Scottish Steel Sector Analysis

Report commissioned by the Scottish Government in response to tender document CASE/488656

Date: 20/03/2020

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Introduction and Context

Warwick Manufacturing Group (WMG), part of the University of Warwick, has undertaken an analysis of the steel sector in Scotland. The analysis looks at the Scottish steel sector in relation to the global steel sector, its relation to the steel sector in the UK, its economic value to Scotland and opportunities for the steel sector.

Steel has played an important part in Scotland's economy since 1751. There have been 12 iron and steel works in Scotland. The last major integrated works to close was Ravenscraig, which closed in 1992. Scotland's industrial heritage has relied upon steel, it has been at the heart of Scotland's shipbuilding, energy, rail and civil engineering industries.

Steel is the most widely used metal in modern society, a key material for industrialisation and urbanisation. In particular steel is a dominant material in the energy sector, about 10% of the steel produced in the world is consumed by the energy sector, where it is used in pipelines, pressure vessels and support structures such as wind turbine towers.

This report presents data gathered about Scotland's current steel making industries, steel imports and exports, how steel is used in Scotland, recycling of steel in Scotland and presents opportunities for the future of the steel sector.

Definitions and Declarations

To complete the analysis a number of definitions and declarations has to be made.

Definitions:

- **Crude iron and steel production** – production of crude steel is defined as the manufacture of liquid iron or steel from raw materials. This process is typically completed in either a blast furnace (BF) or electric arc furnace (EAF) process. A BF produces pig iron from coke and iron ore which must then be further reduced in a basic oxygen furnace (BOF) to produce steel. At the end of crude steel production the liquid steel is solidified as slab, bloom, billet (continuous processing) or ingots.
- **Steel processing** – the slab, bloom, billet or ingot is processed into a finished steel product usually by heating, rolling and/or forging. The act of turning a slab, billet or bloom into a finished steel product is defined as steel processing.
- **Finished steel products** – at the end of steel processing steel is in the form of uncoated plate, strip, bar, section, rail, rod or wire. These are defined as finished steel products.
- **Heavy steel articles** – heavy steel articles are products which have been made by joining different finished steel products together to form a structure, component or machine. Examples of heavy steel articles would be bridge spans, oil rig sections, wind turbine support columns or pressure vessels.
- **Steel fabrication** – the act of joining finished steel products together to form an article of steel usually by bolting or welding.
- **Steel stockholders** – businesses that hold finished steel products from any supplier for resale to steel users.
- **Steel recycling** – to be recycled steel is melted (either via an EAF route or by addition to the BOF / secondary steel making process) and cast into a slab, bloom, billet or ingot before being processed into a finished steel product.
- **Steel reuse** – where steel is reused and repurposed without being melted down for recycling.
- **Steel plate** – a flat rolled product from slabs or ingots of greater thickness than sheet or strip; typically greater than 10mm thick

- **Steel strip** – a coiled flat rolled product from slabs, typically less than 10mm thick
- **Integrated process** – the production of crude steel through BF and BOF processes, this is the traditional steel making process. The integrated process can use up to 30% of scrap steel
- **EAF process** – the production of crude steel in an EAF. The EAF process uses electricity to melt scrap steel for the production of crude steel. EAF process can use up to 100% scrap steel for manufacture
- **Mini-mill** – Mini-mills are typically based on the EAF processes that can handle between 200kt and 400kt of liquid steel per year. Often located close to the market for the steel produced and focussed on a smaller number of products than an integrated works.

Declarations:

- It is not possible to measure the amount of iron, steel or steel products that cross internal UK borders as this data is not tracked.
- All data presented is from the latest source, databases are updated at different times and no data is presented that is considered to be too old to be relevant.
- Individual company data shown is from the latest Company House records or from communication with the company itself.
- References to all data sources are provided with links should further interrogation be required.

World Steel Data

Crude Steel Production

In 2018 a total of 1.816 billion tons of crude steel was produced globally using blast furnace (BF) + basic oxygen furnace (BOF) and electric arc furnace (EAF) techniques. The United Kingdom produced 7.3 million tons of crude steel in 2018, 0.004% of global production. Scotland has produced less than 6000 tons of crude steel per year in the last three years. Global crude steel production is dominated by Asia, in particular China, which produced 928 million tons of crude steel alone in 2018 [1]. Figure 1 shows the overall trends for global crude steel production.

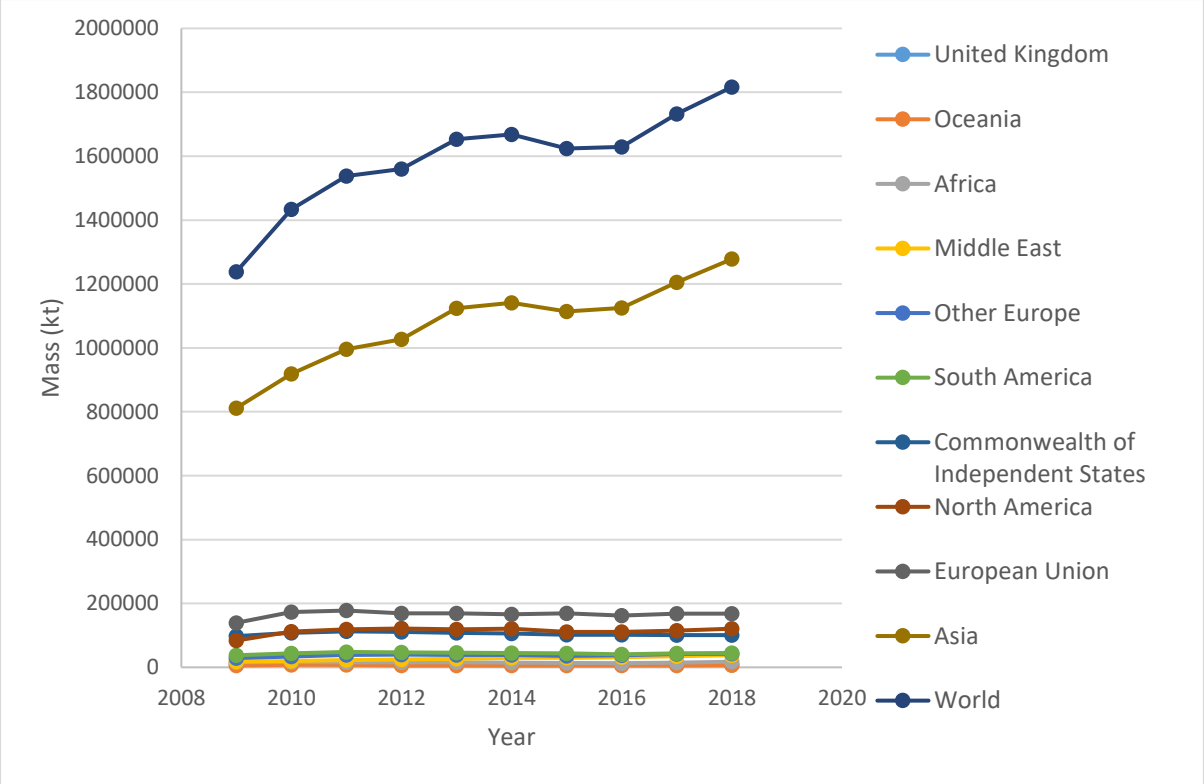

Figure 1: Global crude steel production from 2009 to 2018 [1]

The data presented in Figure 1 is hard to interpret due to domination by Asian countries. Figure 2 shows the same data with Asia removed. The data shows that in most sectors crude steel production has remained relatively stable from 2009 to 2018, the exceptions being the Middle East which has shown an increase over the period.

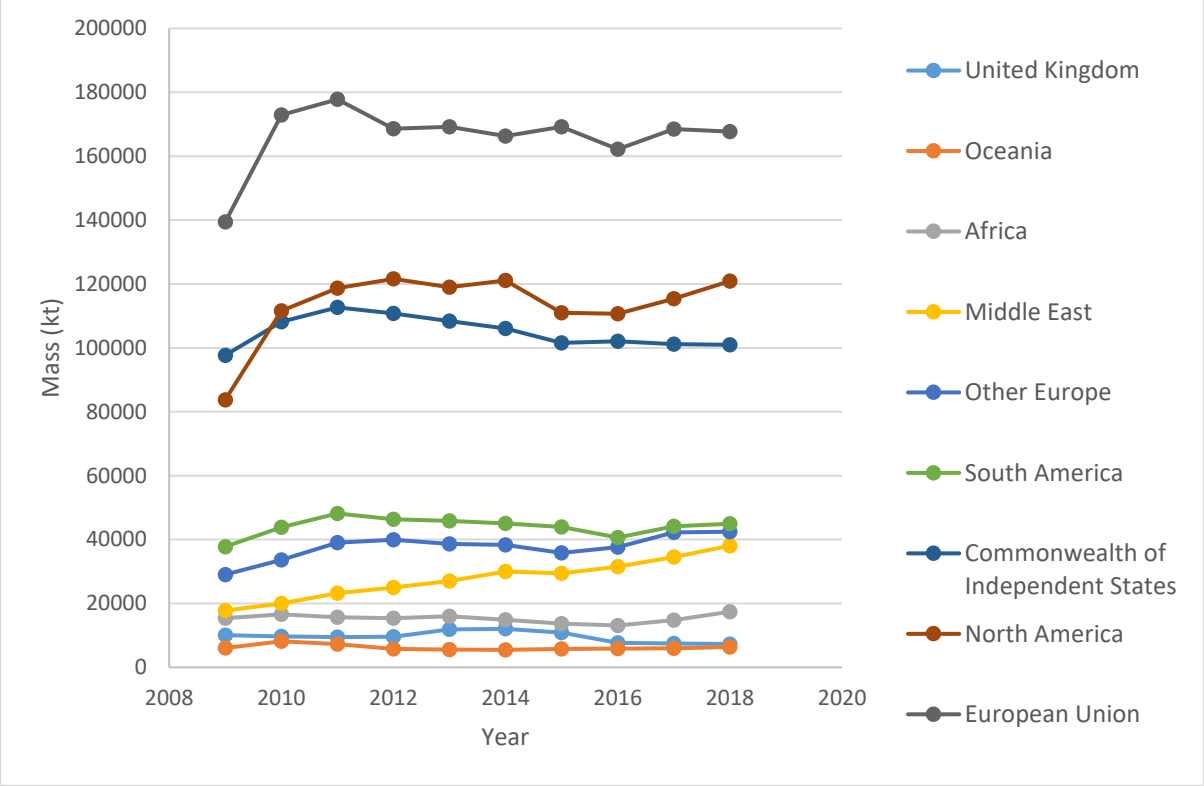

Figure 2: Crude steel production for all sectors apart from Asia from 2009 to 2018 [1]

Production of crude steel has grown by 0.57 billion tons from 2009 to 2008, this is predominantly driven by Asia which is responsible for 0.47 billion tons alone. Short range forecasts show a global increase in production to 1.81 billion tons by the end of 2020. Production in Asia and Oceania is expected to slow, likely due to overcapacity of current production, the bulk of the extra production taking place in Central and South America, Other Europe and Africa [2].

Steel Use per Capita

The amount of steel consumed per capita across the world is an indicator of the importance of steel to the populations of a given region, steel use per capita is usually higher in developed countries than developing countries, driven by energy consumption and major infrastructure projects [3].

