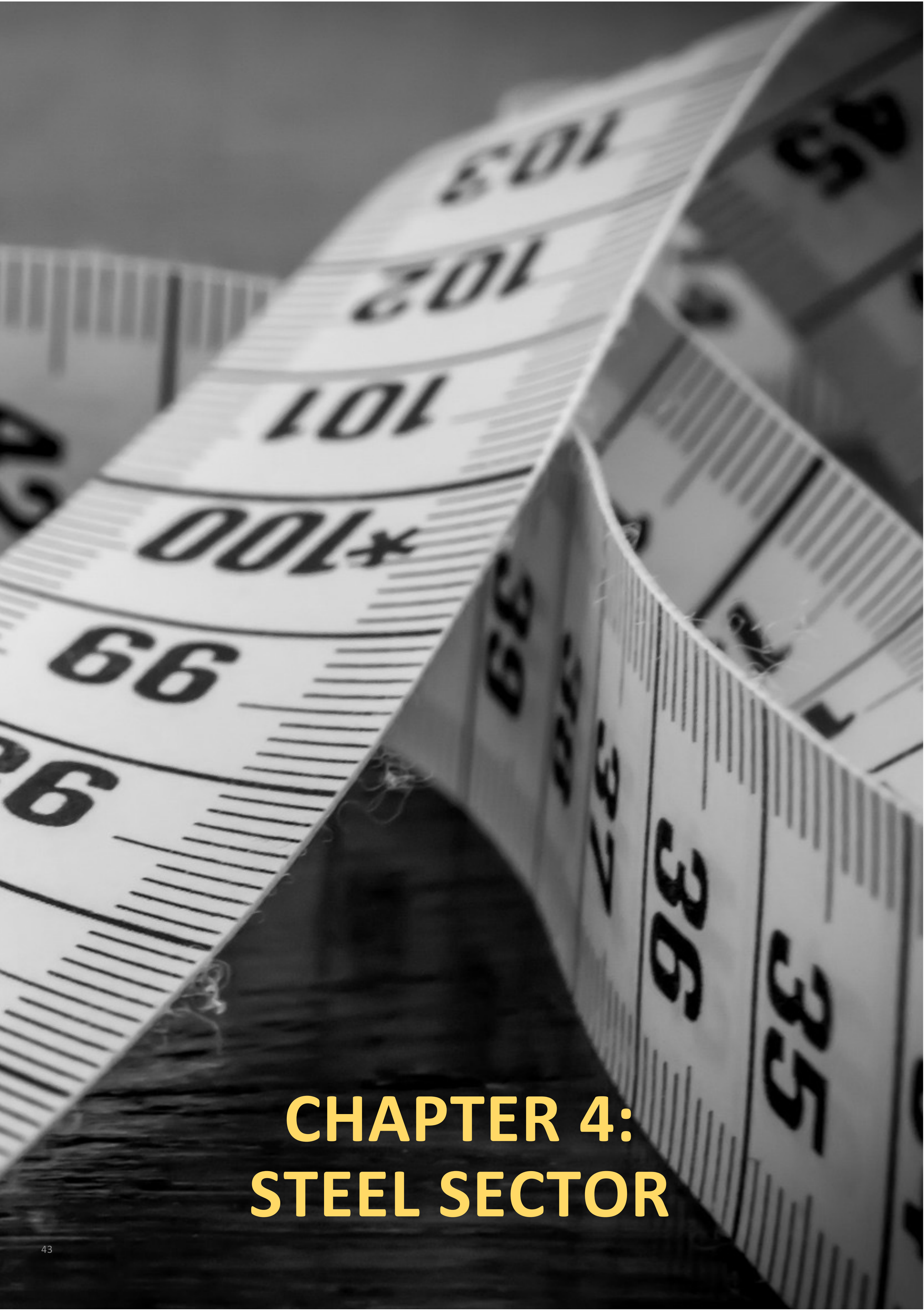


CHAPTER 4: STEEL SECTOR

4 STEEL SECTOR

GENERAL OVERVIEW

After chemicals, the iron and steel sector represents the second largest industrial energy consumer globally. It amounts to 20% of industrial consumption of energy. Furthermore, it emits the largest industrial amount of CO_2 if the process emissions of coke ovens and blast furnaces are also taken into account (Wortswinkel & Nijs 2010). The sector is currently only affected by the energy transition to a limited extent due to its organisation into diverse associations whose strong negotiating power has led to a high share allocation of free certificates in regions such as the European Union.

The transition risk story for the steel sector articulates itself along a few trends:

- **Growth of the Electric Arc Furnaces (EAF) production route**. Due to an improvement in recycling and circular economy, more scrap steel will be available, which is required to apply EAF more widely.

