Prepared for the

NSW Environment Protection Authority

# Comparative review of load based licensing fee systems

Final report

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## Acknowledgement

The NSW Environment Protection Authority engaged BDA Group to prepare a comparative review of pollution emission incentive fee schemes in OECD countries, to identify successful system characteristics and to assess the extent to which they are transferable to the NSW context.

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## Glossary

| | | |
|---|---|---|
| AOX | – | absorbable organic halides |
| A$ | – | Australian dollar |
| BOD | – | biochemical oxygen demand |
| $BOD_5$ | – | five day biochemical oxygen demand |
| BTU | – | British thermal unit |
| CAD | – | Canadian dollar |
| COD | – | chemical oxygen demand |
| DKK | – | Danish Krone |
| EU | – | European Union |
| EUR | – | Euro |
| FRT | – | fee rate threshold |
| GWh | – | gigawatt hours |
| HFC | – | hydrofluorocarbon |
| LBL | – | load based licensing |
| LRA | – | load reduction agreement |
| MGD | – | millions of gallons per day |
| MWh | – | megawatt hours |
| $Nm^3/h$ | – | normal metre cube per hour |
| NOx | – | nitrogen oxides |
| NPDES | – | National Pollutant Discharge Elimination System (USA) |
| OECD | – | Organisation for Economic Co-operation and Development |
| PAH | – | polycyclic aromatic hydrocarbon |
| PCB | – | polychlorinated biphenyl |
| PFC | – | perfluorocarbon |
| PLZ | – | Polish Zloty |
| PM | – | particulate matter |
| $PM_{10}$ | – | particulate matter 10 micrometres or less in diameter |
| PRP | – | pollution reduction program |
| SCAQMD | – | South Coast Air Quality Management District (California, USA) |
| SEK | – | Swedish Krona |
| SKK | – | Slovakian Koruna |
| SS | – | suspended solids |
| STP | – | sewage treatment plant |
| TRS | – | total reduced sulphur |
| TSP | – | total suspended particulates |
| TGAP | – | General Tax on Polluting Activities |
| USD | – | United States dollar |
| VOC | – | volatile organic compounds |

# EXECUTIVE SUMMARY

NSW employs a 'load based licensing' (LBL) requirement for certain activities, which sets limits on the pollutant loads that can be emitted and an annual licence fee made up of two components:

- an administrative fee based on the type and scale of licensed activity; and
- a load based fee proportional to the quantity and types of pollutants discharged and the conditions of the receiving environment.

The load based fees fall within a class that are sometimes referred to as pollution taxes as they apply the 'polluter pays' principle to provide an incentive for licensees to reduce air and water pollution.

This report provides a comparative analysis of market based instruments similar to the LBL load fees, and excluding trading schemes, which provide incentives for reducing pollutant emissions to air and water from individual industrial facilities in OECD countries.

In general, pollution fees have been more common in Europe than other OECD countries, with some European schemes operating since the 1960s. The Australian experience is briefly canvassed below ahead of the international experience.

## Australian pollution fee systems

The structure and purpose of pollution fee schemes in Australia varies across jurisdictions. Typically licence fees are directed at recovering the cost to governments in administering their licensing regimes. However NSW, SA and WA also include a load based incentive component in their licence fees, with fees payable proportional to the actual pollution emission loads from premises.

The NSW load fees are applicable to 12 types of air pollutants and 17 categories of water pollutants. The fees are differentiated by the relative impact of each pollutant and priority placed on reductions from licensed premises. Fee liabilities are also adjusted to reflect the sensitivity of the receiving environment, and the per kg pollutant load fee is doubled for that part of a licensee's emissions which exceeds a threshold for each industry type / pollutant that represents what can be reasonably achieved with modern technology. Total emissions of each pollutant must still generally remain within the facility's annual load limit.

Emission loads can be measured (through real time monitoring) or estimated using acceptable emission estimation methods. All fee revenue is paid into the state's consolidated revenue and there is no revenue hypothecation, earmarking or recycling.

It was recognised when the enabling legislation was introduced that the load based fees would, at least initially, be set below the value of the health and environmental (externality) impacts of discharges. But with substantial changes to the fee scheme settings for air pollutants since the scheme was introduced, fee levels for pollutants such as NOx and VOCs are now approaching some estimates of marginal externality costs.

A new licence fee system incorporating a load based fee component was introduced in SA in 2009. The scheme has many similarities with the NSW LBL scheme. It applies to a similar licensed community, requires emission loads to be assessed in accordance with an approved estimation or monitoring technique and fees are differentiated to account for locational factors affecting the harmfulness of discharges as well as being reflective of priorities for emission reductions from licensed premises.

The key difference between the schemes is the level of fees. Total load fees under the SA scheme are capped at recovering the cost of administering the licensing scheme, and therefore fee rates are much more modest compared to the NSW fees.

The WA licence fee scheme has incorporated a discharge component based on the amount and type of pollutants and the receiving environment since 1987. The structure of the incentive fees again have similarities with the NSW LBL scheme, but like the SA scheme, fee levels are capped to recover only the costs of administering the licensing system. Fees payable by individual premises in the WA scheme are also capped, and at relatively modest levels. This further weakens the incentive force of the fees.

## OECD pollution fee systems

A literature review identified some 17 OECD countries with water effluent charging schemes and 16 OECD countries with air emission charging schemes. Summaries of each water and air pollution fee scheme are provided in Appendixes A and B respectively, while the characteristics of the schemes are compared and contrasted in the main body of the report.

The pollution fee systems can be broadly categorised as mainly:

- an incentive for pollution abatement; or
- a financial instrument to raise revenue to fund pollution control programs.

However, as at least some revenue from nearly all schemes is used to fund related environmental programs, the fiscal and incentive functions tend to overlap.

### *Water pollution fee systems*

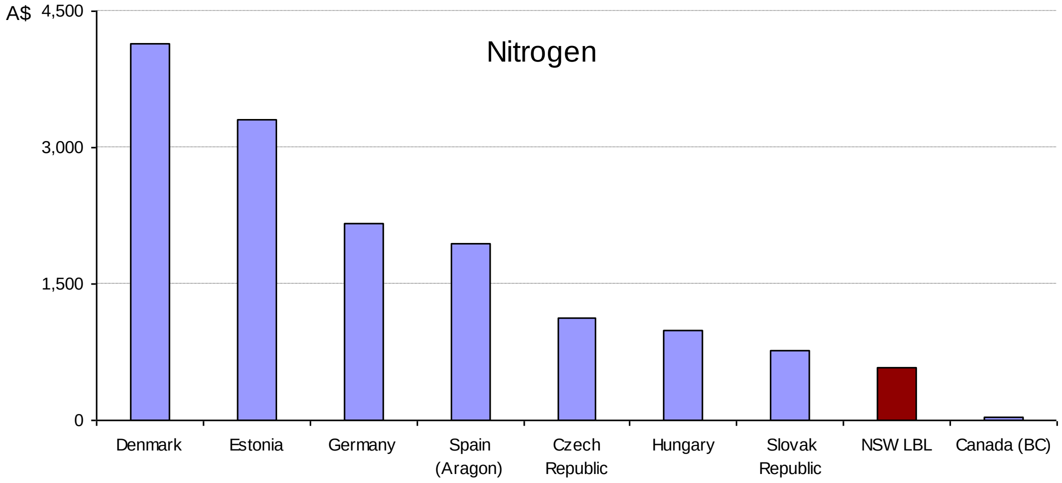
Most water effluent fee schemes cover only point source discharges to surface water, and in general, only a small number of pollutants. The most common pollutants are measures of the amount of organic compounds in water (such as BOD, COD), phosphorus, nitrogen and suspended solids.

