LAPLACE CONSEIL

Impacts of energy market developments on the steel industry

74th Session of the OECD Steel Committee

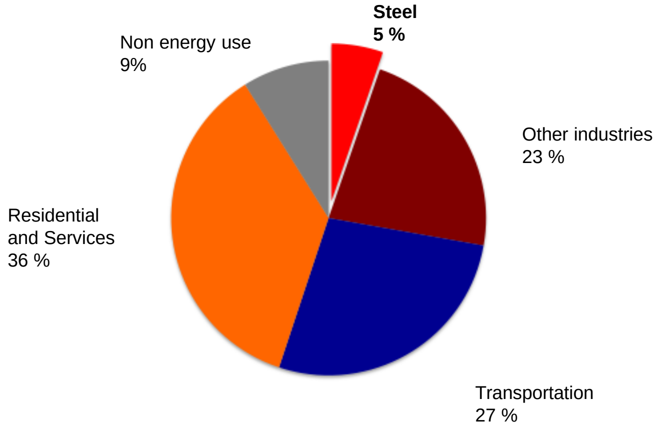
Paris, 1-2 July 2013

Content of this presentation

- In 2012, the steel industry consumed about 5 % of all *primary* energy produced worldwide. The steel industry contributed to 7 % of all global CO_2 emissions due to a higher share of coal in the industry fuel mix.
- The steel industry has made great progress to reduce its energy consumption and its environmental impact. In the OECD, steel consumption per tonne of steel has been halved since 1975.
- More progress is technically possible, but will require substantial capital to modernize. The feasibility of these investments will require adequate pricing for the carbon avoided.
- Traditional integrated steel producers face the biggest challenges as new low carbon technologies favour modern minimills, hence social and regional adjustments by integrated mills are also likely, leading to resistance to change.
- Energy production, transformation and transportation require large quantities of steel that represents 12 % of total steel output.
- Improvements in steel quality leads to major economies in consuming industries that far outweighs the energy needed to produce that steel

In 2012, the steel industry consumed about 5% of all primary energy produced

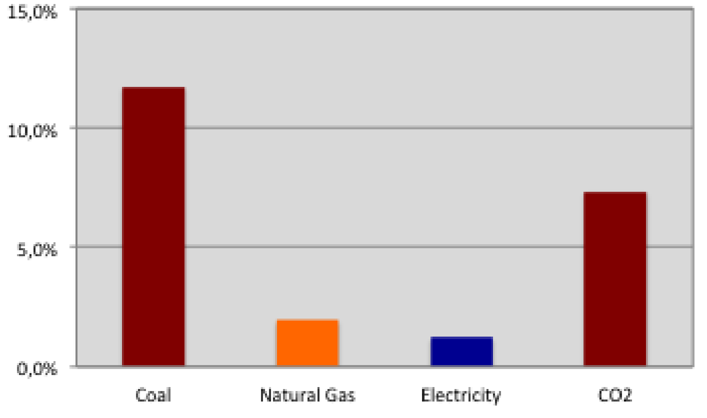
Repartition of the World Energy produced (%)*



* Assume an equal repartition of the energy losses from primary energy production to final energy consumption
Source : IEA, WorldSteel, BP Energy statistics, World Coal association, Midrex, Laplace Conseil analysis

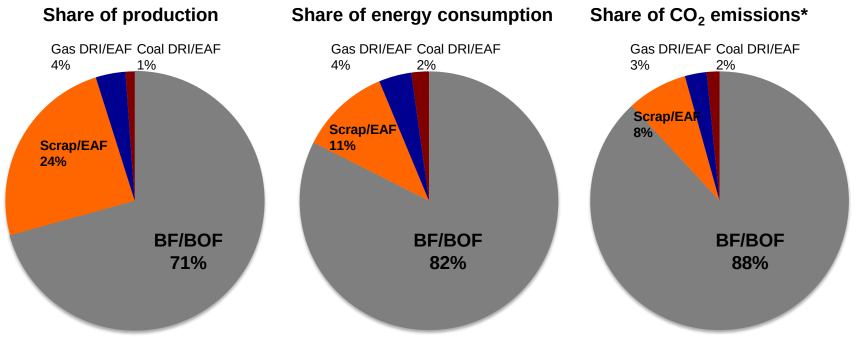
The steel industry consumed 11% of all hard coal produced and generated 7 % of all CO_2