- **Incremental technological changes with short payback times**. Profitability of steel companies is low and therefore large investments in emission reduction measures are considered unrealistic. Selected measures (e.g. efficiency measures and heat recovery) and some technologies (e.g. Top Gas Recovery for Blast Furnaces (TGRBF) may see increased deployment in the next years, due to their emission savings potential of 20% to 30%. Its implementation is even foreseen in scenarios without policy subsidies.

- **Increased quality requirements and growing demand for specialized steels**. Increased quality requirements and demand for specialised steels, such as composite materials and high ductility steel for the automobile industry, will arise more and more in the future.

The scenario involves the following parameters:

PRODUCTION & TECHNOLOGY	
Crude Steel production (Mt) Share of primary/secondary steel (%) Energy Intensity (GJ / t crude steel)	Carbon Intensity (t CO_2 / t crude steel)
MARKET PRICING	
Crude steel price (USD/ton) Raw material prices (USD/ton)	
POLICY MANDATES, INCENTIVES & TAXES	
Allocation of free CO_2 allowances (%)	

5 THINGS BEFORE GETTING STARTED

1. **Carbon Leakage Issues.** The steel industry plays a significant role for industrial countries. Steel often stands at the beginning of many industrial and engineering products such as machines, tools, cars, ships, bridges and buildings and can enable future low carbon technologies to come. Iron and steel production is perceived as an integrated and significant part of industrial nations' economies. Steel associations often point out that carbon leakage, i. e. the relocation of carbon-intensive production into an area not covered by CO_2 emission trading schemes or CO_2 taxes, could have a significant impact on the competitiveness of affiliated industrial sectors, as transportation distances lengthen and benefits of long-term built mutual trust is lost.

2. **Steel Oversupply.** The global financial and economic crisis has pushed the world steel industry into recession and the steel industry is still just slowly recovering. Global steel production almost doubled in less than a decade at the turn of the century due to a massive capacity increase in China, Brazil and India. The combination of oversupply and a sharp contraction of global steel demand led to a drop in the steel price which resulted in zero or even negative profit margins for steel production. As a result, steelmakers have introduced major production cuts and trade of steel has declined dramatically. In the ongoing aftermath of the crisis, steelmaking capacity continued to increase despite the market downturn.

3. **Energy Intensity of Steelmaking Processes.** There are three major routes to produce steel, i.e. oxygen or primary route, electrical or secondary route and Direct Reduced Iron (DRI). On the global level, around 70% of steel is produced via the oxygen or primary route. This route uses coke (from coal) and iron ore and is carbon intensive. Around 25% of the steel is produced via the electrical or secondary route. Here, electric arcs are used to melt steel scrap which requires only one third of the energy and with only a fourth of the direct CO_2 emissions per ton of crude steel in comparison to the oxygen route. 5% is produced as DRI. It is the most recently developed route and requires iron ores and high amounts of natural gas, which is why it is usually located in areas of cheap gas (e.g. USA, Middle East). The transition to a low carbon economy will require scaling production of the secondary route.

4. **Carbon Intensity of Steelmaking Processes.** Oxygen or primary steel is the most common type of steel but it is also the most carbon-intensive of all production routes. Without accounting for external effects, it has the lowest production costs as coal and iron ore can be imported comparatively cheaply. Besides energy-related CO_2 emissions, reducing iron ore (mostly iron oxide) to iron is associated with process-related CO_2 emissions. New and capital-intensive production processes or CCS are required to abate process-related CO_2 emissions.

5. **Steel Types Substitution.** The substitution of primary to secondary steel seems a viable option to abate CO_2 emissions. However, the substitution is limited to two factors: the availability of steel scrap, which serves as an input material, and the demand for special steel, as some processes require a high level of purity of steel which only the oxygen route or DRI are able to produce. The availability of scrap depends on price, recycling infrastructure and the amount and lifetime of steel products.

4.1 STEEL PRODUCTION

Overview. Steel is (currently) one of the major building blocks of modern society. It is widely used in buildings (e.g. reinforced concrete), infrastructure (e.g. bridges), vehicles, machinery and tools. Steel demand is often positively correlated with GDP. Additionally, steel will be needed to satisfy the demand of low carbon technologies such as wind turbines, rail transport, district heating and CCS. Over the last 25 years, global crude steel production has more than doubled. The increasing global population and GDP suggest an increase in the demand for steel which will require more ambitious CO_2 intensity reductions to meet the climate targets.

Risk pass-through mechanism. The massive increase of steel production capacity in Brazil, China, Russia and India over the last decade added to the effects of the global economic crisis, resulted in falling crude steel prices in 2009 and 2010. These factors lowered utilization rates and increased pressure on revenue margins of traditional steel producers in Europe and USA. Current and future overcapacity will continue to play an important role for steel producers in terms of revenue margins and capacity utilization.