Figure 3 shows steel use per capita trends by global sector. The EU, Other Europe, North America and Asian sectors show increases in steel use per capita over the period of 2009 to 2018. In the UK there has been a slight increase in the amount of steel consumed per capita since 2009, but this was mostly in the period between 2009 and 2011, after 2011 consumption of steel has remained constant.

In 2018 the average amount of steel used was 248kg per capita globally, in the UK 178kg of steel per capita was consumed. The EU is the primary consumer of steel, using 359kg of steel per capita in 2018. The relatively low quantity of steel used per capita in the UK in 2018 is likely due to there not being any major expansion of energy networks or major infrastructure projects.

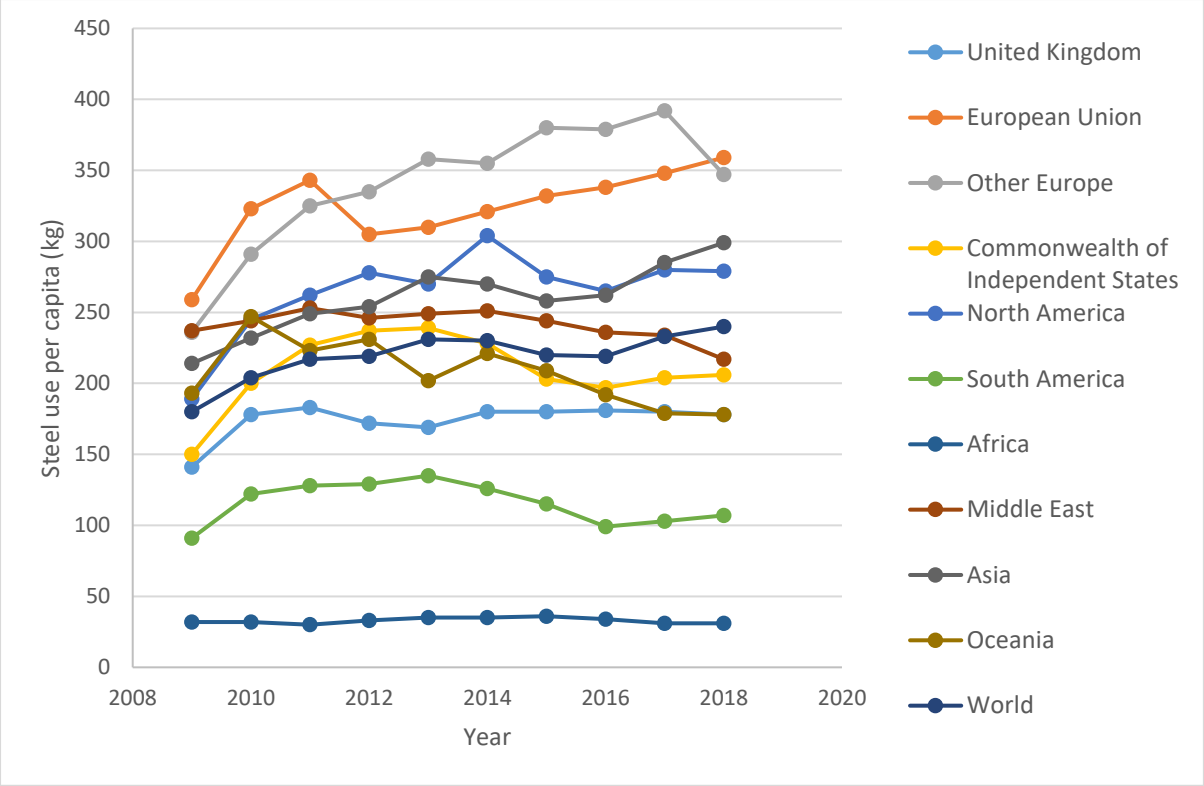

Figure 3: Global steel use per capita from 2009 to 2018 [1]

Global Usage of Finished Steel Products

Finished steel products are the final forms that steel manufacturers manufacture, including rod, strip, plate, rail and complex forms such as I-beam sections. Figure 4 shows the global use of finished steel products from 2009 to 2018, the total amount of finished steel products used in 2018 was 1.71 billion tons. Globally the use of finished steel products increased by 0.56 billion tons from 2009 to 2018, the increase in consumption was driven by Asia which is solely responsible for 72% of the increase.

Figure 5 shows finished steel product usage data with the global total and Asia data removed. The data shows that there has been a significant increase in consumption of finished steel products in the EU and North America. In the UK the use of steel products increased by 2913kt from 2009 to 2018, a 37% increase on the 2008 usage figure.

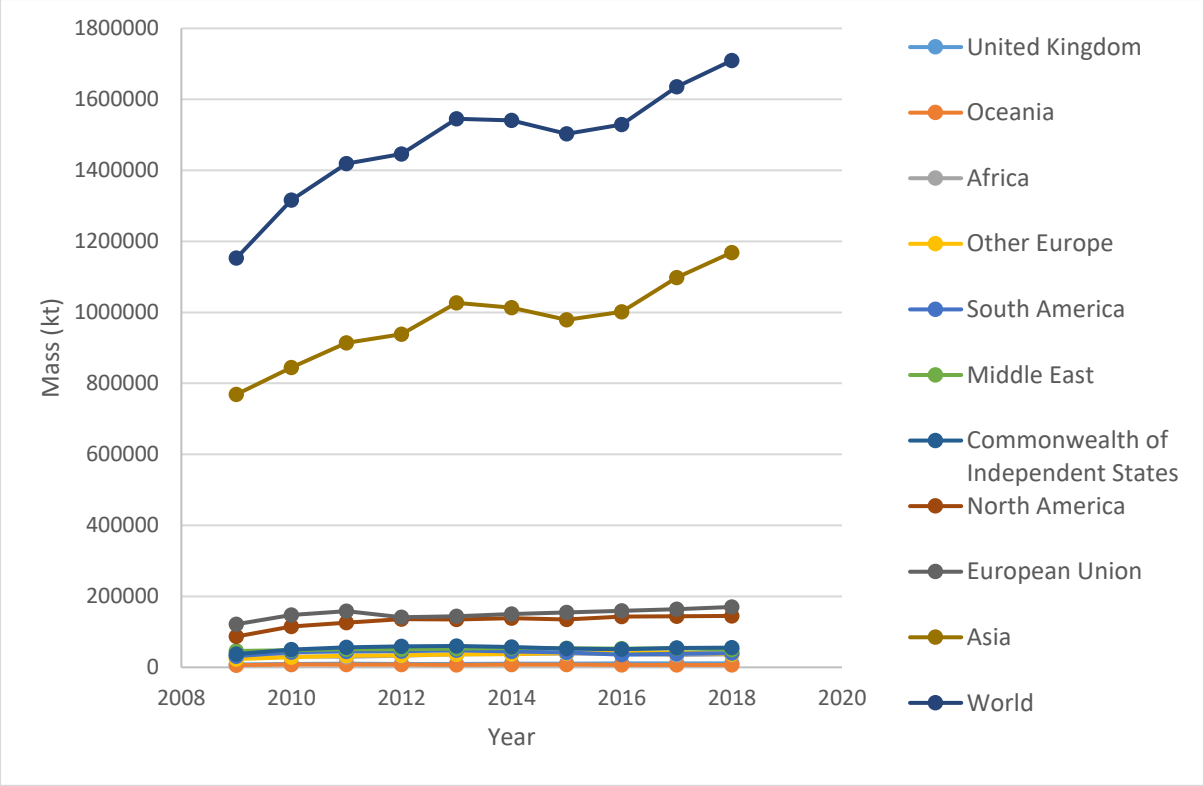

Figure 4: Global usage of finished steel products from 2009 to 2018 [1]

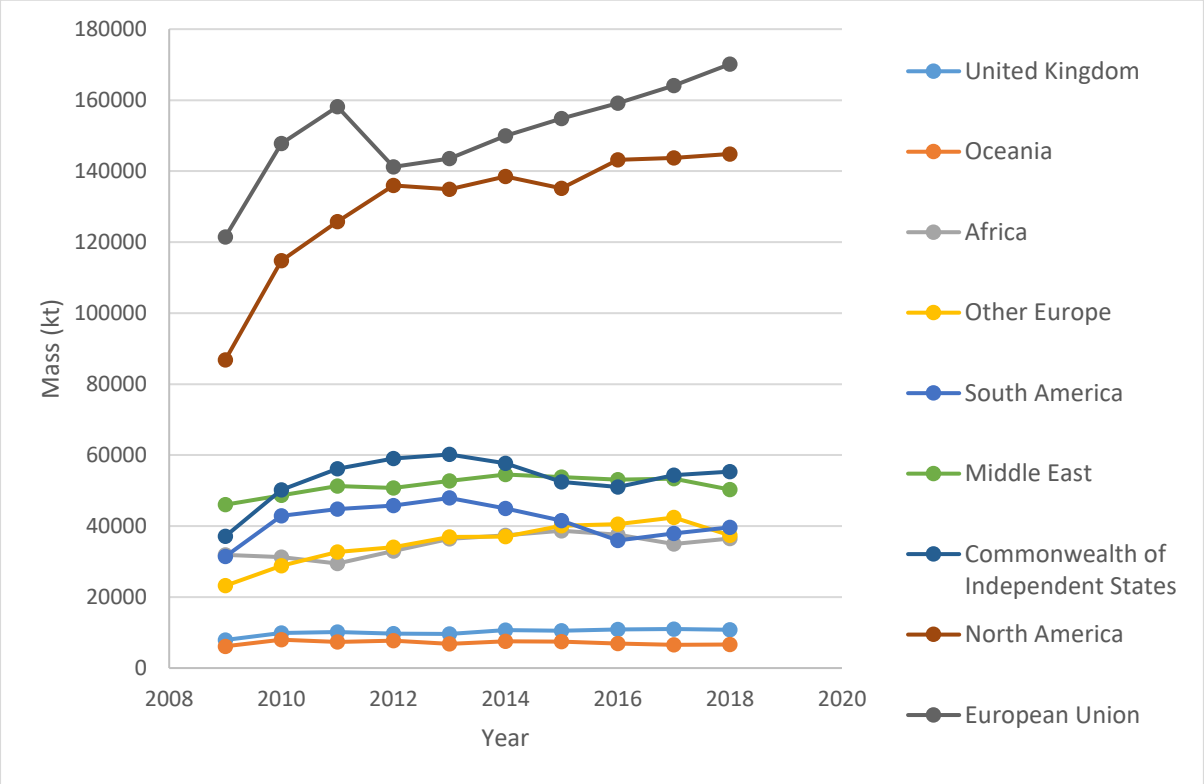

Figure 5: Global use of finished steel products for all sectors apart from Asia from 2009 to 2018 [1]

Global Scrap Steel Production

Steel scrap is recycled and used for crude steel production, 40% of worldwide crude steel production is from scrap steel during its manufacture. Scrap steel is generated from household and industrial sources. Figure 6 shows the amount of scrap steel consumed in crude steel making in the major steel producing regions from 2014 to 2018. In 2018 a total of 469 million tonnes of steel scrap were consumed in crude steel production, for comparison a total amount of 1.82 billion tonnes of crude steel was produced in 2018. China, USA and the EU are the largest users of scrap steel. China's consumption of scrap steel has grown significantly since 2016 and is twice that of the EU. The importance of scrap steel in the production of crude steel should not be underestimated and is expected to increase in the future [4].

