

Combining IPPC and Emission Trading: An Assessment of Energy Efficiency and CO₂ Reduction Potentials in the Austrian Paper Industry

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ABSTRACT

In the framework of an innovative project partnership E.V.A. - the Austrian Energy Agency worked with the Austrian paper industry for the last 2 ½ years in developing a sector-specific climate change strategy. Within the scope of this project, an assessment of the energy efficiency status of the sector was carried out as well as an evaluation of realizable energy savings and CO₂ reduction potentials.

This paper presents the methodology applied, which combines a top down approach (benchmarking & best practice) with a bottom up approach (on-site interviews & energy audits), supported by a huge data collection process.

Within the benchmarking process all Austrian paper industry installations affected by the European Union (EU) emission trading directive were benchmarked against their respective integrated pollution prevention and control/ best available technique (IPPC /BAT) values. Furthermore, an extensive list of best practice examples derived from existing or ongoing studies was compared with the energy efficiency measures already carried out by the companies (“early actions”).

These theory-oriented findings were complemented by several on-site interviews with the respective energy managers as well as by detailed energy audits carried out by a consulting company, covering in total more than 80% of the Austrian paper industry’s CO₂ emissions.

This paper concludes with the main results of the project, presenting the pros and cons of working with IPPC documents and BAT values in terms of energy efficiency assessments. Recommendations are presented on how to improve the allocation exercise for the next emission trading period from 2008 to 2012.

Introduction – Emission Trading and the IPPC / BAT

With the adoption of the EU-wide emissions trading scheme to reduce greenhouse gas (GHG) emissions [EC 2002], a new instrument entered the “energy efficiency market” creating a need for integration within the existing policy mix.

Within the EU emission trading scheme, each affected installation received absolute emissions allowances, which were reported to the European Commission in the so-called national allocation plan (NAP). The time before 31 March 2004, the deadline for the first NAP covering the period from 2005-2007, was very turbulent in almost all EU countries, since negotiations between authorities and industry on how to agree on absolute emissions targets are a very “delicate” matter. For the industrial companies it meant for the first time that they were given a cap on their emissions which could effect their economic growth considerably. Thus they were tending to get as many allowances as possible so as not to limit possible production increases.

On the other hand, it was important for the authorities to make the system work and to achieve high environmental benefits. National governments had to consider that the allocation plan should be consistent with the targets of their national climate change programmes as well as with the obligation under the EU burden sharing under the Kyoto protocol. They also had to make sure that the quantities of allowances matched the actual (technological) potentials.

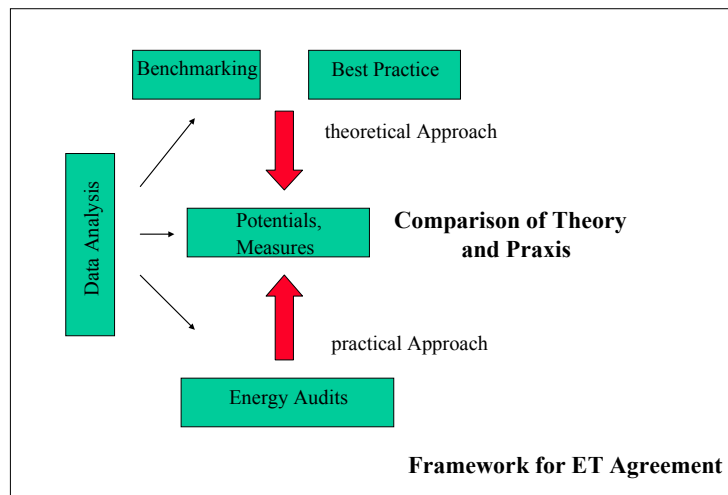
Of course this led to conflicting situations between industry and authorities and therefore transparent information on the available carbon dioxide (CO₂) reduction potentials was of utmost importance. This was the time when the IPPC directive with their respective best available technologies (BAT) values played an important role [IPPC 1996]. The BAT values represent EU-wide accepted benchmarks which could be taken as an indicator for existing energy efficiency potentials. How this benchmarking process was applied in the case of the Austrian paper industry is explained in this paper.

In the framework of an innovative project partnership E.V.A. worked with the Austrian paper industry since 2002 in developing a sector-specific climate change strategy [Starzer et al 2005]. This included an assessment of the energy efficiency status of the sector, as well as an evaluation of realizable energy savings and CO₂ reduction potentials. The project was closely connected to the EU emission trading scheme, since future potentials were considered as crucial information to determine the amount of emissions allocated.

