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# The Use of Transferable Permits in the Transport Sector

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**Informal Experts Workshop on Domestic Tradable Permits  
Lessons and Future Directions**

**THE USE OF TRANSFERABLE PERMITS  
IN TRANSPORT SECTOR**

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*Abstract*

This report focus on the potential use of domestic transferable permit (TPs) systems in the transport sector, in order to address the issue of mobility needs management and especially the reductions of airborne pollution and greenhouse gas emissions. Firstly the context of the transport sector is briefly reviewed, the main arguments for or against the use of TPs in the sector are analysed and relevant areas are identified. Secondly four case studies of past, present or possible future permits systems are presented and evaluated. The main conclusions are: TPs applied to mobile sources are technically feasible at acceptable financial costs for protecting sensitive geographic areas. TPs schemes applied to automakers for unit vehicle emissions are also viable. Clarity, simplicity in target and pragmatism in scheme design help for their success. Regarding the broader GHG issue end-user TPs would currently involve significant administrative costs when compared with fuel tax system. Given the social resistance encountered by increase in fuel taxes in several countries, end-user TPs with free allocation may intrinsically have potential greater effectiveness and acceptance and should be thoroughly evaluated case-by-case as an alternative.

# THE USE OF TRANSFERABLE PERMITS IN TRANSPORT SECTOR

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## INTRODUCTION

“There is a clear understanding that we cannot provide for the world’s continuing and growing needs for mobility by simply extending today’s means of transportation.”<sup>1</sup> Clearly today mobility is part of the whole sustainable development issue: that is to say how can we meet the needs of today without diminishing the capacity of future generations to meet theirs?

Maintaining a sustainable mobility means to continuously assess and drive efficiently its different aspects for now and the future: that is to say economic (e.g. achieve a better balance between demand and supply), financial (e.g. finance transport infrastructure and operation), environmental (e.g. avoid harmful health effects) and social aspects (e.g. maintain spatial and social cohesion).

There are already numerous studies about the way transport activity could be made more sustainable. ECMT (1997) has conducted a detailed review of the available policy options to reduce overall CO<sub>2</sub> emissions of the transport sector. With its Environmentally Sustainable Transport (EST) program, OECD has recently achieved a thorough analysis of possible scenarios to make transport environmentally sustainable for 2030 and elaborated related packages of measures (OECD, 2000b). The business side (World Business Council for Sustainable Development) is also undertaking a sustainable mobility initiative (WBCSD, 2001)

Within the wide range of policy instruments Transferable Permits (TPs) are currently attracting growing interest in OECD Member countries. In both theory and practice, the main strength of applying TPs has been for larger point sources for air and water pollution, while smaller or non-point sources have been better addressed through taxes. Given that transport sector is increasingly becoming the major source of air pollution as well as greenhouse gases, the possibility of applying TPs to non-point sources is worth exploring.

One strong conclusion of the studies on transport emissions reduction strategies is that these strategies should involve multiple technological, economic and societal aspects, thus meaning a *package* of instruments within a proper implementation. With this respect, the focus of this report is much more limited and is on the potential use of domestic transferable permit systems in the transport sector. It aims at answering the question of potentials of TPs to address the issue of mobility needs management and especially the reductions of airborne pollution and greenhouse gas emissions stemming from transport. The analysis will be conducted both on a general level and on the basis of a few case studies.

The first section reviews the context of the transport sector and, in particular, the environmental problems posed by transport activities. The main arguments a priori for or against the use of transferable permits are analysed and areas where they might be used within the transport sector are identified.

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<sup>1</sup> WBCSD, 2001.

The second section presents four case studies of past, present or possible future systems and analyses their potential.

The third and final section concludes by drawing common lessons from these case studies and by identifying the avenues which remain to be explored.

## **1. THE TRANSPORTATION SECTOR CONTEXT**

The transportation sector, understood as embracing all infrastructure and services that allow for the movement of people and goods, is key to the economic and social functioning of modern societies.

These societies have only been able to grow because of accelerating economic and social interaction and exchange. The transportation system has grown apace with political transformations (the creation of unified nation States, the abolition of internal customs barriers, safer highway networks) and has benefited from technical and economic innovations: creation of highway, rail, air and river infrastructure, development and wide use of internal combustion engines. Transport has in fact been an essential vector of economic and social development, and will surely be called upon to continue as such.

In the course of achieving these general objectives, the transportation system is now subject to a number of major constraints, given the current state of its technologies: these constraints relate to concerns over energy dependence, the global environment, the local environment and quality of life, the shortage of available space in densely populated areas, and the ensuing congestion, and finally the scarcity of public funding. This paper will confine itself to the environmental aspects, while bearing in mind the other constraints that also impact on any policy for controlling the transportation system.

### **1.1. The global environment and the greenhouse effect**

The global environmental constraint is becoming increasingly severe, and concern is rising, in particular, over the potential for global climate change caused by human activities. At the centre of these concerns is the greenhouse effect, with its associated gases (carbon dioxide CO<sub>2</sub>, methane CH<sub>4</sub>, nitrous oxide N<sub>2</sub>O, and also tropospheric ozone<sup>2</sup> O<sub>3</sub> via its precursors, notably nitrogen oxides, carbon monoxide, CH<sub>4</sub> and non-methane hydrocarbon) a great part of them resulting from the combustion of fossil fuels. To these we must add chlorofluorocarbons (CFC) released by air conditioners, particularly during the automobile wrecking process: these pollutants can persist for more than two centuries in the upper atmosphere. While the nature and scope of their effects are still the subject of debate, the stakes are such that, in accordance with the precautionary principle, ways should be found to reduce

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<sup>2</sup> However tropospheric ozone is not recognised by the UNFCCC as a greenhouse gas, since significant uncertainties remain in the understanding of its contribution to the climate change.

emissions of these gases, as well as the consumption of fossil fuels in the transportation sector.

Following the 1992 Rio conference (UNFCCC), which adopted the principle of an international agreement to reduce greenhouse gases emissions at least by half, industrialised countries (known as the "Annex I Countries" under the protocol) agreed in 1997 at Kyoto on a protocol for limiting emissions over a horizon extending to 2010, but with a more limited target of average –5% compared with 1990. Every Annex I country committed itself to the limitation target.

In most industrialised countries the transport sector is one of the most significant GHG emitter and particularly of CO<sub>2</sub>, the main greenhouse gas associated to transport activity (for instance 34% of CO<sub>2</sub> in France<sup>3</sup> in 1999, 30% of CO<sub>2</sub> in the US in 1997). However the biggest threat is that the rate of growth in CO<sub>2</sub> emissions from the transport sector is projected to outstrip that for the other sectors in most countries, so the share of CO<sub>2</sub> emissions from the transport sector is expected to be even greater in the future. According to the OECD transport is the second highest growth sectors in terms of GHG emissions in the OECD area (following industrial processes), with the share of CO<sub>2</sub> emissions increasing from about 25% in 1995 to 30% in 2020 (OECD, 2000a). Within the European Union, it is expected in a recent study (Bates et al, 2001) that the growth from 1990 to 2010 in the CO<sub>2</sub> emissions from transport in the EU would be 35% in the baseline trend and 25% taking into account the full effect of the voluntary agreement with the car makers<sup>4</sup>. This result should be related to the Kyoto objective of –8% for the EU.

According to the OECD (1995), forecast traffic growth (in vehicle kilometres travelled, VKT) is such that current strategies for reducing unit vehicle emissions will be inadequate to reduce overall emissions. Only with more intensive application of a combination of technical solutions for reducing emissions, enhancing the energy efficiency of engines and slowing the growth of VKT will it be possible to reduce greenhouse emissions over the coming 30 to 40 years.

## **1.2. The local environment and its impact on daily life**

The local environmental constraint relates to localised emissions of atmospheric pollutants, as well as to transportation noise and safety concerns.

### *Local and regional airborne pollutants*

The principal atmospheric pollutants produced by automobile traffic (OECD, 1995, 2000b) are:

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<sup>3</sup> CITEPA, 2000

<sup>4</sup> Known as the "ACEA-EU agreement" it is a voluntary agreement between EU and European (ACEA), and then Japanese (JAMA) and Korean (KAMA) car manufacturers to reduce the average CO<sub>2</sub> emissions of all new cars.

- Carbon monoxide (CO) which, as a haemoglobin oxidant, hinders oxygen transport in the body; the short term limits set by the WHO are often exceeded (in one-half of the world's cities, according to the United Nations).
- Volatile organic compounds (VOC), including benzene, 1:3 butadiene, formaldehyde, acetaldehyde and polynuclear aromatic hydrocarbons; these result from the incomplete combustion of fuels and from evaporation losses during the fuel distribution, storage and transport cycle. They are for the most part highly carcinogenic. According to the USEPA (the USA's Environmental Protection Agency), mobile sources may account for 54 percent to 58 percent of cancers associated with toxic air pollutants in the USA.
- Nitrogen oxides (NO<sub>x</sub>), which are the second cause of acid rain after sulphur dioxide and are among the precursors of tropospheric ozone or smog, together with VOC; they provoke respiratory problems, particularly in children (coughs, rhinitis, sore throats) and increase the sensitivity of asthma sufferers to urban dust and pollen.
- Sulphur dioxide (SO<sub>2</sub>), released primarily by diesel fuel, is a contributor to acid rain and also to respiratory irritation.
- Particulate matter (PM), which include dust, dirt, soot, smoke, and liquid droplets. They are emitted directly, for instance resulting from the incomplete combustion of diesel fuel, or formed by condensation or transformation of emitted gases such as SO<sub>2</sub>, NO<sub>x</sub>, and VOC into tiny droplets. Fine particles (PM<sub>10</sub> of a diameter less than 10 microns) are the most readily inhalable. These substances also produce respiratory problems, and are probably carcinogenic. Gasoline releases fewer particles, but they are more highly toxic.
- Lead as a gasoline additive; this has harmful effects on health, even in extremely low concentrations (behavioural problems, difficulty in concentrating, low IQ); it is widely dispersed through exhaust emissions, but is now gradually disappearing in most OECD countries<sup>5</sup>.
- Other pollutants, such as asbestos, use of which is to be reduced in any case (brake pads, clutches, automatic transmissions), toxic heavy metals, and dioxins, which are present in infinitesimal quantities but pose a grave risk when accumulated.

It is important to appreciate the complexity of the mixtures of chemical compounds that, under the effect of solar radiation for example, produce photochemical fogs or smog (tropospheric ozone, a harmful irritant, in contrast to stratospheric ozone, which provides protection against ultraviolet radiation).

This atmospheric pollution is worse in urbanised areas with features such as unfavourable topography (e.g. mountainous basins) or meteorology (e.g. thermal inversions) which prevent dispersion of pollutants. The improvements made in fuel quality and vehicle emission standards in most OECD countries tend to lower the trend of total emissions of these kind of pollutants (for instance in the USA<sup>6</sup> or in the European Union<sup>7</sup>). However the continuous and fast growth of VKT tends to offset the optimistic projections in these countries while the rapidly growing use of old and less compliant vehicles in developing countries (e.g. in Latin America) is a major source of high-level air pollution in urbanised areas of the developing world (Onursal

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<sup>5</sup> Cf. the discussion of the gasoline lead phase-out program in the United States, below.

<sup>6</sup> see the ZEV case study below

<sup>7</sup> see the Auto-oil programme

and Gautam, 1997). The OECD projections to 2030 confirms the continuation of the decline of traffic-related local pollution in the OECD area (OECD, 2000b) while in the rest of the world this pollution should increase.

#### *A technology dilemma?*

While the generalisation of catalytic converter is an adequate answer to the local/regional pollution problem, this is not the case for CO<sub>2</sub> emissions. Of course reductions in unit vehicle emissions or consumption can still be achieved while battery electric vehicles are developed for introduction to the market within the next 10 years to address this issue of local/regional pollution<sup>8</sup>. However this last solution is criticised from the point of view of both CO<sub>2</sub> emissions, depending on the way electricity is produced, and waste recycling or stocking, whether considering batteries or nuclear power.

This dilemma could resolve by considering the longer term perspective of CO<sub>2</sub> emissions reduction. As underlined in the EST study (OECD, 2000b) if the CO<sub>2</sub> target is met, mostly by reduction of overall fuel consumption, the other air pollutants emission targets would also be met. This is why a focus given to CO<sub>2</sub> target would probably not offset the achievement of other pollutants targets.

It could be said that in the longer term, e.g. more than 30 years, completely new and perhaps truly “clean” technology will be available. However the current situation requires immediate actions to be undertaken, whether addressing the local/regional pollution issue in urbanised areas in both industrialised and developing countries, or the Rio objectives on GHG emissions which are much more ambitious than the Kyoto ones. As already pointed in the previously quoted studies, technology alone will not be sufficient.

#### *Safety, physical disruption and noise*

Apart from these environmental aspects, the need to maintain the quality of life also implies dealing with the safety hazards posed by vehicle traffic, not only for motorists but also for pedestrians and cyclists. It also implies minimising the disruption caused by transportation infrastructure works; this increases further the cost of projects for burying or covering roads. Vehicle hazards translate statistically into numbers of accidents, deaths and injuries, and remain a major problem in most countries, linked to the continuous growth of road traffic.

