Micro-Economics of Coal Production

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Why clean coal?

…to reduce coal ash content.

… to increase coal heating value.

… to limit coal particle size.

… to lower rail/barge transport cost.

… to reduce emissions of pollutants.

… to improve overall coal marketability.

Purpose of coal prep … is to make money!

Need to change our perspective…

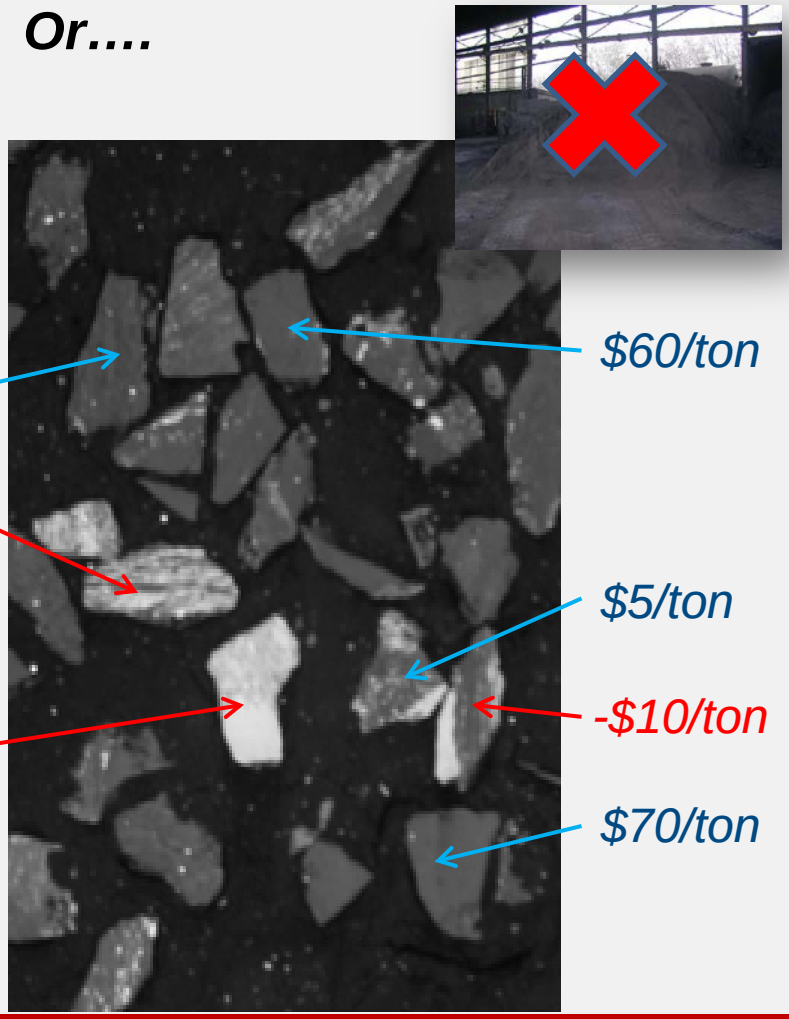
We love to sell “piles” of coal…

… but would a retail store do this?

Need to change our perspective…

$50 per shopping cart?
Or….

$50 per ton?
Or….



Need to know “inventory” and “price”!

Let’s price what’s in the basket…

Specification:	Combustion Properties Ash, Sulfur, Heat (AR)
Payment:	$/MM BTU (AR) Buying “heat”

Steam Market

Let's price what's in the basket…

Steam Market

Assume 12,500 BTU/lb is worth $25/ton

1 ton x 2000 lb/ton x 12,500 BTU/lb = 25 MM BTU

$25/25 MM BTU = $1.00 per MM BTU

$25/12,500 BTU = $0.20 per 100 BTU

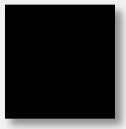
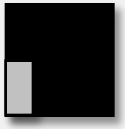
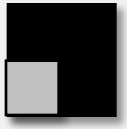
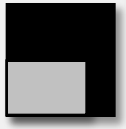
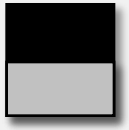
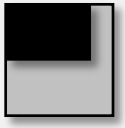
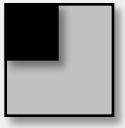
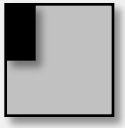
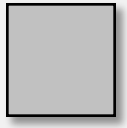
If $50/ton, then:

$2.00 per MM BTU

$0.40 per 100 BTU

Let's price what's in the basket…

Steam Price = $50/ton *(Prorated $0.40 per 100 BTU above/below 12,500 BTU/lb; $1.00 per 1% ash above/below 12.5% ash; $2.50/ton sales-related cost)*

SG Value	1.30	1.38	1.48	1.59	1.71	1.86	2.03	2.24	2.50
									
Ash	0%	12.5%	25%	37.5%	50%	62.5%	75%	85%	100%
Heat Value	15,000 BTU/lb	13,125 BTU/lb	11,250 BTU/lb	9,375 BTU/lb	7,500 BTU/lb	5,625 BTU/lb	3,750 BTU/lb	1,875 BTU/lb	0 BTU/lb
BTU Adjustment	+$10.00 Premium	+$2.50 Premium	-$5.00 Penalty	-$12.50 Penalty	-$20.00 Penalty	-$27.50 Penalty	-$35.00 Penalty	-$42.50 Penalty	-$50.00 Penalty
Ash Adjustment	+$12.50 Premium	$0.00 Penalty	-$12.50 Penalty	-$25.00 Penalty	-$37.50 Penalty	-$50.00 Penalty	-$62.50 Penalty	-$75.00 Penalty	-$87.50 Penalty
Sales Cost	-$2.50 Penalty	-$2.50 Penalty	-$2.50 Penalty	-$2.50 Penalty	-$2.50 Penalty	-$2.50 Penalty	-$2.50 Penalty	-$2.50 Penalty	-$2.50 Penalty
Net Value	**+$70.00 /ton**	**+$50.00 /ton**	**+$30.00 /ton**	**$10.00 /ton**	**-$10.00 /ton**	**-$30.00 /ton**	**-$50.00 /ton**	**-$70.00 /ton**	**-$90.00 /ton**