Share of energies consumed and CO2 produced by the steel industry in 2012



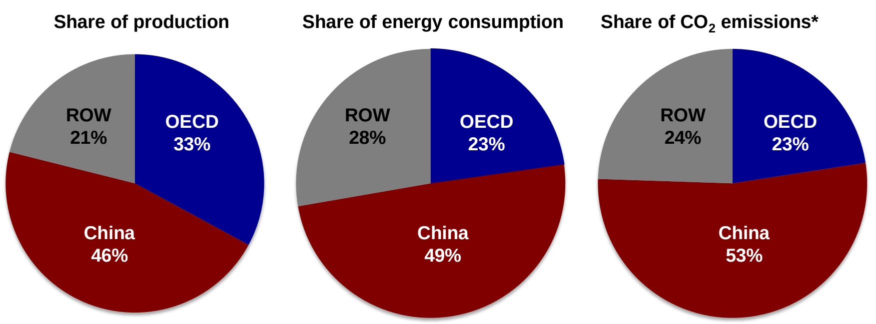
Source : IEA, WorldSteel, BP Energy statistics, World Coal association, Midrex, Laplace Conseil analysis

The integrated sector (BF/BOF) represents 71% of world production, 82% of energy and 88% of CO_2



* Includes share of CO2 from electricity needed; assume same mix of primary energies for electricity production
Source : IEA, WorldSteel, BP Energy statistics, World Coal association, Midrex, Laplace conseil analysis

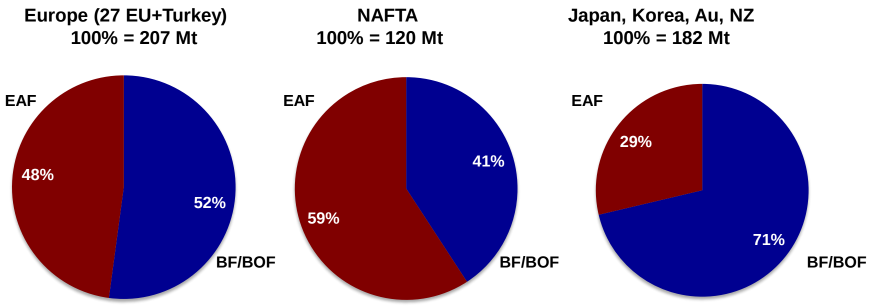
OECD accounts for 33% of steel production but only 23% of energy consumption and CO_2 emissions



* This is primarily due to a higher share of scrap recycling in EAF and also to somewhat better efficiency
Source : IEA, WorldSteel, BP Energy statistics, World Coal association, Midrex, Laplace conseil analysis

NAFTA mills have switched to EAF for 59% of their production, while Asian mills for only 29%

Breakdown of OECD crude steel production by process BF/BOF vs EAF (%)



Source : Worldsteel, Laplace Conseil analysis

Social, economic and political reasons explain the differences in minimill production share.

- In NAFTA, where competition is most intense and industrial policy not favored, new EAF mills, union free, relentlessly push back the integrated mills and will continue to gain share, currently at 59%. Minimills competitive advantage will be further enhanced by the discovery of low priced shale gas that allow economic production of DRI to complement scrap and dilute scrap impurities.
- In Europe, the situation is more contrasted: In Northern Europe, large historic integrated mills have succeeded to limit minimill growth to 30%, but in Southern Europe of more recent industrialization, minimills command a leading share of 72%. Central Europe (only 40% EAF) is facing the toughest challenge with many Comecon era integrated plants that need major modernization
- In Japan, Korea and Chinese Taipei, integrated mills effectively own or control most EAF producers and contain their growth at 31% of total production.