Finally, one of the worst nuisances felt by city dwellers is the noise that penetrates their homes. For instance this has become a subject of major concern in the European Union. Yet the disparity of exposure is great: vehicle traffic is more disturbing in large cities, while motorcycles and heavy trucks are a greater concern in suburban or sparsely populated areas. This problem also has obvious social implications: for example, in France the number of people subject to an average noise level of more than 65 dB is four times as high among the lowest income groups than among the wealthiest. Generally speaking, the conjunction of urban crowding and automobile

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<sup>8</sup> see the ZEV case study below



traffic growth tends to increase people's exposure to noise. Despite efforts to date to equip urban highways with acoustic barriers, technical solutions remain very limited.

### **1.3. Selecting a control strategy and instruments**

In seeking an optimal, or at least acceptable, balance for the community as a whole, a trade-off must be made between the advantages offered by the development and use of transportation systems, on one hand, and the environmental and social costs which follow from, on the other hand. This trade-off should be such as to maximise the total net surplus for the community, i.e. advantages less costs.

Strategies for controlling the transportation system must take account of certain specific features of transportation, in comparison to conventional economic goods. For the transportation system user (motorist, pedestrian, public transit passenger, freight carrier) transportation is an intermediate good: it allows a citizen, for example, to pursue his work in a given place, or a wholesale business to deliver a good to a retailer for sale. The demand for transportation is a derivative of the demand for conducting activities in determined places, or the demand to make goods available in determined sites. It follows that transportation, since it consists of a service for moving goods and people between two given places, is a unique good in spatial terms: a given movement can rarely be substituted by another, because it will not have the same utility.

This intermediary good is itself not storable, and not transportable, which explains why its production is subject to specific peaks in space and time. This production involves the following agents:

- The public authorities who regulate the transport activity, supply the infrastructure, and subsidise the transport operation, sometimes through public-private partnership.
- Automobile makers who provide the vehicles that use the roads.
- Oil producers, importers and refiners, who supply the fuel used in the vehicles.
- Road hauliers, companies using road for transporting freight for their own account, and other transportation operators providing transport service, including urban public transport, railways, coach lines, taxis and airlines operators.
- Households, through their own automotive consumption (car purchase, maintenance and use).
- As well, transport infrastructure and service users inject their own travelling time as an input in the production of transportation.

Available controlling instruments involve not only the transportation system in its strict sense, but also land use management. They may be broken down into the following categories:

- Regulations governing land use (lot occupancy coefficients, zoning), roadway use (traffic regulation, sharing the road between different modes, speed limits), fuel standards and vehicles (emission and safety standards).
- Taxation, essentially through fuel taxes, but also through land use taxes (real estate and home occupancy taxes).
- Transferable permits as a hybrid instrument between regulation and taxation.

- Voluntary agreements negotiated with business industries, such that they limit their emission or consumption of depletable resources.
- Infrastructure user fees, through road tolls and railway fares.
- Land use planning policies, through exercise of expropriation rights and official powers to decide the location of public facilities.
- Financing the supply of infrastructure and transportation services (by the means of the general budget, specific taxes, or user fees, sometimes through a public-private partnership), and subsidisation of new technology developments (new engines, new fuels, etc.)
- Organisation of transport markets (organisation and regulation of markets, concessions and licenses).

#### **1.4. Pros and cons of using transferable permits in the transport sector**

Two main criteria can be used for judging the relevance of permits systems<sup>9</sup>: these are, on one hand, the ability to impose a constraint or a right defined in a quantitative manner within a specified space-time, and on the other hand the ability that agents have to transfer all or a portion of these quantitative obligations.

First, permit systems are of particular interest because of the relevance of certain of their attributes<sup>10</sup> to control of the transport sector:

- In cases where a given environmental performance must be achieved in a context of uncertainty over agents' price response functions; in such cases a permit system is more likely to achieve a quantitative objective than taxation.
- In cases where agents are more sensitive to quantitative signals than to price signals (notably if the elasticity of demand to prices is low in the short or medium term).
- In terms of flexible implementation of control policy, permit systems (like road tolls) can be used to target local and regional problems arising from transport activities.
- In political terms, systems in which permits are allocated free of charge are seen by agents as a means of avoiding an additional tax: in some cases, e.g. high fuel duties in Europe, this can enhance the acceptability of the new instrument.
- A quota system is the only type of system which allows distributive impacts to be treated explicitly and separately from the issue of the economically efficient allocation of efforts to reduce environmental damage. Given the fundamental role that transport plays in the right to mobility, these distributive impacts merit close attention.

Since the most difficult step is firstly to set up permits in the transport sector, most of the discussion on pros and cons is about permits system per se. Making them transferable is a second step which would essentially add transaction costs, as mentioned below.

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<sup>9</sup> Cf. OECD, 2001

<sup>10</sup> See OECD, 2001

### *Arguments for*

Besides the previous general aspects, there are other arguments in favour of the use of permit systems in the transport sector.

In many instances it is possible to set precise and measurable targets, as in the case of local or global emissions of air pollutants (greenhouse gases) or congestion. In all cases, it is the sum of individual outputs of agents which produces the overall output<sup>11</sup>. In contrast, this does not apply to noise which does not increase linearly in accordance with the number of individual emissions.

It is also possible in many of the cases to establish space-time equivalents of aggregate nuisances, as in the case of local or regional air pollution for which permits can be traded within the corresponding geographical area; this is also the case for global air pollution such as greenhouse gas emissions, for which the corresponding geographical area is obviously the planet. Such equivalents can not be applied as readily to congestion, which is a phenomenon that is usually restricted to specific routes and times of the day. It would nonetheless be possible, in the case of conglomerations or urban areas subject to widespread road congestion, to design quota systems applicable to trips made by road within the area<sup>12</sup>.

Lastly, the appearance of threshold effects may require a quantity-based approach to be adopted. This is clearly the case for greenhouse gas emissions, but also applies to local emissions of air pollutants which must not be allowed to exceed specific thresholds beyond which they become a health hazard.

### *Arguments against*

Among the arguments against the use of permit systems in the transport system, the foremost is the question of the cost of administering such systems which by definition target a large number of mobile sources. From this standpoint, if the target nuisance can be linked, with an acceptable degree of approximation, to fuel consumption (for reducing greenhouse gases emissions, for example), then increasing existing duties on fuel would naturally be the cheapest solution. In other cases such as congestion, the use of automatic vehicle identification technology to collect electronic road tolls from moving vehicles, a practice that is currently growing rapidly, would seem to be the most appropriate solution. Indeed this technology can provide a basis for reducing the administrative costs of certain types of permit system (see the case study below on Ecopoints in Austria).

Moreover, making permits transferable would involve well-known transaction costs (Stavins, 1995). Resolving this issue of administrative and transaction costs is a key element in the introduction of any transferable permit system in the transport sector. We shall see in the case studies examined later in this report how this issue can be dealt with under different conditions.

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<sup>11</sup> Primary gases in the case of air pollutants. Possible secondary chemical reactions, such as ozone formation, are not taken into account.

<sup>12</sup> See, for example, Marlot (1998) or Viégas (1999).

It is by no means clear, a priori, which of the two instruments would be the least socially acceptable, i.e. rationing of the activity either by outputs (permits) or by prices (a much higher tax than currently to meet the objective of reducing emissions): such a rationing would target indirectly, at least in the short term, the number and length of automobile trips. Since the automobile plays a fundamental role in mobility, as there is frequently no transport alternative, that would make explicit restriction on freedom of movement, a fundamental right that is universally recognised in declarations of human rights such as that of the United Nations.

Lastly, compared with the sole use of regulations, transferable permits would introduce the notion of a commercial transaction on the *rationing* of the universal right to freedom of movement, as mentioned above. In many cultural contexts this might represent an additional handicap.

### **1.5. The potential for transferable permit programs in the transportation sector**

The global output of transportation activity is the result of a combination of factors relating to land use (location of activities and consequences for distances travelled), the supply of infrastructure and services (price and quality of service for different modes of transport), technical features of transport vehicles (energy source, unit consumption, emissions) and the intensity of vehicle use (mobility as a function of economic and social trends). These factors all offer potential fields of action for controlling nuisances in the transport sector.

The first potential field concerns land use, and in particular the battle against urban sprawl and the dispersal of activities, which lead to longer travel distances: these longer distances are most often travelled by private automobile, since in such scattered settings there is no public transit alternative. This field is currently managed through the regulatory approach, but it could be the subject of quantitative controls in the form of rights yet to be devised.

A second field concerns the supply of infrastructure, which is today controlled primarily by the availability of financing through general budgets, but is increasingly the subject of user fees. The use of permits would not seem appropriate in this field, a priori, but we will suggest hereafter some points for debate on the co-ordination between permits and financing.

A third area concerns, on one hand, vehicle technology, through the regulation of unit emissions of local or global (greenhouse) air pollutants, and on the other hand, the technical characteristics of fuels. This is where we find the most advanced use of permits, as we shall see below, applied either to automakers or to fuel refiners (quality standards).

A fourth field concerns total fuel consumption by vehicles, as a function both of the intensity of use and of unit consumption, where the natural instrument is a tax. However, as we shall see, the observed social limitations on fuel taxes suggest the

wisdom of exploring permits systems that would target the intensity of carbon consumption inherent in fuel consumption.

Finally, there is a fifth field, related to the previous one, which also involves controlling vehicle use but is focused more precisely on VKT (vehicle kilometres travelled), as a medium-term solution for controlling noise emissions or congestion. The most common approach to noise control is still through regulation or funding for acoustic protection around transportation infrastructure. With respect to congestion, control is still achieved essentially through the waiting line, despite the ongoing and long-time debate about congestion pricing. One relevant use of permits could therefore involve setting quotas on VKT or trips within a given urban area that would be allocated to motorists and could be transferred among them<sup>13</sup>.

In addition to the well-known problems of designing and implementing transferable permits systems in general<sup>14</sup>, however, their use in transportation systems involves some specific considerations. These relate, on one hand, to the great number of externality sources, and on the other hand, to the burden of a regulatory system that, as described briefly above, is already quite complex.

The great number of mobile emission sources that automobiles represent constitutes an obvious obstacle to decentralising permit systems in the transportation sector, since administrative costs would appear, a priori, to be prohibitive. This explains why most proposals to decentralise permits have stopped at the level of automobile makers, and have been targeted at unit vehicle emissions. We shall return to this question later.

The pre-existence of a complex control system for the transport sector implies that the design of transferable permits will have to consider how they can be inserted into the system. As we shall see in the following case studies, these systems can be used as a supplement to existing controls.

Given the limited scope of this study, it has been impossible to explore all the potential fields identified above. We have selected four case studies that illustrate the diversity of possible applications.

## **2. THE CASE STUDIES**

The first case study is the US lead phase-down in gasoline and illustrates the case of fuel quality standards. This is a program of lead rights tradable between refineries that was implemented from 1982 to 1988 to ease the accelerated phase-down of lead in gasoline until a complete ban came into effect in the USA in 1996.

The second case study is the Ecopoints system for heavy goods vehicles (HGV) in transit (Austria) and points to the issue of vehicle intensity of use. This is a non-tradable permits system which was introduced in Austria in 1992 to prevent an excessive rise in HGV emissions throughout the country's Alpine region. Although the permits are not transferable, the experience gained in this experiment serves to

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<sup>13</sup> See Verhoef et al (1996), Marlot (1998).

<sup>14</sup> See OECD, 2001.

highlight the potential advantages and drawbacks of permit systems applied to mobile sources such as HGV.

The third case study is California's Zero Emission Vehicles (ZEV) program and illustrates the case of unit vehicle emissions. This is an on-going scheme of tradable permits aimed at reducing the level of local pollution stemming from car use, by increasing the proportion of ZEVs and LEVs (Low Emission Vehicles) sold by automobile manufacturers in California.

The fourth case is a prospective study in France for introducing transferable permits within the transport sector in order to control the GHG emissions of this sector. It was conducted by a working party of experts and representatives of transport operators and users. The study reviewed possibilities for introducing both "upstream" and "downstream" tradable permits and covers the wide range of implementation levels, from unit vehicle emissions to fuel whole consumption

## **2.1. The Lead Phase-down Program (USA)**

The objective of this program was to eliminate use of lead as a gasoline additive in the United States. This system of granting refineries rights to add lead to gasoline was part of a family of permits based on the concept of averaging. The program was in place from 1979 to 1996, when lead was effectively banned. It was also accompanied by a program of rights transfers that was in operation from 1982 to 1987: the trading of rights between refineries was authorised from 1982 to 1986, and the banking of rights was authorised from 1985 to 1987.

### **2.1.1. Context**

Lead is one of the substances added to gasoline to increase the octane rating and reduce engine knock. These properties were discovered by engineers at General Motors in 1921, and the use of lead spread quickly. The toxic effect on human health of lead in high doses had been suspected, if not fully understood, since Roman antiquity at least. But it was only after the enormous expansion of lead use, as automobile travel became generalised, that the first scientific proof of its toxicity, even in low doses, surfaced during the 1960s and 1970s: lead then came to be seen as a threat to public health (Lewis, 1985).

The combustion of leaded gasoline disperses lead particles into the atmosphere. Lead is a severely toxic pollutant that causes neurological dysfunction that can have grave consequences, particularly on the foetus and on children. In adults, low doses provoke hypertension and increased risk of heart disease. This, then, was the primary motivation of the control programs that were introduced in many countries to cut back or completely eliminate lead in gasoline.