Let's price what's in the basket…

SG Class	1	2	3	4	5	6	7	8	9	10	11	12	13	Totals
Sink SG	1.28	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.80	1.90	2.00	---
Float SG	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.80	1.90	2.00	3.20	---
1/Mean SG	0.78	0.75	0.73	0.70	0.68	0.66	0.63	0.62	0.60	0.57	0.54	0.51	0.38	---
Mass (%, dry)	43.59	16.09	5.90	3.47	2.05	1.03	0.91	0.45	0.58	0.95	0.92	0.87	23.19	100.0
Ash (%, dry)	3.65	7.83	13.31	18.90	24.20	29.45	33.30	37.37	41.13	44.59	51.58	60.35	87.22	27.45
Sulfur (%, dry)	0.70	1.26	1.94	2.16	2.14	2.45	2.47	2.15	2.05	2.64	3.15	2.82	1.12	1.15
BTU/lb (dry)	14511	13866	12960	12072	11229	10443	9707	9110	8339	7732	6498	4934	845	10627
BTU/lb (maf)	15061	15044	14950	14885	14814	14802	14553	14546	14165	13954	13420	12444	6612	14649
Mass (%, ar)	43.59	16.09	5.90	3.47	2.05	1.03	0.91	0.45	0.58	0.95	0.92	0.87	23.19	100.0
Moisture (%, ar)	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
Ash (%, ar)	3.41	7.32	12.44	17.67	22.63	27.54	31.14	34.94	38.46	41.69	48.23	56.43	81.55	25.67
Inerts (%, ar)	9.91	13.82	18.94	24.17	29.13	34.04	37.64	41.44	44.96	48.19	54.73	62.93	88.05	32.17
Sulfur (%, ar)	0.65	1.18	1.81	2.02	2.00	2.29	2.31	2.01	1.92	2.47	2.95	2.64	1.05	1.07
BTU/lb (ar)	13568	12965	12118	11287	10499	9764	9076	8518	7797	7229	6076	4613	790	9937
lb SO2/MM BTU	0.96	1.82	2.99	3.58	3.81	4.69	5.09	4.72	4.92	6.83	9.70	11.43	26.51	2.16
Boiler Cost ($/MM BTU)	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00
Freight Cost ($/MM BTU)	$0.74	$0.77	$0.83	$0.89	$0.95	$1.02	$1.10	$1.17	$1.28	$1.38	$1.65	$2.17	$12.66	$1.01
Evap. Cost ($/MM BTU)	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03	$0.18	$0.01
Ash Cost ($/MM BTU)	$0.03	$0.06	$0.10	$0.16	$0.22	$0.28	$0.34	$0.41	$0.49	$0.58	$0.79	$1.22	$10.32	$0.26
SO2 Cost ($/MM BTU)	($0.02)	$0.06	$0.18	$0.24	$0.26	$0.35	$0.39	$0.35	$0.37	$0.56	$0.85	$1.02	$2.53	$0.10
Worth ($/MM BTU)	$1.25	$1.10	$0.88	$0.71	$0.56	$0.33	$0.15	$0.05	($0.17)	($0.54)	($1.31)	($2.44)	($23.69)	$0.63
Boiler Cost ($/ton)	$54.27	$51.86	$48.47	$45.15	$42.00	$39.06	$36.30	$34.07	$31.19	$28.92	$24.30	$18.45	$3.16	$39.75
Freight Cost ($/ton)	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00
Evap. Cost ($/ton)	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28
Ash Cost ($/ton)	$0.68	$1.46	$2.49	$3.53	$4.53	$5.51	$6.23	$6.99	$7.69	$8.34	$9.65	$11.29	$16.31	$5.13
SO2 Cost ($/ton)	($0.64)	$1.60	$4.35	$5.37	$5.48	$6.82	$7.06	$6.00	$5.80	$8.14	$10.32	$9.44	$4.00	$1.91
Worth ($/ton)	**$33.95**	**$28.51**	**$21.35**	**$15.96**	**$11.71**	**$6.45**	**$2.74**	**$0.81**	**($2.58)**	**($7.84)**	**($15.95)**	**($22.55)**	**($37.43)**	$12.42
Tons (dry)	43.59	16.09	5.90	3.47	2.05	1.03	0.91	0.45	0.58	0.95	0.92	0.87	23.19	100.00
Tons (ar)	46.62	17.21	6.31	3.71	2.19	1.10	0.97	0.48	0.62	1.02	0.98	0.93	24.80	106.95
Cum. Tons (ar)	46.62	63.83	70.14	73.85	76.04	77.14	78.12	78.60	79.22	80.24	81.22	82.15	106.95	---
Cum. Mass (%, ar)	43.59	59.68	65.58	69.05	71.10	72.13	73.04	73.49	74.07	75.02	75.94	76.81	100.00	---
Cum. Ash (%, ar)	3.41	4.47	5.18	5.81	6.30	6.60	6.91	7.08	7.32	7.76	8.25	8.79	25.67	---
Cum. Sulfur (%, ar)	0.65	0.80	0.89	0.94	0.97	0.99	1.01	1.02	1.02	1.04	1.06	1.08	1.07	---
Cum. BTU/lb (ar)	13568	13405	13289	13189	13111	13063	13014	12986	12946	12873	12791	12698	9937	---
Individual Worth ($)	$1,583	$491	$135	$59	$26	$7	$3	$0	($2)	($8)	($16)	($21)	($928)	$1,328
Cum. Worth ($)	$1,583	$2,073	$2,208	$2,267	$2,293	$2,300	$2,303	$2,303	$2,301	$2,293	$2,278	$2,257	$1,328	---

