A CIRCULAR TRANSITION FOR THE UK STEEL INDUSTRY: THE IMPACTS OF UTILISING DOMESTIC SCRAP AND INCREASED SECONDARY STEEL PRODUCTION

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Abstract

The steel industry in the United Kingdom has an uncertain future. It must remain competitive globally whilst simultaneously decarbonising in order to achieve domestic climate change targets. On top these issues, the recent energy crisis has exasperated conditions for an industry with small profit margins and in a country with comparatively high energy costs compared to many neighbours. There are two large primary steel plants which produce roughly four fifths of steel output in the UK and contribute to over 90% of the industry's emissions. The future of the blast furnaces on these sites is imperative to the industry as a whole. One potential option is to convert existing sites to recycled steel facilities given that the UK currently exports much of its available scrap. While this approach could help rejuvenate the industry while utilising domestic waste, it comes with a variety of potential limitations. Here we use the ENGAGE-materials model to consider the macroeconomic implications of the UK transitioning to a steel industry based greater levels of secondary steel. We implement a range of scenarios which analyse the transition from primary to secondary steel production for the UK while keeping the steel industry competitive in the global market. We consider increased taxes on production, subsidies for recycling and taxes on exports of scrap to encourage greater domestic utilisation.

Keywords: Computable General Equilibrium, Steel, Circular Economy, National Analysis

JEL classification: D58, Q31, Q53, 052

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1. Introduction

A transition away from mineral extraction of primary materials towards a more circular economy requires more efficient utilisation of key resources and materials through a combination of reuse, remanufacturing and recycling. The latter option will require a move away from primary production towards increased levels of scrap collection and utilisation and secondary production of materials. The steel industry is already well-positioned to harness the potential of recirculating its waste materials through production via the Electric Arc Furnace (EAF) technology which includes scrap steel as a significant input which allows for production of recycled steel products (as opposed to the Blast Furnace-Basic Oxygen Furnace (BF-BOF) primary production route with can only utilise relatively small amounts of scrap).

In 2021 about 29% of global steel was produced using EAF (World Steel Association, 2022). With a lower climate impact per tonne of steel, the greater use of secondary steel can assist in the decarbonation of the global steel industry to achieve the Paris agreement targets, especially in the next decade where alternative steel routes such as green hydrogen and carbon capture utilisation and storage (CCUS) are still scaling. However, levels of secondary steel are influenced by a number of factors including scrap availability, product lifetimes, electricity prices, scrap quality, collection processes, recycling capacity and supply chains. These will be unique to each country's own situation. Here we consider the implications specifically for the UK steel industry. Section 2 provides background on the UK industry and recent literature focused on UK steel recycling. Section 3 describes the modelling approach, details of the UK initial

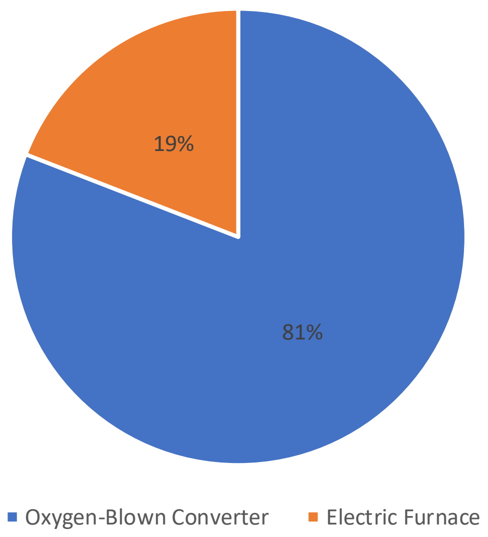
2. The UK steel industry

The United Kingdom has reduced its steel production capacity over the last decades. Overall, the UK is now a net importer of steel. The country produced 7.1 Mt total in 2020 while consumption is larger, at 11.9 Mt in 2018 (Hall et al. 2021). When you consider the amount of UK steel exports, only roughly around a sixth of final consumed steel goods in the UK are from domestically produced steel (Allwood et al. 2019). The majority of UK steel, 81% in 2020 (World Steel Association, 2022), is produced from the two BF-BOF sites at Port Talbot and Scunthorpe, which are operated by Tata Steel and British Steel,[2] respectively. The UK government appears to wish to retain a domestic steel industry while also having a net zero