The second motivation for phasing out lead in gasoline had to do with the use of catalytic converters, which are rendered inoperable by the presence of lead in the fuel. Catalytic converters were introduced by all U.S. automakers, beginning in 1975, to reduce other emissions associated with fuel combustion (hydrocarbon compounds,

carbon monoxide, oxides of nitrogen). This requirement also explains the declining consumption of leaded gasoline, as the automobile fleet was gradually renewed.

The use of lead as an automotive gasoline additive has now been banned in most OECD countries. On the other hand, lead continues to be widely used in Africa, in Central and South America, in Asia and in Eastern Europe. In many of these regions there is no lead-free gasoline available (Kaysi et al. 2000). The essential rationale behind continued use of lead in some countries is that lead is still the least expensive means for increasing the octane rating of fuel<sup>15</sup>.

### **2.1.2. Program description<sup>16</sup>**

The regulatory program for reducing lead in gasoline was initiated by the U.S. Environmental Protection Agency in December 1973. The EPA is a federal agency responsible for defining and enforcing environmental regulations and standards pursuant to federal environmental legislation, and in particular the Clean Air Act.

Flexibility was built into the lead phase-down program in a series of three successive stages: averaging, trading and banking.

*First stage: averaging over a quarterly compliance period.*

At the end of 1973, the EPA proposed new regulations for a five-year reduction in the average lead content of all gasoline products (leaded and unleaded) for every refinery, measured on a quarterly basis: this average was to be cut from the current level of about 2 grams per gallon to a maximum of 0.6 grams per gallon in 1978. Enforcement of the new regulation was held up for several years by lawsuits, and the 0.5 grams-per-gallon rule came into effect only on October 1, 1979. This was the first stage in the introduction of a degree of flexibility in the standard, which was applied not to each gallon but as an average to total output over a three-month period.

*Second stage: tightening of the standard and introduction of the rights trading option*

New scientific revelations about the toxicity of lead allowed the EPA to tighten the standard in 1982, to a maximum of 1.1 grams per gallon, but calculated this time solely on the total of leaded gasoline produced by the refinery. As well, the very small refineries were granted a slightly less rigorous rule, from October 1, 1979 to July 1, 1983.

To facilitate this adjustment, a program was introduced for trading rights to add determined amounts of lead to gasoline.

This rights trading program reflected a concern to give refiners (in particular the smaller ones) some flexibility in adapting to the new rules.

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<sup>15</sup> The alternatives consist of replacing lead by oxygenate additives such as ethanol or methanol, which are less expensive, or modifying refineries to use other procedures for increasing the octane rating (platforming, alkylation, isomerisation).

<sup>16</sup> The principal reference works are: Hahn and Hester 1989, Kerr and Newell 2001, Kerr and Maré 1998, Nussbaum 1992.

The rights allocated to each refinery were calculated in terms of the quantity of leaded gasoline produced by the refinery and the authorised amount of lead per gallon (as determined by the EPA). For example, a refinery producing 100 million gallons of leaded gasoline during any quarter of 1983 or 1984, when the standard was 1.1 g per gallon, received rights to 110 million grams for the quarter. If the refinery added less than the authorised amount of lead, it could sell its lead rights up to an amount equal to the difference between the actual amount added and the norm. If on the other hand the refinery wanted to add more lead than the rule allowed, it would have to purchase rights prorated to the excess.

The balance between rights held or acquired and rights needed for each refinery was recalculated every quarter, and had to be either positive or nil.

The validity of the rights was limited to three months. Refiners could use up their rights over the course of that period (by adding more or less lead to their gasoline during the quarter) or they could sell these rights to other refiners during the same period. Any rights not used or sold would expire at the end of the quarter for which they were created.

This last rule was amended with introduction of “banking” in 1985.

*Third stage: further tightening and introduction of the rights banking option*

The allowable level of lead in gasoline was further reduced to 0.5 g per gallon in mid 1985, and the EPA announced that the program for trading rights between refineries would end in 1986. In 1985 the EPA also introduced the banking of rights, which could be used until the end of 1987.

In anticipation of the tightening of the rule in mid 1985, refineries added less than the authorised amount of lead during the first two quarters of 1985, and banked the balance of their rights: the smaller refiners were then able to use or buy banked rights from the larger refiners during the second half of the year, and could thereby exceed the norm.

In 1986, the standard was cut again to 0.1 g per gallon, while the ability of a refinery to bank its rights was abolished. Rights acquired by one refinery from another could still be banked, but few refiners took advantage of this possibility. The reaction of refiners was to use their previously accumulated rights to continue exceeding the stricter standard.

*Fourth stage: windup of the rights transfer program*

The rights trading program came to a close at the end of 1986. On the other hand, banked rights could still be used until the end of 1987. In 1988, after the rights transfer program was terminated, the 0.1 g per gallon rule was applied to each refinery individually. Lead was finally banned as an additive to gasoline for road vehicles in 1996.

In summary, during the course of the gasoline lead reduction program, which ran from 1979 to 1996, the rights transfer program was operational from 1982 to 1987.



### *Participants in the program*

All refiners were subject to the EPA rule governing the authorised amount of leaded gasoline. On the other hand, participation in the rights trading program was optional. In 1983 and 1984, for example, it is estimated that there were between 300 and 400 refineries involved in such trading.

### *Managing transfers*

No prior approval was required from the EPA for trading permits, but an ex post declaration had to be submitted (see below).

There were however some minor restrictions on trading:

- California refiners, which were subject to a stricter standard, could not resort to trading in order to exceed the State norm.
- Small refineries, which initially faced a less severe standard, were not allowed to sell their rights to the large refiners.

This second restriction was eliminated on July 1, 1983, after which time all refiners were subject to the same standard.

The most important restriction concerned the life of the permits, which was limited to three months after 1985. Nevertheless, there was significant trading both before and after that date.

### *Monitoring and auditing*

Under the regulations, every refinery had to submit a quarterly declaration to the EPA on its output of gasoline and the amount of lead used. Refineries participating in the trading and banking programs also had to indicate in the declaration the amounts traded or banked, and the refineries with which they had conducted their trades.

Overall, transaction costs as identified by Kerr and Maré (1998) were not insignificant: they included the costs of optimisation, the costs of seeking a partner and researching prices, the cost of uncertainty about the validity of permits that were, in practice, traded before they were validated by the EPA at the end of each quarter, the costs of negotiation and the costs of disclosing confidential information on refinery output. The presence of these costs explains why the smaller refineries, those belonging to companies of smaller scale or with fewer refineries, tended not to participate in the trading. By contrast, refineries belonging to the larger companies were more active in trading, reflecting their degree of specialisation in producing different types of fuel.

### **2.1.3. Assessment**

The market for these rights was very active, and the volume of trading between refineries rose steadily as the standard was progressively tightened. In 1983 and 1984 there were between 300 and 400 potential participants in the trading, and refineries purchased between 10 and 20 percent of all the lead rights they used (Kerr and Maré, 1998). The tightening of the standard in 1985 and the simultaneous introduction of

the banking option further stimulated trading from 1986 onward. The portion of lead rights traded reached 50 percent of the total by mid 1987 (Hahn and Hester, 1989).

Overall, the small refiners were net buyers of rights from the large refiners, which adjusted more quickly to the standard. However, some of the small refiners also took advantage of the program by selling their rights.

#### *Costs and benefits of the program*

Since the trading was conducted freely and was subject only to a simple declaration, the EPA did not collect systematic data on the trading price of rights. It would appear that the price was about one cent per gram of lead before banking was authorised, and rose to between two and five cents per gram thereafter (Hahn and Hester, 1989).

Enforcement of the standard for gasoline lead additives, quite apart from the rights transfer program, required the EPA to monitor and audit the amounts of lead consumed by the refiners. The incremental cost of administering the rights transfer program were limited to ex post controls over trading between refineries and the detection of invalid rights. It could be said, then, that the administrative costs due specifically to the transfer program were very modest.

Cost savings to the refiners from the trading and banking program have been estimated at several hundred million dollars (Hahn and Hester, 1989)

Finally, Kerr and Newell (2001) have shown that the refiners with the lowest adaptation costs were more likely to adopt new technologies under the marketable permits regime, and this encouraged the spread of those technologies.

#### *The debate over the program's cost efficiency*

It has been objected that the concept of allocating rights proportionate to total leaded gasoline produced was in itself an incentive to overproduction of leaded gasoline. In response, it has been argued that, since the addition of lead is the most profitable way to increase fuel octane ratings, the total amount of lead authorised by the standard would have been used whether there was a trading program or not. That program merely rearranged the distribution and use of lead among refineries, and did not increase the total amount of lead that could be used. Moreover, any incentive to overproduction of leaded gasoline was offset by the constantly rising market share of unleaded gasoline, as vehicles with catalytic converters became more common.

The fact that refineries were free to manage their rights without prior certification, and that their only constraint was to file a declaration at the end of each quarter, was certainly an advantage in activating the market, but it also gave rise to legal problems. Since the balance between rights acquired and rights required was calculated at the time of the end-of-quarter declaration to the EPA, it was possible that rights might be sold only to be found invalid after the sale, having been improperly created, either by error or intentionally. Once they were sold -- and they could in effect be resold several times by brokers -- it was difficult if not impossible to blame the error on a party that had bought them in good faith.

Moreover, the emergence of brokerage activity as a means of facilitating trading had no formal connection to the EPA program. Brokers did not take ownership of the rights, but merely established a market between refineries. The EPA therefore has no direct knowledge of the scope of their intervention.

In the end, the program was regarded as a success: the total authorised amount of lead was not exceeded, and some refiners that would likely not have remained in business in the absence of this flexibility were in fact able to adapt successfully.

#### **2.1.4. Conclusions and lessons**

The success of the program can be explained by the lack of restrictions on trading and by the possibility of banking: the market thus remained very active. Administrative requirements were kept to a minimum (a simple declaration of trading and additive purchases). But these factors alone cannot explain its success: we must add the fact that the refiners were accustomed to dealing together on other markets, in particular for other additives (Hahn and Hester, 1989).

In summary, this program exhibited three basic features that may be taken as essential ingredients for ensuring the success of the transferable permits program:

- A precise definition of the permit unit (gram of lead) eliminated all ambiguity as to what was being traded or banked.
- The rules to be followed were simple and trading could be conducted freely.
- Program implementation was pragmatic, and offered several options.

A further positive factor that facilitated implementation of the program was the availability of affordable technological solutions for replacing lead in gasoline, together with the fact that the consumption of leaded gasoline was on a declining trend because of the evolution of the automotive fleet. The transferable rights program served to accelerate the decline in lead use.

We may say that, in terms of the continuing consumption of leaded gasoline in other parts of the world (see Introduction), a program of this type could be a viable option, provided the local political and regulatory context is appropriate.

## **2.2. The Ecopoint program in Austria**

Ecopoint is an ongoing program for limiting pollution and noise from truck traffic passing in transit through Austria. It belongs to the quotas category, but in this case they are of the "cap but no trade" type, since they are not transferable. The interest in analysing this program is to show how a system of permits applied to mobile sources can be put in place to protect the environment of a given region.

### **2.2.1. Context**

Austria is located at the crossroads of Central Europe's transit routes. Through it pass the north-south route between Italy and Germany and one of the major links between countries of Eastern Europe and Western Europe<sup>17</sup>.

Austria's typically mountainous geography funnels north-south traffic along Alpine valleys, and in particular the Brenner Valley, where the ecosystem is very fragile. The morphology of these valleys is such that exhaust emissions cannot readily escape, and highway noise is intensified. The concentration of nitrogen oxides is three times as high as on a plain with similar traffic volumes.

Moreover, until recently neighbouring Switzerland has imposed a maximum truck limit of 28 tons, versus 40 tons in European Union. Beginning 2001 these regulatory limits have been suppressed (free traffic for 28-34 tons, quotas until 2005 for 34-40 tons) while road fees are imposed on trucks. Waiting at borders and road fee still constitute an incentive for north-south traffic to take alternative routes through France or through Austria.

The result has been a sharp and steady increase in truck traffic transiting through Austria: such traffic rose by 46.9 percent between 1993 and 1999, for trucks of member States of the EU-12, to a total of 1,445,700 trips in 1999<sup>18</sup>, with an increasingly adverse impact on the natural and human environment in the areas traversed. The Brenner Valley received more than 60 percent of this traffic in 1999.

At the same time, freight transiting by rail rose by 35.66 percent between 1991 and 1999 (52.7 percent between 1993 and 1999, with a sharp decline in 1993). It amounted to more than 23 million tons in 1999. More than a quarter of this freight moves between Germany and Italy.

Concern over this growing pressure on the environment led Austria to negotiate an agreement with the European Economic Community in 1992, calling for a reduction in noise and atmospheric pollution generated by heavy trucks transiting through Austria. The chosen target is NO<sub>x</sub> emissions produced by trucks of a gross weight of more than 7.5 tons. The initial objective in the agreement was to reduce these emissions by 60 percent, as compared to the reference year 1991, over the 12 year life of the agreement, i.e. by 2003.

In 1995, when Austria joined the European Union, this agreement was confirmed as a derogation to the Single Market provisions. Protocol 9 of Austria's act of accession extends the regime to December 31, 2003.

### **2.2.2. Program description**

The agreement between the EEC and Austria introduced a system of transit rights known as "Ecopoints" ("Ökopunkte") for heavy goods vehicles of a gross weight of more than 7.5 tons transiting through Austria, whether loaded or empty.

