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Authors:
Evy Crals
Lode Vereeck

Department and affiliation:
Limburg University Belgium – department of Economics and Law

Mailing addresses:
Limburg University
Universitaire Campus – gebouw D
3590 Diepenbeek
Belgium

E-mail addresses:
evy.crals@luc.ac.be
lode.vereeck@luc.ac.be

Phone number:
0032 11 26 87 10

Fax number:
0032 11 26 87 11

Property Rights in the Transport Sector: The Implementation of Tradable Fuel Permits

DRAFT VERSION

By

Evy Crals and Lode Vereeck

Limburgs Universitair Centrum
Faculty of Applied Economic Sciences
3590 Diepenbeek
BELGIUM
{evy.crals@luc.ac.be;lode.vereeck@luc.ac.be}

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Abstract

Automotive road transport creates many external costs, such as congestion, pollution, noise and stress. These externalities are generally considered the blatant symptoms of an unsustainable economic and transport system. Therefore, transport economists are searching for more sustainable systems. So far, their main focus is on pricing mechanisms: road and congestion pricing, variable taxation and tolls. But these traditional policy measures are not only ineffective (congestion is not to disappear due to demand inelasticity) and inefficient (road tolls typically reflect average operational costs, not marginal benefits) but also unjust because they risk to deprive poor people of their right of free movement.

If, however, property rights can be established, the efficiency properties of markets can be combined with social concerns. More precisely, markets for transport rights can be set up that allocate permits for transportation among all citizens whilst internalizing the costs of pollution, noise and so on. Hence, tradable rights may potentially become the key concept in sustainable development policies.

Opponents of a permit system in the transport sector argue that the transaction costs of such a system are prohibitively high. However, since the introduction of Intelligent Transport Systems – which are also used in pricing systems – the design of an efficient permit system is becoming more realistic. The permit system may thus create a sustainable and affordable road transport network. Firstly, the system is highly effective in reaching its goals since precise and measurable targets can be set easily and the automotive transport industry is more sensitive to quantitative than price signals. Secondly, the system allows a fair social distribution of means.

Tradable rights have already been introduced in practice. The most important examples are emission rights (the U.S. Acid Rain Program and the California RECLAIM program). We draw upon these experiences to develop tradable fuel permits (TFP). This paper examines the design of a TFP system of which following aspects are discussed: geographical distribution, target group, allocation aspects, cap and trade, implementation path and technology. Specific attention is paid to monitoring, enforcement and transaction costs. The implementation of the TFP-system will not only lead to a sustainable road transport system, it will be an unequivocal enhancement for further innovation in the car industry.

1. Introduction

In our modern world, sustainable development has become an issue of worldwide concern. The E.U., for instance, has stated that sustainable development must be the central goal in all policies.[1] The standard definition of sustainable development is: 'meeting the needs of the present without compromising the ability of future generations to meet their own needs'[2]. It is a strategy that requires the integration of economic growth, social equity and environmental management.

This idea of sustainable development was spurred by a gradual climate change due to unsustainable economic policy. Meteorological observations show that since 1900 the European average annual temperature has increased with 0,3 to 0,6°C. Furthermore, climate models predict a further increase of approximately 2°C in 2100 compared to the 1990 level. The greenhouse effect will cause the Arctic ice to melt, increasing sea and ocean levels by 1-2 m, thus flooding many parts of the world like Bangladesh and the Netherlands. To make sure that the further increases in temperatures are limited to maximum 0,1°C each decennium, the industrial countries have to limit their green house emissions (carbon dioxide (CO2), methane, …) by the year 2010 with at least 30-55% with regard to the level of 1990.[3]

These reductions are much higher than agreed in the Kyoto protocol[4]. It is unlikely that the E.U. will achieve these CO2-reductions since the most recent 'business as usual' scenario of the European Commission (made before Kyoto) indicates an increase in CO2 emissions of about 8%, with the largest increase in the transport sector (39%).[5] Since these trends are not sustainable, the necessity of a sustainable transport network is obvious.[6] The OECD[7], forecasts that traffic growth (in vehicle kilometres) is such that the current strategies will be inadequate to reduce the overall emissions over the coming 30 or 40 years. Reducing overall emissions will only be possible by combining technical solutions for reducing emissions (for instance the usage of Intelligent Transport Systems), enhancing the energy efficiency of engines and slow down the growth of vehicle kilometres travelled.

[1] European Commission, *Duurzame ontwikkeling in Europa voor een betere wereld: Een strategie van de Europese Unie voor duurzame ontwikkeling*, COM(2001)264/2, Brussels, 2001, p. 2
[2] Brundtland report (1987): United Nations World Commission on Environment and Development
[3] European Environment Agency, *Het milieu in Europa: de tweede balans*, OPOCE (Office for official publications of the European communities, European Communities, 1998, p. 37
[4] Under the Kyoto Protocol, the industrialized countries must reduce their emissions by at least 8% below 1990 levels within the commitment period 2008-2012.
[5] European Environment Agency, o.c., p. 37
[6] EST report, *Environmentally Sustainable Transport – Futures, Strategies and Best Practises*, Synthese report of the OECD report on EST, presented at the International EST conference, 2000, Vienna, Austria, p. 9
[7] OECD, *Implementing Domestic Tradable Permits: Recent Developments and Future Challenges*, 2002, p. 143

Automotive road transport creates many external effects such as congestion, pollution, climate change, noise and stress which, by definition, are not taken into account by drivers and thus not or inadequately reflect in market prices. The market system needs a correction here. There are many devices for internalization. The best-known are probably (Pigouvian) taxes[8] and regulation. Examples are taxes on industrial emissions and on petrol. Within the wide range of policy instruments to reduce emissions, transferable permits are currently gaining interest. They have been analysed largely (and positively) in the literature from a general and theoretical perspective[9]. While the initial allocation is open to societal and political discussion, trading in such property rights would reveal the true preferences of the citizens without expensive cost-benefit analysis and without misplaced nostalgia on environment and even human rights.

