Economic effects of national emissions trading schemes; national dilemma's within a global issue

Machiel Mulder, CPB, The Netherlands[1]

Paper prepared for the 25th Annual International Conference of the IAEE (International Association of Energy Economics), Aberdeen, Scotland, UK, June 26-29, 2002

Abstract

This paper investigates the effects of the various systems of tradeable allowances for CO_2-emissions in the Netherlands. These effects are compared with those of raising and adapting the current energy taxes.

The results show that a hybrid emissions system (with a absolute cap for sheltered sectors and a relative cap for exposed sectors) performs best in terms of a net national income measure of welfare. An emissions reduction of 12 Mton in 2010 results in carbon price of 95 Euro per ton carbon dioxide and 0.3% loss of Net National Income (NNI). A uniform emission ceiling yields a lower CO_2- price (45 Euro/ton), but also a lower national income (-1.1%), due to the relocation of energy-intensive exposed sectors across the border. Increasing energy taxes within the current tax system is also less efficient (-0.7% NNI), due to the inferior design.

From an economic point of view, a national hybrid system of CO_2-trading is an expensive policy instrument, due to the high transaction costs of the performance benchmark and the distinction between sheltered and exposed sectors. The first-best option therefore is to impose CO_2-emission trading on an international level. Such a scheme will result in a lower allowances price and less loss of national income.

In the national context improving the energy tax design seems to be the most efficient implementation of the domestic climate policy. The current energy tax system can be improved by extending it to all energy use in combination with the current energy efficience covenants and by introducing carbon dioxide differentiation.

Key words: emissions trading, energy taxes, Kyoto Protocol, Netherlands/ JEL codes: Q28, Q43, Q48

1 Introduction

Trading in greenhouse gas emissions allowances is broadly recognized as an efficient instrument for reaching emissions reduction. Emissions reduction will take place at those places where marginal reduction costs are relative low. The advantages of emissions trading are supposed to be large when it is implemented in an international context. After all, marginal costs to reduce emissions differ strongly between countries. Although international carbon taxes also can be efficient, one expects international emissions trading being more conducive to the diffusion of new technologies.

[1] CPB, Netherlands Bureau for Economic Policy Analysis, Department of Energy and Raw Materials, P.O. Box 80510, 2508 GM The Hague, The Netherlands;
I= www.cpb.nl/eng/; E: M.Mulder@cpb.nl; T: 0031-70-338 338 3, F: 0031-70-338 33 50

Due to this characteristic emissions trading is nowadays viewed as an possible alternative for domestic climate policy instruments. In the United Kingdom for example a national emissions trading scheme started quite recently, while in the Netherlands domestic emissions trading is currently dominating climate policy discussions. The efficiency of a national emissions trading scheme is however still under debate. Since marginal reduction costs differ also between various energy users in a country, one can imagine emission trading will also be advantageous when implemented within one country. Otherwise, emissions trading demands much organisational efforts, like the initial allocation of the allowances by means of grand fathering or auctioning and the establishment of a allowances market. In addition, special attention has to be paid to the position of the so called exposed sectors, i.e. sectors which are highly energy-intensive and sensitive to foreign competition. These sectors are favourably treated under the current energy tax system.

In order to assess the feasibility of emissions trading in the Netherlands the Dutch government installed the Advisory Committee on CO2-trade (hereafter committee). The committee was given the task to explore the possibilities of domestic emissions trading without harming energy intensive, international operating sectors. On request of this committee CPB has made an analysis of the economic effects of various schemes for domestic emissions trading. An extensive research report is given in Broer et al. (2002). This paper gives a summary of the results from this study. In addition, the results will be mentioned from research on the economic and environmental effects of adapting the Dutch energy tax system (see Lijesen et al., 2001).

Section 2 describes the method of research, paying attention to the models used and the assumptions made. The design of emissions trading schemes and energy tax systems is discussed in section 3. Section 4 presents the economic effects of different emissions trading systems, which are compared to the effects of raising the tariffs of the Regulatory Energy Tax system within the current design. Section 5 answers the question whether it is efficient to implement emissions trading in the national context. The paper is ended with possible ways to improve the current energy tax system without harming the competitiveness of the energy intensive and export oriented sectors.

2 Method

The assessment of the economic effects of emissions trading and energy taxation schemes is made with using NEMO, an acronym of Netherlands Energy Demand Model (Koopmans et al., 2001), and Athena, a multi-sector macroeconomic model of the Dutch economy (Vromans, 1998). In these models, an allowances market is introduced. Special attention is paid to the position of electricity in the trading scheme. Labelling both domestic and imported electricity according to the emitted carbon dioxide would be optimal, but is however not possible at this moment. Therefore all types of electricity, except renewable, are supposed to generate the same amount of emissions per unit.

