HYDRAULIC EXCAVATOR VS. ROPE SHOVEL PERFORMANCE

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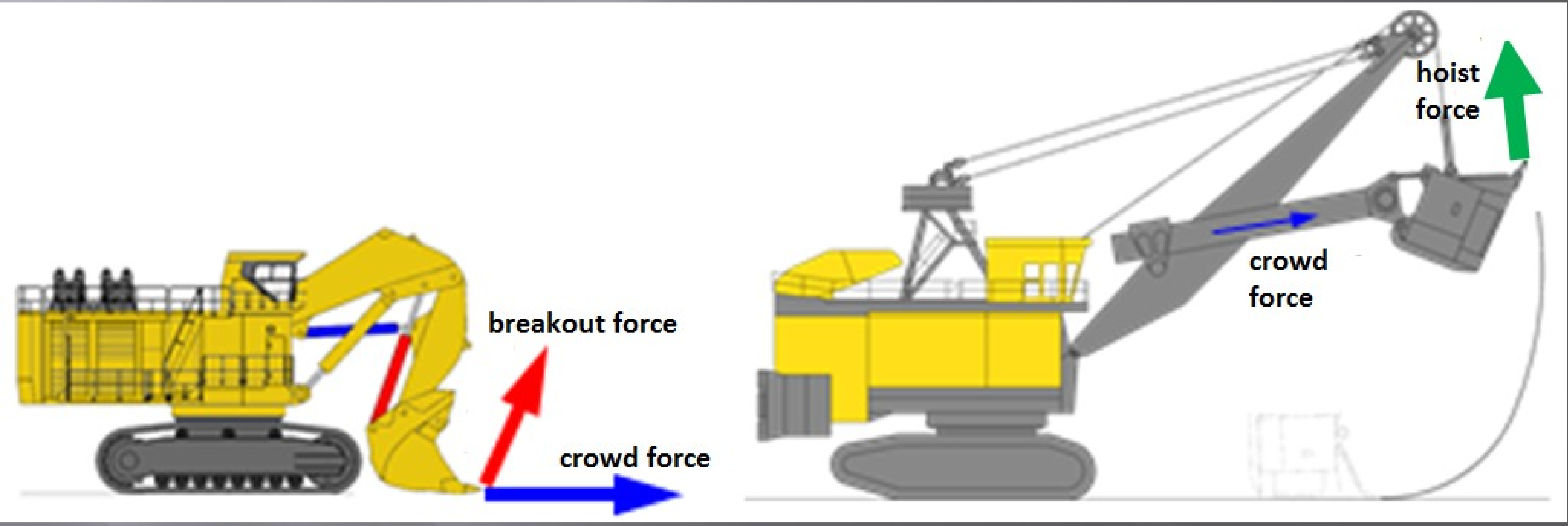
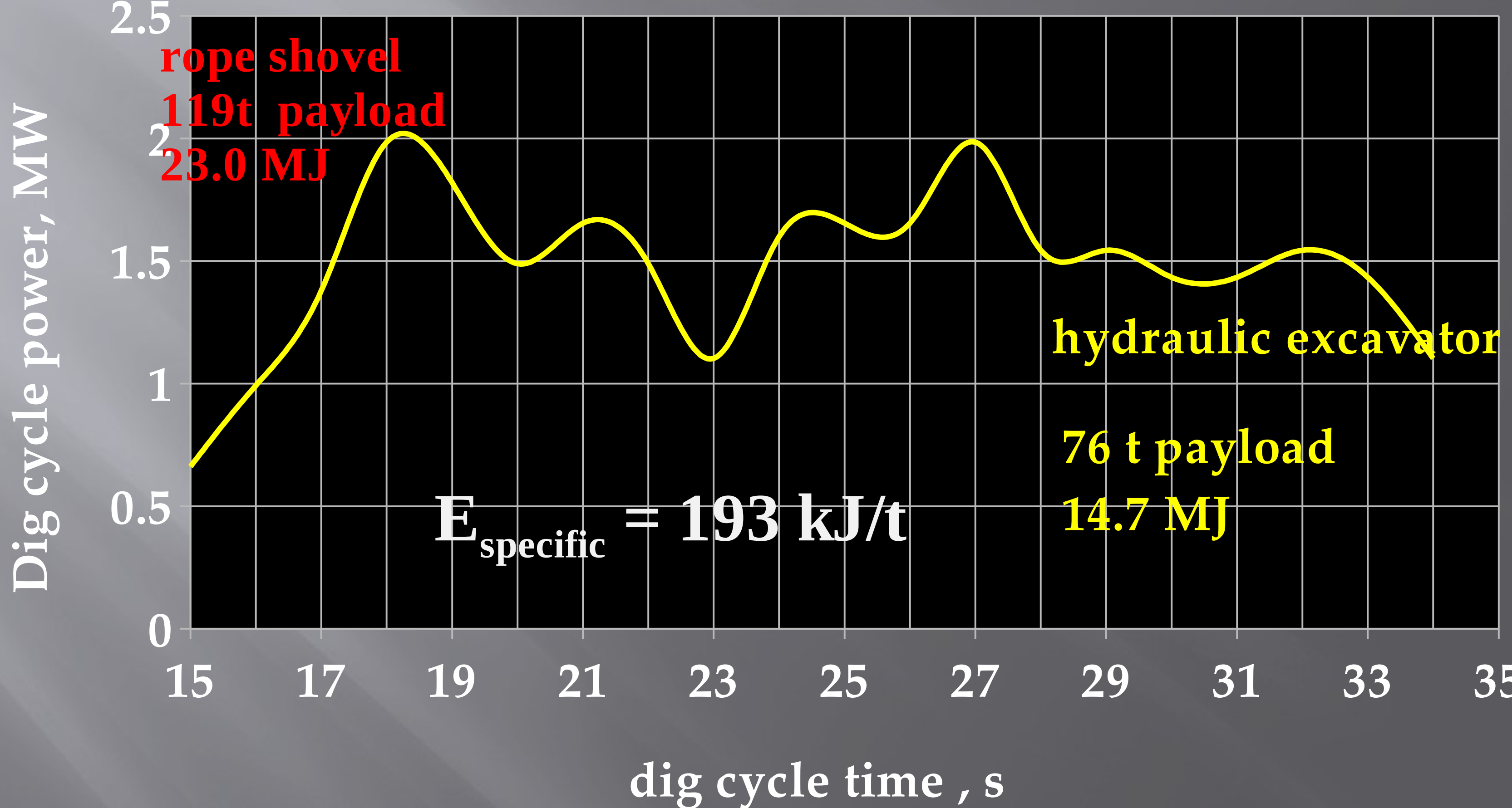
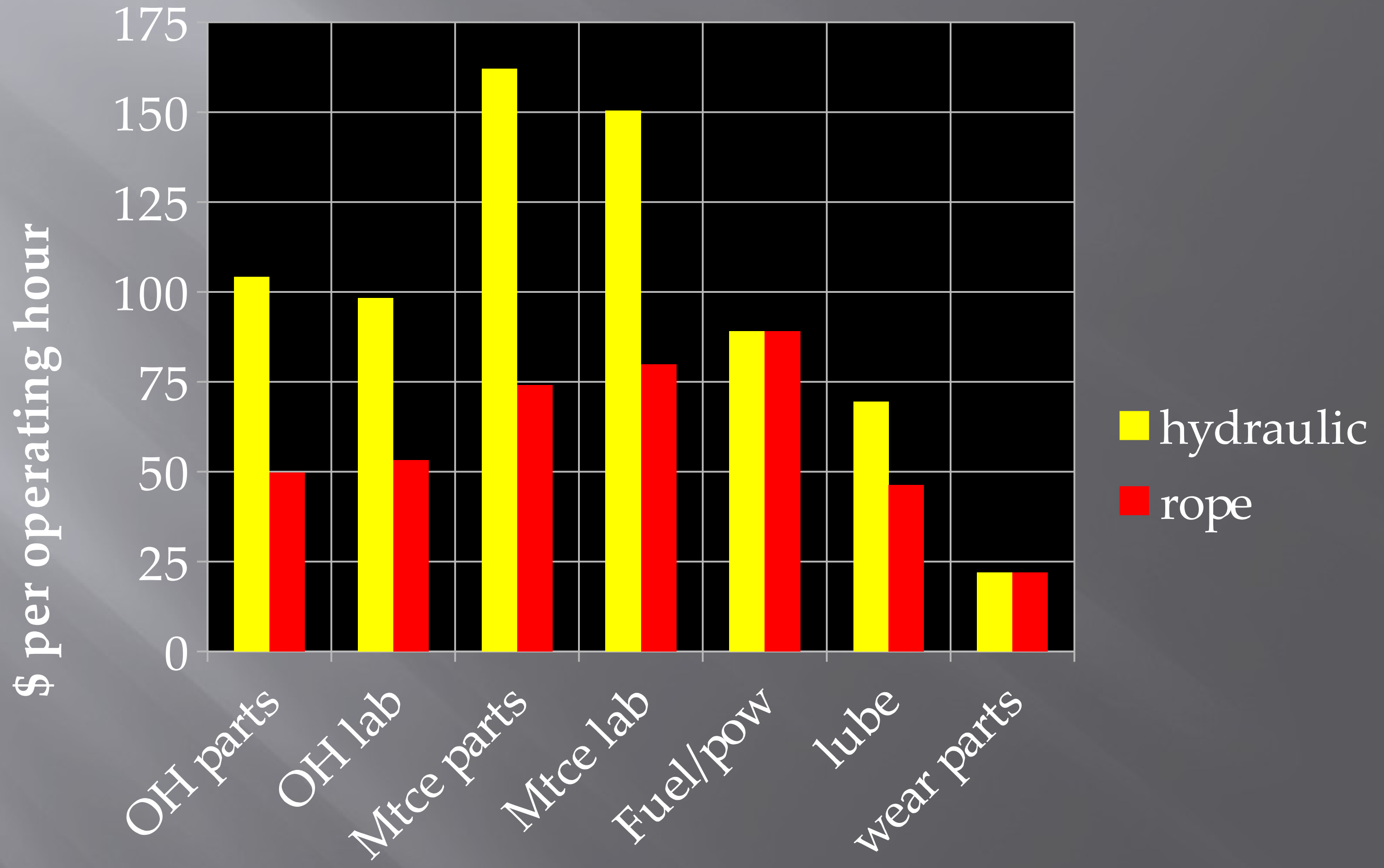
Recall Tim & John at H&L 2013
Ultra class excavator vs. shovel
> 40 m^3 capacity



