

Integrated Environmental and Economic Accounts for Tradeable Carbon Dioxide Emission Permits

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1 Introduction¹

- Purpose* It is the purpose of this paper² to introduce the Environmental-Economic Accounting framework as a means for organising data on carbon dioxide (CO₂) permits³ and a tool for analysing both the physical and the monetary aspects of the CO₂ permits as well as the CO₂ permits flow through the economy.
- Background* The background of this paper is that the common European market for tradeable CO₂ emission allowances came into force on 1 January 2005.
- Reduction obligations* The CO₂ allowance market was established to help meeting the CO₂ reduction obligations that the EU, and thereby also Denmark, is committed to under the Kyoto Protocol.
- The common European CO₂ reduction goals concerning the Kyoto Protocol are laid down in Council Decision (2002/358/EC). The legal obligations imply that the EU member states have, on average, to emit 8 per cent less CO₂ than in 1990 over the period 2008-2012. According to the Council Decision, Denmark is legally obliged to carry out a reduction of 21 per cent compared to the 1990 level.
- Complex market* The European emissions trading scheme, which is part of the global carbon dioxide (CO₂) emission allowance market, constitutes a complex market for CO₂ permits. Therefore, means for organising data on permits, which enable analyses of the permits' flow, are crucial. The Environmental-Economic Accounting framework provides such a means.
- Structure* This paper consists of 7 sections. Section 2 provides a general overview of the Integrated Environmental and Economic Accounting framework and highlights the advantages of organizing environment and energy statistics and data on environmentally related taxes and subsidies as well as data on CO₂ permits in an accounting framework. Sections 3 and 4 outline the structure and features of the emission trading scheme. Section 5 deals with the flow of the physical CO₂ permits through the economy, whereas section 6 outlines the monetary flow. Section 7 briefly describes applications and describes how data on permits could be organised in order to be used as input in macroeconomic models. Section 8 summarises the key points of the paper.
- The theoretical background of introducing a system with tradeable CO₂ emission permits is outlined in the appendix.

2 Integrated Environmental and Economic Accounting

Integrated Environmental and Economic Accounting provides a way of structuring information that allows decision-makers and others to gain new insights into public policy issues. It enables to systematically analyse the impact of the environment on the economy, and *vice versa*.

- SEEA-2003* The System of Integrated Environmental-Economic accounting (SEEA-2003) is a satellite system of the System of National Accounts (SNA), which is the standard system for organising economic information. As such, it has a similar structure to the

¹ The views expressed in this paper are those of the author and do not necessarily reflect the views of Statistics Denmark.

² This paper is based on the report 'Integrated Environmental and Economic Accounts for Tradeable Carbon Dioxide Emission Permits – Denmark 2005' (Statistics Denmark, 2006). The report benefited from funding by the European Commission, Eurostat, through grant agreement no. 71401.2005.001-2005.292, Action 3 for the study entitled "Environmental Statistics and Accounts – Other Economic Instruments - Permits".

³ In this paper, the terms permit and allowance are used synonymously.

1993 SNA and shares common definitions and classifications. It provides an integrated set of aggregate environmental and economic information from which indicators of performance can be derived. These can be at the sectoral and macroeconomic level, as well as at more detailed levels, and may guide resource managers and policy makers alike.

Coherent framework The SEEA-2003 provides a set of definitions, classifications, statistical accounts and tables to analyse the interactions between the economy and the environment. It provides a framework for organizing environment and energy statistics together with economic information using common concepts, definitions and classifications. It also enables to analyze links between different environmental domains (e.g. between energy, pollution, land, water, etc). In short, the SEEA-2003 provides an integrated framework allowing trade-offs to be examined.

The integration of information on the economy and energy allows decisions and policies to be designed, analysed and reviewed for effectiveness. In the case of energy and associated air emissions, policy-makers need to be aware of the likely consequences for the economy of implementing or increasing targets for reducing air emissions. Similarly, those industries making extensive use of energy resources in production processes need to be aware of the long-term consequences of their use on the environment (e.g. increased temperatures, reduced water availability).

Analytical value The accounting system has substantial analytical value. By integrating economic and environmental and energy accounts it becomes possible to develop a coherent and consistent set of indicators to examine the implications for different patterns of production and consumption of the environment and energy resources, or conversely, to examine the economic consequences of maintaining given environmental standards. Because economic activities and their environmental impacts, in terms of resource use and emissions, can be compared directly, the system makes it possible to calculate intensities and to derive various kinds of indicators. Moreover, since it uses an input-output structure it can be used for modelling; for example the impact of introducing specific energy taxes or CO₂-permits on resource consumption and emissions.

Consistent analyses Overall, the Environmental-Economic Accounting framework enables the user to make consistent analyses of the economic activity, the use of energy, the associated air emissions, environmentally related taxes and subsidies as well as the flow of CO₂ permits.