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<sup>17</sup> The main reference used for this report is CEC (2000), apart from a few Internet resources.

<sup>18</sup> 1,706,545 trips for the EU-15.

The trucks concerned are those of all European Union member countries and certain other countries (Switzerland, Norway, Liechtenstein and Slovenia) that have signed agreements with European Union.

Emissions are represented by a quota of points called Ecopoints, which must be used by trucks transiting through Austria. The total quota as calculated in 1991 is to be reduced every year on a straight-line basis to reach the 60 percent reduction target in 2003.

#### *Definition of Ecopoints and period of validity*

Since October 1, 1990, unit emissions of heavy vehicles are referenced in an approval document produced at the time the vehicle is manufactured. Each member State must establish a COP (Conformity of Production) document for the vehicle, declaring NO<sub>x</sub> emissions and the number of Ecopoints required to travel through Austria.

An Ecopoint corresponds to the emission of one gram of NO<sub>x</sub> per kilowatt-hour (kWh). For example, a vehicle normally emitting 10 grams of NO<sub>x</sub> per kilowatt-hour will have to use up 10 Ecopoints to transit Austria.

For vehicles manufactured before October 1, 1990, or without a COP document, a flat charge of 16 Ecopoints is required. When a vehicle receives a new engine, it will be given a new COP document.

Ecopoints are valid from January 1 of each year until January 31 of the following year, i.e. for 13 months. This allows hauliers to avoid having to use two different sets of Ecopoints when making round trips at the end of the year.

#### *Initial allocation*

Ecopoints are distributed by the European Commission among member States according to an allocation schedule established in the regulations and periodically revised by the Commission. Countries are then responsible for redistributing their Ecopoints among their own hauliers.

The allocation schedule among States was based on their share of the traffic between the Community and Austria in 1991. In practice, Italy and Germany use two-thirds of the Ecopoints, while the third-largest user is Austria itself (15 percent).

A Community reserve has been established, holding 3.34 percent of each member State's allocation, to meet any temporary deficit of Ecopoints.

Ecopoints are allocated to member States every year by the Commission in two blocks, one before October 1 of the year preceding the year of validity of the Ecopoints, and the other after March 1 of the validity year. Countries that do not expect to use all of their allocated Ecopoints must return the unused points by October 15 of their validity year. The Commission can then redistribute these points, together with those from the Community reserve, to other countries, in accordance with recognised criteria, and at latest one month before the end of the validity year. This redistribution is decided by a committee of member State representatives.

The transfer of Ecopoints, then, does not involve any kind of market. It is done exclusively through an administrative process that involves all participating States, and is limited to unused Ecopoints.

NO<sub>x</sub> emissions were targeted in order to encourage the use of increasingly cleaner trucks. A further objective was to reduce noise. To avoid a situation where NO<sub>x</sub> emissions might be reduced while allowing an increase in transit traffic, a special quantitative limit on transit trips, the so-called "108 percent clause", was imposed from the outset: if the number of transit trips in any given year exceeds that of the reference year 1991 by more than 8 percent, the number of Ecopoints distributed in the following year must be cut by 20 percent beyond the linear reduction already established.

Such a situation occurred in 1999, and sparked a dispute between Austria and other member States: this was settled by the European Commission in 2000, by suspending temporarily enforcement of the clause. According to that clause, many countries (including Germany, the principal user of Ecopoints), would have reached their quota as early as the summer of 2000: carriers from those countries would no longer have been able to transit through Austria. This crisis, marked by demonstrations in Austria against truck traffic on the Brenner motorway, led to a reassessment of the program and proposals for reform from the European Commission. In February 2001, the Commission set forth new regulations that would: suspend the "108 percent clause" on an exceptional basis for the year 2000, but confirm its enforcement for the years 2001 to 2003; impose a new reduction in Ecopoints until 2003 to reach the initial objective of a 60 percent cut; and establish a four-year rescheduling of the reduction of Ecopoints that would result from renewed enforcement of the 108 percent clause. This reduction would be shared among member States as a function of the growth rate of traffic generated by their own hauliers. However, Austria appealed to the European Court of Justice to overturn the new regulations and on February 23, 2001, the President of the Court ordered suspension of the measure rescheduling the Ecopoint reductions over four years.

#### *Monitoring and auditing*

The Ecopoints were initially issued in paper format, a system that required systematic manual controls at the border. With Austria's entry into the European Union and abolition of internal border controls within the Union, systematic border stopping were no longer required and a system had to be found that was compatible with these new provisions.

This was accomplished with the introduction, on January 1, 1988, of an electronic system for processing Ecopoints by automatically detecting heavy vehicles with the aid of an onboard device.

Consistent with the desire of member States to minimise the cost to hauliers of installing the equipment, it is a very simple device. The onboard electronic transponder<sup>19</sup>, called an "Ecotag", identifies the haulier and the vehicle and contains details from its COP document.

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<sup>19</sup> 5.8 GHz DSRC transponder.

The haulier must first register with the competent authorities of his own country, who have a direct link to the central system in Austria for recording information on hauliers, their vehicles (COP data) and their Ecopoint credits. The haulier must purchase an Ecotag (available in member countries and at the main Austrian border points) and then, before its first use, it must be initialised and mounted behind the vehicle's windshield by Austrian officials on duty at selected border crossings.

The Ecotag automatically signals the passage of the truck across the border<sup>20</sup>. It is only if the vehicle is en route to a destination in Austria (and not in transit) that the driver must push a button to signal this exemption. Information on the date, time and point of entry into Austria are recorded in the Ecotag. These data allow for inspection by mobile control units within the country. Upon leaving the country, the vehicle's passage will again be detected by the electronic station, which will read the information recorded in the Ecotag and transmit it to the central system that maintains haulier accounts. If Ecopoints are required, the central system debits the points, transmits an electronic invoice to the haulier's country and notifies the authorities of any trips not covered by sufficient Ecopoints. The system will reject Ecopoints if their validity date has expired. Hauliers can consult the balance on their Ecopoint account through national terminals located in member countries.

European regulations require that the electronic system must be used for most transit trips. This means the purchase and installation of the Ecotag device, which may seem an excessive burden for occasional transit trips. The regulations therefore authorise each member country to use the paper system up to a limit of 0.6 percent of the total quota, or some 9,000 trips for each country. In practice, more than 95 percent of Ecopoints are handled electronically.

For vehicles without Ecotags transiting Austrian borders within the European Union, the driver must cancel the paper Ecopoints in special machines located at the principal points of entry to Austria. Random controls are performed on vehicles travelling within the country.

Systematic control of paper Ecopoints has been retained at Austria's frontiers with non EU countries. The driver must present his COP document and the required Ecopoints, which will be stamped. One copy is retained by the Austrian entry-point authorities, one is kept by the driver as proof for presentation during random inspections, and a third copy is handed over to the authorities upon exiting Austria. The year of validity is printed on the paper Ecopoints, and they must not be used after the expiration of their validity period.

About 4 percent of trips declared by Ecotag involve unauthorised use, and perhaps half one million fraudulent Ecopoints are used each year. On the other hand, there are no data on fraud committed by vehicles not equipped with Ecotags<sup>21</sup>.

#### *Regulatory framework and authority responsible for program operation*

The principle of the Ecopoint program was adopted by the European Union upon Austria's accession in 1995, as a derogation from the provisions governing the Single

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<sup>20</sup> 169 border crossings are equipped with overhead electronic readers.

<sup>21</sup> Bearing in mind that the paper system represents only 5 percent of Ecopoints.

Market, which prohibit any barrier to trade in goods between member States. Nevertheless, to the extent that the Ecopoint program applies to all member States, it does not violate the essential principles of non-discrimination and harmonisation of competition. The Ecopoint distribution formula is established by regulation of the European Commission.

The Ecopoint system is the property of the Austrian Ministry of Transport. Installation and operation of the electronic system has been contracted to a private operator.

### **2.2.3. Evaluation and comment**

There is very little quantitative data available on the costs and benefits of the Ecopoint program. With regard to costs, one must consider the fact that electronic road pricing systems targeting trucks will be implemented and interoperable in the short term in several European countries: this is already the case in Switzerland since 2001 and it is planned in Austria and Germany. Thus it can be assumed that once these systems are operating the incremental cost of operating a permit system addressing truck traffic in ecologically sensitive areas will be low.

In terms of benefits, there has been a very clear technological training effect. The proportion of trucks (measured by number of trips) paying 15 Ecopoints or more dropped from 51 percent in 1993 to less than 2 percent in 1999. On the other hand, the proportion of trucks paying 7 Ecopoints or less (EURO II) skyrocketed from 0.1 percent in 1993 to more than 78 percent in 1999<sup>22</sup>. Thus, the average number of Ecopoints used by member country trucks has declined more swiftly than the target value established in the agreement.

Although it is impossible to say exactly what role the Ecopoints have played in this technological evolution, it is probable that the system has had a supplementary effect in accelerating the impact of the overall program for tightening European emission standards (EURO I, II and III).

On the other hand, the program's design has revealed a number of shortcomings. These are of four kinds: insufficient coverage of pollution sources, lack of incentive to use even cleaner trucks, an excessively comprehensive measure for addressing the objective of preserving alpine valleys, and a degree of mistargeting in environmental terms.

#### *First limitation: inadequate coverage of pollution sources*

Several categories of heavy goods vehicles escape the obligation to produce Ecopoints:

- Trucks en route to or from destinations in Austria are not affected by the Ecopoint system. The same is true for trucks travelling exclusively within Austria.

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<sup>22</sup> The Euro III Standard applicable in 2000 corresponds to a maximum of 5 Ecopoints.



- Trucks from non-member countries<sup>23</sup> of the European Union and those using ECMT permits<sup>24</sup> are also exempt.
- The system does not apply to light-duty vehicles (less than 3.5 tons PTAC) or to buses, which produce NO<sub>x</sub> emissions at levels similar to those of trucks.

In short, most heavy-duty vehicles travelling in Austria do not pay Ecopoints, because they are travelling to or from points in Austria. This loophole could provide an incentive to circumvent the Ecopoint system by splitting a transit trip into two trips, and simply transferring the cargo within Austrian territory.

*Second limitation: lack of incentive to use cleaner trucks*

Statistics on the average Ecopoints used by member State trucks show that the number declined by 44.7 percent from 1993 to 1999, or more swiftly than the target values established in the agreement.

Now that low-emission vehicles are in production and are being used, the "108 percent clause" represents a hindrance to the development of truly low-emission vehicles. In effect, using such vehicles would only make sense if additional trips beyond the 108 percent could be made for the same number of Ecopoints, which is not the case.

*Third limitation: an excessively broad measure for meeting the objective of preserving alpine valleys*

Although most transit traffic passes through the Alps (60 percent through the Brenner pass), the Ecopoint system applies to the entire territory of Austria. The system makes it possible for transit traffic, and hence emissions, to grow sharply in the alpine valleys as long as it is offset by reductions on the plains. The system as currently designed, then, is not accurately targeted at protecting regions that are particularly sensitive to local emissions.

*Fourth limitation: environmental mistargeting*

Targeting NO<sub>x</sub> emissions was seen as an indirect way of limiting overall nuisances, not only in terms of atmospheric pollution but also of noise. However, trucks have become steadily cleaner, and have exceeded the specific objective set for NO<sub>x</sub> emissions.

Given that traffic volumes have been maintained and have even grown, despite the 108 percent clause (which was suspended for a time), there has been no improvement in other nuisances such as noise. In fact, the noise problem is unlikely to be abated unless something is done at the point of contact between the tire and the pavement, or unless traffic is moderated. The NO<sub>x</sub> emissions target thus no longer plays a role in reducing the general level of nuisance from the road transport of goods.

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<sup>23</sup> With the notable exceptions of Switzerland, Norway, Liechtenstein and Slovenia, which also use the Ecopoint system.

<sup>24</sup> 752 permits. Excessive use of these permits seems to be reported.

#### **2.2.4. Conclusions**

The Ecopoint system has the advantage, first of all, of showing that it is technically quite feasible to apply a quota-based system of permits to mobile sources within a defined area. It thus provides one element of a response to the frequently heard objection that the administrative costs of permit systems for mobile sources will be too high.

The Ecopoint system suffers from several limitations, however, that could well present stumbling blocks for other programs of a similar nature designed to protect sensitive regions:

- To target nuisance vehicles in a given region more thoroughly would require a great many electronic detection devices: a trade-off would have to be found between the costs and benefits involved, depending on highway geography. Such a system would only be applicable in certain fairly specific geographical configurations (for example in valleys with few points of entry and exit).
- If there is to be continued incentive for further reductions in unit vehicle emissions, restrictions on total traffic volume would have to be abandoned.
- One possible option for avoiding excessive traffic growth (which produces noise and diminishes road safety) might be to set stricter NO<sub>x</sub> emission quotas while allowing them to be transferred among hauliers on a market basis: in this case, the incentive to reduce emissions could be maintained while controlling traffic growth.
- However, tightening emission quotas in order to control traffic growth would create a gap between the physical basis of the quotas (pollutant emissions) and the target (traffic) that could give rise to allocational inefficiencies. An alternative might be to modify the physical base, in one of two ways: either by combining NO<sub>x</sub> emissions and trips, or by replacing NO<sub>x</sub> emissions by trips. The second option would have the advantage of keeping the base simple, an indispensable consideration for a properly functioning system. It would also do more to foster use of the rail as an alternative for crossing the country.

