# Assessing the impact of carbon pricing on refinery profitability

## The carbon cost to the European refining industry arising from EU policy will depend on the carbon price and on the refinery's carbon footprint

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The current global economic slowdown has shifted the focus of public, media and policy makers away from climate change and climate action. However, local as well as inter-governmental authorities are still further developing climate legislation, the speed, result and effectiveness of which, however, are subject to discussion.

Although UN-led negotiations to reach a global agreement on greenhouse gas (GHG) emissions reduction seem like a continuing series of failures, the signature of the Durban Platform in which the parties agree to come to a binding treaty by 2015 justifies some moderate optimism. But then again, one day after the conference, Canada announced that it would quit the Kyoto protocol in order to avoid the fine it would be subjected to for not meeting its commitment.[1]

There are more local initiatives to put a price on carbon:

- 2011 was not the best year for Europe's Emission Trading Scheme (EU ETS), with security breaches, cases of fraud and carbon prices at record lows due to the economic slowdown, resulting in an oversupply of free emission permits. Nevertheless, the EU authorities adhere to the plans for the third phase of the EU ETS starting in 2013 and consider measures to support the carbon price.

Switzerland has its own ETS, with voluntary participation, and plans to link its system to the EU ETS

- After failing three times to successfully vote an Emissions Trading Scheme, the Australian government passed a national carbon pricing scheme in November 2011. The law establishes a carbon tax of AUD$23 per ton of emissions on 500 sites beginning in July 2013. The tax will rise by 2.5% until 2015, at which point the scheme will change into a trading scheme with the price set by the market. Under the Jobs and Competitiveness provisions of the new scheme of the act, refineries will initially receive 94.5% of the emission permits for free
- An emission trading scheme started in New Zealand in 2008. Emitters must surrender New Zealand Units (NZUs) to cover emissions. From 2013 onwards, one permit will be required for each tonne of $CO_2$ emitted. The NZU follows the trend of the EU ETS emission permits. Early 2011 spot prices for NZUs have ranged from NZ$19-21,[2,3] but NZUs dropped below NZ$7 in January 2012[1]
- Canada has abandoned its GHG reduction ambitions through carbon pricing to avoid jeopardising development of the tar sand industry. However, British Columbia and Quebec schedule to run carbon tax or cap-and-trade schemes.[1]

Ontario, British Columbia, Quebec and California (USA) participate in the Western Climate Initiative (WCI). A cap-and-trade programme is advised within the WCI, but not all Canadian provinces have committed to implementing it, while all but one US states had pulled out of the programme in November 2011 as a result of the political shift after the 2010 US elections

- In the US, federal cap-and-trade legislation has been pushed off the table after the Waxman-Markey bill failed to obtain the required support in the federal Senate. Subsequently, cap-and-trade was declared dead. Support for GHG legislation through carbon costing further vapourised in many states after the 2010 elections.

