MRTS

RMISTF

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Monitoring Analytics

Step 1: Signal Design

- **Two signal design, designed around fast (RegD) and slow (RegA) signals.**
  - **Signals designed to compliment each other.**
  - **In combination can improve control and reduce (relative to RegA only set up), the number of total MW needed achieve control.**

Step 2: Assume fleet capabilities

- **Assume RegA capabilities and performance scores (ability to follow the signal).**
  - **Duration**
- **Assume RegD capabilities and performance scores**
  - **Duration**

Step 3: Different combinations

- **Set up multiple combinations of total Reg MW and proportion of RegA and RegD**

Step 4: Run simulations for multiple hours and system conditions

- **Simulation of ability to control ACE under varying system conditions, given different levels of regulation MW**
  - **Different ratios of RegA and RegD**

Step 5: Calculate ACE control

- **Calculate simulated ACE control metrics**
  - **Collect scores for every hour using different total MW and ratios of RegA and RegD**

Step 6: Identify Isoquants: Heat Maps (CPS1 Scores)

Sum of CPS-1	Column Labels: RegA MW																				
RegD MW	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
0									143.4	144.275	145.15	145.975	146.8	147.625	148.425	149.2	149.95	150.7	151.45	152.125	152.725
50								145.75	146.75	147.725	148.725	149.775	150.725	151.65	152.6	153.475	154.3	155.075	155.8	156.5	
100							147.7	148.775	150.025	151.175	152.375	153.575	154.725	155.75	156.725	157.675	158.55	159.375	160.15		
150						148.875	150.35	151.75	153.15	154.625	156.025	157.35	158.6	159.775	160.85	161.875	162.825	163.675			
200					149.35	151.125	152.85	154.5	156.125	157.8	159.375	160.9	162.25	163.5	164.7	165.8	166.775				
250				149.175	151.125	153.125	155.05	156.95	158.825	160.7	162.375	163.95	165.45	166.75	168.075	169.1					
300			148.475	150.525	152.725	154.9	156.975	159.075	161.15	163.125	164.9	166.55	168.025	169.475	170.8						
350		147.45	149.575	151.775	154.1	156.45	158.625	160.975	163.2	165.2	167.075	168.75	170.225	171.7							
400	146.425	148.4	150.625	152.925	155.375	157.775	160.125	162.55	164.95	167	168.925	170.55	172.1								
450	147.175	149.275	151.6	154	156.475	159	161.45	163.95	166.325	168.55	170.45	172.1									
500	147.925	150.1	152.5	154.975	157.475	160.05	162.625	165.15	167.6	169.925	171.8										
550	148.6	150.85	153.325	155.875	158.425	161.125	163.725	166.3	168.775	171											
600	149.275	151.55	154.1	156.65	159.325	162.075	164.725	167.325	169.8												
650	149.875	152.2	154.775	157.475	160.15	163	165.6	168.175													
700	150.45	152.775	155.45	158.2	161	163.8	166.4														
750	150.95	153.35	156.025	158.875	161.725	164.525															
800	151.475	153.825	156.625	159.475	162.375																
850	151.975	154.325	157.125	160.025																	
900	152.425	154.825	157.625																		
950	152.85	155.275																			
1000	153.275																				
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Step 6: Identify Isoquants: Heat Maps (NEW Metric Scores)