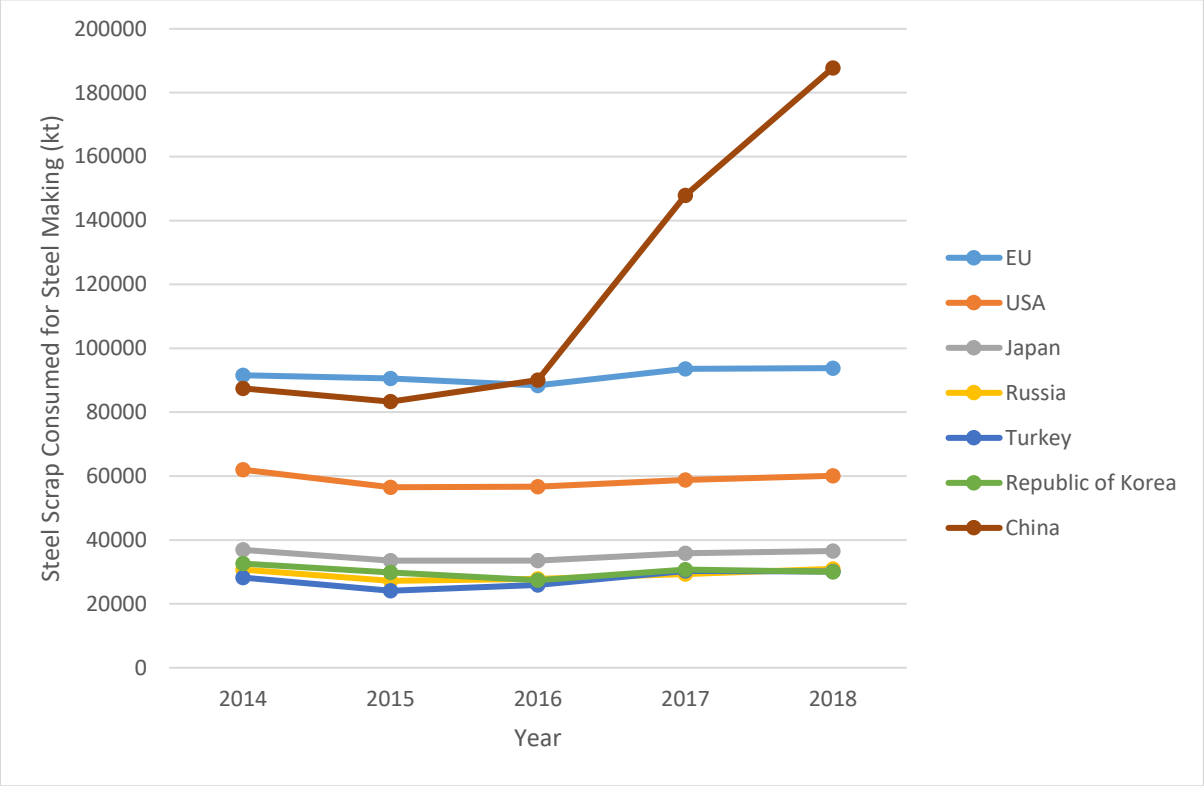

Figure 6: Steel scrap consumed for steel making from 2014 to 2018 [4]

Figure 7 shows the amounts of scrap steel consumed and crude steel produced in EU countries in 2017 (2018 data not published at the time of writing this report). Germany was the largest steel producing country in the EU in 2017 (43.3Mt), followed by Italy (24.1Mt) and then France (15.5Mt). The amount of crude steel produced does not necessarily reflect in the amount of steel scrap consumed, Italy consumed more scrap steel than Germany (21.6Mt versus 19.0Mt). The UK produced 7.49Mt of crude steel in 2017 and consumed 3.7Mt of scrap steel [4]. On average the UK produces 10Mt of scrap steel per year, Scotland produces around 820kt of scrap steel per year.

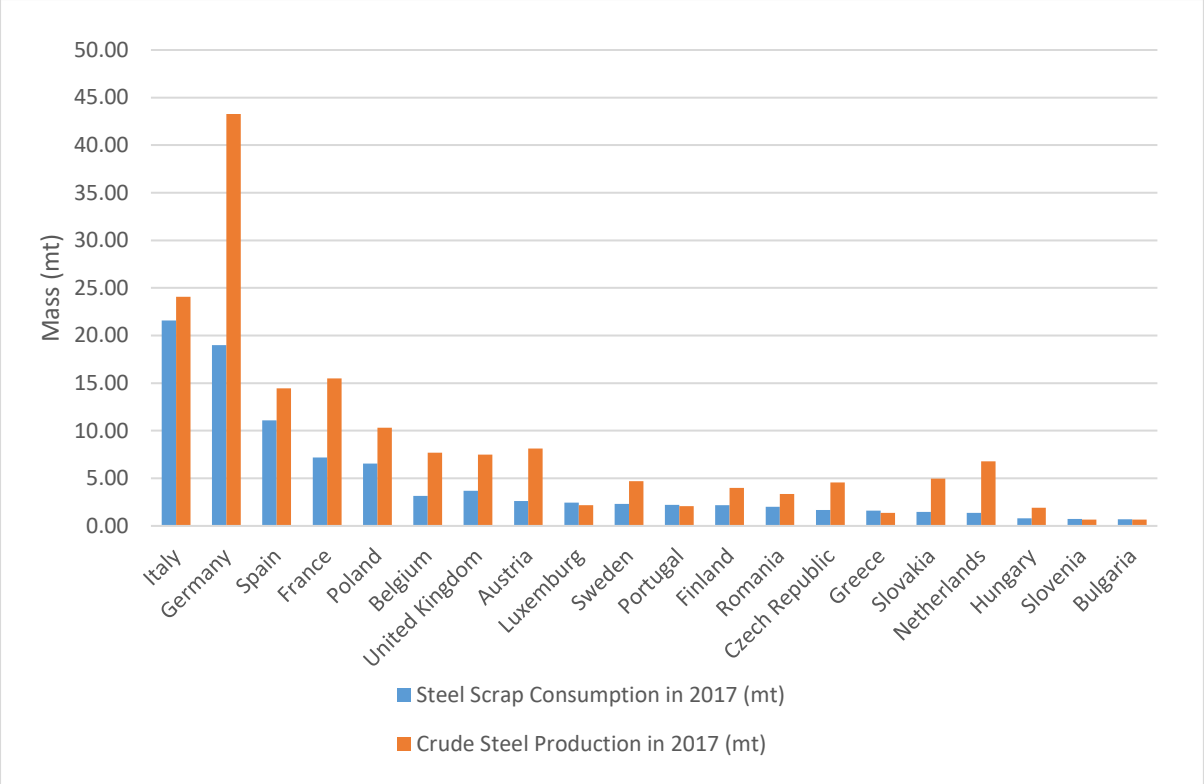

Figure 7: Scrap steel consumption and crude steel production in EU countries in 2017 [4]

Steel Sector in Scotland

Description of the Current Steel Sector (1)

Scotland does not produce a significant amount of crude steel. The largest steel plant in Scotland, Liberty Steel Dalzell (LSD) based in Motherwell, does not produce crude steel, LSD processes slab steel into steel plate. Progress Rail (part of the Caterpillar group) based in South Queensferry produces products for the railway industry from liquid steel but only on a small scale. Vallourec, based in Motherwell processes finished steel products (slab and strip) into tubular products for the oil and gas industry. Further information on each company is provided in section 3.2.

While Scotland is not a primary steel producer, it does consume a significant amount of steel for fabrication into other products as data for steel consuming markets, section 3.3, will show. The importance of steel to Scotland as a manufacturer is clear.

Primary Steel Processors in Scotland (1)

Focus on Liberty Steel Dalzell, Progress Rail and Vallourec

Liberty Steel Dalzell (LSD) is part of the Liberty House Group. Previously owned by Tata Steel UK, the plant was mothballed and closed in 2014, then acquired and reopened by Liberty Steel is 2016. LSD is a standalone business unit within the Liberty House Steel group. The Liberty House Group works across commodities, recycling, engineering, aluminium and steel production. The Liberty House Group has committed to the GREENSTEEL programme aimed at reinvigorating and decarbonising steel production in the UK as well as rebuilding downstream steel using engineering businesses [5]. The Liberty House Group has capability to recycle scrap steel into crude steel at its Stocksbridge based Speciality Steel business using an electric arc process.

LSD manufactures heavy steel plate from steel slab. Slab is sourced from British Steel's Scunthorpe plant and delivered by rail. The plate manufacture process requires reheating of the slab to approximately 1200^{o}C, then passing it through rollers which reduce the thickness of the slab (300mm) to that of a plate (typically less than 20mm) and increase the length and width, the plates are then further heat treated or left to cool before trimming to final shape for shipping. Plates are shipped to customers by road.

The majority of LSD's equipment is legacy equipment, typically installed in the 1950s. Steel processing equipment is very expensive, ranging from tens of millions of pounds for single pieces of equipment such as a rolling stand through to hundreds of millions of pounds for fully integrated systems such as a new electric arc furnace and rolling equipment for a new product. The high cost of equipment is a barrier to investment, steel companies cannot easily afford to purchase new large pieces of equipment, making investment difficult and infrequent.

LSD produces plate for structural, shipbuilding, off-shore and pressure vessel markets. LSD produces a wide range of plate strengths, the highest strength plate produced has a yield strength of 960 MPa. LSD data sheets suggest that most plates produced are in the 275 MPa to 460 MPa range. The highest strength plates are produced using a hot rolling and subsequent heat treatment process.

LSD has capability to produce 250,000 tons of plate per year, currently LSD is processing around 80,000 tons of plate per year.

LSD's main competitors are based in Korea, China, Sweden and the EU. The only domestic competitor is Spartan UK, part of the Metinvest Holding LLC group, Spartan UK both manufactures finished plate products and also trades in already finished plate that is imported from its other facilities outside of the UK. A significant portion of LSD's customers are plate stockholders, although LSD has recently started to work directly with customers, reducing the need for stockholders in the supply chain [6].

According to the latest Company House records LSD employs 172 employees with an average salary of £26,733. LSD's turnover in 2019 was £41.8m.

Progress Rail is part of the larger Caterpillar group and manufactures railway crossings and security bollards. The components that Progress Rail manufactures have high structural integrity and are made from crude steel produced in Progress Rail's foundry. Progress Rail operates two electric arc furnaces with associated secondary steel making capabilities for manganese and stainless steels. Progress Rail is capable of casting components up to 5 tons in weight, with maximum length and width dimensions of 8.2m and 1.3m respectively. Progress Rail's components are consumed within the UK and also exported to France, United States of America, South America, Australia and Hong Kong.

Progress Rail processes just under 6000 tons of steel per year. 50% of the steel used to produce crude steel comes from scrap, typical sources of steel are profile cuttings, sheared steel plates and construction H beams. A significant portion of the steel that is recycled into the products that Progress Rail makes comes from their own internal processes, recycling scrap from their own foundry processes. Progress Rail employs 120 people and has a turnover of £55M per year.

Vallourec Oil and Gas UK Ltd produces tubular solutions for energy, construction and engineering sectors. Vallourec Oil and Gas UK is part of the larger Vallourec group which produces tubular steel solutions for transport, construction, energy (including renewables and oil and gas), agriculture and engineering industries. Vallourec employs 203 people and has an average salary of £43,660. Over the period of 2017 to 2019 Vallourec have processed an average of 18.7 thousand tonnes of steel per year and have reported an average turnover of £48.3M.