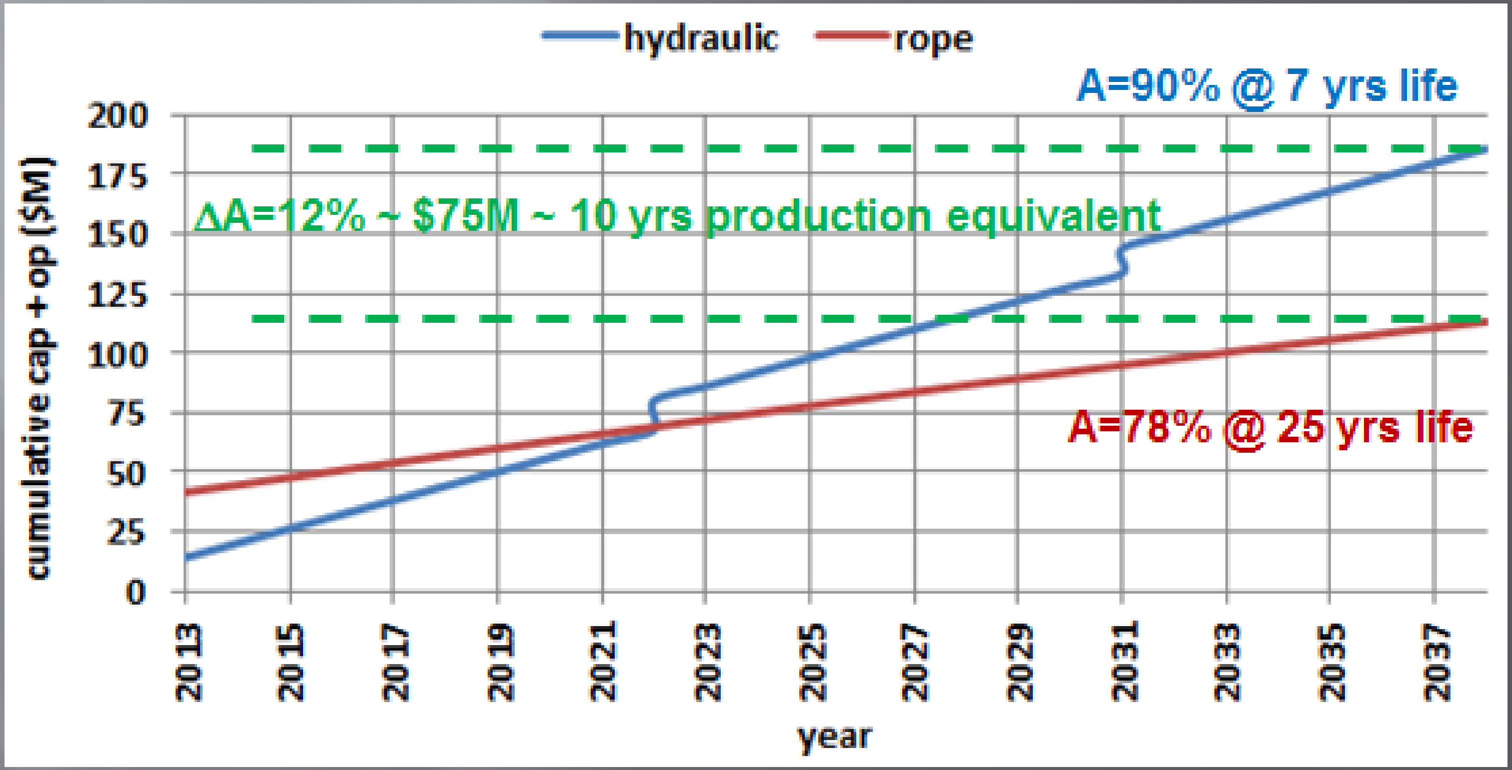
Specific energy comparison



Operating & maintenance cost



Cumulative cost of ownership Sammut & Joseph, 2013 H&L



Availability

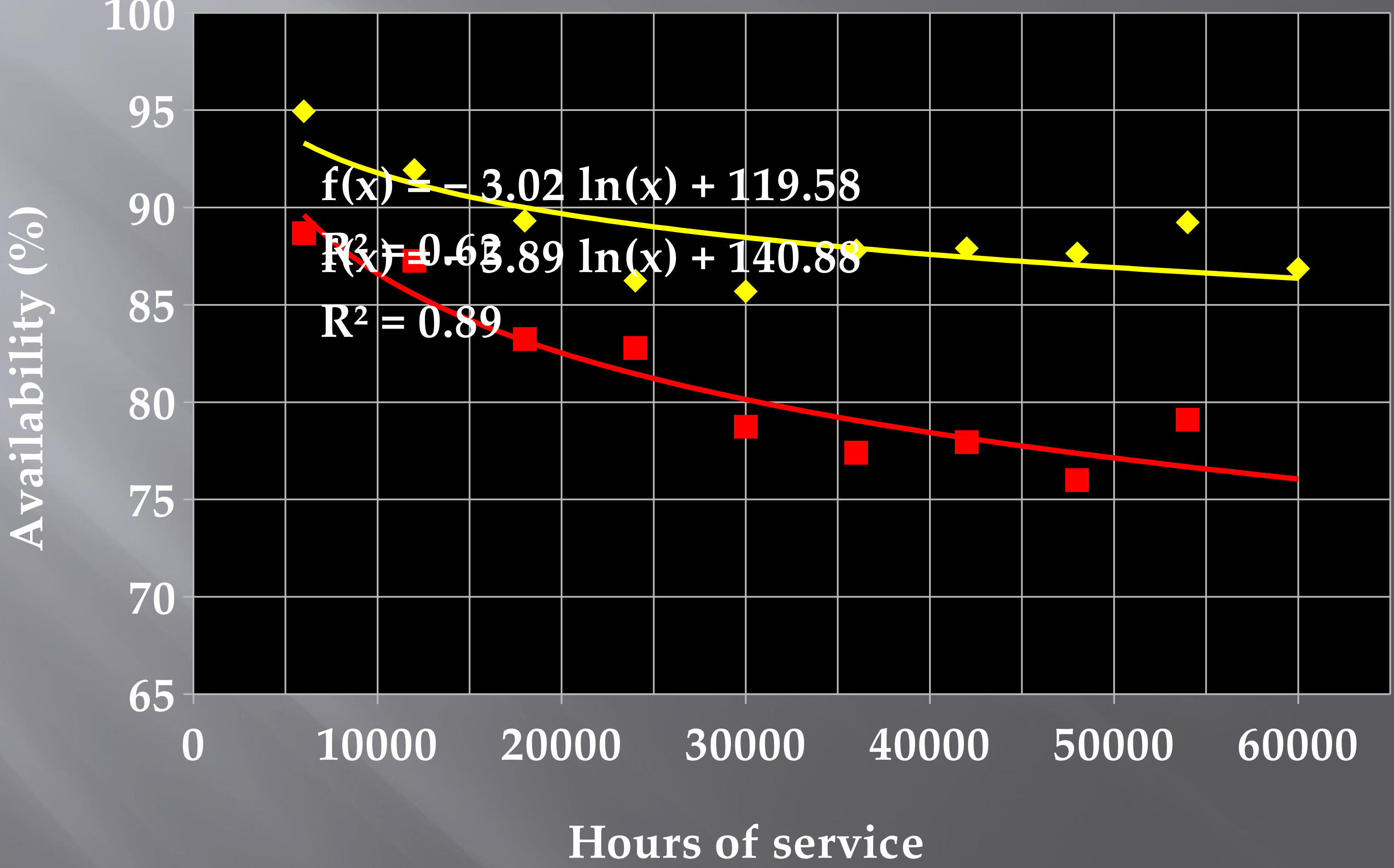
$$A = \left\{\frac{\text{Available } hours}{\text{Scheduled } hours} = \frac{\text{Available } hours}{(\text{Calendar } hours - \text{Scheduled } delays)} = \frac{(\text{Scheduled } hours - \text{Maintenance delays})}{(\text{Calendar } hours - \text{Scheduled delays})}\right\} \text{ x } 100\%$$

