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6) All staff are not allowed to trade in any stock or accept stock options before, during and after (for a period of 6 weeks) the research process.

For more information regarding our services please refer to our website www.independentresearch.com.au.
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TNG Limited (ASX: TNG)  
Update - November 2019

NEARING DEVELOPMENT

TNG Limited ("TNG" or "the Company") has made significant progress towards a planned Final Investment Decision ("FID"), expected by mid-2020, for its 100% owned Mount Peake Vanadium-Titanium-Iron Project ("Mount Peake" or "the Project"), located in the Northern Territory ("NT") of Australia. The Project includes two components - the Mount Peake mine site located near Alice Springs, and the TIVAN® processing plant in Darwin.

A key advance, as presented in our December 2018 Flash Note, has been the mandating of the German Government owned KfW IPEX-Bank as the lead debt arranger; the mandate commenced in January 2019, and as part of the mandate KfW IPEX-Bank has been providing input, largely relating to costs, into the ongoing Front-End Engineering and Design ("FEED") Study being overseen by the Company’s German strategic engineering and construction partner, SMS group GmbH ("SMS group"). The mandating of KfW IPEX-Bank should allow access to export credit agency ("ECA") debt finance, with this generally having superior terms to traditional sources.

The FEED Study has resulted in an optimised delivery strategy as recently released; this presents a single stage, 2 Mtpa project with a life of 37 years, in contrast to the two stage 3 Mtpa/6 Mtpa project as presented in the original and updated Definitive Feasibility Study ("DFS"). It is expected that the study will be completed by mid-2020, at which stage a FID will be made. This has led to a slight decrease in expected up-front capex (and no requirement for expansion capex) and an as expected incremental increase in operating costs - costs however are interim, and will be firmed up in the ongoing FEED Study.

The Company now has ~80% by value of planned production under binding offtake agreements, including 100% of the planned 100,000 tpa of titanium dioxide pigment (trademarked as TNG360™) with Swiss based global group, DKSH, and 60% of the planned vanadium products with WOOJIN Metals of South Korea. The Company is currently advancing offtake for the planned 500,000 tpa of high grade iron fines products.

Significant progress has also been made on the permitting front, with the Mining and Ancillary Licences/Leases being granted, following formal execution of the Native Title Mining Agreement and environmental approvals - the final key approval is that of the Mining Management Plan ("MMP"), with this document recently being lodged. TNG has also recently lodged the Environmental Impact Statement ("EIS") for the proposed TIVAN® facility in Darwin. Approval of both is expected in Q1/22, CY2020.

KEY POINTS

Robust project: Although the Company’s modelling results in a lower NPV of A$2.8 billion (pre-tax), the optimised delivery strategy for Mount Peake still results in a robust project with the inputs used - our modelling indicates that it can readily absorb 15% adverse movements in both costs and revenues.

Permitting and offtake largely in place: The Project is close to being fully permitted, and thus has been significantly de-risked - this is also reinforced by having the majority of the potential product value being under binding offtake agreements, including 100% of the titanium dioxide pigment which is expected to provide ~60% of the revenue.

KfW IPEX-Bank: In addition to providing access to quality debt financiers (including ECA debt), the bank undertakes very comprehensive due diligence with a hands-on role in the FEED Study, which will result in robust outcomes and a potentially readily financeable project.

Cashed up: With ~A$20 million in the bank, the Company should be funded through to the FID.

VALUATION SUMMARY

Our risked, after tax and funded (using a conceptual funding model with a diluted share structure of 2.9 B shares) technical valuation of TNG has reduced to A$0.369/share from our previous valuation of A$0.601/share as presented in our December 2018 Flash Note. This is largely due to the change of project scope, and is in line with the change in the Mount Peake NPV as presented by the Company.

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<td>$0.000</td>
<td>Current</td>
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<td>N/A</td>
<td>$1,079</td>
<td>$0.369</td>
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</tr>
</tbody>
</table>

Please note that our valuation is based on interim cost figures as presented in the Company’s release of September 11, 2019. As noted by TNG, estimated costs may change with progress of the FEED Study, and thus costs used, and hence the valuation should be treated as being indicative only.
**ACTIVITIES UPDATE**

- The report presents an update to our previous reports, available on the TNG and IIR websites.
- TNG’s strategy is the development of Mount Peake, which includes the mine and concentration plant near Alice Springs, and the planned TIVAN® processing plant in Darwin. Concentrate will be trucked 85 km from the mine site and then railed 1,180 km to Darwin for downstream processing (Figure 1).

