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Addendum to Economic Impact Analysis of Green Steel Project: Castalia response to Expert Panel Minute #2:

12 November 2025

This Addendum responds to the Expert Panel's Minute #2 "Request for Information" dated 31 October 2025 and clarifies certain aspects of Castalia's report "National Steel Limited's Green Steel Project: Economic Impact Analysis" dated March 2025 (Castalia's Report).

This Addendum has been prepared by Andreas Heuser, Senior Advisor to Castalia and the principal author of Castalia's Report. We respond to the points directed to Castalia. Together with Castalia's Report, this Addendum forms Castalia and Andreas Heuser's evidence for the Expert Panel. It responds to the following points in the Expert Panel's Minute #2:

Table 0.1: Points addressed in this Addendum

Paragraph reference	Summary of issue
4-6	Assumptions and information used in analysis
8-9	Regional and national benefits identified
10-14	Emissions benefits and assumptions
17 and 19	Emissions associated with EAF vs BF/BOF processes
18	Counterfactual emissions associated with imported steel to New Zealand
19	Emissions from LPG
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22	Carbon price assumptions
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24(i)	Additional benefits including social and cultural benefits
25	EAF plant useful life
26	Other negative impacts (costs)
27	Other environmental benefits

Overall, we repeat the finding in Castalia's Report that the Project will realise significant regional and national economic benefits. The responses to the Panel's questions and requests for clarifications below reinforce this overall finding. We deal with each point as follows:

Paras. 4-6: Assumptions and information used in analysis

The Panel states "*[Castalia's Report] does not provide a critical analysis of the assumptions and information from which it has assessed the benefits. It has relied on the Applicant's "business plan assumptions" but there appears to have been no verification or testing of these.*"

Castalia has relied on National Steel's CEO and staff expert understanding, and the expertise of its appointed consultants and experts on EAF technology and the estimated costs and commercial return expected from the Project. In our view, National Steel is the best source of information and Castalia's use of information and assumptions supplied by National Steel is entirely justified because:

- National Steel's proposed Project plant will be the first and only commercial, non-subsidised, EAF mini-mill facility in New Zealand. National Steel is the **only** party in New Zealand with a full understanding of the costs, risks and expected returns of a EAF mini-mill plant
- National Steel is investing significant sums. It therefore has strong incentives to ensure its estimates of costs and expected commercial returns are robust and well-founded because it is putting significant sums of its own capital at risk. If National Steel has underestimated the costs and/or overestimated the expected return, then its business will fail. It is highly incentivised to ensure its assumptions used for investment planning are robust.

Furthermore, Castalia has tested National Steel's assumptions against typical commercial benchmarks. For instance, Castalia estimated National Steel's weighted average cost of capital (WACC) with reference to comparable companies, used macroeconomic inputs from Reserve Bank of New Zealand and Statistics New Zealand and emissions assumptions from published sources.

Paras. 8-9: Clarifying definition of regional and national economic benefits

The Panel states that the "*financial return to the project's owners… would not of itself constitute a significant regional or national benefit*" in paragraph 8. This statement is alarmingly inconsistent with standard public-sector and academic definitions of benefits.

The New Zealand Treasury's *Guide to Social Cost Benefit Analysis (2015)* says "*all benefits and costs that impact on people should be taken account of in the CBA*". Economic benefits are typically defined as any increase in the total welfare or resources available to people, including private sector profits, wages, and returns to capital, except where these are purely transfer payments. In other words, returns to investors are a legitimate component of regional and/or national economic welfare when they reflect productive activity that expands a region's and/or New Zealand's output and income base. That is exactly the case here. International authorities[1] make clear that producer surplus and after-tax profits are integral elements of a project's net benefits, provided they arise from genuine value creation rather than monopoly rents or subsidies.