[2] The British Steel plant in Scunthorpe was purchased by the Chinese-owned Jingye Group in March 2020, after it entered compulsory liquidation in 2019 having previously been bought by Greybull Capital in 2016.

target of 2050 which will require the entire sector's decarbonisation. At present, steel accounts for around 2% of the UK's total GHG emissions (ONS, 2021). Figure 2 shows that the two BF-BOF sites account for over 90% of the sector's greenhouse gas emissions.

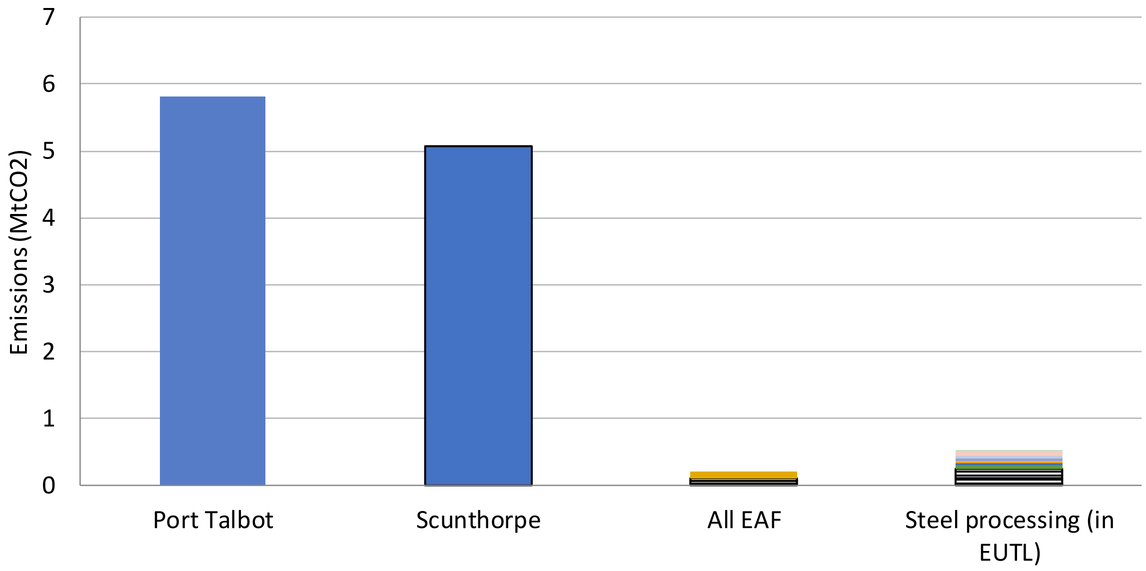
Figure 1: Percentage of UK steel production by type 2020



Source: World Steel Association (2021)

At present around only 19% of UK steel production comes from EAF. The relatively low carbon-intensity of the UK electricity supply makes it some of the lowest-carbon secondary steel with further potential as electricity decarbonises further. Around 2.7m tonnes of scrap is utilised in the UK in a year. However, the UK's scrap steel supply is considerably larger, and it currently exports three-quarters of domestic scrap (8.7 million tonnes in 2018) with Turkey being the largest consumer. Therefore, it is worth considering whether it is possible to better utilise this resource, which is currently exported at low value-added, in order to grow the ailing domestic steel industry or at least replace a significant proportion of the current BF-BOF production with EAF.

Figure 2: UK steel sector emissions by site/type for 2018



Source: Ember Steel Production Dataset (2020)

Allwood et al. (2019) suggest that despite its current poor situation, the UK specifically has four comparative advantages in the steel sector's transformation: (1) abundant scrap resource, (2) low carbon electricity, (3) a history of innovation in materials and materials processing to allow greater substation of scrap with primary steel, and (4) relatively weak supply chains, vis-à-vis those places on which we are heavily import dependent, mean that new business models can help add more value to less steel, in particular vertical integration.