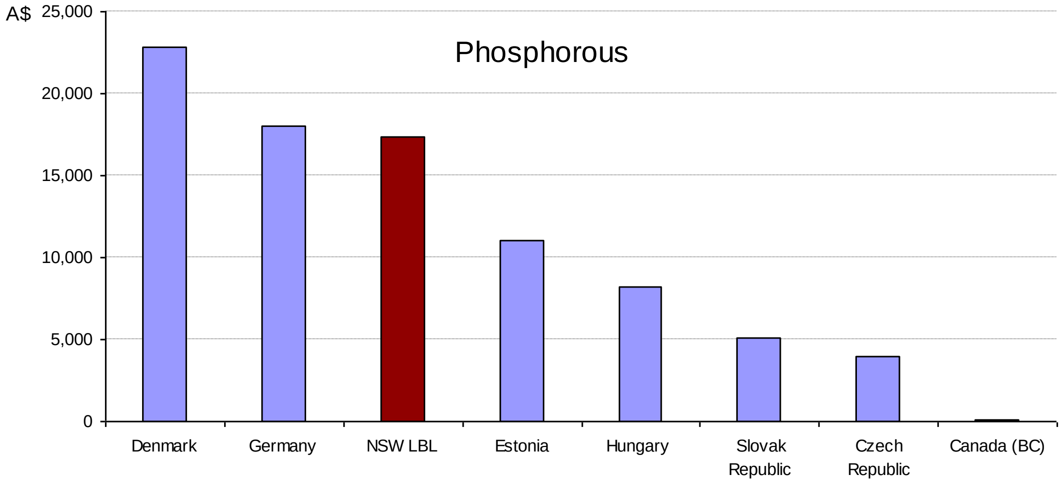
Fees are charged on the basis of weight (as in British Columbia, Denmark, Estonia or Hungary) or, less frequently, on specific pollutant units that correspond to the toxicity of effluent loads (as in Germany, the Netherlands or Slovenia). Reductions in pollutant charges are often tied to improvements that reduce effluent loads. Reduced charges are also often applied when plants agree to adopt best available technologies, implement new procedures or engage in pollution reduction programs generally or where firms bring their emissions below relevant effluent limits.

Most schemes differentiate fee rates according to industry type, plant size, effluent volumes or the receiving area's sensitivity. In fact, it is rare for countries to charge flat fees irrespective of these differentiating features. A common criticism of many schemes is that charges have been set too low to act as an incentive for effluent abatement.

Figure E1 compares the highest fee rates per tonne of nitrogen and phosphorous emitted for countries that charge levies on these pollutants. The fee payable under the NSW LBL scheme is highlighted in red.

**Figure E1: Nitrogen and phosphorous emission fees by country** (A$ / tonne)




Rates for nitrogen and phosphorus are highest in Denmark, where a tonne emitted of each will attract a charge of A$4,144 and A$22,794, respectively.

The experience of the Danish wastewater fee is briefly presented in Box E1, where it is noted that the fee levels have been estimated at 'approaching externality impact values'. Perhaps for this reason, the scheme stands out as generally being considered as an economically efficient instrument.

**Box E1: The Danish wastewater fee**

The Danish wastewater fee applies to wastewater treatment plants and industries with direct discharges. Notably, the Danish fee rates are much higher than applicable under other schemes and approach estimated health and environmental impact values associated with the emissions.

The fee applies to discharges of organic material (biological oxygen demand), nitrogen and phosphorus. The fee was phased in with rates in 1997 at 50% of the full level that came into effect in 1998. The fee rates were to have been increased by 50% from 2010, but as of 2014 EU approval is still being sought.

The revenue from the fee was around A$61m in 1998, falling to A$32m by 2011. Of the revenue from the scheme, some A$14m per year has been hypothecated to an independent Water Fund to finance projects to protect and secure future water supply.

The Danish Ministry for the Environment conducted an economic assessment of the fee in 2005. The analysis found that 16% of wastewater treatment plants had responded to the fee by 2000. For industrial dischargers, 14% of those paying the full fee responded by reducing their pollutant loads. The Ministry estimated that the economic benefit of the wastewater fee during its first four years was around A$1m per year.

While the fee has provided an incentive to reduce pollution, it has been suggested that the administrative regulations operating alongside the fee may have reduced flexibility for dischargers in responding to the fee. Also, the ability of the public wastewater utilities to simple pass the higher costs back to wastewater generators will have lessened the incentive force of the fees.

Many countries offer exemptions for small businesses or polluters that discharge modest effluent volumes. However, other countries such as Denmark, Estonia, Germany and Slovenia do not exempt polluters according to firm size or effluent volumes. It is also common across schemes to exempt certain industries and facilities, typically where they are considered 'trade-exposed' - that is, where fee imposts are considered likely to impact their competitiveness with trading partners.

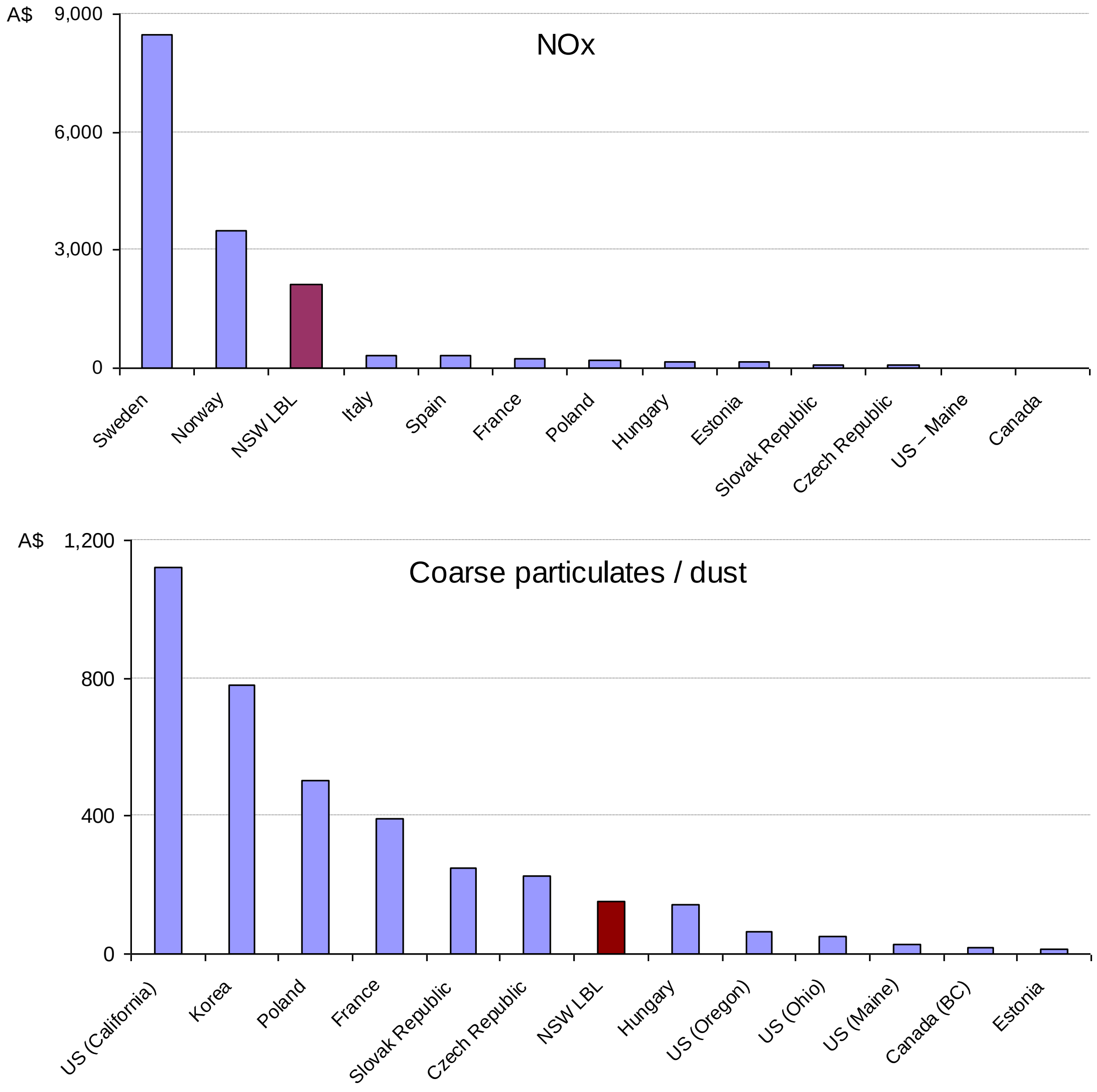
### *Air pollution fee systems*

Countries either design targeted air pollution charging schemes or schemes that encompass a range of air pollutants. Examples of the latter are British Columbia’s scheme that covers 15 air pollutants (including a catch-all in ‘contaminant not otherwise specified’) and the Polish scheme that includes some 63 pollutants. Countries that opt for targeted schemes tend to focus mostly on NOx (Norway, Sweden), SOx (Japan) or both (Italy, Hungary, Galicia and Andalusia). A few countries such as France, Estonia and Korea have schemes that levy fees on between six to nine pollutants.

