Proposed Revision to the Adjusted Total Cost Formulation and the Benefits Factor Curve

Regulation Performance Impacts

Special OC Meeting

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Highlights of Root Cause

- Two Market Clearing Issues identified

  - Adjusted Total Cost formulation is ineffective in instances of RegD self-scheduled and/or offered at $0;
    - Market Clearing Engine is unable to optimally procure RegA/D mix

  - The current Benefits Factor curve is not aligned with regulation signal types dispatch in Operation
    - RegD control signal at times in opposite of ACE control due to energy neutrality reset

The Adjusted Total Cost - Issue 1

$$\textbf{\textit{The Adjusted Total Cost}}\ (\$) = \left(\frac{\textbf{\textit{Cap}}\$ + \textbf{\textit{LOC}}\$ + \textbf{\textit{Perf}}\$}{\textbf{\textit{PS}} * \textbf{\textit{BF}}}\right)$$

- The Adjusted Total Offer Cost in section 3.2.7 of Manual 11
- The modeling equation has performance score (PS) and benefits factor (BF) as denominators
  - Resources with high PS should look cheaper to the clearing engine
  - RegD resource with BF > 1 should look cheaper while BF < 1 should look expensive
  - The modeling equation is ineffective for instance when
    - Multiple resources self-scheduled for regulation
    - Multiple resources offered for regulation at $0

Benefits Factor Calculation - Issue 1 Potential Fix

$$The\ Adjusted\ Total\ Cost\ (\$)_{BF\ calc} = \left(\frac{Cap\$+LOC\$+Perf\$}{PS*BF}\right) + \left(\frac{1}{PS*BF}\right)$$

- The modeling equation revised to include performance adder component
  - The revised equation will be used solely for RegD BF ranking
  - The performance adder component to quantify performance score
  - Almost unique BF for RegD except a very rare instance of same PS
    - When multiple resources self-scheduled for regulation
    - When multiple resources offered for regulation at $0

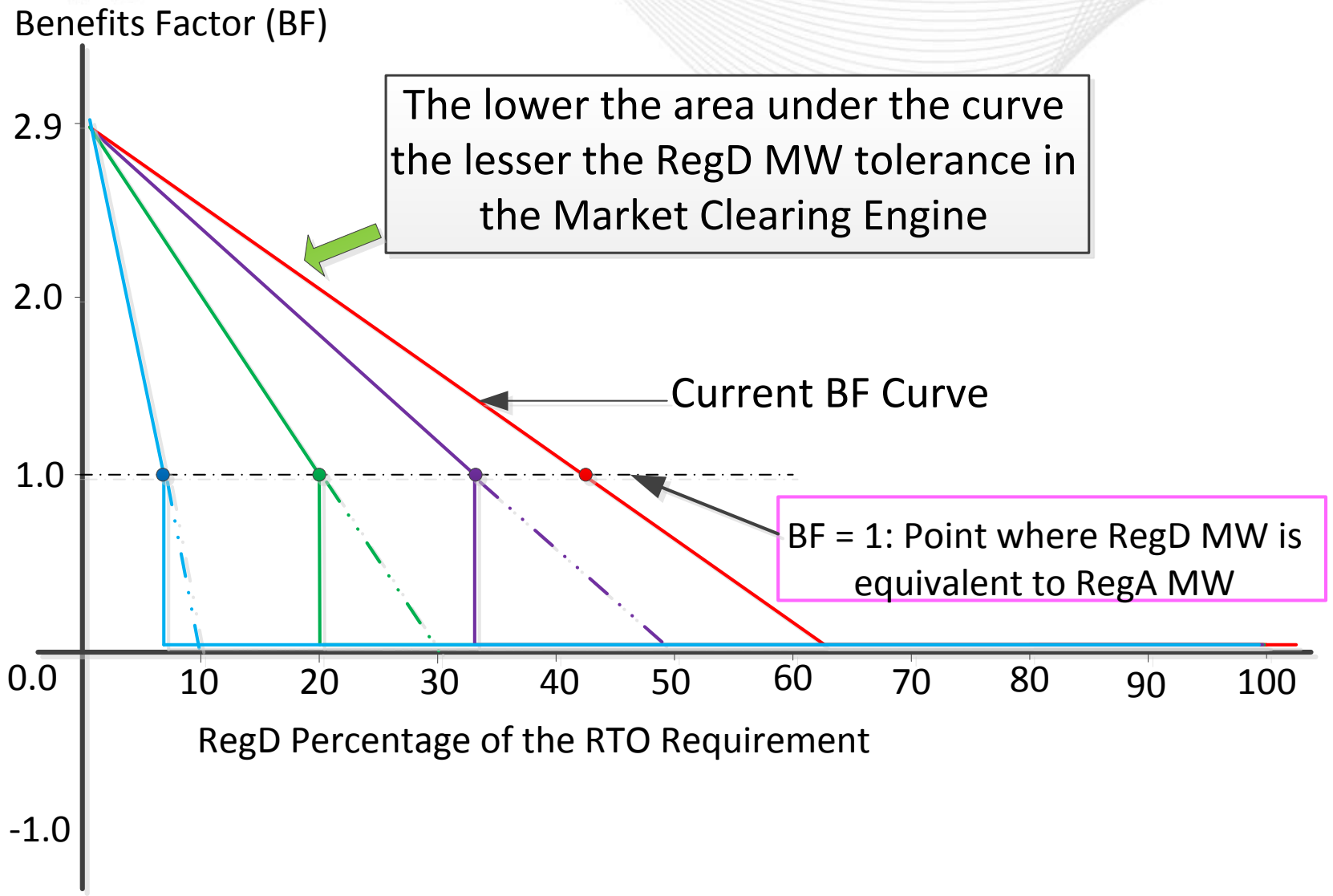
Performance Adder Component For BF ranking ONLY