SEEA-2003 under revision It should be mentioned that in the SEEA-2003, which is currently under revision, permits are seen as an economic asset and as a result of that the link to the physical aspects, the consumption of energy and the associated air emissions are not mentioned, i.e. only the monetary flow is dealt with.

Physical flows should be accentuated Therefore, the current description in the SEEA-2003 on how permits, e.g. CO₂ permits should be dealt with is likely to be changed. In 2008, based on the revised 1993 SNA, possible solutions are going to be discussed⁴. However, the description in the revised SEEA should not be limited to the guidelines in the revised 1993 SNA. As is shown in section 5, the link to the physical flows should be accentuated.

⁴ The discussion is to take place within the United Nations London City Group on Environmental Accounting.

3 The Emission Trading Scheme

<i>International market</i>	All EU member states are part of the European market for tradeable CO ₂ emission allowances. The CO ₂ allowance system also includes an opportunity for cross border trade. Initially, this is only possible within the EU. In the future, it will also be possible to trade globally.
<i>Future market</i>	At the moment, it is only selected industries primarily the manufacturing industries and the energy supply industries, which are legally obliged to be part of the CO ₂ allowance market. However, even now there are talks about extending the emission trading scheme so that also emissions from international air traffic will be included in the scheme.
<i>Increasing interest</i>	That there is an increasing interest in the CO ₂ allowance market can also be seen by the fact that there is an increasing number of companies which engage in trade with the CO ₂ allowances. These companies are not legally obliged to be part of the emission trading scheme, but act on the market because of arbitrage opportunities. For instance, the investment bank Morgan Stanley has announced that they will increase their engagement in the CO ₂ allowance market.
<i>Danish carbon market</i>	The Danish market for tradeable CO ₂ allowances is, as already mentioned, a part of the European market. The Danish CO ₂ allowance system is, in general, designed in such a way that the majority of the allowances are allocated free of charge (grandfathering), while the aim is that a minority will be sold.
<i>Places of production</i>	<p>The unit level for the units that are used for the allowance system is the production unit (local kind-of-activity unit, KAU), not the companies themselves.</p> <p>In Denmark, 374 places of production are covered by the allowance system in 2008 (251 in electricity and heating, 116 in industry and 7 in offshore industry). Inside the EU c 10,000 places of production are covered.</p>
<i>Allowances are only imposed on selected industries</i>	The industries on which the allowance system is imposed are chosen using a <i>least-cost</i> consideration, i.e. it is the industries that are expected to be able to make the most effective reduction of their CO ₂ emissions at the cheapest cost, which are included in the allowance system. In Denmark, the annual CO ₂ emissions of the industries in the allowance system constitute approximately half of the CO ₂ emissions accounted for by the Kyoto Protocol.
<i>The permits</i>	One permit gives the right to emit 1 ton of CO ₂ . The permits only exist electronically in the allowance register. The permits, besides being marked with the validity period, are marked with information on the country in which the permit was issued, a unique serial number and information on the type of permit.
<i>The different types of permits</i>	<p>The permits that are allocated or acquired at an auction can be traded and used in all EU countries (EU permit). The proceeds from the sale of the permits go to the Treasury.</p> <p>It is also possible to acquire permits using what is referred to as the flexible mechanisms, i.e. by taking part in the following types of projects:</p> <p>CDM (<i>Clean Development Mechanism</i>) – projects. This involves a company taking part as a (co)financier of a project with a partner in a developing country. The CO₂ reduction that the project implies is credited the (co)financier and the company thereby gets a larger number of permits at its disposal.</p> <p>JI (<i>Joint Implementation</i>) – projects. Similar to CDM projects, but where the partner is in a country, which is also obligated to reduce CO₂ emissions according to the Kyoto Protocol. It has been possible to take part in this type of arrangement since the beginning of 2008.</p>

CDM and JI projects have to be approved by the United Nations (UN) before they can be put into action. From 2008 a ceiling will be placed on how large a part of a production unit's CO₂ reduction can be paid for using CDM and JI credits. The credits from the CDM and JI projects can also be traded.

The initial distribution of the allowances

The initial distribution of the allowances is laid down in the National Allocation Plan (NAP) on the basis of the average historic emissions of the places of production for specific base years. The NAP has to be approved by the European Commission.

The main part of the permits are allocated free of charge (grandfathering). For the period 2008-2012, 90 per cent of the permits will be free of charge, while 10 per cent of the permits can be purchased. The selling method and the price are currently unknown. Finally, three per cent of the permits are set aside in the so-called growth pool for new places of production and new activities.

When the permits have been allocated to a company, they are considered to be the property of that company.

The permits can be used freely in the period 2008-2012. Permits that have not been used can be transferred to the period 2013-2018.

If a company chooses to reduce or cease its production, the production unit will not lose the permits it has already been allocated.