Let's price what's in the basket…

Outdated Perspective…

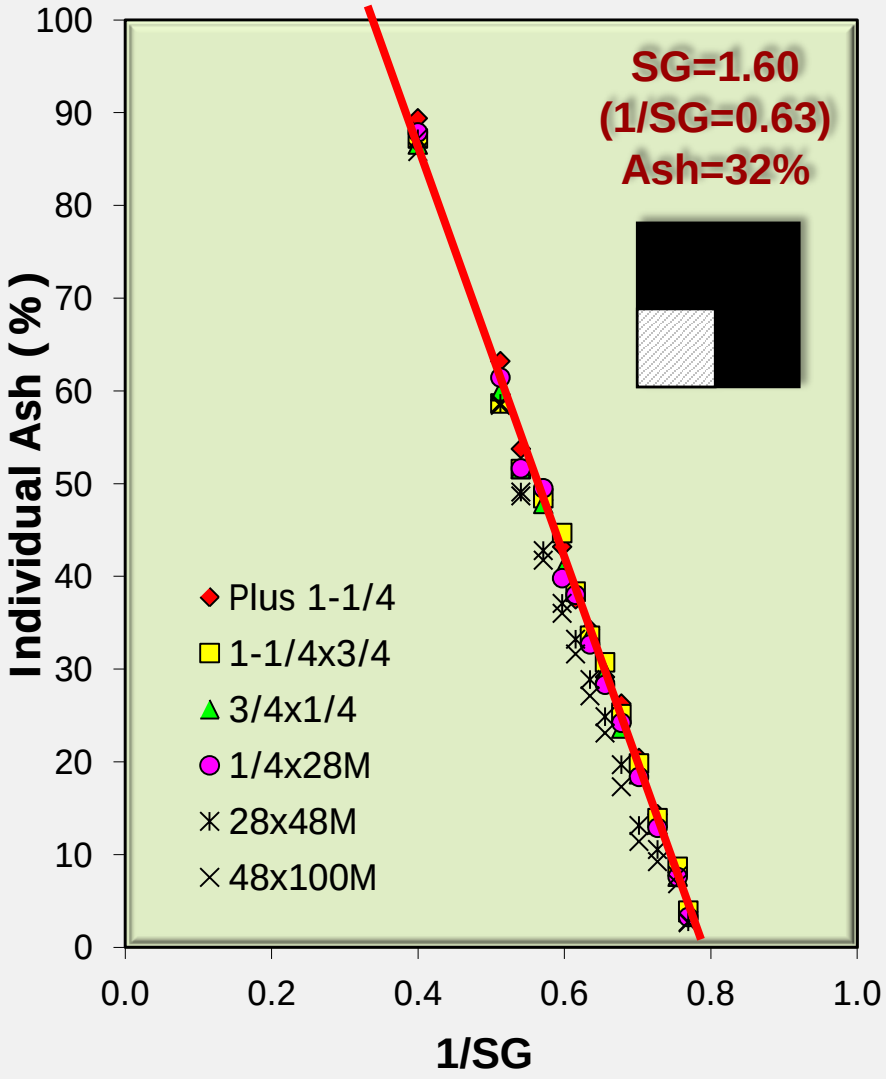
Modern Perspective…

Let’s price what’s in the basket…

Hey, wait a minute…

…I don’t see a price tag!

Let's price what's in the basket…

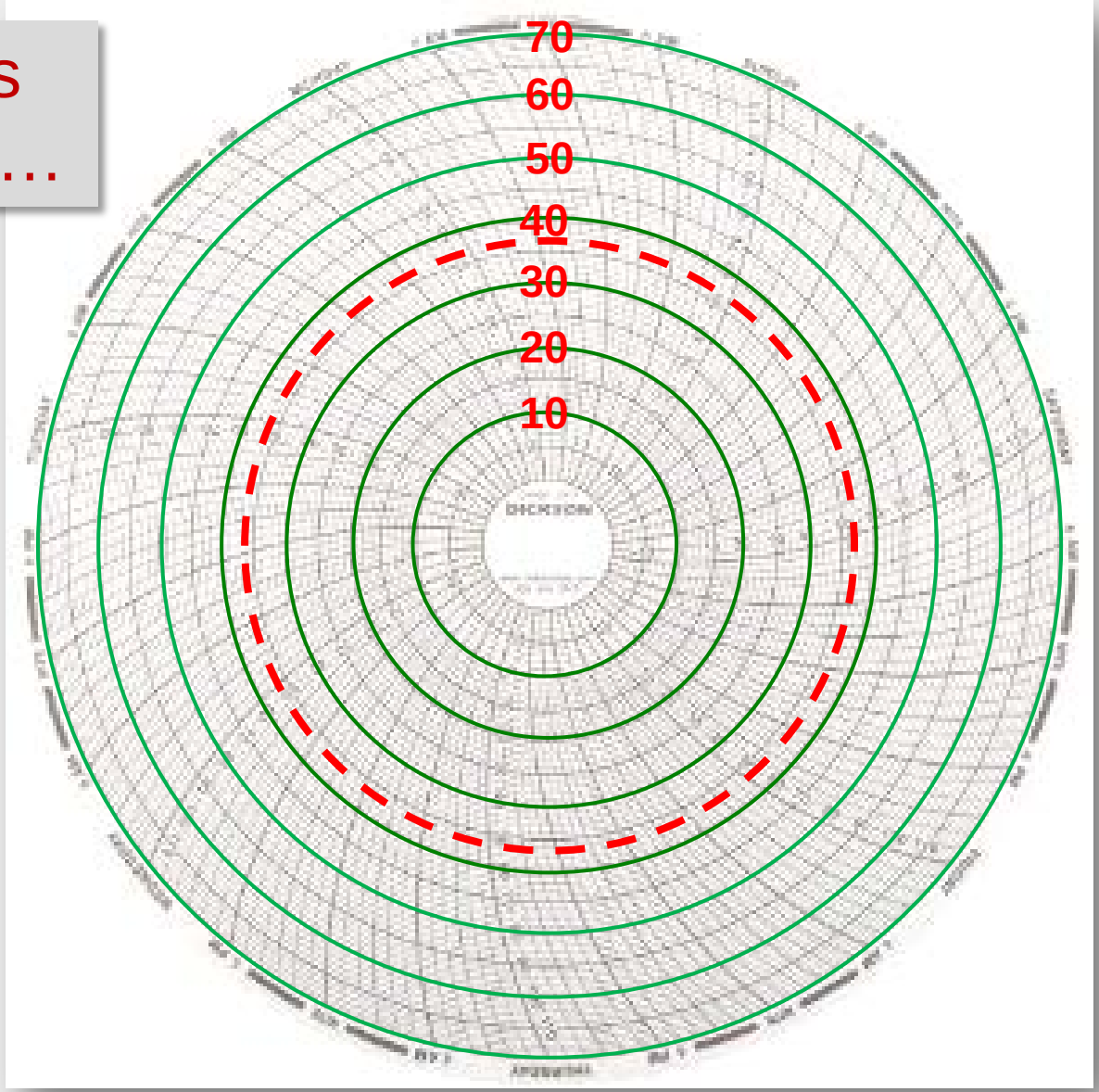


If you know density…

…then you know ash!