Sources. Scenarios present inputs around crude steel production generally at macro-level (e.g. IEA 2016, Greenpeace 2015). As an example, in IEA's ETP global crude steel production is given on a global level and on aggregate level for OECD and non-OECD countries. As the future demand is associated with high uncertainties, other studies tend to give results according to different demand patterns. For example, Morfeldt et al. 2015 assume a stagnating global steel demand in the long run (e.g. 2050 and beyond).

Method. In line with the IEA ETP scenario, the same global steel demand and steel production is assumed in both the ACT and LCT scenarios. The process to compute the estimates is the following:

- Current global and country-specific steel production are taken from World Steel Association (2016) statistics.
- Production of USA, Mexico and Brazil are forecasted using their respective regional production growth (i.e. Latin-America, OECD) from ETP 2015 until 2025.
- Production pattern of USA, Mexico and Brazil between 2015 and 2025 (e.g. USA steel production increase less compared to Mexico's production) is estimated in relation to the global steel production of ETP 2016 until 2040.
- The crude steel production of Germany, France and Italy is forecasted following a linear relation to the prospective sectoral GDP growth of each country until 2040 according to the EU Reference Scenario Trends to 2050 (EC 2016).

Results. Crude steel production will continue to increase steadily over next 35 years of a global level. The growth rate, however, is expected to be lower in comparison to the significant increase observed during the last 25 years. Production increase varies significantly among regions. While European steel production is more or less stagnating, even decreasing in France, Brazil and Mexico continue their momentum and are expected to increase steel production by more than a third until 2040. During the same period, US steel producers are set to recover and surpass production levels of 2015 in 2040. It is important to highlight that for 2015, 87% of the global steel is produced outside the countries in focus. By 2050, the share increases to 89%.

TABLE 4.1 GLOBAL AND COUNTRY-SPECIFIC CRUDE STEEL PRODUCTION (MT) FOR BOTH SCENARIOS (SOURCE: AUTHORS BASED ON, IEA ETP 2016, 2015, EC 2016 AND WSA 2016)

Country	2015	2020	2025	2030	2035	2040
World	1 621	1 750	1 938	1 989	2 093	2 174
Brazil	33	38	44	46	49	52
France	15	15	15	14	14	14
Germany	43	44	46	48	48	48
Italy	22	22	22	22	22	22
Mexico	18	21	24	25	27	28
USA	79	82	86	87	89	91

4.2 SHARE OF PRIMARY AND SECONDARY STEEL

Overview. There are three major methods of steel production: oxygen, electrical and DRI. At a global level, around 70% of the steel is produced via oxygen or primary route, 25% via the electrical, and the remaining share though DRI. The two latter methods use electric arcs to melt steel scrap which requires only one third of the energy and with only a fourth of direct CO_2 emission per ton of crude steel (i.e. emissions from combustion) in comparison to the oxygen route.

Risk pass-through mechanism. The production cost structure varies between primary and secondary steel significantly. While for primary steel producers over 50% of the production cost originates from coal and iron ore, for secondary steel producers steel scrap makes up for more than 50% of total production costs (SOTN 2016). Production costs of primary steel producers are more sensitive to carbon pricing mechanisms, as the primary route emits four times more CO_2 per ton of crude steel compared to the electrical route.

Sources. In general, scenarios present inputs around primary and secondary steel production at macro level (e.g. IEA, Greenpeace). As an example, in IEA's Energy Technology Perspectives 2015 crude steel production is given per production routes on a regional level (e. g. Latin America). Morfeld et al. 2015 calculate that steel scrap can supply 50% of the crude steel production until 2050 based on typical turnover rates of heavy steel equipment and machinery.

Method. In line with the IEA ETP 2016 and 2015 assumptions, the same steel production structure under different climate targets is assumed. The utilization of steel scrap is mainly driven by its price which in turn depends on its availability. Estimates of the ACT and LCT scenarios are computed as follows:

- Current crude steel production share by type of route is taken from WSA 2016 statistics.
- Until 2025, country-specific production is forecasted in linear relation to the production share of the respective region (i.e. Latin America, USA and Canada, Europe) following ETP 2015.
- The country-specific production share pattern between 2015 and 2025 (e. g. Italy's share of secondary steel is twice to that of the global average) is continued in relation to the global secondary steel share, which increases up to 50% in 2040 according to WEO 2016.

Results. The share of secondary steel in global steel production will double from 25% in 2015 to 50% in 2040 in both scenarios. Today, the secondary steel share varies significantly between regions. In countries like Mexico, Italy and USA secondary steel already outweighs primary steel production. Low electricity prices or a rapidly developing economy tend to drive the investment decision for secondary steel. In these countries, secondary steel share will increase less (e.g. by 6 and 8 percentage points in Mexico and USA, respectively). Countries like Germany, France and Brazil with a high production share of primary steel tend to have a long history of steel production or access to cheap coal. Here, the secondary steel share will increase, respectively, by 20, 35 and 29 percentage points, in Brazil, France and Germany until 2040 with respect to 2015 levels.