Trading in permits

Anyone can purchase and trade in permits, provided they have an account in a European allowance register. The Danish companies that are included by the allowance system have to be registered in the Danish allowance register. Anyone else who wishes to act on the allowance market can choose for themselves in which allowance register they wish to be recorded. The same applies to private citizens.

Until 2008 registration was limited to the European registers. From 2008, it is possible to record in the allowance registers of any country included in the Kyoto Protocol.

In the case of Denmark, this means that the permits can be traded between Danish agents, agents in the EU and finally between agents in other countries.

Sanctions

If the allocated or purchased permits are exceeded by the actual CO₂ emissions, the company is fined (From 2008, 100 Euro/ton). Besides the fine, the number of permits with which the production unit has exceeded their allowance is deleted from their allowance in the following period.

CO₂ credits

As already mentioned, CDM and JI projects are some of the strategies that it is hoped will contribute to helping Denmark meet its reduction obligations under the Kyoto Protocol.

Funds

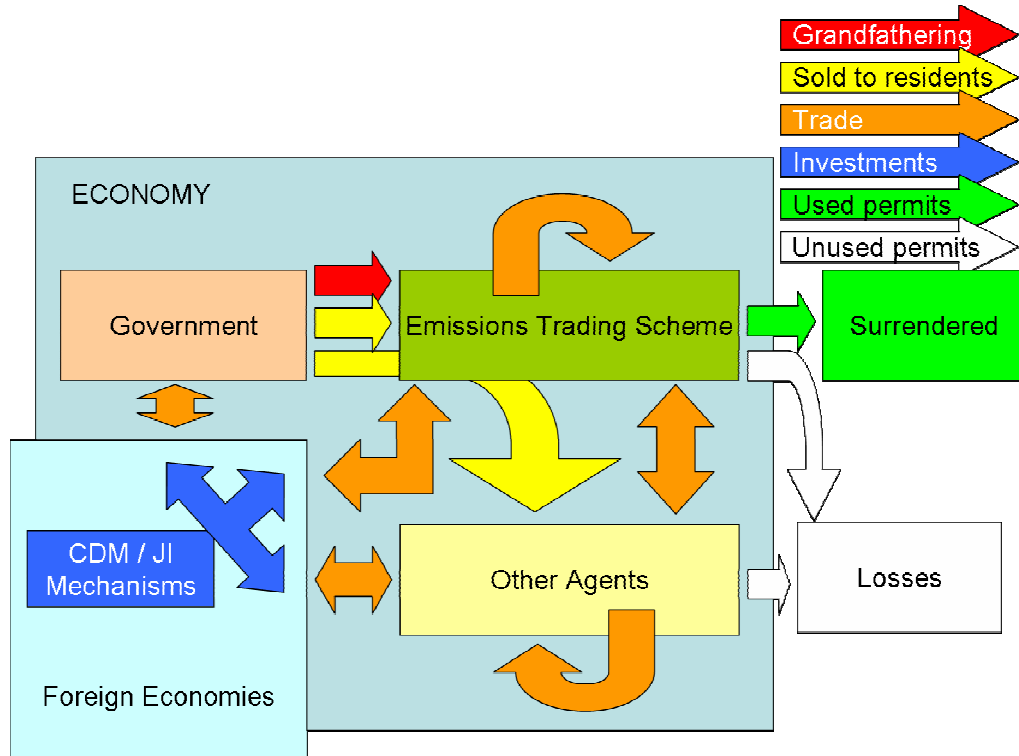
In Denmark, the Government has put aside funds for CDM project and JI projects. The price per permit from the projects is expected to be substantially below the market price, i.e. below the costs for most of the domestic reduction initiatives. The permits are not earmarked to relieve the reduction targets of specific industries.

The fund is going to finance CO₂ credits from CDM and JI projects in developing countries and from countries in Central and Eastern Europe, i.e. investments in technologies that lead to more effective energy use. The credits thus attained can be interpreted as the return on these investments.

4 Economic aspects of the permits flow through the economy

The focal point in this section is the flow of permits, which we would like to describe within the Environmental-Economic Accounting framework.

Figure 1: The flow of permits through the economy



4.1 Permit creation

Creation and issue Either the permits are created and issued by the Governments or they are created as a consequence of the use of the flexible mechanisms. This is how the permits enter the economy in the first place.

The flow of the permits through the economy then depends on whether or not they end up with agents for whom it is mandatory to be part of the emission trading scheme.

4.2 Agents in the emission trading scheme

Grandfathering The companies that are legally obliged to be in the allowance system will typically receive a number of permits free of charge from the Government corresponding to their historic emission of CO₂ (grandfathering).

If this number of permits is enough to cover the company's emission of CO₂, the company can choose to save (banking) extra permits for later use, or the company can choose to sell the permits to a domestic or foreign company. It can be to a company that is also included in the allowance system, or it can be to a company or person that is not included in the allowance system.