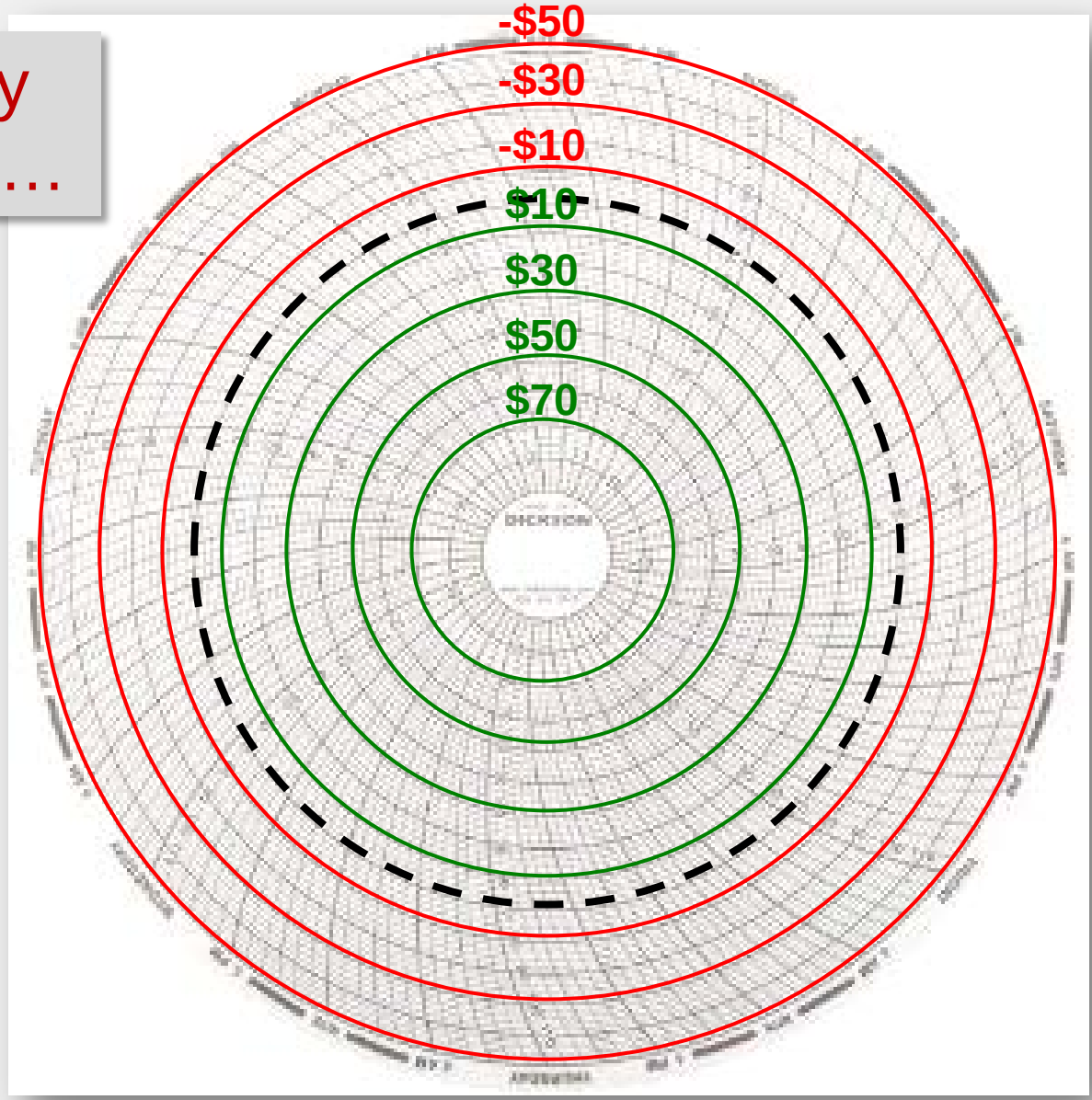
Let’s price what’s in the basket…

Plant density scale is really an “ash scale”…

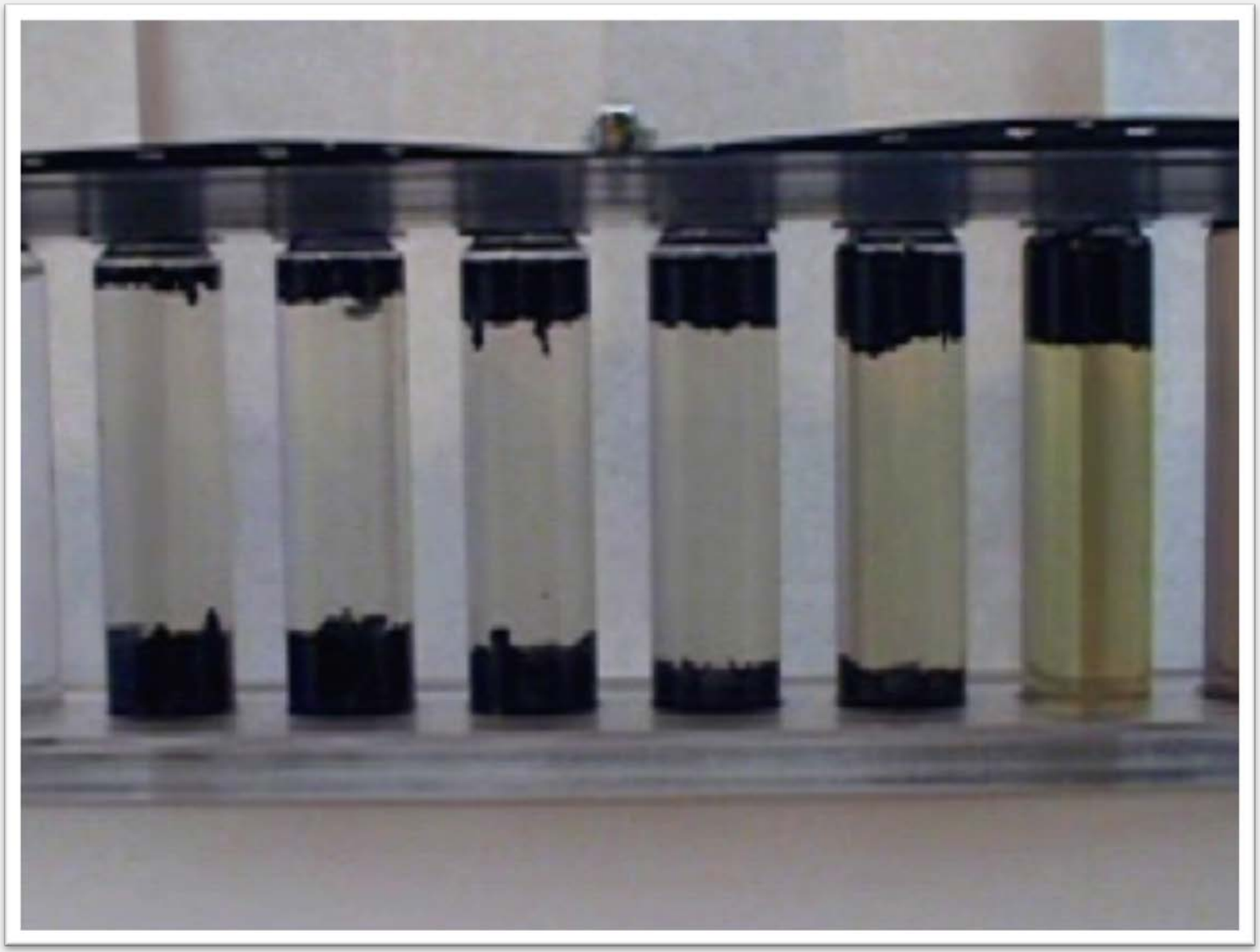


Let’s price what’s in the basket…

Density scale is really an “Price Tag” scale”…



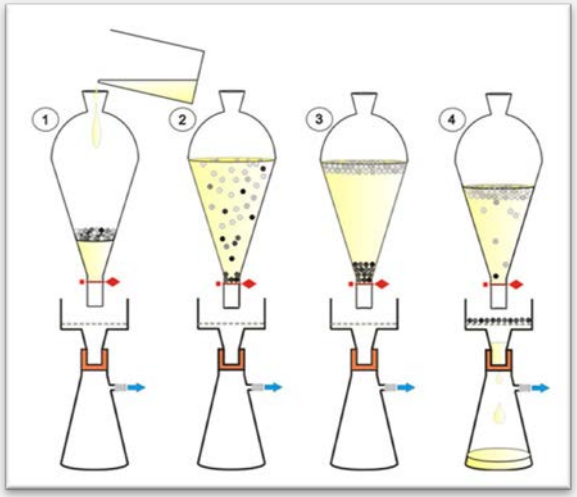
Let’s count what’s in the basket…



1.3 1.4 1.5 1.6 1.8 2.0

Let’s count what’s in the basket…

Coal Washability = Product Inventory



Coal ⟷ **Rock**

How to know what's in the basket…

What does "washability" tell us?

Block Value	Sink SG	Float SG	Individual Mass (%)	Individual Ash (%)	Cumulative Mass (%)	Cumulative Ash (%)
$70		1.30	11.36	3.86	11.36	3.86
	1.30	1.35	27.48	8.30	38.84	7.00
$50	1.35	1.40	16.26	14.15	55.10	9.11
	1.40	1.45	3.82	20.14	58.92	9.83
$30	1.45	1.50	2.12	25.76	61.37	10.46
	1.50	1.55	1.26	29.67	62.63	10.85
$10	1.55	1.60	0.77	33.89	63.40	11.13
	1.60	1.65	0.25	37.11	63.65	11.23
-$10	1.65	1.70	0.31	40.12	63.96	11.37
	1.70	1.80	0.40	44.99	64.36	11.58
-$50	1.80	1.90	0.63	52.73	64.99	11.98
	1.90	2.00	0.54	62.06	65.53	12.39
-$90	2.00		34.47	88.54	100.00	38.64

Micro-Economic Applications

Does this make a difference?

Micro-Economic Applications

If run at constant ash …

	High Quality Feed				Low Quality Feed			
SG Value	Mass (%)	Ash (%)	Cum Mass (%)	Cum Ash (%)	Mass (%)	Ash (%)	Cum Mass (%)	Cum Ash (%)
1.30	31.12	4.44	31.12	4.44	5.32	4.51	5.32	4.51
1.35	28.27	7.65	59.39	5.97	11.32	7.50	16.64	6.55