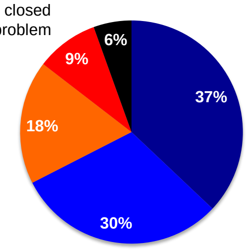
Despite intense restructuring, one third of OECD integrated producers are still not fully competitive

Breakdown of Crude steel production by integrated BF/BOF OECD Producers (%)
100% = 286 Mt

Obsolete steel mills
Should be closed
Major social and economic problem

Marginal steel mills
Difficult economic and/or social situation
Major (uneconomic ?) revamp investment
Likely to experience restructuring
in next few years

Average steel mills
Smaller or more ancient mill
Miss several criterias to be competitive
Dependent on market conditions
for adequate performance
Need major investment to reach
safe long term position
May find solace in niche markets



World class steel mills
Crude steel annual production > 4,5 Mt
Capacity utilization > 85%
Fully integrated from coking to hot rolling
Close to deep harbor and customers
Modern or modernized facilities with BAT
Excellent maintenance, no major revamp
Good productivity > 1000 tonnes/man
Good social relationship, strong culture
Excellent products quality
Reliable service and reputation
Sound balance sheet and financial ratios

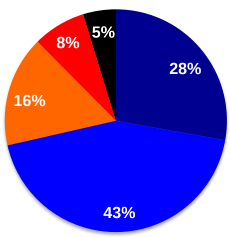
Competitive steel mills
Same as world class mills
but miss one or more criterias
May need substantial investment
to move to world class

Source : Laplace Conseil analysis

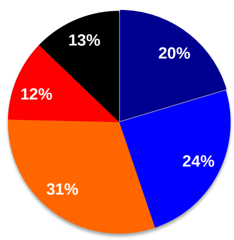
The Asian integrated mills are the most modern

Breakdown of crude steel production by integrated BF/BOF OECD Producers (%)

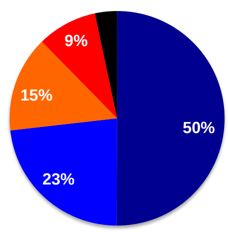
Europe (27 EU+Turkey)
100% = 108 Mt



NAFTA
100% = 49 Mt



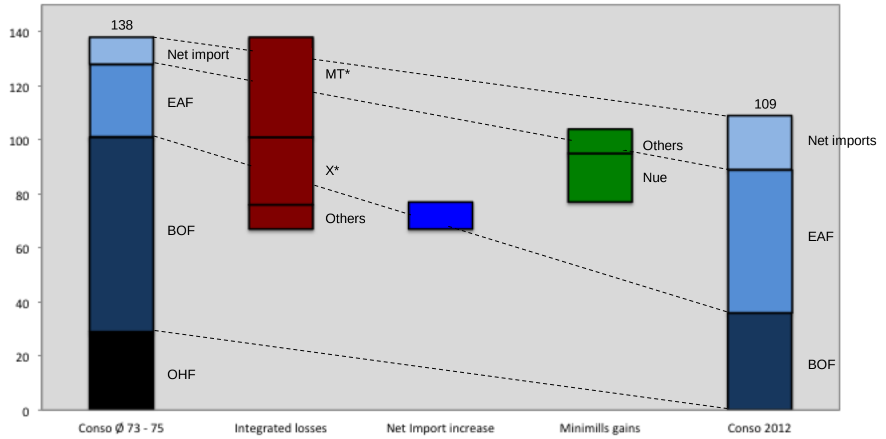
Japan, Korea, Au, NZ
100% = 130 Mt



Source : Laplace Conseil analysis

In the USA, the entry of minimills accelerated the decline of integrated mills much more than imports