The majority of schemes impose a standard fee on pollutants from stationary sources, and either exempt smaller emitters on the basis of combustion capacity or charge reduced fees for smaller sources of emissions.

The level of fees varies significantly. For example, Figure E2 shows the highest rates levied on NOx and coarse particulate emissions, excluding any differentiation countries apply to account for industry type or firm size.

**Figure E2: NOx and coarse particulate emission fees by country** (A$ / tonne)




Stavins (2002) argues that the Swedish $NO_x$ fee - due to the scale of fees charged - is the only fee in Western Europe to have caused air emission reductions on its own accord. After the fee was introduced, facilities covered by the fee reduced their NOx emissions by 35% within the first 20 months. Indeed reductions in emission intensity were rapid during the first 3-4 years of the scheme and then slowed. Both innovation as well as the spread and adoption of existing technology were found to have played a substantial role.

A study of the Swedish NOx fee is provided in the main body of the report, and brief comment is provided in Box E2.

**Box E2: Swedish NOx fee for large energy users**

In 1992, Sweden introduced a charge of A$6.60/tonne on emissions of NOx from energy generation at combustion plants. The value of health and environmental damage costs were not estimated for the purpose of fee setting. Rather the charge level was based on engineering data on the expected effectiveness and costs of NOx abatement at power stations and heating plants. Nevertheless, a latter study indicates that the emission charge appears to have been established close to a level that would equate with health and environmental damage costs.

The Swedish charge has been used as an example of an instrument promoting dynamic efficiencies, as it provides a continual incentive to reduce emissions and maximum flexibility in how this can be achieved. It created strong incentives for fuel switching, modifications to combustion engineering and the installation of specific abatement equipment such as catalytic converters and selective non-catalytic reduction.

All revenue is returned to the participating plants in proportion to their production of energy. This made it politically easier to set charges high enough to generate an environmental improvement compared with a straight emission charge. The Swedish experience suggests that a refunded charge can be designed to ensure it does not overly compromise instrument efficiency, in contrast to the French experience (Box 3)

Air pollution fee revenues are overwhelmingly applied to national environmental programs or anti-pollution measures, or are 'recycled' back to licensees through subsidies for pollution abatement. Notably, the early French scheme offered generous investment subsidies for new technological investment, which as described in Box E3, significantly undermined the efficiency of the scheme.

**Box E3: French industrial air emission fees**

France introduced an air pollution fee in 1985 to provide an incentive to regulated plants to reduce emissions. Fee levels were progressively increased, and by 1998 were A$43/tonne for NOx and HCL emissions and to A$58/tonne for NOx and VOC emissions. While the scheme has subsequently been reformed, its operation in these early years is instructive.

Seventy five percent of the revenues from the fee were earmarked for subsidies for abatement investments. Plants paying the fee could apply for a subsidy and the level of the subsidy related to the size of the fixed capital investment. All applications were funded, and almost all plants received a subsidy of 15% of the capital works investment.

An empirical analysis has been carried out of the impact of the French air pollution fees and subsidies over the period 1990-1998. It found that the effect of the subsidy was to *increase* total emissions from these plants, and to an extent that generally dwarfed the negative impact of the fee. That is, the combined fee/subsidy scheme may have had the perverse effect of increasing pollutant emissions.

Further, the program for allocating subsidies based on the capital cost of the investment favoured end of pipe technologies rather than more cost-effective process changes, leading to higher cost emission reductions.

## Features of successful pollution fee schemes

Below we draw on our observations to highlight key features that have affected the comparative performance of incentive schemes.

### *Real incentives require fee levels to exceed the cost of emission abatement*

Notwithstanding the generally low level of fee rates observed, behavioural changes in emission management are unlikely if voluntary action by facilities will result in a net cost to them - that is, fee savings will not outweigh expenditures in pollution abatement. However the right level of fees need not be punitive. The targeting of incentives with priority emission reductions and providing maximum compliance flexibility to liable facilities can provide real incentives within a modest overall level of charges.

### *The environmental effects of incentives are compromised by the existence of exemptions*

Exemptions are common in both air and water emission schemes. Where exemptions seek to exclude facilities with small emission loads, the compliance costs savings are likely to outweigh any efficiency losses.

However exemptions to certain industries or classes of facilities to increase scheme acceptability has often impacted the effectiveness of schemes. Frequently exemptions have been argued based on maintaining the competitiveness of trade-exposed industries. However even in these circumstances, dynamic adjustments which minimise exposure to the fee are usually possible, and need to be considered in scheme evaluations.

### *Be judicious and cautious with rebates*

The vast majority of schemes earmark revenues to return to liable facilities (revenue-recycling) or to fund broader environmental expenditures by the government. Revenue-recycling in particular can create significant efficiency losses.

The case studies examined and broader research has shown that efficiency losses are likely to be greater when recycled revenues are tied to pollution abatement subsidies (as in the case of the French fee on air pollution) rather than when recycled in the form of output subsidies (as with the Swedish $NO_x$ scheme). However output based recycling still sacrifices some of the first round efficiencies of an emission fee, with the efficiency losses sensitive to how the subsidy is structured and applied.

### *Ensure incentives are complementary to broader regulatory settings*

In almost all OECD countries examined, emission fees sit alongside regulatory standards that variously dictate the abatement technology that is to be employed and / or concentration-based emission standards. In several instances commentators have argued that success in reducing pollutant loads requires incentives to be effectively integrated in broader regulatory settings.

However broader regulatory settings can also work to limit compliance flexibility in response to fee incentives, such as if technology-based discharge concentration standards unnecessarily limit compliance options, or in relation to price regulation of publicly owned monopoly water utilities.

***Large emission reductions are typically associated with emission measurement***

The OECD observe that continuous (and correct) measurement of emissions is important for bringing attention to low-cost emission reductions that can be achieved simply by "trimming" production processes. In a number of countries, continuous measurement of a broad spectrum of pollutant emissions is now compulsory for many sources.

## Future directions

Based on our review, emerging trends in the use of emission fees include:

- increasing attention to the selection of pollutants. Some schemes such as the French air emission fees have been broadened recently to include more pollutants, whereas other schemes such as in the Slovak and Czech Republics have reduced the number of liable pollutants;
- the use of thresholds to determine liable activities remains common and subject to little change. Thresholds to determine liable facilities have been the subject of reform, typically to lower production thresholds for inclusion in a scheme. A number of schemes have also refined thresholds to exempt fee liabilities on emissions below minimum quantities, fee levels or associated with best practice pollution management. In this way regulatory burdens have been lessened with minimal environmental implications;
- no fee rates appear to have been reduced, while many jurisdictions have increased pollutant fee rates in real terms. Indeed increases in France and the Czech Republic have been significant, such that it would be reasonable to term the fee rates as 'towards' externality pricing;
- a number of jurisdictions have also sought greater differentiation in fee rates based on the receiving environment. This is consistent with the other trends towards increased incentive targeting and higher rates, to sharpen the incentive force of incentives;
- fee waivers, similar to load reduction agreements under the NSW LBL scheme, are a common feature of schemes. There is little information on the success or otherwise of these agreements, or whether they are becoming more broadly available. On the other hand, there do not seem to be instances where access to the agreements has been discontinued; and
- finally, there appears to be a greater targeting of rebates and subsidies, now that evidence has emerged from France, Germany and Hungary that rebates have significantly reduced the effectiveness and efficiency of their incentive schemes.

# 1. INTRODUCTION

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes the NSW environmental regulatory framework and includes a licensing requirement for certain activities. All licences attract annual administrative fees (currently based on the type and scale of licensed activity), and some licences are also required to pay annual 'load based' fees (proportional to the quantity and types of pollutants discharged and the conditions of the receiving environment).

The EPA is proposing to introduce a risk-based approach for setting licence administrative fees, and is currently consulting on a draft framework.

In addition, the EPA has advised that after 14 years of operation, a review of the effectiveness of the load based licensing (LBL) fees is underway. The review of the LBL fees will aim to:

- improve the effectiveness of the LBL scheme in driving reductions in air and water pollutant emissions;
- improve the efficiency and ease of use of the scheme for licensees and for the EPA; and
- ensure the scheme has a range of tools that can be used to respond to emerging pollution related issues.

The review in this report has been commissioned by the EPA to inform their review of the LBL fees by providing a comparative analysis of economic incentives for industry to reduce emissions of pollution to air and water. The analysis is limited to market based instruments which provide incentives for pollution reduction from individual premises, similar to the LBL fees, and does not include trading schemes.