1.40	13.41	13.74	72.80	7.40	16.32	13.52	32.96	10.00
1.45	1.71	19.40	74.51	7.67	4.32	19.54	37.28	11.11
1.50	0.90	24.67	75.41	7.88	2.35	25.11	39.63	11.94
1.55	0.64	29.60	76.05	8.06	1.23	30.14	40.86	12.48
1.60	0.87	34.22	76.92	8.36	1.03	34.14	41.89	13.02
1.65	1.03	38.55	77.95	8.76	1.24	39.01	43.13	13.76
1.70	1.26	42.63	79.22	9.30	1.92	41.95	45.05	14.97
1.80	1.45	48.30	80.67	10.00	2.21	47.69	47.26	16.50
2.00	2.95	58.30	83.62	11.70	3.28	59.23	50.54	19.27
Feed	16.38	87.22	100.0	24.07	49.46	86.54	100.0	52.54

Coal Tonnage

500(80.67) = 403

500(32.96) = 165

= 568 TPH

Ash Tonnage

403(10.0) = 40.3

165(10.0) = 16.5

= 56.8 TPH

Total Product

56.8/568 = 10% Ash

Micro-Economic Applications

If run at constant SG…

	High Quality Feed				Low Quality Feed			
SG Value	Mass (%)	Ash (%)	Cum Mass (%)	Cum Ash (%)	Mass (%)	Ash (%)	Cum Mass (%)	Cum Ash (%)
1.30	31.12	4.44	31.12	4.44	5.32	4.51	5.32	4.51
1.35	28.27	7.65	59.39	5.97	11.32	7.50	16.64	6.55
1.40	13.41	13.74	72.80	7.40	16.32	13.52	32.96	10.00
1.45	1.71	19.40	74.51	7.67	4.32	19.54	37.28	11.11
1.50	0.90	24.67	75.41	7.88	2.35	25.11	39.63	11.94
1.55	0.64	29.60	76.05	8.06	1.23	30.14	40.86	12.48
1.60	0.87	34.22	76.92	8.36	1.03	34.14	41.89	13.02
1.65	1.03	38.55	77.95	8.76	1.24	39.01	43.13	13.76
1.70	1.26	42.63	79.22	9.30	1.92	41.95	45.05	14.97
1.80	1.45	48.30	80.67					
2.00	2.95	58.30	83.62					
Feed	16.38	87.22	100.0					