![Figure 1: Project location map and Mount Peake site layout](image)

Source: TNG

- The 100% TNG-owned TIVAN® is a proprietary hydrometallurgical process, initially developed by TNG, Perth based Metallurgical Engineering Technical Services ("METS") and the Commonwealth Scientific and Industrial Research Organisation ("CSIRO"), designed to extract high purity vanadium, titanium and iron oxide products from titaniferous magnetite concentrates; subsequent work has been carried out in conjunction with SMS group, a major European based global metallurgical engineering group.
- As announced in December 2018, the Company has mandated the German Government owned KfW IPEX-Bank to structure the total debt package of up to US$600 million (~A$850 million) - this is part of the broader KfW Group, a leading global provider of export credit and project financing.
- KfW IPEX-Bank is working with SMS group, the Company and other key consultants on the ongoing FEED Study for Mount Peake, with part of this including providing inputs into the opex and capex assumptions for the Project.
- Work on the FEED Study to date has resulted in the development of an optimised single stage, 2 Mtpa project delivery strategy, as released to the market on September 11, 2019, and detailed later in this report - it is noted that this is an interim study, which will be updated on completion of the FEED Study and due diligence by KfW IPEX-Bank.
- The revised strategy is designed around the production of 100,000 tpa of TiO₂ pigment, 500,000 tpa of high grade (+64%) Fe₂O₃ fines and 6,000 tpa of high purity vanadium pentoxide flake.
- This replaces the previous two stage strategy as presented in both the initial (July 2015) and updated (November 2017) DFS.
- Other project advances made since our previous notes include permitting, progressing agreements with the Project delivery team and firming up offtake and finance agreements.

**OPTIMISED DELIVERY STRATEGY, FEED STUDY**

- On September 11, 2019 the Company announced an updated single stage project delivery strategy, replacing the two stage strategy as outlined in previous studies.
- This is in response to outcomes from the ongoing FEED Study, which is being co-ordinated and managed by SMS group - as mentioned previously there is also input from KfW IPEX-Bank, particularly in relation to capital and operating costs, which feed into the financial model for the Project and hence will affect the ultimate funding structure.
- The FEED Study included an updated mine study as released to the market on August 19, 2019 - this is based on a focus on mining two higher grade vanadium pits within the overall Resource during the first 10 years of mining that could result in a lower mining and processing rate to deliver the same targeted magnetite volume and quality.
The results as presented in the optimised delivery release are interim only - costs may change with advances in the FEED Study - the outcomes are presented in Table 1; this also includes a comparison to results of previous studies.

In addition to the change in production profile, the latest study has removed the pig iron plant and is planned to produce +64% Fe₂O₃ high grade iron fines instead.

Although the optimised study has decreased the estimated capex by A$29 million, the Company plans to absorb this into increased contingency.

### Table 1: Mount Peake development study results comparison

<table>
<thead>
<tr>
<th>Key Physicals</th>
<th>Optimised Strategy, September 2019</th>
<th>Updated DFS, November 2017</th>
<th>Initial DFS, July 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-production Capex (Stage 1 infrastructure, mine site, concentrator, process plant)</td>
<td>A$824 million</td>
<td>A$853 million</td>
<td>A$970 million</td>
</tr>
<tr>
<td>Stage 2 Capex (largely funded out of Cash Flow)</td>
<td>N/A</td>
<td>A$969 million</td>
<td>A$792 million</td>
</tr>
<tr>
<td>IRR pre-tax</td>
<td>33%</td>
<td>44%</td>
<td>41%</td>
</tr>
<tr>
<td>NPV (at 8% discount)</td>
<td>A$2.8 billion</td>
<td>A$4.7 billion</td>
<td>A$4.9 billion</td>
</tr>
<tr>
<td>NPV (at 10% discount)</td>
<td>N/A</td>
<td>A$3.8 billion</td>
<td>A$4.0 billion</td>
</tr>
<tr>
<td>NPV (at 12% discount)</td>
<td>N/A</td>
<td>A$3.3 billion</td>
<td>A$3.3 billion</td>
</tr>
<tr>
<td>Payback</td>
<td>2.8 years</td>
<td>3 years</td>
<td>4 years</td>
</tr>
<tr>
<td>Pre-tax net annual average cash-flow</td>
<td>A$359 million</td>
<td>A$738 million</td>
<td>A$785 million</td>
</tr>
<tr>
<td>Life-of-mine net cash-flow</td>
<td>A$12.2 billion</td>
<td>A$11.7 billion</td>
<td>A$11.6 billion</td>
</tr>
<tr>
<td>Product Prices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A$-US$ Exchange Rate</td>
<td>0.7</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Total Operating costs</td>
<td>A$2.10 per tonne of ore processed</td>
<td>A$1.85 per tonne of ore processed</td>
<td>A$1.67 per tonne of ore processed</td>
</tr>
<tr>
<td>Year 1 - 4 - ore feed</td>
<td>N/A</td>
<td>3 Mtpa</td>
<td>3 Mtpa</td>
</tr>
<tr>
<td>Year 5 - 17 - ore feed</td>
<td>N/A</td>
<td>6 Mtpa</td>
<td>6 Mtpa</td>
</tr>
<tr>
<td>Year 1 - 35 ore feed</td>
<td>2 Mtpa</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Scheduled mined material (Mt)</td>
<td>69</td>
<td>81</td>
<td>78</td>
</tr>
<tr>
<td>Strip Ratio</td>
<td>1.1:1</td>
<td>0.9:1</td>
<td>0.9:1</td>
</tr>
<tr>
<td>Head Grade</td>
<td>0.37% V₂O₅, 26.38% Fe, 6.87% TiO₂</td>
<td>0.37% V₂O₅, 26.38% Fe, 6.87% TiO₂</td>
<td>0.38% V₂O₅, 27.1% Fe, 7.04% TiO₂</td>
</tr>
<tr>
<td>Overall Metallurgical Recovery</td>
<td>90% V₂O₅, 70% Fe, 85% TiO₂</td>
<td>82% V₂O₅, 66% Fe, 63% TiO₂</td>
<td>84% V₂O₅, 66% Fe, 69% TiO₂</td>
</tr>
<tr>
<td>Magnetic concentrate (Mt)</td>
<td>23.3</td>
<td>24.3</td>
<td>21.7</td>
</tr>
<tr>
<td>LoM Fe₂O₃ (Mt)</td>
<td>17.6</td>
<td>10.6</td>
<td>9.6</td>
</tr>
<tr>
<td>LoM V₂O₅ (Mt)</td>
<td>0.23</td>
<td>0.24</td>
<td>0.27</td>
</tr>
<tr>
<td>LoM Titanium Pigment (Mt)</td>
<td>3.5</td>
<td>3.5</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Source: TNG, IIR analysis