Therefore, it is erroneous to treat profitability as a private gain (which the statement appears to do) with no regional or national benefit. In this Project, profits are derived from new value creation in the processing of scrap metal domestically instead of exporting it and substituting for imported steel. The income funds wages, supplier payments, tax revenues, reinvestment and economic profits, all of which are domestic welfare gains.

Finally, the possibility that ownership might in future change to a foreign owner is immaterial: under accepted CBA principles (including in the New Zealand government's own guidance).

[1] For example: Mishan and Quah, Cost-Benefit Analysis, Chicago University Press, Becker (1974) and Harberger (1971)

Benefits are assessed on the expected distribution at the time of decision, not on hypothetical changes in ownership. In any case, if the Project were to be sold to a foreign person, the New Zealand owners would receive payment reflecting the economic value of the Project. The green steel plant would physically remain in Waikato, New Zealand and the employment benefits, emissions benefits and other benefits would not change because of the nationality of the plant owner.

Paras. 10-14: Emissions benefits and assumptions

Castalia's emission-benefit estimates apply internationally accepted lifecycle accounting principles. We adopted emissions intensities for blast-furnace/basic-oxygen-furnace (BF/BOF) steel from *World Steel Association* and *IEA* data (1.8–3.0 t CO_2/t steel) and for electric-arc-furnace (EAF) production from *OECD Steel Outlook* (0.4–0.6 t CO_2/t steel).

The differential of 1-2 t CO_2/t steel underpins the quantified [redacted] million NPV emission benefit in the base case. We also note that the approach is conservative because it excludes upstream emissions avoided through lower freight and ore extraction.

Paras. 17 and 19: Emissions associated with steelmaking EAF vs BFF/BOF processes

Castalia reviewed international sources to validate the assumptions for the emissions per tonne of steel produced using:

- Traditional 'virgin' steel blast-furnace/basic-oxygen-furnace (BF/BOF) method using coal: World Steel Association and IEA data confirm a range of 1.8–3.0 t CO_2/t steel. This remains the least-cost method in countries with low labour costs, less stringent emissions rules and lower cost coal resources
- EAF method: We assumed emissions intensity of 0.5 t CO_2/t steel. Given that New Zealand's electricity grid is already largely renewable, using a 0.5 t/tonne assumption for the EAF is conservative in Castalia's modelling. A review of international benchmarking of modern EAF facilities confirms this:
  - A recent U.S. study reports emissions intensities for EAF-based steelmaking at 0.68 t CO_2/tonne steel compared with 2.11 t CO_2/tonne for BF/BOF in the U.S. context[2]
  - European market commentary notes EAF produces "under 500 kg of CO_2 per tonne" and is considered green.[3]

Most of New Zealand's imported steel comes from China and India. It is beyond the scope and relevance of this application to speculate on future steel business models in China and India in the next 20 years. However, we note that around 73 percent of global steel production is via BF or BOF and most of the remainder is EAF scrap recycling.[4] It is unlikely these proportions will change as there is typically not enough scrap feedstock to satisfy the majority of steel demand.

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[2] United States Trade Commission (February 2025), Greenhouse Gas Emissions Intensities of the U.S. Steel and Aluminum Industries at the Product Level, p. 157, available at: https://www.usitc.gov/publications/332/pub5584_0.pdf

[3] Fastmarkets, 2025, available at: https://www.fastmarkets.com/insights/eaf-steel-addressing-decarbonization-in-the-sector

[4] Institute for Energy Economics and Financial Analysis (2022), Fact Sheet: The facts about steel making, available at: https://ieefa.org/sites/default/files/2022-06/steel-fact-sheet.pdf

Paras. 18: Counterfactual emissions associated with imported steel to New Zealand

The assumption in Minute 2 that the Project will simply displace the recycling of scrap overseas is incorrect. It is likely that the scrap used in the proposed facility would otherwise be exported in the counterfactual and probably recycled overseas. However, the steel imports replaced by the proposed facility are in fact overwhelmingly not recycled steel—they are mostly 'virgin' steel. This is because (as noted above) the source countries of New Zealand's steel continue to rely heavily on BF/BOF processes (at ~2 t CO_2/t steel).