Methodology to evaluate the Energy efficiency status of industry

How does one consider energy efficiency when allocating CO₂ emissions? To answer this question, E.V.A. developed a transparent methodology on how to evaluate energy efficiency potentials [Starzer et al 2003]. In the course of this project, a transparent process was proposed to verify technological potentials. This process includes the elements energy benchmarking, best practice examples and energy audits (see figure 1).

Figure 1. Framework for the Assessment. Benchmarking, Best Practice and Audits



In order to identify the technological potential of concerned emission trading installations, a two-fold approach was used:

First, a theoretical top-down approach was applied:

Based on a comprehensive data analysis of all energy and CO₂ related data, benchmarks were developed for each comparable type of facility. This work was based on previous experiences gained within several EU SAVE II projects [IEC 2001, BPI 2002]. In many cases the values presented in the BAT (best available technologies) documents of the IPPC directive [IPPC 1996] served as master benchmarks to define a “best” value. The benchmarks take into account the thermal as well as the electricity consumption. The distance from the best value gives a first indication on the technological potential.

However, it is essential to know that benchmarking is not a perfect instrument. It can only indicate the general tendency. Therefore parallel checklists of theoretically possible best

practice measures were developed, based on the knowledge of the most recent potential studies in the EU [Haworth 2000, Drasdo 2000, Martin 2000, Alsema 2001, De Beer et al 2001]. By completing this check list the companies pointed out which measures they already accomplished since 1990 (early actions) and which could still be implemented. Pay back time and risks concerning product quality were important criteria to justify that measures are not yet undertaken.

Second, the process was complemented by a practice-driven bottom-up approach:

To be able to compare the theoretical results with “real life”, the companies undertook energy audits in order to show the realistic potentials applicable on their site. The audits were carried out by a consultant (in the most cases by ALLPLAN) who in general was paid on the basis of energy costs saved. The audit followed clearly defined audit procedures, to ensure the quality and comparability of the results [Väisänen et al 2003]. E.V.A. was able to check all audit reports and had detailed talks with the respective project managers of the consultant. E.V.A. also carried out on-site interviews with the responsible company staff, in order to ensure the quality of the results.

The Top-Down Approach – Energy Benchmarking

In the course of the national discussions when developing the national allocation plan, benchmarks were seen as one element to derive emissions allowances on an installation basis. By comparing internationally valid indicators, the Austrian companies should be judged whether they had done their energy efficiency “homework” and whether early actions could be taken into account. This approach considers the fact that in Austria (and in many other countries) not many comparable sites exist.

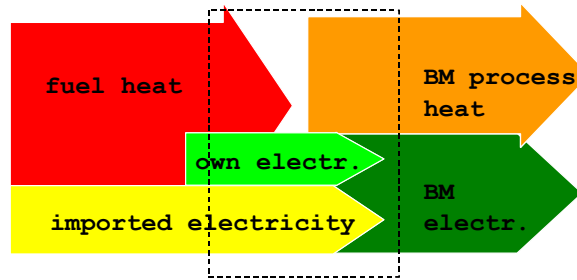
In the course of the project, a set of indicators was derived using sector-specific values and approaches. Installations were distinguished by production, i.e. whether they represented pulp, paper or integrated mills. Furthermore different types of pulp as well as different types of products had to be distinguished to develop a useful set of indicators. For each indicator the thermal and the electricity consumption were related to the relevant production data (see table 1).

Table 1. Schematic Suggestion for a Set of Indicators

Type of installation	electricity	heat	CO₂
integrated production	MWh / tonne of paper	TJ / tonne of paper	CO ₂ / tonne of paper
pulp production	MWh / tonne of pulp	TJ / tonne of pulp	CO ₂ / tonne of pulp
paper production	MWh / tonne of paper	TJ / tonne of paper	CO ₂ / tonne of paper

Defining the system border in terms of energy losses presented a special problem. In a first attempt all energy losses were included within the benchmarks. Thus the indicator was calculated by using the primary energy consumption, initially the heat benchmark was calculated with the fuel heat minus the own production, the electricity benchmark with the electricity consumption, including own production and imported energy (see figure 2).