Griffin and Hammond (2021) explore the prospects for decarbonising the sector and suggest the main options are deindustrialisation, carbon capture, bioenergy, hydrogen as a carrier and also electrification. And they believe the shift from primary to secondary production "may actually be the long-term destiny of the UK steel sector without significant government intervention… balancing its economic and social development with environmental protection".

Hall et al. (2021) state that there is significant scope to more than double the use of scrap in UK steel production using current steel facilities if they could be operated at full capacity. This, however, would require both greater downstream investment in downstream facilities and increased demand, whether domestically or abroad, for UK products. However, even greater use of domestic UK scrap steel would require an expansion of the current capacity of EAFs. They estimate the cost of a new facility could potentially be over £1 billion. They also provide details on many of the barriers that require to be overcome to attract greater investment including energy costs and business rates as well as scrap sorting standards, technologies and business alignment with manufacturers.

Reports from the steel industry itself emphasise that electricity prices are a major factor in the industry's ability to compete internationally and are key to its survival as high electricity costs lead to underinvestment compared with competitor countries (UK Steel, 2021). It should also be noted that other routes to decarbonisation of the steel industry e.g., hydrogen (H-DRI-EAF) and CCUS, will require competitive electricity prices too.

Yet major specific decisions have not been made by Government since the industrial decarbonisation strategy in 2021. In early 2023 the UK government pledged £600m to help fund the transition of the industry to green steel meaning there would be £300 million for each Scunthorpe and Port Talbot to assist them in transitioning. Whether this is enough remains to be seen. There are also plans for a UK-specific carbon border adjustment mechanism (CBAM) which would help alleviate elements of competitive concerns, particularly when the EU is introducing its own CBAM in the near future.

3. Methodology

3.1 Model

We utilise the ENGAGE-materials CGE model developed by University College London for the analysis of energy, environmental, resource and economic policies (Winning et al. 2017, Nechifor et al. 2020). ENnvironmental Global Applied General Equilibrium (ENGAGE) model is based upon standard Walrasian general equilibrium assumptions such a market clearance, zero profits, and utility maximisation/cost minimisation of representative agents. All industries are modelled through a representative firm, which maximizes its profits in perfectly competitive markets. The production functions of each economic sector to create a level of sectoral output are specified using a series of nested constant elasticity of substitution (CES) functions. Domestic and foreign inputs are not perfect substitutes and therefore are modelled using the "Armington assumption", which accounts for product heterogeneity between different world regions. A representative consumer in each region receives household income, defined as the service value of national primary factors. The national income is allocated between aggregate household consumption, public consumption and savings. A money metric measure of economic welfare, the equivalent variation, can be computed from the model output.

ENGAGE uses national accounts data and a system of non-linear equations to solve for a baseline equilibrium against which policy shocks can be implemented. ENGAGE uses the latest GTAP database as a main data source, which is combined and enhanced with other databases (e.g., EXIOBASE, FAO). The ENGAGE model is written in GAMS and based upon the GTAP9inGAMS model in MPSGE developed by Lanz and Rutherford (2016).

The model was extended with the circular economy in mind to include a representation of different production technologies for the global steel industry which are outlined in Winning et al. (2017) and Nechifor et al. (2020). In particular, ENGAGE-materials models iron ore, primary and secondary steel production technologies which take into account the possible pathways for steel production capacities across the electric arc furnace (EAF) and basic oxygen furnace (BOF) routes. Furthermore, the model represents the scrap treatment and recycling sector as a standalone economic activity producing treated scrap which can be used domestically or traded internationally.

3.2 UK database

In the initial database used in ENGAGE-materials, which constructed using GTAP 9 for 2011 plus a variety of other data sources detailed in Winning et al. (2017) and Nechifor et al. (2020).[3] There are a number of key elements in the Social Accounting Matrix that must sense checked be in order to understand the impacts of the scenarios and policies implemented.

