Sustaining capital of alumina refinery projects

P.-H. ter Weer, TWS Services & Advice, Bauxite Alumina Consultancy

Sustaining capital cost (or expenditure), abbreviated as sustaining capex or Susex, is a project cost item which is easily overlooked and sometimes ignored. To many it is unknown and it may be (partly) hidden in other operating cost items. The relationship – and the difference – with repair and maintenance costs is not always clear and may inadvertently lead to incomplete cost estimates. This article is based on a paper presented at the TMS Light Metals 2016 conference [1]. It explores several facets of sustaining capital and aims at clarifying some of these Susex issues for alumina refinery projects.

Sustaining capital – an overview

General: Sustaining capital expenditure in general refers to expenditure related to capital asset additions, replacements or improvements required to maintain/sustain existing assets. Required investments covered under Susex contribute to ensuring that the operation's overall reliability is maintained at the existing production level and that all (existing and new) reliability, legislative, regulatory, environmental and safety requirements are met. Considered from an economic perspective, Susex does not generate additional revenues.

Drivers of Susex include:

- Reliability and risk mitigation which includes but is not limited to life extensions, end of life replacements, and system reinforcements (designed and implemented to meet existing and new requirements)
- Regulatory compliance
- Health, Safety & Environment compliance and improvements
- Social requirements
- Product market requirements.

Alumina refinery projects: Focussing on alumina refinery projects, Susex is the ongoing capital expenditure required to avoid the eventual discontinuation of the operation, to maintain its production level and its product at target quality, and to maintain Health, Safety & Environment (HSE) on target/in compliance. It covers items such as:

- Replacing worn-out equipment and major equipment repair
- Developing bauxite residue ('red mud') disposal areas
- Repair of facility structures
- Investments to meet (existing and new) HSE requirements
- Investments to meet (existing and new) alumina product quality standards
- Investments to meet social obligations.

Often an alumina refinery project includes other project elements such as a bauxite mine and (country) infrastructure (port, railway, roads, personnel housing, etc.). In that case most of the above applies also to the additional project elements, and supplementary Susex items may include:

- Mine mobile equipment replacement
- Mine fleet expansion to maintain plant throughput capacity (if applicable)
- Resettlement costs of local communities (if applicable)
- Port dredging (if applicable)
- Railway rolling stock and locomotive replacement (if applicable).

Operation closure costs: The development of a greenfield alumina refinery project may require inclusion of an allowance in the financial model covering the costs of closure of the operation, and the costs of rehabilitation of the affected mine lease and refinery areas at the end of project life. Mine area rehabilitation is normally a progressive process, but final closure of the operational residue area and the refinery site itself will require expenditure at the end of project life. After operation closure, port and housing facilities and any other functioning infrastructure are sometimes handed over to the country's government without further expense. Operation closure costs are not included in this article's Susex cost.

Difference with repair and maintenance costs: The principle difference between Susex and repair and maintenance (R&M) costs (including maintenance materials and contract services) as included in the alumina refinery cash operating cost is that Susex is depreciated (spread) over a period of time while R&M costs are expensed, i.e. form part of a plant's cash operating costs (Opex).

However when comparing Susex between different projects, elements of R&M costs should be considered as well because operating plants do not always use the same basis for these two cost items (see below).

Sustaining capital cost values

Actual Susex values: The actual sustaining capital cost of a project depends on aspects such as its location, age, technologies used, operational and maintenance methods, infrastructure, scale of the operation, etc. It should

Table 1: Susex ranges and values

	Sustaining capex, $/tA	
Project element	**Indicative range**	**Typical value**
Bauxite mine	2.5-5.5	~3.5
Infrastructure	1.5-3.5	~2.5
Alumina refinery	6-12	~8
Total	**10-21**	**~14**

