ENERGY SAVINGS IN CHEMICAL INDUSTRY

K. Van Reusel, LABORELEC, Belgium
R. Belmans, Katholieke Universiteit Leuven - President UIE

INTRODUCTION

This paper provides an overview of some key problems and their solutions as encountered by the collaborators of LABORELEC during consultancy tasks while auditing the energy efficiency in Belgian chemical plants. Many of these plants are partnered with international companies, therefore the data presented here have implications in a broad setting.

CO_2 REDUCTION POLICY CONTEXT

Before discussing the auditing experience in the chemical industry some background information on the CO_2 policy may be of use.

After ratification of the Kyoto protocol by the Belgian parliament, the government established an “Energy Efficiency Benchmarking Covenant” for energy intensive industry. This benchmarking covenant is a tool for the CO_2 reduction policy. The principles of this covenant fulfill the economic requirements aimed at fulfilling the Kyoto commitments, and safeguard the expansion possibilities of industry. Energy intensive companies may join the covenant on a voluntary base. If they join, they commit to use the best international references of energy efficiency by the year 2012. This must be a commitment, not a mere effort promise. As compensation these companies are exempted from future CO_2 taxes and future compulsory CO_2 emission ceilings.

Benchmarking Legal Framework

Essentially, there are two main points in the benchmarking covenant, i.e. the legal framework for energy benchmarking. The best reference for a given process has to be defined; and because it is likely most companies are not the most efficient, the gap between their process and the best reference must be determined. In this way, the best reference and the effort required to reach the best reference are the two cornerstones in the benchmarking system.

A whole process is set into motion for each company that joined the covenant. After identification of the energy flows, an assessment is made to determine the gap with the best reference. An energy efficiency plan is drawn up. This energy plan must be submitted to the authorities before implementation will be imposed. After some interim targets are attained, the goal of the company is to reach the performance of the best reference in energy efficiency by the year 2012.

To carry out the benchmarking studies of their processing plant, companies joining the covenant must appoint a consultant. The benchmarking covenant prescribes that the best reference on energy efficiency should be determined by benchmarking the energy efficiency of comparable processing plants elsewhere in the world. If the company can support the claim that the processes used and production techniques do not allow to make a useful benchmark with facilities abroad, the audit method may be applied to them to define the best reference.

Audit Method

The audit method consists in a systematical inventory of all possibilities to improve energy efficiency in the company. The possibilities are listed in a study, and may or may not be supported by measurements.

In the audit method for determining the best reference, the best international reference in energy efficiency is defined as the efficiency the plant could attain after taking all energy saving measures that are cost-effective. The cost-effectiveness will be fixed according to a financial criterion. Cost-effective measures are deemed to be all measures with an internal rate of return of 15%.

For the controlling administration, a real benchmarking is the preferred approach. A company using the audit method has to support its claim that its situation does not allow for real benchmarking. In spite of these facts, experience shows that most companies prefer the audit method. The main reason for this attitude is that while performing the audit, the energy plan is drawn up simultaneously. Most companies are rather cooperative in drawing up the energy plan. It is set up as a tool to meet the CO_2 reduction requirements, but as it is expressed in terms of energy efficiency, the energy plan promises two kinds of benefits. Not only CO_2 taxes are avoided, but also the energy costs are reduced. The first task after starting an energy audit is to make an inventory of potential projects. Therefore, from the beginning, there should be made a distinction between the total energy consumption of a plant and operations that may have some potential for energy efficiency improvements and are thus taken into consideration for further screening.

SAVING RESULTS IN THE CHEMICAL INDUSTRY

Energy Consumption

Thus far, the overall framework sketched the energy audit as part of the benchmarking covenant. Now a more detailed discussion on the saving results achieved in the study of the Belgian chemical industry is given. In order to provide useful information for the reader, while respecting confidentiality, the figures will be shown as an aggregate of the 5 or 6 plants examined. Table 1 gives the figures for the year 2002.