Value of Steel Processing to Motherwell Area

LSD and Vallourec's manufacturing plants are very close to each other, both in the Motherwell area. In combination LSD and Vallourec directly employ around 375 people with an average wage of £35,196 (average wage for Scotland is £29,988). Assuming 70% of wage is taken home, direct employees could be worth as much as £9.24m to local employee's families. It can be assumed that LSD and Vallourec support a further 1125 people within their supply chains indirectly using a conservative estimate of one direct employee to three indirect employees [7].

Steel Using Markets in Scotland (5, 6, 7)

The major steel using markets in Scotland are shipbuilding, construction, aerospace, energy (including oil and gas) and general manufacturing. Table 1 shows data gathered for the major steel using market sectors in Scotland from 2017 (the most recent data reported) [8]. The data gathered represents the whole of the sectors, not where the sector directly uses steel. Oil and gas data is a subsection of the energy sector as a whole, but has been included separately due to its scale. The turnover per employee reflects the skill level required for the industry, higher skilled workers have higher salaries and make a greater contribution to the economy.

The total number of direct employees for all of the sectors combined is 266,500, indirect employees in the supply chains can be estimated at around 800,000 people, giving a total estimated working population for the steel using sectors of 1.06M people. The total working population of Scotland in 2018 was 3.48M. The summed turnover of the steel using markets from Table 1 is £74.6Bn, Scotland's total turnover in 2017 was £239Bn, and steel consuming markets represent 31.2% of Scotland's overall turnover. This shows the value of the steel using markets to the Scottish economy [7-10]. The types of steel used in each sector are shown in appendix 1.

Table 1: Market size data for the major steel consuming markets in Scotland [8]

Market*	Employees	Turnover (£m)	Turnover / employee (£m)	% of total Scottish turnover
Shipbuilding	7700	1556	0.20	0.7
Construction	137200	18374	0.13	7.7
Aerospace	4600	2293	0.49	1.0
Energy	67000	43817	0.65	18.31
Oil and Gas *	17800	7792	0.43	3.3
General Manufacturing§	50000	8558	0.17	3.6

* Oil and gas are included in energy for the total figures used for comparison with population and GDP, but given a separate line in the table for scale

§ Manufacture of Basic and Fabricated Metals, Machinery, Motor Vehicles and Other Transport equipment

Representative Steel Using Company Data (13,14)

A representative list of 373 steel using companies was analysed, the list was provided for analysis by the Scottish Government. The list of companies is not exhaustive but is representative of Scotland's steel using sectors. For each company the following actions were carried out:

1. The purpose of the company was checked to make sure it was a company that used steel as part of its primary manufacturing processes. If this was not judged to be the case, for example if a company was listed incorrectly or was actually a user of a different type of metal, it was removed from the list.
2. Companies House data was interrogated to extract the number of employees, the companies worth and where possible the companies turnover. A companies worth was taken to be its net asset value less its liabilities. Company turnover is only reported when a company is above a certain size, so is not available from Company House records for all of the companies in the list. Only 88 companies were large enough to report a turnover.
3. The postcode for each company was recorded and used to plot a geographical distribution.

From the list of 373 companies, 34 companies were removed, leaving 339 companies for consideration. The average company size from the list was 62 employees, the average company worth was £4.5M and the average turnover was £6.1M. The average data is heavily skewed by a few very big companies.

Figure 8 shows the distribution of companies by employee number, showing that 243 companies have 50 employees or below. There are two companies reporting more than 1850 employees, Caledonian Petroleum Services Ltd. and Global Energy Group Ltd.

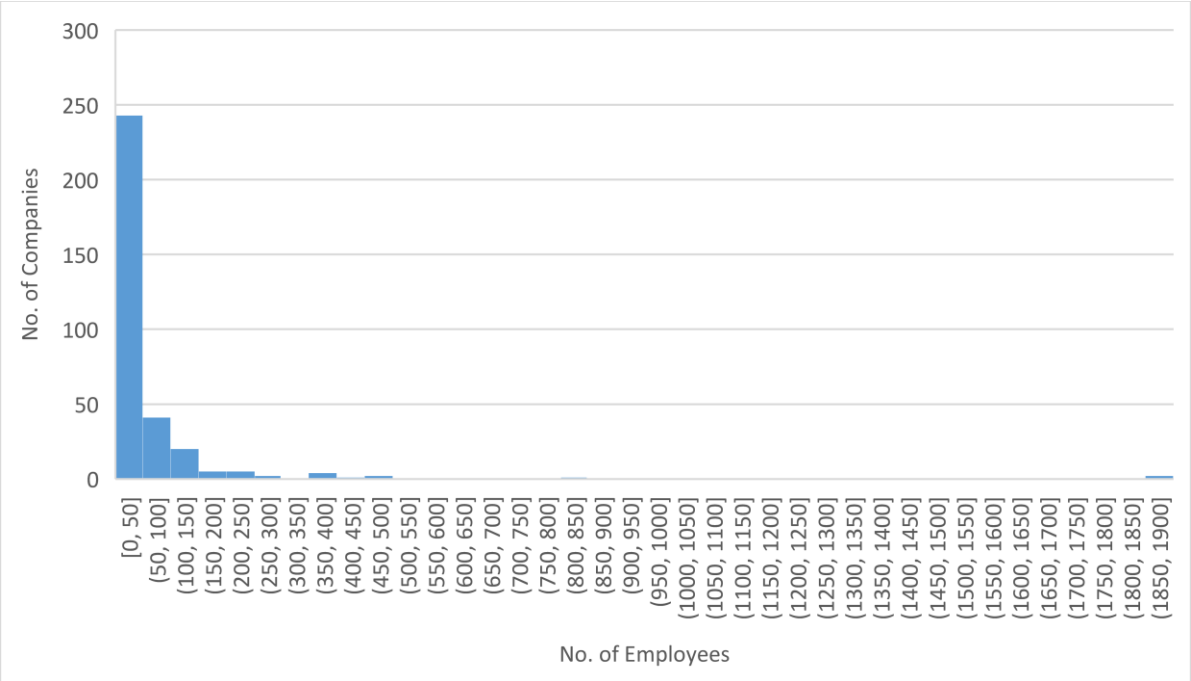

Figure 8: Company size distribution by number of employees

Figure 9 shows the distribution of company by its value (net assets minus liabilities). It can be seen that 283 companies have a value less than £5M. Two companies reports a worth of over £125M, Global Energy Group Ltd. and DRIL-QUIP (Europe) Ltd.

Figure 9: Company worth distribution (£M)

The data shown in Figure 8 and Figure 9 identifies that the steel using companies in Scotland are mostly small businesses. This is in agreement with general UK data for small businesses, where 99% of the total business population belongs to small businesses and small businesses represent 99.3% of all business in the UK [11].

The distribution of turnover value for the 88 companies big enough to report turnover is shown in Figure 10. The chart shows that the majority of companies report a turnover less than £15M, there are two companies reporting turnovers greater than £295M.

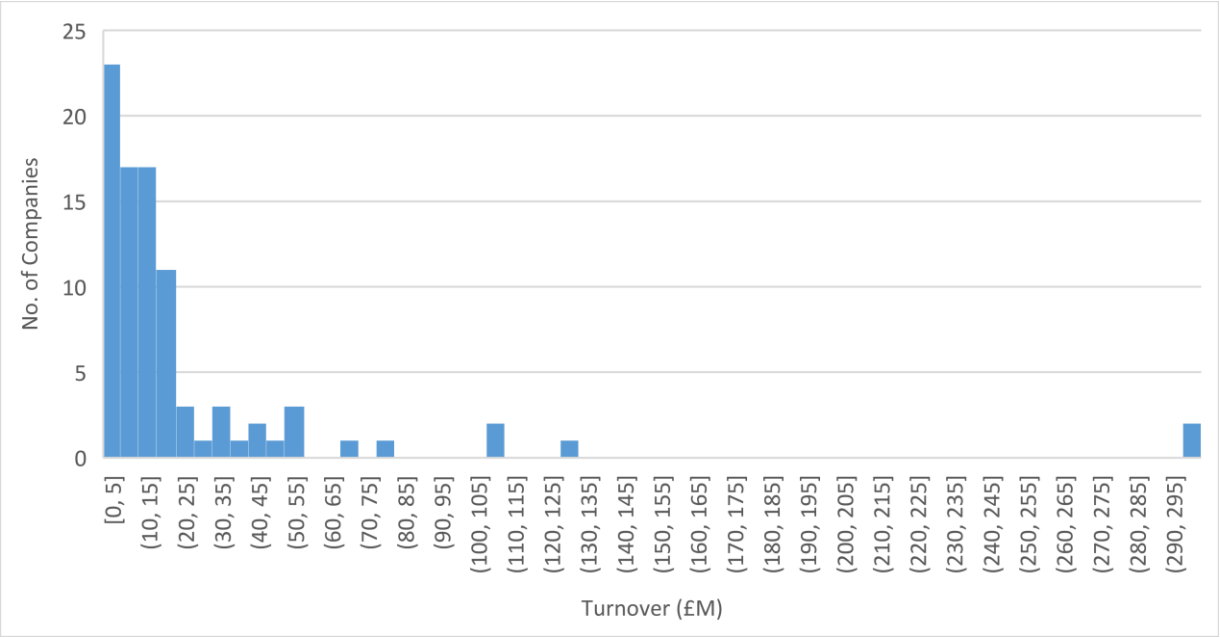

Figure 10: Company turnover distribution (£M)

Figure 11 shows the geographical distribution of the companies that were investigated. It can be seen that companies are generally based in and around Scotland's major urbanised areas of Glasgow, Edinburgh, Dundee and Aberdeen. No companies from this data set are present in the North West of Scotland. There are 202 companies in the Glasgow area, 41 companies in the Edinburgh area, 19 companies in the Dundee area and 55 in the Aberdeen area.

Figure 11: Geographical distribution of analysed companies in Scotland

Figure 12 shows the distribution of companies with a closer view of the major industrial areas, it can be seen that the Glasgow area hosts more companies than the other centres.

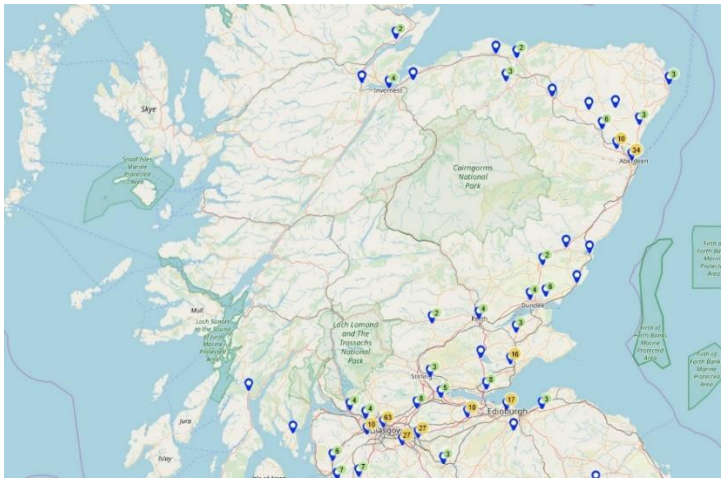

Figure 12: Geographical distribution of analysed companies in the centre of Scotland

Table 2 shows the numbers of companies analysed by standard industrial classification (SIC) code. It must be noted that a company's SIC classification is often a very broad descriptor of what the company

does. The SIC codes with the most companies listed against them are 24200 - Manufacture of metal structures and parts of structures (112 companies) and 25990 - Manufacture of other fabricated metal products (97 companies).