%

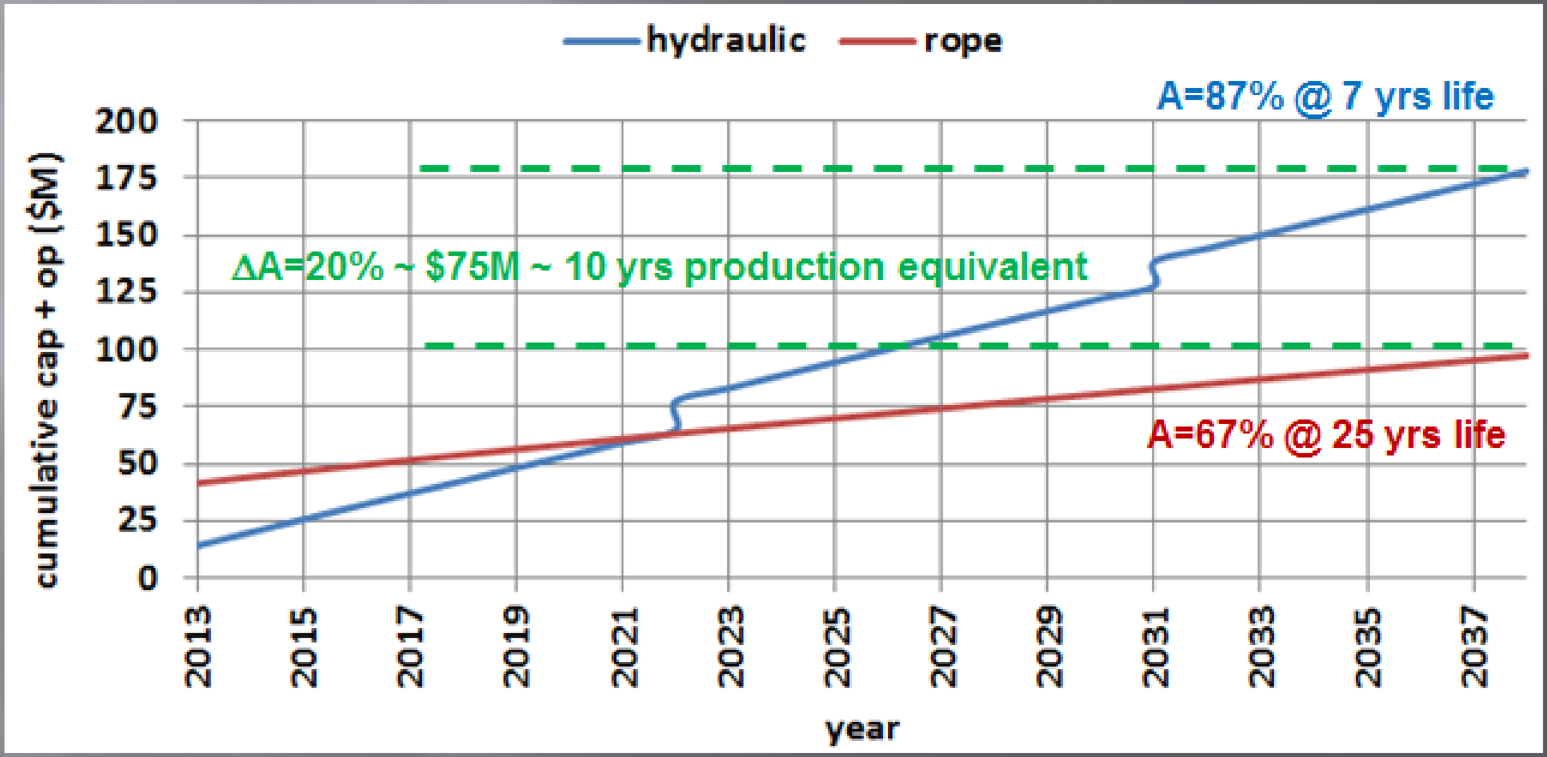
Operations' Availability data

								Op.hrs					
m3 cap	Mined ore	Region	#	6000	12000	18000	24000	30000	36000	42000	48000	54000	60000
10	Coal	Europe	4	94.5	89.7	88.5	87.6						
11	Coal	Europe	4	92.2	91.7	86.9	77.3	82.6	82.5	80.3	76.1		
15	Coal	Asia	8	97.3	96.2	95.1	92.6	92.8	88.1				
22	Coal	Lat Am	5	94.3	89.6	88.8	89.0	90.2	90.8	91.0	93.2		
22	Coal	Europe	1	95.7	91.6	81.5	73.7	66.1	86.7				
22	Coal	Asia	14	94.5	91.4	91.0	89.4	87.8	86.4	90.6			
22	Coal	Africa	5	95.6	94.4	94.0	89.2						
19	Iron Ore	Australia	5	81.2	78.6								
19	Iron Ore	Africa	5	75.0	84.8	91.6							
19	Copper	Lat Am	1	90.9	81.0	87.2							
28	Coal	Europe	1	94.5	92.7	78.0	76.1						
28	Coal	Australia	1		93.4								
28	Coal	US	2	95.8	93.4	90.4	94.9		88.9	90.8	91.0	92.6	
25	Iron Ore	Australia	5	79.6	77.4	81.5		76.8	77.9				
25	Iron Ore	Africa	2		81.6	77.6							
25	Iron Ore	Europe	2	91.3	89.2	84.1	83.1	88.9					
28	Copper	Lat Am	17	88.2	85.8	81.8	82.6	73.8	82.2	82.8	84.6	87.9	85.5
28	Phosphate	Africa	1					95.0	95.0				
25	Uranium	Africa	4						92.4		96.0	93.3	93.3
42	Coal	Lat Am	19	95.0	91.4	91.1	90.9	89.3	89.3	89.7	89.2	88.6	91.0
42	Coal	Africa	2		91.5	89.4	84.7						
42	Copper	Lat Am	8	86.5	83.2	72.6	62.7						
10 -18	Coal	Europe	6	86.6	86.6	83.9	87.3	81.5	80.4	76.6	74.4	78.0	69.2
20	Coal	Europe	2	91.8	88.4	77.9	67.7	65.3	59.3				
33	Coal	Europe	2	91.8	88.1	86.6	84.3	83.9	86.5	82.0	80.8	82.4	