Table 1. Aggregated Energy Consumption Figures for 2002.

Total energy consumption in 2002 [GJp]	**22,128,223**
Screened electricity consumption [MWhe/y]	231,852
Screened primary energy consumption (non electric) [GJp/y]	7,404,859
Total Screened energy consumption [GJp/y]	**9,491,524**
Total energy savings - primary energy units [GJp/y]	**483,569**

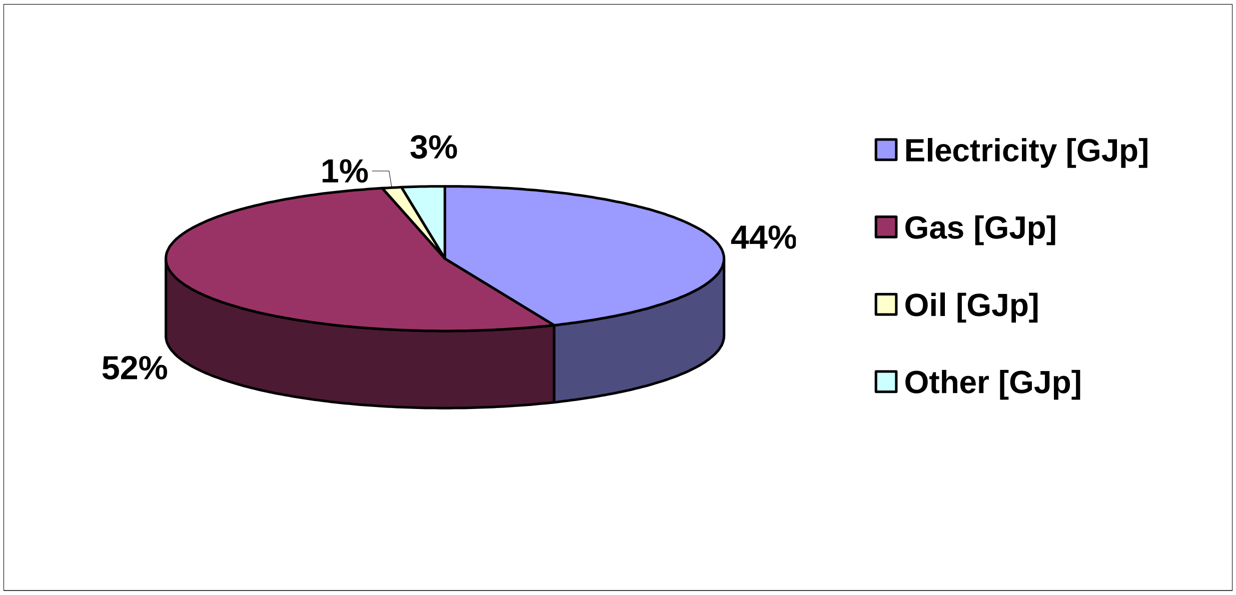
In overall energy consumption, electricity consumption is included, converted to primary energy by a conversion factor of 2.5. The average efficiency of electricity production in Belgium is deemed to be 40%.

As mentioned earlier, by making an inventory of promising energy saving possibilities, a distinction is made between overall and screened energy consumption. The total energy consumption for the year 2002 amounts to 22 PJp (p indicates that primary energy is considered, i.e. electrical energy converted by the above mentioned conversion factor 2.5). The part of the screened energy consumption amounts to 9.5 PJp. This is almost the half (i.e. 43%) of the total energy consumption.

The total energy savings that could be identified amount to 483,569 GJp, i.e. almost 5% of the screened energy consumption.

An achievable saving potential of 5% has come out of the analysis while examining almost half of total energy consumption. Figure 1 shows relative shares of electricity, gas, oil and other energy carriers.

Figure 1. Energy Consumption Chemical Industry 2002.



Gas has the main share of supplied energy, i.e. 52%. Oil represents a share of 1%. Also for the sake of this pie diagram, electricity has been converted to primary energy units by the factor 2.5. To round out the numerical analysis, the total energy savings are broken up into different pay back times related to the investments required to achieve the energy savings.