The ongoing FEED Study has included the review and optimisation of both the concentrator and TiVAN® plant - the proposed flowsheets are presented in Figures 2 and 3.

The Darwin facility includes the titanium dioxide pigment technology developed by German company Ti-Cons, a key partner of TNG - the Company has trademarked the high quality pigment product as TNG360™.

A key aspect of the pigment production is the very low iron content of the TiO₂ feedstock - this is in contrast to most other pigment plants which have high iron in the feedstock, and which ends up as waste material.

![Image]
OFFTAKE AND FINANCING

♦ The Company has the majority of planned production of titanium and vanadium products under offtake agreements, with those currently in place including:
  – A Binding LOM Offtake and Marketing Agreement for 100% of titanium dioxide pigment production with DKSH, a Swiss based Market Expansion Services Provider; and,
  – A Binding LOM Offtake Agreement for 60% of vanadium products with WOOJIN Metals of South Korea (this incorporates a “Technology Transfer Agreement” whereby TNG has access to WOOJIN’s V₂O₅ to ferrovanadium production technology, with the potential to install this on site sometime in the future).

♦ Negotiations are currently underway with potential offtake partners for the iron products with this expected to be secured shortly.
The titanium and vanadium agreements are critical, in that they provide around 92% of the expected revenue from the project; the current offtake agreements, using our prices, cover 80% of expected revenue.

A key advance has been the mandating of KfW IPEX-Bank to structure the total debt package of up to US$600 million (~A$850 million) - this is part of the broader KfW Group, a leading global provider of export credit and project financing.

KfW IPEX-Bank is working with SMS group and the Company on the ongoing Front-End Engineering and Design ("FEED") study for Mount Peake, with part of this including providing inputs into the opex and capex assumptions for the Project.

One advantage of KfW IPEX-Bank is that it should provide access to export credit agency ("ECA") cover, which can result in very attractive debt finance terms.

Due to the hands-on approach and thorough due diligence by KfW IPEX-Bank, projects that have been through the process should be regarded as being robust.

Other debt finance providers previously approached include the North Australian Infrastructure Fund ("NAIF") and EFIC, Australia’s Export Credit Finance Agency - discussions with these groups are early stage and any potential involvement in funding the Project is currently unknown.

PERMITTING

One of the key aspects of project development is permitting, with the Company making significant progress on this aspect, with permitting close to being complete.

The major advances have been made at the proposed mine site, with the Mining and Ancillary Licences/Leases now having been approved and granted - this follows completion and granting of the environmental approvals (at both State and Federal levels) and execution of the formal Native Title Mining Agreement.

The final stage in the mine approval process has been the lodgement of the Mine Management Plan ("MMP") in October 2019 for approval by the relevant authorities.

More recently the Company has lodged the EIS for the proposed Darwin processing plant, which is the final stage in the environmental and permitting process for the overall Mount Peake project - this will be assessed under the bilateral agreement between the State and Federal Governments.