The scope of the review is limited to economic incentives in OECD jurisdictions - Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States.

In this section, the role of pollution discharge fees as an economic incentive is identified to help focus the subsequent review. In the following section, Australian pollution emission fees systems are described. This is followed in Section 3 with an overview of international experiences which is supported with individual summaries in appendices A and B. In section 4, a number of pollution fee system case studies are presented. In section 5 an assessment is provided of the most successful economic incentives, and lessons for application in the NSW context.

## 1.1 Classification of pertinent incentives

The LBL fees fall within a class that are sometimes referred to as pollution taxes as they apply the ‘polluter pays’ principle to provide a greater incentive for licensees to reduce air and water pollution. The fees complement a standard licensing approach to pollution control through providing a financial incentive to go beyond compliance with licence conditions. Similar incentives internationally may be labelled differently - for example, as performance-based environmental charges, polluter pays fees, emission charges, emission fee - but typically they are described as environmental taxes. [1]

Environmental taxes for pollution control and natural resource management are an increasingly important part of environmental policy in OECD countries. Environmental taxes can serve to discourage behaviour that is potentially damaging for the environment and can provide incentives to lessen the burden on the environment and to preserve it by '*getting the prices right'*. The economic rationale for their use comes from their ability to influence markets in a cost effective way.

Importantly, an environmental tax is one whose fee base is a physical unit (or a proxy of a physical unit) of something that has a proven, specific negative impact on the environment. Governments also collect other types of receipts such as licence fees, administrative charges and so on. However the receipts should be treated as '*sales of services'* if the government uses the issue of a licence to organise some proper regulatory function and if the payments are clearly in proportion to the cost of providing the services. That is, the payment is being made to, at least in part, defray the cost of providing the service[2].

The European Union (2013) classifies environmental taxes into four main categories:

- energy taxes (including fuel for transport), including taxes on greenhouse gases;
- transport taxes (excluding fuel for transport);
- pollution taxes; and
- resource taxes.

The pollution taxes include taxes on measured or estimated emissions to air and water (excluding greenhouse gases) - and it is these taxes which are similar to the LBL load fees and are the focus of our review. Resource taxes include taxes linked to the extraction or use of natural resources, such as water, forests, wild flora and fauna, etc., as these activities deplete natural resources. These taxes are not included in the review.

## 1.2 LBL-like pollution fees constitute economic taxes

The terms 'pollution fee' and 'environmental tax' are sometimes interpreted to mean a Pigovian tax.[3] A Pigovian tax is a fee levied on a market activity that generates negative externalities. Economic theory describes the concept of an externality as a cost or benefit not transmitted through prices. The benefit corresponds to a positive externality and the cost corresponds to a negative externality. Negative

1 Clarification as to what constitutes an environmental tax, an economic tax and the focus of this review draws on the tax classifications adopted by the European Union (2013).

2 European Union (2013).

3 After Arthur Cecil Pigou, a British economist. Pigou, A. C. The Economics of Welfare, 1920.

externalities or 'social costs' are related to the environmental consequences of production and consumption.

In the presence of negative externalities, the cost to society of an activity is not accurately reflected in the costs faced by those undertaking the activity. In such a case, there is likely to be a higher level of that activity than is socially efficient. That is, if a producer of pollution is not liable for the costs the pollution imposes on other parties, they will undertake the polluting activity at a higher level than if they were liable for the costs. This will be socially inefficient, as at the margin, the benefit from the activity will be less than the costs imposed on others.

A Pigovian tax is a fee levied on the negative externality at a rate that is equal to the marginal damage costs and is considered to correct the market outcome back to efficiency. In practice, the application of Pigovian tax theory faces the difficulty of calculating what level of tax will counterbalance the negative externality - ie: what tax rate equals the marginal social costs. Furthermore, Pigovian taxes should be levied directly on the negative externality or on tax bases that are very close proxies of the social costs, such as emissions.[4]

Given the difficulties with estimating Pigovian tax rates, environmental taxes defined by the EU include more than the Pigovian taxes as described in economic theory. As an example, the rate of a tax on pollutant emissions may be set with fiscal motives in mind and may be higher than the marginal damage costs associated with losses in air or water quality.

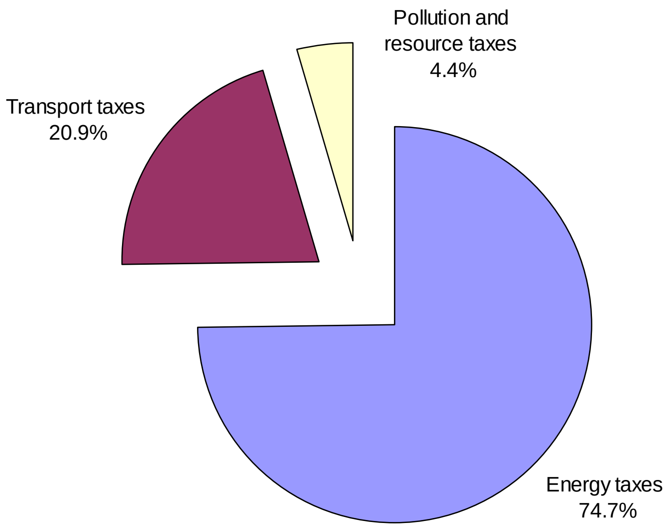
Indeed non-economists typically associate the term tax with revenue raising objectives, as this is primarily the purpose of common taxes (including income tax, goods and services tax, payroll tax, and so on). To minimise confusion, the term fee is generally used throughout this report, and where possible we indicate whether the policy objective is to provide an incentive for pollution reduction and / or as a revenue raising instrument.

In general, pollution fees have been more common in Europe than the United States with some European schemes operating since the 1960s. More recently, some European countries have implemented pollution fees as part of a "green tax reform," shifting the tax burden away from labour and/or capital and toward the use of environmental resources.

Environmental fee / tax revenue in the EU is significant, and has grown by some 20% between the year 2000 and 2011 to some EUR 300b (A$460b). However the revenue is predominately from energy and transport taxes, with revenue from pollution and resource taxes increasing their share of total environmental revenues from 3.3% in 2000 to only 4.4% in 2012 (Figure 1.1).

4 European Union (2013)

**Figure 1.1: EU environmental tax revenue - percentage by category 2011**




Source: European Union (2013)

## 1.3 The concept of revenue recycling

"Revenue recycling" is used by some jurisdictions to provide an incentive for reducing emissions while at the same time ensuring that net revenues collected do not exceed the regulator's licensing administration costs or revenue target. The approach has similarities to "hypothecation" or "earmarking" of revenues where revenues from a fee or levy generated from a broad group is used to fund specific programs. The revenues can be returned in different ways, for example as a reward for reducing pollution loads, or through a scheme to fund programs by licensees to reduce pollution.

Several jurisdictions 'hypothecate' or 'earmark' environmental fee revenues to fund specific programs, such as in the Danish scheme where some revenue is hypothecated to an independent Water Fund to finance water supply projects. As shown in the review across OECD countries, more commonly the programs benefiting from the revenues are concerned with treating the environmental impacts of the liable activity or discharges, and in these circumstances the fee is effectively treated as an environmental user contribution to the needs of the program.

In fewer instances, schemes aim to implement a fee for its incentive effects, while they refund or recycle some of the revenues to help offset the burdens to the regulated parties. A common method is to recycle revenues according to output (such as in the case of the Swedish NOx fee), although a range of allocation rules have been used including as subsidies to fund programs by the regulated parties to reduce pollution (such as in the case of the French air fees).

# 2 AUSTRALIAN LICENSING FEE SYSTEMS

In this section, a brief overview of the purpose and structure of the pollution fee systems employed across Australia is presented. A summary of the NSW scheme is then presented as a basis for comparison with other fee schemes. Lastly, a description of the SA and WA schemes is provided, as these schemes also have an incentive component levied on actual pollutant discharges.

## 2.1 Overview of Australian schemes

The structure and purpose of pollution fee schemes in Australia varies across jurisdictions. Fees levied by environment agencies for licensing activities are commonly based on activity type and scale as a proxy for the activity's environmental impact to minimise the level of resources required for licensing. Many States also include an additional load based incentive component in the licence fee. The approach to fee setting across Australian States is shown in Table 2.1.