Numerical Example - Adjusted Total Cost Formulations Comparison

Resource	Offer MW	Offer $	Performance Score	Effective MW (initial)	Adjusted Total Cost $ (current)	Adjusted Total Cost $ (Revised)
A	10	0	1.0	10	0	1
B	10	0	0.9	9	0	1.11
C	10	0	0.8	8	0	1.25
D	10	0	0.7	7	0	1.43
E	10	0	0.5	5	0	2.0
F	10	0.01	0.5	5	0.02	2.02

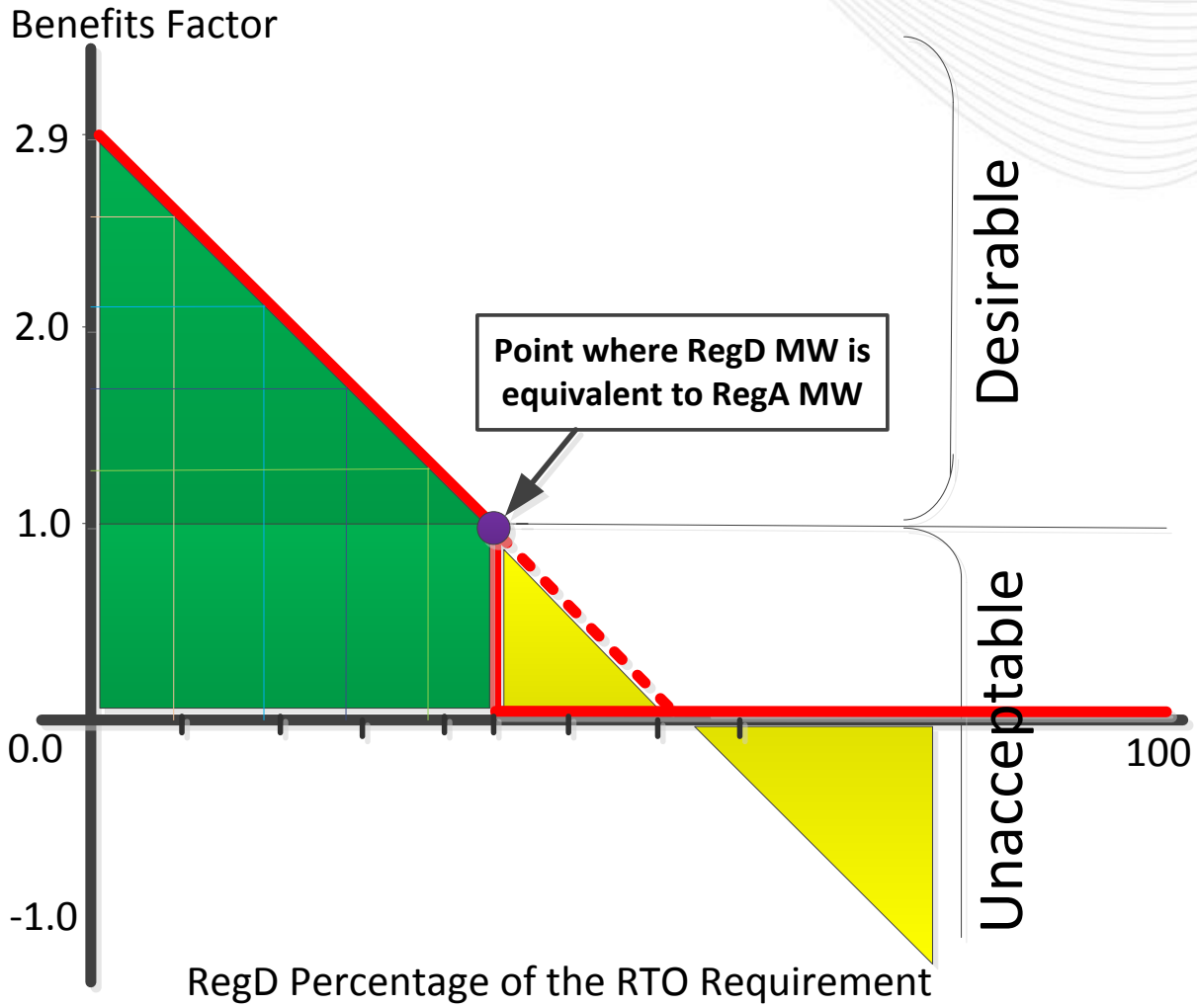
- The Performance Score is now valued in the adjusted total cost (revised) calculation
- Self-scheduled and $0 offer are still considered before economic offer
  - Resource F is valued after E