Tradable permits seem to be an effective instrument for the emission reduction of larger point sources[10] and for air and water pollution (for instance the U.S. Acid Rain Program[11]), while taxes can be used to reduce the emission of smaller or non-point sources[12]. Virtually nothing has been written about the practical implementation in specific industries such as transport. Nevertheless, this industry is the major source of air pollution as well as greenhouse gases as said before. Therefore, a tradable transport permit system genuinely merits further research.

This paper is structured as follows: the first section lists the possible policy instruments to environmental protection and deals with the choice of tradable (fuel) permits in the transport sector, in contrast with taxes on fuel. In the second section, the different design elements of a tradable fuel permit (TFP) system are described while the third section gives an evaluation of the system. In the last section transaction costs of tradable (fuel) permits and taxes (on fuel) are compared.

[8] Pigou Arthur Cecil, *The Economics of Welfare*, London: Macmillan, 1920

[9] For example: Joskow P.L. and R. Schmalensee, *The Political Economy of Market-Based Environmental Policy: the U.S. Acid Rain Program*, Journal of Law and Economics, vol. 41, 1998, p. 37-83 - Ermoliev Y., M. Michalevich and A. Nentjes, *Markets for Tradeable Emission and Ambient Permits: A Dynamic Approach*, Environmental and Resource Economics, vol. 15, 2000, p. 19-56 - Joskow P.L., R. Schmalensee and E.M. Bailey, *The Market for Sulfur Dioxide Emissions*, American Economic Review, vol. 88, no. 4, 1998, p. 669-685

[10] Point sources represent sources which are well-defined, such as a factory smokestack.

[11] The Acid Rain Program was promulgated in Title IV of the Clean Air Act as part of the 1990 Clean Air Act Amendments

[12] Non-point sources refer to sources whose emission points are not readily identified, such as fertilizer runoff from farms.

2. Different Policy Instruments

Economists classify the different policy instruments for reaching environmental goals in three categories: voluntary initiatives, the so-called 'command-and-control' measures and the 'market-based' instruments.[13]

Voluntary initiatives are those activities undertaken by industry that are not previously mandated by government through legislation, or market interventions.

The traditional or 'command-and-control' policy is the most familiar for reaching environmental goals. Examples are limits on the amount of pollution allowed to enter the natural environment, specifying abatement technologies and establishing pollution reporting systems. These instruments have the potential to be effective but they are mostly criticized because of their inefficiency and the absence of the incentive to innovate. Tietenberg[14] among others shows that command-and-control policies are not cost effective. He calculates the ratio of the command and control allocation costs to the lowest cost of meeting the same objective for each study. He finds that these policies cost at least 78% more than the least cost policies. Difficulty in obtaining information about abatement costs of individual polluters and the lack of flexibility in choosing the technology to decrease emissions increases the cost of regulation.

Already during decennia economists believe in a 'market-based' approach for the protection of the environment. The 'market-based' or 'incentive-based' mechanism gives flexibility at actors and creates an incentive to search for more efficient ways of reaching environmental goals. There is no single standardized definition of a market-based instrument. A definition that can be used is[15]: "a market-based instrument decentralizes decision-making to a degree that the polluter or resource user has a maximum amount of flexibility to select the production or consumption option that minimizes the social cost of achieving a particular level of environmental quality".

We consider two important categories of market-based instruments: namely pollution charges and tradable permits.

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[13] Cassils J.A., *Exploring Incentives: An introduction to Incentives and Economic Instruments for Sustainable Development,* NRTEE, Ottawa, 1991

[14] Tietenberg T., *Environmental and Natural Resource Economics,* Fourth edition, Harper Collings, 1996

[15] Huber R.M., Ruitenbeek J. and R. Serôa da Motta, *Market-based instruments for Environmental Policymaking in Latin America and the Caribbean: Lessons from Eleven Countries,* World Bank Discussion Paper no. 381, 1998, p. 11

Pollution charges levy a fee or tax on the amount of pollution that a firm or source generates.[16] Consequently, it is worthwhile for the actor to reduce emissions to the point where its marginal abatements cost is equal to the tax rate. A problem with pollution charges is determining the appropriate tax level. This will be based via a process of 'trial and error'. When the pollution is more than the desired level, the charge will be increased and vice versa.

Tradable permits are the second form of a market-based approach. Under a tradable permit system, an allowable overall level of pollution is established and allocated among actors in the form of permits. The permits indicate the right to emit a certain amount of pollutant substances. Actors that keep their emission levels below their allocated level may sell their superfluous permits to others. This is a more cost effective approach to environmental protection.

These two policy instruments are price-based, a tax directly affects the production or consumption price. With tradable fuel permits an equilibrium price arises under the cap. In the last section we will evaluate the transaction costs of those two policy instruments.