### **2.3. The ZEV program in California**

The ZEV program (Zero Emission Vehicle) now underway seeks to speed up the introduction of electric vehicles in order to reduce local atmospheric pollution in the State of California. It includes a system of credits based on the concept of averaging. These credits can also be transferred between manufacturers (trading) and over time (banking).

This case study was chosen rather than the Corporate Average Fuel Economy (CAFE) program because the ZEV program goes further on the way of implementation of TPs at the level of automakers. CAFE<sup>25</sup> requires automakers to comply with the fuel economy standards (that is miles per gallon, mpg) set by the US Department of Transportation. CAFE value is computed by averaging the vehicle standards weighted

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<sup>25</sup> See <http://www.epa.gov/otaq/factsht.htm>, Office of Transportation and Air Quality of the US EPA.

by vehicle sales. Fines are set at 5.50 USD per tenth of mpg deficit. Since credits can only be banked or borrowed by the automaker up to three years in order to offset fines calculated in other years, CAFE can be considered as a non-tradable permits system.

### **2.3.1. Context**

In the 1970s it was frequent to have more than a hundred smog alerts in the Los Angeles basin over the course of a year. A major effort was then made to stiffen vehicle emissions standards, and emissions have now been reduced by 98 percent. Smog alerts have declined sharply, to the point where there were none at all in 1999.

The California Environmental Protection Agency, however, has determined that further efforts are required. Today, 95 percent of California residents live in areas where the air quality does not meet U.S. federal standards. Cars and trucks are the second greatest source of atmospheric pollution (accounting for more than 50 percent of smog precursors). Some one million vehicles are sold every year in California, which is the largest automobile market in the United States.

Since VKT are projected to jump tremendously in coming decades, progress in terms of reducing pollutant emissions<sup>26</sup> from gasoline-powered vehicles is likely to reach a dead end, since these vehicles will never be completely "clean". The only solution would seem to be a general resort to vehicles that produce no emissions, i.e. the ZEV. The ZEV is defined as having:

- no tailpipe emissions,
- no evaporative emissions,
- no emissions from fuel production and handling (i.e. at the refinery or at point-of-sale), and
- no onboard emission control system that might deteriorate over time.

In fact, the only technology that currently meets this standard is the electric vehicle<sup>27</sup>.

The California Air Resources Board (CARB), a division of the California Environmental Protection Agency, is the office responsible for California's air pollution control program. The CARB has the legal power to introduce specific programs as necessary to conform with federal and State clean air legislation, as well as to supervise local air quality district programs. It has both the authority and the responsibility to issue State standards for air quality. In particular, it has the authority to regulate road vehicle emissions and other mobile sources. Finally, it is responsible for enforcing emission reduction measures adopted by the State.

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<sup>26</sup> CO<sub>2</sub>, the main greenhouse gas, is not considered as a pollutant in this context.

<sup>27</sup> Emissions from electric power stations, which represent a limited number of sources, are easier to control than those from multiple mobile sources, i.e. automobiles.

### 2.3.2. Program description<sup>28</sup>

The first major drive towards a sharp reduction in pollutant emissions from motor vehicles in California dates from the early 1990s. From the outset, this program relied on the principles of averaging-based permits, while setting a highly ambitious objective for the introduction of electric vehicles. The program has undergone several amendments that have taken some of the rigor out of the march towards the ZEV objective, while maintaining that goal despite pressure from automobile makers.

*The 1994 program: annual averaging, trading and banking of credits, and introduction of ZEVs.*

The CARB drew up the LEV I (Low Emission Vehicle) program in 1990. From the beginning, the California LEV program was seen as a complement to the federal exhaust emission reduction program, but one that was more rigorous in terms of its standards, in the context of the devolution of powers from the federal to the State level.

The LEV I program was designed both to enforce more rigorous emission standards and to give automakers greater flexibility in specifications for fuels, pollution control techniques and type of propulsion. It came into effect in 1994.

The program made reference to the concept of ZEV, and established four categories of LEV: the transitional LEVs (TLEVs), LEVs, ULEVs (Ultra LEVs) and the ZEVs. Each category is defined according to a maximum emissions level for hydrocarbons (NMOG, non-methane organic gases), carbon monoxide and nitrogen oxides. The NMOG index is taken as the reference indicator reflecting total emissions of atmospheric pollutants.

Instead of requiring every vehicle sold to meet a single emissions standard, automakers are allowed to spread their fleet among the four vehicle categories and to conform with the standard on the basis of a weighted average of emission rates for the entire fleet<sup>29</sup>. They can also earn credits if they are exceeding the required standard, and they can then sell or bank these credits, or they can purchase credits if their fleet does not meet the standard.

Finally, a constraint was issued requiring a minimum percentage of ZEVs to be delivered for sale. The initial legislation required the 7 most important automakers (American and Japanese)<sup>30</sup> to ensure that at least 2 percent of their vehicles delivered for sale in California be ZEVs in 1998, and this percentage was to rise to 5 percent in 2001.

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<sup>28</sup> A useful source of information is the CARB web site, at [www.arb.ca.gov/msprog/zevprog/zevprog.htm](http://www.arb.ca.gov/msprog/zevprog/zevprog.htm). The main references used in this section are CARB (2000a, 2000b, 2001) and Friedman et al (1998).

<sup>29</sup> This weighted average is calculated for each automaker by breaking down the vehicle fleet into the four categories and applying the maximum allowable emission rate to the number of vehicles sold in each category.

<sup>30</sup> Originally General Motors, Ford, Chrysler, Nissan, Honda, Toyota and Mazda. Mazda was subsequently reclassified as an intermediate volume manufacturer.

Given California's leading role in this area, the initiative was taken up by other U.S. States (Massachusetts, Vermont, Maine and New York), despite several lawsuits brought by the automakers, and these States also adopted the subsequent amendments, with some changes.

*The 1996 amendment: longer deadlines and voluntary agreements*

The automobile and oil industries, along with elected politicians, brought pressure to amend this legislation, resulting in the March 1996 memorandum of agreement (MOA): the CARB agreed to push back the 1998 deadline to 2003, but in return it insisted that the ZEV share of sales should be increased to 10 percent at that date. As well, through voluntary agreements negotiated between the CARB and each of the large volume manufacturers, the latter undertook to produce a certain number of demonstration vehicles between 1998 and 2000.

Mazda, one of the large volume manufacturers, in which Ford has a one-third interest, elected to purchase ZEV credits from Ford in order to meet the minimum production target for demonstration vehicles.

*The 1998 LEV II program: introduction of partial ZEV (PZEV) credits.*

The regulations were again amended in 1998, in recognition of the difficulties that automakers are having in producing low-cost ZEV vehicles, and the wide diversity of technologies available for further reducing emissions (in particular, hybrid electric vehicles and fuel cell vehicles). The LEV II program was also given further flexibility, in the form of partial ZEV credits which could be earned by producing "very clean" but not strictly ZEV vehicles.

Automakers can earn credits by:

- making ZEVs available for sale before the 2003 deadline: credits earned in this way are greater than unity (2 or 3 credits per ZEV prior to 2003, calculated according to the vehicle's all-electric operating range and battery charge data);
- selling vehicles that, although not strictly ZEV, are sufficiently clean to earn partial ZEV credits;
- purchasing credits from another manufacturer.

Partial ZEV credits are calculated by adding up scores under three headings:

- First of all, the vehicle must meet a minimum standard in order to earn a PZEV. It must be a Super Ultra Low Emission Vehicle (SULEV), i.e. a gasoline-powered vehicle certified to meet emission standards for 150,000 miles<sup>31</sup> and to produce no evaporative emissions: such a vehicle earns a credit of 0.2.
- Next, a credit is calculated in terms of the vehicle's zero-emission operating range (i.e. by recharging batteries off the mains); such a vehicle earns a credit of 0.2.
- Finally, the NMOG emissions level resulting from the fuel cycle (manufacture, transport and distribution) is calculated: if this level is less than that of electric power stations (which is the case with compressed natural gas) the vehicle earns a credit of 0.2.

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<sup>31</sup>In order to avoid the deterioration to which conventional vehicles are subject: aging and contamination of the catalytic converter, malfunctioning of the emissions control system, alterations or lack of maintenance by the user. Periodic inspection programs are inadequate to prevent such deterioration.

For example, the PZEV credit will vary from 0.2 for a gasoline-powered SULEV to one full credit for a hybrid electric SULEV (HEV) with an emission-free operating range of 100 miles.

Underlying these changes was the CARB's recognition that significant progress has been made in reducing emissions from SULEVs: because their operating range is greater than that of electric vehicles, they have the potential for greater market penetration and thus for reducing emissions more quickly. The requirement for 150,000 miles of emission-free operation is a further guarantee that SULEVs will maintain this advantage.

Nevertheless, since there can be no absolute guarantee against the deterioration of emission control mechanisms, the CARB issued restrictions on these mechanisms: the large volume manufacturers (those selling more than 35,000 cars and light-duty vehicles annually in California<sup>32</sup>) can meet their 2003 obligation with partial ZEV credits, but only up to 6 percent of the 10 percent ZEV mandate; the remaining 4 percent must be achieved through sales of actual ZEVs. Intermediate volume manufacturers (4,500 to 35,000 vehicles sold annually) can meet the objective entirely with partial ZEV credits, while the small volume manufacturers are not affected.

In introducing this amendment, the CARB expected that manufacturers would naturally turn to producing SULEVs as successors to ULEVs. In fact, this technological shift is less costly than a move to the electric ZEV, which does not yet enjoy the same economies of scale as the gasoline-powered vehicle. Moreover, by producing SULEVs, manufacturers can reduce the average NMOG index of their individual fleets, which provides a further incentive to making SULEVs instead of ZEVs.

To the end of 2000, only the Nissan Sentra (a SULEV), introduced in November 1999, had been certified for PZEV credits. Three other SULEVs introduced in 1999 and 2000 have yet to obtain this certification (because of other criteria, in particular the problem of evaporative emissions).

*The 2000 review: deadlines confirmed and further flexibility*

The 1996 agreement called for automakers to produce 3,750 ZEVs between 1998 and 2000. Thanks to the credits earned through the introduction of advanced batteries, this commitment was reduced to 1,800 electric vehicles. In 2000 there were about 2,300 electric vehicles on California roads but, despite growing consumer interest and a subsidy of US\$5,000 to manufacturers for every ZEV sold, those automakers who reached their quota under this agreement have virtually ceased production. There are two essential reasons behind this "black out": cost, naturally enough, but also uncertainty in the absence of a clearly identified market and a definitive regulatory signal from the State of California.

Under the 1996 agreement, carmakers were to provide the CARB with confidential data on their production plans for meeting their 2003 obligations. According to CARB these plans showed that all automakers have the technical capacity to produce

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<sup>32</sup> This limit was raised to 60,000 at the time of the 2000 program review.

vehicles in the required quantities. Yet all of them argued that the production costs of these vehicles were still high and that the limited operating range of electric vehicles, given the foreseeable state of battery technology, would prohibit any sustainable mass market for such vehicles by that date.

Moreover, during the 2000 debate over the program, some manufacturers declared that they were unable to make full use of the opportunities offered by the PZEV option because they could not produce vehicles in sufficient quantity. This meant that these manufacturers' production of pure ZEVs will have to exceed the required 4 percent minimum.

The 2003 ZEV target was again confirmed by the CARB in January 2001, following the biennial review of the program in 2000, but further amendments were introduced to reduce the cost of the program to manufacturers. The principal changes are as follows:

- the required number of "pure" ZEVs is reduced by half in the first years of the program; this number may be reduced further for manufacturers producing other kinds of very clean vehicles;
- the ZEV credit multiplier for an pre-2003 ZEV sale is increased to 4 for sale in 2001-2002 (compared to 2 to 3 before) and to 1.25 for sale in 2003-2005;
- the number of vehicles needed to obtain PZEV credits in the first years is also reduced;
- on the other hand, the 2003 mandate of 10 percent for ZEVs or equivalent credits is increased in stages to 16 percent by 2018.

The result is that manufacturers must produce between 4,650 and 15,450 electric vehicles in 2003, depending on which of the various options they select. The authorities also decided to include sport utility vehicles (SUVs), pickups and light vans, as of 2007, in calculating the required percentage of ZEVs, thereby increasing the calculation base by 50 percent.

According to the CARB, the savings to manufacturers resulting from these changes to the program, compared to its previous version, will amount to between \$130 million and \$400 million by 2003, depending on the option selected. The CARB has also established an \$18 million subsidy fund for consumers as an incentive to purchase or lease ZEVs (up to a total of US\$9,000 for a three-year lease prior to 2003, and up to US\$5,000 after 2003): these subsidies are in addition to other local or federal incentives.

#### *Content, nature and calculation of ZEV credits*

Automakers who offer more ZEVs for sale than required in any model year will earn ZEV credits. The ZEV credits are expressed in grams of NMOG per mile. They are calculated by subtracting the number of ZEVs required from the number of ZEVs delivered for sale, and multiplying this balance by the average NMOG emission standards required for the manufacturer's light-vehicle fleet (cars and light-duty trucks). As well, a credit multiplier can be earned for vehicles delivered for sale prior to 2003 (see above).

A manufacturer can comply with regulations by submitting a certain number of ZEV credits, either earned previously or acquired from another manufacturer. The number of credits required is calculated in the same manner as before.