Table 2: Analysis of number of companies by SIC code

SIC Code	Number of businesses
06200 - Extraction of natural gas	1
09100 - Support activities for petroleum and natural gas extraction	1
16290 - Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	1
22220 - Manufacture of plastic packing goods	5
24100 - Manufacture of basic iron and steel and of ferro-alloys	16
24200 - Manufacture of tubes, pipes, hollow profiles and related fittings, of steel	6
24520 - Casting of steel	1
25110 - Manufacture of metal structures and parts of structures	112
25120 - Manufacture of doors and windows of metal	7
25290 - Manufacture of other tanks, reservoirs and containers of metal	8
25500 - Forging, pressing, stamping and roll-forming of metal; powder metallurgy	3
25610 - Treatment and coating of metals	5
25620 - Machining	44
25730 - Manufacture of tools	9
25920 - Manufacture of light metal packaging	1
25930 - Manufacture of wire products, chain and springs	5
25940 - Manufacture of fasteners and screw machine products	5
25990 - Manufacture of other fabricated metal products	97
38320 - Recovery of sorted materials	1
46150 - Agents involved in the sale of furniture, household goods, hardware and ironmongery	1
46720 - Wholesale of metals and metal ores	10

Major UK Steel Market Forecast Data (8)

Table 3 shows steel market forecast data for the UK from 2015 to 2030 by estimated tonnage and value. As a whole the demand for steel is forecast to increase by 1.55Mt by 2030, worth a total of £3.8Bn to the UK economy. The forecasts assume that domestic supply chains will not change and that the biggest boost will come from major infrastructure projects.

Areas of growth for steel consumption are:

- Construction – typically consuming hot rolled products such as rebar and H sections or cold rolled products such as building panels
- Machinery and engineering – typically consuming all types of steel but in particular castings for machine housings and high strength steels suitable for machining and cutting
- Yellow goods (earth moving equipment) – typically consuming hot rolled structural steel strips or plates and abrasion resistant steels
- Rails – typically consuming hot rolled high strength rail steels
- Other applications – consuming all types of steels, where growth is expected due to electrification and the use of electrical steels

The sectors where decreases in demand in the UK are forecast are the automotive and oil and gas sectors [12].

Table 3: UK steel market forecasts from 2015 to 2030 by tonnage and value [12]

	Tonnage (kt)				Value (£M)			
	Current demand	**Forecast demand**	**UK sales**	**Future opportunity**	**Historic demand**	**Forecast demand**	**Value of sales**	**Future opportunity**
	2015	2030	2015	2030	2015	2030	2015	2030
Construction	5554	6879	2539	4340	2003	3352	880	2170
Other applications	1510	1760	756	1004	654	1122	232	770
Automotive	711	645	285	360	348	471	120	293
Machinery and Engineering	538	611	304	307	226	349	116	194
Packaging	456	462	259	202	213	314	122	138
Oil and Gas	353	253	57	196	191	163	27	129
Yellow Goods	142	186	43	143	58	104	17	80
Rails	166	182	158	24	84	94	80	12
Total	9430	10978	4401	6576	3777	5969	1594	3786

Steel Import and Export Data (including comparison with UK) (2,3,5)

Overall Import and Export Data

Iron and steel import and export value data has been gathered using regional trade statistics (RTS) data and using standard international trade classification (SITC). RTS data includes iron and steel import and export data from all areas of the world but does not allow interrogation of specific product or steel types. SITC data allows import and export data to be gathered for different product types but does not include data from the EU. All tables and charts presented were constructed using data from custom made tables from the HMRC UK trade info website [13]. It is not possible to get information on the physical mass of steel that are imported and exported from individual UK countries.

Regional Trade Statistics (RTS) Data

Figure 13 shows iron and steel import data for UK countries from 2016 to 2019. Dashed lines from 2018 to 2019 represent incomplete data for the time period, only data until October 2019 was available at the time the data was accessed. Figure 13 shows that England imports more iron and steel than Scotland, Wales and Northern Ireland combined. The data shown does not reflect material crossing internal UK borders, for example steel may have been imported into England and crossed into Scotland. In 2018 the RTS data shows that £371.4M worth of iron and steel was imported into Scotland, in total the UK as a whole imported £6158M of iron and steel in 2018.

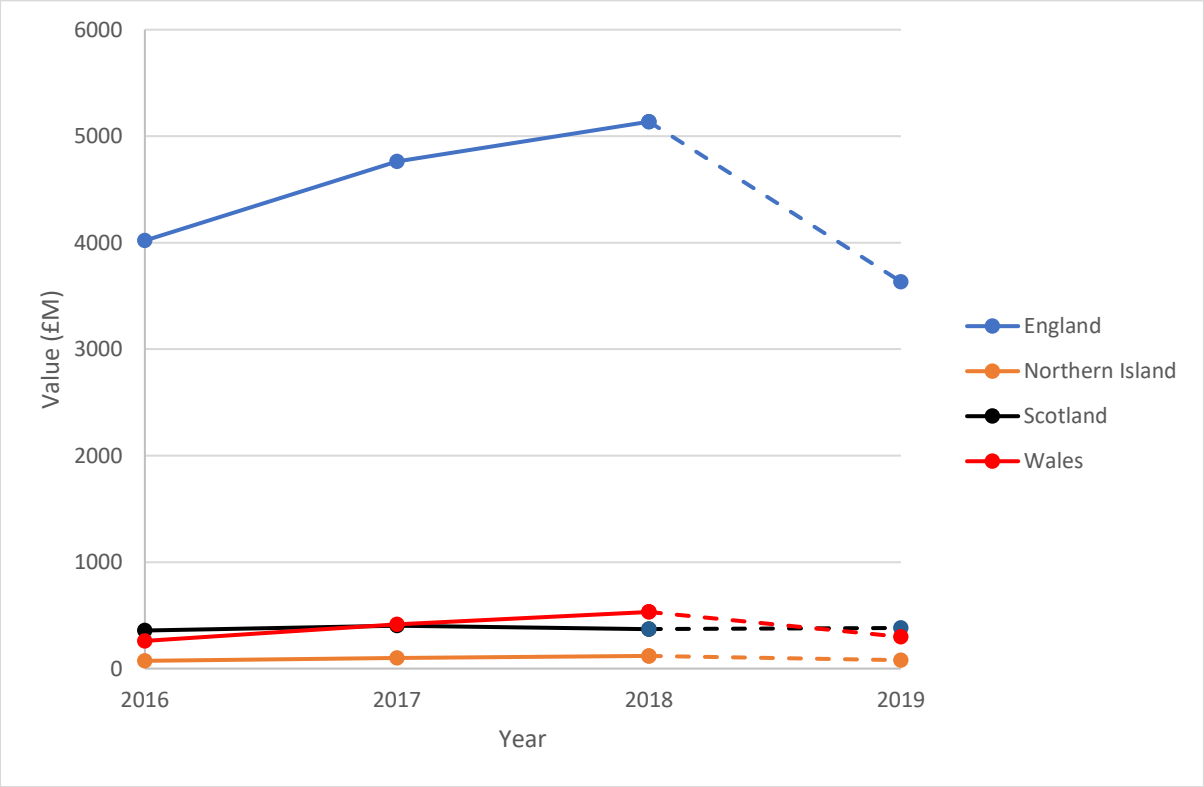

Figure 13: Iron and steel import data for UK countries from 2019 to 2019 from RTS data [13]

Figure 14 shows RTS export data for iron and steel for UK countries from 2016 to 2019. Dashed lines from 2018 to 2019 represent incomplete data for the time period, only data until October 2019 was available at the time the data was accessed. Figure 14 shows that England exported more iron and steel than Scotland, Wales and Northern Ireland, the data does not show where steel was moved across an internal UK border before being exported. Figure 14 shows that in 2018 Scotland exported £313M worth of iron and steel, the UK as a whole exported £4585M worth of iron and steel.

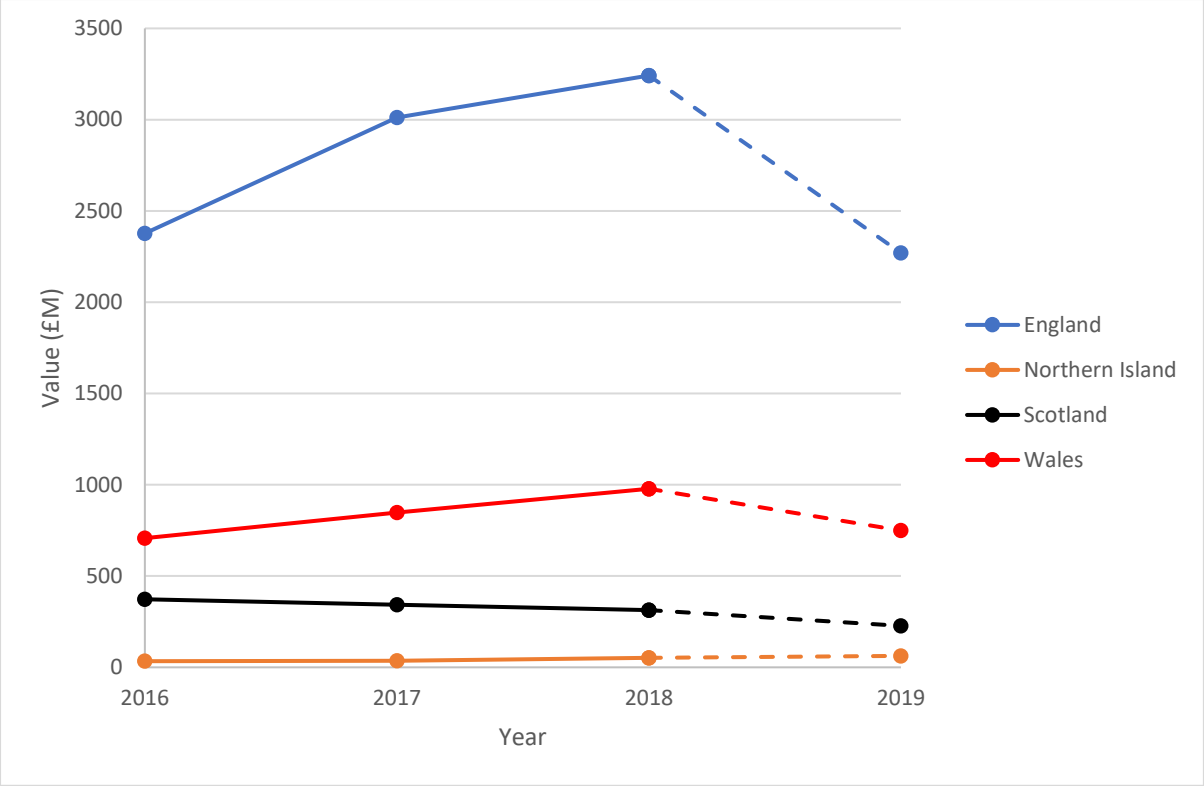

Figure 14: Iron and steel export data for UK countries from 2016 to 2019 from RTS data [13]

Figure 15 shows the iron and steel import and export values for Scotland from 2016 to 2019. The data shows that exports of iron and steel from Scotland have decreased and that imports have remained at around £375M for the time period.