TABLE 4.2 SHARE OF SECONDARY STEEL PRODUCTION IN TOTAL CRUDE STEEL PRODUCTION FOR BOTH SCENARIOS
(SOURCE: AUTHORS, BASED ON IEA 2016A, IEA 2015 AND WSA 2016)

Country	2015	2020	2025	2030	2035	2040
World	25%	29%	32%	38%	47%	50%
Brazil	20%	23%	26%	31%	38%	40%
France	34%	39%	44%	52%	65%	69%
Germany	30%	34%	38%	45%	56%	59%
Italy	78%	79%	80%	82%	84%	85%
Mexico	70%	71%	72%	73%	76%	76%
USA	63%	64%	65%	67%	70%	71%

4.3 ENERGY INTENSITY

Overview. Steel is one of the most energy-intensive industries. Primary steel production utilizes a range of fossil fuels such as coal, coke, gas and oil. Carbon-rich gases are produced as by products in coke oven, blast and blast oxygen furnaces which are further used to generate electricity in Combined Heat and Power (CHP) plants on-site or to heat the rolling mills. In electrical steel production electricity, natural gas and coal is used. The wide range of energy carriers and the high level of process integration makes determining the energy intensity of a steel mill a challenging task. Studies like Tanaka 2012 show that the energy intensity can vary significantly depending on the calculation method used.

Risk pass-through mechanism. Energy costs like coal for primary steel production and electricity for secondary steel production make up to one third of the total production costs (SOTN 2017). Increasing the energy efficiency is often a viable option for steel producers to gain a competitive advantage. Failing to decrease energy intensity in relation to competitors could lead to lower market volumes and revenues.

Sources. As with most of the indicators in the sector, scenarios generally present total final energy consumption and total crude steel production at the macro level. ETP 2015 reports the aggregate energy intensity at regional level in 2012 and for 2025. Some sector-specific organizations developing climate constrained scenarios disclose the indicator but only cover their region of interest (e.g. EUROFER 2013).

Method. In the ACT scenario, ETP 2016 2DS global estimates are used to compute the global aggregated energy intensity. Energy intensity is computed using the ratio of total final energy consumption and total crude steel production until 2040. In the LCT scenario, energy efficiency gains of EUROFER (2013) are applied to the ETP 4DS estimates of global energy intensity until 2030. A linear regression is used to extrapolate to 2040.

To compute country-specific data, 2014 OECD statistic data on the sector’s final energy consumption is used and put into relation to the total crude steel production from World Steel Association 2016. This resulted in a lower energy intensity as, among other things, energy consumption of coke ovens is not listed under steel production. Thus, OECD energy intensity of ETP 2015 2DS and 4DS scenarios is used as a correction factor of global energy intensity. The country-specific intensity is then forecasted in linear relation to the steel production shares of the respective region (i.e. Latin-America, US and Canada, Europe) in ETP 2015 until 2025. Based on the development pattern from 2015 to 2025, the country-specific intensities are forecasted until 2040 in relation to the global intensity of ETP 2016.

Results. In the ACT scenario, the global energy intensity needs to be reduced by 30% until 2040 in relation to 2015. The energy intensity varies among the countries depending on the secondary steel share and energy efficiency. Thus, increasing the secondary steel share in total steel production will reduce the aggregated energy intensity. Countries with a low energy intensity like Germany and Italy have limited options to reduce energy intensity by 25% or more until 2040 compared to 2015. Brazil, as one of the most energy intensive producers in the world, will have to decrease its aggregate energy intensity by more than 35%. In the LCT scenario, the global energy intensity decreases by less than 15% despite having the same increasing share of secondary steel as in the ACT scenario.

TABLE 4.3 GLOBAL AND COUNTRY-SPECIFIC AGGREGATE ENERGY INTENSITY IN THE ACT AND LCT SCENARIOS (GJ/T CRUDE STEEL) (SOURCE: AUTHORS, BASED ON IEA ETP 2016, 2015, OECD 2016, WSA 2016)

Country	2015	2020		2025		2030		2035		2040	
		ACT	LCT	ACT	LCT	ACT	LCT	ACT	LCT	ACT	LCT
World	21.3	21.2	20.5	18.9	20.0	16.5	19.5	15.7	19.0	14.8	18.5
Brazil	24.5	24.6	23.7	20.8	23.1	17.8	22.4	16.8	21.8	15.8	21.3
France	18.6	17.0	17.9	14.9	17.5	13.4	17.0	12.9	16.6	12.4	16.1
Germany	11.7	11.6	11.3	11.6	11.0	10.6	10.7	10.3	10.4	10.0	10.2
Italy	12.8	13.5	12.3	11.9	12.0	10.9	11.7	10.6	11.4	10.3	11.1
Mexico	14.4	14.8	13.9	12.5	13.6	11.4	13.2	11.1	12.9	10.7	12.5
USA	14.8	14.2	14.3	12.5	13.9	11.4	13.5	11.1	13.2	10.7	12.8