Concluding we can say that market-based instruments attempt to internalise non-market effect in private decision-making. They can have a dramatic effect on commercial activities, investment flows, and patterns of production and consumption. As a result, they can also have major impact on people's livelihoods, as well as the state of the environment.[17]

At this moment, transport and environmental economists focus mainly on pricing mechanisms: road and congestion pricing, variable taxation and other taxes to develop more sustainable transport systems. For instance, governments can levy a 'carbon' tax as a mean of reducing emissions by making fuel more expensive. There are several potential problems associated with taxes on fuel that can be identified. First of all, since the price inelasticity of the demand for fuel is high, the likely reduction will be rather low. Van Mierlo[18] estimates the price elasticity of the demand for fuel in relation to the number of drives around -0,2. This elasticity is even smaller for drives for professional purposes. The average price elasticity of demand for fuel in relation to the number of kilometres is a little bit higher, around -0,3. This elasticity is also smaller when looking

[16] Pigou Arthur Cecil, o.c.
[17] Bishop J. and F. Vorhies, *Market-based instruments for global environmental benefit and local sustainable development: Lessons from recent developing country experiences*, Research Proposal for the Ring for Sustainable Development and the IUCN Commission on Environmental, Economic and Social Policy (CEESP), 1998, p. 3
[18] Van Mierlo H., *Beleidsfalen en beleidsevaluatie in de publieke sector* in Peeters L., Matthyssens P. en L. Vereeck (eds), *Vlaams 25e Wetenschappelijk Economisch Congres: Stakeholder Synergie*, Garant, 2002, p. 703

at drives for professional purposes. This estimates show clearly that the price inelasticity of the demand for fuel is high, therefore, there is no certainty about the environmental outcome. Secondly, it may be very difficult to determine an appropriate level of taxes. Moreover, the suggestion that the level can be found by a process of trial and error is not a solution. The wrong initial level might lead to a situation where producers are locked into inappropriate technologies. Finally, there is a need for administrative intervention to respond to exogenous changes. The tax system will not respond automatically to those changes.

Tradable permits are another example of a market-based instrument and have the potential to achieve identical goals but at lower transaction costs. Tradable permits entitle the permit holder to a certain amount of usage, for example a certain amount of fuel (TFP). By issuing permits for a limited amount of fuel, governments are able to keep the usage at or below a specified level. Permits can be bought and sold, but governments will limit the amount of fuel to less than the current level of usage (otherwise there would be no need to have permits). Permits will therefore command a price like any other commodity. Under the cap, actors need to reduce their current levels of usage, or obtain sufficient permits from others.

Permits allow participants also flexibility in the way in which energy use reduction is achieved, enabling them to select the most cost-effective approach. Participants who are able to reduce their usage relatively cheaply will do so, rather than purchasing permits. Those who face higher abatement costs will tend to purchase permits to satisfy requirements. In this way, reductions are made by those who can do so at least costs (being compensated by those that face higher costs)[19]. In addition, they provide a continuing incentive for actors to search for innovative approaches for further permit reductions in the future.

In this paper, we look into the possibilities of designing a tradable permit system in the transport sector. This trading system should be designed according to the following general principles[20]:

- Effectiveness, which requires a successful evaluation, monitoring and verification ;
- Economic efficiency refers to the realization of the policy against minimum costs. Within the framework of the theory of environmental policy, a static efficient allocation refers to an allocation in which the marginal damages caused by a unit of pollution and the

[19] Morgenstern R.D., *Reducing Carbon Emissions and Limiting Costs*, Resources for the Future, 2002, p. 5
[20] OECD, *Key Issues in the design of new mechanisms under the Kyoto Protocol: a scoping paper*, COM/ENV/EPOC/DCD/DAC/IEA(98)1, Paris, 1998

marginal costs of avoiding that unit of pollution are equal. Within the same framework, dynamic efficiency refers to a situation in which environmental policy instruments induce environmentally friendly technologies, innovation and production processes[21];

- Equity, which means that no interest groups should gain an unfair advantage;
- Social and political acceptability which is an indispensable requirement for practical implementation.

3. Design Implications of the Tradable Fuel Permit (TFP) system

In this section we describe the different design elements of a TFP system. The choice of these elements is based upon already existing cap-and-trade programs, such as the U.S. Acid Rain Program and the California RECLAIM[22] program. These programs have proven that emissions trading have considerable potential in practice, as well as in theory. Also the design of the emission trading under the Kyoto protocol is taken into account. Table 1 summarises the characteristics of the TFP system.

Table 1: Design elements of the TFP system

Cap and Trade	• Overall cap or emissions level required by the programme.
Allocation Aspects	• Allocation type (grandfathering, auctioning, free or updating).
Geographical Distribution	• Scale of implementation (E.U., country, state, lane,…).
Target Group	• Type of actors covered by the trading programme to which allowances are allocated.
Technology	• Technology required implementing the TFP system.
Implementation Path	• Timetable of actual introduction of the sytem.
Transaction Costs	• The costs of establishing the TFP system and the costs of transaction.
Monitoring & Enforcement	• Level of monitoring (upstream, downstream). • Level of penalties with non-compliance of the system.

[21] Paulus A., *The Feasibility of Ecological Taxation*, Dissertation no. 95-33, Faculty of Economics and Business Administration, University of Limburg, Maastricht, The Netherlands, Datawyse/Universitaire Pers Maastricht, 1995, p. 35

[22] Regional Clean Air Incentives Market

3.1. Cap and Trade

A cap and trade program sets an upper limit and trades allowances, which are allocated among all actors.[23] A cap and trade system gives the highest certainty about reaching the reduction set forward.