Furthermore, even if the Project simply displaced recycling that would otherwise occur overseas, it would still reduce emissions. This is because New Zealand has a very high proportion of grid electricity supplied from renewable energy (as discussed below), compared to overseas recyclers. By processing scrap domestically using EAF technology powered by low-emissions electricity, the Project delivers a cleaner pathway to structural steel production than both the virgin steel import alternative and the scrap export counterfactual.

Para. 19: Emissions from LPG

We understand that LPG and/or biomethane may be used to keep steel molten in case of production sequencing issues. However, the facility operator has strong incentives to avoid this and use electrical energy. We did not include emissions from LPG and/or biomethane in the analysis for two key reasons:

- The total annual LPG and/or biomethane consumption is indeterminate (but likely low). We accept that there would be some net emissions associated with LPG use, but the total emissions (and the economic cost) cannot be estimated with any certainty
- We were provided with evidence of advanced discussions with a local landfill operator that is collecting biogas from solid waste which could be used in the Project. The use of biomethane is considered carbon neutral and can even have negative emissions in some cases if it converts methane that would otherwise have been released to the atmosphere into carbon dioxide in consumption. The total available amount of biogas and the amount that might be used is unclear at this stage, further complicating a robust estimate of net emissions.

To further clarify the emissions impact of LPG or other gas use in the equalising furnace, we note that Lumen's Emission Plan for Resource Consent (Attachment 29) estimates residual emissions of 3,900 tCO_2e per annum after implementing the Best Practicable Option (hot charging), which is a requirement under the resource consent. Based on projected annual steel output of 200,000 tonnes, this equates to approximately 0.0195 t CO_2 per tonne of steel which is just under 4 percent of the 0.5 t CO_2/t steel assumptions used in Castalia's Report. This confirms that LPG emissions are minor and already substantially mitigated through design-phase efficiency. Even if LPG emissions were included in the analysis, this would reduce the Project net benefit by $[redacted] million (or around [redacted] percent). Their inclusion would not materially affect the Project's emissions profile or the overall benefit-cost outcome, which remains strongly positive.

Para. 20: Grid emissions factor and any new emissions from grid-powered EAF

We have seen the statement from James Carmichael dated 11 November 2025 on the emissions impacts of the Project using grid power. We generally agree with those points. We can also comment on the expected change in New Zealand's emissions from increased electrical energy use by the facility.

Castalia (and Andreas Heuser) are experts in modelling the New Zealand energy system and estimating incremental grid emissions. Recent publicly released Castalia reports show that the new North Island load would be served ~93 percent by renewables and ~7 percent by open-cycle gas in the 2026-27 timeframe:

- Castalia's report to Gas Industry Company Limited (GIC) on consequences of gas distribution network switch off on North Island dated October 2025[5]
- Castalia's report to GNS Science (now Earth Sciences New Zealand) on economic viability of supercritical geothermal energy dated January 2023.[6]

Given that the additional incremental load of the Project will be modest relative to overall demand growth, the implied emissions increment is negligible (< 0.02 t CO_2/t steel) and does not materially offset the emissions benefits of the EAF route.

Para. 22: Carbon price assumptions

We used the relevant NZ ETS price ($61.36/t CO_2) and conducted sensitivity testing using the New Zealand Treasury's shadow social cost of carbon ($101/t CO_2). This ensures robustness from both a regulatory and social accounting perspective.

The carbon price assumptions are used to estimate the monetised benefit (cost) of emissions. This is a standard approach in cost benefit analysis. We simply grouped the impacts into categories in Castalia's Report (financial, employment, emissions) for simplicity. The emissions impacts are not included in the financial benefits.