4.4 CARBON INTENSITY

Overview. Production of iron and steel is the second largest CO_2 source of all industry. Besides the utilization of a range of fossil fuels such as coal, coke, natural gas and oil, further process-related CO_2 emissions occur during the reduction from iron oxide to iron in primary steel production. Secondary steel production has a more than four time lower CO_2 intensity. Secondary steel uses steel scrap which only needs to be melted and not chemically reduced. This means three times less energy and no process-related CO_2 emissions. Furthermore, the steel scrap is melted with electricity. If the electricity is generated by renewables sources, the remaining CO_2 emissions come from natural gas and coal which are required for process control, but only on a small scale.

Risk pass-through mechanism. Primary steel production currently emits 1.3 to 1.8 ton CO_2 per ton of crude steel. With increasing CO_2 certificate prices, the costs for CO_2 can make up to one fourth of the total production costs in an ACT scenario by 2050 (Morfeld et al. 2015). Decreasing the CO_2 intensity could become an import leverage for steel producers to gain a competitive advantage as most of the production inputs like coal, iron ore as well as the product crude steel are globally traded bulk commodities. Failing to decrease CO_2 intensity in relation to competitors could lead to lower market volumes and revenues.

Sources. Scenarios disclose total CO_2 emissions and total crude steel production generally at macro level (e.g. IEA 2016a, Greenpeace 2015). Some sector-specific organizations developing climate constrained scenarios disclose the indicator but only cover their region of interest (e.g. EUROFER 2013).

Method. For both scenarios, ETP 2016 2DS and 4DS global aggregated CO_2 intensity is computed by building the ratio of total final energy consumption and total crude steel production for the years 2010 until 2040. To compute the country-specific data, OECD statistical data on the sector's fossil fuel related CO_2 emissions by country in 2014 is used and put it into relation to the total crude steel production from World Steel Association 2016. The global CO_2-intensity is lower compared to ETP 2016 as the OECD statistical data does not include process-related CO_2 emissions e.g. originating from reducing iron oxide. Thus, OECD CO_2 emission data is used as a correction factor of ETP global CO_2 emissions. The country-specific intensity is forecasted until 2025 in linear relation to the production shares of the respective region (i.e. Latin-America, USA and Canada, Europe) provided in ETP 2015. Based on the development pattern during 2015 to 2025, the country-specific intensities are then forecasted in relation to the global intensity of ETP 2016.

Results. In 2040, the CO_2-intensity under both scenarios will differ significantly. In the LCT scenario, the CO_2 intensity needs to be reduced by only 12% until 2040 compared to 2015. In contrast, the ACT requires a 53% reduction. The less ambitious reduction in the LCT is to some degree the result of the high marginal CO_2 abatement costs relative to other sectors. The CO_2 intensity varies among countries depending on the secondary steel share, energy efficiency and fuel types. For instance, as of today, Brazil has a comparatively high energy intensity but utilizes biomass (e.g. Biochar). Countries with a lower intensity like Italy and Mexico are more limited in low cost CO_2 abatement options (e.g. higher share of electrical steel) and are required to reduce intensity by 15-20% in the ACT scenario by 2040. Countries like France and Brazil with a higher CO_2-intensity are required to reduce it about 30% until 2040 in comparison to 2015.

TABLE 4.4 GLOBAL AND COUNTRY-SPECIFIC AGGREGATE CO_2 INTENSITY IN THE ACT AND LCT SCENARIOS (T CO_2/T CRUDE STEEL) (SOURCE: AUTHORS, BASED ON IEA ETP 2016, 2015, OECD 2016, WSA)

Country	2015	2020		2025		2030		2035		2040	
		ACT	LCT	ACT	LCT	ACT	LCT	ACT	LCT	ACT	LCT
World	1.7	1.6	1.8	1.4	1.7	1.1	1.6	1.0	1.6	0.8	1.5
Brazil	1.1	1.1	1.1	1.1	1.1	0.9	1.0	0.8	1.0	0.8	0.9
France	1.1	1.0	1.1	1.0	1.1	0.8	1.0	0.8	1.0	0.7	1.0
Germany	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.6	0.8	0.6	0.7
Italy	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.5	0.4	0.4
Mexico	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6
USA	0.9	0.8	0.8	0.8	0.8	0.7	0.8	0.6	0.8	0.6	0.7

4.5 CRUDE STEEL PRICE

Overview. Crude steel is a heavily traded commodity. The rapid growth in steel production during the first decade of the 21st century and the financial and economic crisis resulted in a global oversupply of steel. Subsequently, steel prices dropped by more than 50% compared to their peak price in 2008 and continued to experience a high volatility in a comparatively low price band until today.