If the number of permits is not enough to cover the company's emission of CO₂, then the company has two ways of obtaining extra permits.

The first way is to buy permits from a domestic or foreign company. Also, the Government might have permits in an extra pool, which it is possible for the company to buy. The Government could decide to sell the permits at a fixed price, but normally the Government would sell the permits at an auction.

The other possibility is to use the flexible mechanisms. That is, the company can choose to finance a project that causes a reduction in CO₂ emissions. The company will then get a number of permits corresponding to the reduction in CO₂ emissions.

When a company has surrendered a permit because of its CO₂ emission, the permit will cease to exist. The permit is then no longer available for agents in the economy.

If a permit is not surrendered before it expires, it is lost. The economic value is then zero. However, from 2008, the permits can be transferred to the next period, so the loss is unlikely to happen.

4.3 Other agents

Other companies and private citizens Companies and private citizens, which are not legally obliged to be part of the allowance system, can also choose to participate in the allowance market.

The reason for choosing this is to make a profit by speculating in how the price of the permit will develop. These agents are only in the market because of arbitrage opportunities.

Agents who are in the market because of the opportunities for arbitrage must remember to sell the permit before it expires, since it will otherwise have no economic value. As already mentioned, this was only relevant until 2008, from which, the permits can be transferred to the next period. Only companies in the allowance system can surrender permits.

Environmental organisations and environmentalists could also have an interest in buying permits and not using them, because they could in this way contribute to the reduction of the CO₂ emissions⁵.

5 Physical flows of the CO₂ permits

The CO₂ permit registry The most important source, to the description of flows of the CO₂ permits, is the CO₂ emission permit registry, which can be thought of as an internet bank in which, the deals that take place are registered. In Denmark, the register is administered by the Ministry of Climate.

Object of the register The object of the register is not to effect contact between buyer and seller. Neither does the price appear from the register. The deal is registered in the form of a transfer from the seller's account to the buyer's account.

The information in the allowance register creates an opportunity for compiling a large amount of statistics, which are relevant for the environmental accounts as well as the national accounts.

Method The data obtained from the CO₂ allowance register is at micro level. Therefore, the task is to allocate the information in the emission registry to the national accounts industry classification⁶, which is also the basis for the environmental accounts.

⁵ This has actually been the case in Sweden where private individuals bought allowances in order to give them as Christmas gifts.

⁶ In Denmark, the national accounts industry classification is based on the NACE industry classification.

More details For a more comprehensive description of the emission permits registry and the methods used, in order to relate the data to the national accounts industry classification, please see Statistics Denmark (2006).

5.1 Information to be gained from the Environmental Accounts

New information in the Environmental Accounts When the data on the permits has been related to the national accounts industry classification, it is possible to imagine a number of statistics on the permits. Some of the possibilities are mentioned below.

Depending on the level to which environmental accounts already exist in a country, it would be relevant to juxtapose information on the industries' use of energy, the associated air emissions, and the industries' payment of energy taxes and in addition to this, a series of information on the CO₂ permits.

Policy relevant For politicians and other decision-makers, information on the CO₂ permits is very policy relevant. If described within the Environmental-Economic Accounting framework, the CO₂ emission permits accounts would be able to answer the following questions:

- Questions that could be answered*
- What are the origins of the permits?
 - a. Are they issued by the Government?
 - b. Are they purchased from abroad by the industries? Or by the Government?
 - c. Or did the permits enter the economy as a consequence of the use of the flexible mechanisms (joint implementation or clean development mechanism)?
 - From where have the industries received the permits?
 - a. Are they received from the Government for free (grandfathering)?
 - b. Are they bought, maybe at an auction, from the Government?
 - c. Are they bought from a foreign company?
 - Who owns / holds the permits?
 - a. Is it the energy companies or manufacturing industries that need to have permits in order to undertake their activities?
 - b. Or is it investment banks which are only interested in the permits from an arbitrage perspective?
 - Who is actually trading with the permits?
 - a. What is the trade in volumes?
 - b. What is the value of the trade?
 - c. What is traded internally between the industries (not only the industries included in the allowance system)?
 - d. What are the imports and the exports of the permits?
 - What is the relationship between the use of energy and the CO₂ emissions?
 - a. What is it for the total industries?
 - b. What is it for that part, which is included in the emission trading scheme?

- What is the relationship between the emissions of CO₂ and the emission permits?
 - a. What is the relationship between the industries' total CO₂ emissions and that part of the industries CO₂ emission, which is included in the emission trading scheme?
 - b. Have the industries acquired a sufficient number of permits compared to their CO₂ emissions?
 - c. If not, how big fines have had to be paid (from 2008, 100 Euro/ton).

