ResponsibleSteel GHG progress level data review – findings and recommendations

7th December 2023

Recommendations

The ResponsibleSteel decarbonisation progress level thresholds should be changed as shown:

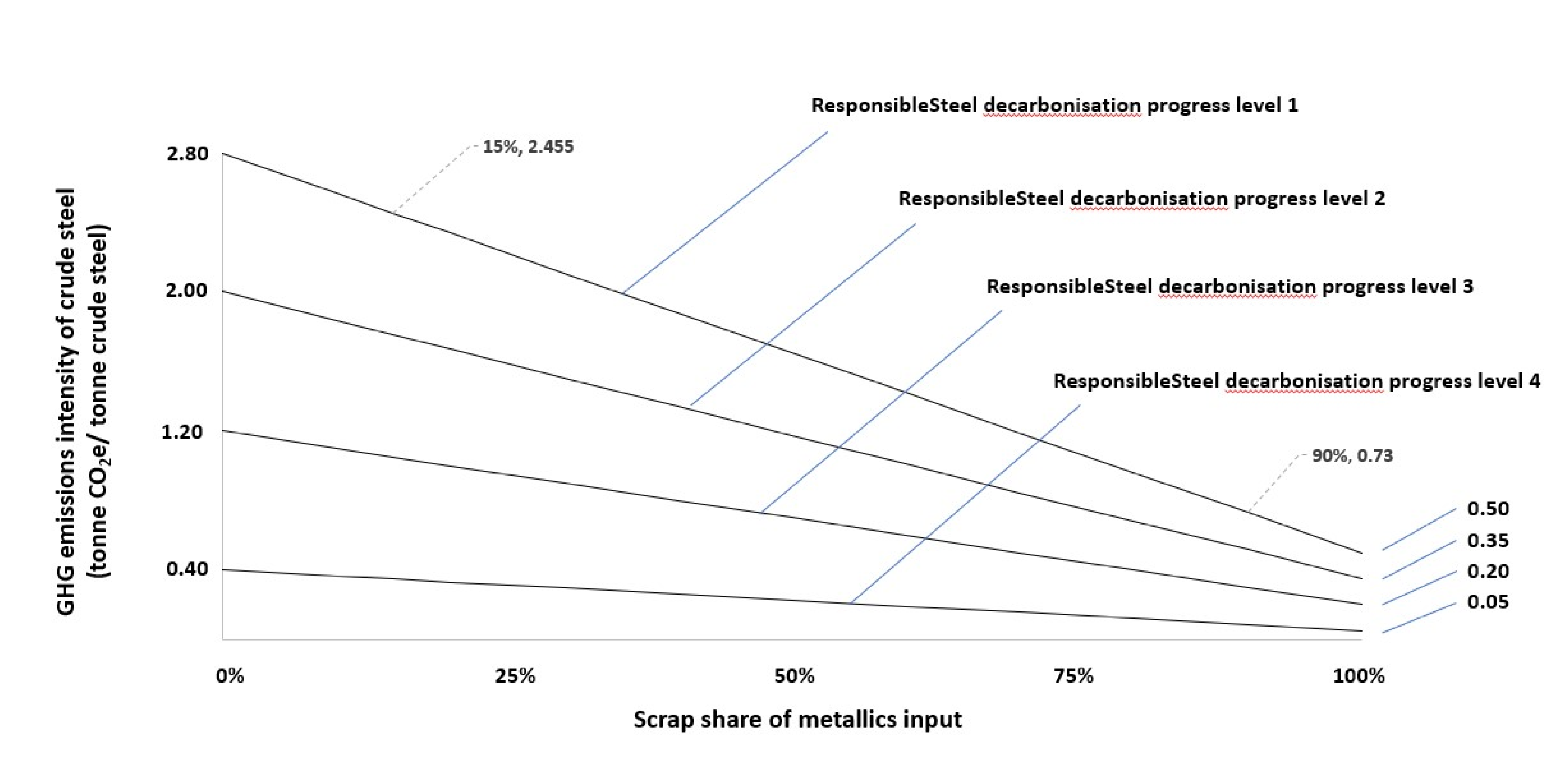
Responsible Steel progress level	Current value for 100% iron ore (kgCO2e/tonne crude steel)	Recommended value for 100% iron ore (kgCO2e/tonne crude steel)	Recommended change (kgCO2e/tonne crude steel)	Current value for 100% scrap (kgCO2e/tonne crude steel)	Recommended value for 100% scrap (kgCO2e/tonne crude steel)	Recommended change (kgCO2e/tonne crude steel)	Recommended change (%) (kgCO2e/tonne crude steel)
1	2800	2800	0	350	500	150	43%
2	2000	2000	0	250	350	100	40%
3	1200	1200	0	150	200	50	33%
4	400	400	0	50	50	0	0

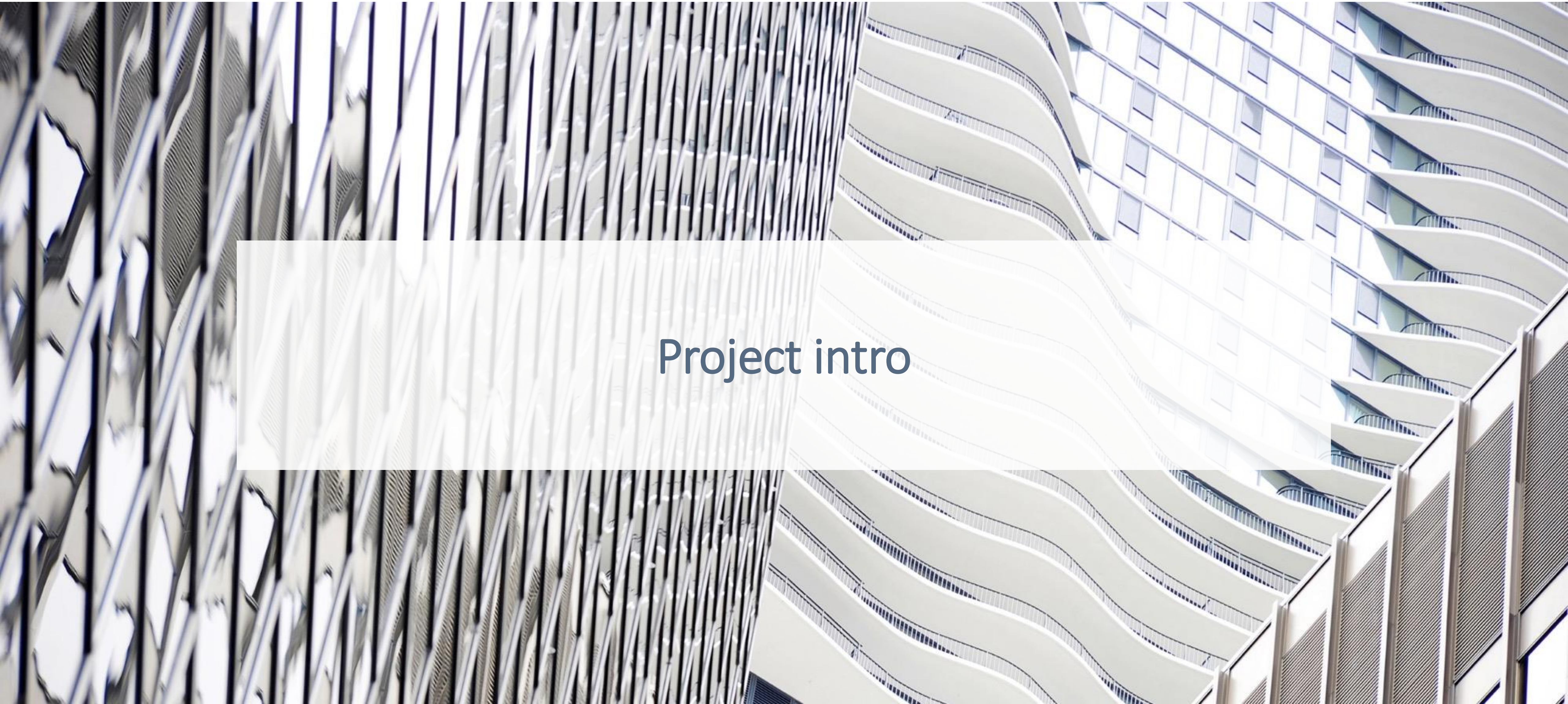
Recommendations

Based on these revisions, we estimate that:

- ~50% of steelmaking sites with less than 20% scrap as a share of metallic inputs will be below the progress level 1 threshold today
- ~62% of steelmaking sites with more than 80% scrap as a share of metallic inputs will be below the threshold today

We propose that these thresholds optimise incentives to reduce the steel sector's global GHG emissions at the same time as incentivising scrap use.





