

A Steelmaking Carol



Charles Dickens was a remarkable man who experienced hardship in his early years when his father was put in prison due to insolvency. Charles had to quit school to work but resumed his studies some years later and became a fantastic writer and observer of mankind. His novella *A Christmas Carol* was published 180 years ago and is the inspiration for this article on the endeavour of decarbonizing the steel industry by 2050. By **Rutger Gyllenram***

The ghost of steelmaking past

With the introduction of the Bessemer, Thomas and Siemens-Martin processes in the second half of the 19th century, it became possible to decarburize blast furnace iron in liquid form. The amount of manual work decreased, the economies of scale increased and thus productivity and profitability. For small ironworks in Sweden, it was a disaster and entire communities disappeared. Many probably swore by Henry Bessemer, but the few companies that had enough capital and opportunity, invested in the new technology and grew. The death of mills did not go unnoticed by the politicians and legislation was demanded to prevent the transformation of the industry from taking place. That did not happen and it took until the energy crisis at the end of the 1970s before a similar crisis appeared.

This time the politicians were more active and gave extensive support to investments in the steel industry to secure jobs. Blast furnaces were shut down and replaced by electric arc furnaces and certainly jobs were created, first when the new plants were built and again when they were dismantled

to be shipped to where they could be operated at a profit. A complete waste of money. Now that the steel industry is once again facing great stress and demands for change, do we have anything to learn from this story?

As cruel as it may sound, the first lesson should be that there is a time for everything and when the conditions that made a place a successful industrial location disappear, in the long run the industry will also disappear. Trade secrets, skilled employees and niche products may be sufficient conditions for survival and prosperity, but new technology alone will not help if it can be applied with greater success elsewhere. Furthermore, it is interesting to note that when investment in new steelmaking processes took off, they had reached what we call today a top technical readiness level (TRL). Sir Henry Bessemer may have invented the Bessemer process, but it was after long trials that it finally succeeded when Göransson, who was manager at Högbo mill north of Sandviken, could take it into operation. The Thomas and Siemens-Martin processes had similar stories: they were developed in England, Germany and

France and were introduced on a wide scale in Sweden where they were first proven.

Another lesson is that process development takes time. Bessemer's ideas to use oxygen instead of air in steelmaking and to replace ingot casting with continuous casting took until the mid-20th century to be implemented for steel. To continue, the energy crisis led to extensive development programmes worldwide to replace the blast furnace with processes that did not need agglomerated raw materials. After 50 years, there are few implementations of new reduction technology, and the blast furnace is still the dominant reduction process. A successful story is, however, the natural gas-based direct reduction process that has gone from moderate sizes of 100 kt/yr to the mega modules we see today of 2.5 Mt. It is impressive, but has taken more than 50 years to scale up.

What the ghost of steelmaking present can tell us

Today, more than half of the world's production of steel is made in China, and India has announced that it will increase

*Founder and CEO, Koblode & Partners

Köppern



HBI is here to stay!



For 50 years, Köppern briquetting machines have played a key role throughout the world in the production of HBI for DRI processes.

And HBI is still in demand, as demonstrated by the new HBI plants equipped with Köppern roller presses at LEBGOK (Russia), ArcelorMittal (USA), CLIFFS (USA) and upcoming installations, reducing the CO₂ footprint of the steel industry.

- » State of the art technology
- » Experts in process technology
- » High plant availability
- » Long-lasting equipment

Köppern – Quality made in Germany.

www.koepfern.com

Raw material assessment for DRI and Scrap in a number of process routes

Calculation of scrap chemical
analysis and uncertainty from
production data

Estimating gains from raw
material upgrade and scrap
alloy recovery

Benchmarking recipe cost
against theoretical optimum

Software and training services

 **KOBOLDE &
PARTNERS AB**

Ringvägen 100
SE - 118 60 STOCKHOLM
S W E D E N

Rutger Gyllenram
rutger.gyllenram@kobolde.com

info@kobolde.com
www.kobolde.com



production drastically. The blast furnace is the dominant reduction process for iron ore followed by natural gas-based direct reduction. Scrap is the other ferrous raw material and the amount available for steelmaking is greater in industrialized countries than elsewhere although the amount of available scrap is continuously increasing. When it comes to greenhouse gas emissions the relation between the three processes can, for the sake of discussion, be set as roughly 2kg, 1kg and 0.5 kg CO₂-eq/kg steel.

Just a few years ago, the issue of greenhouse gas emissions was only mentioned in passing in the steel industry. Projects like EU-funded ULCOS, aimed in the first decade of this millennium to develop low greenhouse gas emission alternatives to ironmaking processes; their most successful project was the oxygen blast furnace with top gas recirculation and carbon capture

and storage (CCS) which was tested with good results on a pilot scale. Then, many of us experienced that the lid was put on. Instead, projects with direct reduction using hydrogen were introduced and were funded by the EU. These projects are now reaching demonstration level in the one million ton scale but are reported not to be profitable with present hydrogen prices.