The supply of allowances is determined by the cap on the emissions of the sheltered sectors and the degree to which the exposed sectors are outperforming their PSR, and their total production level. The demand for allowances is a function of the total energy use of the sheltered sectors and the carbon dioxide emissions per unit of product of the exposed sectors compared to their PSR and, again, their total production level . The allowance price affects the opportunity costs of the exposed sector's energy use and hence their supply of and demand for allowances. Since the allowance price influences, indirectly, the energy price for the sheltered sector, it also affects their energy use and demand for allowances.

Special attention is paid to the transaction costs of the different emissions trading variants and of the current climate policy. Transaction costs are the costs of searching and gathering information, negotiation, decision making, compliance, monitoring and maintaining. There is little evidence about the absolute level of these costs. Indications about the relative size of the transactions costs could however be deducted from literature (see e.g. Allers (1994) and Stavins (1995).

The transaction costs of the base variant are supposed to be 8% higher in terms of total allowances turnover than in the case of a pure cap-and-trade system without a distinction between groups of firms. The relatively high transaction costs of the base variant result from the introduction of two groups of emitters and the use of a relative emission cap for one of those groups. These system elements demands much administrative and maintaining effort by the government. Also the current national climate policy, especially the covenants, involves higher transactions costs than a cap-and-trade system, but lower costs than in the base variant of emissions trading.

3 National emissions trading schemes

Implementing an emissions trading scheme demands a carefully considered design. In the following the cardinal aspects of that design are mentioned. Figure 1 gives an overview of the design characteristics of the committee’s proposal.

- upstream, midstream or downstream?

There are various ways to attribute energy use and hence emissions to economic sectors. In an upstream system producers and importers of energy (i.e. the upstream link in the energy chain) are obliged to turn over allowances in accordance with their sales of energy. In a midstream system energy traders have that obligation, while in a downstream system end users participate in the emissions trading scheme. In an upstream and midstream system producers and importers respectively traders pass on the allowance price more or less to their customers.

The Dutch committee proposes a mixed system, in which large users face a downstream system and small users (such as households) a midstream system.

- range

The range of a trading scheme refers to the number and the type of sectors that are participating. In theory, emissions trading is most efficient when all energy users join the scheme. After all, differences between marginal reduction costs increase with the number of participants. In fact, practical considerations are reason to restrict the range of an emissions trading system. The committee uses this argument to phase the introduction of a domestic system, starting with only large users and ending with all users.

In addition, the proposal distinguishes between exposed and sheltered sectors. Exposed sectors are defined as energy intensive sectors, being sensitive to foreign competition (on export and/or domestic market), while the remaining sectors are titled as sheltered.

- absolute or relative ceiling?

  Trading in emissions allowances demands a ceiling of total allowances or, equivalently, total emissions. A ceiling can be an absolute emissions cap or a relative ceiling. Total emissions are restricted in the former case, while in the latter emissions are allowed to grow with total production. In the proposal, the sheltered sectors will be subject to an absolute emissions cap, while the firms in the exposed sectors face a relative ceiling, based on a Performance Standard Rate (PSR).

  In a trading scheme with an absolute cap (i.e. a cap-and-trade system) the allowance price raises the marginal cost of energy use and hence product prices, with declining demand and production as result. In a PSR-trading scheme however, marginal costs are not affected, since an increase in production level is accompanied with an increase in allowances. A PSR-trading scheme therefore has no effect on product prices and hence consumption and production decisions in other parts of the economy. Opportunity costs of energy use are however affected.
- allocation

  To start an emissions trading system the initial emissions allowances have to be allocated to the participants. There are two allocation methods, namely grandfathering and auctioning. In the former case allowances are given free of charge, based on for example historical emissions level or standards. At the secondary market allowances will get a price. In case of auctioning an allowance price emerges already at the primary market.