Project intro

GHG data review project: key questions

1. Can we improve the data?
2. Does the policy specification ('50% of sites above and below the threshold, for both low and high scrap sites, with slightly shallower gradient'):
   - Unintentionally disincentivise the use of scrap?
   - Effectively drive decarbonisation?
3. Can we set better thresholds, once we have reviewed the data and the policy specification?

1a. Can we improve the data?

Data analysis

- Application of CRU methodology, with ability to modify and test variations
- Steelmaker data for 35 sites in total (earlier analysis based on 16 sites)
- 28 sites with direct comparison to CRU data (earlier analysis based on 13 sites)

Constraints:

- Steelmaker confidentiality concerns:
    - Steelmaker site data has different levels of detail
    - only 5 sites analysed in high detail
    - cannot cross-check directly with CRU
- 2020 and 2021 data may be distorted due to Covid
- Some data always in arrears (e.g. grid emissions, and company finalisations)

Initial differences between CRU and company data for project sites

	Company average for project sites, N=28 (std deviation)	CRU average for project sites, N=28 (std deviation)	Absolute difference (tonnes CO_2e/tonne crude steel [except for scrap %])	Percentage difference
Total GHG emissions intensity (tonnes CO_2e / tonne crude steel)	1.79 (+/- 0.80)	1.79 (+/- 0.76)	0.00	0%
% scrap	35% (+/- 31%)	32% (+/- 28%)	-3%	-3%
Scope 1 intensity (tonnes CO_2e / tonne crude steel)	1.17	1.19	0.02	2%
Scope 2 intensity (tonnes CO_2e / tonne crude steel)	0.05	0.09	0.04	89%
Upstream Scope 3 intensity (tonnes CO_2e / tonne crude steel)	0.57	0.50	-0.07	-12%

28 comparable sites, two sites excluded as outliers in their differences.

Potential adjustments to CRU GHG emissions data set

6 possible sources of variance investigated:

a) Allocation of upstream GHG emissions for transportation of scrap: CRU does not include allocation for scrap transportation

b) Discrepancies between CRU and company data in relation to Scope 2 grid emissions value data years: differences in grid data year applied, typical that grid emissions factors are in arrears

c) Treatment of process gases and related ‘credits’: possibility that credits for downstream use of process gases not fully included in CRU

d) Categorisation of scrap and calculation of ‘scrap as a percentage of gross metallics’

e) Treatment of upstream Scope 3 emissions for ferroalloys and non-ferrous metals: analysis conducted for V2.0 of the Standard did not include an estimate for the emissions for ferroalloys and non-ferrous metals. Review the upstream Scope 3 ‘replacement value’ for ferroalloys and non-ferrous metals.

f) Estimated scope 2 differences resulting from geographical differences between CRU representation of sites and global production volumes

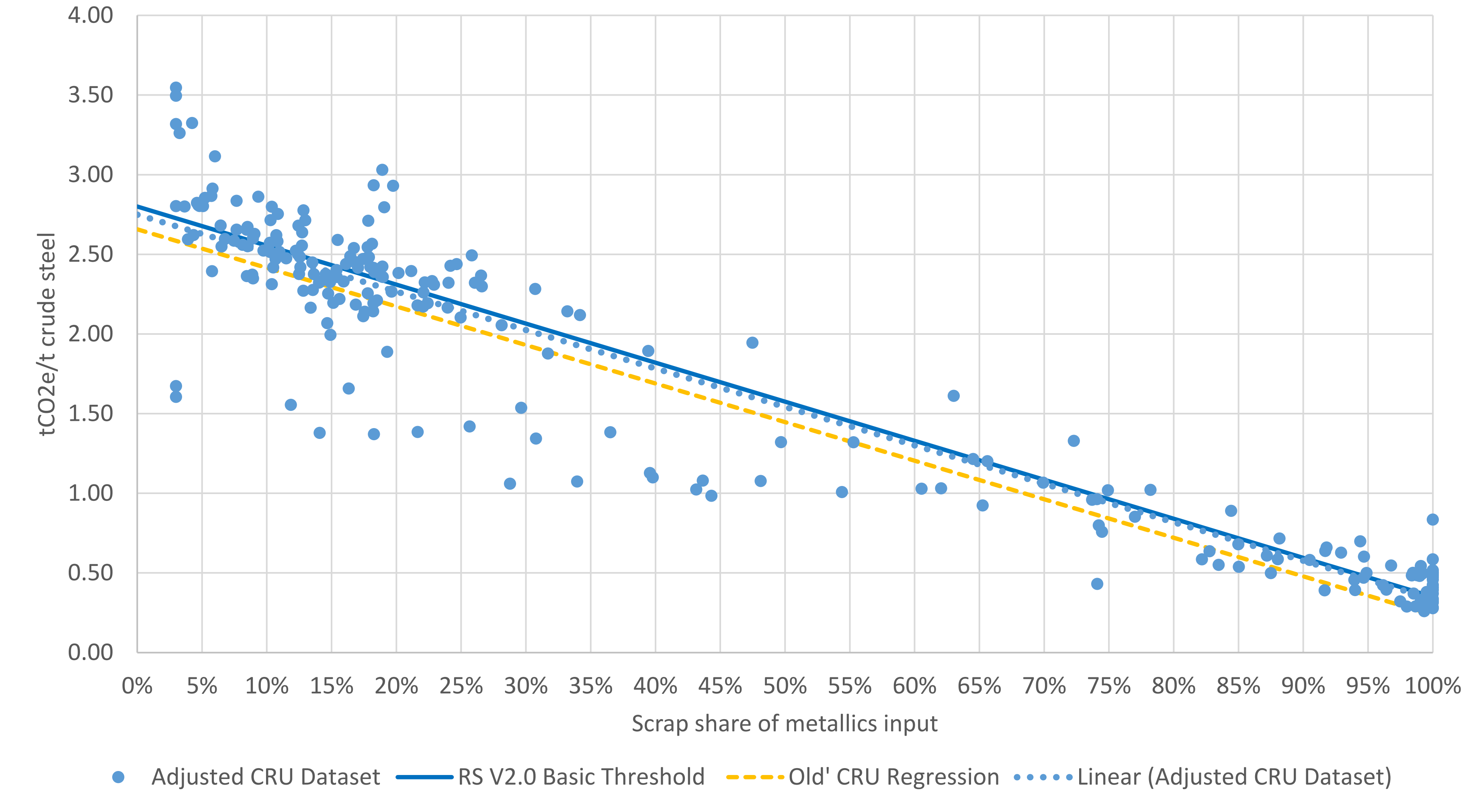
Quantitative summary of review

1. **Definitions and details really matter! We should all be extremely cautious about comparing GHG emissions intensity data and 'scrap %' values without knowing exactly how they were calculated. Apparently small differences can be significant.**
2. **Figures referenced by companies or other organisations not applying the ResponsibleSteel standard are unlikely to be directly comparable.**
3. **Can we improve the data?**
   - Yes, although the data is noisy, and assumptions have to be made to quantify improvements

Reason for Adjustment	Effect at 0% Scrap Value	Effect at 100% Scrap Value
a) Upstream transportation emissions of scrap	0	+14 kg CO2e/t crude steel
b) Scope 2 grid emission factors	+3.5kg CO2e/t crude steel	+15.2 kg CO2e/t crude steel
c) Process gas credits	-22kg CO2e/t crude steel	0
d) Scrap categorization and calculation	+72.6kg CO2e/t crude steel	+72.6kg CO2e/t crude steel
e) Include non ferrous metals and ferro alloys at replacement value	+32.64kg CO2e/t crude steel	+2.63kg CO2e/t crude steel
f) Geographical representation of production and scope 2 emissions	+6.4kgs CO2e/t crude steel	+59.4kgs CO2e/t crude steel
Total:	**+93.14 kg CO2e/t**	**+163.33kg CO2e/t**

* Revised replacement value to equivalent for cold iron: 2.632 tCO2e/t.