Figure 2. Pay Back Periods for the Different Technologies To Be Installed.

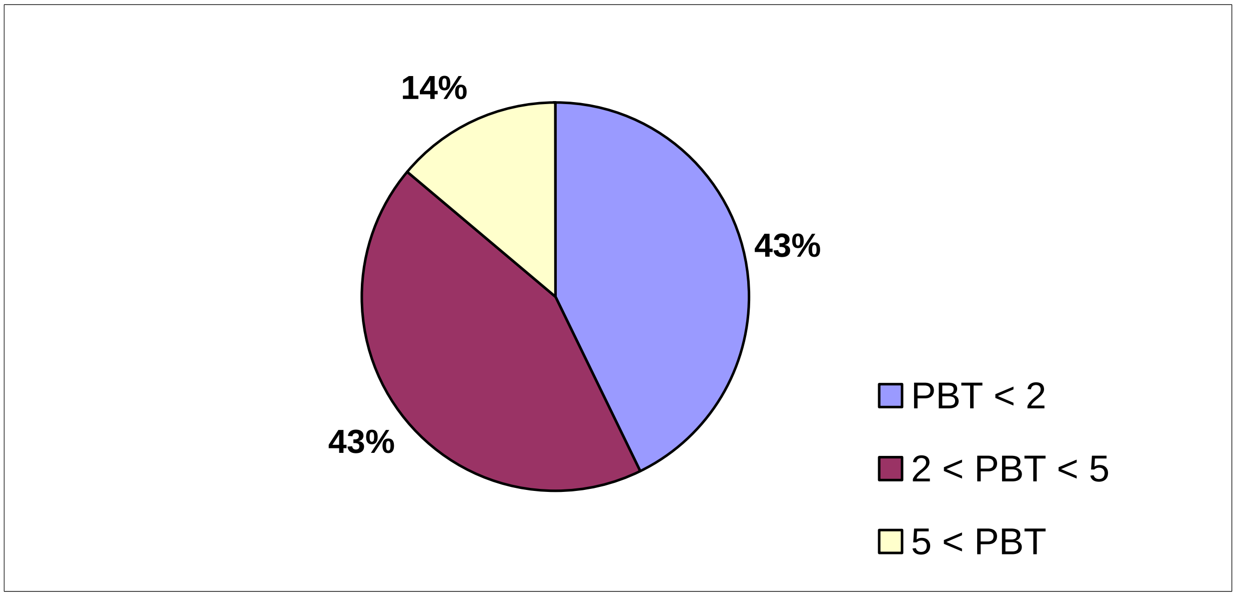


Figure 2 is important for governmental policy on subsidizing companies hesitating to implement the energy saving projects. When the payback time is less than 2 years, most companies implement the saving projects quite promptly. When the payback time is between 2 and 5 years, companies become more reluctant. Therefore, governmental policy should focus on this segment to push hesitating industries towards a positive decision. As the share of this payback time amounts to 43%, it gives an idea about the funds that must be put aside to finance such a subsidy policy.

For the sake of clarity a distinction is made between electricity and primary energy. It has to be kept in mind that it is not energy as such that matters in industry. Energy is converted in technical systems, supplying the operational elements needed in the industrial process. All these technical systems together will be referred to as the utilities. If the chemical industry has a good reputation for energy efficiency, it is mainly due to the fact that the chemical processes themselves are well-mastered, mostly according to the latest state of the art. Where it often goes wrong, however, is in the utilities.

In the well-reputed chemical sector the weak point or the of Achillesheel in energy efficiency lies in the utilities.