  The proposal chooses for grandfathering of allowances to the exposed sectors on the basis of a PSR and auctioning the allowances to the sheltered sectors via their energy traders.
- recycling

  The auctions returns can be recycled to firms and households by means of a reduction in labour or capital taxes or lump sum, in order to mitigate distribution effects of the trade system. All these recycle mechanisms are analysed.
- electricity

  A sector that needs special attention in any emissions trading scheme is the electricity generation sector. Electricity is a secondary energy carrier, i.e. it is generated via the use of primary energy carriers like natural gas and coal. As a consequence, the production rather than the use of electricity is accompanied by emissions. In a downstream system the carbon content of electricity generation would be attributed to the end users. At present however, labelling electricity is not possible, although it will be in a few years. For that reason, all electricity, except renewable, is treated in the same way by attributing a fixed amount of carbon dioxide emissions to each unit of electricity. This measure applies also for imported electricity in order to prevent a deterioration of the competitiveness of the domestic electricity generation. As this approach does not give an incentive to the domestic electricity companies to reduce their emissions, they face a PSR, like other exposed sectors.

From the above follows different possible emissions trading schemes. The base variant of emission trading is defined as a system in which the sheltered sectors are subject to an absolute emission ceiling, while the exposed sectors are subject to a relative ceiling, based on a performance standard (PSR) for their CO_2-efficiency. The economic effects of this hybrid scheme, hereafter called base variant, are compared to the effects of a national cap-and-trade system and a system in which there is only emissions trade between firms belonging to the exposed sector (see table 1). All trading systems are also compared with the raising the energy taxes within the current design.

In all the above variants, the total domestic reduction in 2010 of carbon dioxide emissions is supposed to be 12 million ton carbon dioxide.[1] In order to demonstrate the sensitivity of the results to the emissions target, two additional targets are analysed, one with 8 and one with 4 million ton emissions reduction in 2010.

In addition an assessment is made of the effects of different recycle mechanisms. Finally the question is answered whether or not implementing a national hybrid system is a good first step towards an international system of emissions trading.

4 Economic effects

- base variant of emissions trading:
The allowance price in 2010 in the base variant is 95 Euro/ton (Table 1). The contribution of the sheltered sectors to the total emissions reduction of 12 million ton is 7.5 million ton, while the remainder (4.5 million ton) is realized by the exposed sectors. The emissions reductions by the exposed sector are mainly (namely 3.5 million ton) sold to the sheltered sector. The allowance price of 95 Euro/ton sets the opportunity costs of the exposed sector's energy use obviously above their marginal reduction costs, while the marginal reduction costs in some sheltered sectors are higher than this allowance price.

The loss of real Net National Income (NNI) of introducing the base variant of emissions trading is 0.3% in 2020. The sectoral effects are not uniform. Agriculture, an exposed sector, is facing a relative large reduction in value added, while the value added in Chemicals and Metal, both mainly exposed, is declining much less. Within the group of sheltered sectors, value added of the Building sector is affected positively, while the value added of the Food industry is declining.

This mixed picture can be explained by the interaction of a number of effects. Transaction costs of emissions trading are relatively high for sectors with many small firms, such as agriculture. Sheltered sectors benefit in different ways from the reduction in taxes and social security tariffs. Exposed sectors have different opportunities to meet their PSR.

In general, however, exposed sectors will profit from selling allowances to the sheltered sectors.[2] The opportunity costs of the allowance price of 95 Euro/ton is higher than the shadow prices of the current covenants. Exposed firms are getting an additional incentive to improve their efficiency. As result, these firms receive allowances which can be sold on the secondary market to sheltered sectors. The returns can be viewed as product subsidies that decreases marginal production costs what will stimulate production. This phenomenon will, as may be clear, lead to increasing emissions by the exposed sectors and additional supply of allowances.

- cap-and-trade for all sectors
When a cap-and-trade system applies to all sectors the allowance price will be 20 Euro/ton in 2010 when total emissions reduction is 12 million ton. The much lower price compared to the price in the base variant results

from the fact that energy-intensive, export oriented sectors will now face a deterioration of their competitiveness, what will result in the relocation of production activity abroad. These changes in industry structure lead to macroeconomic adaptation costs (unemployment and loss of productivity in the medium term). As a result, the loss of real NNI in 2020 is rather large, namely 1.1%. In later years there will be a recovery, what results in a smaller loss.

- raising energy taxes
  Intensifying the current national climate policy (by means of raising the current regulatory energy tax without changing the tariff structure) results in a real NNI-loss of 0.7%. This welfare loss is greater than in the base variant because of the non-optimal design of the current energy tax. This tax does not affect the large energy users in their marginal energy use: raising the tariffs will therefore only result in higher (average) production costs without reducing energy intensity.