Coal Tonnage

500(76.92) = 385

500(41.89) = 209

= 594 TPH

Ash Tonnage

385(8.36) = 32.2

209(13.02) = 27.2

= 59.4 TPH

Total Product

59.4/594 = 10% Ash

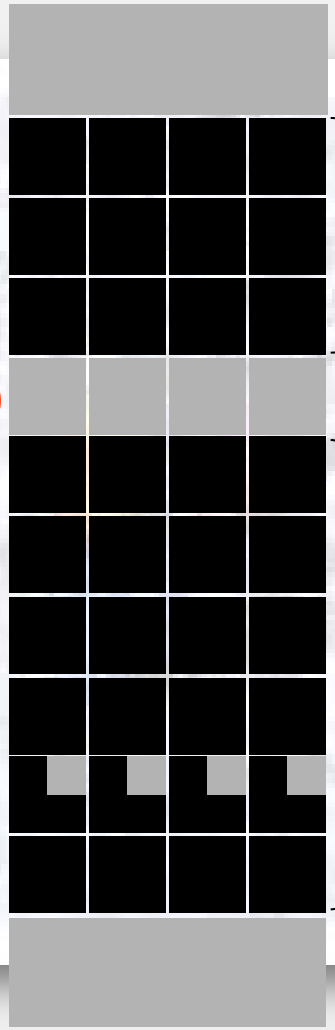
Improvement = 594-568= 26 TPH

26 t/hr x $50/ton x 5500 hr/yr = $7.2 MM

Preparation Starts at the Face…

Preparation Starts at the Face…

Ship
12.5% ash
$50/ton



Ship
$70/ton

Bury This!

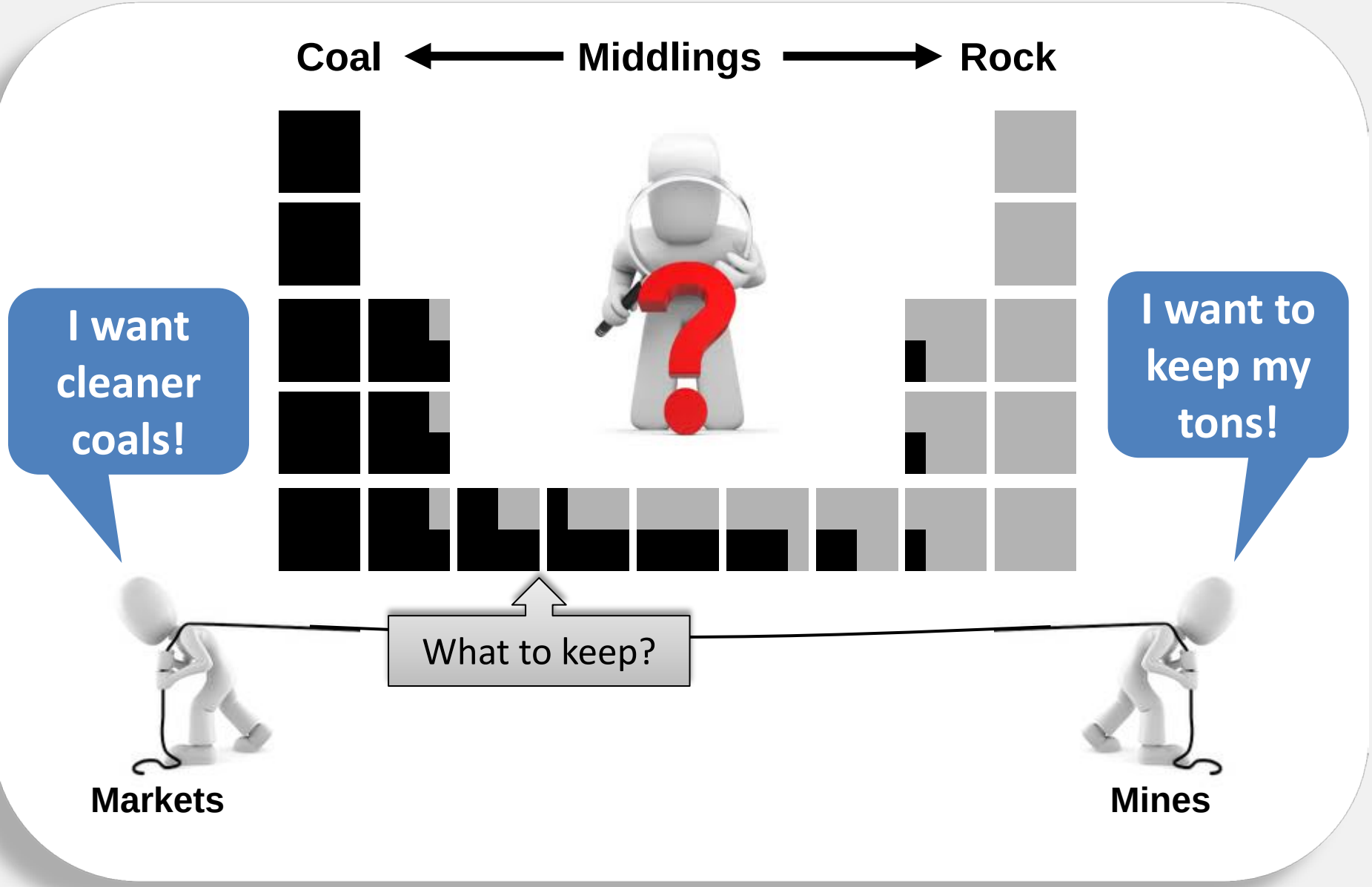
Ship
$63/ton

Preparation Starts at the Face…

Which coal should be washed?