- What is the relationship between the CO₂ permits and other taxes / subsidies?
 - a. The cost for CO₂ permits in relation to the environmental related taxes.
 - b. The value of the permits received for free in relation to other environmental related subsidies.

Link to the economy As already mentioned, the description of the flow of CO₂ permits within the Environmental-Economic Accounting framework not only makes it possible to analyse the relationship between CO₂ permits and other environmental domains. Because of the link to the national accounts, the description of the CO₂-permits within the Environmental-Economic Accounting framework also enables analyses of the relationship between the economic activity and the CO₂ permits, e.g. output, gross value added, employment etc.

5.2 Results from a Danish experience

Results from the Danish experience Below, some of the results from a Danish experience are shown. See also Statistics Denmark (2006).

Danish experience only covers a subset of the emission trading scheme However, it is only a subset of the emission trading scheme, which is covered in the tables. It is only that part of the emission trading scheme, in which it is mandatory to be part of, which is covered in the tables. This is due to the fact that it was not possible to gain full access to the Danish emission registry. Where information is missing this is indicated by a NA. Therefore, the tables should not be seen as a comprehensive description of the Danish carbon market, but more as what is possible and as an introduction to the possibilities.

Initial allocation Table 1 shows the initial allocation of the allowances. It is only the industries *Agriculture, fishing and quarrying, Manufacturing and Electricity, gas and water supply* which are affected by the emission trading scheme. The allowances are valid from 2005 to 2007. The companies can choose for themselves in which year they want to use the allowance. However, the allowances cannot be surrendered after 2007.

Table 1 Initial allocation of the tradeable permits

Industries	2005	2006	2007
	————— 1 000 allowances / 1 000 tonnes CO ₂ —————		
Total	40 046	30 679	30 590
Permits to be sold by the Government	1 675	1 675	1 675
Permits for new entrants and new activities	1 000	1 000	1 000
Total industries	37 371	28 004	27 915
1 Agriculture, fishing and quarrying	3 056	2 292	2 292
2 Manufacturing	7 525	5 601	5 601
3 Electricity, gas and water supply	26 790	20 111	20 022
4 Construction	0	0	0
5 Wholesale and retail trade; hotels, restaura.	0	0	0
6 Transport, storage and communication	0	0	0
7 Financial intermediation, business activities	0	0	0
8 Public and personal services	0	0	0

Table 2 shows the number of permits grandfathered to the industries and the (verified) emissions actually caused by the industries being part of the emissions trading scheme. The table shows that the companies had to surrender fewer allowances than were actually provided for them in 2005. This implies that it is possible for the companies, because they have a surplus of allowances, either to increase their emissions in 2006 and 2007 or to sell that surplus on the allowance market.

Table 2 Allocated permits, verified emissions and surrendered permits 2005

Industries	Allocated permits	Verified emissions	Surrendered permits
	————— 1 000 allowances / 1 000 tonnes CO ₂ —————		
Total	37 371	26 476	26 471
Households	0	0	0
Total industries	37 371	26 476	26 471
1 Agriculture, fishing and quarrying	3 056	2 328	2 328
2 Manufacturing	7 525	5 452	5 438
3 Electricity, gas and water supply	26 790	18 696	18 704
4 Construction	0	0	0
5 Wholesale and retail trade; hotels, restaura.	0	0	0
6 Transport, storage and communication	0	0	0
7 Financial intermediation, business activities	0	0	0
8 Public and personal services	0	0	0

Verified emissions Table 3 shows the verified emissions compared to the total emissions accounted for in the Danish air emissions accounts. The total emission is exclusive of the Danish operated ships and aeroplanes bunkering abroad. The emissions relevant for the emissions trading scheme account for 58 pct. of the industries CO₂ emissions and for 46 pct. of the total emissions, including the households.

Table 3 Verified emissions and total emissions 2005

Industries	Verified emissions	Total emissions
	————— 1 000 tonnes CO ₂ —————	
Total	26 476	57 911
Households	0	11 941
Total industries	26 476	45 970
1 Agriculture, fishing and quarrying	2 328	4 723
2 Manufacturing	5 452	6 530
3 Electricity, gas and water supply	18 696	25 059
4 Construction	0	1 297
5 Wholesale and retail trade; hotels, restaura.	0	1 345
6 Transport, storage and communication	0	5 203
7 Financial intermediation, business activities	0	529
8 Public and personal services	0	1 284

Even though, there was generally a surplus of allowances in 2005, a few companies did not manage to surrender the correct amount of allowances. These companies had to pay a fine as a consequence of that. The fine amounts to 40 € / ton in 2005, so the total fine paid by the companies amounted to 0.56 mill. Euro.

This amount of allowances, which is not surrendered, is referred to as the amount of under surrendered permits.