Understanding Benefits Factor Curve – Issue 2 and Proposed Fix



- The current curve allows for more RegD clearing than the right mix;
- The right mix should be consistent with operation experience on regulation dispatch for ACE control

Proposed BF Curve - RegD Acceptable Benefits Factor Range



BF Range	Signal Type Effective MW	Remark
BF > 1	RegD_Eff_MW > RegA_Eff_MW	Desirable
BF = 1	RegD_Eff_MW = RegA_Eff_MW	Acceptable
BF < 1	RegD_Eff_MW < RegA_Eff_MW	Unacceptable

- Proposed Logic Revision
  - If a resource BF is less than 1
    - Set the BF to 0 in the Market Clearing Engine
    - Then Effective MW = Raw MW * PS * 0 = 0
    - Resource will not clear as RegD
  - Tie breaking logic will favor RegA over RegD

Market Simulation Setup

- Step 1: For RegD resources that self-scheduled
  - Changed offer MW from self-scheduled to economic
  - Changed from price taker to economic offer at $0.01 (capability cost and price)
- Step 2: For RegD resources that offered at $0
  - Changed the $0 offer to $0.01
- Step 3: For resources with dual signal capability
  - Made offers for both signal types at $0.01
  - Made status for both signal types to ‘available’
- Step 4: Define Benefits Factor curve to BF = 1 but extended to various x-axis intercept points

Market Simulations and Results – June 2nd, 2015 Hour Beginning 13

X-Axis Intercept	Original (62%)	50%	40%	30%	25%	20%
BF = 1 Intercept	40.6	32.8	26.2	19.7	16.4	13.1
RegA_MW_Actual	348.4	384.5	521.0	553.9	629.4	664.6
RegD_MW_Actual	357.8	227.3	127.3	127.3	96.0	95.0
Reg_MW_Total_Actual	706.2	611.8	648.3	681.2	725.4	759.6
RegD_Actual_Percentage	50.7%	37.2%	19.6%	18.8%	13.2%	12.5%
RegA_MW_Eff	294.6	323.0	440.0	469.6	520.3	542.9
RegD_MW_Eff	405.4	377.0	260.0	230.4	179.7	157.1
Reg_MW_Total_Eff	700	700	700	700	700	700
RegD_Eff_Percentage	57.9%	53.9%	37.1%	32.9%	25.7%	22.4%
RMCP						
MBF	1.03	1.24	1.66	1.24	1.38	1.02
CPS1_Score	115.6%	117.1%	118.3%	118.3%	118.5%	118.4%