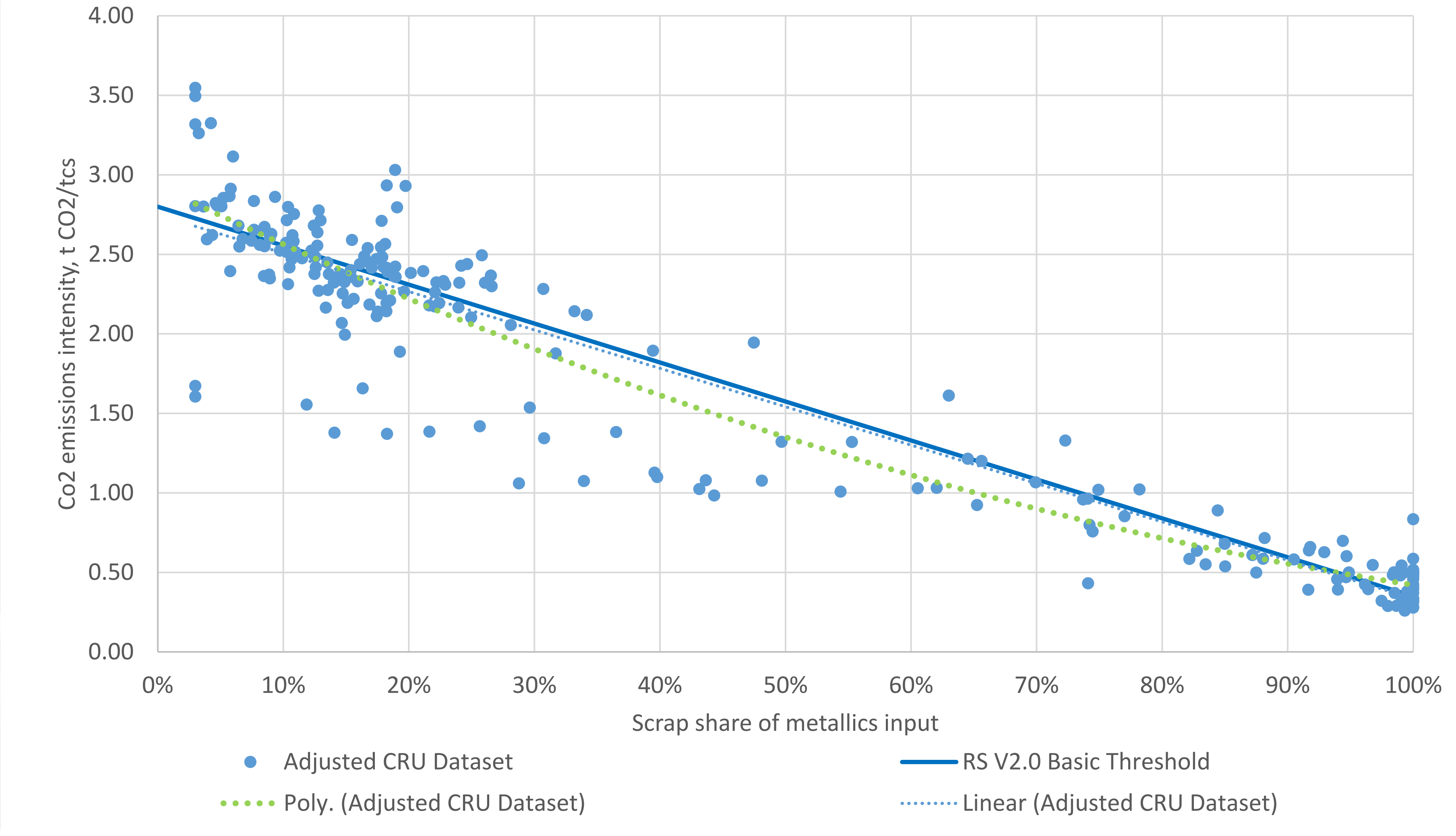
‘Old’ and Adjusted Linear Regression



The linear regression of the adjusted data is above the linear regression from the analysis conducted to set the thresholds for V2.0. The new regression is close to the current threshold of progress level 1.

1b. What is the relationship between GHG emissions and scrap content?

a) Relationship between GHG emissions and scrap content, based on improved data



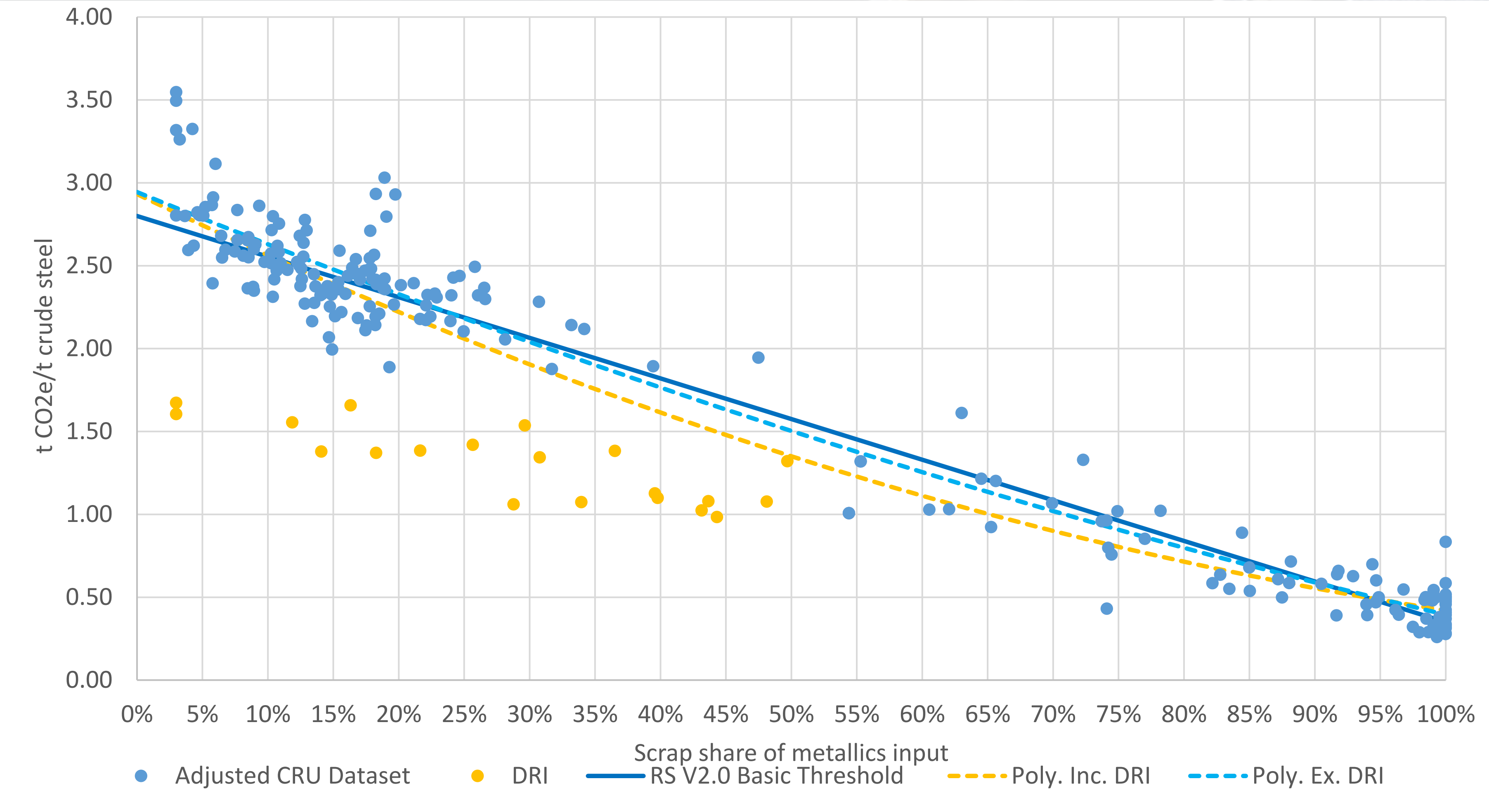
Adjustments to the CRU dataset*:

- 14kgsCO2e/tonne scrap for transportation.
- 3% increase to the scrap percentage at each site.
- Scope 2 emissions increased by 6.8%.
- FA/NFM adjustment by cold iron factor
- Process gas crediting adjustment

*CRU data for 2021, modified to incorporate findings from comparison of company and CRU data for 2019.