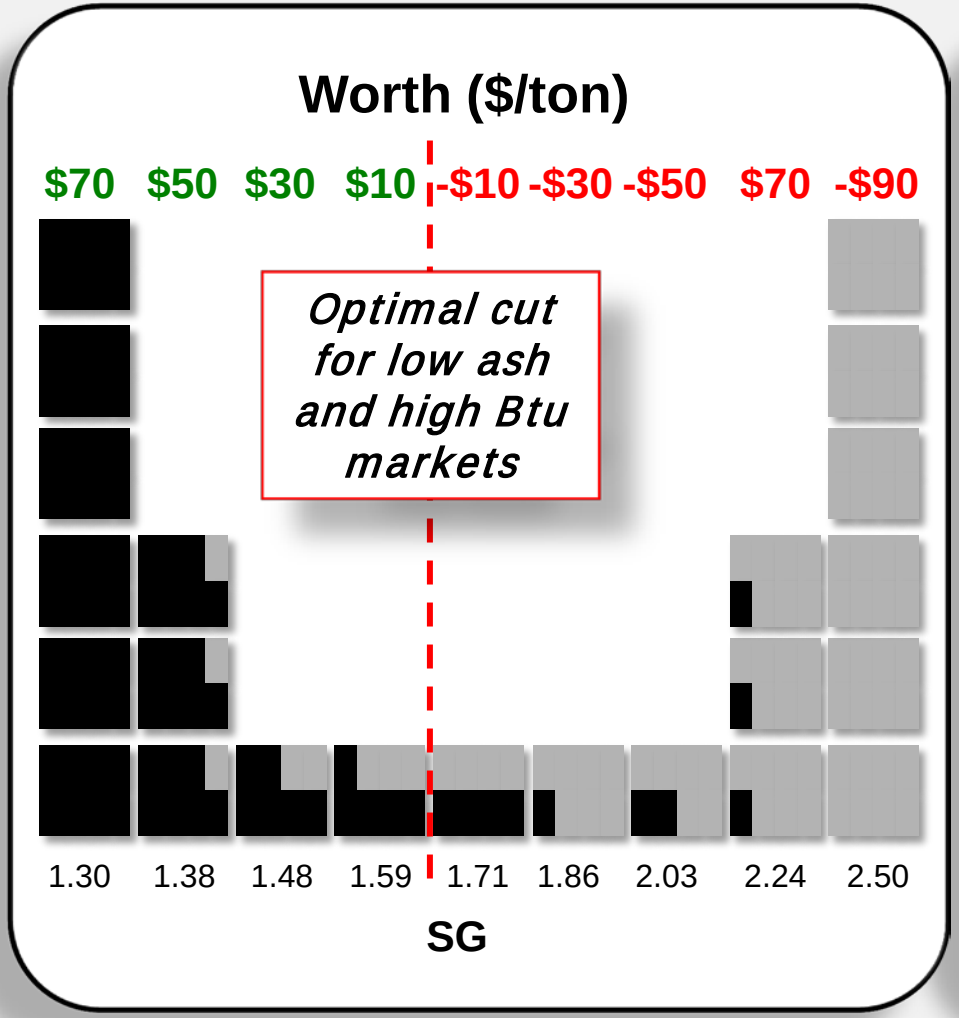
Wash coals that give high reject ash!

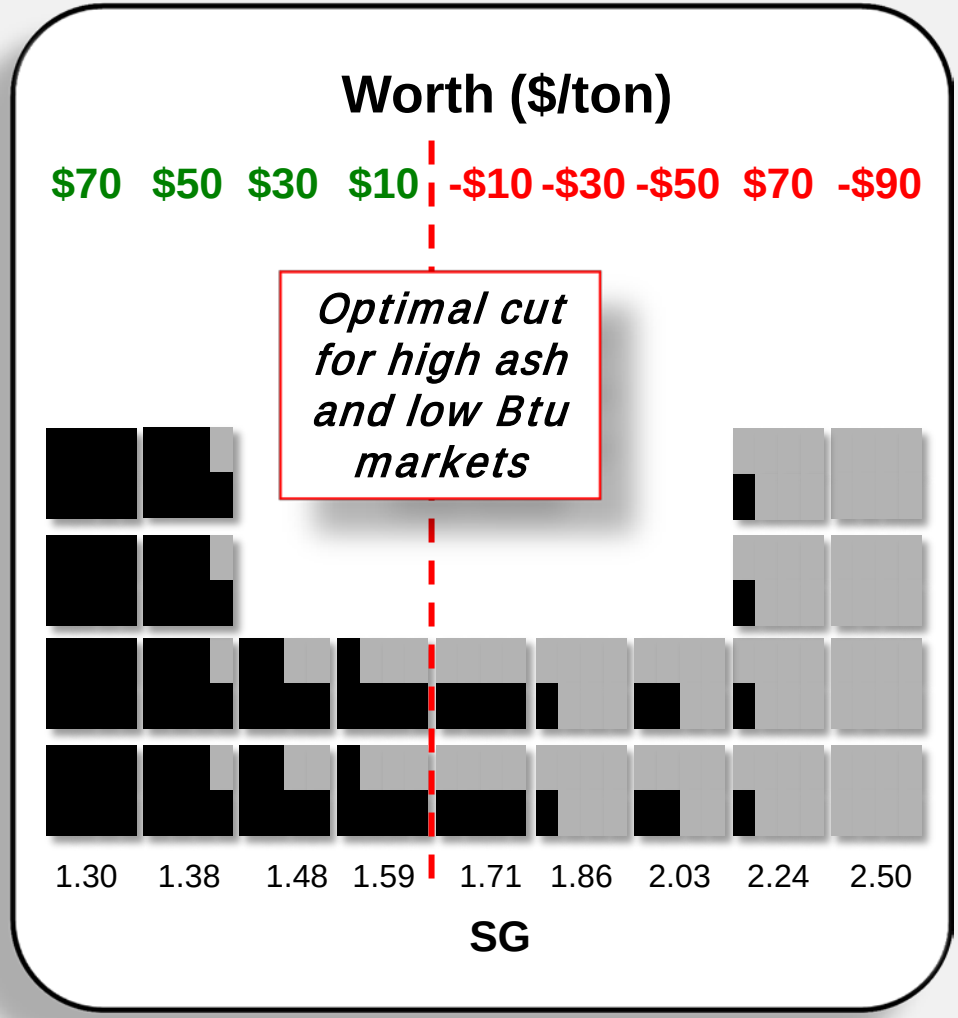
Who should decide?