Energy Savings

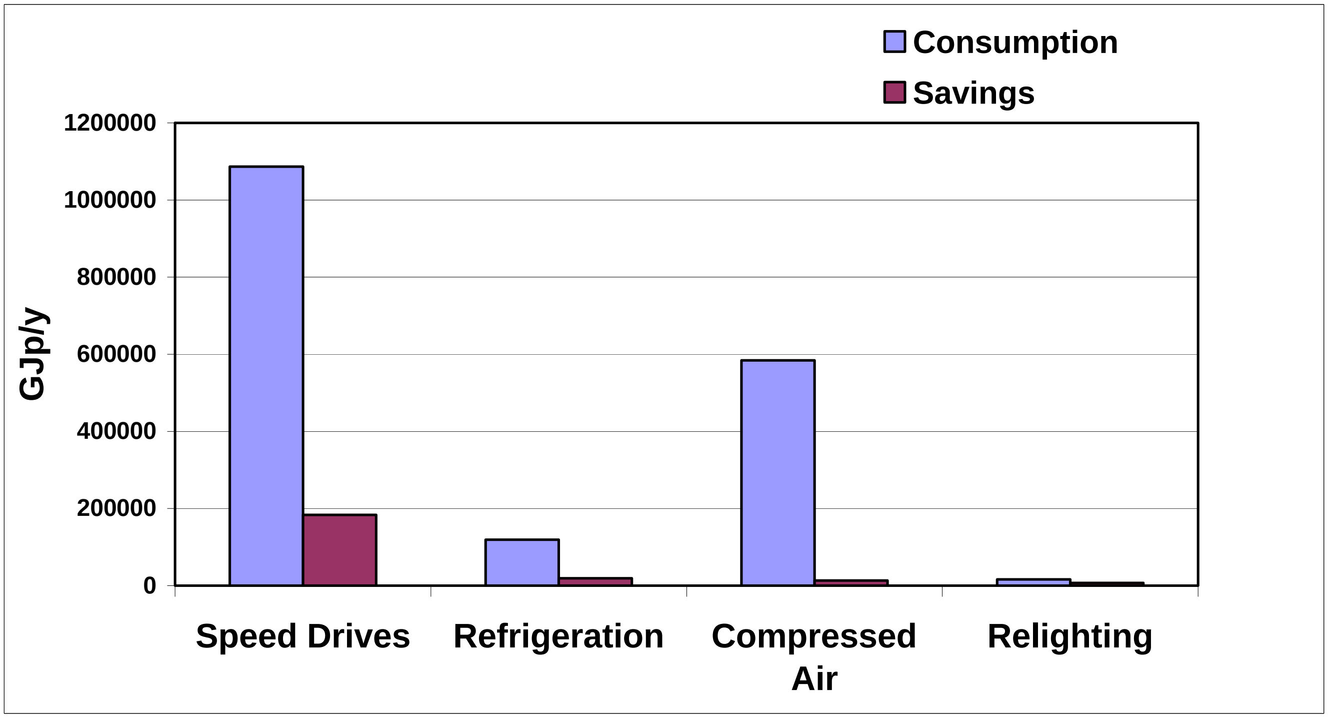
a) Energy savings in the processes

Covering baths, decreasing processing temperature, optimizing cooling temperature: these measures will always lead to a quick win. Heat recovery is another potential for energy savings. For heat recovery, investments are much higher, if possible at all.

b) Energy Savings in the Utilities

Energy savings in utilities is the essential point to be broached when discussing energy savings in the chemical industry. Again a distinction is made between electricity and primary energy. Firstly the savings in electricity will be discussed. As to electricity, variable speed drives, refrigeration, compressed air and relighting are areas where potential savings can be found.

Figure 3. Potential Energy Savings – Electricity.



As can be seen from Figure 3, the saving potential for variable speed drives is more or less one fifth or 20% of the total consumption. How is this saving potential explained? Many times consultancy has as an unmasking effect. Fixed ideas and practices are questioned.

Figure 4. Example of a Steam Boiler Pump for Energy Savings: Real Operating Points.