Today, the debate about the development of the steel industry, at least in the Western world, is dominated by the issue of reducing greenhouse gases, and those who bring it to the agenda are mainly politicians, financiers, customers and the steel companies themselves. Organizations such as the UN, IEA, WTO, WEF, OECD, worldsteel and the G7 are committed to developing systems to drive development towards low emissions steelmaking. Organizations of investors and customers as well as steel makers and non-profit

organizations are also engaged in developing calculation systems, roadmaps, threshold values or different types of labels. Today, it is almost a full-time job to follow this development and to understand the effect different systems or programmes can have on the market and on the steel production companies.

A dilemma suddenly arises here. It's quite simple. If we are to reduce emissions to 0 by 2050, we should look at what is emitted when producing each ton of steel and report this. If it is below a certain value, it can be considered close to 0. If you as a producer want to sell steel that is close to 0, you must invest in processes that do not emit greenhouse gases. Supply blast furnaces and direct reduction plants with carbon capture and usage or storage, CCUS, or switch to hydrogen or biogenic syngas as a reducing agent. It will, however, take time since the fossil-free processes are probably not ready for the market in full scale yet. Much can be done to reduce emissions to some extent, but few if any can reach close to 0 immediately, and politicians and customers must understand that.

The final question is: are we right to assume that all companies must survive the transition to close to 0 steel? It was not like that in earlier crises and if we twist the labeling systems so it becomes easier for a company with higher emissions to get the same label as a company with lower emissions, are we then working for decarbonization? Finally, when governments subsidize investment in new technology to save jobs, are we sure the plants can be run with a profit in the long run and the jobs will stay or is it just a waste of money?

Meet the ghost of steelmaking yet to come

In *A Christmas Carol*, Ebenezer Scrooge is, after confrontation with the ghosts of past and present Christmases, given the opportunity by "The ghost of Christmases yet to come" to – in a dystopic way – see into the future in order to make what we can call life-changing decisions. Let's think about what we might experience if we were visited by "The ghost of steelmaking yet to come" and escorted to the "Greenish Steel Conference 2050" just in time for the inauguration speech:

"Dear delegates, as we gather here today, we can state that we have put a successful year behind us. After extensive negotiations,

the number of definitions of greenish steel has now been reduced to 300, which is three less than last year. Since both steel manufacturers and steel customers are involved in the design of each of the programmes, a greenish steel label that satisfies consumers can be guaranteed.

"The number of research projects for fossil-free steelmaking has now reached 2000 and the number of pilot installations of the five leading alternative processes for pig iron and DRI in operation has reached five i.e., one of each. Additional plants are planned when it is judged that it is possible to compete with traditional plants producing greenish steel.

"Projects to relocate steel facilities to areas with conditions for them to be operated without heavy losses are happily underway among many of our members. They represent great manufacturing potential for greenish steel once they are in the right place.

"Scrap exports have now completely ceased from the USA and the EU as they closed their ore-based works, which is why the countries that previously used this scrap

raw material have switched to sponge iron production in rotary kilns. Admittedly, this results in higher emissions of greenhouse gases than the previous ore-based production in the EU and the USA, but through a new calculation formula, this DRI can also be assessed as greenish.

The question of who should pay for the capture and storage of carbon dioxide as well as the extra cost for hydrogen production has now entered a decisive phase. Since all products are greenish even without CCS or hydrogen, there is no possibility of passing this cost on to the consumer. We expect to be able to have a conference on this and come to a decision around 2060-2070.

"This concludes my introductory remarks. Unfortunately, greenhouse gas emissions increased last year, so today we are 30% above the 2020 level, but in 2051 we expect the rate of increase to decrease."

Epilogue

A Christmas Carol by Charles Dickens ends happily with Scrooge realizing that there are values other than money. In the business

world, unfortunately, it's just a beautiful thought. A company's task is to increase capital for its shareholders. Nothing else. However, laws and regulations, other stakeholders such as employees, public opinion, and, of course, customer requirements are considered, all of which affect the company's profitability and long-term survival. It is natural for management to wish for regulations that favour their existing plants and way of production regardless of the impact on the climate.

Transition to near zero will hurt

Earlier crises have forced companies to rethink their supply chains and their business ideas, and some have been forced to close. Cash injections from governments in the wrong projects have only prolonged the pain since the laws of business economy are what they are. If we really want to meet the goals of the Paris agreement, we must brace ourselves and realize that the transition to near zero steel making will hurt, but not having a transition will hurt even more. Then, maybe even this carol can have a happy ending. ■

COMBILIFT 25
LIFTING INNOVATION *Years*

Safety Storage Efficiency

Combilift is the perfect fit for the steel industry. Our multidirectional forklifts, straddle carriers and mobile gantry cranes are perfect for handling long product, allowing you to maximise your storage, efficiency and safety.

- Safer product handling
- Optimised production space
- Improved storage capacity
- Increased productivity & output
- Enhanced profits

combilift.com