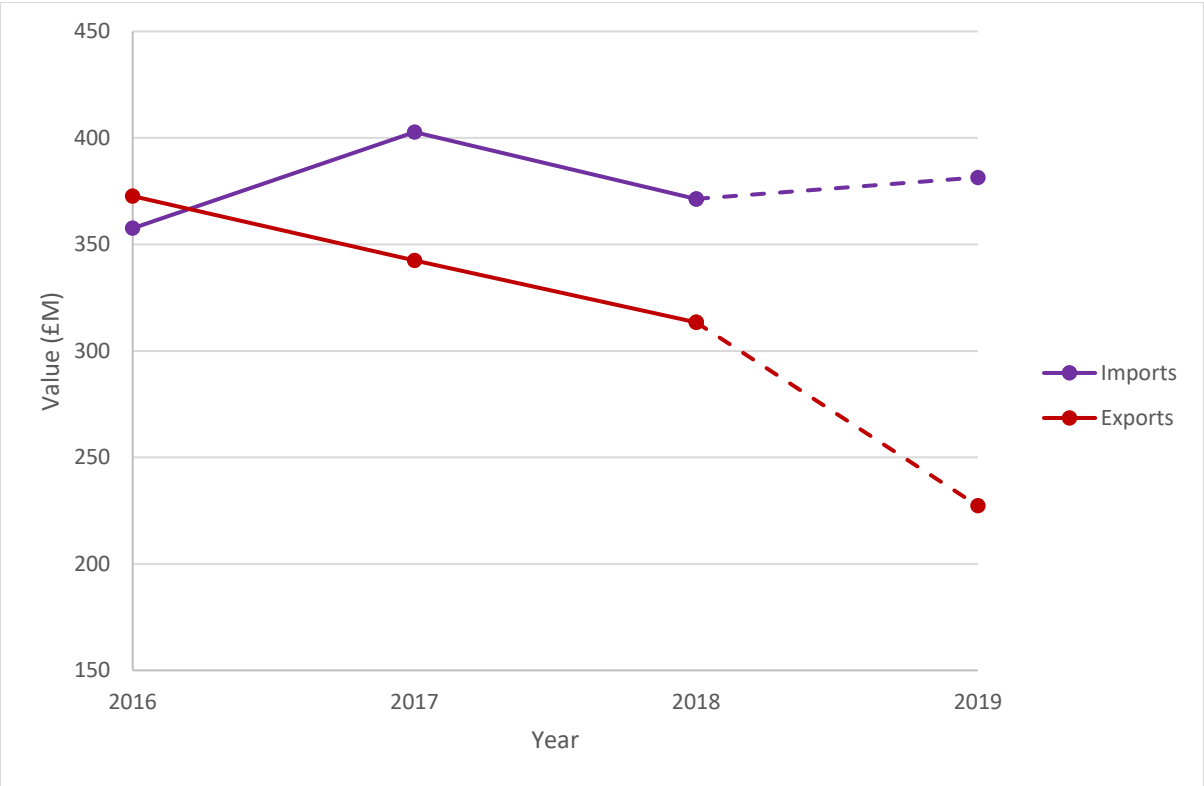

Figure 15: Iron and steel import and export data from 2016 to 2019 for Scotland only [13]

Standard International Trade Classification (SITC) Data

SITC data allows the reader to drill down into more detail with regard to the types of iron and steel that are imported and exported from UK ports and airports. SITC data does not include data for steel that is imported and exported to the main EU countries. As with the RTS data the data shown does not indicate where imported or exported iron and steel was finally used.

Figure 16 shows the import and export trends for Scotland using the SITC data. In 2018 Scotland exported £154M worth of iron and steel, the RTS data shows that Scotland exported £313M worth of iron and steel. The difference between the SITC and the RTS data figures is due to the EU not being included in the SITC data, it also suggests that the value of the EU to iron and steel exports for Scotland is £159M.

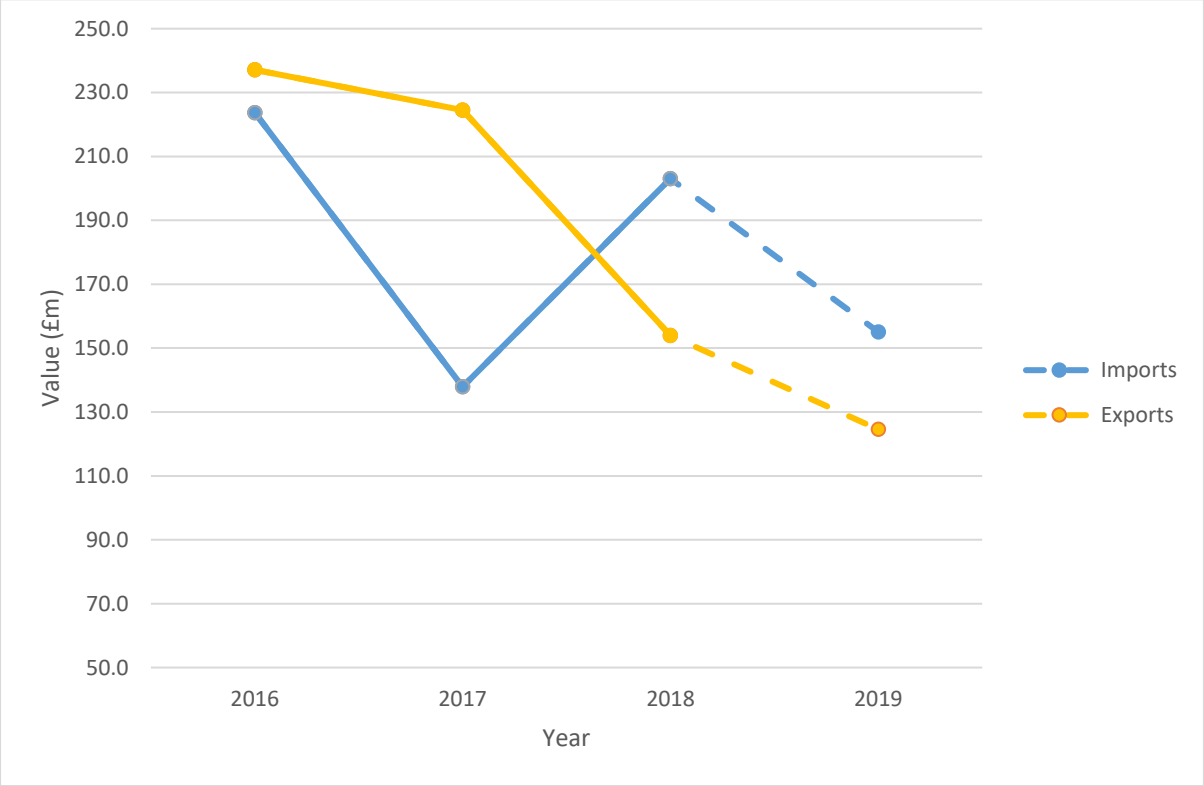

Figure 16: SITC import and export data for Iron and Steel from Scottish ports from 2016 to 2019 [13]

Figure 17 and Figure 18 show the countries with the greatest values for imports and exports respectively for Scotland from 2016 to 2019. Outside of the EU Norway has dominated both imports and exports for all Scottish iron and steel products, from 2016 to 2019 Scotland imported £224M worth of iron and steel from Norway and exported £317M worth of iron and steel products. This is likely connected to the needs of the energy industry which are shared by both countries.

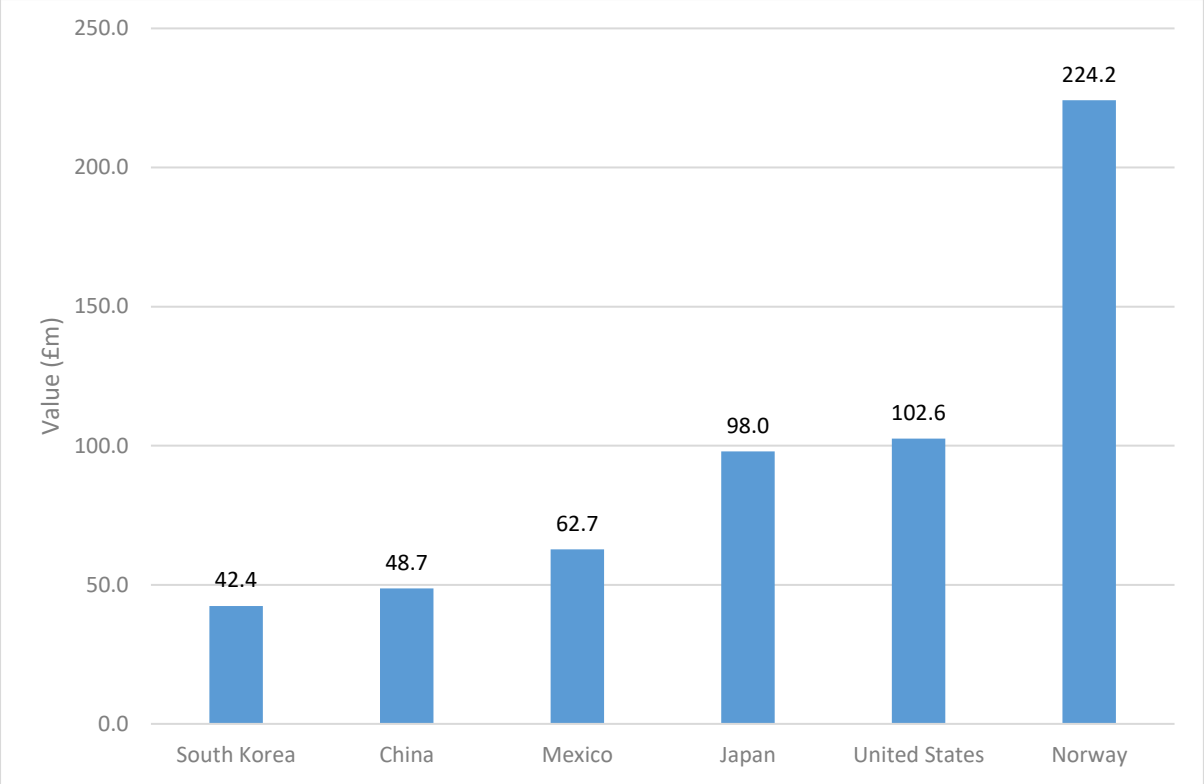

Figure 17: Non-EU countries with the highest import value of iron and steel for Scotland from 2016 to 2019