Para. 23: Employment benefits and counterfactual (Waikato average wage)

The employment benefit estimate accounts for 200 direct jobs at an average salary of $102,394 versus the Waikato median wage of $68,681. We understand that the 200 direct jobs analysed are 'new', not transfers of staff from National Steel's other premises. In fact, 25-30 jobs for shredder operation at the Project have been excluded from the calculation of employment benefits since those jobs will be relocated from National Steel's other premises. We also do not include benefits from the construction-related jobs (and related services). National Steel's business plan budgets for this average salary amount. For the reasons outlined above, we consider National Steel's own cost estimates are the best source of information.

We consider National Steel's Project average salary figure to be a robust estimate. The Project will involve a range of semi-skilled manufacturing roles and highly skilled technical and managerial positions. The national median wage for manufacturing (all sectors) is $73,216.[7] However, the Project jobs will be at an industrial manufacturing plant with heavy machinery and complex processes, which means wages will be higher than the national median (for Project semi-skilled roles). The Project average wage is also pulled up because of the higher-paid managerial and technical specialist roles.

Finally, the jobs will be 'additional' (in case the Panel considers that the Project may simply be displacing other jobs). Treasury CBA guidance confirms that employment benefits reflecting

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[5] Available at: https://www.gasindustry.co.nz/assets/CoverDocument/251009-Final-Report-Impact-of-switching-off-gas-network-v3.pdf

[6] Available at: https://www.gns.cri.nz/data-and-resources/the-economic-value-of-supercritical-for-new-zealand-andreas-heuser-castalia/

[7] Statistics NZ (2025), Earnings from main wage and salary job by industry (ANZSIC 2006).

higher productivity and wages are non-transfer welfare gains rather than mere labour-market redistribution. This means we must include the difference in wages in the analysis.

Para. 24(i): Additional benefits including social and cultural benefits

As noted above, we focussed on material, quantifiable benefits (and costs). There are additional benefits from the Project that would be prohibitively costly and complex to attempt to measure. These are:

- Strengthening regional industrial capability and skills
- Diversifying industry in the Waikato
- Improving New Zealand's resilience to external economic shocks by improving the balance of payments which reduces susceptibility to sudden reversals of capital flows or changes in global interest rates
- Improving resilience by anchoring a high-technology manufacturing base in the Waikato
- Providing localised employment for local Iwi and Hāpu, for instance National Steel's partnership discussions with Ngā Muka Development Trust will ensure cultural values and environmental kaitiakitanga are integrated into site development and operations.

These benefits are consistent with Treasury's recognition of non-market social and cultural effects as part of total welfare.

Para. 25: EAF plant useful life

We confirm that we incorporated the plant's 20-year useful life into the analysis. The NPV assessment covers this 20-year period, spanning from 2027 to 2046. This period captures the asset's productive life while avoiding speculative terminal values. Our NPV is therefore conservative. Any residual value beyond 2046 is excluded, though in reality the plant could operate longer with maintenance and technology upgrades.

Paras. 26-27: Other negative impacts (costs)

Other potential negative impacts were judged to be immaterial relative to total benefits and therefore not quantified. The only quantified cost is the foregone pastoral output from 53 ha of rural land, valued at $855,000 NPV. We assume temporary construction disturbance, noise, or traffic effects are short-term and managed under standard consent conditions. There are no unmitigated environmental externalities of material scale.

Paras. 27: Other environmental benefits

The Project is likely to contribute additional environmental gains not fully monetised in the CBA. These were not quantified as these are relatively minor compared to the significant commercial return, employment and emissions benefits. Other economic benefits not modelled include:

- Reduced landfill disposal of end-of-life vehicles and whiteware through domestic scrap recovery
- Lower maritime transport emissions via import substitution
- A demonstration effect supporting New Zealand's circular-economy transition and emissions-reduction commitments.

While not quantified, these co-benefits further strengthen the Project's positive net impact.