A requirement for establishing a fuel permits market is a good definition of the property rights that are traded. Following aspects need to be determined: the nature of the good that will be traded, the tradability of the good and the initial allocation.

The cap-and-trade approach is most appropriate when following conditions are fulfilled:

- The problem arises in a large area;
- There are many possible sources that are responsible for the problem;
- The compliance costs differ from source to source;
- Pollution can be measured in a consistent and correct way.

To obtain sustainable transport growth, non-fuel consuming transport modes are to be encouraged. For that reason, these modes are excluded from the TFP system. The cap of the system is set on the total vehicle kilometres of the reference year. The allocation to each Member State will occur based on the average energy efficiency of fuel, divided in gas, diesel and LPG. This average may vary because of the differences in technology used in the Member States. (See § 3.3. Geographical distribution)

To set the cap, a reference year from which to draw the data needs to be determined. A compromise is struck between a reference year in the distant past and a recent reference year. A reference year in the distant past has the advantage that environmental efforts made earlier will be rewarded. A disadvantage is the lack of correct information. When a recent reference year is chosen the database will be more reliable but earlier efforts are not rewarded.

The duration of the permit's validity is important because it determines the efficiency gains of trade. The tradability of a right becomes more difficult when the permit duration is shorter. A short permit's duration augments the transaction costs that the government and the market

[23] Tietenberg T.H., *The tradable Permits Approach to Protecting the Commons: What have we learned?*, 2000, p. 5

players have to make, because these are related to the frequency of the allocation of the TFP. There are also some arguments against a long validity period of time. The uncertainty about the price development can influence the revenues of the rights negatively. A future market for TFP will not function well if the policy lines of the government, who determine the rules, are not known. Another disadvantage of a long validity period of time is the difficulty of the government to adjust the policy on a regular basis.

The permit duration of the TFP is set on one year. Imposing a time limit on the use of TFP offers a convenient administrative mechanism for monitoring and controlling on an annual basis. TFP issued at the beginning of a year would simply expire at the end of the year, and new ones would be issued for the next period. Banking[24] and borrowing[25] is not allowed. Banking could have as a consequence that the tradability after some time would show a cyclical pattern. Although banking is relatively uncontroversial, borrowing is much more controversial. Borrowing of allowances effectively enables companies to postpone emissions reductions until some future date[26]. This is undesirable with respect to the environmental impact of the scheme, and the credibility of the scheme.[27] Opponents fear that borrowing makes it more difficult to check whether emission sources are in compliance with their emission limits. Borrowing could conceivably even discourage trading among individual actors, thus reducing market liquidity or undermining the incentive to search for cleaner technologies.

3.2. Allocation Aspects

Allocation of permits is one of the most complex elements of the TFP system design. In the literature, four allocation schemes are described, which are briefly discussed in the next paragraphs.

3.2.1. Free distribution of the permits

The initial allowances can be distributed for free to the various actors, whereby the total number of allowances equals the overall cap.

[24] Transfer of the rights to the next year.
[25] Borrowing TFP of the next year to use this year.
[26] Stephan G. and G. Müller-Fürstenberger, *Banking and trade of carbon emission rights: a CGE Analysis*, Presented at the EMF-IEW Workshop, Paris, 1999, p. 7
[27] OECD, *Towards International Emissions Trading: Design Implications for Linkages*, COM/ENV/EPOC/IEA/SLT(2002)5, 2002

The most important benefit of this scheme is that the social and political acceptance is readily high. Distributing permits for free to individuals lowers the overall cost burden of the cap-and-trade program.

The administrative costs of this scheme are likely to be low. Once the cap is set, the permits can be distributed among the population without taking into account past or future usage. This way of allocating has some distributional impacts. People who don't need their annual permits can sell them to others who do. A disadvantage of the scheme is that it will not raise any direct revenues for the government.

3.2.2. Grandfathering

The rights can also be distributed among the population on the basis of historical indicators, the so-called 'grandfathering' principle. The total cap can vary over time, but since future allocations depend entirely upon historical data, the share that each participant receives is fixed. This means that a participant namely a firm or an individual, has no incentive to change its behavior.

A first benefit of this scheme is that the average costs to the population will not increase. Allocating rights to historic users causes the least disruption from historic patterns and it entails a small financial burden on users. Further, this scheme makes it fairly easy to estimate the economic effects of the TFP system[28]. Thirdly, the public acceptance will increase because they receive a certain number of rights for free.

However, there are also some disadvantages of this scheme. Since the distribution of the rights is based on a reference year, well-defined criteria need to be determined. The choice of the reference year will be based upon the actual level of technology in the Member States. It seems realistic that there will be different reference years for different Member States.[29] Secondly, grandfathering does not take into account new market entrants. To this end, the government could reserve a number of allowances for new entrants, or new entrants may have to buy permits from the market. A set-aside allocation for free to new entrants would be more favorable, as new entrants would otherwise incur direct additional costs to enter the market. Finally, on a short

[28] Sijm J.P.M., K.E.L. Smekers, T. Kram and M.G. Boots, *Economic Effects of grandfathering CO2 emission allowances*, Paper presented for the Energy Research Centre of the Netherlands (ECN), ECN-C-02-022, 2002, p. 11

[29] Tietenberg T.H., e.a., *International Rules for Greenhouse Gas Emissions Trading: Defining the Principles, modalities, rules and guidelines for verification, reporting and accountability*, United Nations Conference on Trade and Development

term, grandfathering can augment pollution because individuals are aware of the fact that current usage leads to a higher level of future permits.