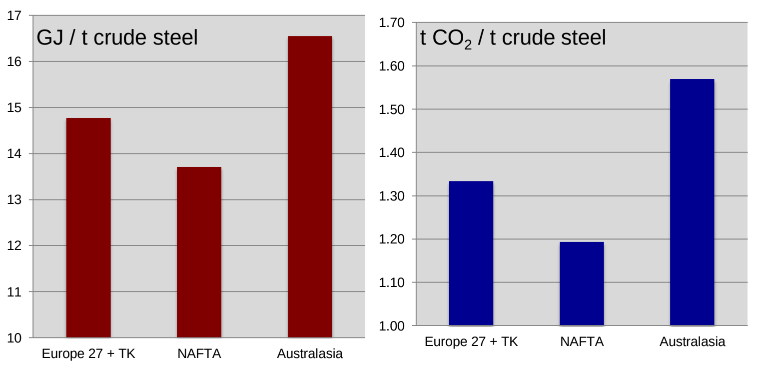
Evolution of market supply in the USA since 1974 (Mt of crude steel equivalent)



* and preceding companies
Source Worldsteel, Laplace Conseil analysis

Thanks to its higher share of EAF, NAFTA has the lowest energy consumption and CO_2 emissions

Comparison of Energy and CO_2 per tonne in OECD regions



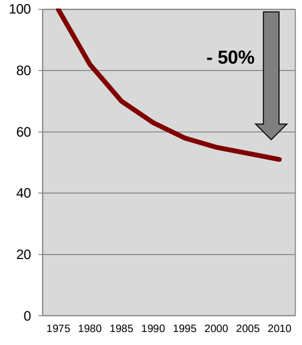
Source : IEA, WorldSteel, BP Energy statistics, World Coal association, Midrex, Laplace conseil analysis

Reducing energy consumption and CO_2 emissions is vital for the industry, but progress will be difficult

1. Improving energy efficiency of existing plants
   - \+ Indispensible to keep plant competitive and maintain jobs
   - – Most « low hanging fruits » already captured
   - – Increasing pay-back and financial constraints ; dependent on carbon price
2. Replacing BF/BOF production by scrap/EAF production
   - \+ Most efficient method; Proven technology, growing share of possible products
   - \- Imply closing BF/BOF capacity with large job losses and cleanup cost
   - \- Availability of suitable scrap in question; steel quality consideration
3. Replacing coal energy with (shale) gas energy
   - \+ Reduce CO_2 by 40% with DRI as substitute for scrap
   - \- Necessitate cheap gas, only available in OPEC countries and USA
   - \- Imply closing BF/BOF capacity with large job losses and cleanup cost
4. Medium to long term options
   - – CCS : not yet fully proven; dependent on high carbon price; local acceptability
   - – Ulcos, Finex, other new processes : not yet proven; necessitate CCS

In OECD, energy consumption has been halved since 1975. Main sources of progress are caught

Evolution of energy consumed in the main OECD countries and sources of progress

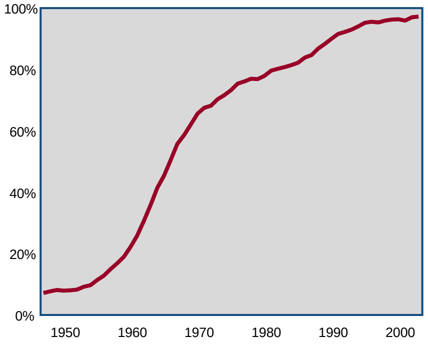


Process efficiency	70 - 80% complete
Continuous casting	99% complete
Elimination of obsolete capacity	80 - 90% complete
Replacement BF/BOF by EAF	40 – 60% complete
Replacement of coal by shale gas	5% complete
Breakthrough processes	not before 2020 - 2030