Figure 2. Calculation of Heat and Electricity Indicator (First Attempt)



Basis for Benchmarks:

BM process heat = Fuel heat – own electricity

BM electricity = Own electr. + imported electr. – exported to grid

In the course of the project this method was changed for two reasons: first, to make the data and results compatible with the data collection project of the UBA (the Austrian environmental agency) and IIO (consultant), carried out to support the ministry in the preparation of the allocation plan. And second, the investigation of the BREF document [IPPC 2001] made it necessary to modify the process to be able to use the published benchmarks for comparison.

It was concluded that a third benchmark should be calculated to compare the efficiency of the energy production process (production of process heat, district heat and electricity related to primary energy consumption). Thus the benchmarks for electricity and process heat consequently included only the energy consumption used for the paper and/or pulp production process.

Due to the lack of information within the BAT documents concerning system borders, some open questions are still remaining. It is not clear whether the energy consumption always is calculated without energy losses, or if sometimes the energy losses are included e.g. for integrated plants. Of course this might lead to completely different benchmarking results. For plants with black liquor recovery system only the produced heat should be taken into account for the benchmark.

According to the above mentioned procedure, the Austrian paper mills were put into different benchmarking groups. By using confidentially reported data, a benchmarking comparison was carried out for all emission trading facilities. The different benchmarking groups and the BAT benchmarks derived from the BREF document [IPPC 2001] are presented in table 2. Possible process related differences had to be evaluated individually.

Table 2. Benchmarking Groups for the Austrian Paper Mills (Source: [IPPC 2001])

Benchmarking group	BAT electricity kWh/t		BAT process heat GJ/t	
	from	to	from	to
Mechanical Pulp				
Integrated				
<i>Newsprint (>50% mechanical pulp)</i>	2000	3000	0	3
<i>LWC mill (> 50% mechanical pulp)</i>	1700	2600	3	12
<i>SC mill (> 50% mechanical pulp)</i>	1900	2600	1	6
Kraft (Sulphate) Pulp				
Non-integrated				
<i>Bleached Kraft pulp</i>	600	800	10	14
Integrated				
<i>Kraftliner, unbleached</i>	1000	1300	14	18
<i>Sackpaper, unbleached</i>	1000	1500	14	23
Sulphite Pulp				
Non-integrated				
<i>Bleached sulphit pulp</i>	700	800	16	18
Integrated				
<i>Bleached sulphit pulp and coated fine paper</i>	1500	1750	17	23
<i>Bleached sulphit pulp and uncoated fine paper</i>	1200	1500	18	24
Recovered paper processing				
<i>RCF based Testliner and Wellenstoff without de-inking</i>	700	800	6	6,5
<i>RCF based cartonboard or folding boxboard, no de-inking</i>	900	1000	8	9
<i>RCF based newsprint, de-inked</i>	1000	1500	4	6,5
<i>RCF based tissue, de-inked</i>	1200	1400	7	12
Paper production				
Non-integrated				
<i>Uncoated fine paper</i>	600	700	7	7,5
<i>coated fine paper</i>	700	900	7	8
<i>Tissue mill (process heat up to 25 GJ/a)</i>	600	1100	5,5	7,5

The benchmarks were discussed in detail with each company and possible mistakes were corrected. The companies could chose whether they wanted to use these benchmarking results within the “distance to best practice” exercise carried out by IIO and UBA.

The Bottom-Up Approach

The bottom-up assessment distinguished three types of energy efficiency measures:

- Measures on the supply side: These measures deal with the energy production on-site incl. CHP, fuel switch and renewable energies.
- Measures on the demand side: These measures are split into two groups: process technologies i.e. technologies to be applied in the paper and pulp production process (such as shoe press etc.) and cross-cutting technologies such as motors and drives, compressed air, heat recovery, heating, air conditioning , lighting etc.
- Organisational measures: These soft measures focus on energy management systems, purchase of efficient appliances, energy efficient behaviour of the staff and similar issues.

In order to distinguish technical potentials from economic feasible potentials, E.V.A. together with the relevant companies carried out several case studies. Within this study a potential was defined as economic feasible when the pay back time of a measure was equal or below 5 years.

Supply Side Measures

Combined Heat and Power (CHP)

Within the Austrian paper industry, 27 paper production sites were assessed in detail, of which 20 are equipped with combined heat and power (CHP). The majority of CHP plants are based on back pressure turbines, but also several gas turbines are in operation, partly in combined cycles. Additionally, 16 installations are equipped with small scale hydro power plants.