Table 4 Under surrendered permits and payment of fines 2005

Industries	Under surrendered permits	Fine
	— 1 000 allowances —	€
Total	- 14	563 480
Households	0	0
Total industries	- 14	563 480
1 Agriculture, fishing and quarrying	0	0
2 Manufacturing	- 14	563 440
3 Electricity, gas and water supply	0	40
4 Construction	0	0
5 Wholesale and retail trade; hotels, restaura.	0	0
6 Transport, storage and communication	0	0
7 Financial intermediation, business activities	0	0
8 Public and personal services	0	0

Until now, the tables have only showed information on that part of the emissions trading scheme of which the companies are legally obliged to be part. However, in order to account for the entire CO₂ allowance market table 5 has been established.

As already mentioned, because of all the problems connected with gaining access to the most detailed information in the CO₂ allowance register, it is not possible to fill out table 5 completely. Therefore, where data has not been available, the cells in the table are marked with a NA.

Asset account The places of production are allocated an average number of permits every year, so it is necessary to establish a sort of asset account for every industry, in order to show: the stock at the beginning of the year; the supply in the form of allocated and purchased permits, and credits from JI and CDM projects; the amount of used permits, including those that may have to be given back because of fines in the previous period; and finally the stock at the end of the year. The closing stock provides the opening stock for the year YYYY+1. Thus, table 5 takes into account all transactions with CO₂ allowances.

The number of allocated permits in column (2) equals the amount of the allocated permits. Cf. table 1.

If information had been available on the trade with allowances, the industries' purchase of allowances would have been registered in column (3), whereas the amount of allowances sold should be registered in column (6). Allowances originating from CDM and JI projects should be registered in the columns (4) and (5).

Table 5 Balance sheet 2005

Industries	Opening stock			CDM credits	JI credits	Sold	Surrendered allowances	Surrendered (fines, etc)	Closing stock
	Allocated	Purchased							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) (=1+...+5-6-7-8)	
1 000 allowances / 1 000 tonnes CO ₂									
Total	0	37 371	NA	NA	NA	NA	26 471	0	10 901
Households	0	0	NA	NA	NA	NA	0	0	0
Total industries	0	37 371	NA	NA	NA	NA	26 471	0	10 901
1 Agriculture, fishing and quarrying	0	3 056	NA	NA	NA	NA	2 328	0	728
2 Manufacturing	0	7 525	NA	NA	NA	NA	5 438	0	2 087
3 Electricity, gas and water supply	0	26 790	NA	NA	NA	NA	18 704	0	8 086
4 Construction	0	0	NA	NA	NA	NA	0	0	0
5 Wholesale and retail trade; hotels, rest.	0	0	NA	NA	NA	NA	0	0	0
6 Transport, storage and communication	0	0	NA	NA	NA	NA	0	0	0
7 Financial intermediation, business active.	0	0	NA	NA	NA	NA	0	0	0
8 Public and personal services	0	0	NA	NA	NA	NA	0	0	0

The number of surrendered allowances in column (7) should equal the verified emissions. Cf. table 2.

If the production unit emissions exceeds the number of permits surrendered then, as already mentioned and besides the fine, the number of permits with which the production unit has exceeded their allowance is deleted from their allowance in the following period. This is accounted for in column (8). See also table 4.

Table 6 Balance sheet 2006

Industries	Opening stock			CDM credits	JI credits	Sold	Surrendered allowances	Surrendered (fines, etc)	Closing stock
	Allocated	Purchased							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) (=1+...+5-6-7-8)	
1 000 allowances / 1 000 tonnes CO ₂									
Total	10 901	28 004	NA	NA	NA	NA		0	
Households	0	0	NA	NA	NA	NA		0	
Total industries	10 901	28 004	NA	NA	NA	NA		0	
1 Agriculture, fishing and quarrying	728	2 292	NA	NA	NA	NA		0	
2 Manufacturing	2 087	5 601	NA	NA	NA	NA		14	
3 Electricity, gas and water supply	8 086	20 111	NA	NA	NA	NA		0	
4 Construction	0	0	NA	NA	NA	NA		0	
5 Wholesale and retail trade; hotels, rest.	0	0	NA	NA	NA	NA		0	
6 Transport, storage and communication	0	0	NA	NA	NA	NA		0	
7 Financial intermediation, business active.	0	0	NA	NA	NA	NA		0	
8 Public and personal services	0	0	NA	NA	NA	NA		0	

The closing stock in 2005 equals the opening stock in 2006. However, it is important to remember that banking is not possible between the two periods 2005 – 2007 and 2008 – 2012. Therefore, the opening stock in 2008 is going to be zero. Hence, it is very important to be aware of the rules in relation to banking between the different periods.

Trade, imports and exports Tables on the domestic trade and the external trade should also be a part of the system. However, due to the fact that it was not possible to gain access to the CO₂ allowance register, it was not possible to provide any information in the Danish experience on the trade or the foreign trade with the CO₂ allowances. It is also important to be aware that the imports and the exports of allowances also have implications for the balance of payments.