**Table 2.1: Licence fee setting in Australian States**

| State | Fee components | Basis for fee components |
|---|---|---|
| Victoria | Base fee + | Activity type and scale of operation |
| | Component fee | Load of pollutants allowed to be discharged under licence (stack and effluent pipe emissions only) |
| New South Wales | Administration fee + | Activity type and scale of operation |
| | Load based fee | Actual load of assessable pollutants emitted (stack, effluent pipe and some fugitive emissions) |
| South Australia | Flat minimum fee + | Flat paperwork fee for all activities |
| | Environment management fee + | Activity type and materials used or processed, production volumes or processing capacity |
| | Resource efficiency fee | Actual emissions (above set thresholds) |
| Western Australia | Premises fee + | Design capacity/throughput |
| | Discharge fee | Actual load of assessable pollutants emitted |
| Queensland | Annual fee | Environmental risk calculated based on environmental emissions profile for each activity type and scale of operation |
| Tasmania | Fixed fee + | Activity type and scale / size (designed to reflect administration/management fees) |
| | Variable fee | Activity type and scale / size (designed to reflect regulatory effort required) |

The role and mechanism for charging licensing fees, and in particular the load based fee components, varies significantly across States. For example, the Victorian scheme charges the load component based on the load limit (allowed to be discharged) stated in the licence, whereas the NSW scheme is based on the actual loads of pollutants discharged (either through estimation techniques or load monitoring).

Table 2.2 compares the proportion of total licensees paying load based components in each State that charges a load based fee. The data do not relate to the same licensing year, and the number and type of licensed activities can be expected to vary between states given differences in industrial sectors. Nevertheless, the relative focussing of load fees is readily apparent.

Victoria and Western Australia have the highest proportion of total licensees paying a load based component. New South Wales and South Australia have focused their load based incentives on a much smaller percentage of the licensed group.

**Table 2.2: Comparison of licensees paying load based components**

| State | Number of licensees paying load component | Total licensees | % paying load component |
|---|---|---|---|
| Victoria | 315 | 573 | 55% |
| Western Australia | 349 | 850 | 41% |
| South Australia | 300 | 2,200 | 14% |
| New South Wales | 280 | 2,500 | 11% |

Source: NSW figures from discussions with DECCW December 2010. Victorian data provided by Vic EPA December 2010. WA data from discussions with DEC in 2006. SA data from SA EPA 2007.

Table 2.3 shows the proportion of fees collected through the load based component under the fee systems. Similar qualifications to this data as per that in Table 2.2 should be noted. However the significance of load fees to total fees is readily apparent.

New South Wales has the highest proportion of total fees from the load based component at 80%, and this is collected from only 11% of licensees. Victoria and Western Australia collect almost 70% of total fees from the load based component, but it is collected from 55% and 41% of licensees respectively.

The different approaches employed across the States reflect varying objectives for the fee regimes. The primary objective of the Victorian pollution fee regime is cost recovery, and basing licence fees on allowable load limits without differentiation to reflect the circumstances of individual premises is a relatively low cost way of ensuring that licence administrative costs are borne in a transparent way.

**Table 2.3: Percentage of fees collected from load based component**

| State | Fees collected from licensees paying load based components ($m) | Total fees collected ($m) | Contribution of load fees to total fees |
|---|---|---|---|
| New South Wales | 37.6 | 41.9 | 80% |
| Victoria | 8.8 | 12.8 | 69% |
| Western Australia | 10.1 | 14.9 | 68% |
| South Australia | 3.7 | 9.25 | 40% |

Source: NSW figures for 2012/13 provided by the NSW EPA February 2014. Victorian data provided by Vic EPA December 2010. WA data from 2009/10 annual report and correspondence with DEC. SA data from SA EPA 2007.

The primary objective of the NSW fee regime is to implement polluter pays charges and so to provide an incentive to reduce emissions. The NSW emission load fees are highly differentiated (see Section 2.2) to best reflect the likely harmfulness of emission discharges at each premise. The SA and WA schemes also embody differentiated fees based on actual emissions, but the incentive objective (and associated fee revenues) is secondary to a cost-recovery objective - and indeed overall load fees are capped at the level of administration costs in both schemes.

In the following sections we describe the NSW scheme as well as the SA and WA schemes.

## 2.2 New South Wales load based licensing scheme

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes the NSW environmental regulatory framework, and introduced in 1999 a new 'load based' licensing requirement for certain activities. The *Protection of the Environment Operations (General) Regulation 2009* sets out the detail of load based licensing (LBL).

The scheme sets limits on the pollutant loads emitted by holders of environment protection licences. An annual licence fee is made up of two components - an administrative fee based on the type and scale of licensed activity; and a load based fee (for premises conducting specified activities) proportional to the quantity and types of pollutants discharged and the conditions of the receiving environment.

The objectives of the regulation that relate to the fee scheme are to:

(a) provide incentives to reduce the load of pollutants emitted based on the polluter pays principle and to do so within an equitable framework;

(b) reduce pollution (in particular, assessable pollutants) in a cost effective and timely manner;

(c) give industry incentives for ongoing improvements in environmental performance and the adoption of cleaner technologies;

(d) provide incentives that are complementary to existing regulation and education programs for environment protection.

### *Type of incentive mechanism*

The load based fee represents a pollution fee, as it is based on the mass of discharged pollutants, with fee liabilities differentiated with respect to perceived health and environmental damages. Accordingly, the fees provide an incentive to licensees to reduce pollutant discharges from their regulated premises.

### *Type of emissions*

The scheme covers a range of pollutants to air and water from licensed premises. This largely involves discharges from point sources, but in some instances includes fugitive / diffuse sources. For example, fugitive emissions of VOCs from leaks and spills at oil refineries.

### *Pollutants included*

The load based licensing scheme covers 12 types of air pollutants and 17 categories of water pollutants, shown in Table 2.4.

**Table 2.4: Pollutants included in the NSW load based fees**

| Air pollutants | Water Pollutants |
|---|---|
| Arsenic, lead, fluorides, nitrogen oxides, mercury, sulphur oxides, volatile organic compounds, hydrogen sulphide, coarse particles, fine particles, benzene and benzo(a) pyrene | arsenic, BOD, cadmium, chromium, copper, lead, mercury, oil & grease, pesticides and PCBs (polychlorinated biphenyls), salt, selenium, total nitrogen, total PAHs (polycyclic aromatic hydrocarbons), total phenolics, total phosphorus, total suspended solids and zinc. |

### *Emission estimation methodology*

The load of a pollutant is the mass (in kilograms) of the pollutant released into the environment. It is calculated by using the techniques described in a Load Calculation Protocol [5]. The protocol sets out acceptable methods for estimating emissions. When a licensee can show that a more reliable and accurate emission estimation method can be used, the EPA may authorise the use of a site-specific emission factor or another technique to report emissions.

An LBL Technical Review Panel has been established to advise the EPA on the current or desirable contents of the Load Calculation Protocol. The Panel includes representatives of licensees, local government, environment groups, EPA and an independent adviser.

5 http://www.epa.nsw.gov.au/resources/licensing/09211loadcalcprot.pdf

### *Assessment period*

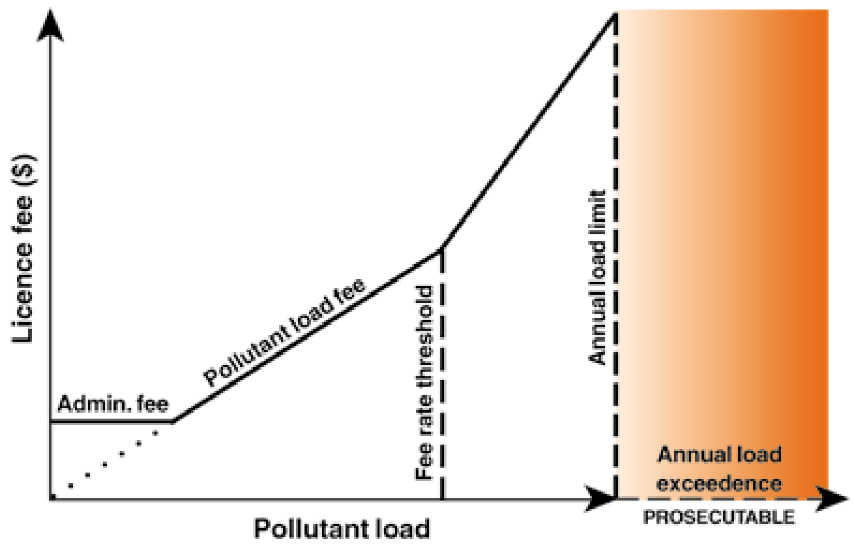
Assessment periods are generally annual, based on emissions over the preceding year, except for 'oxides of nitrogen' and 'volatile organic compounds' released from a range of Sydney facilities during the three summer months from 1 December to 28/29 February.