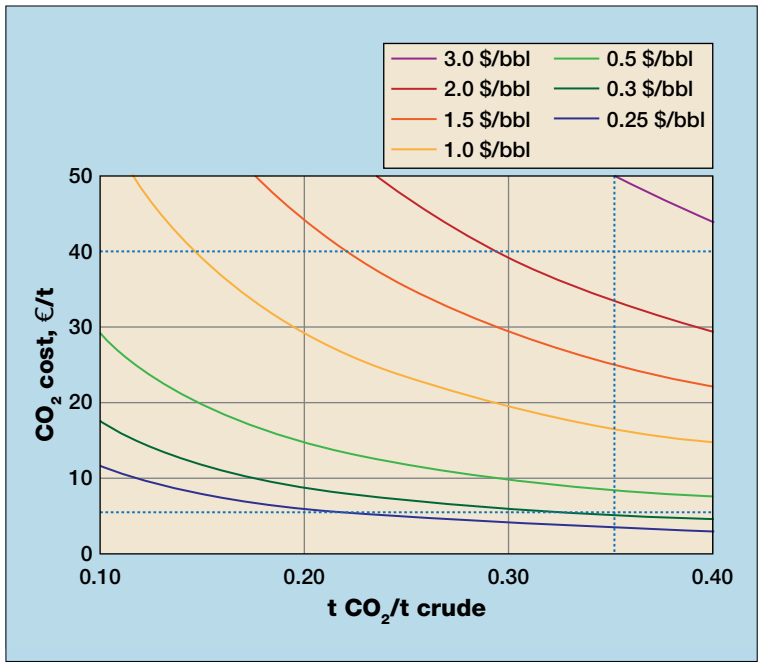


**Figure 1** Impact of carbon cost on refinery margin

California, however, still intends to put in place the US's first economy-wide emissions trading system in 2013, targeting covered entities in the electricity, industry and transportation sectors, including oil refineries.

The Regional Greenhouse Gas Initiative (RGGI) of the eastern states and Canadian provinces is another cap-and-trade system, which, however, is limited to power generation only

- Since 2008, South Korea has been working on policies aimed to establish a GHG Emissions Trading Scheme. For the first phase, over 95% of allowances will be freely allocated to the industries.[2] However, a bill to launch emissions trading in 2015 is currently stalled in parliament[1]
- Industrial sectors and some regions in China are encouraged to take on carbon trade. Shenzhen has been selected to host the country's seventh regional pilot carbon trading scheme from 2013 onwards. The others are Guangdong, Beijing, Shanghai, Tianjin, Chongqing and Hubei. State Council approved a proposal under which there is a plan to set up a national carbon accounting system during the 2011-2015 five-year plan period.[2]

These local initiatives show, on the one hand, that carbon pricing and cap-and-trade are not dead everywhere, but, at the same time, that the road to carbon pricing is long and slow. Only Europe is currently pricing carbon emissions, and only partly. And only a limited number of other countries (Australia, New Zealand and California) have concrete plans to limit GHG emissions through emission pricing in the future. For an outsider, this will seem surprising, since cap-and-trade is generally considered to have been (cost) efficient in reducing acid rain in the US. The stakes in the case of GHG emission pricing, however, are much higher, as carbon-intensive industries could potentially be seriously affected by carbon pricing.

## Carbon cost and refinery profitability: the full cost case

Figure 1 shows what the impact is of carbon pricing on refinery profitability if all emissions have to be paid for. It should be noted that all carbon pricing schemes that have been proposed or voted include at least a partial compensation for the polluters, normally by supplying free emission permits.

Carbon cost is a function of carbon price, on the one hand, and of the carbon intensity of the refinery on the other, the latter being defined as tonnes of carbon emitted per tonne of crude processed. Carbon intensity not only depends on crude and fuel type, refinery complexity and energy efficiency, but also on the import/export policy of steam, power and hydrogen.

If the EU oil demand figures of 680-690 million tonnes of crude processed annually, as reported by Europia, are used as a basis, then, using verified emission data published by the European Commission,[4] the average carbon footprint of the EU ETS refineries is around 0.21 $tCO_2$/tcrude.

KBC estimated the carbon footprint for different refinery configurations and crude types using KBC's Petro-Sim software to calculate unit rates, hydrogen consumption and FCC coke make, and KBC's Best Technology Energy Benchmarking methodology to calculate the carbon footprint of different refinery configurations. It is assumed that hydrogen, steam and power are produced on-site. Carbon footprint varies widely from 0.08 $tCO_2$/tcrude for some hydroskimming refineries

to 0.35 $tCO_2$/tcrude for high-conversion complexes.[5]

Figure 1 shows that, depending on carbon price and refinery footprint, the impact on refinery margin can vary from a marginal 0.1$/bbl (at 5€/$tCO_2$) to a hefty 3$/bbl (at 50€/$tCO_2$). So, in order to make any statements with respect to the burden of carbon cost on refinery profits, it is necessary to investigate more closely both the carbon price and the carbon footprint for each particular situation. Further, the fact that all schemes on the table worldwide also include (partial) compensation of the carbon cost has to be accounted for.

In the following paragraphs, the carbon burden for refineries will be investigated more closely, using the European situation as a case study.