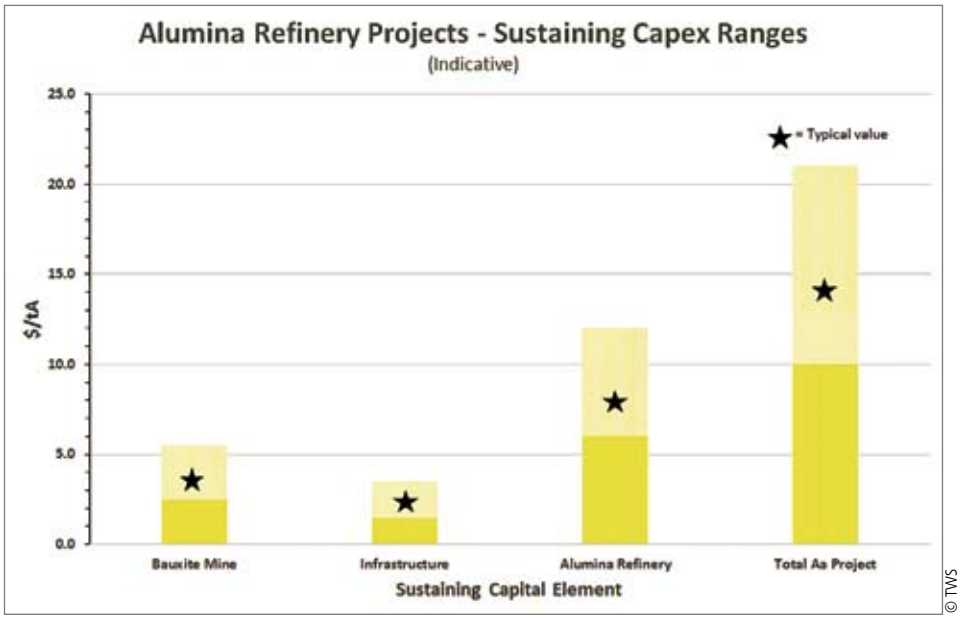

Fig. 1: Alumina refinery projects – Susex range of project elements

Table 2: Alumina refinery sustaining capex build-up

Alumina refinery	Typical greenfield capex values, $/annual tA		Lifetime, years		Calculated annual long term Susex				
					Greenfield project basis				Mature portfolio basis[4]
Capex element	Indicative range	Typical value	Indicative range[5]	Typical	Indicative range, $/tA	Typical, $/tA	% of direct, Total capex (range)	% of direct, total capex (typical)	% of direct, total capex (range)
Equipment		150	40-60	50	2.5-4	3			
Commodities[1] / structures		370	60-70	65	5-6.5	5.7			
Direct capex		520			7.5-10.5	8.7	1.4-2	1.7	2.8-4
Indirect capex[2]		480							
Total capex	850-1,400[3]	1,000					0.8-1.1	0.9	1.6-2.2

1) Structural steel, concrete, piping, wire and cable, raceway (cable trays), instrumentation, electrical equipment, earthworks, etc.
2) Freight, EPCM, temporary construction support, commissioning, insurance, owner's engineering, etc.
3) Dependent on production capacity, location, bauxite quality, technologies, etc.
4) Project portfolio with (bauxite and) alumina projects which on average are midway their expected lifetime
5) Refer for instance [2]

also be remembered that due to its nature actual Susex values may vary (significantly) from year to year, oscillating around a long term average.

The Susex values in Table 1 are based on available global historical data and include typical bauxite mine and alumina refinery Susex values and ranges (for both low and high temperature digestion plants) for existing bauxite and alumina projects, and Infrastructure values based on greenfield project data. Fig. 1 provides a graphical illustration of Table 1.

Calculated / derived alumina refinery Susex values: The approach used here to reconcile an alumina refinery's Susex is based on the underlying capex build-up and the lifetime of its components as shown in Table 2.

Table 2 illustrates that, based on typical values for refinery capex and the lifetime of equipment and structures, a typical annual long-term alumina refinery Susex value may be derived of ~8.7 $/tA which is consistent with the actual typical value as shown in Table 1 (~8 $/tA).

The indicative Susex range derived this way of 7.5-10.5 $/tA, although being narrower than the actual range, refer Table 1 (6-12 $/tA), is not inconsistent as it falls entirely within the range of Table 1.

Sustaining capital – industry majors

To provide a context for the above numbers, Susex values in relation to properties, plant and equipment (P, P&E) of Alcoa, Hydro, and Rio Tinto have been compared for the years 2013 and 2014 based on their respective annual reports [2], [3] and [4]. The results are shown in Table 3. Fig. 2 provides a graphical illustration of Table 3.