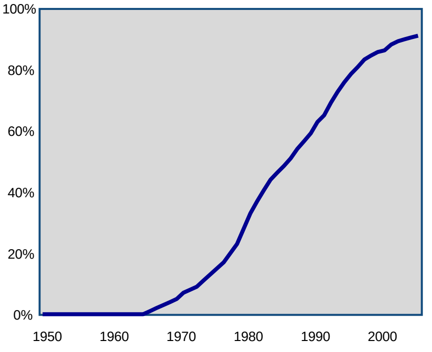
Source : IEA, WorldSteel, BP Energy statistics, World Coal association, Midrex, Laplace conseil analysis

Crude steel production is now almost exclusively produced via EAF or BOF and continuously cast

BOF + EAF crude steel production (% world total production)



Continuous casting evolution rate (% world crude steel production)



Source : WorldSteel, Laplace Conseil analysis

Several energy saving technologies are currently implemented in the OECD steel industry

• Coke dry quenching	10% introduced
• Sinter plant cooler heat recovery	20% introduced
• BF Top gas recovery turbine	45% introduced
• BF Pellet ratio optimization	8% introduced
• BF Injection of H2 rich gas	2% introduced
• BF Top gas recycling	under development
• BOF Gas recovery	25% introduced
• Semi hot charging in reheating furnaces	35% introduced

Source : BCG Eurofer report, Laplace Conseil analysis for other OECD regions

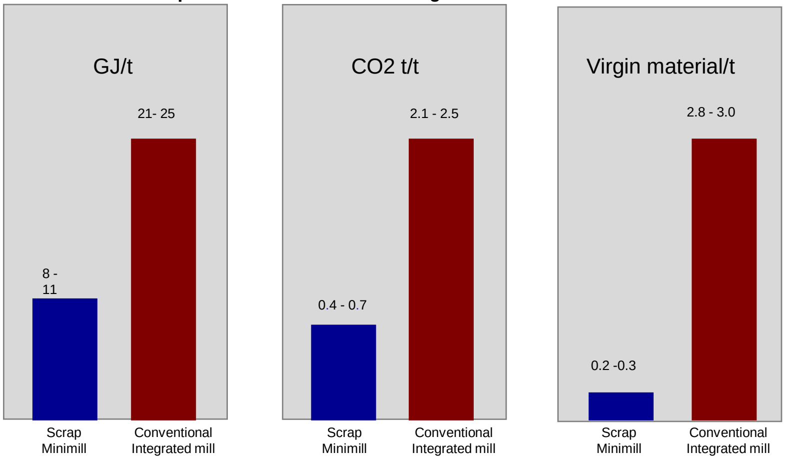
Recycling scrap in EAF's is the most efficient available technology, not just for energy.

+ Steel like all metals is indefinitely recyclable without loss of properties. Steel is not « consumed » but « used » over and over again.
+ The energy needed to melt scrap represent 40% of the energy and 30% of CO_2 to smelt iron ore in a modern BF/BOF integrated mill.
+ In addition, capital cost per tonne of capacity is 60 to 70% lower; maintenance costs are decreased in the same proportion.
+ Labor productivity is twice as high and smaller size of mill usually leads to better social relationships and more flexible production schedule
+ Innovative « minimills » have pioneered thin slab, thin strip and near net shape casting, further enhancing the EAF competitiveness.

- In mature OECD markets, EAF growth can only occur at the expense of incumbent BF/BOF plants, leading to large job losses and financial distress of the integrated mills. Hence several objections to more EAF.

The environmental advantages of scrap recycling over traditional BF/BOF smelting are important