*This does not include adjustment f) from previous section, which was identified after completion of section 2 analysis.

Comparison of Polynomial Curves – Inc. and Ex. DRI



Orange data points are sites which are using DRI as the majority of their gross metallics input.

When DRI sites are excluded, the curve of the polynomial regression is less pronounced. This is shown by the blue curved line (DRI inc.) and the orange curved line (DRI ex.)

2. Should we change the policy specification?

Policy considerations

Basis for setting threshold:

a) Linear vs non-linear thresholds
b) Thresholds to consider thermodynamics of scrap use in blast furnaces?
c) Include or exclude high DRI sites?
d) Separate thresholds for flat and long products?

Does the current policy specification, *'50% of sites above and below the threshold, for both low and high scrap sites, with slightly shallower gradient'*:

- Unintentionally disincentivise the use of scrap?
- Effectively drive decarbonisation?

a) Linear vs non-linear thresholds

- There is some evidence that a polynomial equation would be a better fit to the data than a linear regression.
- The effect is reduced when DRI-EAF sites are excluded from the data set.
- The remaining difference is around 2.1% at the ‘low scrap’ end of the curve, it is an 8.5% difference at the ‘high scrap’ end, which could make as much as 30kg CO_2e/tonne difference if not adjusted for.
- There are significant benefits in maintaining a linear fit, in terms of simplicity, but also in relation to consideration of claims that might be made when steel from multiple furnaces or sites is mixed to meet orders, and a claim needs to take account of a number of different progress levels.
- On balance, it is proposed to maintain linear thresholds, but to ensure that the final threshold is slightly shallower (i.e. more generous to high scrap-based steelmaking), as an adjustment.

b) Thermodynamics of scrap

We were not able to carry out this analysis

Unclear how the results of such an analysis would inform the outcome of the current project, which is essentially empirical

Do not propose to allocate additional resources at this time

c) Excluding high DRI sites from linear regression

	Regression line	0% scrap threshold	100% scrap threshold
Improved CRU linear regression: - including high DRI sites	y = - 2.414x + 2.7492	2,749 kg CO_2e/ tonne	335 kg CO_2e/ tonne
Improved CRU linear regression: - excluding high DRI sites	y = - 2.5x + 2.86	2,860 kg CO_2e/ tonne	360 kg CO_2e/ tonne
Difference		**111 kg CO_2e/ tonne**	**25 kg CO_2e/ tonne**

- We have compared data with and without ‘high DRI’ sites
- ‘High DRI’ is an imperfect definition
- There is a difference
- We propose that the policy specification *‘50% of sites above and below the threshold, for both low and high scrap sites, with slightly shallower gradient’* should be considered on the basis that we *include* DRI sites, when looking at the % of sites that would initially meet the ‘progress level 1’ threshold
- See the final recommendations

d) Flats vs Longs

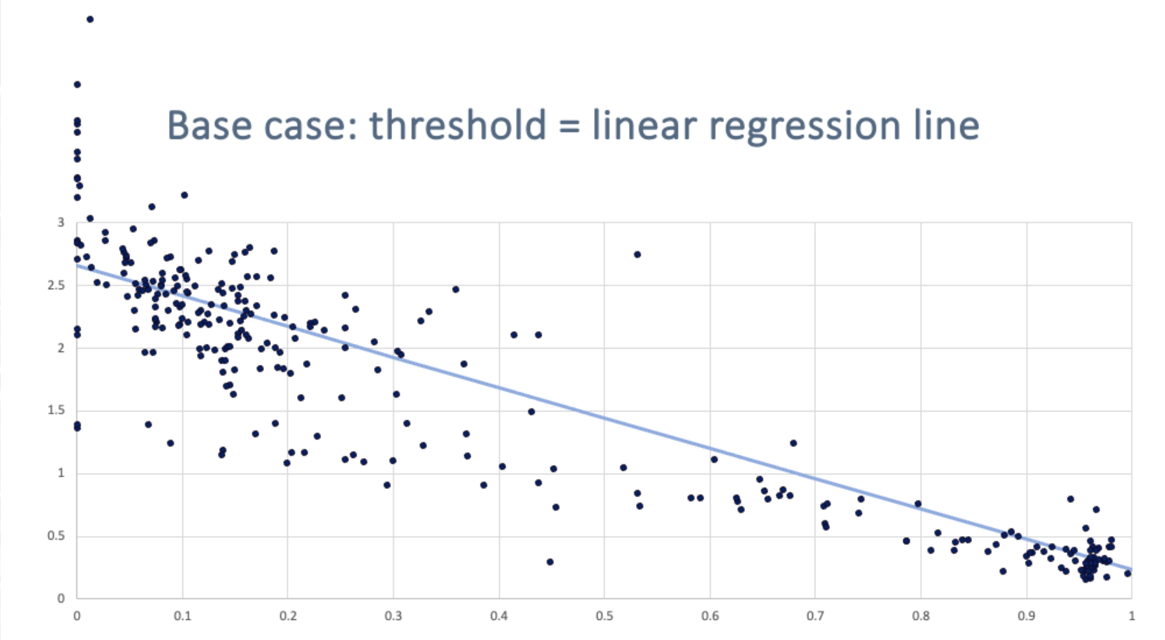
- We have compared site level data for ’Flats’ vs ‘Longs’
- Some sites produce both ’Flat’ and ‘Long’ products
- We don’t see evidence to justify the development of separate progress levels for ’Flat’ vs ‘Long’ sites
- It would also add considerable complexity to the ResponsibleSteel system to try to define different progress levels for different product categories

➢ Do not propose to develop separate threshold values for ‘Flat’ vs ‘Long’ products or sites