## European Emission Trading Scheme (EU ETS)

Since 2005, all major European GHG emitters have to report their emissions and submit permits for those emissions. The idea is to have a capped amount of permits in the system (but not for individual emitters) and to reduce that cap over time. So far, most permits were distributed for free to the emitters, while shortages and excesses have been traded between individual emitters.

The first (trial) phase of the EU ETS, which ran to 2007, ended in failure when the price of the EU ETS carbon permits (EU Allowances or EUAs) crashed due to over-allocation of free emission permits to the local industries by the authorities of the different member states. In order to avoid the same happening again during the current second phase of the EU ETS, which runs until the end of 2012, a stricter assessment of the emission permit allocation plans that the member states supplied was performed by the European Commission. But there was nevertheless still a lack of uniformity, with different states applying different allocation methodologies and policies.

The EU ETS now covers the 27 EU member states plus Norway, Liechtenstein and Iceland. As mentioned earlier, Switzerland plans to link its ETS to the EU ETS soon.

To further expand the level playing field, an almost unique set of rules for all participating states was set up for the third EU ETS phase, which will run from 2013 to 2020. The overall EU GHG emission reduction target of 20% versus the 1990 baseline by 2020 has been translated into a 21% reduction for the EU ETS emitters versus the 2005 baseline. GHG emissions under the EU ETS cap have to drop from 2.04 billion tonnes in 2013 to 1.78 billion tonnes in 2020. The emission reduction target for the non-EU ETS sources was set at 10%.[4]

One of the key changes compared to the previous phases is that Phase III emission permit allocation is no longer regulated by the individual states but on a European level, and that free allocation to installations will be provided for through harmonised community-wide rules, so-called ex-ante benchmarks.[6] The reference point for these benchmarks is the average performance of the 10% most efficient installations in a sector or sub-sector in the EU in the years 2007-2008.[6]

In principle, the amount of free emissions will decline from 80% of the benchmark level in 2013 to 30% in 2020, with a view to reaching no free allocation in 2027. However, there is a risk that industries that are subject to a significant competitive or trade risk from outside the EU ETS will move abroad due to the carbon cost, and with them the jobs and carbon emissions. To avoid this, these so-called carbon leakage-sensitive industries will continue to receive 100% of the benchmark emission permits for free.[6]

In December 2009, the European Commission published a list of approximately 165 sectors that will continue to receive 100% of benchmark emissions for free, out of a total of 258 sectors identified.[4] The carbon leakage-sensitive sectors represent 77% of all industrial emissions, excluding the power sector. The carbon leakage list of exposed sectors applies until 2014 and will then be subject to review. Oil refineries are on the list of carbon leakage-sensitive industries.

## Free emission permits for the EU refining industry after 2012

The EU ETS-wide benchmarking method is a more sound basis for free emission permit distribution than the set of different approaches used by the different states during Phase I and II. In April 2011, the European Commission issued a decision on how this will be applied.[7]

For oil refineries, allocation will be based on the so-called $CO_2$ Weighted Tonne method (CWT, often also referred to as Complexity Weighted Tonne). Thereby, the single product of the