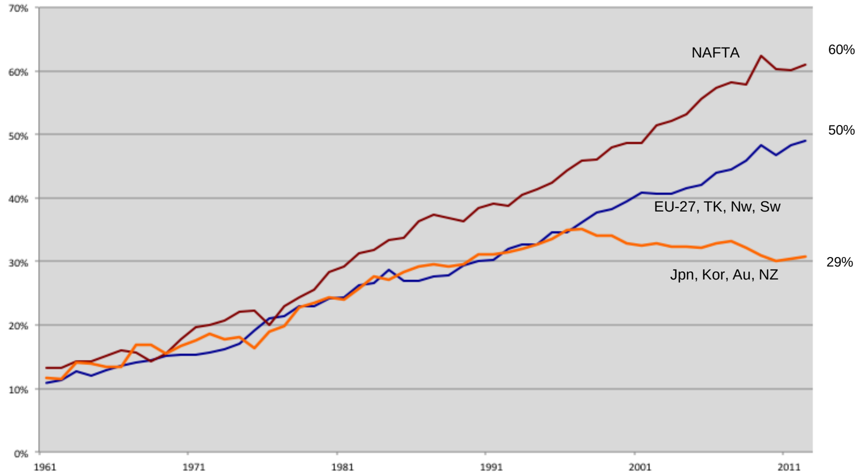
Environmental comparison of minimills and integrated mills in OECD countries



Source : Industry data, Laplace Conseil estimates

For many decades, the share of EAF steel has grown steadily in Europe and NAFTA

EAF share in crude steel production, by region (%)



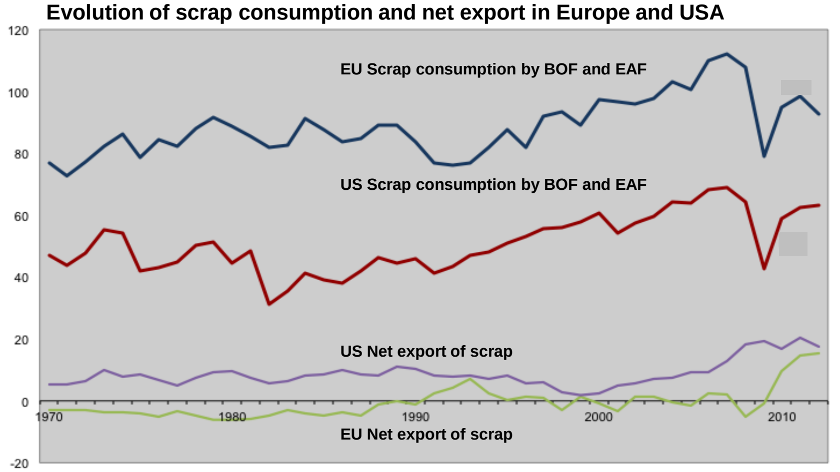
Source : WorldSteel, Laplace Conseil analysis

Is there enough good quality scrap to increase EAF share ?

- In the past 50 years, scrap collection has kept pace with scrap demand, but recycling rate can never reach 100% so there is a limit.
  - Home scrap (recycled within the plant has been reduced dramatically with the introduction of continuous casting.
  - Prompt scrap (new scrap from downstream processing industries are highly sought after since their origin can be traced), but industry also reduce arising.
  - End of life scrap (after steel containing products or structure are decommissioned or thrown away) is collected by a constantly evolving recycling industry, but some steel has a very long useful life (bridges) or are hard to collect (reinforcing steel)
- Scrap quality is decreasing; high quality steel cannot be made that way
  - Old scrap is polluted by copper unsuitable for deep-drawing high qualities
  - Today, 100% of long products and 70 – 80% of flat products can be made with scrap
  - Scrap impurities can be diluted with pig iron or DRI.
- Scrap exports limit availability for domestic producers
  - All three OECD regions are net exporters of scrap for many decades

USA was always a large scrap exporter; EU started to export significant quantities after 2009.