The primary administrative cost associated with grandfathering is the cost of collecting the data which are used as the basis of the allocation. The greater the number of actors included in the system, the larger the data requirements, which means higher administrative costs.

3.2.3. Auctioning

The rights can also be auctioned. Under auctioning, all actors are treated equally in the sense that they must acquire allowances regardless of whether they are new or existing actors. New entrants that need allowances can buy these from other actors via the market. An auction gives a reference price for the TFP and it creates revenue for the government, which can be used to offset existing taxes. So, auctions can be relatively favorable for consumers and taxpayers, assuming the revenues are used to reduce taxes.[30]

Auctioning has also some disadvantages. It generally imposes greater costs on actors because they must buy a permit for all fuel used, which is not the case for grandfathering where permits are distributed for free and only additional consumption requires the purchase of permits.[31] Therefore auctioning is assumed to have a lower public acceptance.

There are two major sources of administrative costs under an auction: auction design and the ongoing administrative costs of the auction. Most of the auction design costs occur only once, namely when the system is established. In addition to the initial design of the auction, it has to be periodically or annually administered. An auction thus involves some ongoing administrative costs.

3.2.4. Updating

Finally, we discuss the "updating" scheme, which involves allocating permits to actors based upon information updated over time. For example, allocations in 2005 might be based upon activity in 2004, allocations in 2006 based upon 2005 activity, and so on. This is in clear contrast to the grandfathering approach in which a participant receives his allocation regardless of current or future activities. But, as with grandfathering, the permits are distributed free of charge and

[30] Cramton P. and S. Kerr, *Tradeable Carbon Permit Auctions: How and why to auction not grandfather*, University of Maryland, 1999, p. 2

[31] Brouwer F.M., e.a., *Verhandelbare rechten voor de emissie van broeikasgassen in de Nederlandse landbouw: een verkennende studie*, Den Haag, LEI, 2001, p. 19

each participant's allocation is updated on the basis of his activity level. If a participant has a higher usage than others, his allocation will be higher in the next commitment period; symmetrically, a source with lower use will receive a lower allocation the next period.

The main disadvantage of the system is that it loses the key element of permit trading: because some participants receive a greater share of the total amount of permits if they use more. Therefore, each participant would tend to increase its usage level.

Administrative costs under updating are likely to be substantial high because of the ongoing need to collect the relevant data.[32]

3.2.5. Determination of initial allocation mode

These methods can also be used in combination with each other, by which a portion of the rights are distributed for free and the rest will be allocated via auctioning.[33]

Concluding we can say that with a free distribution of the permits, the administrative costs of the scheme are likely to be low because past or future usage does not have to be taken into account. The most important administrative cost with grandfathering is the collection of the necessary information about past usage. With auctioning, there are two major sources of administrative costs, namely the costs associated with the design of the auction and the costs of administrating the auction on a day-to-day basis. Finally, the administrative costs under updating are expected to be the highest because of the ongoing need for information.

Primarily because of the low administrative costs but also for reasons of social justice and general acceptance, the TFP should be distributed for free. Not everybody will receive the same number of permits but different age categories will be distinguished: between 0 and 18 years (youngsters), between 18 and 65 years (active) and above 65 years (retired). This will be discussed in more detail in § 3.4. target group. Organising the system this way does not necessarily imply a burden and gives a certain amount of freedom to individuals.

At the beginning of the calendar year, the TFP will be distributed. Individuals who do not use all their annual rights, can sell them partly or entirely at the daily market price to others who need

[32] Harrison D. and D.B. Radov, *Evaluation of Alternative Initial Allocation Mechanisms in a European Union Greenhouse Gas Emissions Allowance Trading Scheme*, National Economic Research Associate, Prepared for the DG Environment European Commission, 2002, p. 67-71
[33] Brouwer F.M., e.a., o.c., p. 19

more. These prices are established by the traditional stock market exchange principles. Financial institutions and broker act as an intermediate player between buyers and sellers. Brokers will be needed who specialize in trading permits in order to reduce a participant's transaction costs of finding a trading partner. Thus, the use of this existent institutions and brokers will minimise the operational costs of the trading scheme.

In addition to the choice of the initial distributional mode, the allocation mechanism must also specify the year or years from which to draw the data. There are several problems with the choice of the reference year. The most important one concerns the possibility that an unrepresentative year is chosen. If a single year is used, there is a greater risk that the allocation will be based on unusual circumstances for some people – for example many people were commuting that year because of various reasons. Drawing data from multiple years reduces the risk that the allocation will reflect a typical operation.

3.3. Geographical Distribution

TFP can be applied to different geographical circumscriptions varying in size. Implementation can be realised on a European, interregional, regional of intraregional scale.

A larger geographical area implies more market players and, therefore, more tradability of the rights. A smaller geographical area implies less market players, which means limited efficiency gains. A well-defined area, surrounded by geographical borders (sea, mountains) or checkpoints is desirable because it will make it more difficult for actors to operate in an area where the system is not in operation.[34]

The geographical scope of the program depends on the problem (congestion, pollution, noise) that one wishes to address, in particular the problem of sustainable growth in the transport sector. We choose for an implementation on a European scale because of the greater number of market players and to vindicate the free movement of goods and persons in the EU. Moreover, the European Commission aims at an integrated approach of the transport problems in all the Member States.