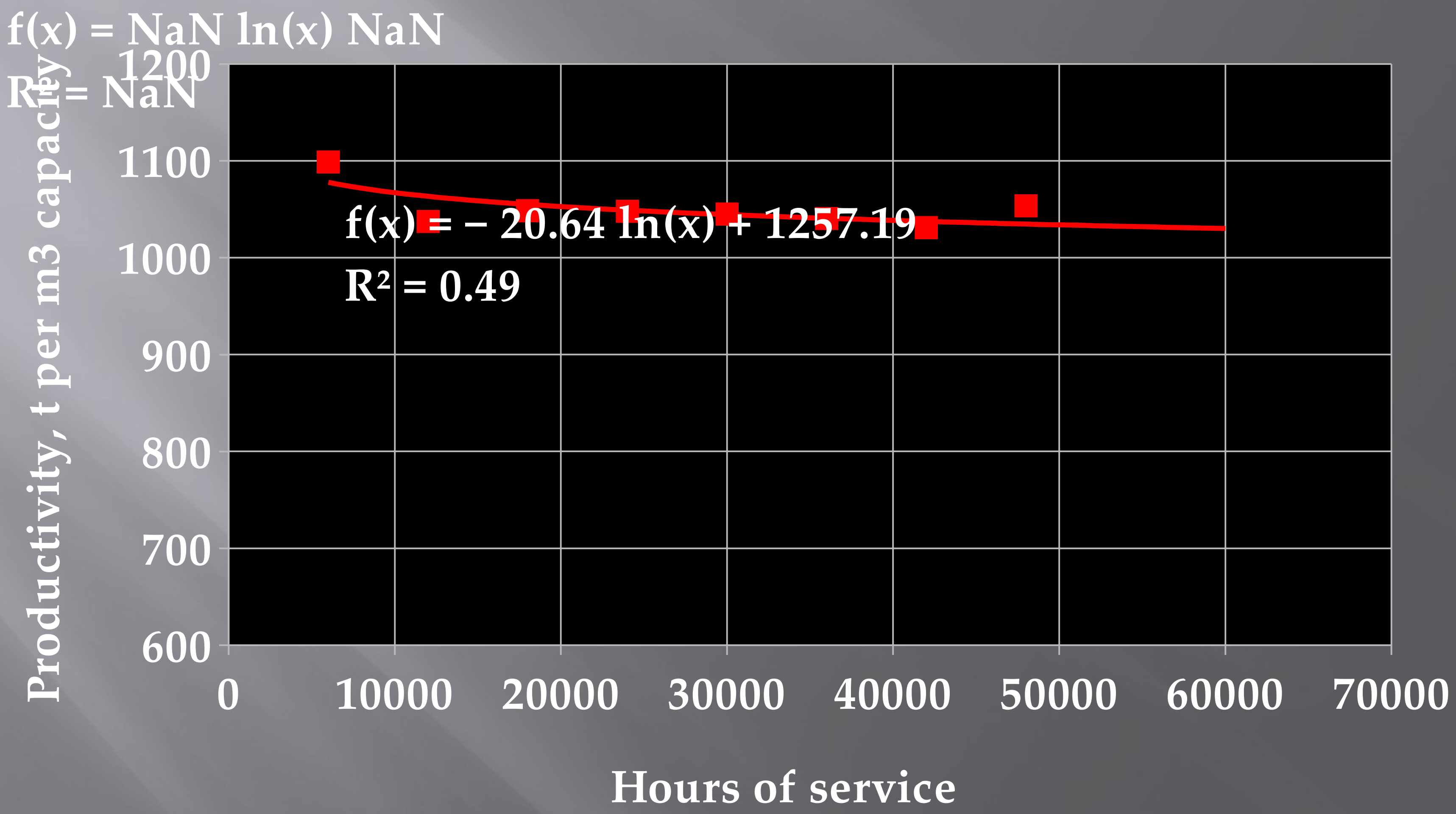
Availability



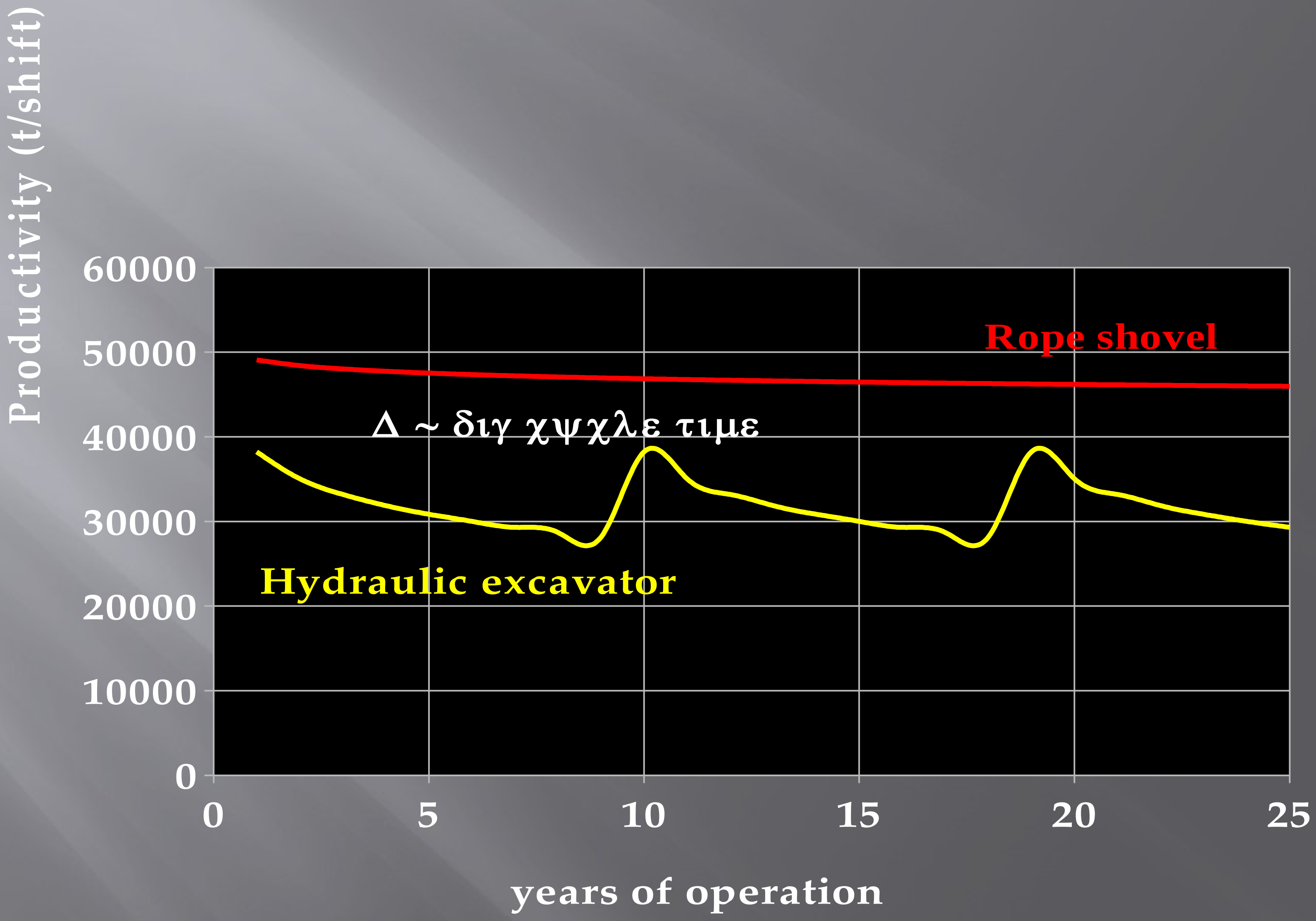
Joseph & Sammut 2013 modified availability – cost assessment