A manufacturer offering fewer than the required number of ZEVs for sale in any model year must make up the deficit before the end of the following model year, by submitting a certain number of credits. Any manufacturer that fails to offer the required number of ZEVs, or to submit the required number of credits, without making up the deficit within the specified time limit, will be subject to a fine under the Health and Safety Code. This fine applies to any manufacturer selling a new motorised vehicle not compliant with the State emission standards, and amounts to US\$5,000 per non-conforming vehicle. The number of non-conforming vehicles is calculated in terms of the ZEV credit deficit.

It has been suggested that the option of paying a fine should be eliminated, and that the manufacturer should be forced to make up any credit deficit by purchasing credits from another manufacturer. The CARB has rejected this proposal, since the manufacturer could then be faced with paying an exorbitant price to other manufacturers for such credits. A maximum price for credits is then established, equal to the amount of the fine established in the regulations.

#### *Program management*

All automakers, except for those in the "small volume" category, are subject to the ZEV mandate and are required therefore to participate in the credit program.

As noted in the introduction, the CARB, as a State agency, has full authority to establish objectives and standards and to implement the credit system, within the framework of federal and State clean-air legislation. The CARB is also responsible for certifying vehicles and verifying the credits submitted by manufacturers.

On the other hand, participating manufacturers have full freedom in negotiating credit transfers.

### **2.3.3. Assessment**

Our assessment relates to estimates of operating costs and the advantages expected of the program. Next we present a summary of the positions of the various stakeholders in the debate over the program's evolution.

#### *Operating costs of the program*

The administrative cost of the program itself includes the CARB's measurement and monitoring of pollutant emissions, tracking new developments in engine and battery technologies, and verifying the credits submitted by manufacturers. Among these costs, only the last one is specific to the credit program, the others being an inherent part of any regulatory system. In the absence of more accurate data, it can be concluded that the incremental administrative costs represented by the credit program are fairly low.



### *Costs relating to accelerated introduction of electric vehicles*

In contrast, the costs flowing from the accelerated market introduction of electric vehicles are quite another matter. The CARB (2000a) has estimated the incremental initial cost in 2003 of producing electric, hybrid or PZEV vehicles (vehicle, battery and charger) and the total life-cycle incremental cost per mile travelled<sup>33</sup>, compared to the baseline SULEV vehicle. These calculations involve a number of assumptions about the trends in battery technologies and costs, the costs of specific vehicle components and recharge equipment, electricity prices, gasoline prices, vehicle performance, maintenance costs, and inflation and discount rates.

The all-in incremental cost of the battery-powered electric vehicle compared to the conventional vehicle in 2003 ranges from US\$7,500 for a "city EV" to US\$20,000 for a freeway-capable vehicle. Most of this incremental cost relates to the batteries. By comparison, the incremental cost of a hybrid vehicle is US\$3,300, and for a PZEV, US\$500. On a per-mile basis, the incremental cost ranges from US\$0.082 for a 4-passenger PZEV to US\$0.27 for a 4-passenger battery-powered EV. The extra cost of battery-powered vehicles remains significant even under different assumptions involving higher gasoline prices or longer battery life. Only when volume production is reached (more than 100,000 vehicles per year) will high-efficiency electric battery-powered vehicles achieve costs per mile comparable to those of hybrid vehicles or PZEVs, which will by then be regarded as standard vehicles.

During the three-year period covered by the 1996 agreement (i.e., from 1998 to 2000), electric vehicles sold in California benefited from a buy-down grant of US\$5,000 paid to the manufacturers, and financed in equal proportions by the California Energy Commission and by the local air pollution control districts. Manufacturers applied the subsidy as a discount to their ZEV lease or purchase price. In addition to this subsidy, an \$18 million consumer incentive program was introduced in 2000.

### *Expected benefits*

The CARB (2000a) has estimated reductions in both direct and indirect<sup>34</sup> vehicle emissions in the South Coast Air Basin by 2010, depending on market penetration by battery vehicles, hybrid and gasoline PZEVs, and SULEVs. The emissions considered are hydrocarbon compounds (NMOG), oxides of nitrogen (NO<sub>x</sub>) and toxic air contaminants.

Per-vehicle emissions of NMOG compounds from battery vehicles are 96 percent lower than those of the cleanest gasoline vehicle (PZEV SULEV). Other reductions include 88 percent for NO<sub>x</sub> and 86 percent for toxic air contaminants (compared to a hybrid PZEV).

Total (fleet-wide) emissions are estimated for 2010, exclusively for the light vehicle fleet sold between 2003 and 2010, and using different electric vehicle penetration scenarios, with a maximum of 10 percent. The analysis shows that the advantage in terms of air quality is fairly low compared to a base scenario in which no battery vehicles are sold (maximum reduction of 1.91 tons of pollutant per day compared to total emissions of 25.45 tons per day in the base scenario). Only under a scenario

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<sup>33</sup> Total production and operating costs assuming ten-year lifetime miles traveled of 117,000.

<sup>34</sup> Including the production, processing, transport and distribution of fuel (including electricity).

where 50 percent of all vehicles on the road were ZEVs by the year 2020 would direct daily emissions be reduced by 30 percent at that time.

The benefits are thus essentially long-term ones, reflecting the time that will be needed for electric vehicles to achieve significant market penetration.

The program has sparked intensive research and development efforts by federal agencies and private business, reflected in the filing of many patents: from 1982 to 1991 the number of patents relating to electric vehicle technology averaged about seven per year, and was declining despite federal funding. Yet this rate rose to more than 50 patents in 1994, the year the LEV I program came into effect, and then to more than 80 per year between 1996 and 1998.

A further advantage lies in the diversification that the ZEV mandate will bring in terms of energy supply.

In terms of CO<sub>2</sub> emissions, the performance of electric vehicles depends on the way electric energy is produced. Currently, an electric vehicle powered relying on electricity produced in California emits about 250 g/mile of CO<sub>2</sub>, compared to 300 g/mile for conventional gasoline vehicles<sup>35</sup>. This advantage is less obvious, however, in comparison to a diesel or natural gas vehicle (less than 270 g/mile) and disappears completely when compared to a latest-generation hybrid vehicle.

#### *The positions of the different stakeholders in the debate*

Stakeholders in this debate fall into three broad categories, namely the automakers, the fuel industry, and environmentalists.

Although they have not been presenting a united front, the automobile manufacturers are primarily concerned by what they see as excessive interference in their affairs and an imposed obligation to produce vehicles at a loss. They argue that by introducing partial credits (PZEV), the CARB has implicitly recognised that there is no market for ZEVs and is therefore providing a means to circumvent the regulations. According to them, the CARB should admit this and abolish the ZEV mandate. In response, the CARB insists that it will not withdraw the ZEV mandate and that PZEV credits are a way of allowing manufacturers greater flexibility and encouraging the nascent ZEV industry.

The oil industry has no interest in the ZEV mandate, which represents a threat to its business. It has therefore opposed the program strongly.

On the other hand, the natural gas industry finds the PZEV system very interesting, because it can produce fuel for SULEV vehicles.

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<sup>35</sup> Or 155 grams of CO<sub>2</sub> per kilometer, for the electric vehicle. In Europe, the voluntary agreement negotiated by the European Automobile Manufacturers' Association (ACEA) with the European Union calls for average emissions of 140 g CO<sub>2</sub>/kilometer for new vehicles sold in 2008, a less ambitious objective than that initially sought by the European Commission, which was 120 g CO<sub>2</sub>/kilometer in 2005.

The electricity industry is torn between disappointment over the lower required percentage of ZEVs, which means lower future demand for electricity, and the hope of increasing sales through the compression of natural gas.

Environmentalists are divided between those who think that this further flexibility will reduce opposition to the 2003 regulatory deadline, and those who think that allowing credits for gasoline vehicles, even those that are "ultraclean", will end up contributing to increase of total pollution.

Another problem relates to small and intermediate volume automakers that are majority-owned by another manufacturer. The consolidation process that has been underway in the automobile industry in recent years has tended to undermine the CARB's classification of manufacturers by sales volume (large, intermediate and small). Small volume manufacturers are not subject to the minimum ZEV sales percentage, while intermediate manufacturers can meet their obligation entirely through PZEV credits. CARB staff proposed in 2001 that the sales of 2 or more manufacturers should be aggregated if one of them has more than a 50 percent interest in the other(s). This aggregation would become effective in 2003, and its implications for classification and the resulting ZEV obligations would be taken into account from 2006.

#### **2.3.4. Conclusions and comment**

It is difficult to say today whether the program is a success, because its full measure cannot be taken until 2003. Till mid-2001, credit transfers have been limited to meeting automakers' voluntary commitment to produce demonstration vehicles over the period 1998-2000 (e.g. the transfer of credits between Ford and Mazda).

From the viewpoint of implementing systems of transferable permits among automakers, the California example shows that such a system is quite feasible, because incremental administrative costs are low in comparison to a conventional regulatory program. It is on this point that we find the most proposals in the literature on CO<sub>2</sub> emissions certificates (Wang 1994, Albrecht 2000).

The real difficulty in the California ZEV program has been, and remains, to get the automakers to disclose the real costs of research, development and production for electric vehicles. This is, in effect, a classic case of information asymmetry between a public regulator and private economic agents. The disclosure process is not specific to the ZEV credits program, but rather inherent in any industrial regulation policy. It takes strong political will at every turn to find a politically acceptable compromise with the automakers, and that political will must be backed up by a public opinion that is sensitive to local atmosphere pollution.

If we consider the issue of aggregate pollutant and CO<sub>2</sub> emissions reduction, which are not the primary objective of the ZEV program in itself, some considerations can be put forward with regard to the potentials of this kind of program.

In the face of emissions resulting from automobile travel, the policy choice has been to come down heavily on per-vehicle emissions, rather than on car mobility itself.

Significant progress has thus been made in terms of total emissions, but reducing emissions from gasoline vehicles has now reached its limit. Future improvements will come more slowly, and will depend on the speed with which electric alternatives suitable for the mass market can be developed. It is unclear whether progress might have been swifter if efforts had focused on reducing automobile travel, but such efforts would have run up against serious social resistance, given the fundamental role of this form of mobility in American society.

Moreover, the shift from very clean gasoline vehicles to electric vehicles is a risk that local pollution hotspots be only moved from urbanised areas to areas where electricity is produced if it is based upon charcoal or oil, despite it is easier to limit emissions from a point source. This shift also does nothing to address the issue of CO<sub>2</sub> emissions, given the way electricity is produced in California, but that was not the objective of the program. This suggests that, from the viewpoint of reducing unit CO<sub>2</sub> emissions, an all-out drive towards electric vehicles is perhaps not the best strategy. However, by sharply reducing emissions from SULEV and hybrid vehicles, the program has been indirectly responsible for significant progress in terms of per-vehicle CO<sub>2</sub> emissions from internal combustion vehicles.

## **2.4. Exploring new approaches in France**

A working group of the National Transportation Council, an advisory body on transport policy in France, has been exploring potential applications of decentralised systems of transferable permits in the transportation sector.

After examining the context in which this work has been undertaken, this paper describes the approaches adopted, together with the principal points of debate.

### **2.4.1. The context**

At the 1992 Earth Summit in Rio, and later at the 1997 Kyoto Conference, the European Union committed itself to an 8 percent reduction in greenhouse gases (GHG) over the period 2008-2012, compared to 1990, and subsequently issued “bubble regulations” distributing the required effort among its member States. Accordingly, France is to reduce emissions to their 1990 level over the period 2008-2012.

Among greenhouse gas-emitting activities in France, the transportation sector is seen not only as having the most significant emissions (22 percent of GHG in 1997) but as presenting the greatest threat, by far, of higher future emissions: 10.3 percent higher in 2010, compared to low growth or even decline in other sectors<sup>36</sup>. In the transportation sector, GHG emissions are produced primarily by the combustion of

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<sup>36</sup> A specific feature of France's energy supply is the already very high share of nuclear electric generation, which produces no GHG but generates radioactive wastes. Consequently, France has hardly any technological maneuvering room for reducing GHG emissions in sectors other than transportation.

fuels in road transport (84.3 percent of the sector's emissions in 1997), and in a subsidiary manner by air transport (10.8 percent, including international refuelling tanks).

Kyoto represents a first, and modest, stage of reductions (- 5 percent world-wide), which is to be followed by further stages for which more drastic reduction targets must be defined. The question of the transport sector's responsibility for GHG emissions, compared to other sectors of activity, thus arises. Should the transportation sector be allowed to continue with growing emissions, while other sectors are called upon to make additional efforts, or should ways be sought to curb transport activity?

The potential advantages of regulation and supply-side policies have been widely explored in a report on the French program to combat climate change<sup>37</sup>. Other incentive mechanisms involve economic instruments, taxation on one hand, and transferable permits on the other hand, which have the advantage, compared to other mechanisms, of minimising the total cost to society of reducing emissions.

With respect to taxation, the currently proposed level of the carbon tax, an average of 0.07 euro per litre of fuel, represents about 7 percent of the final price paid by the consumer for super-grade gasoline. In other words, current automotive fuel taxes are 7 to 10 times higher than the proposed carbon tax. The behavioural effect of a carbon tax at this level is likely to be very weak. If there were to be a more stringent "post Kyoto" tightening of objectives, the tax would have to be raised sharply: it would have to be at least three times as high, *ceteris paribus*, in order to achieve a reduction of 10 percent in automotive fuel consumption, given what we know about fuel price elasticities. The tax hike would have to be even higher if accelerating economic growth, such as we have had recently, were to increase mobility, and hence fuel consumption, through the income effect.