[34] Broer P., M. Mulder and M. Vromans, *Economische effecten van nationale systemen van CO2-emissiehandel: nationale dilemma's bij een mondiaal vraagstuk,* CPB document, 2002, p. 30

3.4. Target Group

The system can be directed to different target groups, namely companies, individuals, schools, municipalities, fuel wholesalers or producers. An example of tradable emission rights on the level of companies is the Acid Rain Program in the U.S. Here, SO2 emission rights are allocated to companies in specific sectors (electricity units) and they can trade them among themselves.[35] The Kyoto Agreement foresees international emission trading (IET) between countries to be introduced in 2008 as one of the 'flexible mechanisms' of the program.[36] At present, there are no examples of allocation of permits to individuals. This is attractive, though, because it would provide a direct incentive to reduce fuel consumption not only through choice of vehicle, patterns of travel behaviour and residential location, but also through driving behaviour such as reduced speed.

In this proposal, the target group is the individual European fuel user. The allocation to individuals can occur based on different criteria such as age, location, income, economic activity, family composition, etc. They are summarized below:

- Age: It is possible to divide the TFP among all citizens older than 16 or 18 years old. The allocation can also occur based on the need for movement by age category. Three age categories – from 0 to 18 years (youngsters), from 18 to 65 years (active) and above 65 years (retired) – can be allocated a different amount of TFP.
- Location: When the TFP system is used to induce more people to live in the city, a different amount of TFP can be allocated amongst the population in urban areas and in rural areas. If the citizens from the rural areas receive less TFP, they are stimulated to move to an urban area or to an area closer to their work. This will reduce their annual kilometres.
- Income: TFP redistributes income from polluters to non-polluters and creates some form of basic income.
- Economic activity: A possible allocation can be: active population, non-active population and retired population.
- Family composition: A distinction can be made between singles, families without children, families with one child, etc. By making a distinction with regard to the amount

[35] Ellerman A.D., P.L. Joskow, R. Schmalensee, J.-P. Montero and E.M. Bailey, *Markets for Clean Air: the U.S. Acid Rain Program*, Cambridge University Press, 2000
[36] OECD, o.c., 2002

of children, the TFP system takes into account the displacements that are made for those children, while the children do not yet have TFP.

In this paper, we opt for an allocation based on age, with a division in three age categories. This allocation offers the possibility to differentiate. It is self-evident that a person of 5 years old has less need for mobility than someone who has to go to work every day.

3.5. Technology

Existing technologies can be used for the implementation of a TFP-system. The system of depreciation and recharging of permits should ensure that privacy is not invaded, that it is interoperable between member States and that all users are treated in a non-discriminatory way. Furthermore it should be a cost-effective (low maintenance and transaction costs), easy to use, fraud-resistant, safe, physical accessible and reliable system.

The technology, which seems most opt for TFP-use, is an electronic card that discharges TFP when refuelling. Terminals will be situated at gas stations. Crucial is that it will be impossible to refuel without using this discharge card. Public transport operators can integrate the TFP into the ticket price or passengers can transfer the rights by discharging their card when buying a ticket. Recharging the card can take place at bank terminals at sales offices and via an individual internet account number. Due to the already widespread use in the E.U. of chip cards, operational costs will be minimal.

3.6. Implementation Path

To set-up this system, a European institution has to be founded. This institution has three important duties. Firstly, it will allocate the TFP among the Member States. This will be done based on the cap chosen, the reference year and the average energy efficiency of engines. The different Member States then distribute these rights among the local governments. Secondly, it will define the annual cap for each Member State. Thirdly, it will control the Member States on the correct compliance of the TFP system. These monitoring and enforcement issues will be further discussed in the next paragraph.

Along with the political acceptance on a European level, the administrative costs and the social acceptance are from a decisive importance. The introduction of the TFP system will require a lot of political courage. The costs of the administrative preparation, the political decision-making and lobbying are very difficult to estimate. After the first agreement between the Member States, the

necessary legislation also has to be developed. As an indication for the actual introduction of the system, a period of 5 to 10 years can be expected.

TFP is a far-reaching system. Therefore, a pilot project will have to be set up just before the system can be introduced on a wider scale. This pilot project of 2 or 3 years will test the effectiveness and will give an estimation of the expected administrative costs.

3.7. Transaction costs / Monitoring & Enforcement

In general, transaction costs are ubiquitous in market economies and can arise from the transfer of any property right because the different parties have to exchange information.[37] There are several definitions of transaction costs. Transaction costs are "the costs of arranging a contract ex ante and monitoring and enforcing it ex post[38]"; "the costs of running the economic system[39]", and "the economic equivalent of friction in physical systems[40]". In his article on externalities, Coase[41] uses the phrase "the cost of carrying out market transactions" to refer to interactions between firms or between individuals and firms. Coase refers to administrative costs when the resolution of the externality comes about within a firm or by government regulation.

In this paper, we define transaction costs as search and information costs, contract costs, bargaining and decision-making costs and costs created by monitoring and enforcement.

Transaction costs play a key role in the success of a permit trading system. In the past, only emissions trading programs with low transaction cost have succeeded in substantially lowering the cost of compliance, including the allowance programs such as the Acid Rain Program and the RECLAIM program. Several environmental problems (including mobile source air pollution such as the transport problem) involve many pollutees and/or many polluters. A large number of affected parties makes bargaining and negotiating more onerous. Eventually it entails the risk that transaction costs will not lead to a bargained solution and free-riding behaviour.