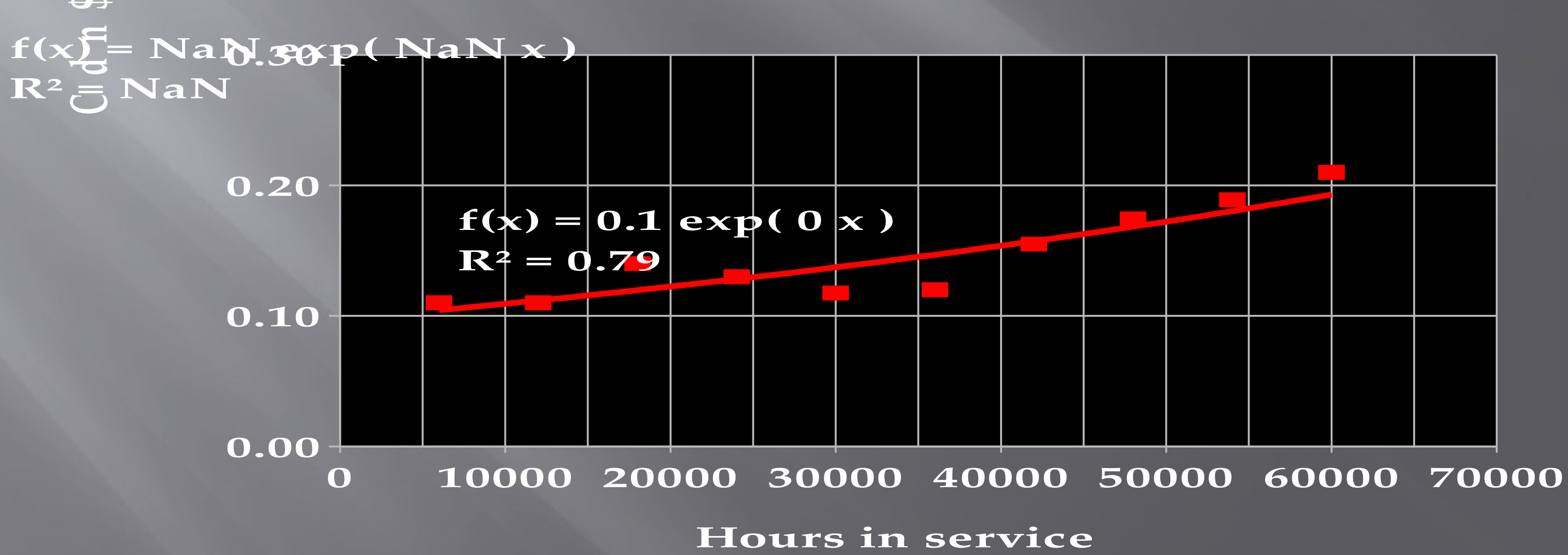
Productivity per m^3 capacity



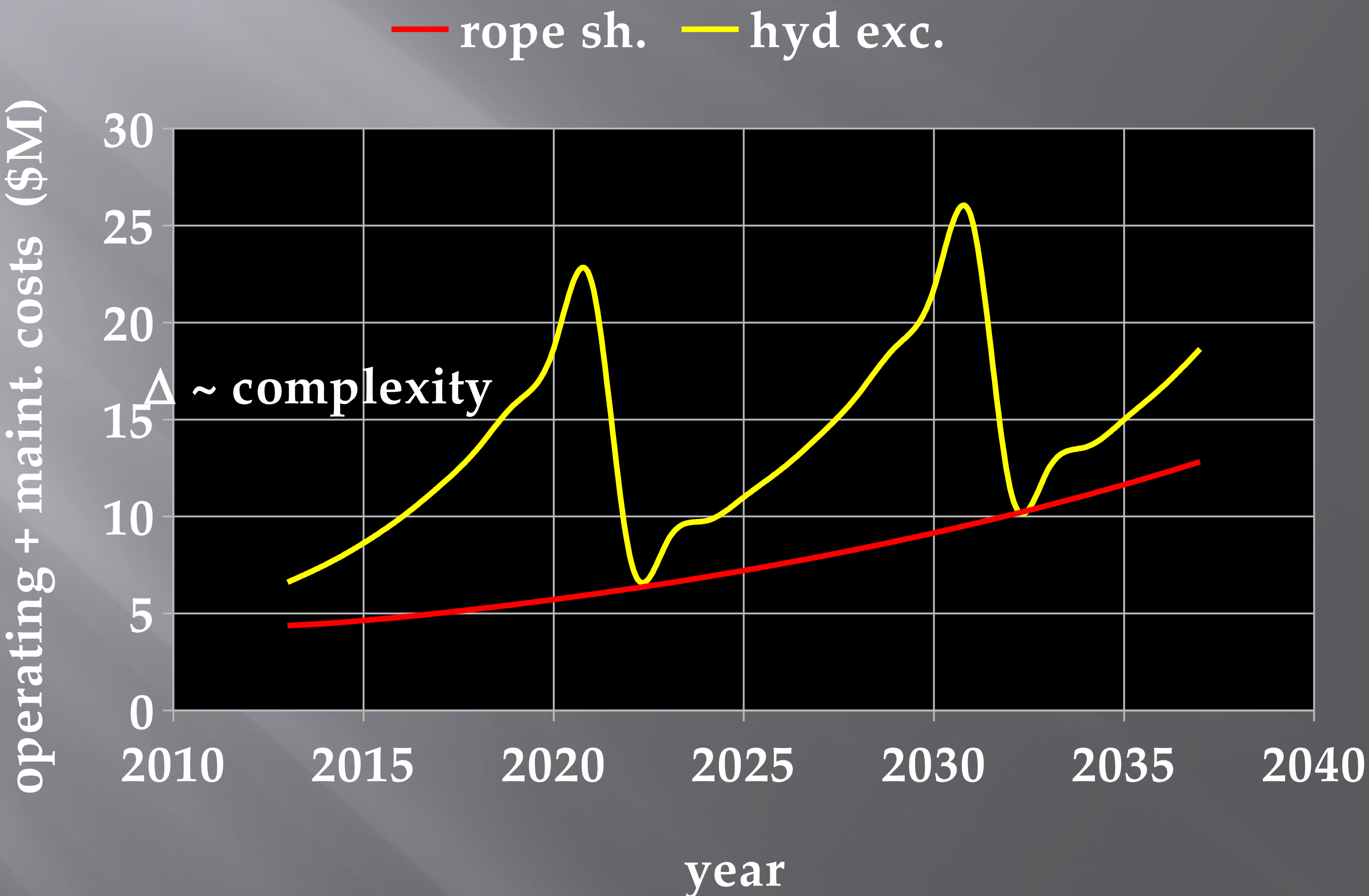
Productivity over 25 years



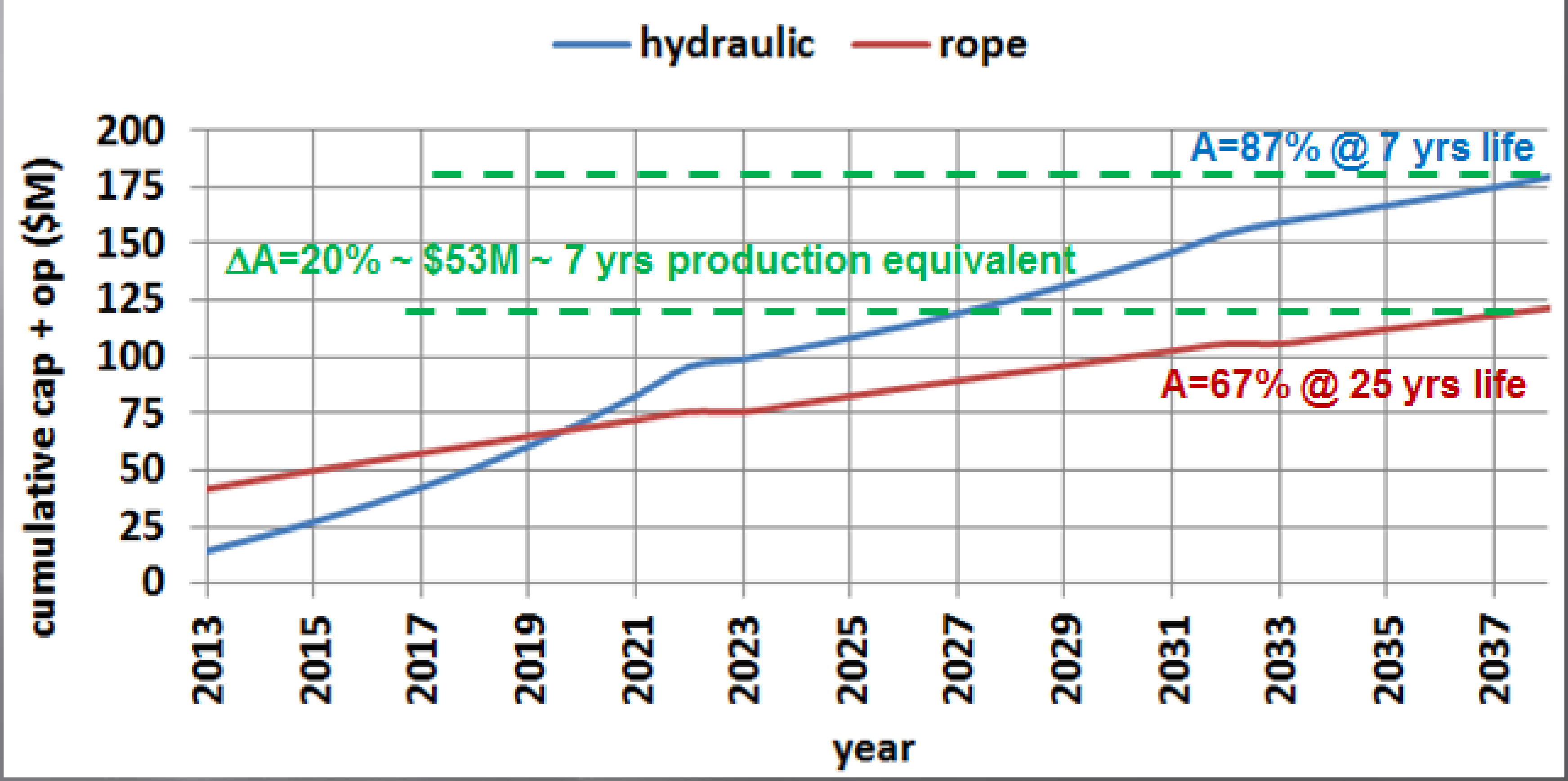
Maintenace cost per m^3



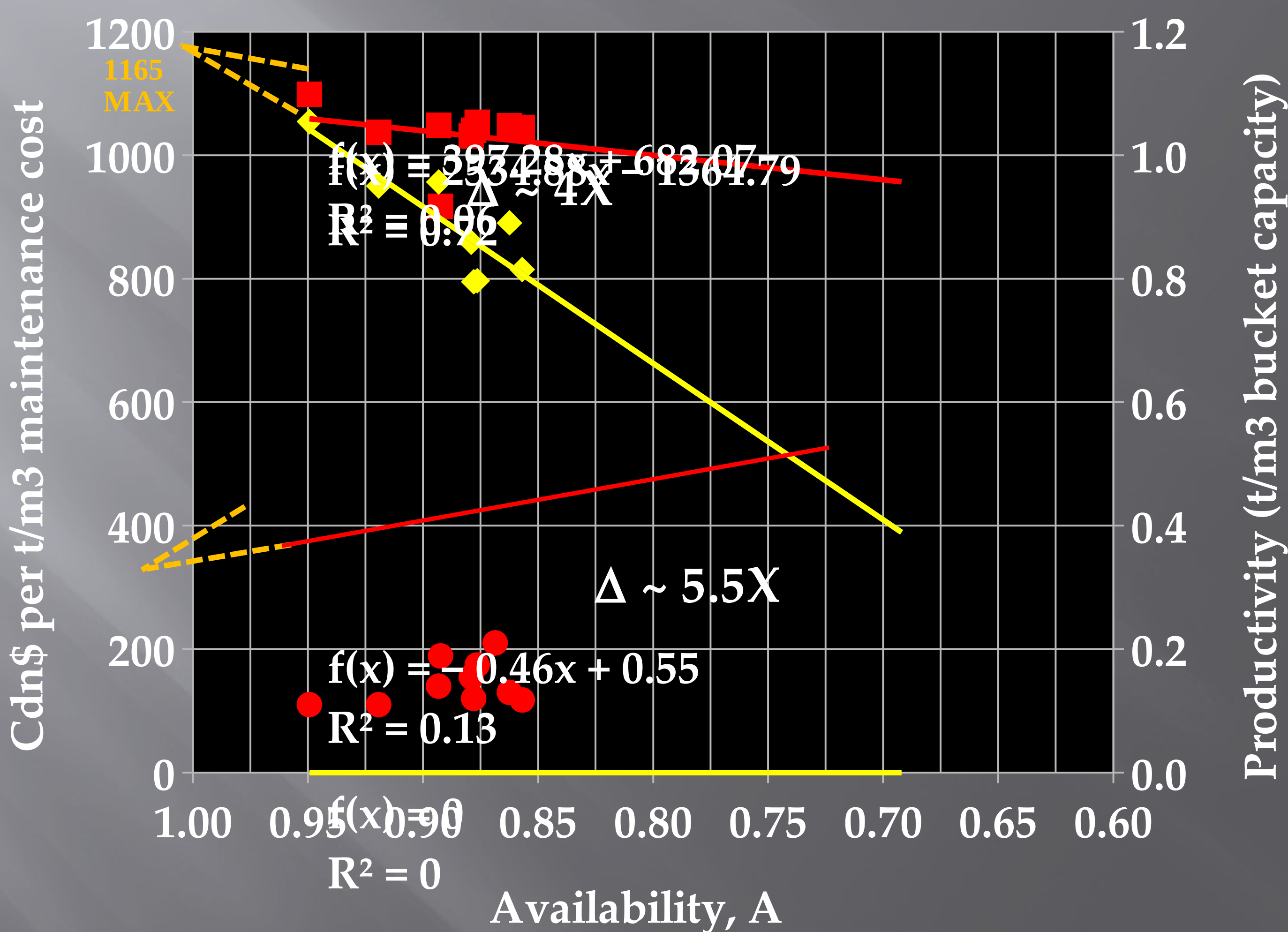
Comparing operating and maintenance costs