The overall efficiency of the energy production (heat and power) was 80.3 %; the efficiency for electricity production was 15.7 % and the efficiency of the heat production was 64.5 %. In order to assess the quality of the CHP plants, E.V.A. calculated the primary energy savings (PES) compared to the separate production of power and heat by applying the “primary energy savings” (PES) formula of the CHP directive [EC 2004], as shown below.

$$PES = (1 - 1/(\eta_{CHP_{th}}/\eta_{REF_{th}} + \eta_{CHP_{el}}/\eta_{REF_{el}})) \times 100 \%$$

- PES: primary energy savings
- $\eta_{CHP_{el/th}}$: is the electrical/heat efficiency of the cogeneration production defined as annual electricity from cogeneration / annual useful heat output divided by the fuel input used to produce the sum of useful heat output and electricity from cogeneration.
- $\eta_{REF_{el}}$: is the efficiency reference value for separate electricity production (here 40,6 %).
- $\eta_{REF_{th}}$: is the efficiency reference value for separate heat production (here 90 %).

If all facilities of the Austrian paper industry are treated as ”one singular plant” the PES amount to 9.4 % which is very close to the benchmark for high efficiency cogeneration of 10% mentioned in the CHP directive (annex III).

Re-Powering

According to a SAVE study carried out by CEPI – the confederation of European paper industries [CEPI 2002] – high CO₂ reduction can be achieved by re-powering existing CHP units into combined gas-steam cycle units. In detail this means to replace a common steam boiler (mainly gas fired) by a gas turbine with heat recovery boiler. The potential mentioned by CEPI results in a CO₂ reduction of 2.4 million tonnes/year.

The figures mentioned in the CEPI study seem too high for Austria. The evaluation of the technical potential for repowering leads to an additional power production of about 713 GWh, which is comparable to about 214.000 t CO₂/year, if the emission factor of the Austrian fossil electricity mix is applied. However, according to the CEPI study, repowering for Austrian plants is so far not economically feasible.

Fuel Switch

A classic possibility to reduce CO₂ emissions is to switch to more climate-friendly fuels, e.g. from coal or oil to gas. Within the Austrian paper industry the share of coal and oil is still about 20% of the fossil fuel consumption. In order to assess whether this amount can still be

switched to more climate-friendly fuels, E.V.A. together with the relevant companies carried out several case studies. These case studies resulted in a technical potential of about 17,500 t CO₂/year of which about 9,000 t CO₂/year are also economically feasible. Due to technical reasons it is very difficult to reduce the share of coal and oil further.

Electricity Production from Biomass

With nearly 50%, the share of renewables is already high within the Austrian paper industry. This is due to the large share of black liquor (79%) which is a by-product of the pulp production. So far several Austrian companies use black liquor for their energy production, others use biomass boilers with fluidised bed combustion.

In order to quantify the future potential to increase electricity production from biomass, E.V.A. undertook several case studies together with the concerned companies. In total a technical potential for further CO₂ reduction of about 280,000 t CO₂/year was identified, of which about 38,000 t/year are economically feasible. This potential could be realised by co-firing units or with new biomass boilers.

Demand Side Measures

Process Technologies

A check list plus questionnaire was filled in by the majority of companies. The list of measures was reduced from 120 down to about 70 energy efficiency measures which are really relevant for the sector. The companies reported which measures they already realised and which are still open. The “open” measures were analysed in case studies and resulted in a technical potential of about 44,400 t CO₂/year. None of the measures were economically feasible (i.e. below 5 years of pay back time), which leads to the conclusion that these type of measures are rather realised in the course of production increases.

The same applies to optimisation measures which consequently lead only to specific energy savings (i.e. energy reduction per tonne of paper/pulp). The potential for this savings is very difficult to evaluate and is not included in this study.

Cross-Cutting Technologies

12 companies which represent more than 80% of the energy consumption were checked by energy audits carried out by consultants (mainly by ALLPLAN). The results show that the companies deal very carefully with energy matters. In the most cases, energy issues are well integrated in common business routines of the companies. Some companies even try to integrate their staff in the identification of measures via employee suggestion systems.

On the electricity side the consultants checked motors and drives, lighting systems as well as compressed air systems and vacuum pumps. On the heat side they investigated the heating systems, several heat recovery options and air conditioning. Also the efficiency of boilers was evaluated. In total the audits identified a technical potential of about 68,000 t CO₂/year of which about 62,000 t/year are economic feasible.

Organisational Measures

It was not possible to get quantitative results for organisational measures. Almost all companies have very sophisticated energy management systems in place and some involve their staff in employee suggestion systems.