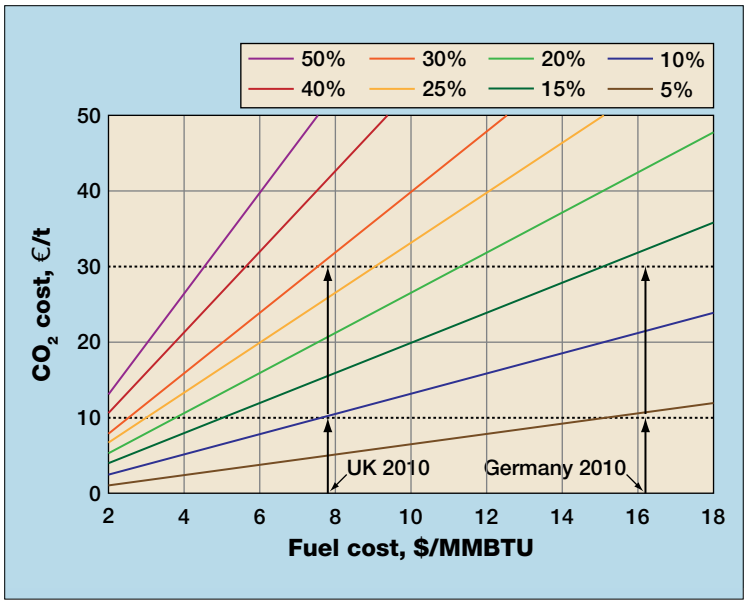


**Figure 2** Carbon cost as percentage of energy cost (natural gas firing)

refinery is the CWT and its production has been calculated by summing the contributions of the different process units, each of which has been weighted with an emission factor relative to crude distillation, denoted as the CWT factor. This CWT factor is representative of the $CO_2$ emission intensity of that unit at an average level of energy efficiency. A catalytic cracker, for example, has a CWT factor of 5.5 versus 1.0 for a crude unit. Thus, the refinery CWT is sum of the unit median feed rates during 2005-2008 multiplied by the CWT factors for the respective units. The CWT is then corrected for power generation and for heat transfer to non-EU ETS entities. A default emission factor of 0.465 $tCO_2$/MWh is applied for power generation. CONCAWE estimates that 12% of refinery emissions are related to power generation.[8] The CWT method was developed by Solomon Associates (the owner of the methodology) and CONCAWE.

In principle, benchmarks for emissions allocation should be based on product rates and exclude plant-specific parameters such as configuration, fuels and feeds.[9] From this point of view, the CWT method is flawed, since it is highly configuration and technology dependent. However, oil refining is a much more complex process than, for example, cement clinker production, with many different product streams, which makes it difficult to develop a benchmark that meets the theoretical criteria while still being representative of real refinery emissions. Therefore, and because no better alternative was suggested and also because the methodology is claimed to have been validated, the CWT methodology has been retained for refinery emission permit allocation by the commission after an additional assessment.[8]

For the years 2006 to 2008, CONCAWE has constructed a benchmark curve using data received from the EU ETS refineries. From this curve, the average emissions of the 10% most efficient installations has been estimated at 29.5kg $CO_2$ per CWT. Therefore, each refinery will receive 0.0295 (tonne of) emission permits for each CWT.[8]

## Carbon balance and market in Europe

Towards the end of Phase I of the EU ETS, the EUA emission permit price had crashed to zero due to an oversupply of free emission permits by the different EU member states. In spite of the reduction in free emission permits during the current second Phase II, it looks like the EU ETS will again end up with a substantial excess of emission permits, this time largely due to the economic turndown. The fact that the allocation of free permits is based on historical and not on actual production has further exacerbated the situation and resulted in a large oversupply of free permits to some sectors (steel and cement production, in particular). Thus, rather than driving GHG emission abatement, the second phase of the EU ETS has mainly been a subsidy scheme from power suppliers (which are short of emission permits and have passed on the cost to consumers) to the industries with an excess of free emission permits.

This excess of emission permits has led to a price crash of the emission permits to 7€/t at the beginning of 2012. A crash to zero has been avoided by allowing the emitters to bank Phase II permits for usage during Phase III. Sandbag estimates 670 million tonnes of permits will be carried over to Phase III,[10] while others mention even 1.4 billion surplus allowances up to 2020.[11] To boost carbon prices back to a level where they

will actually incentivise GHG abatement, calls are made to either increase the emission reduction target from 20 to 30% (versus the 1990 base), which would mean an increase in the EU ETS reduction target from 21 to 34% (versus 2005), or to withhold a substantial amount of permits.[1, 11]

Figure 2[12] shows which fraction carbon cost represents of the fuel cost (in case of natural gas firing). The graph indicates that at the January 2012 low EUA carbon emission permit price level of around 7€/t and high German gas prices, the cost of the emission permits represents less than 5% of the cost of the fuel that generates the emissions. At this level, the impact of carbon cost is almost marginal and the only real driver for reducing GHG emissions is the price of the fuel itself. At 30€/t for the permits, however, carbon cost could represent almost 30% of fuel cost in the case of cheaper (UK) gas prices.

## Future carbon cost for European refineries

Wood Mackenzie has estimated the impact of the Phase III EU ETS on refinery profit with Europia and CONCAWE, and found that, in spite of the continued free allocation of permits, the average EU ETS refinery will still be 30% short of emission permits, which it will then have to purchase on the market. This would increase operating costs by 13%.