Land and land rights (Alcoa, Hydro) and mining properties and leases (Rio Tinto) have been excluded from P, P&E in this comparison under the assumption that no sustaining capital has been spent on these items. Construction work-in-progress, respectively capital works in progress (WIP, Alcoa, respectively Rio Tinto) and plant under construction (PUC,

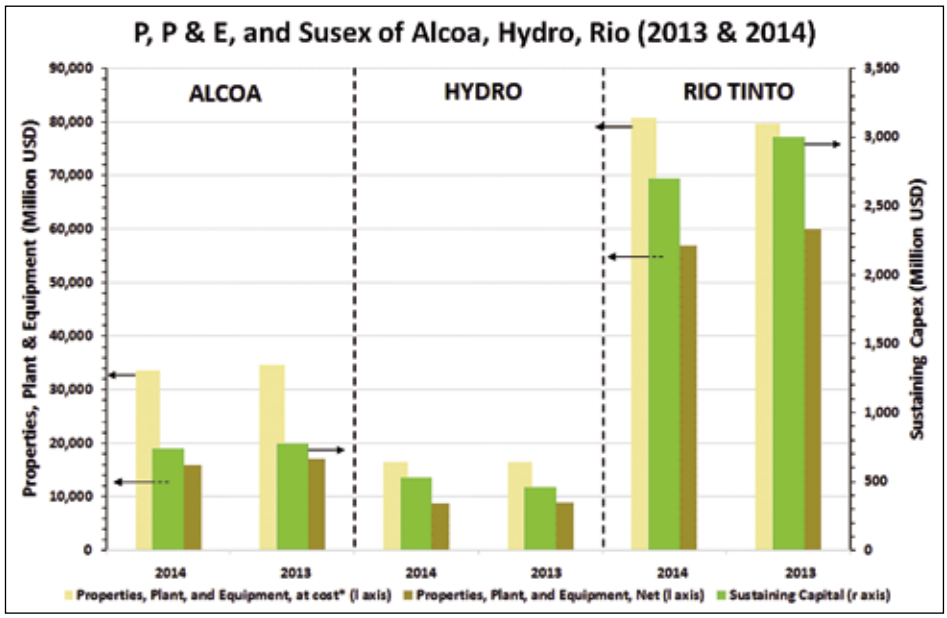

Fig. 2: Properties, plant and equipment, and Susex of Alcoa, Hydro and Rio Tinto (2013 and 2014)

Table 3: Sustaining capex of Alcoa, Hydro and Rio Tinto in relation to their properties, plant and equipment, in 2013 and 2014

Numbers based on 2013 & 2014 Annual Reports	ALCOA				HYDRO				RIO TINTO			
	2014		2013		2014		2013		2014		2013	
	MUS$	As % of Cost	MUS$	As % of Cost	MNOK	As % of Cost	MNOK	As % of Cost	MUS$	As % of Cost	MUS$	As % of Cost
Properties, Plant, and Equipment, at cost*	33,503	100%	34,660	100%	102,856	100%	96,199	100%	80,680	100%	79,757	100%
Accumulated Depreciation, depletion, and amortization	-19,091	-57%	-19,227	-55%	-50,757	-49%	-47,274	-49%	-33,785	-42%	-33,881	-42%
Sub Total	14,412	43%	15,433	45%	52,099	51%	48,925	51%	46,895	58%	45,876	58%
Construction Work in Progress / Plant under Construction	1,466	4%	1,567	5%	2,687	3%	3,020	3%	9,885	12%	14,071	18%
Properties, Plant, and Equipment, Net	15,878	47%	17,000	49%	54,786	53%	51,945	54%	56,780	70%	59,947	75%
Sustaining Capital	735		770		3,300		2,700		2,700		3,000	
Sustaining Capex as % of "P P & E, at Cost" Value, excl. WIP / PUC	2.2%		2.2%		3.2%		2.8%		3.3%		3.8%	
Sustaining Capex as % of "P P & E, Net" Value, excl. WIP / PUC	5.1%		5.0%		6.3%		5.5%		5.8%		6.5%	

* Excl. Land and Mining Properties & Leases

Table 4: Comparison of Susex values

Alumina refinery sustaining capex					
	Indic. range $/tA	Typ. value $/tA	% of total capex (typ)	As % of total capex on greenfield / 'at cost' basis (range)	As % of total capex on mature[2] / nett of depreciation basis (range)
Actual (Table 1)	6-12	8			
Calculated (Table 2)	7.5-10.5	8.7	0.9	0.8-1.1	1.6-2.2
Industry majors[1] 2013-2014 (Table 3)				2.2-3.8	5.0-6.5