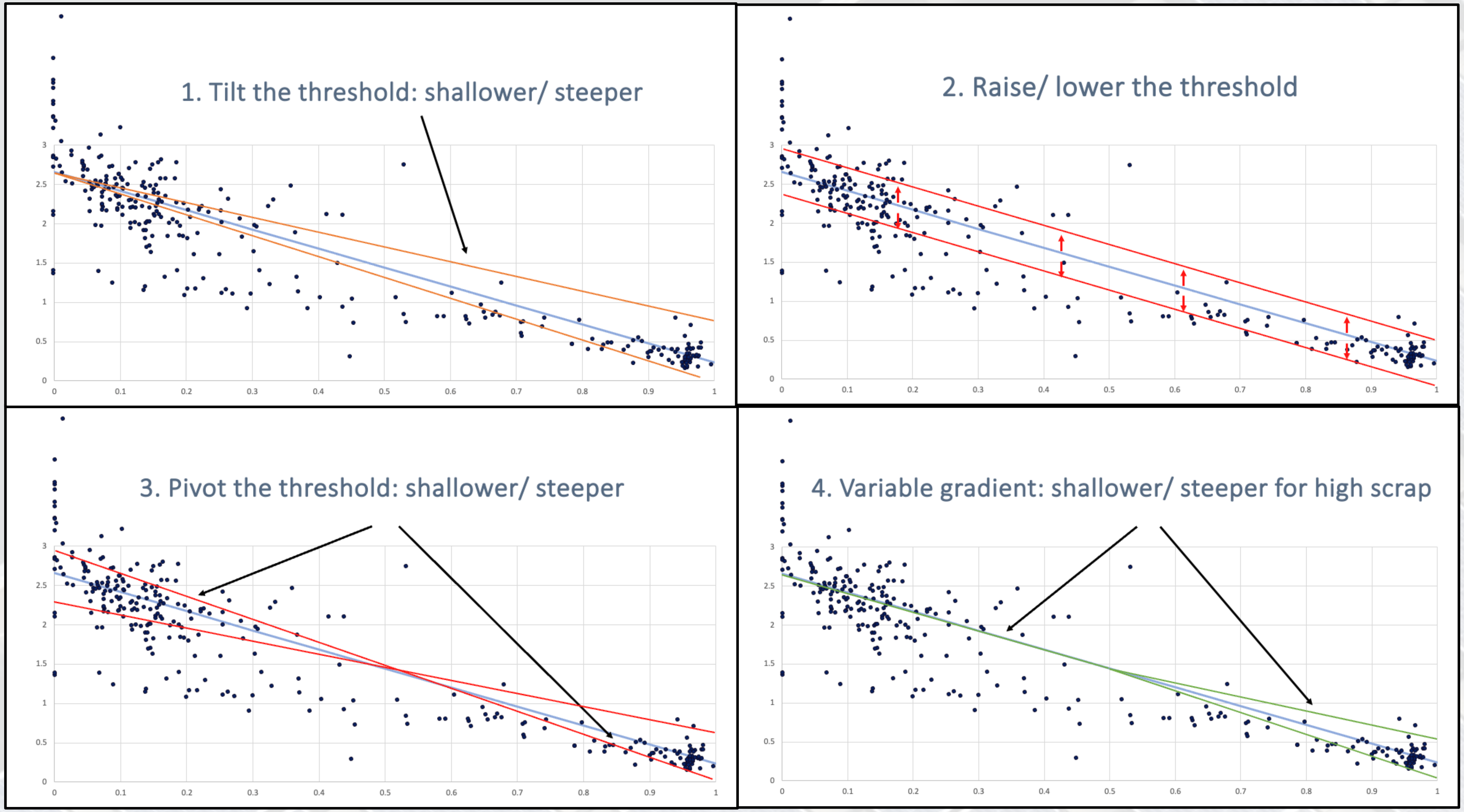
Current policy specification

Does the current policy specification, *'50% of sites above and below the threshold, for both low and high scrap sites, with slightly shallower gradient'*:

- Unintentionally disincentivise the use of scrap?
- Effectively drive decarbonisation?



Four variations

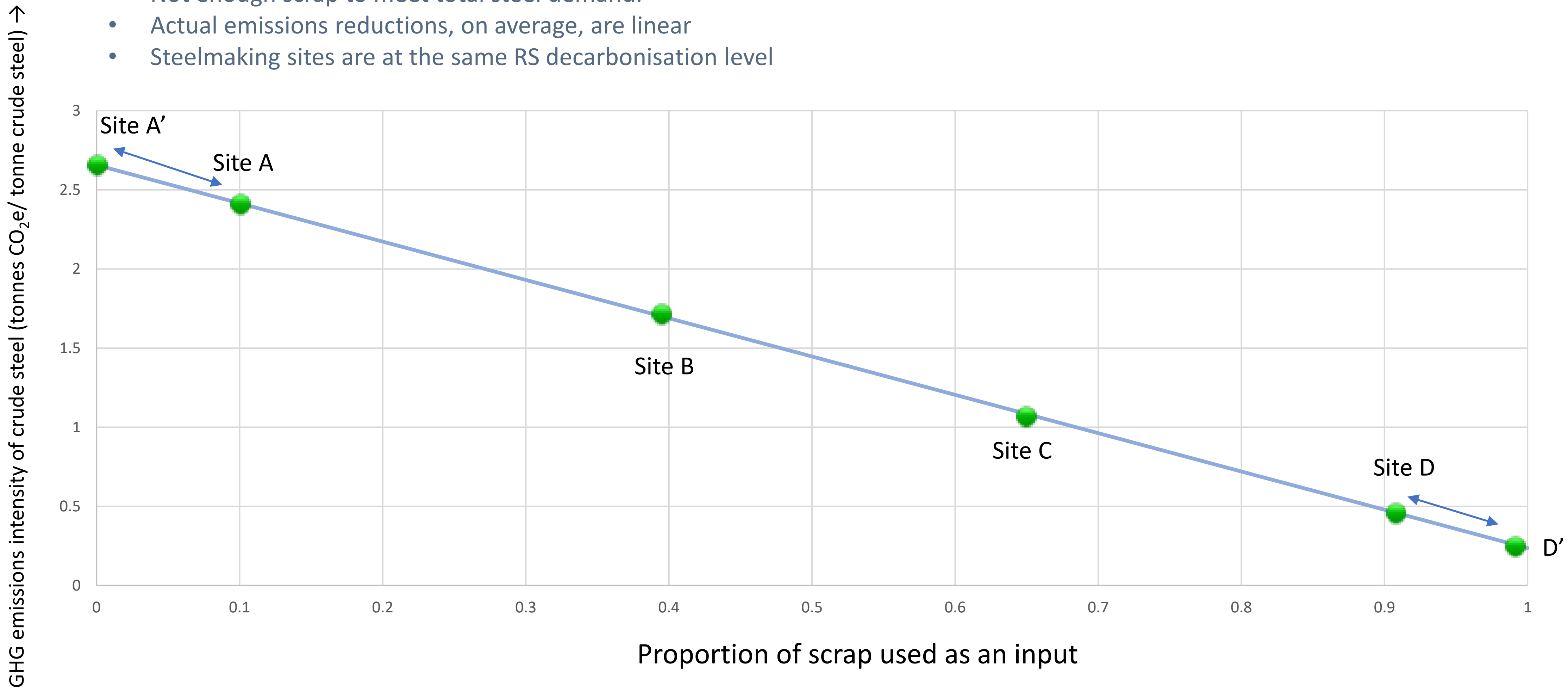


- What are the implications for scrap demand?
- What are the implications for GHG emissions?
- Other considerations?