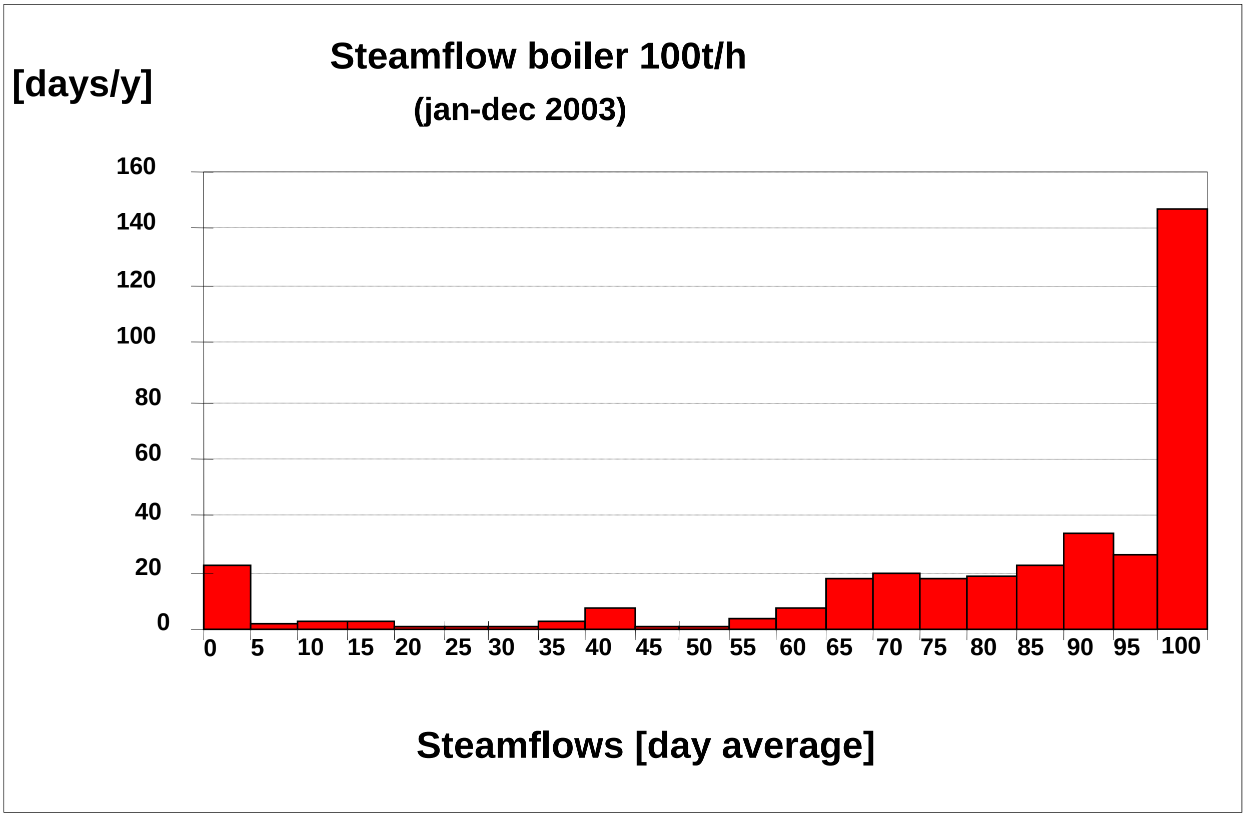