Revisiting the cost of ownership



Productivity & Maintenance Cost as a function of Availability



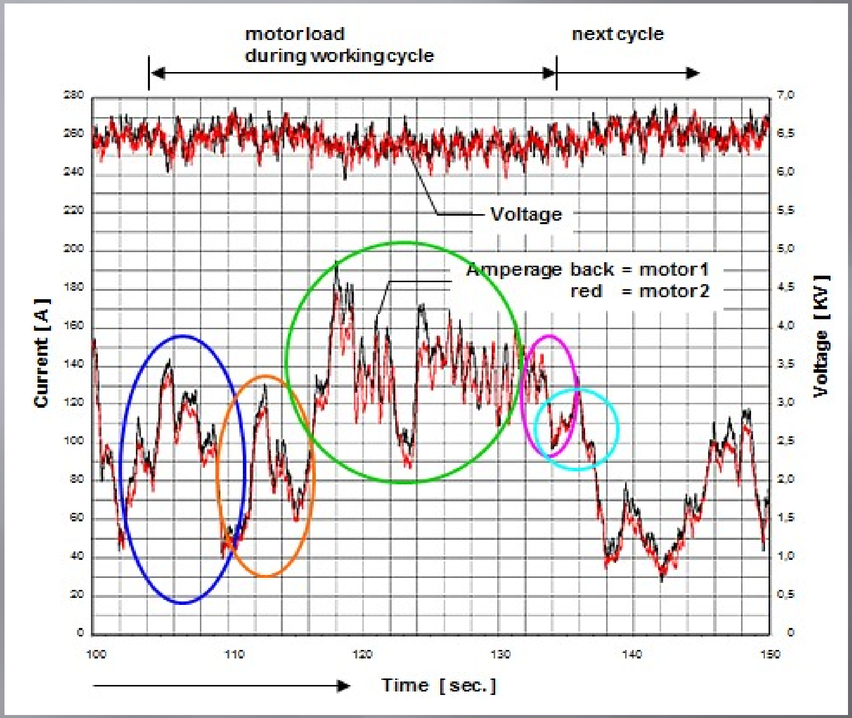
Conclusions

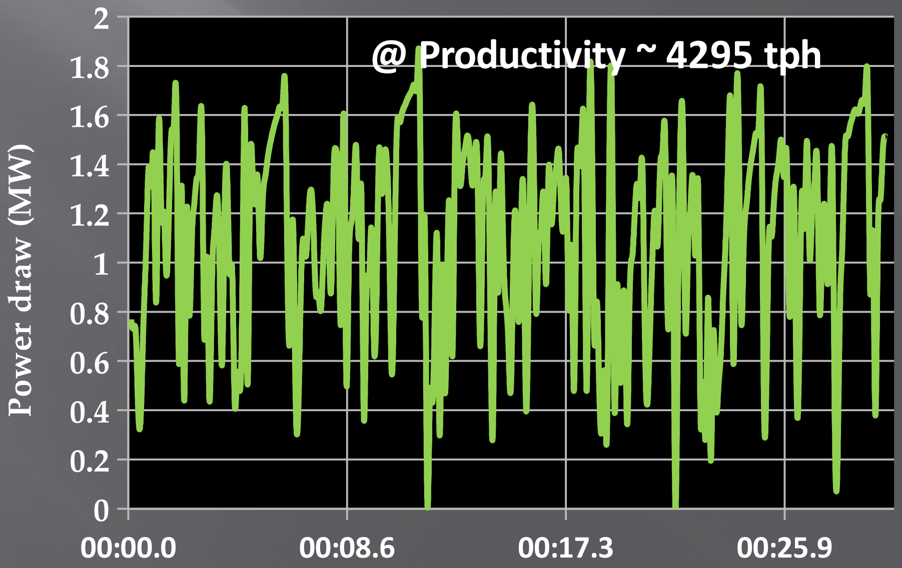
? More Q's

for OEMs & users

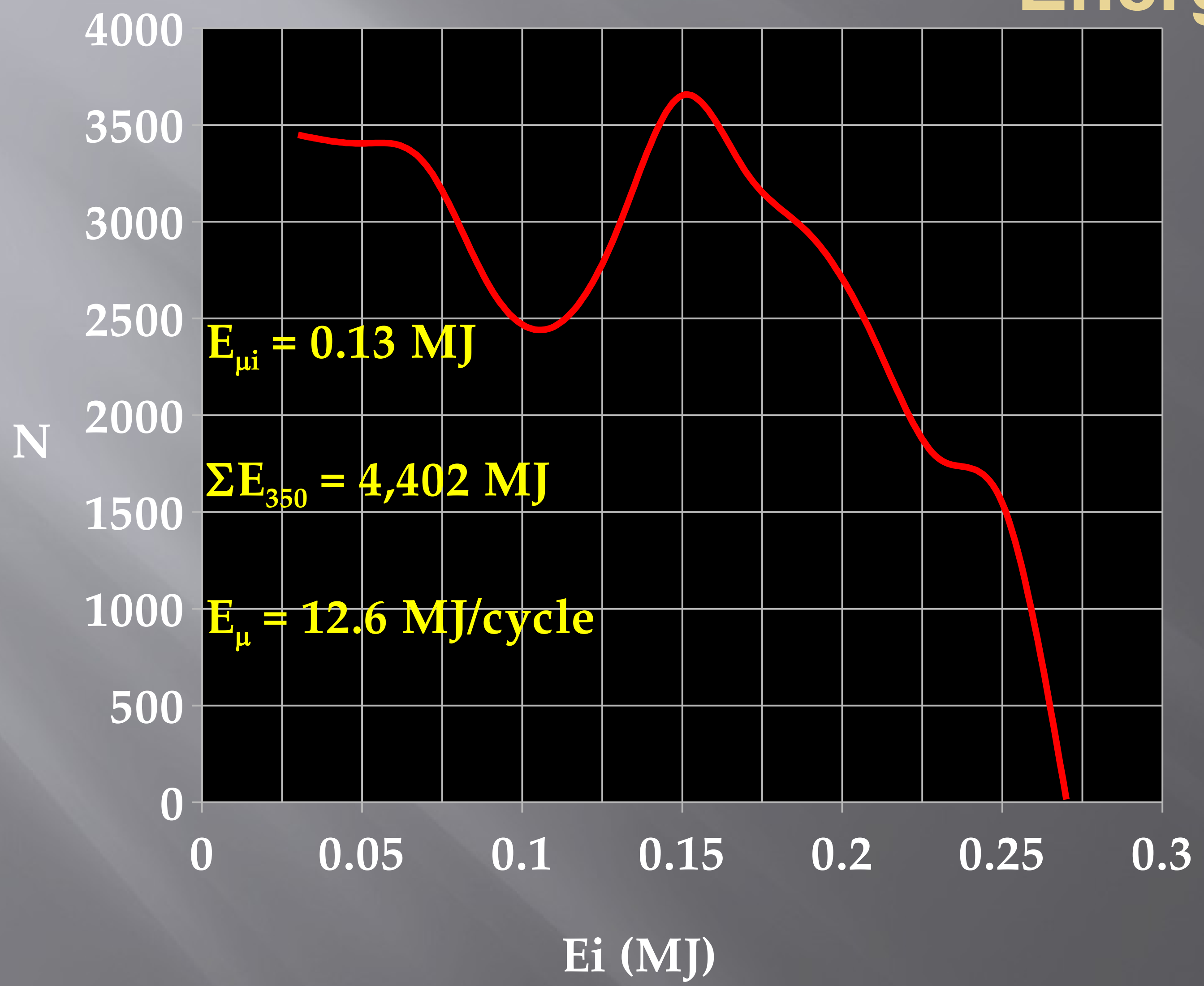
… coming at H&L 2019

Impact of blast quality on shovel & crusher - minimizing E used

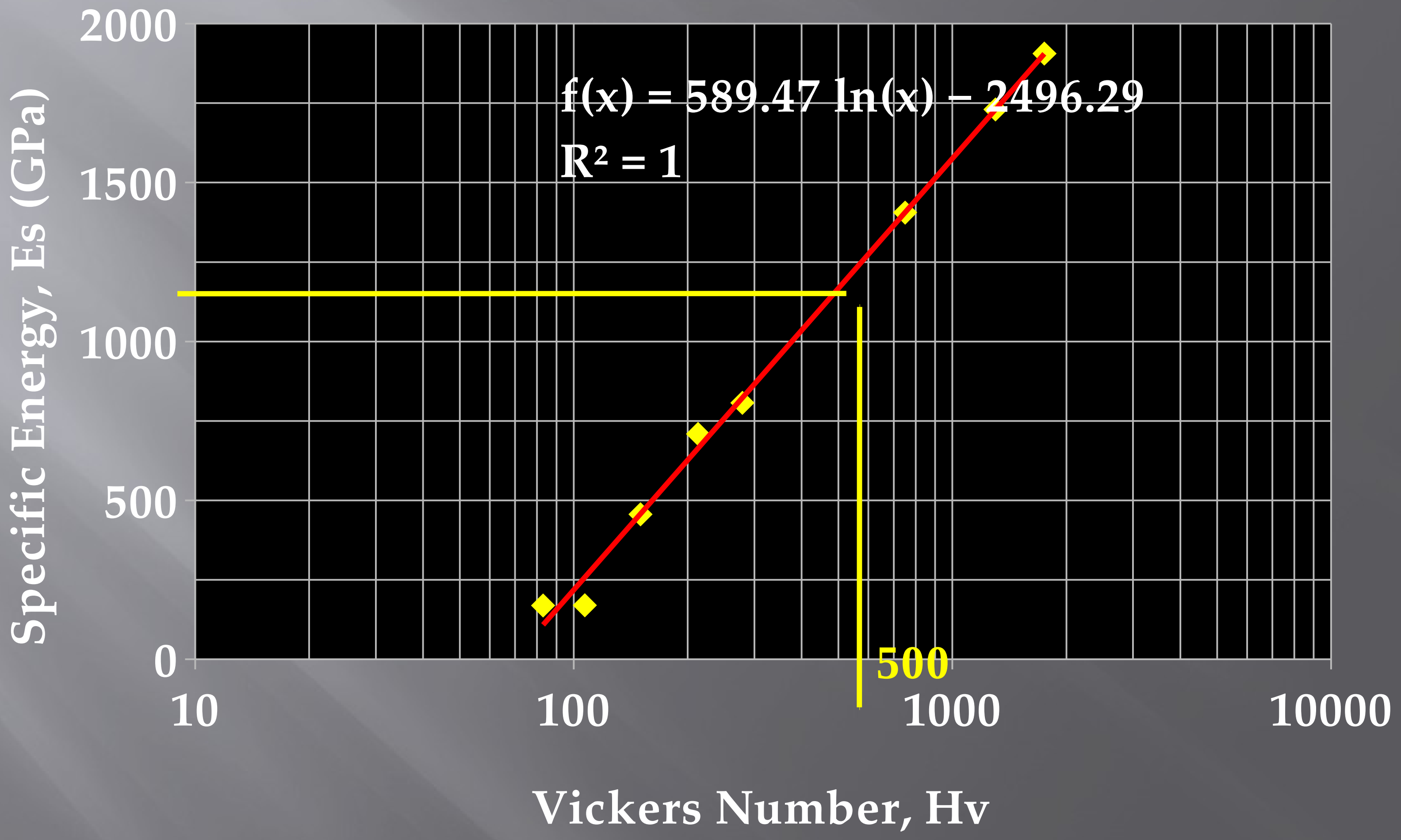




Power and Energy per cycle