GHG impact of scrap allocation between steelmaking sites

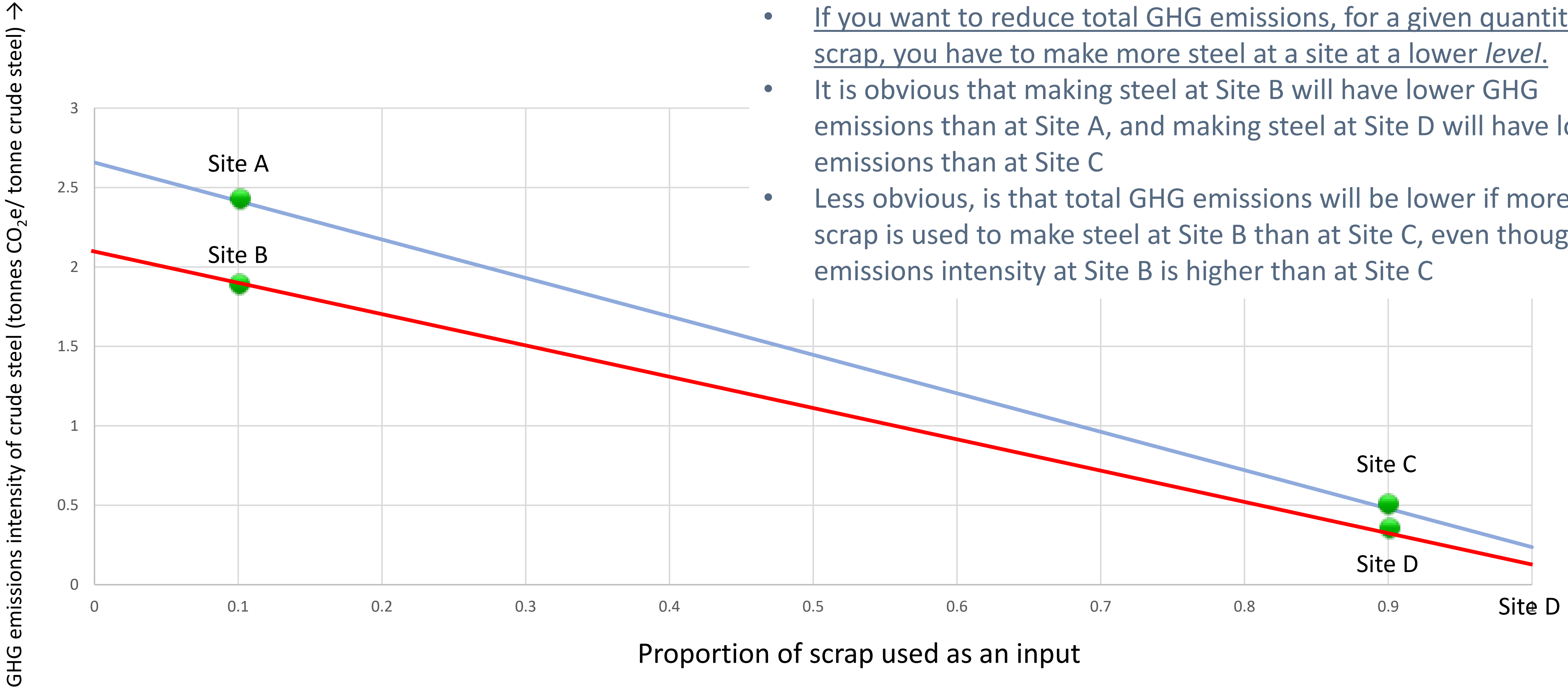
Assumptions

- Total quantity of steel needed to meet demand is constant
- Scrap supply is limited, and all scrap is used
- Not enough scrap to meet total steel demand.
- Actual emissions reductions, on average, are linear
- Steelmaking sites are at the same RS decarbonisation level



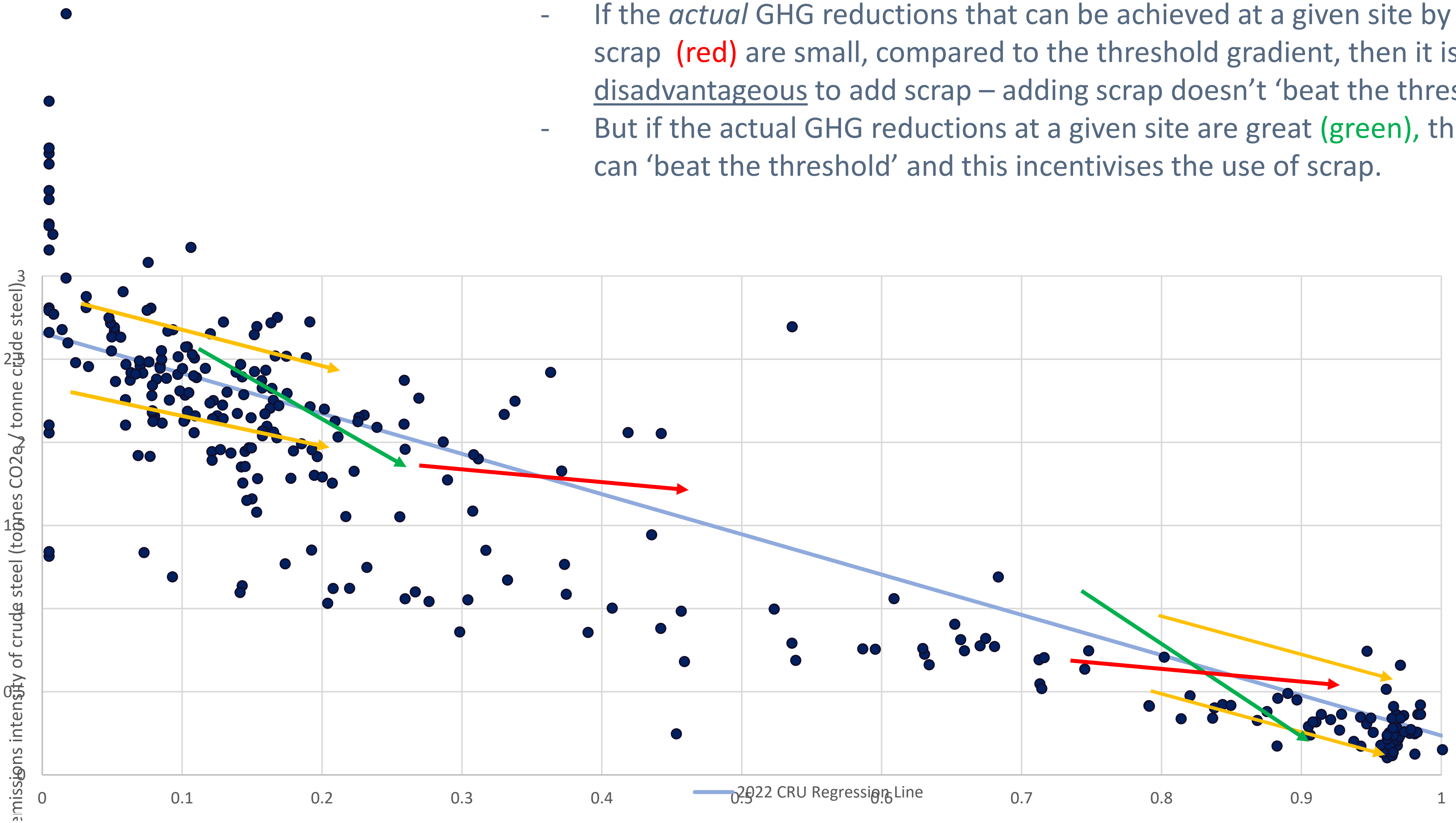
Effects of RS progress level on total GHG emissions…

- Total emissions are the same, if scrap is allocated to sites on the same line
- <u>If you want to reduce total GHG emissions, for a given quantity of scrap, you have to make more steel at a site at a lower *level*.</u>
- It is obvious that making steel at Site B will have lower GHG emissions than at Site A, and making steel at Site D will have lower emissions than at Site C
- Less obvious, is that total GHG emissions will be lower if more scrap is used to make steel at Site B than at Site C, even though the emissions intensity at Site B is higher than at Site C