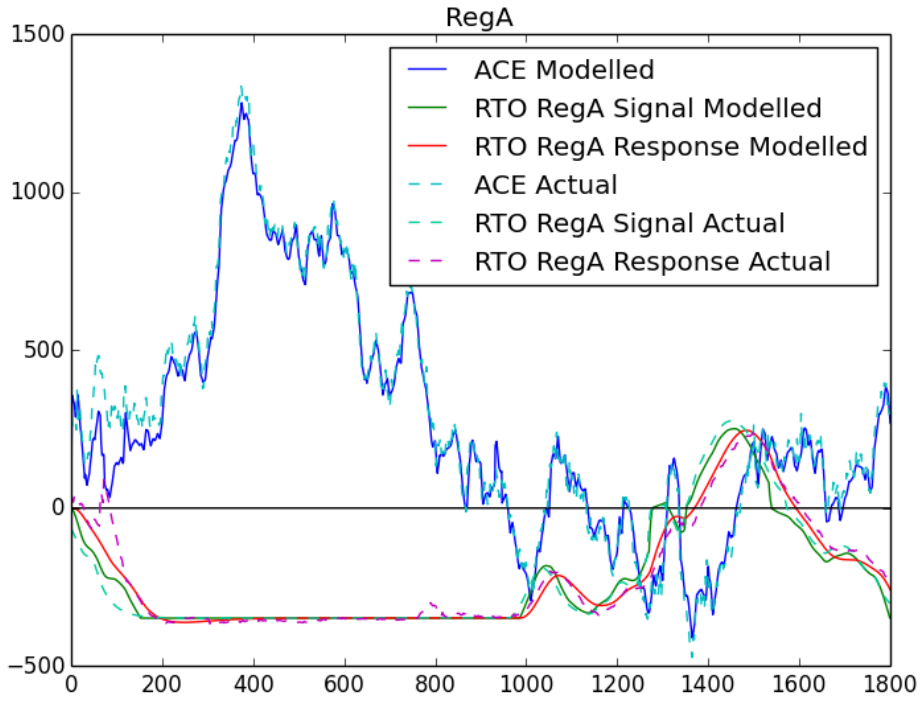
Market Simulations and Results – July 16, 2015 Hour Beginning 17

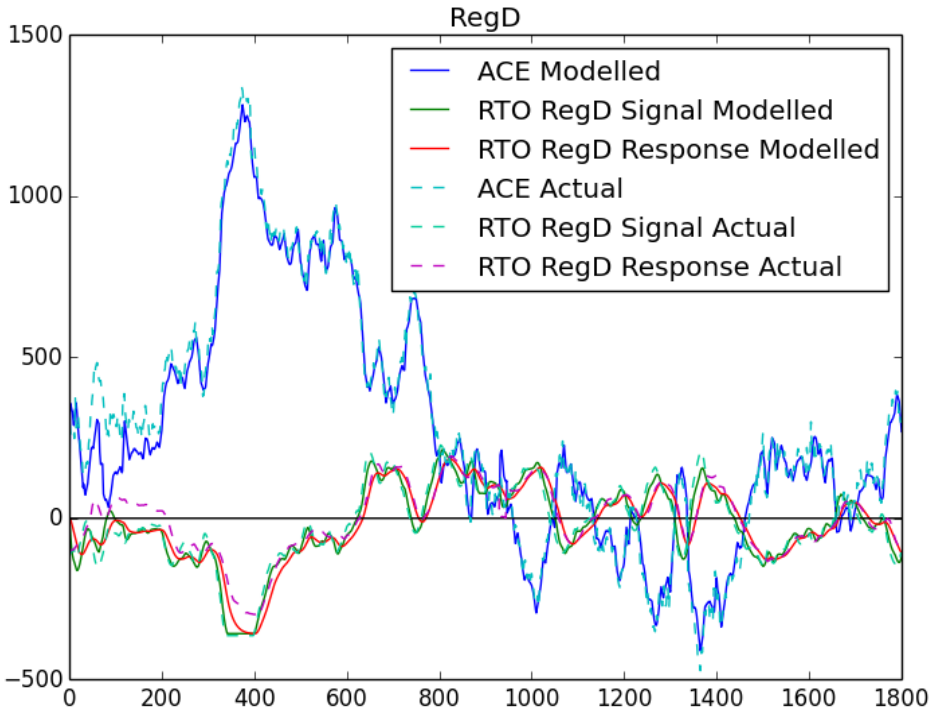
X-Axis Intercept	Original (62%)	62%	62%	50%	40%	30%	20%
BF = 1 Intercept	62	62	40.6	32.8	26.2	19.7	13.1
RegA_MW_Actual	344	222.5	246.9	365.8	493.9	532.7	596.3
RegD_MW_Actual	327	323.1	327.3	236.9	135.8	135.8	103.5
Reg_MW_Total_Actual	671	545.6	574.2	602.7	629.7	668.5	699.8
RegD_Actual_Percentage	49%	59.2%	57%	39%	21.5%	20.3%	14.8%
RegA_MW_Eff	294	188.1	210.7	313.1	428.4	461.6	515.9
RegD_MW_Eff	406	511.9	489.3	386.9	271.6	238.4	184.1
Reg_MW_Total_Eff	700	700	700	700	700	700	700
RegD_Eff_Percentage	58%	73%	70%	55.3%	38.8%	34%	26.3%
RMCP	$3.94	$1.25	$2.5	$3.94	$3.94	$3.94	$3.94
MBF	1.016	1.038	1.016	1.168	1.575	1.133	1.273
CPS1_Score							