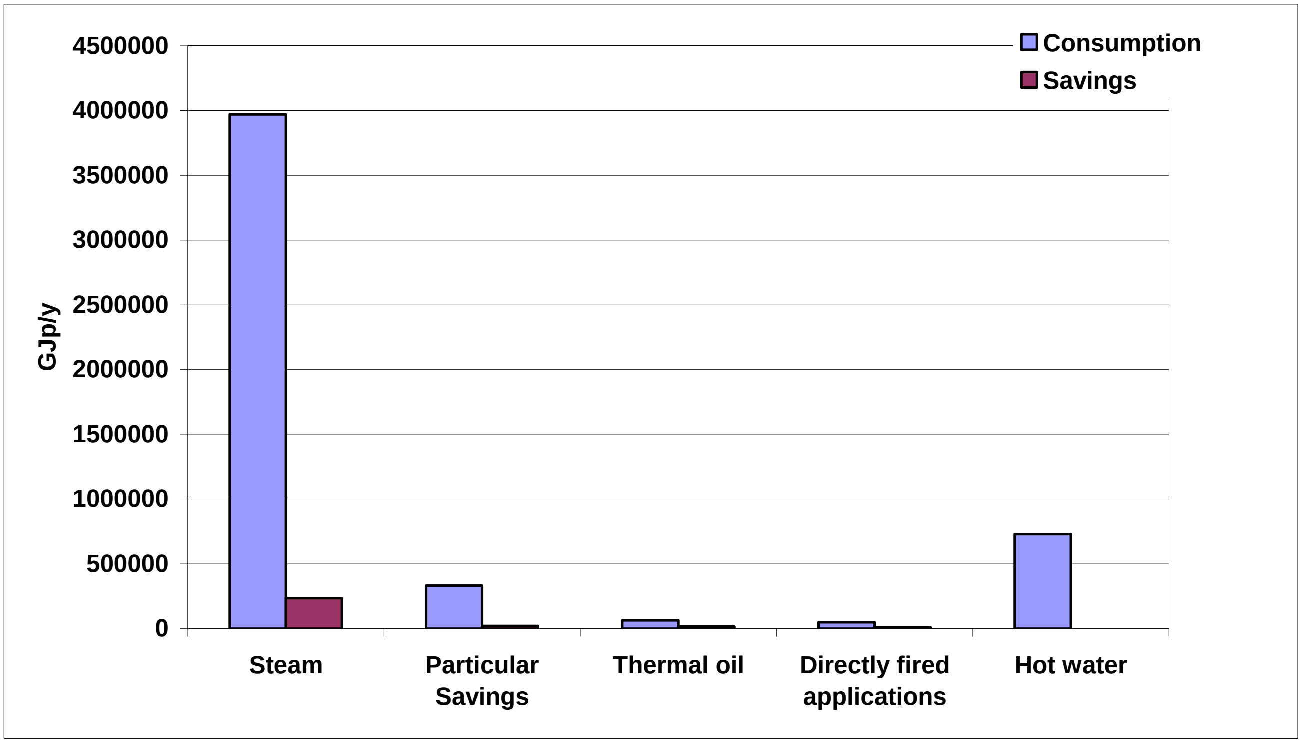