Table 7 Purchase / sale and imports / exports of the permits 2005

Industries	Purchase of permits (or Sale of permits)	Of which imports (or Of which exports)
	————— 1 000 allowances / 1 000 tonnes CO ₂ —————	
Total	NA	NA
Households	NA	NA
Total industries	NA	NA
1 Agriculture, fishing and quarrying	NA	NA
2 Manufacturing	NA	NA
3 Electricity, gas and water supply	NA	NA
4 Construction	NA	NA
5 Wholesale and retail trade; hotels, restaura.	NA	NA
6 Transport, storage and communication	NA	NA
7 Financial intermediation, business activities	NA	NA
8 Public and personal services	NA	NA

6 Monetary flows of the CO₂ permits

The underlying idea of the monetary flows of the allowances is first of all to get an idea of the size of the CO₂ market and the agents who act on this market. Secondly, the monetary account is expected to provide the basis for actually implementing the economic flows associated with the European emissions trading scheme and the global CO₂ market in the national accounts.

All allowances have an economic value A large proportion of the allowances are, as already mentioned, given for free to the companies being part of the emissions trading scheme. However, because the allowances represent an economic value for the companies we put a value on the allowances.

Allowances sold by the Government either by auction or directly have clearly an economic value.

Agents on the carbon market A number of traditional energy companies have established units that mediate and trade with CO₂ permits. Their approach is not only to use the CO₂ permits themselves, but rather to make money on the permits through arbitrage. They also have a function as traders and they act on the global market.

In the same way, financial companies also act on the allowance market. A look at the list of members, which are part of the Nordic Power Exchange (Nordpool) market for CO₂ allowances, show that the list contains energy companies as well as financial institutions.

Size of the carbon market The carbon market has grown dramatically over the last few years. The increase from 2006 to 2007 was 64 pct. so that the global CO₂ permit market had a total value of c € 40 bn. (Borsen, 2008). For 2008, the expectation is that the value of the global market could reach c € 60 bn. (Information, 2008).

The European market constitutes approximately two thirds of the global market.

- Observed prices* In connection to the establishment of the European allowance market, a number of CO₂ trading market places⁷, which buyers and sellers can use, have been established.
- Valuation* The valuation of the CO₂ permits is based on the physical CO₂ permits accounts as well as observed prices.
- Overall method* The overall method for establishing the monetary account is to multiply the amount of allowances by the observed market price for the allowances.
- Unfortunately, we do not have information on the extent to which the companies make use of financial instruments, such as price contracts in order to provide against a rise in the future allowance price. Therefore, the monetary CO₂ permits accounts as shown below are valued at the average spot price.
- Results* The value of the allowances valued at the average spot market price in 2005 appears from table 8. Based on the average spot market price in 2005⁸, which was c € 17, the value of the permits allocated to the Danish industries is c € 0.64 bn.

⁷ See for instance:
www.cantorco2e.com
www.europeanclimateexchange.com
www.eex.de
www.exaa.at
www.nordpool.com
www.powernext.fr
www.pointcarbon.com

⁸ In 2005, the lowest price was observed in January at c € 7 whereas it peaked in July at c € 30.

Table 8 Balance sheet 2005

National Accounts Industries	Opening stock		CDM credits	JI credits	Sold	Surrendered allowances	Surrendered (fines, etc)	Closing stock	
	Allocated	Purchased							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) (=1+...+5-6-7-8)	
	Mill. €								
Total	0	636	NA	NA	NA	NA	451	0	186
Households	0	0	NA	NA	NA	NA	0	0	0
Total industries	0	636	NA	NA	NA	NA	451	0	186
1 Agriculture, fishing and quarrying	0	52	NA	NA	NA	NA	40	0	12
2 Manufacturing	0	128	NA	NA	NA	NA	93	0	36
3 Electricity, gas and water supply	0	456	NA	NA	NA	NA	318	0	138
4 Construction	0	0	NA	NA	NA	NA	0	0	0
5 Wholesale and retail trade; hotels, rest.	0	0	NA	NA	NA	NA	0	0	0
6 Transport, storage and communication	0	0	NA	NA	NA	NA	0	0	0
7 Financial intermediation, business active.	0	0	NA	NA	NA	NA	0	0	0
8 Public and personal services	0	0	NA	NA	NA	NA	0	0	0

Allowances sold by the Government

In addition to the value shown in the table above comes the value of the allowances which it is possible for the Government to sell. Cf. table 1. Based on the same average price the value of this amount of allowances is c € 29 mill.

7 Applications

Analyses

Together with the environmental accounts, the physical CO₂ permits accounts and the monetary CO₂ permits accounts set the scene for a series of analyses in themselves. This could be analyses of the relationship between environmental domains or analyses of the interaction with the economy.