### *Fee structure*

All licensees pay an administration fee. Certain activities are also required to pay a pollutant load fee based on the actual mass of pollutants discharged to the environment.

The load based fees are structured to provide a higher incentive where pollutant loads are above a reasonably achievable discharge level for the pollutant from the relevant licensed activity. The per kg pollutant load fee is doubled for that part of a licensee's emissions which exceeds a threshold for each industry type / pollutant that represents what can be reasonably achieved with modern technology. This provides a more targeted incentive than a flat fee for each kilogram of pollution discharge. Figure 2.1 summarises the key features of the NSW load based licensing fees.

**Figure 2.1: Structure of load based fees in NSW**




Source: NSW DECC (2008)

Box 2.1 shows the formulas used to calculate load based fees under the NSW scheme. Pollutant weightings, critical zone weightings, fee rate thresholds and the pollutant fee unit are specified in *The Protection of the Environment Operations (General) Regulation 2009*.

**Box 2.1: Formula for calculating NSW load based fees**

Where AL is below FRT the formula is:

**Pollutant load fee = (AL x PW x CZ x PFU) / 10,000**

Where AL is greater than the FRT the formula is:

**Pollutant load fee = ((2AL - FRT) x PW x CZ x PFU ) / 10,000**

| | | |
|---|---|---|
| AL | = | assessable load for each assessable pollutant for the licence year |
| FRT | = | fee rate threshold which is a reasonably achievable discharge level |
| PW | = | pollutant weighting which accounts for the relative impact of the pollutant and priority placed on reductions from licensed premises |
| CZ | = | pollutant critical zone weighting which accounts for the sensitivity of the receiving environment |
| PFU | = | the pollutant fee unit which is the dollar value used in the load fee calculation formula for any licence fee period |

### *Compliance / monitoring and evaluation mechanisms*

Licensees are required to submit an annual return which provides a statement of compliance with the licence conditions and reports the pollutant loads generated by the premises.

The annual return must be signed by the licence holder or a person authorised to sign on the licence holder's behalf where the licence holder is a company. The return will usually be signed by two company directors. The authorised signatories must personally certify that each year's load calculations have been completed and recorded in accordance with the Load Calculation Protocol, and face severe individual penalties for false declarations.

Any breach in load reporting or fee payments represents a breach of licence conditions and is enforceable under the offences and penalties under the POEO Act.

The EPA's compliance audit program includes scrutiny of load calculations and returns through various manual and computerised checks on received returns, random audits of licensees' records, and full audits of licensees' compliance with all provisions of the Load Calculation Protocol.

### *Industries / activities subject to the scheme*

Schedule 1 of the Regulation lists those activities with assessable pollutants that attract a load fee. Activities include those producing:

**Table 2.5: NSW industry sectors subject to a load fee**

| | | |
|---|---|---|
| agricultural fertilisers | electricity | plastics |
| aluminium | glass | primary and secondary non-ferrous |
| carbon black production | iron and steel | pulp or paper |
| cement or quicklime | paint | chemical storage (petroleum) |
| ceramics | petrochemicals | waste oil recovery |
| coal seam gas | petroleum refining | waste incineration |
| coke | | |

### *Application of revenues*

All fee revenue is paid into the state's consolidated revenue. There is no revenue hypothecation, earmarking or recycling.

### *Distinctive features*

The annual load fee for each pollutant considered potentially harmful to the environment (the ‘assessable pollutant’) is based on the ‘assessable load’. The assessable load is the lowest of the ‘actual’, ‘weighted’ or ‘agreed’ loads which are defined as follows:

- Actual load: mass of pollutant discharged (in kilograms) during the licence fee period, determined through the monitoring of emissions;
- Weighted load: calculated by applying a discount to the actual load to reflect measures employed to reduce the harmfulness of discharges (such as effluent reuse); and
- Agreed load: a future load reduction committed to under a 'load reduction agreement' with the regulator, providing immediate fee reductions.

Load Reduction Agreements (LRA) allow licensees to immediately reduce their licence fees if they commit to achieving specific environmental outcomes in the longer term. The money they save in lower pollution discharge fees can be invested in achieving these outcomes. LRAs last for a maximum of four years, giving licensees up to three years to implement upgrades and one to demonstrate attainment of agreed lower annual loads. If at the end of an agreement the agreed loads have not been achieved, the licensee must repay the excess fee reductions with interest.

The 2004-05 DEC annual report states that 26 load reduction agreements had been entered into with licensees, with five completed during 2004-05, preventing 2,114 tonnes of pollution per year being discharged into the environment (903 tonnes of air pollutants and 1,210 tonnes of water pollutants). By

2008, around 30 load reduction agreements had been entered into with 7 agreements being successfully completed, 6 partially successful and 17 licensees did not achieve their agreed loads[6].

EPA advise that the use of Load Reduction Agreements after 2008 decreased significantly, and currently there are no agreements in place. This has occurred as the EPA assessed that LRAs were generally found to be less successful than other regulatory tools in resulting in reducing emissions, however their availability is retained for use in appropriate cases such as switching to a non-VOC solvent or undertaking simple modifying equipment.

LBL also allows for fee offsets, where action taken by a licensee reduces pollutant reductions off-site. For example, fee liabilities for emissions of VOCs by a petroleum refinery may be reduced where action is taken to produce fuel that will emit less VOCs when in use. By providing access to off-site emission reductions, compliance costs can be reduced and economic efficiencies realised.

***Effectiveness***

EPA previously reported on the load based licensing scheme in its annual report each year using a Pollutant Load Indicator. The indicator represented the total pollutant load emitted by all LBL activities for a reporting year, adjusted to reflect the relative harm of the pollutant and the sensitivity of the receiving environment (using the weightings in the scheme).

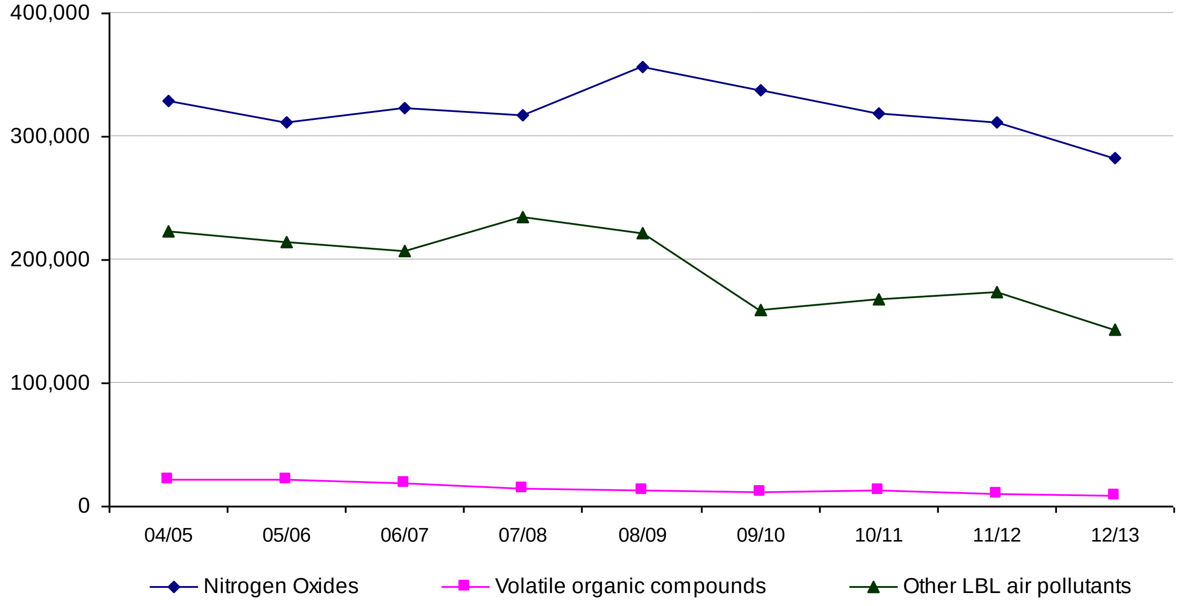
Identifying pollution reductions that can be attributed directly to the load based licensing fee regime is complicated by factors such as changes in the numbers of premises required to pay pollutant fees due to legislative reforms and changes in levels of economic activity. Also, the first year of the scheme was a transition period and some licensees experienced difficulties in establishing monitoring regimes.