The "tax revolt" of September 2000, on the heels of sharp oil price hikes in 1999 and 2000, forged a coalition of road users, private or professional, farmers and fishermen, and forced the government to make concessions on fuel taxation. This experience shows that a drastic increase in such taxation is sure to encounter social and political obstacles.

Moreover, the speed and the magnitude of last oil price increase in 1999-2000 suggest the possibility of an equally swift and severe collapse in this price, net of taxes, as reflected recently. Under such a scenario, the price effect of a carbon tax would be completely wiped out.

In the face of these arguments, and given the difficulties in controlling the effective final price and the doubtful acceptability of imposing a further levy on a product that is already heavily taxed, a working group undertook to explore further the feasibility of introducing decentralised markets for permits in the transportation sector, within France or in Europe. The working group originated in the National Transportation Council and brought together representatives of users and the transportation industry, as well as outside experts (CNT, 2001).

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<sup>37</sup> See "Programme National de Lutte contre le Changement Climatique 2000/2010", Interministerial Mission on the Greenhouse Effect (MIES).

Because they represent a new departure in terms of the transportation sector<sup>38</sup>, the ideas put forth by the working group as to the operational nature of transferable permit systems in the transportation sector do not represent definitive conclusions. Rather, they suggest routes for further exploration and evaluation, primarily from a qualitative viewpoint: the final diagnosis will require more exhaustive study.

As well, the fact that some areas of the transportation industry (e.g. road hauling) are exposed to vigorous international competition means that any measures affecting them would have to be harmonised throughout the European Union, as a minimum.

#### **2.4.2. New approaches explored by the working group**

The group immediately found itself facing a trade-off in attempting to design a set of economic instruments for reducing emissions from multiple mobile sources. On the one hand, a more effective incentive to emission-reducing behavioural change could be obtained by applying the permits downstream in the fuel cycle, as close as possible to the final consumer, rather than increasing fuel taxes (see below the discussion on effectiveness of price-signal). On the other hand, if the intent is to minimise the reduction program's administrative costs, given the existing fuel tax system, then the permits should apply upstream in the fuel distribution process.

The working group therefore explored several different approaches:

- An "upstream" system, where the permits are applied to producers and importers of fossil fuels: such a system has the advantage of covering all points of consumption (and not just the transportation sector). It could also be combined with "downstream" application, involving businesses that are bulk consumers of energy.
- A set of "downstream" permits involving both private and public agents in passenger transportation. The agents examined, in turn, are public passenger carriers, the local transportation authorities, automakers and private motorists.
- A set of "downstream" permits involving road transportation of goods.

All of these approaches are summarised in Table 1 and Table 2, showing in each case the physical basis of the permits (or the intended target), the initial allocation, the trading mechanism, and the major advantages and drawbacks.

In most cases, except for the transport authorities and automakers, the physical basis is the carbon content in the fuel consumed, and the permits would apply to fuel by the litre (proportionately as a function of the carbon content of each type of fuel, gasoline or diesel). This arrangement allows for wide trading, extending to sectors other than transportation. Assuring broad coverage for the permits market is a way to achieve distributional optimisation of the permit price, and hence to diminish the cost of the reduction to the various agents (see below).

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<sup>38</sup> Apart from proposals for emission permits for new vehicles, involving automakers (see this section devoted to the ZEV program).

The quota principle (cap and trade) was adopted in each case, except that involving automakers, where averaging was selected, based on target CO<sub>2</sub> value in grams per kilometre.

Free allocation of permits was adopted in all cases, in order to make each system socially more acceptable. For road carriers of goods or passengers, the level of this allocation would be similar to that of the fuel tax exemptions in place today. For private motorists, the basis of allocation could vary in light of social equity objectives: this could involve allocations to individuals and not only motorists<sup>39</sup>.

Of course, with downstream permits, there is the issue of the costs of introducing and managing the system, which have been described for the time being only in qualitative terms. To moderate the impact of these costs, permit transactions and verification should be closely integrated with the current fuel retailing system based on the use of bankcards. These costs would include:

- Changing the software loaded in the automatic bankcard devices on the fuel pumps, to recognise the permits system (checking the balance, debiting accounts).
- The manufacture and distribution of "smart cards", or integration of microcoding software into existing smart bankcards as they come up for renewal.
- A specific information campaign for launching the new system (in addition to the campaign that would undoubtedly have to be undertaken before introducing any emissions control measure).

Finally, the trading mechanism raises the question of the degree of openness of the market on which agents are to trade their permits: should it be sector-specific (transportation) or inter-sectoral, should it be domestic or international?

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<sup>39</sup> A similar proposal was made by a "popular initiative" in Switzerland in March 2000, aiming at cutting road traffic by half. An "ecobonus" was proposed that is to say a levy charged on car utilization and reimbursed to the population at large in equal shares. Those who travel more than the average would have to pay more while those travelling less would be refund.

	<i>Physical basis</i>	<i>Initial allocation</i>	<i>Trading mechanisms</i>	<i>Advantages</i>	<i>Drawbacks</i>
<b>Upstream permits</b>					
	Carbon introduced into the economy by fossil fuel producers and importers	Free allocation, or Purchase of permits on the international market	Trading with other participants on an open permits market*	Total coverage of carbon introduced into the economy. Least costly permit system to administer.	If allocation is free: - price signal may be less effective (marginal price of the permit is “drowned” in the price to the final consumer); - need for a subsequent tax on operators’ profits
<b>Downstream permits applied to goods transportation</b>					
Trucking operators	Carbon in fuel consumed by trucks hauling goods (e.g. permits per litre of diesel)	Free flat annual allocation identical for all vehicles	Trading among participants on an open permits market*	Direct incentive to optimise tons-kilometres / carbon consumption ratio	Implementation and administrative costs

\* An “open permits market” is a broad permits market that extends to the entire transportation sector or other economic sectors, and operates at the national, European or even world level.

**Table 1 : Summary of approaches explored for marketable permits in the transportation sector**



	<i>Physical basis</i>	<i>Initial allocation</i>	<i>Trading mechanisms</i>	<i>Advantages</i>	<i>Drawbacks</i>
<b>Downstream permits applied to passenger transportation</b>					
Road passenger transportation operators	Carbon in fuel consumed by commercial passenger vehicles (e.g. permit per litre of diesel)	Free flat annual allocation identical for all vehicles	Trading among operators or with other participants in an open permits market*	Direct incentive to optimise the passengers-kilometres / fuel consumption ratio	Introduction and administration costs. Need to offer similar incentive for private cars. Need to involve the transportation authorities
Transportation authorities	Urban GHG emissions from routine travel	Free allocation according to technical characteristics of transport supply, demographics and exogenous determinants	Trading on an open permits market*	Direct incentive to the authorities to optimise supply policies and demand management from the GHG emissions viewpoint. Limited introduction and administration costs	Methodological problems in measuring urban “greenhouse” performance.
Automakers	Unit vehicle CO <sub>2</sub> emissions (e.g. grams of CO <sub>2</sub> /km)	Free flat annual allocation identical for all vehicles sold, against a target set by the authorities (averaging principle)	Trading among automakers	Guarantees a unit emissions standard. Introduction and administration costs limited by the small number of participants	Market is limited to automakers. Risk of distorting world trade if market is restricted to the European Union.
Private motorists	Carbon in fuel consumed by private cars (permits per litre of fuel)	Free flat annual allocation identical for all vehicles.	Trading among participants in a domestic or open permits market*	Strong incentive to optimise individual travel in terms of the “greenhouse” objective.	Introduction and administration costs

\* An “open permits market” is a broad permits market that extends to the entire transportation sector or other economic sectors, and operates at the national, European or even world level.

**Table 2 : Summary of approaches explored for marketable permits in the transportation sector (continued)**

### *What should be the scope of the permits market?*

This issue raises two points, one regarding the effectiveness of transfers, the other regarding the control of effort specifically made by the transport sector.

The effectiveness of transfers is the basic condition for minimising total reduction cost and depends on the heterogeneity of reduction costs among participants. This heterogeneity would be particularly effective regarding the different potential adaptations of mobility between private motorists living in dense urbanised areas and those living in rural areas: in that case a specific and closed market restricted to private motorists may be effective from this point of view. Regarding transportation authorities, since they generally have the same profile of density and modal split within each country or even region, the effectiveness of transfer<sup>40</sup> would imply their participation to broader market involving other kind of participants. This is all the more true for road passenger or trucking operators: one obvious idea would be to involve rail operators, which seems however difficult (see below).

In the case of a domestic market restricted to the transport sector, the level of prices on that market would indicate their relative scarcity and make it possible to anticipate future adjustments. For example, the greater the total number of permits initially allocated, the lower their price will be. Conversely, if the number allocated is too low, the price of the permits will be high, but it could be capped at a tax “t”, at which price the regulatory authority would redeem the permits.

Through a comparison of the permit price on the domestic transport sector market with that of carbon-referenced permits on a domestic or international inter-sectoral market, the relative effort being made in the transportation sector can be compared to that of other sectors. If its effort is inadequate, this means that other sectors will have to make up the gap, or that the regulatory authority will have to finance it by purchasing permits on international market.

By keeping the market closed, the regulatory authority can thus decide to shift the burden to one sector rather than another, for social or political reasons. Generally speaking, if permit allocation is too restrictive or too lax, or if the tax “t” is not properly calculated, the marginal costs of reducing CO<sub>2</sub> emissions will not be equalised across sectors. Such distortions reduce the effectiveness of the system. They can therefore be regarded only as transitional measures.

The market for tradable permits should thus ultimately be an open one, i.e. all emitters of GHG in a country's different economic sectors should be able to trade their rights, even internationally.

### *The tax-versus-permits debate*

It is clear that the least costly mechanism, in terms of introducing and administering it, is to extend current fossil fuel taxation to take account of the carbon tax concept. The administrative cost criterion, however, needs to be looked at in light of two other criteria: the incentive for behavioural change, and public acceptability. Here, the system of transferable permits with free allocation has some undeniable advantages.

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<sup>40</sup> apart from methodological measurement problems mentioned in Table 2

First there is the incentive factor: agents selling their unused permits receive an immediate and tangible monetary benefit. And in terms of acceptability, the system avoids placing a further fiscal burden on a product that is already heavily taxed.

One of the major challenges in designing permit systems is how best to reduce implementation and transaction costs. Only by assessing the total cost of reduction (i.e. implementation, administration and transaction costs plus reduction costs borne by the participants in the system, less eventual fiscal revenues), and adding in the social and political cost of the measure, is it possible to choose one mechanism over the other, or a combination of both (taxation and permits).

#### *The debate over the effectiveness of price signals and their point of application*

In analysing the effectiveness of price signals, we must start from the perspective of changing behaviour by inducing different agents to reduce their consumption through different means and to different levels: individual agents will reduce their consumption to the point where the cost of the last unit of pollution emitted is equal to the advantage derived from the activity producing that unit. Permits and taxes thus have exactly the same marginal effect on the agent to whom the permit or tax is applied.

Depending on where the permit is applied in the fuel cycle (production, distribution and consumption), the system's effectiveness will differ depending on whether the permits are handed out initially free of charge. If permits are auctioned, the price signal will in principle be fully transmitted to the final consumer.

On the other hand, if upstream permits are distributed free there is a risk that as the original price signal from the permits is transmitted through the producers, it will simply be averaged into costs, and will thus be lost sight of (“drowned”) in the price of fuel to the final consumer. If the price signal is in effect blurred, the transportation sector may well end up purchasing reduction credits from other sectors, or from abroad, at greater cost for the community than it would have incurred through its own efforts.

This suggests that, if we want the transportation sector to reduce its emissions, and if permits are to be distributed free for reasons of public acceptance, the permits system should be decentralised downstream, rather than confined upstream. This in turn means applying the permit, as far as possible, at the point where it is most likely to effect behavioural change: to motorists, for example, who may decide to modify their travel habits, or to transport operators, who can revise their business plans.

### **2.4.3. Conclusions and comment**

To bring consistency to the various approaches explored, we must focus on the mechanism for co-ordinating the efforts of the participants involved.

Whether we are speaking of the system of upstream permits or a series of downstream permit systems, the concept of carbon content offers a common unit of allocation and exchange. Taking this as the common physical basis makes it feasible both to ensure

co-ordination among the participants and to make the permits as universally tradable as possible with other sectors, which is a condition for minimising the total cost of reduction.

In contrast, the mechanism proposed for the automakers does not allow emissions per kilometre to be converted into CO<sub>2</sub> permits. Yet the variety of vehicle models and the diversity of automakers, with the differing adaptation costs they imply, should make for a reasonable level of trading within this sector<sup>41</sup>.

What the local transport authorities must do, as we have seen, is to develop a mechanism for calculating emissions from routine or commuter travel in their areas of jurisdiction. Under this condition, the results can be translated directly into CO<sub>2</sub> permits, and the universal market for permits could then be accessed.