Average of Con RegA																					
RegD	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
0									260.4676	253.52	248.3677	244.6573	242.2628	240.7543	239.9615	239.7899	240.2729	241.2953	242.7395	244.6651	246.8473
50								238.2629	229.0765	222.6455	218.013	214.7082	212.4433	211.1378	210.4281	210.2994	210.8478	211.7306	212.9072	214.3292	
100							228.2232	215.4021	205.4934	198.2	192.9836	188.9761	185.8499	184.129	183.0455	182.5161	182.5368	182.6374	182.8033		
150						228.0722	209.5654	195.4245	184.7992	176.5644	170.5145	165.8044	161.941	159.2971	157.4591	156.1529	155.3979	155.1371			
200					233.9134	212.0164	193.1807	178.1102	166.6785	157.9115	151.3098	145.6437	141.1636	138.1651	135.5467	133.5958	132.2064				
250				245.6584	219.5599	197.3763	178.6492	163.3712	151.3158	142.426	135.1577	129.2936	124.6338	121.2239	118.0783	115.8994					
300			263.4692	234.0175	207.258	184.5939	165.7654	150.6714	138.4881	129.8193	122.4056	116.7235	112.1725	108.7225	105.608						
350		286.7793	253.7045	223.8123	196.4878	173.5508	154.8205	140.0527	128.2034	119.6716	112.7312	107.2895	103.2071	99.75885							
400	314.2612	278.4291	245.054	214.5861	186.9844	164.0033	145.4262	131.4191	120.2336	112.18	105.4005	100.4343	96.46236								
450	306.7571	271.0234	236.9429	206.1838	178.5909	155.6877	137.8448	124.4198	114.2869	106.3168	100.141	95.40625									
500	300.1569	264.2888	229.7802	198.5891	171.247	148.3857	131.3197	118.7627	109.2292	101.869	96.14533										
550	294.1045	258.0281	223.5786	191.8847	164.5043	142.1707	126.0324	113.9991	105.1491	98.19274											
600	288.4192	252.372	217.5941	186.0489	158.6807	137.0086	121.5723	110.2575	101.8961												
650	282.9796	247.1173	212.1962	180.5825	153.5373	132.6016	117.9852	107.0773													
700	277.8865	242.4719	207.3627	175.6695	148.7507	128.9552	114.7422														
750	273.279	237.9201	202.9188	171.631	144.5769	125.6129															
800	268.7797	233.5976	198.6674	167.6297	141.1609																
850	264.3141	229.5828	194.8414	163.839																	
900	260.223	225.735	191.2823																		
950	256.4235	222.0159																			
1000	252.7491																				