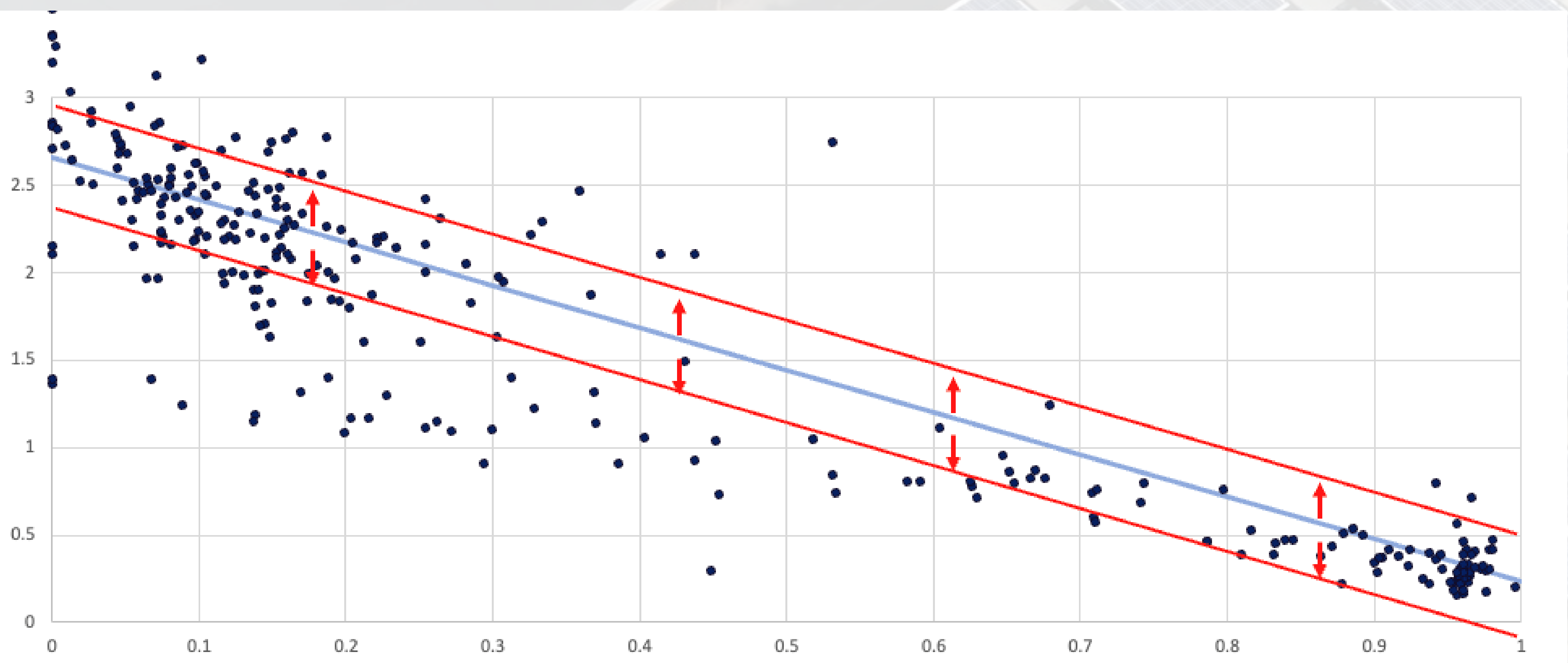


Effects of RS progress level *gradient* on scrap demand

- If the *actual* GHG reductions that can be achieved at a given site by adding more scrap (red) are small, compared to the threshold gradient, then it is disadvantageous to add scrap – adding scrap doesn't 'beat the threshold'
- But if the actual GHG reductions at a given site are great (green), then adding scrap can 'beat the threshold' and this incentivises the use of scrap.



Effects of raising or lowering the threshold



Conclusions

- Total GHG emissions reductions for a given level of total scrap consumption are minimised if the threshold is ‘neutral’
- A *shallower* gradient than the ‘neutral’ linear regression:
  - should increase demand for scrap for all sites and in all countries
  - would be associated with increasing market distortion, in favour of high scrap-based steelmaking technologies and countries
- Increased demand for scrap would be expected to incentivise post-consumer scrap recovery.
- Greater post-consumer scrap recovery should reduce overall GHG emissions. However:
  - The potential to increase post-consumer recovery is limited
  - ‘Hard to recover’ scrap will be associated with higher energy use
- We are not able to quantify the point at which the additional incentive for scrap recovery is counterbalanced by the relative inefficiency of scrap usage, as the threshold gradient is reduced, however:

➢ A ‘slightly shallower’ gradient should be optimal in terms of overall GHG emissions reduction for the sector, and in terms of being the ‘least trade distorting’ method to achieve the environmental objective of steel sector GHG reduction.

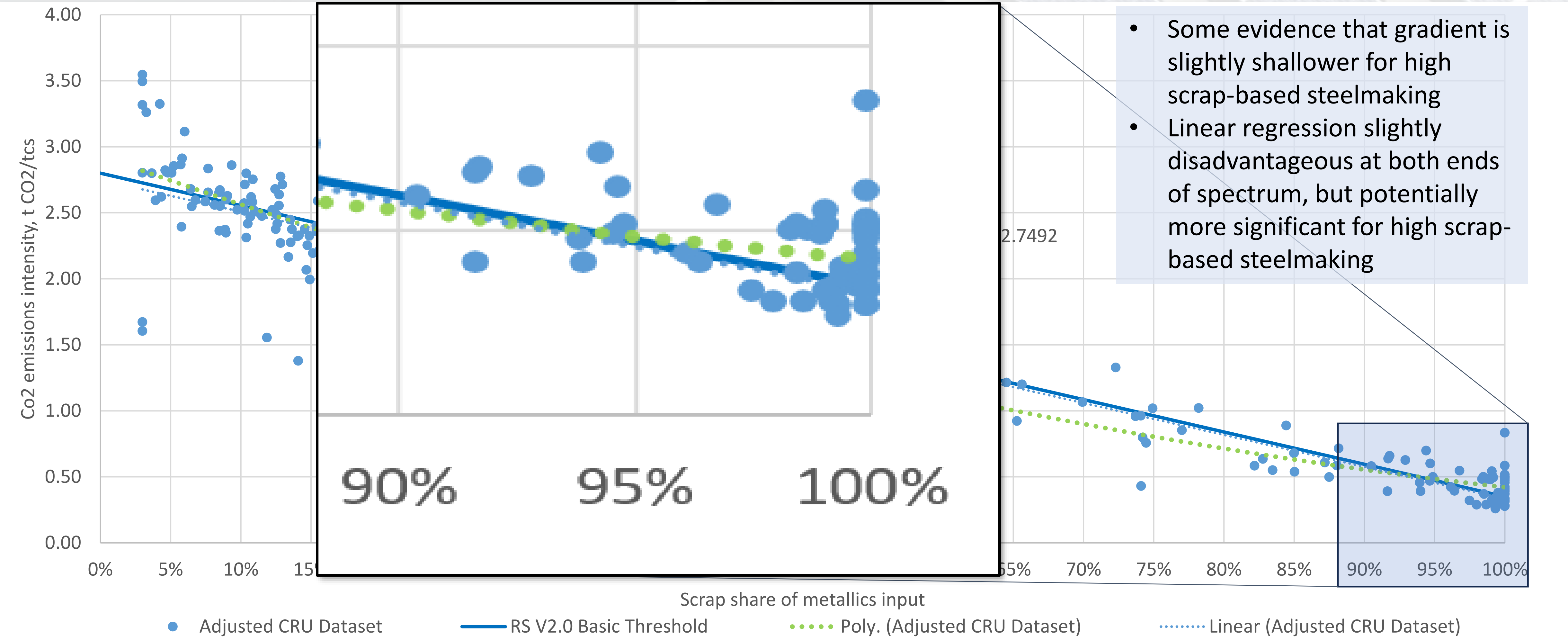
➢ We do not propose changes to the current policy: *‘50% of sites below the threshold, with slightly shallower gradient to favour high scrap-based steelmaking’*

3. What are the appropriate thresholds, given the improved data and the policy specification?

GHG data review : conclusions

1. Can we improve the data? YES
2. Should we change the policy specification?
   - Does the current policy disincentivize the global use of scrap? NO
   - Does it effectively incentivize steel decarbonisation? YES
   - Should we change the specification: *'50% of sites above and below the threshold, for both low and high scrap sites, with slightly shallower gradient'*? NO, but we can provide a more quantitative indication of the implications of specifying a 'slightly shallower gradient'
3. Can we improve the specification of the level 1 threshold, given any changes to the data and the policy specification? YES

Gradient and ‘pass rate’ for very high scrap steelmaking



- Some evidence that gradient is slightly shallower for high scrap-based steelmaking
- Linear regression slightly disadvantageous at both ends of spectrum, but potentially more significant for high scrap-based steelmaking

Setting revised ResponsibleSteel thresholds

Considered the proportion of sites that would be either above or below the level 1 threshold for a range of threshold values, based on the improved CRU data.