Table 1 Economic effects of the base variant, cap-and-trade and raising the energy taxes

	Base variant	Cap-and-trade	Raising energy taxes
Emission reduction (Mton, 2010)	12	12	12
Allowance price (Euro/ton, 2010)	95	20	n.a.
Allowances sold by exposed (Mton)	3.5	n.a.	n.a.
Real Net National Income (% deviation from base line, 2020)	-0.3	-1.1	-0.7
Value added per sector (% deviation from base line, 2020)			
- agriculture a)	-3.9	-7.1	-2.3
- chemicals b)	-1.9	-8.5	-0.8
- metal b)	-0.5	-0.1	-0.2
- food c)	-1	-0.5	-0.7
- building c)	0.1	-1.4	-0.5

a) = completely exposed, b) = mixed exposed/sheltered, c) = completely sheltered
n.a. = not applicable

- PSR and trade

An emissions trading scheme with only trade in the context of a PSR emerges to be ineffective. Emissions reduction and the allowance price are both zero. The explanation for this outcome is that some firms outperform their PSR already in the base line scenario. In a PRS-and-trade scheme those sectors are offered the opportunity to sell allowances that can be bought by firms performing less than their PSR. As result, no additional reduction will be realized and the allowance price will be zero.

This outcome depends of course on the size of the PSR. A sharp PSR for all sectors will initially result in only demand and no supply, resulting in a high allowance price, what is a incentive for supply. The result will be that the average marginal reduction costs are less than in the case of PSR without trade possibilities, while the total emissions reduction is equal in both cases. The total welfare effect depends of course also on the transaction costs.

- remaining variants

Lowering the emissions reduction target goes hand in hand with lower allowance prices. When the reduction target is 8 or 4 million ton in 2010, the allowance price is 60, respectively 25 Euro/ton.

Recycling auction's returns by other mechanisms does not result in a different allowance price, but macro-economic costs are affected. The loss of real NNI in the long run is lowest in the case of reducing the tariffs of both capital and labour taxes. The loss is highest in the case of channeling the auctions' returns lump sum to households. In the former case, contrary to the latter, current distortions of taxation are reduced, resulting in lower welfare losses.

5 National emissions trading: the optimal route towards an international scheme?

From the above follows that implementing a hybrid emissions trading scheme in the Netherlands results in less loss of national income than intensifying the current policy instruments. The transaction costs of the domestic schema are however rather high, because of the distinction between two groups of sectors and the use of a PSR. The question is therefore whether implementing a domestic emissions trading system is the optimal route of the Dutch climate policy.

The optimal route is of course to strive for an international emissions trading system. In an international context the design of emissions trading can be more straightforward. An international cap-and-trade system, as proposed by the EU recently (Commission of the European Communities, 2001), will obviously not result in significant relocation effects, while the allowance price will be lower than in the case of a domestic scheme. In addition, The Netherlands will take much advantage of an European scheme because of its relative high marginal reduction costs. According to Viguier et al. (2001) the marginal reduction costs for reaching the Kyoto-target in The Netherlands are 293 $/ton, while the on average EU marginal costs are 159 $/ton. Capros et al. (2000) estimate the Dutch marginal costs even higher (536 $/ton), while their estimation for the average EU marginal costs is lower (135 $/ton). In the national context seems improving the current energy tax system to be the most efficient implementation of the further climate policy.

6 Improving the energy tax system

Dutch government introduced the Regulatory Energy Tax (RET) in 1996 in order to encourage energy efficiency improvement and the production of renewable energy. The energy taxation is coupled with a reduction of tax tariffs on labour and capital, which means that the tax basis shifts towards environmental polluting factors. This "greening of the tax system" decreases in addition the distortions of the current labour and capital taxation.

The RET is a tax on heating fuels (natural gas and its substitutes, like domestic fuel oil) and electricity, with an exemption for electricity generated with renewable resources. At first the RET was only a small users tax (see table 3), taxing natural gas use below 170,000 m^3 and electricity use below 50,000 kWh. In 1999, the RET is broadened to medium users, taxing also natural gas use up to 1 million m^3 and electricity use up to 10 million kWh. RET tariffs are yearly raised since its introduction. Currently, the RET total return is about 2¼ billion Euro. A part of this return is not recycled through labour and capital tax reduction, but is used for financial stimulation of green energy production.

The effects of the RET are twofold , improving the energy efficiency by end users and decreasing the carbon content of the energy supply, especially electricity. Both effects result in a reduction in carbon dioxide emissions. Raising the current tariffs within the current design (thus with exempting large energy use) in accordance with a total tax return of 1,3 billion Euro would result in about 3 million ton carbon dioxide emissions reduction in 2010 (Lijesen et al., 2001). A third of this effect is realised by means of energy efficiency improvement and two third by substitutions within the electricity sector.