Step 7: Pick Isoquant

Sum of CPS-1	Column Labels: RegA MW																				
RegD MW	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
0									143.4	144.275	145.15	145.975	146.8	147.625	148.425	149.2	149.95	150.7	151.45	152.125	152.725
50								145.75	146.75	147.725	148.725	149.775	150.725	151.65	152.6	153.475	154.3	155.075	155.8	156.5	
100							147.7	148.775	150.025	151.175	152.375	153.575	154.725	155.75	156.725	157.675	158.55	159.375	160.15		
150						148.875	150.35	151.75	153.15	154.625	156.025	157.35	158.6	159.775	160.85	161.875	162				
200					149.35	151.125	152.85	154.5	156.125	157.8	159.375	160.9	162.25	163.5	164.7	165.8	166				
250				149.175	151.125	153.125	155.05	156.95	158.825	160.7	162.375	163.95	165.45	166.75	168.075	169.1					
300			148.475	150.525	152.725	154.9	156.975	159.075	161.15	163.125	164.9	166.55	168.025	169.475	170.8						
350		147.45	149.575	151.775	154.1	156.45	158.625	160.975	163.2	165.2	167.075	168.75	170.225	171.7							
400	146.425	148.4	150.625	152.925	155.375	157.775	160.125	162.55	164.95	167	168.925	170.55	172.1								
450	147.175	149.275	151.6	154	156.475	159	161.45	163.95	166.325	168.55	170.45	172.1									
500	147.925	150.1	152.5	154.975	157.475	160.05	162.625	165.15	167.6	169.925	171.8										
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600	149.275	151.55	154.1	156.65	159.325	162.075	164.725	167.325	169.8												
650	149.875	152.2	154.775	157.475	160.15	163	165.6	168.175													
700	150.45	152.775	155.45	158.2	161	163.8	166.4														
750	150.95	153.35	156.025	158.875	161.725	164.525															
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950	152.85	155.275																			
1000	153.275																				
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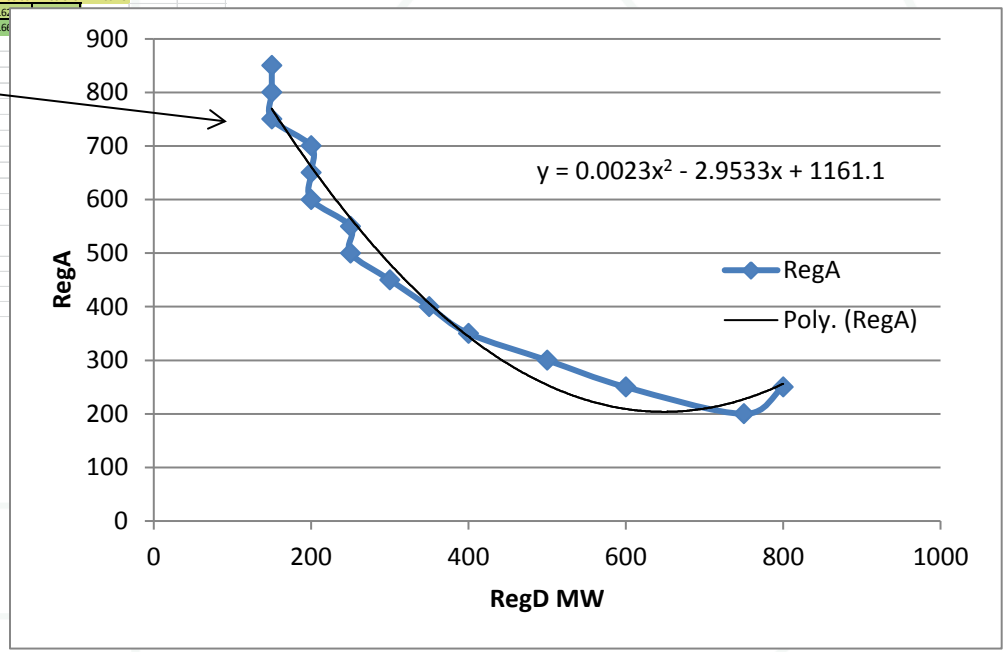
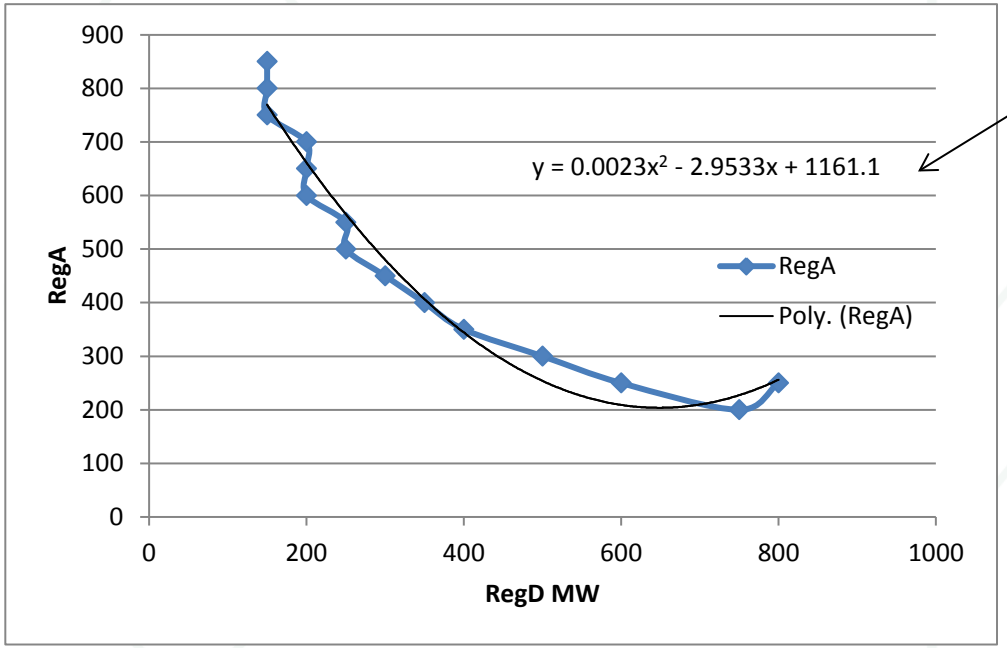


Two inputs, holding output constant.