Risk pass-through mechanism. In contrast to crude steel prices, production costs including raw material prices such as iron ore and steel scrap tend to be more stable. Thus, steel producer's margins are highly impacted by the highly volatile price of steel.

Sources. There is no specific steel price associated with a 2°C or less ambitious scenarios. Estimates around future steel prices range widely. The price of crude steel is in general influenced by three factors: steel demand, steel production, and production costs. The first two factors are covered by the steel production indicator (see Page 45), assuming that the future supply and demand matches. Other authors use global energy system models. For example, Morfeldt et al. 2015, uses a global energy system model and a scrap availability assessment model to analyse the relationship between steel demand, recycling and the availability of scrap and their implications for steel production costs in different regions for 2060 and 2100.

Method. For the LCT scenario, regional crude steel prices of the "reference scenario" of Morfeldt et al. 2015 are used. This scenario assumes steel demand stagnation in 2100. For the ACT scenario, the "RF climate" scenario including CCS is used. Thus, this scenario is expected to be largely in line with IEA's 2D scenario assumptions. Morfeldt et al. 2015 lists prices only for 2060. Current regional prices are thus used to interpolate the prices from 2015 to 2040.

Crude steel prices of Morfeldt et al. 2015 are not directly translatable to currently traded benchmarks for steel commodities such as Hot Rolled Coils (HRC) as they represent end products whilst Morfeldt et al. 2015 represent an intermediate product. Therefore, raw material costs of Morfeldt et al. 2015 are compared against current raw material costs and no margins are applied following the findings of DBS Group (DBS 2017). A constant correction factor to adapt the price to HRC steel is used.

Results. In contrast to the historical HRC price development which tends to have a high fluctuation, the forecasted price for HRC increases steadily in both scenarios until 2040. This price behaviour can be related to the choice of method. In the LCT scenario, a price increase of 7% is expected until 2040 compared to 2015. This is less than the increase of energy carriers and CO_2 certificate prices in the LCT. In the ACT, the steel price increase by 33% until 2040 compared to 2015 due to the higher CO_2 certificate costs and the higher capital expenditures for low carbon technologies.

TABLE 4.5 GLOBAL PRICE DEVELOPMENT HRC OF CRUDE STEEL (USD/TON) (SOURCE: AUTHORS, BASED ON MORFELD ET AL. 2015, BDS 2017, WSE 2016, SOTN 2017)

Scenario	2015	2020	2025	2030	2035	2040
LCT	350	355	359	364	369	373
ACT	350	373	396	420	443	466

4.6 RAW MATERIAL PRICES

Overview. Raw material costs play a significant role in the production cost structure of steel. In terms of electric or secondary steel, raw material costs can make up to two third of the total production costs, while for primary steel, raw material costs can contribute up to one third of the total production costs. The main raw material for primary steel production is iron ore. For secondary steel production it is steel scrap.

Risk pass-through mechanism. From an economic perspective, both steels, i.e. primary and secondary steels, have the same attributes and are, thus, the same commodity with the same price. However, both have a highly different cost structure. For instance, a relative increase in steel scrap (for secondary steel) price in comparison to iron ore price (for primary steel) will increase production costs for electric steelmaking, but have a more limited effect on the global steel price. Thus, the margin for electrical steel making decreases in comparison to primary steel making.

Sources. As with crude steel prices, there are no specific raw material prices associated with 2°C or alternative less ambitious scenarios. The raw material prices are in general influenced by three factors: steel demand, steel production and production costs. The first two factors are covered by the steel production indicator (see Page 45), assuming matching supply and demand. Production costs are generally addressed in sector-specific literature (e.g. Morfeldt et al. 2015) although few publications on the topic exist.

Method. For the LCT scenario, the scrap and iron ore prices of the “reference scenario” of Morfeldt et al. 2015 are used. These prices assume a steel demand stagnation in 2100. For the ACT scenario, the “RF climate” scenario including CCS is used. Morfeldt et al. 2015 lists prices only for 2060. Thus current prices are used to interpolate the prices for 2015 until 2040. Current prices cost structure is taken from SOTN 2017.

Results. In contrast to the historical steel scrap and iron ore price development which tends to have a high fluctuation, the forecasted prices increase steadily in both scenarios until 2040. This is mostly related to the choice of method. In the LCT scenario, a steel scrap price increase of 11% until 2040 compared to 2015 is expected. This is less than the increase of energy carriers and CO_2 certificate prices in the LCT. In the ACT scenario, the steel scrap price increases by 50% until 2040 compared to 2015 due to the higher CO_2 certificate costs and the higher capital expenditure for low carbon technologies.