Figure 4 displays the frequency in days per year for a steam flow. The flow is linked to the operating point of a pump. Operators assumed that most of the time there was an operating point at full load. Examining the exact data for energy consumption revealed that there were non-negligible partial load conditions. This discovery led to a considerable energy savings potential by installing a variable speed drive for the pump to handle the partial load situations.

Figure 5 shows the primary – i.e. non electricity – savings versus consumption.

Figure 5. Potential Energy Savings – Primary Energy.



The main savings are in the production and distribution of steam. Thermal insulation of pipes and taps, and replacement of defective steam traps are quite obvious saving measures in the distribution of steam. The recovered heat from emissions can be used for pre-heating supply waters in hot water installations. As to the savings in the production of thermal oil, substitutions of resistance heating by a gas fired boiler and heat recovery of the emissions are very common saving measures. Decreasing the O_2 surplus in the burner and cut off oil flow during production shut down are further points to keep in mind.

TOTAL COST OF OWNERSHIP

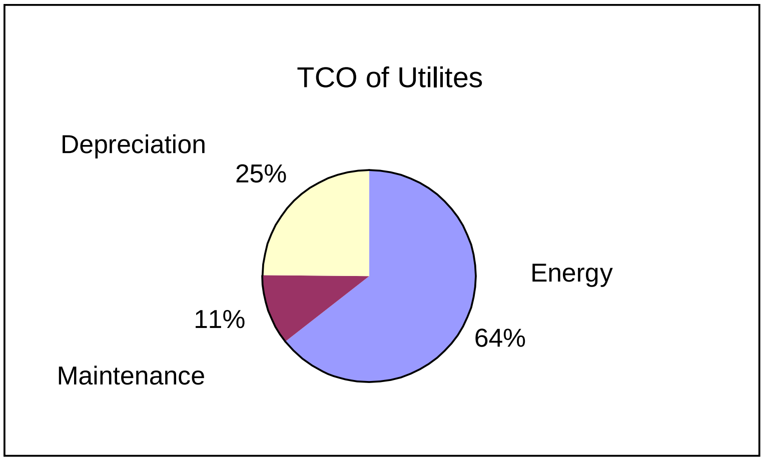
It is obvious in economics that the total cost of products and services is much higher than their initial acquisition cost when taking into account the life cycle. Total cost of ownership as an economic concept in cost analysis stems from the computer industry. A simple example out of that area illustrates an obvious truth: buying a high price computer that is reliable can be more advantageous than the acquisition of a low price computer with consequent repair costs and the potential loss of data. The example of a printer reveals its total cost of ownership at the moment when the first ink cartridge replacement is purchased.

Total cost of ownership applied to utilities can be a very helpful tool in energy and CO_2 economics. It allows easy simulations and scenario analysis.

Because of the flexible mechanisms in the Kyoto protocol as a joint implementation of saving projects, clean development and emission trading, the answer to the question what shall a company do to keep down CO_2 costs is not straightforward and a total cost of ownership concept applied to utilities in the manufacturing process can be very helpful. Total cost of ownership applied to utilities requires first an allocation of the cost to the different intermediaries. After cost allocation, a cost calculation can be done. Applied to utilities total cost of ownership means taking into account energy, depreciation of installations and maintenance cost, including wages.

The elements for which the cost is calculated are defined as “cost objects”. This can be hot water, electricity, cooling water, town water, nitrogen, demineralised water, natural gas, fuel, and electricity generated by diesel groups, etc.

Figure 6. Total Cost of Ownership of Utilities.



The total cost of ownership calculation applied for the whole of the utilities is represented in Figure 6. It allows assessing the weight of each type of cost. As a result, it clearly indicates where the cost reduction efforts have to be focused. The final purpose of the total cost of ownership analysis is to obtain a price per unit as listed in Table 2.

Table 2. Price per Unit of Cost Objects (Utilities).

Cost object	Price per unit		Consumption / Production		Total Cost (€)
Nitrogen	0,1106	€/L	1 907 780	L	211 066
Gas LP	0,2755	€/Nm³	2 286 753	Nm³	629 836
Electricity	0,0609	€/kWh	123 114 370	KWh	7 500 403
Town water	1,5670	€/m³	1 035 433	m³	1 622 530
Softened water	3,4822	€/m³	181 397	m³	631 667
Cooling water	0,0525	€/kWh	67 302 540	kWh	3 533 240
Heating water	8,7034	€/GJ	546 331	GJ	4 754 914

In the price per unit, the CO_2 costs can be integrated when it becomes more clear what these costs are in monetary units. The flexible Kyoto mechanisms make a cost analysis more complex. For industry, it will be possible to make a choice between several scenarios of CO_2 handling. In the future situation of CO_2 scarcity and CO_2 emission allowances trade, the total cost of ownership concept can be a helpful tool to make the choice between different options more clear.

CONCLUSIONS

As an overall impression, after auditing energy efficiency in the chemical sector, it can be concluded that conforming to its excellent reputation on energy efficiency management it is indeed not an easy task to find large energy saving potentials in chemical plants. Nevertheless, there are still savings to be made, mainly in the utilities.

When CO_2 becomes a real cost factor in the near future, the total cost of ownership approach applied to utilities will help industry to make the right choice between different possibilities of CO_2 cost handling.

Finally, if energy saving can be made even in the well-reputed chemical sector, such savings will certainly be present in industry in general.

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