Some observations need to be made here:

- This assessment was done assuming a $CO_2$ cost of €30/t.[13] The EUA emission permit price did reach 30€/t during a couple of months in 2008, but dropped below €10/t by late 2011 and will not rise to any level near 30€/t soon due to the earlier mentioned oversupply. In the medium to longer term, EUA prices may reach or exceed €30/t, provided that the authorities intervene by increasing the EU emission reduction target to 30% and/or by setting aside a large number of emission permits. Calls for intervention to save the flagship of Europe's climate policy are increasing. However, bullish carbon price predictions of €30/t in 2012 and €75/t by 2020[14] will not materialise without intervention and look high for any scenario, even if the options currently considered to boost carbon would be implemented. Indeed, the European commission estimated in May 2010 that an increase in the GHG reduction target would increase the carbon price during Phase III from 16 to €30/t. That was after the start of the economic slowdown, but before the extent of the permit surpluses had become fully clear
- Overall, the refinery sector itself has a limited surplus of emission permits that it will be able to carry over to Phase III of the EU ETS. According to Sandbag, the 2008-2010 refinery emissions surplus amounts to 20 million tonnes[10] while based on registry data.[4] KBC estimates the surplus at around 14 million tonnes, as shown in Table 1. If refinery throughputs remain low, the surplus will reach 30 to 35 million tonnes by the end of 2012, which is equivalent to approximately 3% of the EU ETS Phase III refinery emissions. The refining industry will be able to use this excess to offset part of the carbon cost of Phase III
- In addition to the traded EUA emission permits of the EU ETS, emitters can make limited use of the so-called Certified Emissions Reductions (CERs) emission offsets that stem from the UN Clean Development Mechanism (CDM), as well as from Emission Reduction Units (ERUs), which are emission permits from the Joint Implementation (JI) scheme.[6] CERs and ERUs are priced cheaper than the EUAs, as shown in Figure 3. On average, CERs have been priced 25% cheaper than EUAs. In other words, the marginal carbon cost is lower than the price of the reference EU ETS EUA benchmark. Recently, refineries have started to make more extensive use of CERs and ERUs (see Table 2)
- The EU ETS member states have to publish and submit to the Commission the amount of free permits they plan to give to each installation during Phase III.[6] KBC has investigated the data available on 10 January 2012, as submitted by the UK, Ireland, Poland, Romania and Lithuania. For the units for which data were available, the

**Refinery emission permit balance**

| | Free permits allocated % of emissions | Permit excess Million tonne |
|---|---|---|
| 2008 | 98 | -2 |
| 2009 | 104 | 6 |
| 2010 | 107 | 10 |
| 2008-2010 | 103 | 14 |

**Table 1**

**CERs and ERUs submitted by refineries (million)**

| | CER | ERU |
|---|---|---|
| 2008 | 4.4 | 0 |
| 2009 | 8.0 | 0.3 |
| 2010 | 13.2 | 2.2 |
| 2008-2010 | 26 | 2.5 |

**Table 2**

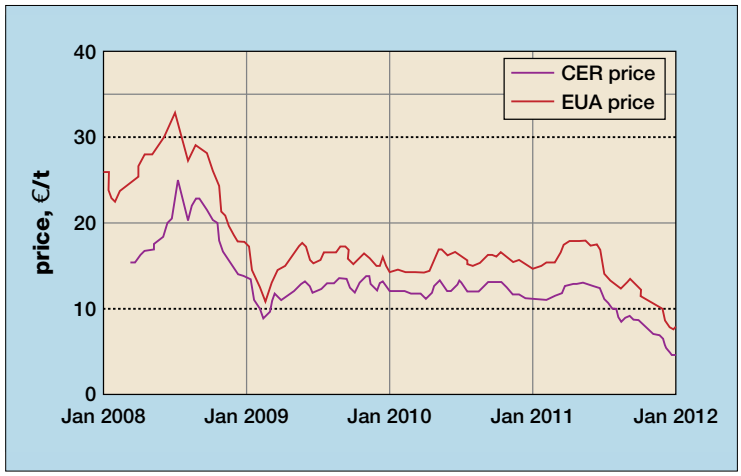


**Figure 3** EU ETS carbon price

amount of free emission permits during the EU ETS Phase III are equivalent to 80 and 83% of the annual emissions during the 2005-2008 and 2008-2010 periods, respectively. The difference between the two periods is due to the fact that refineries reduced throughput after the start of the crisis, in late 2008.