PROJECT IMPLEMENTATION

The key advance in the project implementation process has been the commencement of the FEED process for the overall operation in late 2018, with this being overseen and managed by SMS group, with inputs from KfW IPEX-Bank (largely costings) and other consultants, including Como Engineers Pty Ltd ("Como") and Ti-Cons.

Following the earlier signing of a strategic co-operation agreement, the Company has now engaged McMahon to progress non-process infrastructure requirements at both the mine and processing sites - initial work includes developing the detailed scopes of work and scheduling (including delivery), and advance the existing planning.

As mentioned in our previous update, Como has been appointed as the lead consultant for project management of the construction of the Mount Peake concentrator and key infrastructure - work to date has included the review and enhancement of the Mount Peake concentrator design, with this now included in the final design of the beneficiation plant flowsheet.

The Company has undertaken reverse circulation ("RC") and diamond drilling programmes for largely engineering purposes, including providing samples for equipment selection and optimisation testwork.

TNG has signed a Binding Heads of Agreement ("HoA") with Genesee & Wyoming Australia ("GWA"), the majority owner of the rail line to Darwin from the planned Adnera siding, and the third largest rail operator in Australia.

The agreement covers loading, transport and unloading of concentrate, and the loading and transport of finished products from the treatment facility to Darwin Port - GWA will also provide all necessary plant and equipment.

The Company has also been active in recruiting key executives and staff to take the development of Mount Peake forward.
SUMMARY OF PLANNED ACTIVITIES

- Upcoming activities will be concentrated on finalisation of the FEED Study, permitting, offtake and financing, with a FID expected by mid-2020.
- As mentioned previously, the FEED Study is ongoing, with further optimisation and equipment selection work included in the work - as such the Company has recently sent further concentrate and core samples to Germany to be used in this work.
- Once numbers are firmed up, these will be incorporated into the financial model, which will be used in finalising the optimal finance structure for the Project.
- The majority of permits and licences are in place, with all major documents being lodged - the Company is now awaiting assessment of the mine site MMP and Darwin EIS.
- The Company continues to advance offtake agreements for the iron products.
- These should result in ongoing newsflow in the months leading up to the expected FID - the key piece of news will be the finalisation of the FEED Study.

VALUATION

- We have updated our valuation for TNG, including a risked DCF valuation for Mount Peake, and current valuations for cash and listed investments - our base case valuation is shown in Table 2 - this is post tax, uses a conceptual funding scenario (70% debt, 30% equity @ A$0.15/share) and uses conservative metals prices.

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<td><strong>$0.369</strong></td>
<td></td>
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<tr>
<td>Diluted Shares</td>
<td>2,925 m</td>
<td>Tax Status</td>
<td>Post Tax</td>
<td></td>
<td>30% equity funding, A$0.15/share</td>
</tr>
<tr>
<td>Mount Peake Prices</td>
<td></td>
<td>V₂O₅</td>
<td>Fe₂O₃</td>
<td>TiO₂</td>
<td>AUD:USD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$20,000/tonne</td>
<td>$90/tonne</td>
<td>$3,250/tonne</td>
<td>0.7</td>
</tr>
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</table>

Source: IIR analysis

- Our base case technical value of A$0.369/share is significantly lower than our December 2018 figure of A$0.601/share - this is by virtue of the change in scope of the project, dilution due to equity issues subsequent to our previous valuation and the slight change in the conceptual cost of equity from A$0.16/share to A$0.15/share in our modelling; this also reflects the change in the Company’s valuation of the Project.

- We also note that the Company has stated that both operating and capital costs as presented in the latest study are interim, and may change with progress of the FEED Study - the potential for adverse changes in costs is covered partly by the risk factor we have used, as well as the sensitivity analysis as presented in Tables 4 and 5.

- The sensitivity of the project valuation to changes in capital costs is reasonably low, and, in our view, it is capital changes that are most likely to change with progress of the FEED Study, largely due to equipment selection.

- We have used a total funding requirement of A$900 million in our modelling, which includes the estimated A$824 million capex, and A$76 million to cover possible working capital requirements and financing fees amongst others - the actual funding requirement and mix will be estimated as part of the ongoing financial modelling and optimal financing structure determination by KfW IPEX-Bank.

- We note that at an equity price of A$0.15/share, our conceptual A$270 million of equity funding will be dilutive for shareholders.

- As was the case in our November 2018 valuation update, inputs are largely those as provided by TNG; the changes from our 2018 valuation and the one presented here include the change in the operation scenario as presented in the optimised strategy, an increase in vanadium pentoxide price from US$16,500/tonne to US$20,000/tonne, a decrease in the AUD:USD exchange rate to 0.70 and actual changes in the values of cash and the Todd River holding.
We have also replaced pig iron with Fe$_2$O$_3$ as the iron product - currently 65% Fe trades at an ~8% premium to the benchmark 62% Fe product - we have incorporated this in our pricing of US$90/tonne (US$0.90/mtu), based on the production of fines.

