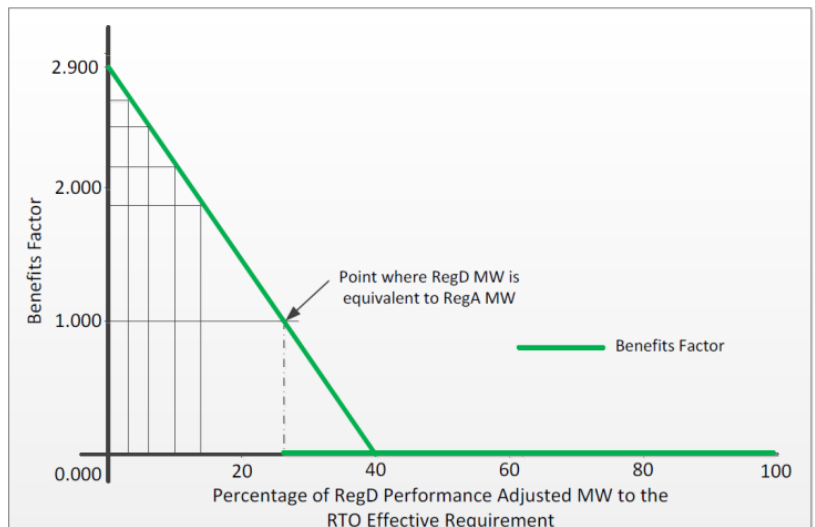
In this example, Resources A, C, B & D all have Initial Adjusted Total Offers of \$0.00. They will all clear before any resource with a non-zero Adjusted Total Offer. Historical performance score is used as a tie-breaker to determine their order.

4. Assign resource specific Benefits Factor based on the defined benefits factor curve.

The Benefits Factor is the intersection on the Y (BF) axis of the corresponding cumulative Performance Adjusted MW on the X (Percentage RegD) axis.

$$BF_i = \frac{Perf_AdjMW_i * (0.0001 - 2.9)}{Percentage\ RegD * RegReq} + 2.9$$

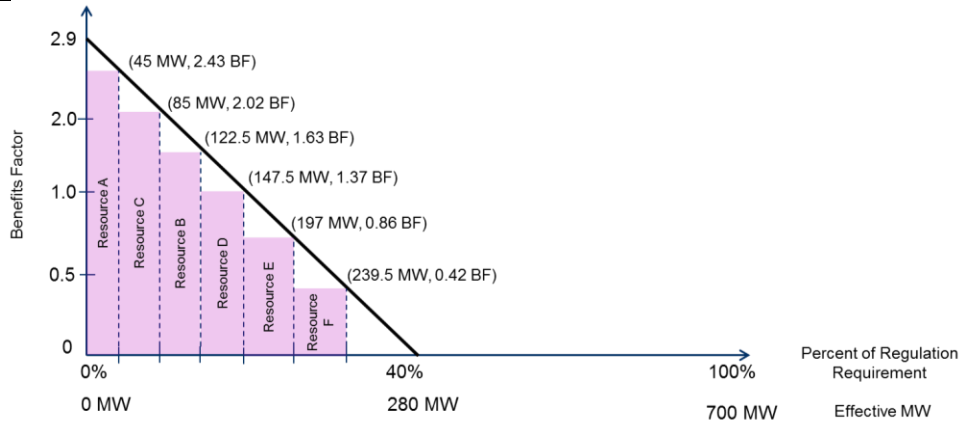
Percentage RegD in the equation is defined as the point on the Benefits Factor curve where an additional MW of RegD will no longer be beneficial to the system (where the curve hits the X Axis). It is currently 40%.



Regulation Market Concepts – Benefits Factor Calculation

Resource	Offer Type	Signal Type	Reg MW	Performance Score	Performance Adjusted MW	Total Cost	Initial Adjusted Total Offer	Cumulative Performance Adjusted MW	Benefits Factor
A	Economic	D	50	0.9	45	\$0.00	\$0.00	45	2.43
C	Self-Scheduled	D	50	0.8	40	\$0.00	\$0.00	85	2.02
B	Economic	D	50	0.75	37.5	\$0.00	\$0.00	122.5	1.63
D	Self-Scheduled	D	50	0.5	25	\$0.00	\$0.00	147.5	1.37
E	Economic	D	50	0.99	49.5	\$1.00	\$1.01	197	0.86
F	Economic	D	50	0.85	42.5	\$2.00	\$2.35	239.5	0.42

Sample Calculations:



$$BF_{Resource\ A} = \frac{(45\ MW) * (0.0001 - 2.9)}{0.40 * 700\ MW} + 2.9 = 2.43$$

$$BF_{Resource\ C} = \frac{(85\ MW) * (0.0001 - 2.9)}{0.40 * 700\ MW} + 2.9 = 2.02$$

$$BF_{Resource\ B} = \frac{(122.5\ MW) * (0.0001 - 2.9)}{0.40 * 700\ MW} + 2.9 = 1.63$$

During defined Excursion Hours (currently HE 7-8 & 18-21), RegD resources will be considered for clearing up to the RegD-RegA neutrality point (where the BF = 1). In this example, Resource E and Resource F would not be considered for clearing because they have Benefits Factors less than 1.

5. Calculate Effective MWs

Effective MWs are what is used to meet the Regulation Requirement.

$$Effective\ MW = Performance\ Adjusted\ MW * Benefits\ Factor$$

Resource	Reg MW	Performance Adjusted MW	Benefits Factor	Effective MW
A	50	45	2.43	109.4
C	50	40	2.02	80.8
B	50	37.5	1.63	61.1
D	50	25	1.37	34.3
E	50	49.5	0.86	42.6
F	50	42.5	0.42	17.9
Total	300	239.5		346.1

Sample Calculation:

$$Effective\ MW_{Resource\ A} = 45\ MW * 2.43 = 109.4\ MW$$

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Additional Information

Calculating the Benefits Factor is one of the initial steps in the clearing and pricing of the Regulation Market.

- Clearing takes place in the Ancillary Service Optimizer (ASO) an hour ahead of the operating hour
- Pricing takes place in the Locational Pricing Calculator (LPC) in real-time

Please send any questions on these examples to PJM Member Relations at custsvc@pjm.com or call 610-666-8980.