As for road operators, their market suffers from destructive competition of a multiplicity of small operators and they feel themselves threatened by opening of the EU to lower-wage countries. Thus they are in a weak position when negotiating prices with those who demand transport services. Why not involve the latter in a permit scheme? The extension of the downstream permits previously designed to those who demand transport services is impossible, given the way sendings are managed by hauliers: a same vehicle can be used within a single tour to serve different clients. It would be then impossible to fairly allocate the quotas to the clients. An alternative option would be targeting big shippers (e.g. distributors) and involve them in voluntary agreements. This could be a first step to get more information on the potentials of emission reductions by the shippers before implementing more incentives.

Finally, it has proven difficult, with these downstream permit systems, to incorporate rail carriers, whose energy requirements are mainly in the form electricity. In fact, the only way of bringing them in would be to design a different type of permits system where the initial allocation would be calculated using an efficiency standard prorated for the service provided (either in passenger-km, in the case of passenger travel, or tons-km, for the transport of goods). In such a program, rail operators would be net sellers to road transport operators. This option, however, has not yet shown itself feasible, since service provided is measured only by surveys, and these are unlikely to withstand a legal challenge.

One possible solution to the problem of integrating rail operators into the permits system based on carbon consumption would be for the regulatory authority to set an overall carbon consumption quota for the subsector concerned (passenger or goods carriers, rail and road). A portion of the quota would then be distributed as a basic allocation to rail operators, prorated to the service they provide, and the remainder would go to road carriers of goods, using the mechanism described in Table 1. Road operators needing permits would then buy them from rail operators. Jancovici (2001) has estimated the value of the permits that the SNCF (the French national railway) could sell at 300 millions euros a year, with a ton of carbon at 76 euros.

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<sup>41</sup> The literature has examples of proposals for permits to automakers, combining unit emissions and kilometer traveled by vehicles (Albrecht, 2000; Winkelmann et al, 2000) or even vehicle ownership (Walton, 1997). See also the section devoted to the California ZEV program.

Any shift from control based primarily on taxes to one based on rationing by imposing rigorous quotas on final consumers would represent a real social shock, involving a resource that is essential to present-day lifestyles in developed countries, and for which there is no credible substitute over the medium term, at least in some situations. Dealing with this shock remains a major challenge.

As for the consequences of this work, it could be said that it has essentially an educational role to play towards both the transport operators and the administration in charge of transport activity. The main operators concerned, road hauliers and airlines, are currently in difficult economic situations: for road operators this has already been mentioned and for airlines this stems from strong world competition and current slowing down of demand growth. In this context it is difficult for them to consider control of their activity either by reinforcing the current fuel taxes (even implementing them for aviation) or introducing TPs. On the other side the administration faced a “fuel tax revolt” in September 2000 which shows that the conventional instrument reaches its limits. There is recognition of the need to find ways to get out of this environmental deadlock. This work has contributed to open the debate and to give an impulse to research on introduction of TPs within the sector.

### **3. CONCLUSIONS AND LESSONS**

#### *Feasible systems: protecting environmentally sensitive areas and reducing unit vehicle emissions*

A system of permits applied to traffic of mobile sources in limited geographic areas is technically feasible at an acceptable financial cost, as the Ecopoint program in Austria has shown. In technical terms, this system is similar to ongoing or near future electronic road pricing systems and could be added to at low cost.

Such a system would seem, a priori, to be adequate for protecting sensitive areas of the local environment (pollution, noise, road safety). The demonstrated limitations of the Ecopoint program, inherent in its original design, suggest that if the vehicles involved are to be covered fully the protected region must be one where points of entry and exit are few and readily controllable. A trade-off would have to be found between the number of points to be controlled and the size of the area to be protected. Of course such TPs market focussed at geographic areas (one market for one area) would need the participation of operators of other modes such as rail in order to benefit from heterogeneity of reduction costs and to foster new modal split. Similar potential systems such as “CO<sub>2</sub> credit card” and linked rail-road transit permits (LRRTP) are briefly described in the OECD-EST study on Alpine freight transport (OECD, 1999).

The California ZEV program, although it will become significant only in the near future, shows that a system of credits applied to unit vehicle emissions and tradable among automakers is quite feasible: its incremental administrative costs are in fact negligible compared to the normal expense of monitoring and enforcing regulations.

*Clarity, simplicity and pragmatism can help permit programs succeed*

The importance of these criteria for transferable permit programs in general has long been recognised. Their validity first became apparent in an analysis of the conditions for success with the gasoline lead phase-down program in the United States (Hahn and Hester, 1989). This finding is reinforced by an analysis of Austria's Ecopoint program and California's ZEV program. In all three cases, the physical basis is clearly identified (grams of lead per gallon, grams of NO<sub>x</sub> per kilowatt-hour, and grams of NMOG per mile, respectively).

The simplicity criterion relates to the rules for managing transfers, which must be facilitated as much as possible if the theoretical advantages of the tradable nature of the permits are to be fully realised. This is the case with the lead reduction program and the ZEV program, where there is no need for the regulatory authority to become involved in trading among program participants<sup>42</sup>.

The pragmatism criterion relates to the design of the program: its various aspects must be able to evolve in light of discrepancies that may emerge between objectives and cumulative understanding of the adaptation costs borne by program participants. Some good examples of such pragmatism can be found in the lead phase-down program, with its different trading and banking phases, and in the ZEV program, where changes to the credit formulas provide automakers with more opportunities to adapt.

On the contrary, such pragmatism would seem to be lacking in the Ecopoint program which, at least in its current configuration, is in something of a crisis. If a program like this were to be established for the European Union, any amendment would require reaching agreement among the member States, the difficulty of which is readily apparent given their divergent interests.

It is all the more obvious that pragmatism is only possible when the regulatory authority enjoys strong political support, and has sufficiently broad powers.

### *Political will and possibilities for low-cost adaptation*

If a regulatory authority is to negotiate successfully with market participants who are often organised in professional groupings with means for exerting considerable political pressure, that authority will have to have effective powers, backed by a strong political commitment.

When low-cost adaptation is possible there is less need for strong political will. This was the case with the gasoline lead reduction program, since there were affordable technological solutions available for replacing lead, and the consumption of leaded gasoline was already on a downward track because of renewal of the automobile fleet.

On the opposite, the commitment of public power will have to be all the stronger if the range of low-cost adaptation possibilities is limited. An analysis of the ZEV program shows that the dynamic equilibrium between political will and pressures from the automakers has been a constant factor in the program's development. The

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<sup>42</sup> The Ecopoint program does not involve transfers, and was not designed for them.

1996 reform, which pushed back the ZEV deadline from 1998 to 2003 and established a voluntary agreement, was interpreted by some as a victory for the automobile manufacturers, whose arguments about the number of industry jobs at stake found a certain political resonance. On the other hand, ecological pressure groups, buoyed up by strong public sensitivity to local air pollution, weighed in heavily in public debate over the program, and in keeping the CARB to its ZEV objectives.

It has been argued that there is no proof of such political will when it comes to reducing greenhouse gas emissions, or, at least, that whatever will exists may be insufficient in light of the scope of the changes required. There is no doubt that public opinion is becoming increasingly aware of the gravity of the situation. Yet because the consequences of climate change are seen as far off and to some extent uncertain, and the social costs of imposing abrupt lifestyle changes in developed countries are deemed unacceptable, the required policy decisions have been delayed.

### *What role can transferable permits play in GHG reduction programs in transportation sector?*

As noted in our analysis of the California ZEV program, technical advances with gasoline engines are reaching their limit, and the electric vehicle is not likely to offer a suitable alternative for significantly reducing CO<sub>2</sub> emissions, given the way electricity is currently produced.

Governments cannot, therefore, rely on unit vehicle emissions for reaching CO<sub>2</sub> reduction objectives, but will instead have to focus on vehicle use. The various incentives available for influencing demand are taxes, permits, or a combination of both.

The terms of the debate are now clear. Tax and permit systems have the same allocation efficiency. Since fuel taxes are already in place, extending them to a CO<sub>2</sub> tax would be less costly to administer for multiple mobile sources than a system of permits applied to those sources.

However these duties would have to be much higher than they are at present if they were to meet the objective of reducing emissions. The "tax revolt" experienced in September 2000 in several European countries, as sharply higher oil prices pushed up gasoline prices that were already highly taxed, highlights the limits on public acceptance of significant further increases in these taxes.

On the other side, permits allocated free of charge are seen by agents as a means of avoiding an additional tax. Moreover agents selling their unused permits receive an immediate and tangible monetary benefit. These are arguments in favour of a potentially greater acceptability of permits with free allocation when compared to new taxes.

For this reason, new approaches have been explored for downstream decentralisation of permits in the transportation sector as a possible alternative to CO<sub>2</sub> taxation<sup>43</sup>. This

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<sup>43</sup> Similar proposals are mentioned for The Netherlands and Sweden in the OECD-EST case studies (1999)

would be a way of seizing the advantages of permits, namely the certainty of achieving the quantitative objective and the further incentive to final consumers to reduce emissions that is inherent in allowing them to sell any unused permits. Moreover, these downstream permits have been designed with a physical basis that is simple and fungible: they can be fully integrated into wider permit systems targeting all sources other than transport, i.e. national and even international markets for CO<sub>2</sub> permits.

Nevertheless, this option poses the formidable question of administrative costs, not to mention the social and political challenge of introducing what could well be seen as a form of rationing.

These considerations point to at least four routes for further research:

- Designing downstream permits systems to keep administrative costs to a minimum, as outlined in the preceding sections: technical progress with onboard electronics over the last 20 years has made it possible to introduce systems that would have been previously inconceivable, such as electronic tolls or Ecopoints, and that now hold significant promise for addressing this question.
- Examining the social and political feasibility of such a rationing program.
- Simulating the operation of downstream permits markets (e.g. trading over-the-counter or on a stock exchange), which could also give indications on possible market power and price distortion effects.
- Assessing the total social cost of reductions (which is equal to implementation and transaction costs plus the costs borne by agents, less eventual fiscal revenues), as a basis for choosing case-by-case between taxes or permits.

### *TGs, taxes and voluntary agreements*

The analysis of the previous case studies showed differing ways of coexistence of these instruments.

In the US lead phase-down case the lead rights program was the unique instrument used, however with variations in the trading and banking options.

In the Ecopoint case, the quota system coexists with the ongoing fuel tax, an incentive to reduce fuel consumption and thus harmful emissions, and with the European regulations on unit trucks emissions (EURO standards). As already mentioned, given the importance of the Austrian route for European truck traffic, the Ecopoint system has probably had a supplementary effect in accelerating the impact of the overall EURO standard program.

In the European context, with regard to the general issue of fuel consumption, a voluntary agreement (VA) of car makers coexists with the conventional fuel taxes. They are both incentives on the supply side, on one hand, on the demand side, on the other hand, to switch to cleaner cars. However VAs are often seen as a willingness by the industry to escape from tighter regulation or tax, by realising part of the pollution reduction: this is possible when the threat of the public authority is not credible, especially when not backed by a strong public opinion as in the case for the GHG issue (Bureau, 2000). The proposal for TGs on car makers aims at guaranteeing the achievement of a specific target in unit-vehicle emission.



Further, in the design of downstream permits on fuel consumption by the French working group, TPs would coexist with current fuel taxes. In this framework fuel taxes would keep their current status while TPs would specifically address the issue of CO<sub>2</sub> emission.

In the California ZEV case study, within the general credit framework, VA has been established in 1996 with automakers agreeing to produce a certain number of electric vehicles between 1998 and 2000. This VA played a specific role to solve temporarily a difficulty in the ups and downs of the negotiation between CARB and the automakers, pointing to the varying credibility of the public authority as mentioned above.

These remarks show that coexistence is possible when needed and must be designed pragmatically.

In addition the case studies showed short term operation of TPs. Some TP schemes may last only a few years, like the lead phase-down program with a duration of five years from 1982 to 1987, or the Ecopoint system since 1992 until today under its current configuration. This shows that TPs can be implemented and used within a short range to ease and speed up a change in technology. However this does not mean that TPs are confined to short term policy. The ZEV credit program is open since 1994 only but may last several years, even decades, depending on the level of market diffusion of electric vehicles. Moreover, in relation to the very long term horizon of the GHG issue, short term implementation of TPs addressing directly fuel consumption of transport end users would result, as for the tax, in several behavioural changes including reduction in trips or in VKT, modal shifts and land use patterns. These changes, and especially the latter, have long term consequences on mobility patterns. Maintaining these behavioural changes in the long term also implies keeping continuous operation of related TP schemes in the long term.

### *Other unexplored possibilities*

There has been little investigation of possible strategies relating to land use, perhaps because transportation and urban planning sciences have not managed to clarify the relationship between transportation and land use. Yet the literature contains proposals for applying marketable permits to real estate developers in terms of the travel volumes that their projects will generate (see for example Ottensmann, 1998). Such investigation should also take into account the experiments with transferable urban construction rights that have been launched in the United States in the beginning of the 20<sup>th</sup> century, as well as the environmentally significant initiatives undertaken during the 1970s and 1980s in France and New Zealand.

Finally, there has been little attention to the supply side of infrastructure, except on the part of local transportation authorities. The scope of the behavioural changes required suggests that governments should not rely solely on the adaptive capacity of final transport users in terms of the current state of supply. Major investments will have to be made, particularly in rail infrastructure, at the same time as permits systems are introduced: it is only from a post-Kyoto perspective, i.e. in moving

towards the real objective of reducing CO<sub>2</sub> emissions by half, that permits might become a significant source of funding for such infrastructure.

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