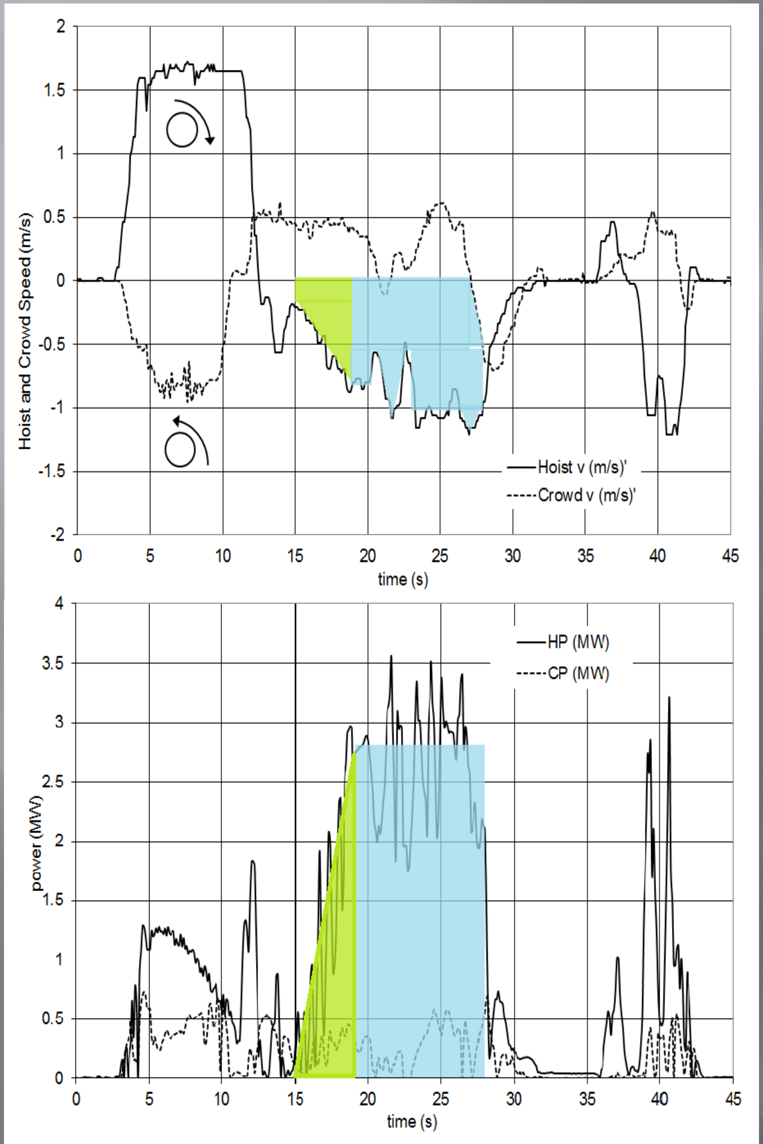
GET wear = f (E_s), Nm/m^3

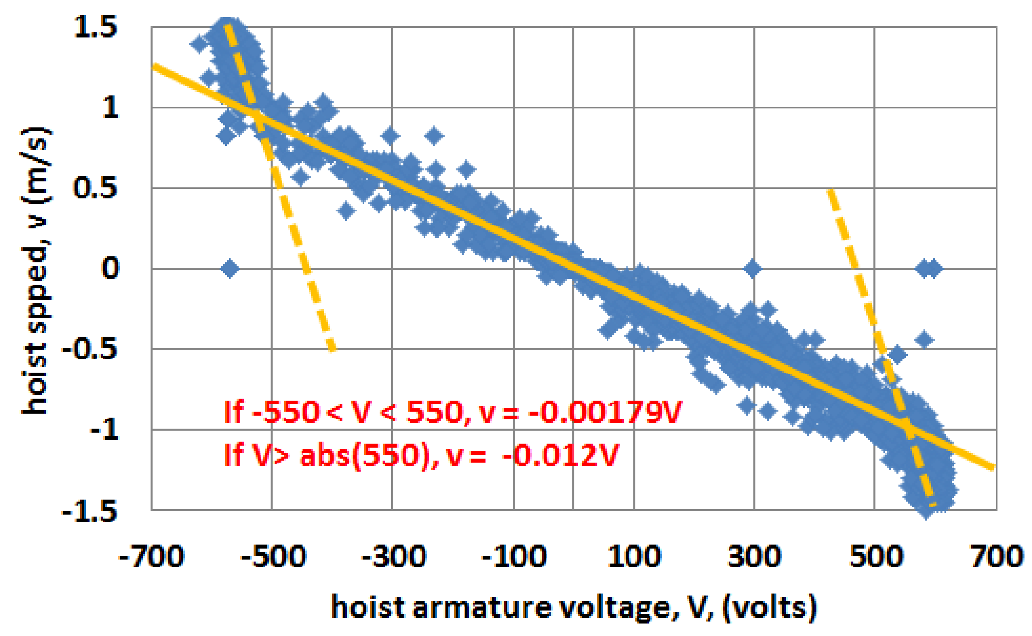


Predicting tooth wear - example

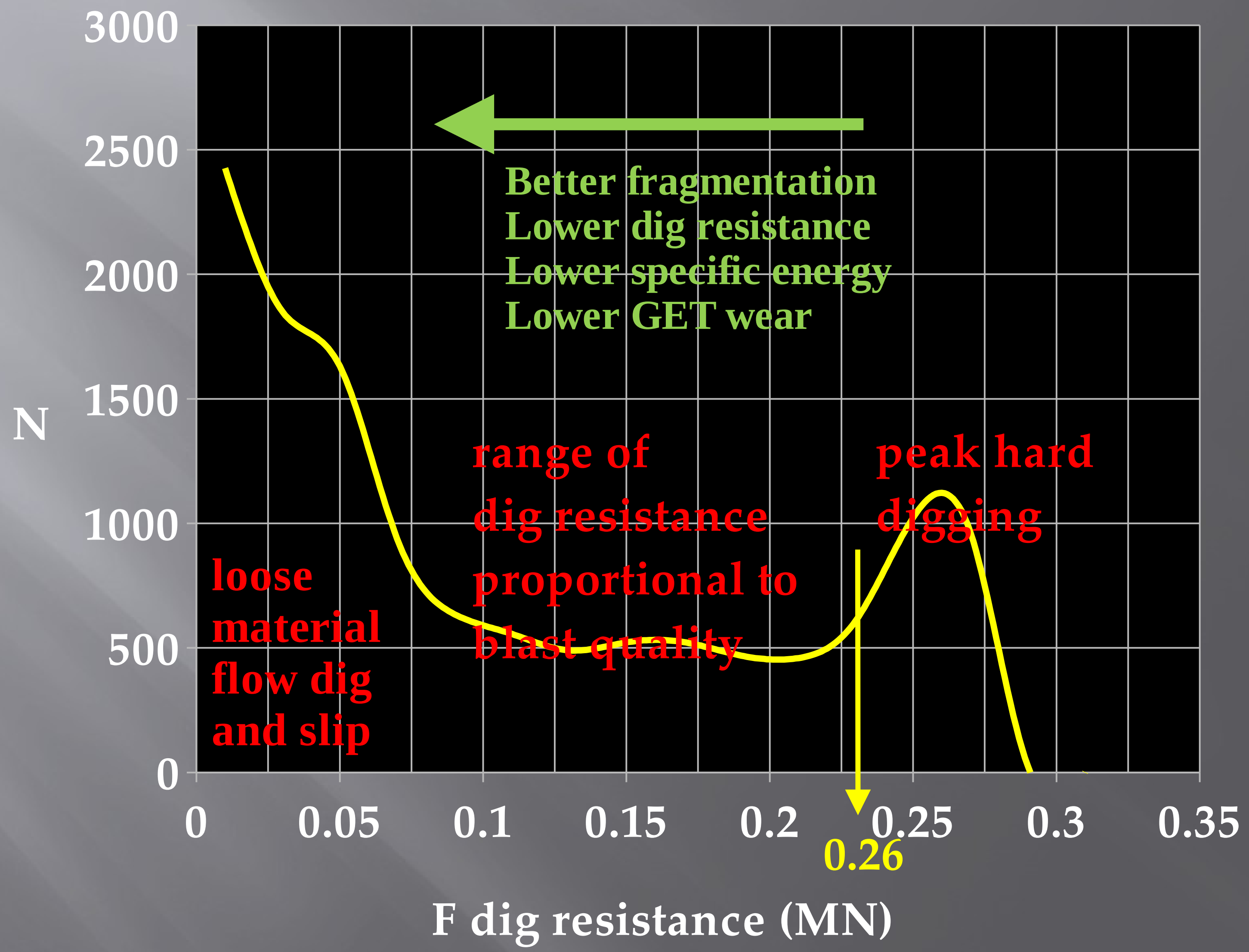
- 9 tooth lip system
- Duty cycle is ~48 s and shovel has 85% availability and 80% utilization = 3672 cycles
- Energy per cycle = 12.6 MJ
- Wear energy expended per tooth ~ 5140 MJ
- Tooth steel 500 Hv, E_s = 1200 GPa (GJ/m^3)