Table 3 highlights the similarities in our pre-tax valuation using TNG’s forecast metal prices to the results as presented in the optimised strategy, and also shows the effect of the different pricing scenarios, with the NPVs using the TNG scenario being around 1.5x those using the conservative IIR scenario - this multiplier can be applied to all subsequent figures, including sensitivity tables - prices used by the Company in the optimised study were US$25,400/tonne for V$_2$O$_5$, US$3,600/tonne for titanium pigment and US$102/tonne for iron oxide, and are based on independent forecasting.

We have based our metal prices on the following (we do not have access to the confidential forecasts as used by the Company, and on which their prices are based):
- V$_2$O$_5$ - average real prices over the past 14 years, taking into account the recent spike (this is updated from US$16,500/tonne in our November 2017 report to US$20,000/tonne now),
- Fe$_2$O$_3$ - this is an estimate for fines, and takes into account the premium paid for 65% Fe$_2$O$_3$ over the 62% product - 62% iron ore prices have steadily increased since the nadir of US$40/tonne in late 2015, to current prices of ~US$90/tonne; and,
- TiO$_2$ - recent prices (we have increased our price to US$3,250/tonne from US$3,000/tonne as used previously).

Although there has been a recent spike in the price of vanadium to over US$30,000/tonne followed by a fall, our view is that the price we have used could be more indicative of longer term pricing; the metal has a history of volatile pricing (refer Figure 8); we have taken a similar approach to titanium pigment prices.

Table 3: TNG comparative valuations

<table>
<thead>
<tr>
<th>Asset</th>
<th>Unrisked Project NPV, Pre Tax, Unfunded</th>
<th>Risked NPV/Share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pricing - IIR scenario</td>
<td>$1,747 m</td>
<td>$1.09</td>
</tr>
<tr>
<td>Pricing - TNG scenario</td>
<td>$2,760 m</td>
<td>$1.72</td>
</tr>
</tbody>
</table>

Source: IIR analysis

Tables 4 and 5 present sensitivity analyses for our valuation of the Mount Peake Project on a conceptually funded, after tax basis.

Table 4: Post-tax, funded and un-risked Mount Peake sensitivity analysis

<table>
<thead>
<tr>
<th>Change</th>
<th>V$_2$O$_5$ Price</th>
<th>TiO$_2$ Price</th>
<th>Fe$_2$O$_3$ Price</th>
<th>Exchange Rate</th>
<th>Opex</th>
<th>Capex</th>
</tr>
</thead>
<tbody>
<tr>
<td>-15%</td>
<td>$1,309</td>
<td>$1,065</td>
<td>$1,461</td>
<td>$2,336</td>
<td>$1,941</td>
<td>$1,562</td>
</tr>
<tr>
<td>-10%</td>
<td>$1,376</td>
<td>$1,214</td>
<td>$1,478</td>
<td>$2,031</td>
<td>$1,798</td>
<td>$1,546</td>
</tr>
<tr>
<td>-5%</td>
<td>$1,444</td>
<td>$1,363</td>
<td>$1,495</td>
<td>$1,758</td>
<td>$1,655</td>
<td>$1,529</td>
</tr>
<tr>
<td>0%</td>
<td>$1,512</td>
<td>$1,512</td>
<td>$1,512</td>
<td>$1,512</td>
<td>$1,512</td>
<td>$1,512</td>
</tr>
<tr>
<td>5%</td>
<td>$1,580</td>
<td>$1,661</td>
<td>$1,529</td>
<td>$1,290</td>
<td>$1,369</td>
<td>$1,496</td>
</tr>
<tr>
<td>10%</td>
<td>$1,648</td>
<td>$1,810</td>
<td>$1,546</td>
<td>$1,087</td>
<td>$1,226</td>
<td>$1,479</td>
</tr>
<tr>
<td>15%</td>
<td>$1,715</td>
<td>$1,959</td>
<td>$1,563</td>
<td>$903</td>
<td>$1,083</td>
<td>$1,463</td>
</tr>
</tbody>
</table>