Market Simulation Results - Discussion

- Benefits Factor curve at 40% zero crossing seemed to strike the right balance of RegA and RegD given the current mode of regulation dispatch
- Marginal Benefits Factor less than 1 may potentially increase the cost of regulation and/or increases the percentage of RegD in operation that tends to at times hurt ACE control based on the current mode of regulation dispatch
- A dual signal capable resource can be cleared either as RegD or RegA
- Currently available study results showed negligible change in the regulation total price

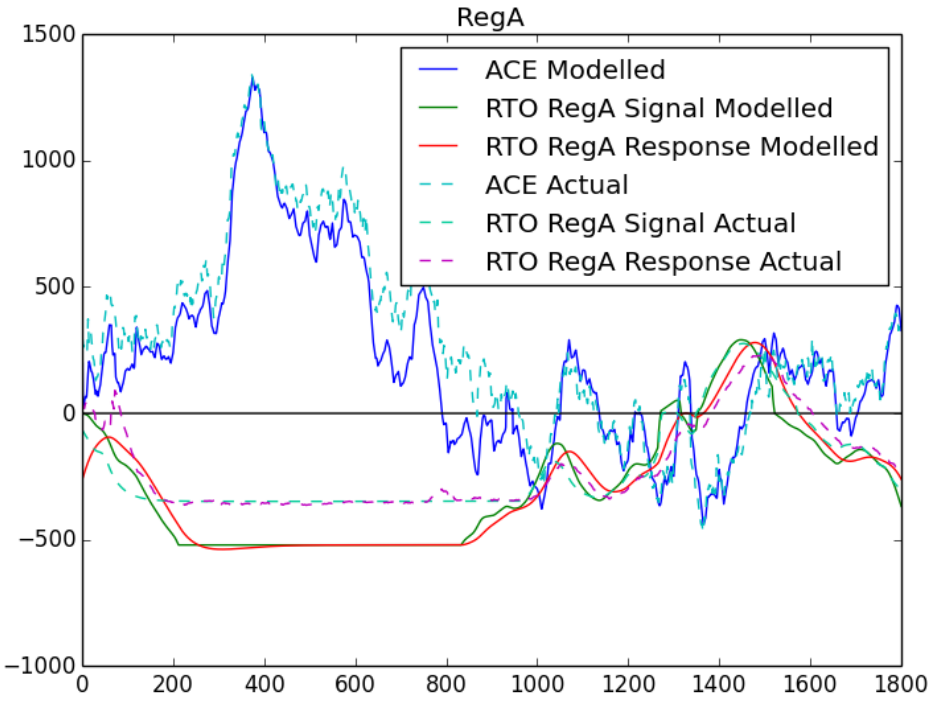
Operation Simulation of Market Analysis – Base Case