- **Predict** volume lost = 5.14/1200 = 0.0043 m^3
- Single shovel tooth measured losing 70 lb (31.75 kg, **0.0043 m^3**) mass in 3 days.

dig force, $F_{dig} = \eta P/v$



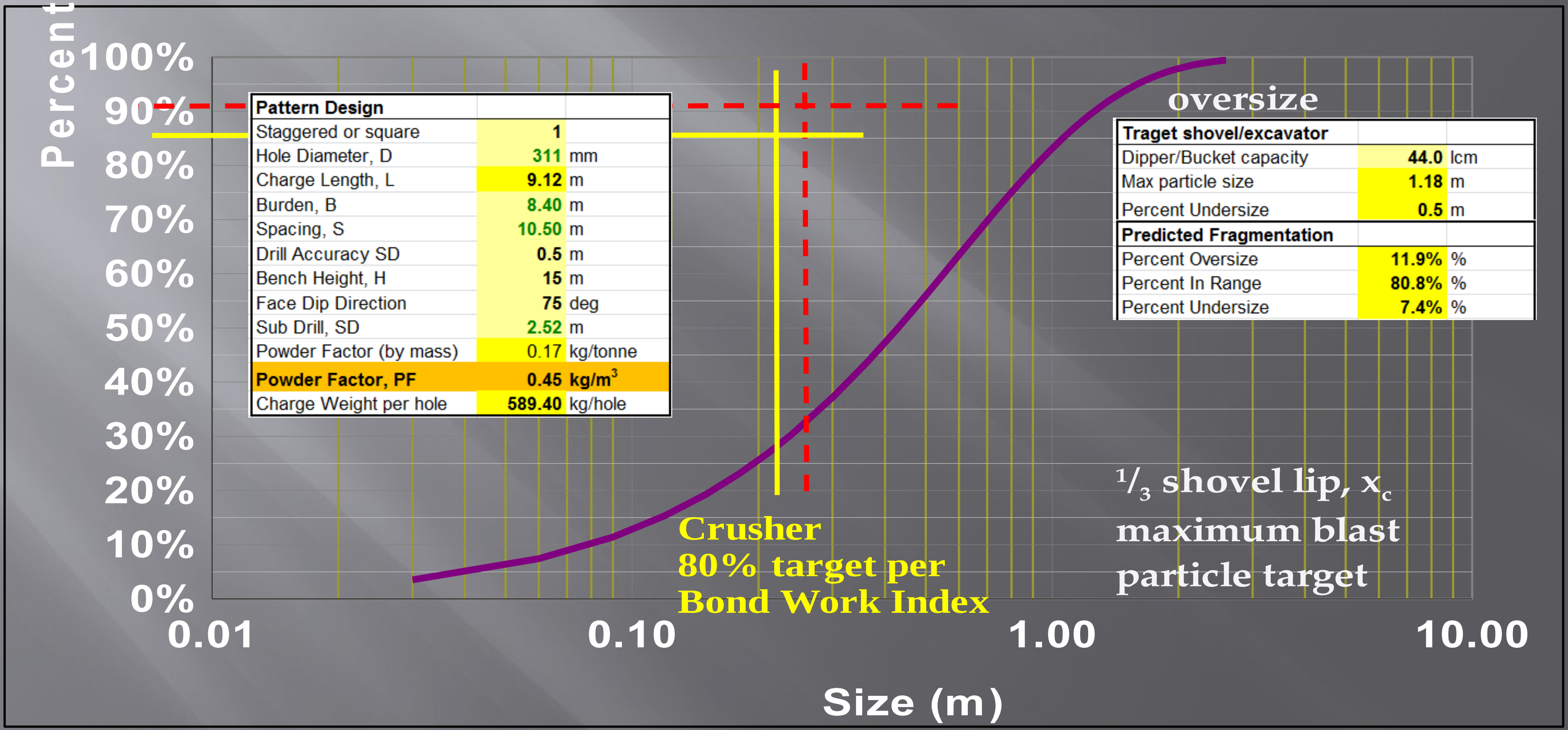


Dig force vs. blast quality



Fill factor = f(blast & flow)

Balancing E
blast vs. shovel vs. crusher



Conclusions

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Next time – see you at H&L 2019