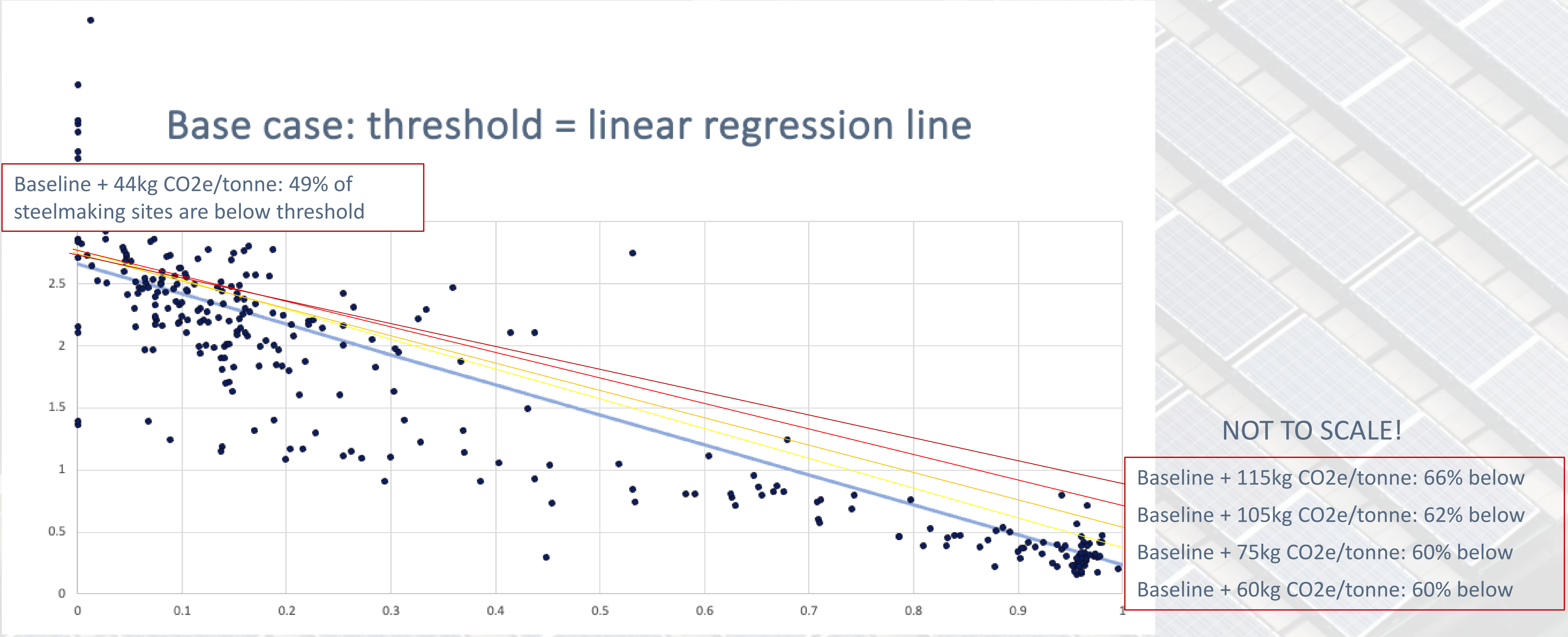
- Threshold is fixed at the 2800 kg CO_2e/tonne for zero scrap input (baseline + 44 kg CO_2e/tonne), and we then consider:
  - Baseline + 60 kg CO_2e/tonne at 100% scrap input (+/- neutral gradient)
  - Baseline + 75 kg CO_2e/tonne at 100% scrap input
  - Baseline + 90 kg CO_2e/tonne at 100% scrap input
  - Baseline + 105 kg CO_2e/tonne at 100% scrap input
  - Baseline + 115 kg CO_2e/tonne at 100% scrap input
- In all cases the ‘near zero’ decarbonisation level 4 was set at the IEA proposed values, and there were equal steps between levels 1, 2, 3 and 4.

Decarbonisation progress level	Linear regression values		leeway at 0% scrap			leeway at 100% scrap				
	0% scrap	100% scrap	kgs from linear reg. (leeway)	+44	Kgs from linear reg. (leeway)	+60	+75	+95	+105	+115
1	2756	395	level 1 (0% scrap):	2800	level 1 (100% scrap):	455	470	490	500	510
2	1971	280	level 2 (0% scrap):	2000	level 2 (100% scrap):	320	330	343	350	357
3	1186	165	level 3 (0% scrap):	1200	level 3 (100% scrap):	185	190	197	200	203
4	400	50	level 4 (0% scrap):	400	level 4 (100% scrap):	50	50	50	50	50
Step between levels:	785	115		800		115	140	147	150	153
Proportion of 'low scrap'* sites below Level 1 threshold:				49%		49%	49%	50%	50%	50%
Proportion of 'high scrap'* sites below Level 1 threshold:						60%	60%	62%	62%	66%

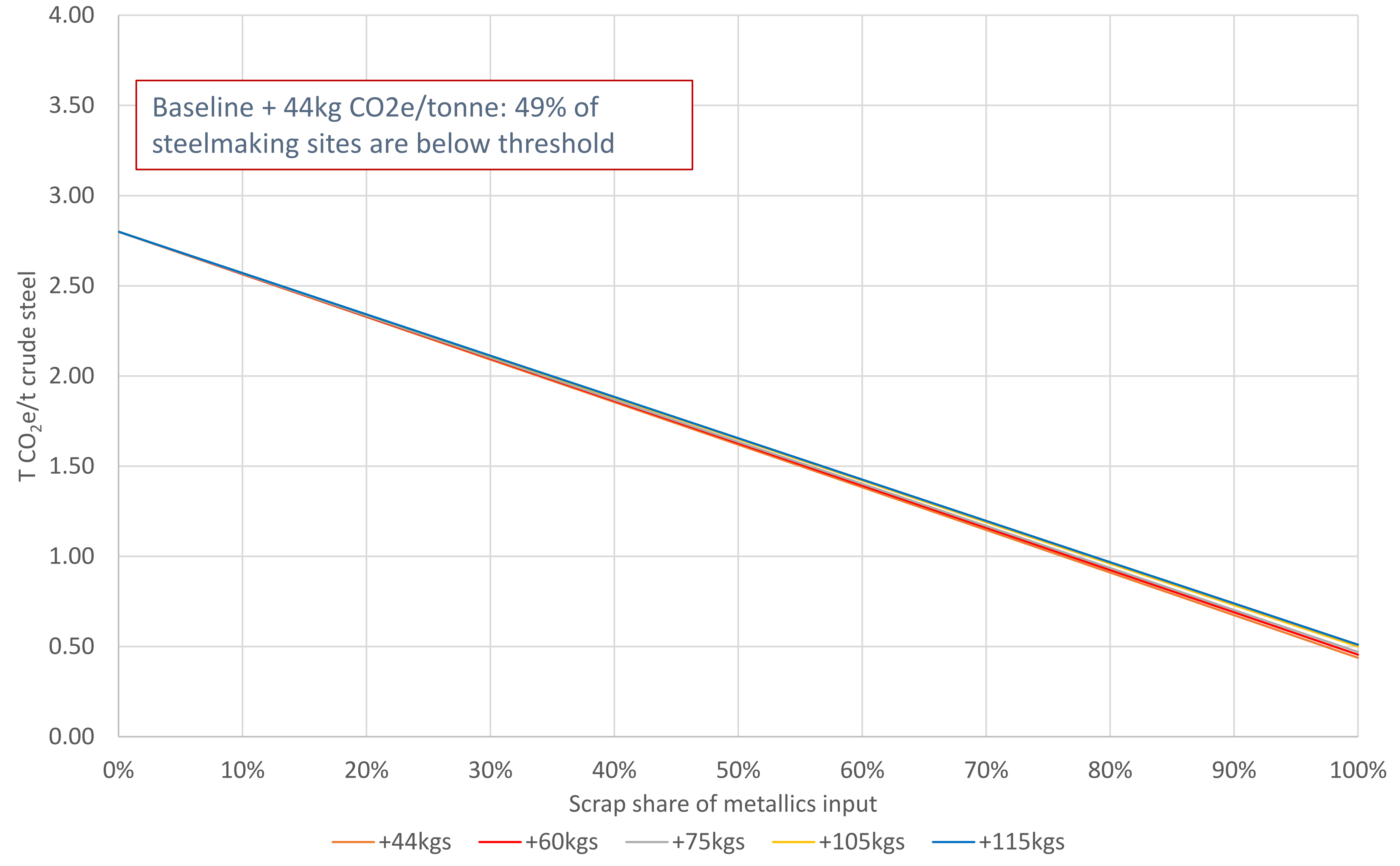
* 'low scrap sites' <= 20% scrap input

* 'high scrap' sites >=80% scrap input

Illustration of Progress Level 1 Specification Options



Graphical Representation of Progress Level 1 Specification Options



To scale

Baseline + 115kg CO2e/tonne: 66% below

Baseline + 105kg CO2e/tonne: 62% below

Baseline + 75kg CO2e/tonne: 60% below

Baseline + 60kg CO2e/tonne: 60% below

Recommendations

The ResponsibleSteel decarbonisation progress level thresholds should be changed as shown:

Responsible Steel progress level	Current value for 100% iron ore (kgCO2e/tonne crude steel)	Recommended value for 100% iron ore (kgCO2e/tonne crude steel)	Recommended change (kgCO2e/tonne crude steel)	Current value for 100% scrap (kgCO2e/tonne crude steel)	Recommended value for 100% scrap (kgCO2e/tonne crude steel)	Recommended change (kgCO2e/tonne crude steel)	Recommended change (%) (kgCO2e/tonne crude steel)
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4	400	400	0	50	50	0	0