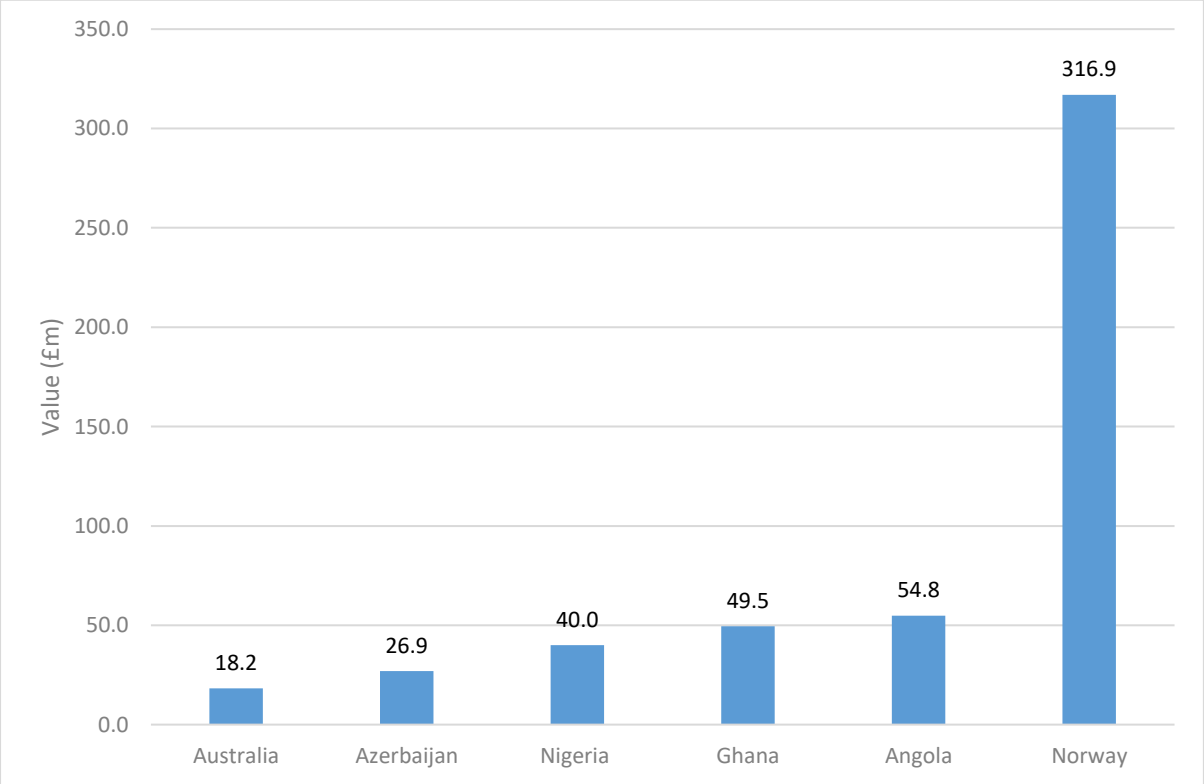

Figure 18: Non-EU countries with the highest export value of iron and steel for Scotland from 2016 to 2019

Table 4 shows the key iron and steel product data for imports and export for Scotland from 2016 to 2019. Import and export of heavy steel articles is much greater than that of flat rolled products and bar, rod and wire. The data does not show whether any product exported was made in Scotland or that any product imported was used in Scotland. The data shown in table 34 is in agreement with knowledge of the steel industry in Scotland, that Scotland produces very little steel but does use a lot of steel for manufacture. Norway's position of lead consumer and supplier of heavy steel articles supports previous import / export data shown in Figure 17 and Figure 18 and also supports the theory of iron and steel for the energy industry where final steel articles (whole structures and equipment) are used versus finished steel products like strip, plate and wire.

Table 4: Key products import and export data for Scotland from 2016 to 2019

	2016 (£M)	2017 (£M)	2018 (£M)	2019 (£M)	Lead supplier / consumer
Flat rolled products					
Imports	1.89	0.59	0.85	0.09	South Korea
Exports	2.01	2.93	3.24	1.45	Mexico, China
Bar, rod, Wire					
Imports	0.91	0.86	0.49	0.26	
Exports	0.60	1.60	1.07	1.00	USA, Norway
Heavy steel articles					
Imports	18.92	151.75	141.09	140.72	Norway
Exports	177.46	162.38	137.82	71.25	Norway

Brokered (scrapped) Steel in Scotland (4, 9)

The UK produces approximately 10M tonnes of scrap steel per year, Table 55 shows how that scrap steel is broken down by category. The category numbers are defined by UK scrap standards, the terms next to the numbers give examples of the sort of source that the scrap steel has come from to give relevance to how easy it is to recycle. The categories used in Table 5 have been used to represent the scrap types produced domestically and industrially in the UK and are based on the full set of categories used by the steel recycling industry [14]. The categories represent the chemistries and qualities of scrap that are available to be recycled.

The mass values in Table 4 are modelled using data from end of life steel arisings distributed by market sector (eg. construction, automotive, aerospace etc.) as well as scrappage and production rates to give categorised scrap masses for the UK. The data for scrap steel presented for Scotland has been estimated by scaling for population (Scotland has 8.2% of the UK's population).

Predicted data was then verified against the latest recorded scrap steel values for Scotland, showing that 754,467 tonnes of ferrous steel scrap steel was produced in 2017. The discrepancy between the total ferrous scrap predicted in Table 5 for Scotland and that reported in 2017 is likely due to the tonnage in category 8A, which is not necessarily included in waste reporting.

Table 5: Estimated steel scrap produced in the UK and Scotland [15]

Scrap Category	Mass produced in UK (kt)	Mass produced in Scotland (kt)
0A - Demolition	1054	86
1 - Thick old	2145	176
2 - Thin old	1468	120
3B - Fragmented	2851	234
6A - Cans & incinerated	760	62
7A - Turnings	110	9
8A - Manufacturing off cuts	1040	85
9A - Old cast iron and rail	422	35
9D - Brake discs and wheel drums	100	8
12A - New cast iron	50	4
Total	10000	820

Categories 0A, 1, 2, 3B, 6A and 7A are the lower quality scrap grades that can be recycled into basic construction grade steels. Table 55 shows that Scotland produces about 687kt of scrap steel that would fit into those categories.

Table 6 shows scrap steel export amounts and destinations for scrap steel in 2017 and 2018. The UK exported 7.03Mt of scrap steel in 2018, an increase of 0.9% from 2017. The bulk of the UK's scrap steel is bought by Turkey where it is consumed in EAF processes for the production of flat steel products. Turkey has successfully implemented the mini-mill concept with Colakoglu Metalurji leading the way in economical production of steel products from scrap steel by EAF mini-mills [16].

Table 6: UK steel scrap export amounts and destinations for 2017 and 2018 [4]

Exporters	2018 (Mt)	2017 (Mt)	% Change	Biggest Buyers	2018 (Mt)	% Change
United Kingdom	7.03	6.97	+0.9	Turkey	2.52	-19.0
				Pakistan	1.05	+9.1
				Egypt	0.86	+4.1
				India	0.70	+38.7
				Bangladesh	0.55	+82.9
				Indonesia	0.41	+472.2

The British Metals Recycling Association lists 43 registered metal recycling yards in Scotland. The geographical positions of those yards are shown in Figure 19, the geographical distribution of the recyclers follows, as expected, the geographical distribution of steel using companies.

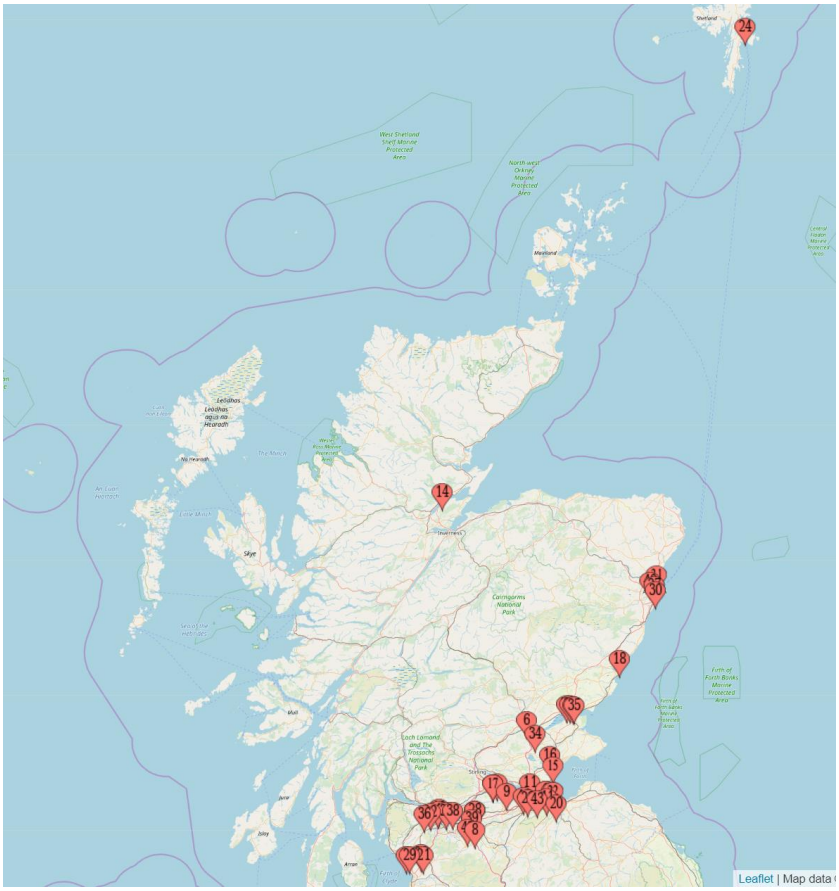

Figure 19: Geographical position of metal recycling yards in Scotland

Domestic / Global Trends for Steel (10, 11)

Steel use is linked to population growth, as populations increase, so does the amount of steel required. The world's population is forecast to increase from 7.7Bn people in 2020 to 9.7Bn people in 2050. In association with this population increase will come rapid urbanisation, with the need for buildings and infrastructure to grow worldwide. Steel plays a key role in construction and infrastructure.

Buildings are reliant on steel for structural components, large buildings are typically made from steel sections (H and U sections) which are then clad in concrete or steel skins. Increasingly roofs and walls of buildings are being covered in steel cladding as it is durable, strong, efficient and easy to replace. Building foundations, usually made from concrete are reinforced using steel bars (rebar). As the number of buildings required increases, so will the amount of steel required. From 2017 to 2024 the global rebar market was forecast to grow by 6.9%, to a market value of £171.5Bn [17, 18].

Transport network infrastructure is heavily dependent on steel for bridges, tunnels and rail tracks. Transport infrastructure is supported by associated buildings such as airports, train stations and fuelling stations. 60% of the steel used in infrastructure is rebar, the rest is sections, plates and rail track [18]. Examples of current major UK infrastructure projects include HS2, Crossrail and Birmingham's Big City plan.

With increasing population comes the need for more energy to power buildings, transport, equipment and lighting. It is forecast that there will be a 30% increase in global energy demand by 2040. As the world moves away from fossil fuels towards renewable energy steel will need to be used in new ways to help provide power to the world. Steel is used in all areas of renewable energy including biomass, solar, hydroelectric, wave or tidal and wind power. Steel is the main material used in the manufacture of on and off shore wind turbines, the majority of components in a wind turbine are made from steel. Steel wind turbine towers are typically made from plate which is cut, shaped, drilled and painted before assembly [19, 20]. As well as the growth in renewable energy there will to be an increase in nuclear power generation, with predictions that energy provision from nuclear power could grow by as much as 67% by 2040. Nuclear power stations are heavily dependent on steel for their construction, high strength, high alloy steels are required for reactor componentry and construction grade steels are required for buildings and power station infrastructure [21].

Globally the need to decarbonise transport is driving the agenda for electric vehicles. Electric vehicles and the infrastructure to support them represents a significant growth opportunity for steel supply. Demand for high strength automotive steels is forecast to increase by 42.6Mt to the European car market alone by 2050 to allow electric vehicle manufacturers to produce lightweight electric vehicles in the most cost effective way. Demand for specialist high silicon electrical steels that are used in generators and electric motors is forecast to increase at around 7% a year, the global market for electrical steel is forecast to exceed £32.1Bn by 2024 [22, 23].