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[37] Stavins Robert N., *Transaction Costs and Tradeable Permits*, Jounal of Environmental Economics and Management, vol. 29, 1995, p. 134
[38] Matthews R.C.O., *The Economics of Institutions and the Source of Growth,* Economics Journal, vol. 96, 1986
[39] Arrow K., *The organisation of Economic Activity: Issues Pertinent to the Choice of market versus non-market allocation,* The analysis of and evaluation of public expenditures, 1969
[40] Williamson Oliver E., *The Economic Institutions of Capitalism,* Free Press, NY, 1985
[41] Coase Ronald H., *The Problem of Social Cost,* Journal of Law and Economics, vol. 3, 1960

The first cost (category search and information cost) may be the most obvious. Brokers step in, provide information and search for potential trading partners, and thus reduce information costs. In the TFP system, financial institutions may provide this information. These search and information costs tend to be high for unique goods and services, and low for standardized goods or services.[42]

The second cost, concerning bargaining and decision, is potentially as important as the first one. They are real resource costs to anyone entering into negotiations, including time and/or fees to brokers, legal and insurance services. Negotiations tend to be simple and easy when information about the threat values and the cooperative solution is public. Conversely, negotiations tend to be complicated and difficult when this information is private. Bargaining becomes also more difficult and costly when it involves three or more parties.

The third component, concerning monitoring and enforcement can also be significant. These costs are typically carried by the responsible governmental authority and not by the trading partners. Therefore, they do not fall under the transactions costs incurred by individuals. The monitoring and enforcement of the TFP system is of utmost importance to realise its economic, social and environmental objectives. In an upstream design, monitoring is at the level of the producers and importers of fuel while in a downstream design, it focuses on the end-users of fuel.[43]

There are significant differences between an upstream and a downstream design in the number and type of market actors who have to be monitored. An upstream design will have far fewer and larger actors than a downstream design. In terms of the impact on administrative efficiency, fewer actors in an upstream monitoring design will be easier to monitor. A downstream monitoring seems impractical with its large number of actors thus incurring high administration costs. The result is an implicit trade-off between administrative efficiency (the number of actors to be monitored) and economic efficiency.[44]

[42] Cooter R. and T. Ulen, *Law and Economics*, Addison-Wesley Longman Inc., 2000, p. 85
[43] Haites E. and F. Mullins, *Linking Domestic and Industry Greenhouse Gas Emissions Trading Systems*, Prepared for Electric Power Research Institute, International Energy Agency and International Emissions Trading Association, 2001
[44] Harrison D. and D.B. Radov, o.c.

The monitoring in the TFP system should be organised upstream, at the level of the different fuel producers and importers[45]. For their fuel sold, they have to present a proportional amount of TFP.

Even the most punctiliously designed system can fail if the enforcement effort is deficient. Ineffective enforcement could undermine the success of a more sustainable road transport system. Beside the size, motivation and competence of the enforcement staff, the nature of the program is a key factor for an effective enforcement program. Some programs are inherently easier to enforce. A successful enforcement program requires a carefully constructed set of sanctions for non-compliance. Penalties should be commensurate with the danger posed by non-compliance, based on the classical economic approach of crime and punishment.[46]

Under the U.S. Acid Rain Program, the enforcement process involves four steps: (1) detecting the violation, (2) notifying the actor, (3) negotiating a compliance schedule and (4) applying sanctions for non-compliance when appropriate.[47] This process can also be used in the development of the TFP system. As discussed in § 3.6., the European institution has the authority to monitor the Member States on the correct compliance of the system. Though the Member States have primary responsibility on the correct compliance of the system, the European institution has the authority to act against offenders.

Under the TFP system, the main enforcement issue is the avoidance behaviour. Although the system will be introduced on a European scale, the problem remains of people who will cross the border to refuel. Since it can be expected that all the incoming traffic will have a full gasoline tank, the problem can be solved by forcing all the outgoing transport to refuel before they cross the border.

As a conclusion, we can say that cap and trade programs generally have low transaction costs and low risk. Individuals can simply transfer permits, by using financial institutions as already stated before or internet, without subjection the transfers to regulatory intervention.[48]

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[45] Nentjes A. and P. Rietveld, *Verhandelbare rechten voor verkeer en vervoer als instrument van klimaatbeleid*, Studies ten behoeve van het VROM-raadsadvies 'Mobiliteit met beleid', p. 179
[46] Becker Gary S., *Crime and Punishment: An Economic Approach*, Journal of Political Economy, vol. 76, 1968
[47] Tietenberg T.H., *Emissions Trading: an exercise in reforming pollution policy*, Resources for the Future, Inc./Washington, D.C., 1985
[48] Tietenberg T.H., e.a., o.c., p. 8

In addition to transaction costs borne by the actors involved in trading, transaction costs are also borne by the regulatory authority to validate and administer the trading system (the third component of transaction costs). These costs also appear to be low under the existent systems such as the Acid Rain Program, EPA has estimated that total cost to the Government for administrating the Acid Rain Program is $ 1,50 per ton abated. [49]

4. Evaluation of the TFP system

There are many different reasons why the use of property rights, such as the TFP system, are particularly promising for regulating the transport market in a way that meets economic, ecological and social demands.