According to the preliminary data available, free emission permits represent at least 80% of past emissions. This may indicate that refineries will have to pay for 20% or less of the total emissions during Phase III instead of 25-30%. However, as data of only 14 refineries out of a total of 96 were available at the time of writing, this will have to be confirmed later.

Fuel cost typically represents approximately 50% of refinery operating costs, while carbon cost, as a percentage of fuel cost, is shown in Figure 2. From this, assuming a carbon price varying between 10 and 30€/t and taking into account that only 30% of emissions have to be paid for, carbon cost can be expected to range from 0.6 to almost 5% of operating cost.

EU refinery margins are expected to remain low for the foreseeable future. However, increasing refinery margins and feed rates will increase the carbon shortage. This will increase the $CO_2$ cost, which in times of higher profitability, however, will be easier to carry

• A study has indicated that value of emission rights allocated for free to the refineries, iron and steel, and petrochemical sectors most likely have been passed through in the product prices in EU markets.[15] Consequently, increased operating cost due to carbon pricing does not seem to lead to reduced profits for the emitters, at least not in the short and medium term, which is the timeframe that was considered in the study. In the longer term and for product exports, however, this may not be the case.

So far, the averaged refining sector has been considered. The carbon balance for individual refineries can differ widely from that average. Indeed, while the average refinery for which data are already available will receive 83% of 2008-2010 emissions for free, this figure varies from 47 to 208% for individual sites. This is due to differences in energy efficiency, to the fuel type used, or to miscalculations or gaps in the CWT methodology. Consequently, some sites will have to buy 50% of their emission permits. Carbon cost of these refineries will be almost 70% higher than the average cost.

## Conclusion

The carbon cost to the refining industry during Phase III of the EU ETS will depend on the carbon price and on the refinery's carbon footprint. Without intervention by the authorities, prices are likely to remain moderate to low (15€/t or less). If, however, the authorities increase the EU emission reduction target from 20 to 30% or set aside a large amount of excess emission permits, carbon prices could reach 30€/t again.

At 10 and 30€/t$CO_2$, respectively, the marginal carbon cost for adding a barrel of crude will be around 0.2 and 1.1$/bbl. With 30% of emission permits to be paid for, the average impact on the refinery margin will be 0.06 and 0.33$/bbl, respectively.

The use of cheaper (CER/ERU) offsets and the fact that the average refinery will be able to carry over 3% excess free emission permits from Phase II into Phase III will reduce the carbon cost by at least 10%.

Without accounting for the softening impact of excess permits and usage of cheaper offsets, average EU ETS refinery operating costs can be expected to increase operating costs by 0.6% to almost 5% at carbon prices ranging from 10 to 30€/t. For the worst performing refineries,

however, the cost will be 70% higher than these averages.

Carbon prices of 10€/t and less will have a marginal impact on refinery profitability. In a higher price scenario, the impact on refinery profitability becomes more significant at around 1$ per marginal crude barrel, but remains only a fraction of the fuel cost and even of the product transportation cost. Further, it should be noted that in the short and medium term, refineries will probably be able to pass on the carbon cost to the consumer within the ET ETS.

It cannot be excluded that, in the future, carbon pricing will be claimed to have been the straw that has broken a refinery's back. However, considering the impact that can be expected within the EU ETS for the years to come, such a claim would have to do more with the visibility of carbon pricing than with the actual economical impact itself, which is dwarfed by the underlying impact of the challenges and handicaps the refining industry is currently dealing with, such as surplus capacity, diesel/gasoline production/demand mismatch, competition from new diesel-oriented and energy-efficient refineries in the (Middle) East, and poor energy efficiency of some sites.

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