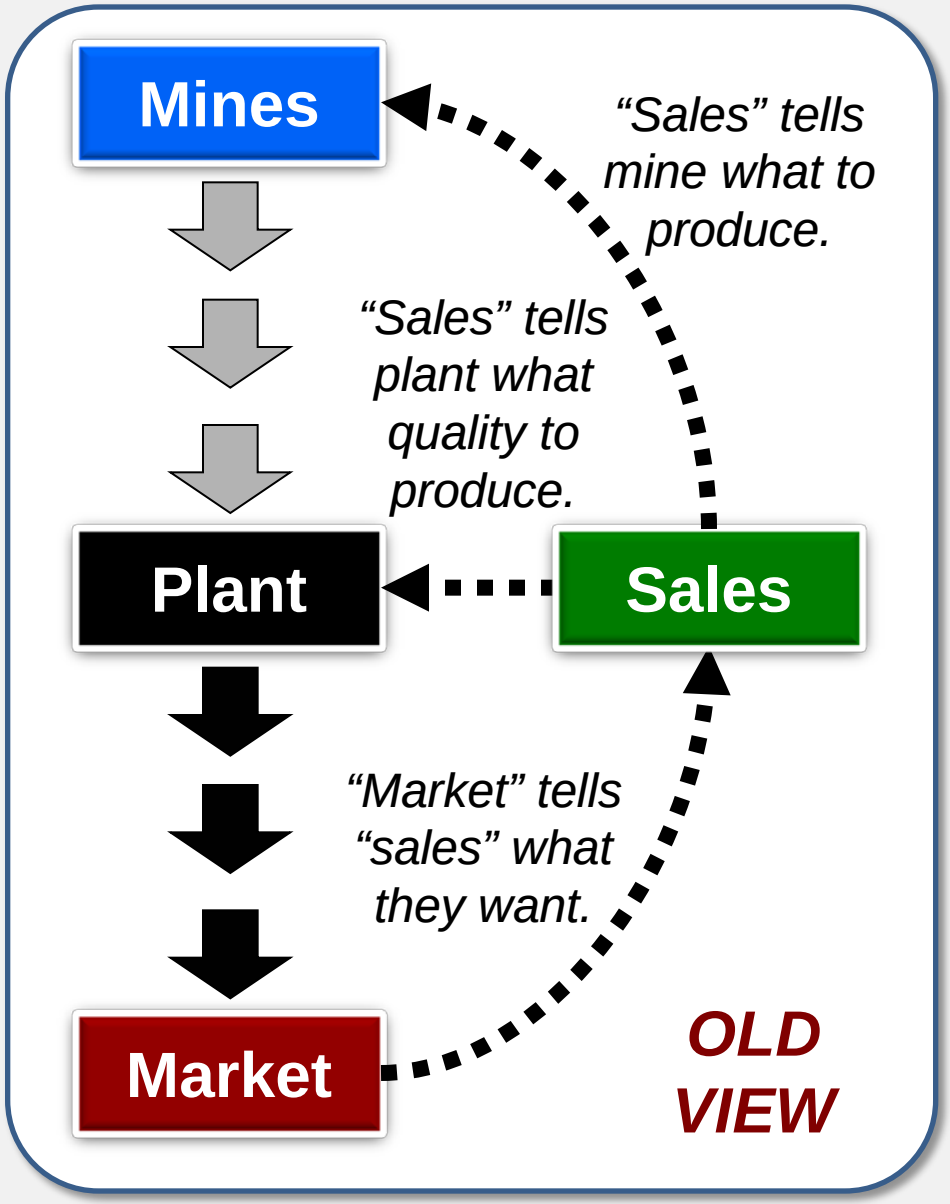
Who should decide?

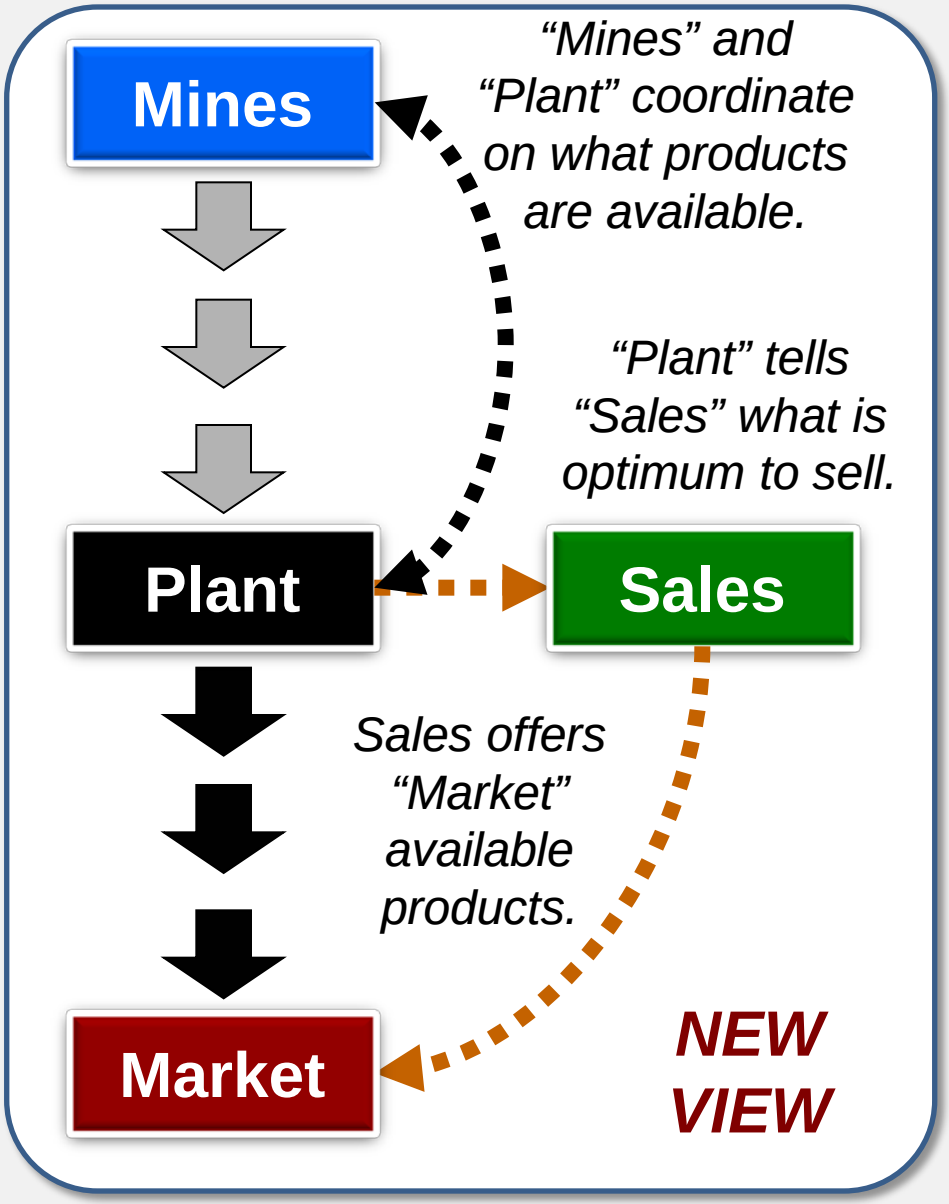
What to “keep” and “reject”?





Who should decide?





Summary…

A FEW SUGGESTIONS…

1. Make sure all understand the “real” purpose of coal preparation!
2. Remember everything has a price … and also a price tag!
3. Produce things that make money …reject things that cost money!
4. Remind all that “Preparation Starts at the Face” is not just a motto!
5. Avoid back seat drivers … especially on the way to market!

Just a reminder…

Just a reminder…

Thank You for Listening…

No gain is so certain as that which proceeds from the economical use of what you already have!

-- Latin Proverb