Table 5: Risked Mount Peake per share sensitivity analysis

<table>
<thead>
<tr>
<th>Change</th>
<th>V$_2$O$_5$ Price</th>
<th>TiO$_2$ Price</th>
<th>Fe$_2$O$_3$ Price</th>
<th>Exchange Rate</th>
<th>Opex</th>
<th>Capex</th>
</tr>
</thead>
<tbody>
<tr>
<td>-15%</td>
<td>$0.313</td>
<td>$0.255</td>
<td>$0.350</td>
<td>$0.559</td>
<td>$0.464</td>
<td>$0.408</td>
</tr>
<tr>
<td>-10%</td>
<td>$0.329</td>
<td>$0.291</td>
<td>$0.354</td>
<td>$0.486</td>
<td>$0.430</td>
<td>$0.392</td>
</tr>
<tr>
<td>-5%</td>
<td>$0.346</td>
<td>$0.326</td>
<td>$0.358</td>
<td>$0.421</td>
<td>$0.396</td>
<td>$0.376</td>
</tr>
<tr>
<td>0%</td>
<td>$0.362</td>
<td>$0.362</td>
<td>$0.362</td>
<td>$0.362</td>
<td>$0.362</td>
<td>$0.362</td>
</tr>
<tr>
<td>5%</td>
<td>$0.378</td>
<td>$0.398</td>
<td>$0.386</td>
<td>$0.309</td>
<td>$0.328</td>
<td>$0.348</td>
</tr>
<tr>
<td>10%</td>
<td>$0.394</td>
<td>$0.433</td>
<td>$0.370</td>
<td>$0.260</td>
<td>$0.294</td>
<td>$0.335</td>
</tr>
<tr>
<td>15%</td>
<td>$0.411</td>
<td>$0.469</td>
<td>$0.374</td>
<td>$0.216</td>
<td>$0.259</td>
<td>$0.322</td>
</tr>
</tbody>
</table>

Source: IIR analysis
The first four columns are considered revenue factors, with these also being proxies for other revenue factors, including grade and metallurgical recovery; for example a 15% change in vanadium grade or recovery will have a similar effect on project economics as a 15% change in price as shown above; in the case of exchange rates, this can be considered as a proxy for changes in revenue factors for the combined metals.

As can be seen the project is most sensitive to exchange rates (and hence to combined falls in metals prices), with changes in operating costs coming second; the project is least sensitive to changes in capital costs.

On the individual product front, the Project is most sensitive to changes in titanium pigment prices.

Changes in the capital cost will also lead to changes in the diluted share structure, and thus have a compound effect on the per share valuation.

RISKS

We view the key risk now as being associated with the outcomes of the FEED Study, and the magnitude of any potential operating and capital cost increases that may effect the financial viability and ability to fund the Project.

As the Company has mentioned, the recently released optimised delivery strategy uses interim numbers, which will be updated as the FEED Study progresses and is completed.

One key factor specifically mentioned by TNG is that there may be the requirement to source a larger than presently assumed portion of capital equipment from fixed countries of origin by lenders, say under an ECA-backed financing structure - the interim capex figure is based on maximising sourcing of largely pre-manufactured modules from qualified vendors from manufacturing hubs with attractive labour costs.

Mitigating this is the relative insensitivity of the Project financials to changes in capital costs, however any such changes will affect the financing strategy.

BACKGROUND – COMMODITIES AND MARKETS

TITANIUM DIOXIDE

Uses and Production

The majority (90%) of titanium dioxide is used in the pigment industry, being used in various products, including paints, coatings, paper and inks.

It is a key white pigment in that it has a high refractive index (whiteness), provides UV protection and is non-toxic.

Other uses include as a metal (military, aerospace and speciality applications) and for welding rod core wire.

The bulk of feedstock currently comes from the mineral sands industry (67%), with the remainder being produced from blast furnace slag from titanium bearing ores - there is currently no hydrometallurgical production directly from titanomagnetite concentrate as is planned for Mount Peake.

There are two main pigment production routes – chloride and sulphate, with chloride generally being cleaner and requiring higher grade feedstocks.

The majority of Chinese capacity is for sulphate grade feedstock; western producers generally use the chloride process, however, given the nature of the feedstock, a sulphate process has been developed for Mount Peake - the low iron content of the TIVAN® titanium product alleviates the requirement to dispose of iron waste, a key environmental issue of other pigment processors.

According to the USGS, installed pigment production in 2016 was 7,400,000 t, with 2,940,000 t (40%) being in China, and with the US coming second with 1,340,000 t (18%) of installed production capacity; current Australian capacity is 280,000 t (~4%).

Current global demand is in the order of 6,700,000 tpa, with the planned average annual production from Mount Peake accounting for some 1.5% of global capacity.