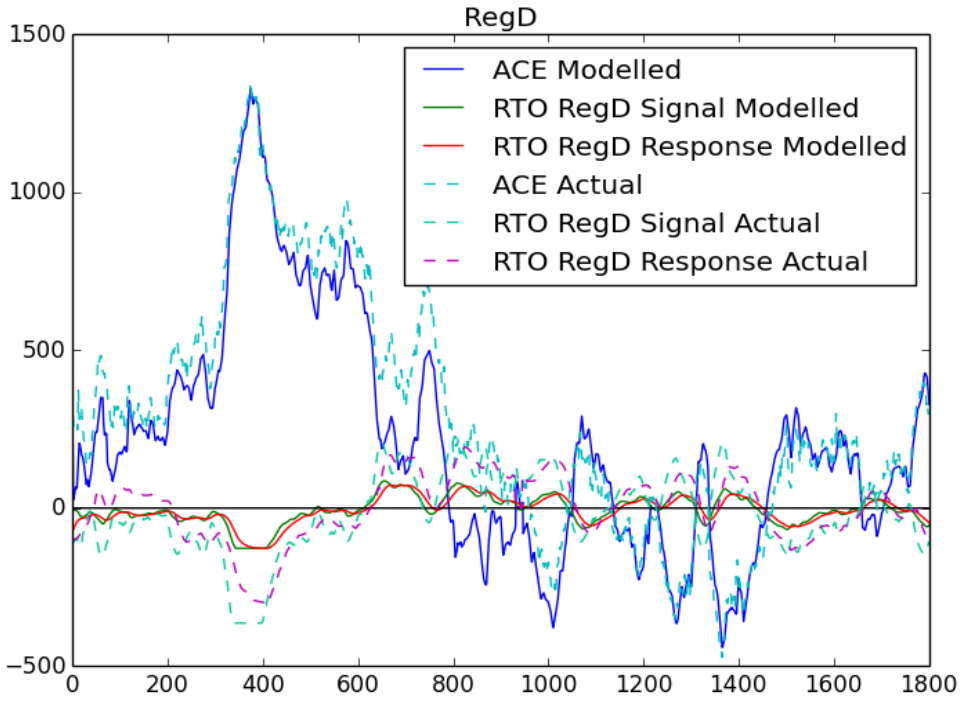




- June 02, 2015 HB13 EPT
- Less than 1% error with respect to calculated CPS1 score
- Modelled ACE very closely matches actual recorded ACE during hour

Operation Simulation of Market Analysis – 40% RegD





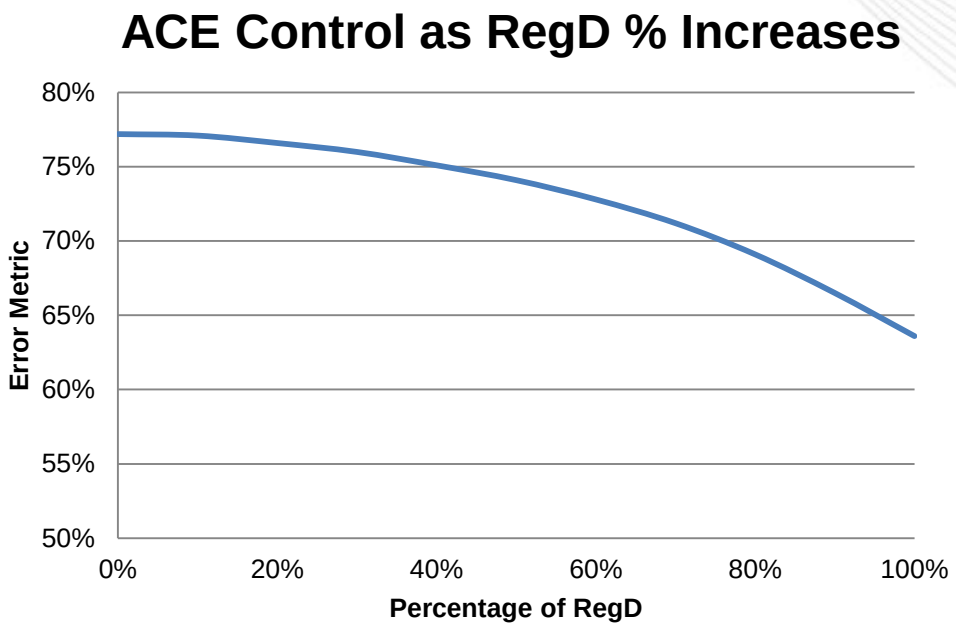
- CPS1 Improvement from 115.6% to 118.3%
- Large increase in control during large ACE excursion
- Decrease in control when ACE is more typical in neutrality