Macroeconomic models

In order to use the data on the CO₂ permits as input in macroeconomic models, it would be useful to break down the value of the surrendered allowances by type of energy product.

Allowances broken down by type of energy

The use of the monetary CO₂ permits accounts, would be to use the value of the surrendered allowances (column 7 in table 8) broken down by the type of energy causing the emissions.

This breakdown is believed to be useful for economic modelling and analysis, because of the fact that the price of the allowances is going to affect the companies' behaviour in relation to their choice of energy mix.

The method for this breakdown would be to start from the air emissions accounts and to use the breakdown of the CO₂ emissions by industry and by type of energy as the key for the breakdown.

The breakdown of the value of the allowances by type of energy would provide an extra price level that can be added to the regular price levels⁹ in the monetary energy accounts. In Denmark, the monetary energy accounts are already used as input in macroeconomic models.

⁹ That is, basic prices, trade margins, taxes, VAT and purchasers prices.

8 Summary

Integrated Environmental-Economic Accounting provides a way of structuring information that allows decision-makers and others to gain new insights into public policy issues. It enables to systematically analyse the impact of the environment on the economy, and *vice versa*.

In relation to CO₂ permits, the physical and the monetary CO₂ emission allowance accounts, together with other types of accounts within the framework of Environmental-Economic Accounting, enables decision-makers to answer policy relevant questions.

The description of the flow of CO₂ permits within the Environmental-Economic Accounting framework makes it possible to analyse the relationship between CO₂ permits and the economic activity, e.g. output, gross value added, employment etc.

In summary, the Environmental-Economic Accounting framework enables the user to make consistent analyses of the economic activity, use of energy, the associated air emissions, environmentally related taxes and subsidies as well as the flow of CO₂ permits.

9 References

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10 Appendix: Theory on tradeable permits

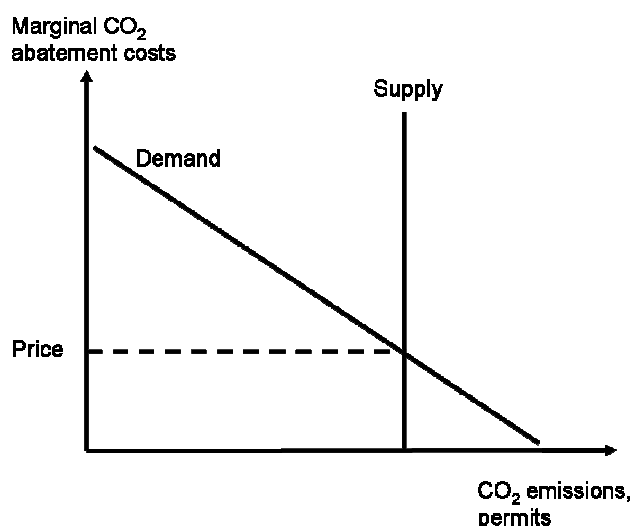
Pollution control The tradeable allowance approach to pollution control was first introduced in 1975 in the United States with what is known as the emissions trading program. Since that time the tradeable permit approach has been applied to several areas of environmental policy. Moreover, support for the market approach to environmental control has increased. See Tietenberg (1995).

Tradeable allowances The underlying idea of the introduction of a tradeable CO₂ allowance system is to create scarcity of the right to emit CO₂. A market for trade with permits is thereby created. By establishing a market for emission allowances, the right to emit CO₂ has been given an economic value. This market will encourage companies to carry out reductions in CO₂ where it is cheapest to do so, i.e. where it is most efficient.

The advantage of the allowance system is that the regulating authority, without knowledge of the CO₂ emitters' cost curves, ensures that the CO₂ reductions are made through the market where it is most efficient.

The regulating authority achieves the desired CO₂ reduction by issuing a fixed number of permits (corresponding to the vertical supply curve) in each period, diminishing in number with each new period.

Figure: Marginal costs



Initial distribution The initial distribution of the allowances can be achieved by selling them, by holding an auction or by *grandfathering* – which is free allocation based on the historic emission levels.

Market adjustment When the permits are made tradeable, the agents on the market will adjust their reduction effort and the stock of permits, so that the marginal CO₂ reduction costs, corresponding to the demand curve, are equal to the price of the allowance. If the marginal reduction costs are larger than the price of the permit, then the agent will keep the permit and vice versa.

Banking The regulating authority can decide if the allowances will only be valid for a single period or if the allowances can be saved for future periods. This is called *banking*.

In general, the permits are most liquid if they can be saved for future periods of time, and if permits for future periods are also issued in the initial offering. See Pearce and Turner (1990).

The alternative The introduction of an optimal (Pigou-) tax on emission of CO₂ will lead to the same solution to the regulation problem as that of the tradeable allowance system. However, to set the precise tax rate it is a necessity for the regulating authority to have complete information on the companies' cost curves.