TABLE 4.6 GLOBAL PRICE DEVELOPMENT FOR STEEL SCRAP AND IRON ORE IN USD PER TON OF CRUDE STEEL (USD/TON) (SOURCE: AUTHORS, BASED ON MORFELD ET AL. 2015, SOTN 2017)

Scenario	Commodity	2015	2020	2025	2030	2035	2040
LCT	Steel scrap	195	199	204	208	213	217
	Iron ore	89	89	89	89	89	89
ACT	Steel scrap	195	215	235	255	274	294
	Iron ore	89	89	89	89	89	89

4.7 ALLOCATION OF FREE CO_2 ALLOWANCES

Overview. The combination of high production volumes and high carbon intensity groups the iron and steel industry among the highest CO_2 emitters of all industry. Further, steel is a heavily traded commodity as demonstrated by its high trade intensity. Both characteristics -high carbon and high trade intensity- allow the steel sector to be qualified as a carbon leakage risk, meaning that there is a high risk that production will move to areas not with no or less ambitious climate policies. Some initiatives to minimize the risk are currently in place. As an example, in Europe, steel producers are granted a volume of free CO_2 allowances which are allocated according to CO_2 intensity benchmarks to minimize carbon leakage risk and their negative impacts on the national economy. The application of these mechanisms will be a key transition risk indicator for the steel industry.

Risk pass-through mechanism. Currently, primary steel production emits in the range of 1.3 to 1.8 ton of CO_2 per ton of crude steel. With increasing CO_2 certificate prices, production costs can be one fourth higher compared to an area not covered by CO_2 emission trading schemes or similar policies (Morfeld et al. 2015).

Sources. Neither IEA's Energy Technology Perspective nor its World Energy Outlook gives detail information on future CO_2 emission trading schemes or free CO_2 allowances. Third party sources focusing only on the steel industry analyze the carbon costs for the steel sector (e.g. Ecofys 2016), but these can be limited in geography.

Method. Due to the lack of scenarios for other geographies, it is assumed that future emission trading schemes in USA, Mexico and Brazil will follow a similar trend to that of the EU ETS. According to Ecofys, the European steel industry will face an annual shortage of free CO_2 allowances for direct emissions increasing from 32% in 2020 to 49% in 2030 based on the proposed ETS revision (Ecofys 2016).

The LCT scenario thus assumes a similar shortage of free CO_2 allowances across regions and countries with a linear extrapolation to 2040. The ACT scenario assumes that the proportion of CO_2 certificates is significantly increased beginning in 2030 with emission trading schemes or similar policies being implemented in all countries in scope, including Brazil. This roll-out of emission trading schemes to major steel producing countries reduces the carbon leakage risk and the need for free CO_2 allowances.

Results. In the LCT scenario, the annual shortage of free CO_2 allowances for direct emissions increases linearly from 32% in 2020 to 66% in 2040. Brazil, with no emission trading scheme in place according to IEA 2016, is an exception and has thus no shortage. In the ACT scenario, the emission trading scheme is rolled out to all regions in scope with no free CO_2 allowances after 2030.

TABLE 4.7 ANNUAL SHORTAGE OF FREE CO_2 ALLOWANCES FOR DIRECT EMISSIONS (% OF TOTAL CO_2 DIRECT EMISSIONS) IN THE ACT AND LCT SCENARIOS (SOURCE: AUTHORS, BASED ON ECOFYS 2016)

Year	EU		Brazil		Mexico		USA	
	ACT	LCT	ACT	LCT	ACT	LCT	ACT	LCT
2020	32%	32%	32%	0%	32%	32%	32%	32%
2030	100%	49%	100%	0%	100%	49%	100%	49%
2040	100%	66%	100%	0%	100%	66%	100%	66%

MEET THE BUILDERS - ET RISK CONSORTIUM

The ET Risk consortium, funded by the European Commission, is working to develop the key analytical building blocks (Fig. 0.1) needed for Energy Transition risk assessment and bring them to market over the coming two years.

1. TRANSITION SCENARIOS

The consortium will develop and publicly release two transition risk scenarios, the first representing a 'soft' transition extending current and planned policies and technological trends (e.g. an IEA NPS trajectory), and the second representing an ambitious scenario that expands on the data from the IEA 450S /2DS, the project's asset level data work (see Number 2), and relevant third-party literature. The project will also explore more accelerated decarbonization scenarios.

2. COMPANY & FINANCIAL DATA

Oxford Smith School and 2° Investing Initiative will jointly consolidate and analyze asset level information across six energy-relevant sectors (power, automotive, steel, cement, aircraft, shipping), including an assessment of committed emissions and the ability to potentially 'unlock' such emissions (e.g. reducing load factors).