Decarbonisation and more efficient use of energy is driving a move towards a more circular economy where steel is reused before scrapping and recycling. Steel as a material that is easily remanufactured, reused and recycled will play a permanent role at the heart of the circular economy. The impact of circular economy on steel production will be less crude steel produced from raw materials as greater amounts of crude steel will be produced from recycled scrap. Steel will be in service for longer periods, a steel component may see several service lives before being finally scrapped and recycled. Circular economy presents new industrial market opportunities both in and around the steel design, manufacturing and recycling sectors. The exact impacts on steel markets are not yet known as the circular economy journey is only just beginning [24].

Crude steel manufacture is shifting away from the traditional integrated process of BF and BOF to EAF. The trend for this is related to the energy cost per ton of crude steel produced by integrated processes versus EAF processes. Generally speaking EAF processes require less energy per ton and rely purely on electricity to make crude steel from scrap steel. Integrated BF and BOF processes rely on the production of pig iron from coke and iron ore which is then reduced into crude steel in a BOF. EAF steel making can use up to 100% scrap steel, whereas integrated BF and BOF processes can only use up to 30% scrap steel. EAF processes use about 10% of the energy required for the integrated BF and BOF process and have the benefit of using scrap steel as a raw material [25, 26].

Steel manufacturers in the UK face some generic barriers that restrict their ability to expand:

- High cost for capital equipment - The scale of steel making equipment makes it prohibitively expensive, with equipment costs ranging from tens of millions of pounds for single pieces of equipment to hundreds of millions of pounds for integrated steel making plant.
- Legacy equipment – Steel manufacturing in the UK often takes place using equipment that is over 50 years old, is hard to upgrade and replace. Legacy equipment can make it difficult to produce steel that is competitive on a global scale where it is competing against new equipment. New steel making equipment is stronger, can process material faster and requires less energy to operate.
- High energy costs in the UK- Energy pricing in the UK is comparatively high compared to other steel manufacturing countries. In 2018 the industrial energy price in the UK was 10.03p per kWh, in the Netherlands it was 5.27p per kWh, in the USA it was 4.95p per kWh, on average the UK's energy costs are 49.1% higher than other industrialised countries. Steel manufacture is energy intensive, high energy costs make it difficult for UK steel manufacturers to manufacture steel that is competitively priced [27].
- Regional advantages – State sponsored steel manufacturing has served to distort international steel markets and provide a significant amount of over-capacity of steel across the world. China and Turkey's steel manufacturers have both received significant subsidies helping them expand and maintain steel production even when local demand has fallen away. In 2016 the Chinese government was reported to have ownership interests in 18 of China's 20 major steel manufacturers. The result of this has been an over capacity in excess of 500Mt. Overcapacity has meant that vast amounts of steel has been pushed into the open market at extremely low prices that UK based steel manufacturers struggle to compete with [28].

Opportunities for the Scottish Steel Sector (12,15)

It is clear from the data gathered that steel plays an important part to the Scottish economy. Steel is embedded in Scotland's manufacturing sector and steel has played an important part in Scotland's history. However, steel production is now a fraction of what it was with very little crude steel being produced in Scotland. To secure a future for steel in Scotland current market and manufacturing trends need to be considered as well as how competition from steel manufacturers foreign to Scotland impact the position. This report does not consider the effects of any of the interventions listed.

Three potential opportunities for the steel sector in Scotland are: direct investment into steel making capability and / or support for Scottish steel supply chains and / or investment into skills to support the sector.

Direct Investment into Steel Making Capability

What could this achieve?

- Manufacture of new steel types in Scotland
- Expansion of current steel making capability
- Reduction of operating costs for steel makers and processors

Potential options for direct investment:

1. Investment in current plant to expand capacity and existing capability, for example working with an existing steel manufacturer to identify where new, upgraded or replacement capital equipment would significantly boost productivity.

   The advantages of this sort of investment could be:
   - Bolsters already existing manufacture of steel
   - Enables current products to be made more cost effectively as new equipment will be cheaper to operate and have a higher throughput
   - Enables lower energy steel processing, with a lower CO2 cost
   - Works with already existing supply chain and customer demands
   - Removes the reliance on legacy equipment
   - Puts state of the art equipment into Scottish steel manufacture
   - Reduces operating risk through the provision of more reliable equipment

   The disadvantages of this sort of investment could be:
   - Does not necessarily introduce new steel manufacture into the Scottish economy
   - Does not necessarily broaden the product portfolio for a given company
   - Does not address the underlying issues of high energy costs and foreign competition
   - Does not necessarily increase direct employment in a given area as equipment may replace already existing equipment, not add to current capacity

2. Investment into EAF steel making technologies for crude steel production of commodity steel grades:

   The advantages of this sort of investment are:
   - Could make use of local scrap steel resources
   - Establishes new supply chains for Scottish steel into steel using markets that are no longer supplied, recycling of scrap steel into construction steels for UK infrastructure projects as an example
   - There is enough scrap steel produced in Scotland to supply an EAF mini-mill
   - Over 70% of Scottish energy supply comes from renewable energy [29], this combined with steel recycling would mean steel production at a low carbon cost to the environment
   - There is a growing UK and global market for structural and construction steels, the majority of which could be made from the EAF process
   - Immediately increases direct and indirect employment during construction of the EAF, its ancillary equipment (furnaces, rolling equipment etc.) and infrastructure.
   - Permanent employment increase in the long term.

   The disadvantages to this sort of investment:
   - Very high cost, estimates for EAF mini-mills are between £300M and £400M
   - Needs a significant amount of land and infrastructure (would need to be constructed on a site that already had a significant amount of supporting infrastructure)
   - Supply chain economics for scrap steel to new EAF plant are unknown
   - Infrastructure to supply large amounts of scrap steel to a new EAF facility does not currently exist and would need to be considered
   - Current technology limits the types of steel that can be made through the EAF process
   - Energy costs in the UK are high, EAF steel production relies on electricity for energy

Support for Scottish Steel Supply Chains

Measures could be taken to reduce the cost of manufacturing steel and fabricating products from steel. These measures could include:

- Reducing or capping energy costs for industry
- Providing incentives for purchase of domestic steel over imported steel

The advantages of these sorts of interventions are:

- Makes steel supply chains in Scotland (and the wider UK) more sustainable for the future
- Reduces the cost of steel manufacture, making Scottish steel more competitive in domestic and global markets
- Reduces operating costs for current Scottish steel manufacturers, enabling greater cash flow and enabling self-investment
- Can be applied across industry, benefitting the entire length of a supply chain fairly
- Allows already existing companies to grow more easily and increase direct and indirect employees
- Enables steel manufacturers to target growth areas for current products more aggressively

The disadvantages of these sorts of interventions are:

- Practical, economic and legal implementation may be impossible
- The economic and employment impacts of the intervention may take a long time to be realised and may be hard to measure
- Does not immediately or directly address any global trend for steel manufacture or use

Skills to Support the Scottish Steel Sector

There is a recognised shortage in technical skills to support manufacturing in the UK. The skills needed cover areas such as engineering, digitalisation, automation, data security and data analysis [30, 31]. There is an opportunity to invest in skills that support Scottish manufacturing.

The benefits of this could be:

- Secures supply chains for the future
- Increases productivity
- Pushes more high skilled workers into the market place, increasing the average salary for the manufacturing sector in Scotland

The disadvantages could be:

- No guarantee that workers educated in Scotland will stay in Scotland or work in the steel sector
- Represents a longer term economic benefit

Acknowledgements

Dr. Stephen Spooner, Research Fellow and Dr. Zushu Li, Reader, WMG Advanced Steel Research Centre

Professor Janet Godsell and the Operations and Supply Chain at WMG

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Appendix 1: Steel Markets and Typical Steel Consumption

Steel markets in Scotland and the typical steel types consumed by description, RTS and SITC code:

Market	RTS Code	SITC code	Steel Type
Shipbuilding	6	7209, 7211, 7213, 7214, 7215, 7216, 7217, 7225, 7226, 7227	Flat hot-rolled steel >= 600mm (not stainless), Flat cold rolled steel >= 600mm (not stainless): Flat hot and cold rolled steel < 600mm (not stainless): Bar and rod, hot rolled, not stainless, irregularly wound: Bar and rod, hot worked, not stainless, twisted after rolling: Bar and rod, hot then cold formed, not stainless: Shaped sections, not stainless: Non-stainless steel wire: High-alloy non-stainless hot or cold rolled flat product >= 600mm: High-alloy non-stainless hot or cold rolled flat product <= 600mm; High-alloy non-stainless bar and rod irregularly wound
Construction	6	7209, 7211, 7213, 7214, 7215, 7216	Flat hot-rolled steel >= 600mm (not stainless): Flat cold rolled steel >= 600mm (not stainless): Flat hot and cold rolled steel < 600mm (not stainless): Bar and rod, hot rolled, not stainless, irregularly wound: Bar and rod, hot worked, not stainless, twisted after rolling: Bar and rod, hot then cold formed, not stainless: Shaped sections, not stainless
Aerospace	6	7216, 7225, 7226, 7227, 7229	High-alloy non-stainless hot or cold rolled flat product >= 600mm: High-alloy non-stainless hot or cold rolled flat product <= 600mm: High alloy steel wire: Stainless steel shaped sections: High-alloy non-stainless bar
Energy	6	7209, 7211, 7213, 7214, 7215, 7216, 7217, 7225, 7226, 7227	Flat hot-rolled steel >= 600mm (not stainless): Flat cold rolled steel >= 600mm (not stainless): Flat hot and cold rolled steel < 600mm (not stainless): Bar and rod, hot rolled, not stainless, irregularly wound: Bar and rod, hot worked, not stainless, twisted after rolling: Bar and rod, hot then cold formed, not stainless: Shaped sections, not stainless: Non-stainless steel wire: High-alloy non-stainless hot or cold rolled flat product >= 600mm: High-alloy non-stainless hot or cold rolled flat product <= 600mm
Oil and Gas	6	7209, 7211, 7213, 7214, 7215, 7216, 7217, 7225, 7226, 7227	Flat hot-rolled steel >= 600mm (not stainless): Flat cold rolled steel >= 600mm (not stainless): Flat hot and cold rolled steel < 600mm (not stainless): Bar and rod, hot rolled, not stainless, irregularly wound: Bar and rod, hot worked, not stainless, twisted after rolling: Bar and rod, hot then cold formed, not stainless: Shaped sections, not stainless Non-stainless steel wire: High-alloy non-stainless hot or cold rolled flat product >= 600mm: High-alloy non-stainless hot or cold rolled flat product <= 600mm
General manufacturing	6	7206, 7207, 7208,	Flat hot-rolled steel >= 600mm (not stainless): Flat cold rolled steel >= 600mm (not stainless): Flat hot and cold rolled steel < 600mm (not stainless): Bar and rod, hot rolled, not stainless, irregularly wound: Bar and rod, hot

		7209, 7211, 7213, 7214, 7215, 7216, 7217, 7218, 7225, 7226, 7227	worked, not stainless, twisted after rolling: Bar and rod, hot then cold formed, not stainless: Shaped sections, not stainless: Non-stainless steel wire: High-alloy non-stainless hot or cold rolled flat product >= 600mm: High-alloy non-stainless hot or cold rolled flat product <= 600mm: High alloy steel wire: Stainless steel ingots, slabs, billets: Non-stainless steel ingots, slabs, billets