Over the first four years the air pollutant indicator fell by around 15%. In 2004, the pollutant weightings for many air pollutants were increased in recognition of growing concern about the impacts of these pollutants. With the change in base, the air pollutant indicator before and after this date cannot be compared. In addition, the weightings for NOx and VOC emissions in the Sydney basin over the summer period were increased from 2007/08.

Excluding this last change for summer NOx and VOC emissions, the overall air pollutant indicator fell 24% between 2004/05 and 2012/13. As shown in Figure 2.2, this included a fall in NOx emissions of 14%, VOCs by 58% and other LBL air pollutants by 36%.

6 NSW DECC (2008)

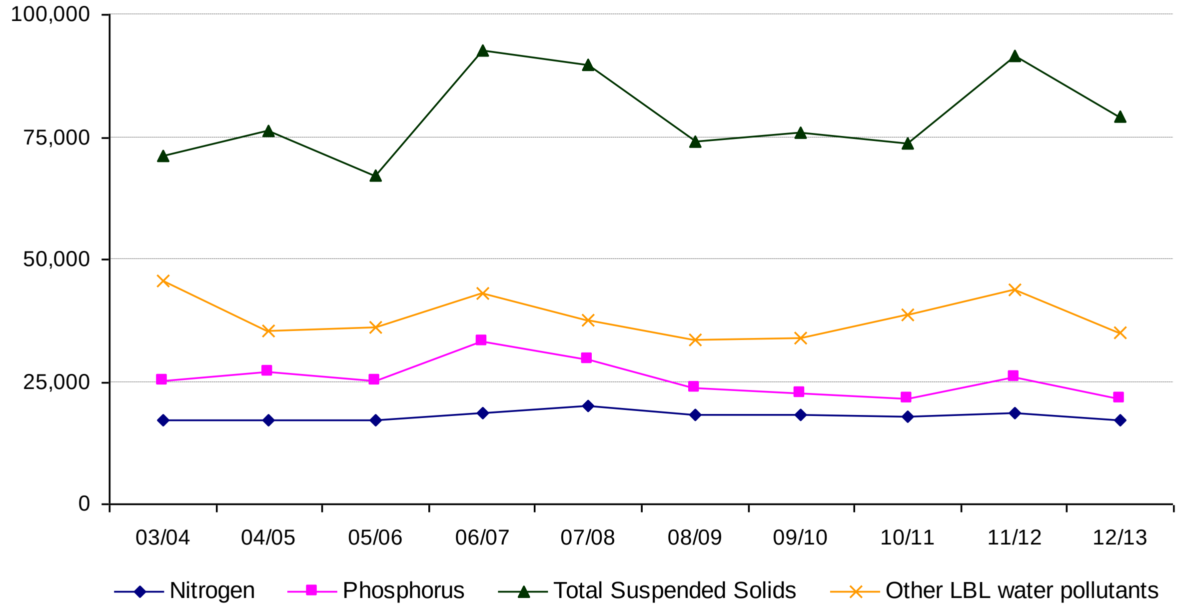
**Figure 2.2: Air pollutant indicator for load based licensing**




Source: Provided by the NSW EPA

For water emissions, the water pollutant indicator also fell significantly over the first four years of the scheme, by around 20%. Much of this was related to the recycling of wastewater to a range of beneficial uses. Since 2003/04, the overall water pollutant indicator has only fallen by some 4%, although as shown in Figure 2.3, this has varied significantly between pollutants. For example, over this period phosphorous emissions fell by some 15% while emissions of TSS increased by 11%.

**Figure 2.3: Water pollutant indicator for load based licensing**



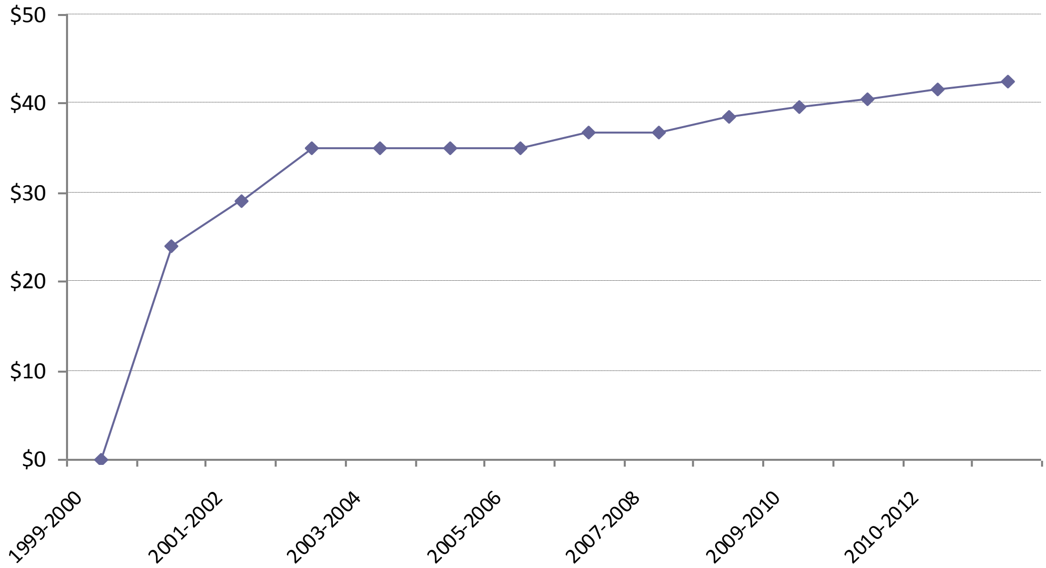

Source: Provided by the NSW EPA

It is important to note however, that attributing the observed emission reductions (in part or full) to the incentive force of the LBL fees is dangerous. The number of premises subject to load fees and their production levels are likely to have varied over time, and a range of other environmental regulations and programs will also have contributed to emission management and performance.

### *Efficiency*

The load based pollution fees were phased in over four years, starting at a value (pollutant fee unit) of $0 in 1999-2000 and increasing to $35 in 2002-2003. Figure 2.4 shows how the value of the pollutant fee unit was phased in, and then indexed to the consumer price index from 2006-07.

**Figure 2.4: Pollutant fee unit value under NSW load based licensing**




It was recognised when the enabling legislation was introduced that the load based fees would, at least initially, be set below the value of the health and environmental (externality) impacts of discharges. However as shown in Box 2.1, the fees were designed to reflect the *relative* external impacts of pollutants and the state's priorities for reductions in these pollutants from licensed sources.

The total maximum fees, in the absence of any abatement action or change in the number and mix of licensed facilities, was originally set at two times the cost of administering the licensing system (estimated at around $30m per annum in 1998). Revenues have however fallen short of this, in part due to a significant reduction in licensed premises that occurred under the new integrated licensing system that was concurrently introduced with LBL, as well as due to an overestimation of loads prior to scheme introduction.

Substantial changes to the fee scheme settings for air pollutants have been implemented over the years. In 2004 the regulation was amended to implement an increase of around 50% to pollutant weightings for all air pollutants. In 2007 the critical zone weighting for emissions of NOx and VOCs in the Sydney Basin during summer increased fourfold from 7 to 28.

The range of applicable pollutant load fees in 2012-13 is shown in Table 2.6. The range typically indicates fee rates below and above the fee rate threshold. In the case of nitrogen, phosphorous and salt emissions to water, the range also accounts for whether the discharge is to open or enclosed waters. For these pollutants as well as NOx and VOC emissions to air, variations are also due to critical zone weightings. Finally, a further weighting is applied to NOx and VOC emissions in the Sydney basin during the summer period.

In anticipation of a statutory repeal and remaking of the enabling regulation in 2009, a review of the scheme was commenced in 2004 and a number of changes proposed in a Regulatory Impact Statement (RIS) in 2008.

The review found that licence administration was operating effectively and recommended no changes to the basic licensing approach for the proposed regulation. However it was recognised that the revenue collected from the administrative component of licence fees (expected to be approximately $12.8 million in 2007–08) only represented a partial recovery of the $25 million incurred by the then Department of Environment, Climate Change and Water (which included the EPA).

The 2008 RIS also discussed the merits of setting the pollutant load fees to reflect the impact of each pollutant on the environment. It was determined that fee levels could not be confidently set in this manner due to the absence of comprehensive information on the external costs of pollution at this time.