1) Note that sustaining capex percentages of industry majors relate to their overall portfolio of operations, not just alumina refinery projects;
2) Project portfolio with (bauxite and) alumina projects which on average are midway their expected lifetime

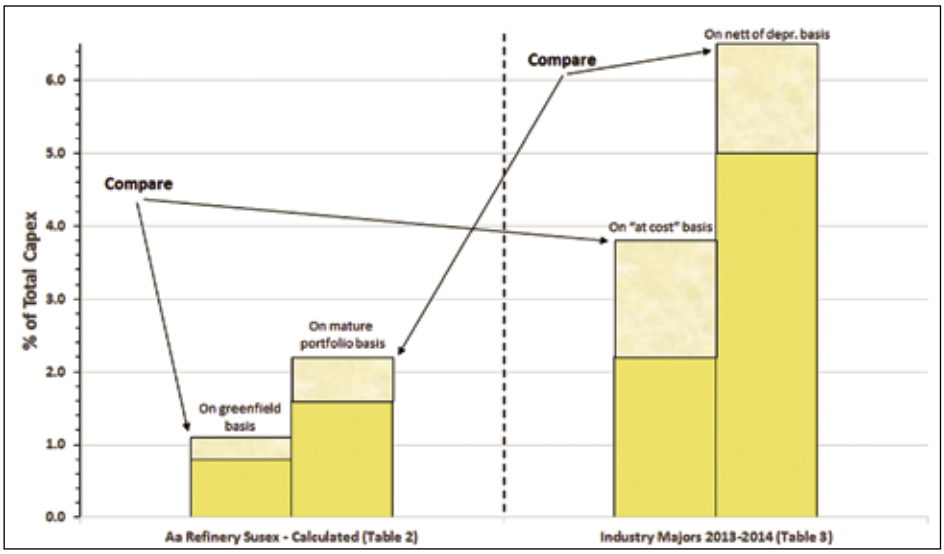

Fig. 3: Sustaining capex as percentage of total capex

Hydro) are separately indicated. These are excluded in the calculation of Susex as percentage of P, P&E under the assumption that they have not (yet) required sustaining capital expenditure.

When interpreting the numbers of Table 3 and Fig. 2, it should be realized that Alcoa, Hydro and Rio Tinto differ significantly in many respects such as scale (2014 revenue: Alcoa ~24bn US$; Hydro ~12.5bn US$; Rio Tinto ~48bn US$) and business focus (Alcoa 2014, an integrated aluminium company with significant downstream activities: alumina and primary metal ~43% of Revenue; Hydro 2014, an integrated aluminium company with limited downstream and other activities: bauxite and alumina plus primary metal and metal markets ~69% of revenue; Rio Tinto 2014, a major mining company (iron ore, copper, diamonds) with integrated aluminium activities: Rio Tinto Alcan ~25% of revenue). Refer to the appendix for further details.

The differences between these industry majors are also reflected in the range of Susex as percentage of P, P&E on 'at cost' basis (2.2-3.8%) and to a lesser extent on 'nett of depreciation' basis (5.0-6.5%). Table 4 provides a comparison of the results. Fig. 3 provides a graphical illustration of some elements of Table 4.

Noticeable from Table 4 and Fig. 3 is that Susex as percentage of P, P&E (i.e. total capex), both on 'at cost' (greenfield) as well as on 'nett of depreciation' (mature portfolio) basis is a factor 2-4 times larger as reported in the annual reports of Alcoa, Hydro, and Rio Tinto than it is as derived above and reported in Table 2. However due to the availability of only limited detail information on Susex provided in annual reports and presentations in general, and on alumina refinery operations in particular it is difficult to reconcile this difference.

Relationship between Susex and maintenance materials and contract services

The following aspect may explain at least part of the delta found above between Susex as % of P P&E (total capex) as reported by the industry majors, and actual and calculated Susex values.