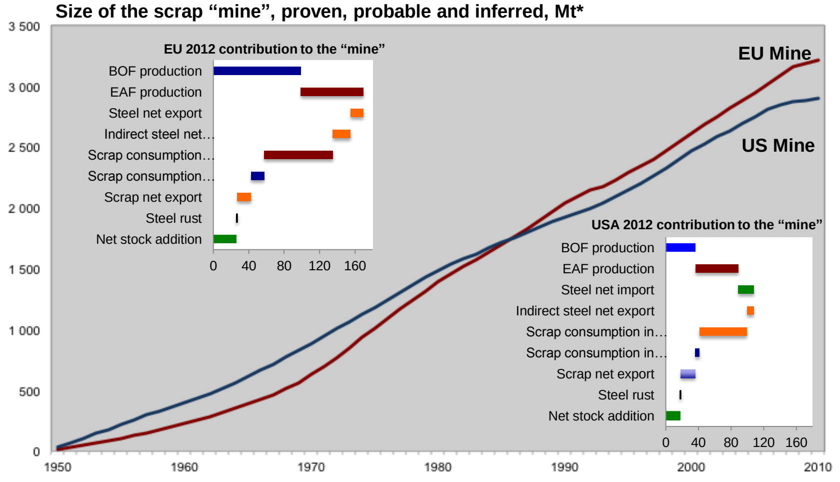
Evolution of scrap consumption and net export in Europe and USA



Source : Worldsteel, Laplace Conseil analysis & estimates

The EU and US scrap “mines” each have a growing proven and probable reserve of 3 billion tonnes

Size of the scrap “mine”, proven, probable and inferred, Mt*



Source : Worldsteel, Laplace Conseil analysis & estimates

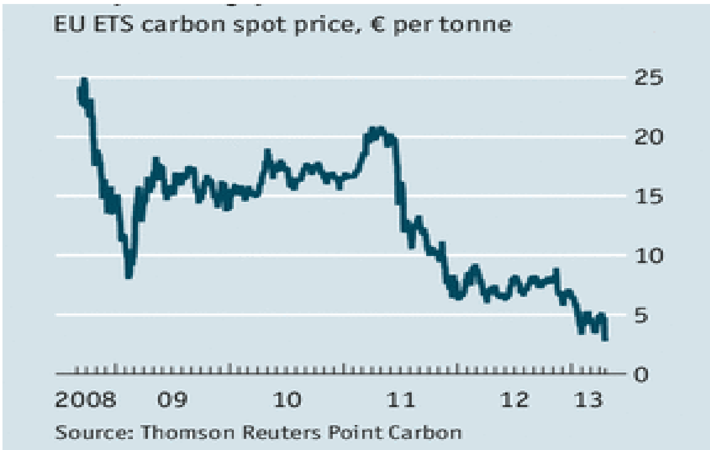
Low priced shale gas is creating an entirely new perspective for the NAFTA steel industry

- The reduction of iron ore into iron needs either CO or H_2 as reductant
- Coal (coke) is the traditional reducing agent in blast furnace
- Natural gas can replace coal in Direct Reduction Process (DRI)
- Energy efficiency of the two processes is similar, but CO_2 emissions are significantly lower with natural gas.
- DRI has been produced for a long time in gas rich OPEC countries and is now available in NAFTA region thanks to shale gas production.
- 10 DRI projects are currently under consideration in the US and the first will start in a few month time.
- Considering the overall cost and quality advantage of DRI/EAF process as well as the dynamism of new steel entrants, we expect that half the NAFTA BF/BOF will be replaced in the next 15 years.
- In Europe, gas prices are unlikely to fall in the medium term, so DRI will not be produced soon but will be imported to substitute BF/BOF production. A first project has been announced recently.

Concerns for the Climate Change has prompted the EU to sponsor an emission trading system

- In 2012, the EU steel industry has accounted for 5% of all EU emissions. Emissions have been reduced by 14% since 1990.
- This is due to a 4% reduction in specific emissions (T CO_2 / T steel) by the integrated industry and a 32% reduction by the minimill sector coupled with an increase from 28% to 49% of the minimill share of production.
- While there is still progress to be made to reduce specific emissions, it is generally accepted that many plants are using best available technologies (BAT) and that further improvements are hard to justify on economic term, especially with the current low value for the carbon offset. In short, the ETS faces difficulties in inducing further improvement in the steel industry while generating concerns for accelerating delocalization of the industry.
- The best opportunity to further reduce the carbon footprint of the industry is to accelerate the switch from BF/BOF to Scrap/EAF.
- This structural change would of course create major social disruptions and has sparked a lively debate on ETS impact, but also about scrap availability and quality, carbon leakage, scrap export restriction, etc.