Actual global production is closely aligned to world economic conditions, which can result in significant swings in demand and hence pricing; the cost and availability of feedstocks also affects pigment pricing.
Table 5: Titanium dioxide products sold

<table>
<thead>
<tr>
<th>Titanium dioxide products sold</th>
<th>TiO₂%</th>
<th>Notes</th>
<th>End Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutile – 10%</td>
<td>95-97</td>
<td>Mined product</td>
<td>Pigments, metal</td>
</tr>
<tr>
<td>Synthetic rutile – 3%</td>
<td>88-95</td>
<td>Upgraded from ilmenite in a furnace</td>
<td>Pigments</td>
</tr>
<tr>
<td>Ilmenite</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphate – 42%</td>
<td>52-54</td>
<td>Processed to pigment - sulphate processing</td>
<td>Pigments</td>
</tr>
<tr>
<td>Chloride – 12%</td>
<td>8-82</td>
<td>Processed to pigment - chloride processing</td>
<td></td>
</tr>
<tr>
<td>Slag</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphate – 11%</td>
<td>80-85</td>
<td>Upgraded from sulphate ilmenite in a furnace</td>
<td>Pigments</td>
</tr>
<tr>
<td>Chloride – 19%</td>
<td>85-90</td>
<td>Upgraded from chloride ilmenite in a furnace</td>
<td></td>
</tr>
<tr>
<td>Upgraded – 3%</td>
<td>95</td>
<td>Upgraded from ilmenite</td>
<td></td>
</tr>
</tbody>
</table>

Source: Iluka

Pricing

♦ The mineral sands and downstream pigment markets are relatively opaque – prices are generally fixed between the producer and buyer, and until 2009-2010 were largely on long term contracts, leading to relatively stable prices.

♦ More recently, changes in demand and supply have led to contracts more commonly being negotiated quarterly or half yearly.

♦ A recent feature of pricing was a sharp decrease in prices in 2013, which continued into 2016 – this followed slowing in demand during 2012, largely due to weakening global economic conditions.

♦ There were also significant price increases in feedstocks starting in 2010 - this was as a result of supply constraints enabling producers to renegotiate prices away from long term contracts, which were a disincentive on bringing on new production, with feedstock prices feeding into pigment prices.

♦ Until 2010 titanium dioxide product prices tended to follow annual GDP growth of around 3%.

♦ It is forecast by TZMI that there may be a deficit of up to one million TiO₂ units (around 2 Mt of feedstock) by 2020-2021, with prices now increasing due to tightening markets.

♦ Again feedstock prices are feeding into pigment markets - over recent quarters we have seen sustained rises in pigment prices following a sharp fall off after a peak from 2011 to 2013, with prices rising by over 20% since the beginning of 2016.

♦ This has resulted in recent prices of ~US$3,200/tonne, with this rising trend forecast to continue.

♦ Real prices (using 2016 dollars) from 1970 to 2016 are shown in Figure 4 - note that these are average annual prices - as mentioned earlier prices have generally been negotiated on a quarterly basis since 2011.

Figure 4: Real historic US$ TiO₂ pigment prices - 2016 dollars

Source: TNG/Artikol
VANADIUM AND VRFBs

Background

- The main use of vanadium is as a steel additive in high-strength steel, which accounts for about 92% of the current global demand of ~90,000 t of vanadium metal (equivalent to ~160,000 t V₂O₅, with the oxide containing 56% V).
- Other uses include chemicals, catalysts and in batteries - vanadium is produced as two main products – FeV for steel-making and V₂O₅ for chemical and battery applications.
- Global production was reportedly ~73,000 t in 2018, with the largest source being as a by-product from slag produced from the smelting of titaniferous magnetite ores for steelmaking (Figure 5) – it is estimated that this accounts for ~73% of total supply, with 17% being derived from mining as a primary product and the remainder from secondary sources, including oil residues and fly ash.
- Supply is concentrated, with over 90% of vanadium products produced in South Africa, China, Russia and Brazil.
- New developments include Largo Resources Maracas Project in Brazil, which is now in full production, and exceeding the planned output of 9,200t of V₂O₅ per year, with a planned FeV plant to be added at a later date.

![Vanadium Sources](image)

Source: Vanitec

- Demand has outstripped supply since 2010, with successive drawdowns on inventory; part of this has been due to industry rationalisation and environmental constraints in China, with this now resulting in the inventories being depleted and hence a recent increase in prices after falling for over 10 years (Figure 8).
- However, as Figure 8 also shows there has been a retracement of this most recent rise in prices, which highlights the volatile nature of vanadium pricing at times.

Demand Drivers

Steelmaking

- The current key demand driver is as an additive in steel – demand for vanadium closely follows the production of steel. This includes two factors – firstly the natural organic growth in steel production and secondly increasing vanadium intensity in steel with the move to lighter weight and higher strength steels – the addition of just 0.2% vanadium to steel increases steel strength by up to 100% and reduces the weight of steel required in relevant applications by up to 30%.
This second factor is particularly relevant in China, where there is increasing vanadium intensity in rebar due to changes in building standards (with new regulations set to become effective in November 2018), partly following on from the 2008 earthquake - there is still a fair way to go with this and thus significant potential growth in use in this application, however this has the potential to increase Chinese vanadium consumption by up to 50% (15,000 tpa).