To properly compare Susex values between projects, costs of 'maintenance supplies / materials and 'contract services' in an operation's operating cost should also be taken into account because some operations account for some Susex cost elements (as described

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Hydro's alumina refinery Alunorte in Brazil

Appendix: Comparison Alcoa, Hydro, and Rio Tinto (basis: annual reports 2014 & 2013)

Annual Revenue

ALCOA			HYDRO			RIO TINTO		
Revenue, MUS$	2014	2013	Revenue, MNOK	2014	2013	Revenue, MUS$	2014	2013
Alumina	3,509	3,326	Bauxite & Alumina	9,568	8,124			
Primary Metal	6,800	6,596	Primary Metal	6,397	3,866			
Global Rolled Products	7,351	7,106	Metal Markets	37,981	29,646	Rio Tinto Alcan	12,123	12,463
Engineered Products & Solutions	6,006	5,733	Rolled Products	21,345	20,286			
Other	240	271	Energy	2,492	2,830	Iron Ore	23,281	25,994
			Other	124	124	Copper	6,282	5,916
						Diamonds & Minerals	4,150	4,193
						Energy	4,308	5,454
						Other, Inter segment Transactions, and	-2,480	-2,825
Revenue, MUS$	23,906	23,032	Revenue, MNOK$	77,907	64,876	Revenue, MUS$	47,664	51,171
			Equiv. MUS$ (@ realized exchange rate)	12,406	11,052			

Upstream Business Unit Revenue as Percentage of Total Revenue

ALCOA			HYDRO			RIO TINTO		
	2014	2013		2014	2013		2014	2013
Upstream [1] Revenue, MUS$	10,309	9,922	Upstream [2] Revenue, MNOK	53,946	41,636	Upstream [3] Revenue, MUS$	12,123	12,463
As percentage of Total Revenue	43%	43%	As percentage of Total Revenue	69%	64%	As percentage of Total Revenue	25%	24%

1) Alumina, Primary Metal

2) Bauxite & Alumina, Primary Metal, Metal Markets

3) Rio Tinto Alcan

Key Operational Information

ALCOA			HYDRO [1]			RIO TINTO		
	2014	2013		2014	2013		2014	2013
Bauxite production (kmt)	46,300	46,900	Bauxite production (kmt)	9,481	7,567	Bauxite production (kmt)	41,871	43,204
Alumina production (kmt)	16,606	16,618	Alumina production (kmt)	5,933	5,377	Alumina production (kmt)	8,134	9,307
Primary Al production (kmt)	3,125	3,550	Primary Al production (kmt)	1,958	1,944	Primary Al production (kmt)	3,361	3,555
			Realized Al price LME (USD/mt)	1,850	1,902			
			Realized Al price LME (NOK/mt) [2]	11,624	11,160			
			Realized NOK/USD exch. rate [2]	6.28	5.87			
Engineered Products & Solutions (MUS$)	6,006	5,733	Metal products sales, total Hydro (kmt) [3]	3,305	3,164			
Global Rolled Products (kmt)	2,056	1,989	Rolled Products sales volumes to external market (kmt)	946	941			
Power production (GWh)	13,783	12,775	Power production (GWh)	10,206	10,243	Power Generating Cap. (GWh) [4]	36,065	36,372

1) Amounts include Hydro's proportionate share of production in equity accounted investments

2) Including the effect of strategic hedges (hedge accounting applied)

3) Sales from casthouses (incl. Neuss), remelters, third party sources and liquid metal

4) Hydroelectric power for Al production only included here

in the Overview section above) under these headings rather than under Susex. The same could well apply to the collection of operations reported on in a company's annual report.

Available information of existing operating alumina refinery projects (both low and high temperature digestion) indicates a range of 18-30 US$/tA for the total of [Susex and maintenance materials and contract services].

Conclusions

The actual typical Susex value for an alumina refinery operation (~8 US$/tA) and its range (6-12 US$/tA) can be reconciled reasonably well by using an approach based on the underlying capex build-up and lifetimes of major capex elements.

The discrepancy between the Susex range as percentage of property, plant and equipment in the annual reports of some of the industry majors and the equivalent range arrived at by using the above mentioned approach cannot easily be resolved. This applies both to a comparison on 'at cost' basis (2.2-3.8% vs 0.8-1.1%) as well as on 'nett of depreciation' basis (5.0-6.5% vs 1.6-2.2%).

When comparing Susex values between operations, costs of 'maintenance supplies/materials' and 'contract services' should be taken into account: for alumina refinery projects the sum of Susex plus these two items ranges between 18-30 US$/tA.

References

1. P.J.C. ter Weer, Sustaining Capital of Alumina Refinery Projects – Important but Unloved (paper presented at Light Metals 2016, Nashville, pp 81-83)
2. Alcoa Annual Report 2014
3. Hydro Annual Report 2014
4. Rio Tinto Annual Report 2014

For further information, please contact P.J.C. ter Weer at +31.646143965, email to twsservices@tiscali.nl or visit www.twsservices.eu.