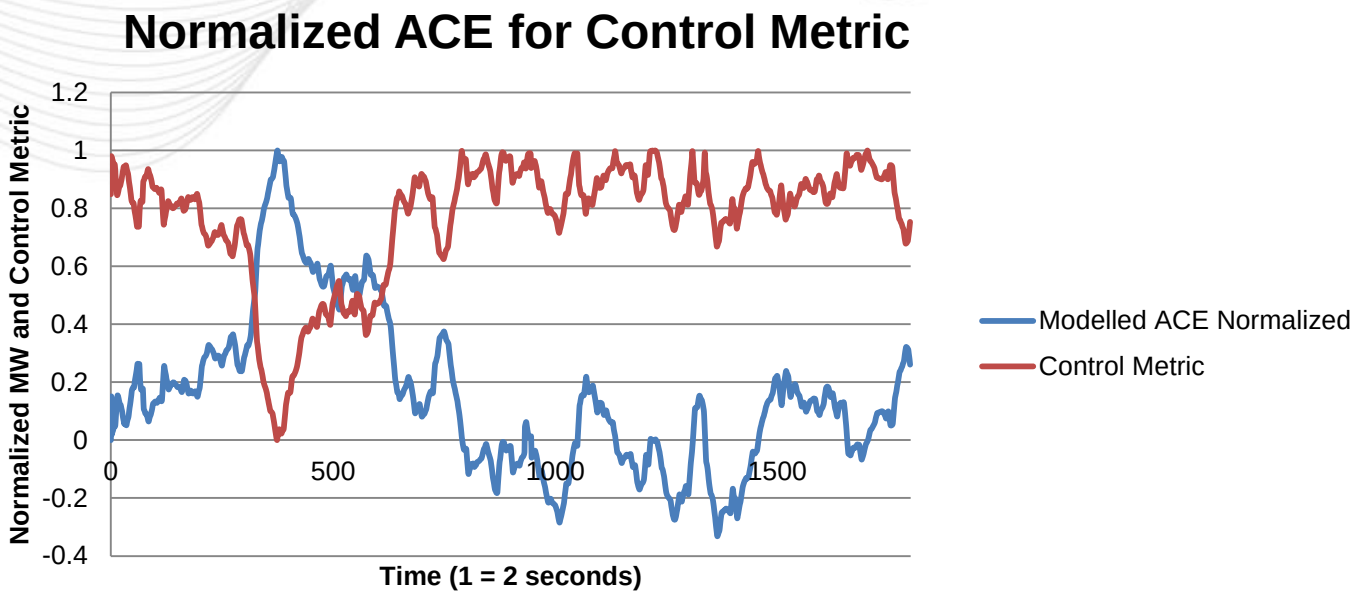
RegA = 521.0 Raw MW

RegD = 127.3 Raw MW

RegD % = 19.6%

Operation Simulation of Market Analysis – Control Metric





- Control Metric calculated based on June 02, 2015 HB13 EPT data
- Total regulation MW held constant at 700 raw MW while % of RegD changed from 0 to 100
- Higher Control Metric = Better Control (100% = ACE at 0)
- Control Metric purely based on amount of deviation of ACE from 0
  - CPS1 is partly based on frequency error which does not change in current simulation software

Summary of Changes

- The proposed revision to the Adjusted Total Cost formulation
  - Incent a better regulation resources performance
  - Allows for a more accurate valuation of RegD
  - Formulation does not affect pricing but Benefits Factor ranking only
- The proposed revision of Benefits Factor Curve
  - Allows for optimal mix of RegD vs. RegA and align with current regulation dispatch practice
- Related changes if these recommendations are taken
  - Tariff or Operating Agreement – No change
  - Manual 11 - revision in section 3.2.7
  - Market Database and Market Software change

Summary of Manual 11 Revisions – Section 3

- Added the benefits factor (bf) calculation steps and which includes the proposed 'initial adjusted total offer cost' for the purpose for benefits calculation only

- Revised the benefits factor curve to reduce RegD tolerance from 62% zero crossing to 40% (?) zero crossing and with consideration of only resources with bf equal or greater than 1 in the Regulation clearing

- Other minor language clean-ups