Roskill estimate that, although steel production will only grow at 1% CAGR over coming years, the increasing intensity of vanadium in steel along with other end uses will result in a long term demand growth of 3.45% CAGR from ~100,000 tpa V in 2015 to 131,000 tpa contained V in 2025, with the forecast supply deficits now being seen.

Figure 6 shows the relative vanadium intensities in rebar between various jurisdictions.

**Figure 6: Vanadium steelmaking intensity**

![Vanadium steelmaking intensity graph]

Source: Australian Vanadium

**Energy Storage – VRFB’s and Li-Ion Batteries**

The blue sky in demand, and the potentially disruptive technology is in grid scale battery usage - the key here will be the adoption of VRFB’s that have the capacity for multi-megawatt scale storage - this makes them useful for grid scale applications, including grid balancing and storing energy from variable output sources, including wind turbines and solar cells.

**Figure 7: VRFB schematic**

![VRFB schematic]

Source: Australian Vanadium

The batteries are inherently simple, relying on the changing redox state of vanadium to store and then supply power.

Other attributes of these batteries include:

- Scalability
– Long lifespan – up to 20 years
– Up to a 1 year charge retention
– 100% discharge without damage, and,
– Only one element – V in various oxidation states – in electrolyte.

There are widely differing forecasts on the growth in VRFB’s, however some commentators see the potential for VRFBs to provide up to 30% of the growing energy storage market, with some forecasting an additional demand of 300,000 t of vanadium over coming years to meet this need.

There are a number of active VRFB developments globally at the moment, reportedly with the largest being the development of a 200MW/800MWh battery in Dalian, China, which reportedly uses 6,950 tonnes of V$_2$O$_5$, at an intensity of 8.7t/MWh; we have also seen documentation for other batteries with a usage intensity of 7.25t of V (12.94t of V$_2$O$_5$) per MWh of capacity.

Other recent developments include a US$200 million, 15MW/60MWh facility by Sumitomo on the Japanese island of Hokkaido.

Development of VRFBs has been partly hamstrung by the lack of a suitable battery grade V$_2$O$_5$ supply – batteries require a higher purity product than that used in steelmaking, and hence arises the opportunity for manufacturers of high purity material.

Some forecasts see the Australian energy storage market reaching 3,000 MWh by 2030 – should the VRFB penetration reach an estimated 30% of the market this will result in the requirement of 900 MWh of VRFB capacity over the same period.

Australia is an ideal market for fringe-of-grid and off-grid storage facilities given the extended power networks and large off-grid areas, thus potentially providing a domestic market for any V$_2$O$_5$ producers.

Assuming a capital intensity of A$1,000,000/MWh, this equates to a A$900 million market, and using an average V$_2$O$_5$ intensity of ~10t/MWh (this intensity will vary depending upon the battery producer), this results in a potential domestic demand for an additional 9,000 t of V$_2$O$_5$ by 2030.

There is also significant forecast demand (~1/3 of that for VRFB’s) for vanadium in Li-ion batteries.

**Pricing**

Figure 8 highlights the recent price recovery to over US$30/kg (US$14 - US$14.50/lb) largely due to de-stocking of inventories over recent years and supply constraints due to rationalisation of the iron ore industry in China (with vanadium being a major by-product) along with environmental constraints leading to a sharp decline in production.

This however also shows the subsequent retracement in prices - this had fallen to around US$9/lb in July 2019.

The 30 year average price has been US$11/kg V$_2$O$_5$, with the inflation adjusted mean since 2004 being ~US$16/kg.

The market is not particularly transparent, and also prices do not correlate with steel production even though this is the key demand driver.

As mentioned earlier wide acceptance of VRFBs may go some way to breaking the price “spike-collapse” pattern over recent times, due to the requirement for a consistent supply of high purity V$_2$O$_5$ for the electrolyte.

However, there is a Catch 22 here, with the consistently higher prices for V$_2$O$_5$ required to get new projects funded and up and running leading to batteries being comparatively expensive, and hence slowing demand.
Although initially looking at producing pig iron on site, the Company now plans to produce hematite fines for export into the seaborne iron ore market.

The current seaborne demand for iron ore is ~1,530 Mtpa, with this including fines, lump and pellets - fines make up 76% of the total, lump 16% and pellets 8%.

Iron ore pricing is based on 62% Fe fines, generally cfr China - different products, including lump and pellets attract a premium, with these premiums affected by various market conditions.

In addition a premium or discount will be applied to reflect the grade - currently 65% Fe hematite attracts an 8% premium to the benchmark 62% Fe product.

The prices for different fines grades are shown in Figures 9 and 10 - we note the steady increase in the 62% Fe benchmark price since the nadir at the end of 2015.

We also note the widening premium for the higher grade products, largely caused by a shortage of high grade feed.
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