The cost structure of the UK primary steel (ISP) sector shows that the largest intermediate inputs are coking coal (P_C) 5%, primary steel itself at 10%, transport 5%, services 10%, and imports at a significant 25%.

Primary steel appears to be more labour-intensive in the UK SAM with 20% of the steel cost going to wages, whereas it is around half that amount in the secondary route. This somewhat represents the reality that EAF production is considered less labour-intensive than BF-BOF, although the magnitudes are unclear in practice in the UK.

Inputs for the secondary steel production (RSS) sector come from itself 14%, scrap treatment 17%, electricity 9%, transport 2.5%, services 5%, and imports 26%. While the scrap treatment (SST) sector uses a significant amount of recycling 8%, electricity 19% and imports 14%.

Most of primary (secondary) steel sales goes to downstream steel-consuming sectors such as fabricated metal products 14% (10%), motor vehicles 11% (8%), other manufacturing 19% (14%), and construction 5% (4%).

In the UK SAM used in this analysis, the share of UK scrap that is directly exported from the scrap treatment sector is high at 72%, with the remainder being used domestically. This appears to be of a similar magnitude as is seen in the present day where around three quarters of UK domestic scrap steel is directly exported each year.

3.3 Scenarios

The UK has no circular economy or climate targets specifically for the steel industry. However, there is a clear understanding that 81% of the current production in the industry, the primary BF-BOF process at the two large sites at Port Talbot and Scunthorpe, require to be fundamentally altered in the coming decades to achieve decarbonisation goals as these two sites account for over 90% of the UK's steel emissions. The Committee on Climate Change, the UK's independent climate advisory body, has undertaken analysis on how industrial decarbonisation and recommend in its Balanced Net Zero Pathway (BNZP) scenario the sector

[3] See Winning et al. (2017) for further details.

has completely decarbonised by 2035 with electrification accounting for 32% of the emissions reduction (CCC, 2020).

Here we implement an analysis which considers how increased recycling in the UK can be achieved. In particular, we undertake scenarios which would entail the doubling of the UK's secondary steel production and what the economic impact of such a change would be on the wider UK economy and related upstream and downstream sectors. The increase can be achieved in a number of ways through policies which will be modelled using economic instruments including taxes of primary steel production, subsidies for secondary steel production and for scrap recycling, an iron ore imports tax and increased government spending.

Table 1: Scenarios for CE analysis

Scenario	Policies	Model implementation
REF	UK's NDC climate policies	Emissions trajectory from TIAM-UCL replicated in ENGAGE-materials
CE-PPT	Production tax of primary steel	Sales tax on isp sector x 1.5
CE-IMT	Iron ore imports tax	Increase in tariff on imports of iron ore
CE-SSS	Secondary steel subsidy	Reduction in sales tax on rss sector x 0.5
CE-EST	Scrap export tax	Increase in tariff on exports of scrap (sst) x 1.5
CE-ELE	Electricity price	Preferential price to the steel sector
CE-ALL	Combination of above	

It is also possible to consider technological options around greater end of life vehicle recycling which could increase scrap availability further. There are also a number of other regulatory policy options which could help drive such changes indirectly like extended producer responsibility, eco-labelling, material passports and eco-design regulation, although these are more difficult to model and will be included in future analysis.

4. Results and discussion

There are a number of other considerations which are important to discuss around increased scrap utilisation in the UK. One difficulty with expanding UK EAF production is the relatively high industrial electricity prices compared to neighbouring regions. Thus far Therefore, any increase in secondary production would likely also require electricity market reform and some protection for industrial .

Demand-side policies should be considered in future analysis. However, circular economy policies that extend the lifetime of steel products in the UK will also reduce future domestic scrap supply.

Development of a UK Carbon Border Adjustment Mechanism (CBAM) which matches the planned CBAM for the EU is also a necessary consideration in the decision-making process of whether to increase investment in the UK.

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