Monitoring Analytics

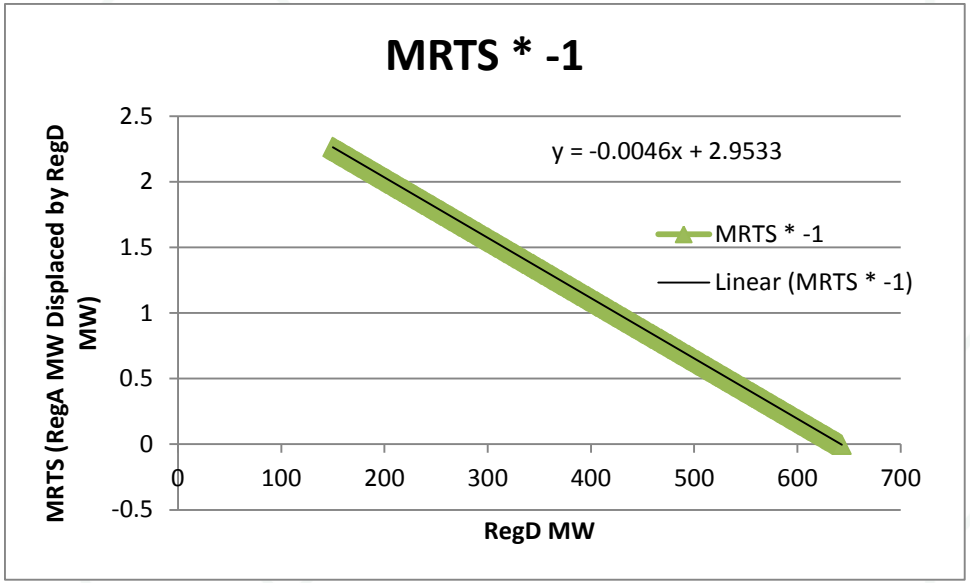
Step 8: Smooth the curve



Derivative of this function is MRTS Function

Change in RegA for Change in RegD, holding control metric constant

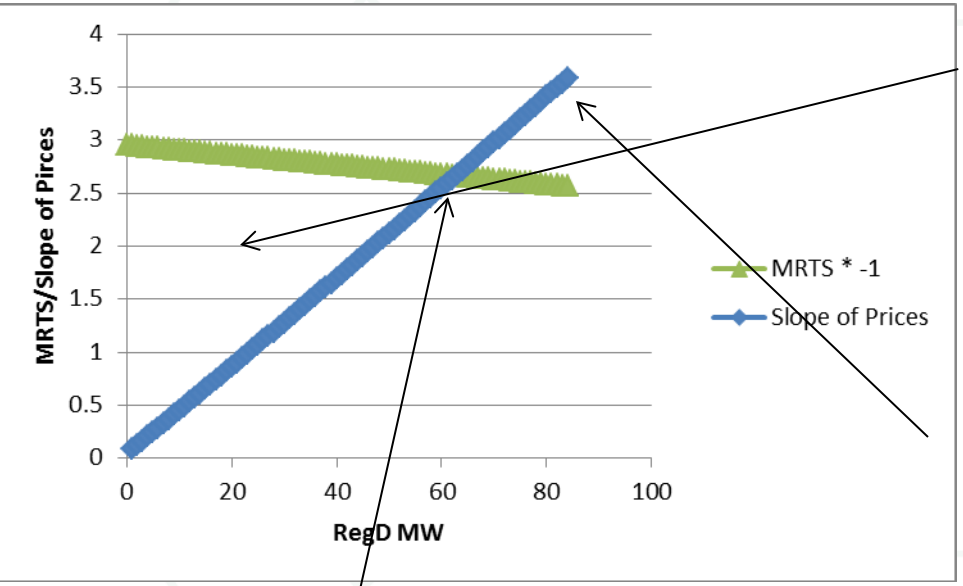
Step 9: PJM based combinations: MRTS



MRTS = Point specific slopes of the isoquant defining the rate of substitution.

Derivative of curve defining combinations of RegA/RegD

Step 10: Apply MRTS in optimization, clearing and settlement



MRTS = ($/D)/($/A)

Where MRTS > $D/$A:

- D is cheaper than A
- Can use 1 D to replace more than 1 A and still produce the same output
- Efficient to replace D with A.

Where MRTS < $D/$A:

- D is more expensive than A.
- Can use 1 D to replace less than 1 A and still produce the same output.
- Efficient to replace D with A.

Step 11: Examine real life results and performance, revaluate relationship over time, adjust signals and isoquant as needed

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100							147.7	148.775	150.025	151.175	152.375	153.575	154.725	155.75	156.725	157.675	158.55	159.375	160.15		
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200					149.35	151.125	152.85	154.5	156.125	157.8	159.375	160.9	162.25	163.5	164.7	165.8	166.775				
250				149.175	151.125	153.125	155.05	156.95	158.825	160.7	162.375	163.95	165.45	166.75	168.075	169.1					
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