1. The permit system is, by nature, highly effective in realising a fixed objective since it is possible to set precise and measurable targets. Once the cap is set, supply is limited and this limit is absolute (disregarding fraud, of course). It follows that the quantitative objective will always be realised. In a system of fuel taxes or road pricing, however, the amount of vehicles kilometres is determined only ex post. Consumption and production may well exceed the optimum amount due to the price-inelasticity of demand.
2. The price for TFP's is determined by the market, hence truly reflects the participant's (marginal) benefit of consuming fuel. Participants who are capable of reducing their usage relatively cheaply will do so, thus receiving extra revenues of selling or saving additional costs of purchasing permits. Those who face higher abatement costs will purchase extra permits to satisfy their transport needs. The government can, in case of market distortions, adjust the annual cap by buying back or selling additional permits. The TFP system gives a clear incentive to improve the technology of energy efficiency of engines. These innovations allow further increase of the road transport. Those who use less energy-consuming vehicles can sell their superfluous TFP.
3. The system allows a fair redistribution of mean since every citizen receives a basic package of TFP's for free. Given the fundamental role that transport plays in exercising the right of free movement, the redistributive consequences of TFP merit close attention. By initially allocating permits for free, additional taxes are avoided. This is likely to promote the political and social legitimacy of the system. Moreover, the government does not have to take deliberate action in redistributing means in society: in the TFP system, there is a transfer of financial benefits from those citizens who pollute most to those who

[49] Tietenberg T.H., e.a., o.c., p. 36

pollute less (polluter pays principle). By giving the citizens a free basic endowment of TFP, the government enables each individual to make a certain amount of car kilometres. The initial allocation can also be used to pursue general and specific social goals. (promotion of socially weak groups, large families, …)

4. Since the introduction of Intelligent Transport Systems – which are also used in pricing systems – the technological design of a TFP system is becoming increasingly realistic and cheap.

5. Evaluation of the transaction costs

In the previous paragraph, we designed a tradable (fuel) permits system for developing a more sustainable transport system. We pointed out that transaction costs play a key role in the success of a policy instrument. Different policy instruments generate a different amount of transaction costs. The socially desirable mechanism is the one which minimises transaction costs. The general idea is: "the lower transactions costs, the more transactions will take place and the higher the GNP". Thus, minimizing transaction costs maximizes the national wealth.

In the following two tables, we compare the transaction costs of using (fuel) taxes and tradable (fuel) permits. Transactions costs can be separated into several categories such as: search and information costs, bargaining and decision-making costs, administration costs and monitoring and enforcement costs. Foster and Hahn[50] pointed out that direct financial costs of engaging in trade, costs of regulatory delay and indirect costs associated with the uncertainty of completing a trade are also important elements of transaction costs of tradable permits. In our analysis, we consider these costs as part of the trading costs.

[50] Foster V. and R.W. Hahn, *ET in LA: Looking Back to the Future*, Working Paper, American Enterprise Institute, Washington D.C., 1993

Table 2: Transaction costs analysis: Fuel Taxes[51]

	Transaction Costs Components	Level	Remarks
1.	Information Costs	HIGH	To effectively reduce emission via taxes, information is required on demand elasticity, which in turn depends on available alternatives and income elasticity.
2.	Trading (Search & Bargaining) Costs	LOW	Apart from public choice costs (fuel industry, lobbyists) decision-making costs are low. The taxes are just paid to the tax authority.
3.	Administration Costs	HIGH	Public administration costs comprise the costs of the taxing bodies that administer the tax collection. They tend to be high unless new ecological taxes can be incorporated into existing tax administration systems. Private administration costs are these costs of firms or individuals who make the actual tax payments.
4.	Monitoring and Enforcement Costs	HIGH	The tax system requires a monitoring and enforcement mechanism to minimise tax avoidance and tax fraud. These costs will also be lower when the fuel taxes can be incorporated into existing tax monitoring systems.

Table 3: Transaction costs analysis: Tradable Fuel Permits

	Transaction Costs Components	Level	Remarks
1.	Information Costs	LOW	In terms of pollution, the stated goal (cap) is easy to quantify: the amount of ton emission. No estimate of the demand elasticity is necessary.
2.	Trading (Search & Bargaining) Costs	LOW	Individuals can trade permits, example given via financial institutions or internet. Fees paid for brokerage depend on technology used.
3.	Administration Costs	LOW	Administration costs depend on the choice of trading system and the initial allocation (free, grandfathering, auction, updating). With the TFP system, we chose a free distribution which minimises the administration costs.
4.	Monitoring and Enforcement Costs	HIGH	Costs to the control agency of ensuring that the actor complies with control requirements.

A major advantage of tradable fuel permits over fuel taxes is that the government can achieve a given aggregate target cost-effectively without knowing anything about individual's abatement costs. Thus, tradable permits have an information advantage above taxes because the cap is more easily to quantify than the tax level.

[51] For an overview of the economic feasibility of ecological taxation, see Paulus A., o.c., 301 p.

A second point is that the existing technology and infrastructure will have an effect on the administration costs. Since the introduction of Intelligent Transport Systems, the design of a TFP system becomes more realistic.

Another interesting implication of this analysis is that the initial allocation of permits affects the amount of transaction costs. With a free distribution, there is no need for additional information about past or future usage and thus information costs will be limited.

The general message is that the existence of transaction costs makes the choice between taxes and tradable permits more difficult. For all the different categories of transaction costs, it is obvious that tradable fuel permits have an advantage above fuel taxes, with the exception of the monitoring and enforcement costs. It is necessary to compare the instruments on a case-by-case basis. Finally, with transaction costs, great attention should be paid at the design of the policy instrument in order to create a system that can be implemented successfully.

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