3. VALUATION AND RISK MODELS

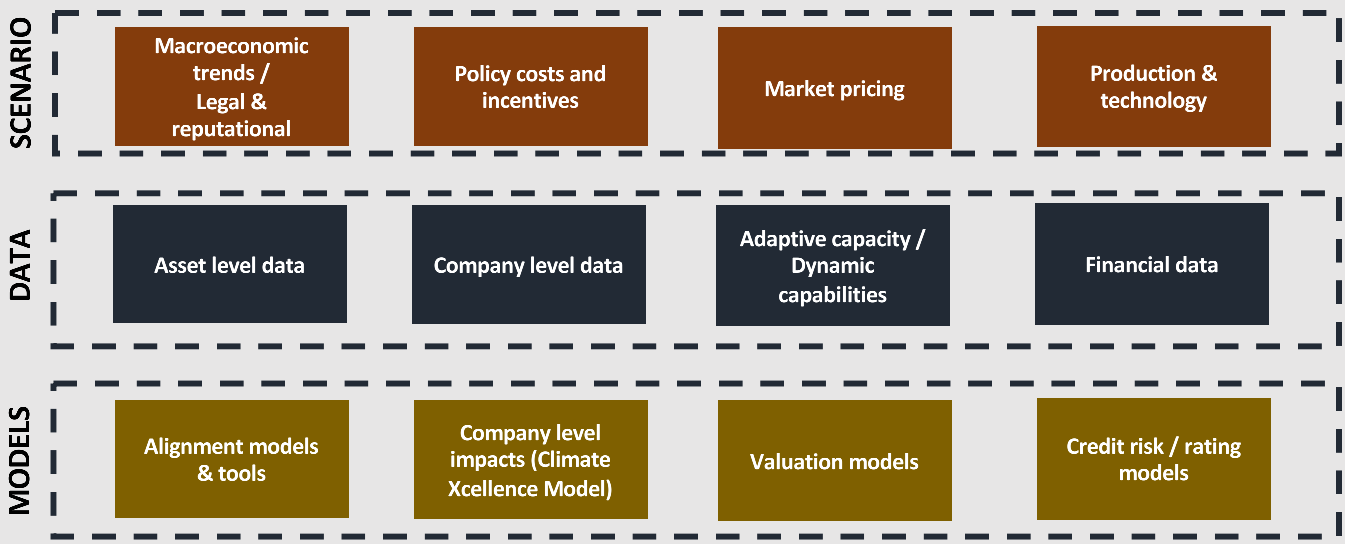
a) **2°C portfolio assessment – 2° Investing Initiative.** 2° Investing Initiative will seek to integrate the project results into their 2°C alignment model and portfolio tool and analytics developed as part of the SEI metrics project.

b) **ClimateXcellence Model – The CO-Firm**. This company risk model comprises detailed modeling steps to assess how risk factors impact margins and capital expenditure viability at the company level.

c) **Valuation models – Kepler Cheuvreux.** The above impact on climate- and energy-related changes to company margins and cash flows can be used to feed discounted cash flow and other valuation models of financial analysts. Kepler Cheuvreux will pilot this application as part of their equity research.

d) **Credit risk rating models – S&P Global.** The results of the project will be used by S&P Global to determine if there is a material impact on a company's creditworthiness. S&P Dow Jones Indices, a S&P Global Division, will explore the potential for developing indices integrating transition risk.

FIG. 0.0: ASSESSING TRANSITION RISK ACROSS THE INVESTMENT CHAIN (SOURCE: AUTHORS)



ABOUT 2° INVESTING INITIATIVE

The 2° Investing Initiative [2° ii] is a multi-stakeholder think tank working to align the financial sector with 2° C climate goals. Our research work seeks to align investment processes of financial institutions with climate goals; develop the metrics and tools to measure the climate friendliness of financial institutions; and mobilize regulatory and policy incentives to shift capital to energy transition financing. The association was founded in 2012 and has offices in Paris, London, Berlin, and New York City.

ABOUT THE CO-FIRM

The CO-Firm GmbH is a boutique consultancy specialized in developing climate and energy strategies for financial services providers, industry, and utilities. Based on financial risk modelling under a range of climate and energy scenarios, the proprietary ClimateXcellence Toolset, and a dataset of more than 200.000 assets and more than 15.000 different technical mitigation measures, The CO-Firm supports its clients in identifying, evaluating and realizing their specific economic opportunities in the national and global climate transition. Specifically, the CO-Firm serves its clients in adjusting their strategies, setting Science Based Targets, creating new business models, and identifying cost savings in their operations and their supply chain. Additionally, the consultancy provides regulatory monitoring services.

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