Main Results

From both perspectives – from the top-down as well as from the bottom-up approach – it can be concluded that the Austrian paper mills show very good results in terms of energy efficiency. In total 25 installations were included in the benchmarking process. In only 3 cases the benchmarks for process heat were slightly less efficient than the BAT reference. In 4 cases the electricity benchmark was less efficient than the BAT range. Of these installations, one was out of both heat and electricity ranges.

One possible explanation is that plants might have reported incorrect energy consumption data. High differences from BAT reference values only were found among some companies where the product spectrum differed considerably from the spectrum used for the BAT reference. In these cases, the BAT values are not representative. Differences also can be explained by partly integrated plants, i.e. if only a part of the produced pulp is used for paper production on site or if additional (imported) pulp has to be added. This leads of course also to very different benchmarks.

By far the majority of plants were within the given range of the BAT reference and 13 plants even had better values than the lower BAT value (see column “from”, table 2). The same was seen for 15 plants for the electricity benchmark.

In the course of the Bottom-up analysis, several case studies were analysed resulting in a total CO₂ reduction of about 413,000 t CO₂/year of which about 109,000 t CO₂/year are also economically feasible (see table 3). In average this leads to an economically feasible CO₂ reduction potential of at least 1% per year, not yet including day-to-day optimisation measures. In comparison, in 2001 the Austrian paper mills were responsible for 1.93 M tonnes of fossil CO₂ emissions and for 3.09 M tonnes of CO₂ resulting from biomass fuels (which do not count in terms of climate change).

The highest identified technical potential of about 214,000 t CO₂/year results from CHP re-powering. However, to be able to realise this potential, industrial sites have to be used more intensively for power production. Also a stronger cooperation between industry and energy industry might be necessary.

Table 3: Summary of Identified CO₂ Reduction Potentials

	Groups of measures	Technical Potential [t CO₂/yr]	Economic Potential [t CO₂/yr]
1	Fuel switch	17,508	9,000
2	Electricity production from biomass	282,380	38,000
3	Production process	44,414	-
4	Cross-cutting technologies	68,390	61,704
	Total	412,692	108,704
	Re-powering of CHP	214,000	Not done
	CHP with back pressure turbines	20,000	Note done

Conclusions

Benchmarking with BAT values from IPPC seems to be a very easy-to-apply methodology for the allocation of emissions. The ideal situation would be as follows: If an installation fulfils the benchmark it has no further potential for improvement, if not the

difference to the benchmark is per definition the potential. The ease of application would present the main pro of the benchmarking approach.

However, real life is not that easy. Benchmarks have to reflect different types of products and processes, sometimes even different sizes. If not, this could result in very different values of energy used per product unit. Therefore not only several categories are introduced in the BREF document, but also each category covers a wide range of BAT values. Here the main conflict for benchmarking can already be seen: In some cases, the benchmark is so general that many aspects of installations are neglected. Then some plants would not reach a strict BAT value, even if they perform well. Or the benchmark is very tailor-made. Then it could happen that it fits only for one particular plant. How to perform benchmarking then?

The actual set of BAT values within the BREF document tries to take into account both aspects. Within this set the Austrian paper plants amount to a maximum of 3 plants per BAT category. The majority of plants are within their given ranges, many of them have even better values than the lower BAT value. This leads to the question whether the BAT references really present the best available technology. However, to be able to answer this question it would be necessary to compare the BAT references also with the benchmarks of paper mills from other EU countries. In any case, a revision of the BAT values and a clearer definition of the system borders can be recommended, especially if they should further be used in the international context such as for benchmarking exercises. This could happen in a couple of years when the next NAP has to be developed for the 2nd emission trading period of 2008 to 2012. However, given the history of the IPPC process, coming up with new BAT-values may go well into future trading periods.

In the actual NAP process the presented benchmarking results were included. If the installations performed well within their respective BAT range, no “energy efficiency malus” was put on their emissions allowances. Thus, the method of combining IPPC and emission trading in principle seems suitable to integrate energy efficiency aspects into the allocation process. However, as the above-mentioned cons point out, the BAT values need to be revised. Furthermore it has to be taken into account that such detailed BAT values are not available for all concerned industrial branches.

The emissions trading scheme can actually present a strong driver towards industrial energy efficiency. The IPPC documents and their respective BAT references could play a crucial role in monitoring the effects of the EU emissions trading scheme, however, the scheme needs credible and transparent benchmarks to do so and they have to be applied throughout the EU. Therefore quick action is needed if such benchmarks should be ready for the forthcoming allocation period.

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