The environmental effects could however be much higher, without deteriorating the competitiveness of export oriented sectors, by improving the design of the energy tax scheme.

The effect of the RET on energy efficiency can be improved by extending the range of the system to all energy use. The current scheme does not give large energy users any incentive for efficiency improvements, since marginal energy costs are not affected. Raising the current tariffs results only in an increase of the average energy costs of large energy users. Extending the scheme to all energy use would however affect marginal energy costs of large users and hence their energy efficiency. Average costs of these firms would however also rise, since recycling the tax returns through labour and capital tax reduction will not be sufficient to compensate energy intensive firms for their energy tax payments. To illustrate this, current Chemical's share in total domestic natural gas use is 31% and in total domestic electric use 13%, while its share in total capital tax payments is no more than 4%. On the other hand, Services pay 80% of total capital tax, but accounts for only 13% of total natural gas consumption and 31% of national electricity consumption. Levying all energy use and recycling returns via capital taxes, would therefore result in higher average costs for chemicals and lower average costs for services. The increase in average costs of chemicals and other energy intensive sectors can result in relocation of those sectors, affecting employment and economic growth in short and medium term. Although positive effects in services will may be compensate for these adverse economic effects from a macro economic point of view, it may be more efficient to anticipate both effects by improving the design of the RET.

The design can be improved for example by relating the tax system to the current energy efficiency covenants. In such a scheme, firms are only obliged to pay energy taxes when their energy efficiency development is below covenant standards. This combination of domestic climate policy instruments accompanies with less transaction costs than a complex domestic trading scheme, while the effects on emissions reduction can be similar.

The RET can also be improved by introducing carbon dioxide differentiation. In that case, electricity produced with e.g. coal fired power plants faces a higher levy than electricity generated with less carbon intensive techniques, like gas fired power plants or wind turbines. Energy taxes differentiated according the carbon content of the different kinds of electricity generation, will affect the investment decisions of electricity producers and hence the carbon content of total electricity supply. Lijesen et al. (2002) shows that this adaptation of the RET enhances its effectiveness in terms of emissions reduction, without damaging the economic development of energy intensive sectors.

References

Allers, M.A. (1994), *Administrive and compliance costs of taxation and public transfers in the Netherlands*, Wolters

Broer, Peter, Machiel Mulder and Martin Vromans (2002), *Economic effects of national systems of CO2-emissions trading: national dilemma's within a global issue*, CPB, document 18 (in Dutch)

Capros, P. and L. Mantzos (2000), *The economic effects of EU-wide industry level emissions trading to reduce greenhouse gases; results from PRIMES Energy-Systems Model*, Athens, Greece

Commissie CO2-handel (2002), *Handelen voor een beter milieu; haalbaarheid van CO2-emissiehandel in Nederland*

Commission of the European Communities (2001), *Proposal for a Directive of the European Parliament and of the Council establishing a framework for greenhouse gas emissions trading within the European Community and amending Council Directive 96/61/EC*, oktober 23, COM(2001)581

Koopmans, C.C. and D.W. te Velde (2001), *Bridging the energy efficiency gap: using bottom -up information in a top-down energy demand model*, Energy Economics, 23/1

Lijesen, Mark, Machiel Mulder and Martin Vromans (2001), *Greening the fiscal system and energy: economic effects of raising and spreading out the Regulating Energy Tax*, CPB, document 006 (in Dutch)

Lijesen, Mark and Hein Mannaerts (2002), *Carbon dioxide differentiation of electricity taxes: an assessment of environmental and economic effects*, Paper prepared for the 25th Annual International Conference of the IAEE, Aberdeen, Scotland, UK, June 26-29.

Stavins, R.N. (1995), *Transactions costs and tradeable permits*, Journal of Environmental Economics and Management, 28, 133-148

Viguier, L.L., M.H. Babiker and J.M. Reilly (2001), *Carbon emissions and the Kyoto commitment in the European Union*, MIT, report no. 70, February

Vromans, M.A.W.M (1998), *The Multi-sector model*, CPB, CPB-report, 3

1.The emission target of 12 million tons carbon dioxide is deduced from the official target of 18 million tons, following from the GC-scenario emissions, the Dutch share in the EU-burden sharing, and the expected effects of already implemented policy measures.

2.Of course, the possibility to outperform the PSR depends on the stringency of this standard.