The economic crisis in Europe has led to over capacity in the carbon market and falling prices



While steel is energy intensive, it is also a major supplier to the energy industry

Consumption of steel by energy industries (Mt)

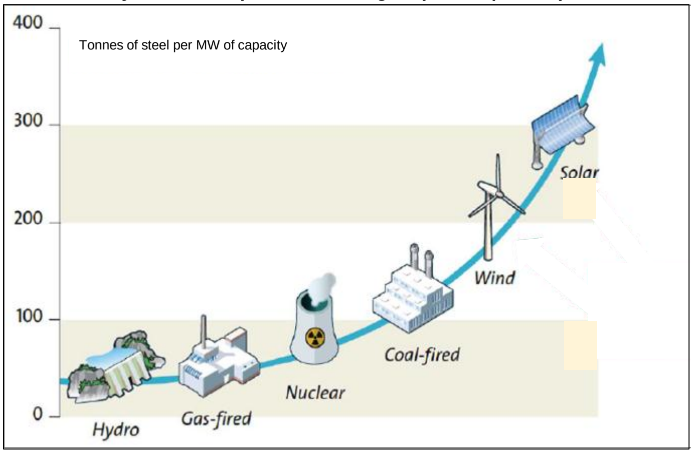
Fuel type	Exploration & Production	Transport to market	Power plant construction	Refining & distribution	Electricity distribution
Oil	25	15	-	5	
Gas	20	40	5	-	10
Coal	10	15	16	-	
Hydro	4	-	4	-	
Nuclear	-	1	2	-	
Wind	-	-	5	-	
Renewable	-	-	1	-	
Total	59	71	33	5	10

178 MT that is 12 % of total finished steel production

Source : Worldsteel, Eurofer, Laplace Conseil analysis & estimates

Wind and solar are the most steel intensive technologies for power generation

Steel intensity of different power technologies (tonnes per MW)

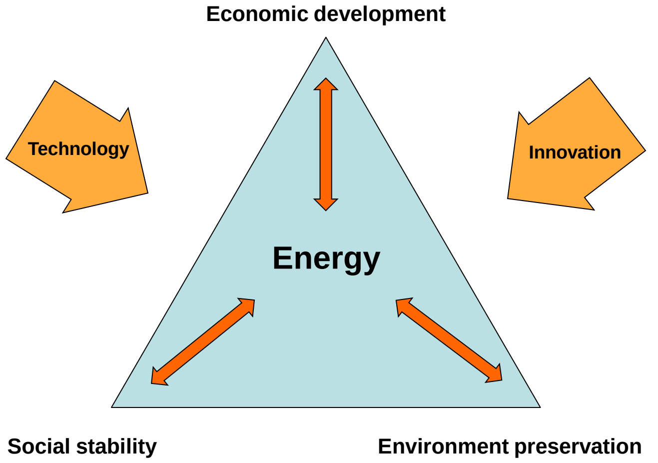


Source: Albanese et al.

Finally, Steel is a major contributor to downstream energy savings

- Higher quality and strength of modern steel allow for the construction of more efficient applications that will use less energy compared to actual applications. Hence, sustained R&D effort in steel is essential to increase the use of these new steel qualities.
- Example of new steels that reduce steel energy consumption :
  - High temperature resisting steel to improve performance of fossil fuel power plants.
  - Replacement of fossil fuel by onshore and offshore wind turbine
  - More efficient electric sheet to improve efficiency of transformers and motors
  - Stronger steel and laser welded blanks allows for weight reduction in cars and trucks and for increased fuel efficiency
  - Combined heat and power generation in households and industry

Conclusions : Energy is at the crossroad of the three dimensions of society evolution. Technology and innovation are the key to future progress



Thank you for your attention

LAPLACE CONSEIL

Metal and mining Consultant

www.laplaceconseil.com