In 2010, there were 2,500 licensees, with 280 of these paying load based fees. The revenue from licensees paying load fees in 2011-12 was $37.6m and revenue from non-LBL licensees was $4.3m, giving a total licence fee revenue of $41.9m.

**Table 2.6: NSW LBL fees 2012-13**

| Pollutant | Fee range (A$ / tonne) | |
|---|---|---|
| | Low | High |
| **Air pollutants** | | |
| NOx | 38 | 2,148 |
| VOC | 28 | 1,575 |
| SOx | 9 | 19 |
| Arsenic | 221,624 | 443,248 |
| Benzene | 3,154 | 6,308 |
| Benzo[a]pyrene (equivalent) | 123,598 | 247,196 |
| Coarse particulates (TSP-$PM_{10}$) | 77 | 153 |
| Fine particulates ($PM_{10}$) | 533 | 1,066 |
| Fluoride | 358 | 716 |
| Hydrogen sulfide | 1,364 | 2,728 |
| Lead | 46,882 | 93,764 |
| Mercury | 468,820 | 937,640 |
| **Water pollutants** | | |
| Total nitrogen | 26 | 588 |
| Total phosphorous | 0 | 17,389 |
| Arsenic | 10,655 | 21,310 |
| $BOD_5$ (enclosed waters) | 4 | 9 |
| Cadmium | 285,554 | 571,108 |
| Chromium | 17,900 | 35,801 |
| Copper | 7,245 | 14,491 |
| Lead | 27,277 | 54,554 |
| Mercury | 767,160 | 1,534,320 |
| Oil and grease | 315 | 631 |
| Pesticides and PCBs | 3,963,660 | 7,927,320 |
| Salt | 0 | 72 |
| Selenium | 42,620 | 85,240 |
| Total PAHs | 16,196 | 32,391 |
| Total phenolics | 20,884 | 41,768 |
| Total suspended solids | 332 | 665 |
| Zinc | 30 | 60 |

Table 2.7 compares per tonne fees for key air pollutants under NSW LBL with available estimates of health damage costs. A range is provided for the estimated health damage costs, with the lower end estimates relevant for licensees in urban areas outside large capital cities and the upper end relevant for licensees in inner areas of large capital cities.

**Table 2.7 Comparison of current LBL fees with estimated damage costs for key air pollutants**

| **Pollutant** | **Marginal fee per tonne payable under LBL (2012-13)** (approx) | **Estimated damage cost per tonne*** | |
|---|---|---|---|
| | | **Watkiss (2002)** (updated to $A 2010) | **DECCW (2010)** ($A 2009) |
| Particulate matter (PM10) | $533 - $1,066 | $116,600 - $427,500 | $55,825 - $235,260 |
| Nitrogen oxides | $38 - $2,148 | $300 - $2,200 | $155 - $1,055 |
| Volatile organic compounds | $28 - $1,575 | $200 - $1,100 | $4,200 |

The pollution damage estimates are based firstly, on a report prepared for the Commonwealth Government by Paul Watkiss from AEA Technology Environment on the air pollution costs of transport in Australia as an input to the Fuel Fee Inquiry conducted in 2002.[7] We have also reported values from DECCW (2010) for comparative purposes.

The values reported by DECCW for PM10 and NOx have been drawn from a 2009 Regulatory Impact Statement on vehicle emission standards by the Department of Infrastructure, Transport, Regional Development and Local Government (DITRDLG)[8]. Notably, the DITRDLG values are merely simple averages drawn from a number of earlier studies, including the study by Watkiss (2002), updated by the CPI with a range of ± 50% added to reflect the inherent uncertainty in values. Nevertheless, the EPA is currently finalising a new study into the health impacts of changes in particle emissions, which for this pollutant, in the Sydney basin, is consistent with the order of magnitude estimates reported by DITRDLG.

The marginal fees payable for particulate matter are a fraction of the estimated externality damage costs. The lower bound marginal fees payable for NOx and VOCs are also a fraction of the lower bound marginal damage costs shown in Table 2.7. However the upper bound marginal fees are of a similar order of magnitude as the upper bound marginal damage costs. This suggests that while the LBL fee levels for most pollutants may be well below the level of associated health damage costs, in the case of

7 In this study, pollution unit cost estimates were based on European values of health impacts for a range of air pollutants. The European work was the 'bottoms-up' ExternE Transport Study finalised in 2000 involving fifty sites across twelve European countries. Watkiss transferred the values to Australian conditions controlling for population densities and we have updated the values to A$2010.

8 Department of Infrastructure, Transport, Regional Development and Local Government (2009)

NOx and VOC emissions in priority areas and times, fee levels approach at least some estimates of damage costs.

***Third-party reviews of LBL***

A number of recent academic studies have investigated the performance of the LBL scheme, and three of these are briefly commented on below - two studies by Tiho Ancev and colleagues exploring the incentive force of selected air emission load fees, and one by Graham and Wright who explore the performance of the broader licensing framework (inclusive of LBL) through case studies of controlling pollutant emissions to water.

Ancev, Betz and Contreras (2012)

An independent academic review of the impact of the NSW load based licensing scheme on NOx emissions by licensed emitters was undertaken in 2006.[9] Data was available for 65 licensees in 16 regulated activity groups covering industries such as cement, ceramics, coke, electricity, glass, paper, paint, petroleum refining, plastics, metals, agricultural fertilisers and biomedical waste incineration.

The review involved an econometric analysis examining whether the NOx abatement was a response to the increasing licence fees. The authors found that the abatement could not be clearly attributed to the fee scheme and believed that the fees were set at too low a level. However, they did conclude that load based licensing had probably contributed toward a reduction in total NOx emissions over the review period.

In response to the study, DECCW noted that the reliability of their results may have been limited because a number of the facilities in their sample did not pay emission fees.[10]

The authors have since updated their analysis in consultation with the EPA, and published their findings in 2012.[11] The updated analysis covers 86 industrial facilities across 15 industry sectors licensed to discharge NOx over the period 2000 to 2009. Despite the richer dataset and benefit of a number of scheme changes over the period which have led to increases in the effective NOx fee paid by licensees, their results remain consistent with their earlier analysis. That is, that overall the effective fee under the LBL scheme does not have a statistically significant effect on NOx emissions.

An interesting finding from the updated analysis is that exceeding the fee rate threshold (FRT) and use of continuous monitoring were found to be significant in terms of facilities exhibiting lower NOx emissions. Due to the significant cost of installing and operating monitoring systems, only some 19% of licenses undertake any monitoring and only 4 % undertake continuous monitoring.

Most licensees estimate emissions using production data and set emission factors. A shortcoming of estimating emissions is that (often low cost) emission reductions through combustion optimisation and

9 Ancev and Betz (2006)

10 Henderson and Norris (2008)

11 Ancev, Betz and Contreras, (2012)

improving overall energy efficiency will not be credited with the use of emission factors that may only differentiate changes in fuel use and end-of-pipe abatement technology.

UNSW Centre for Energy and Environmental Markets (2010)

This study[12] was undertaken by the same authors cited above, focussing on the same licensees but extending air pollutant coverage beyond NOx to also include emissions of SOx, VOCs, fine particulate matter and coarse particulate matter.

Their modelling results found that the effects of fees were statistically insignificant for NOx, fine particulate matter and coarse particulate matter. Some fee related variables were found significant for VOCs and weakly significant for SOx for some variants of their model. They argued that the observation that emissions of air pollutants have moved lower in recent years could largely be explained by reduced physical output, and that the effective fee rate had been too low to create a sufficient incentive for emitters to engage in abatement. The authors concluded:

> *Overall the results from this study indicate that serious revisions of the NSW LBL scheme will need to be contemplated at the policy level, if the goal of reducing emissions of air pollutants and a consequent improvement of air quality is a predominant policy objective.*

An alternative explanation offered by the authors for the muted effects of the LBL fees on emissions of air pollutants was that some other overarching factors may constrain the behaviour of emitters to the point that they are not responsive to incentives provided by the environmental fee. Potential factors cited included environmental regulations (such as short-term concentration standards under the Clean Air Regulations), Pollution Reduction Programs and requirements for the monitoring of emissions.

For example, the introduction of LBL came with a commitment to review concentration limits which hitherto had been used to assist control of both acute impacts and cumulative loads. Failure to have adjusted concentration limits may have constrained licensee flexibility to respond to fee incentives,[13] and this was noted by Ancev et al in their 2012 study.

In addition, the researchers undertaking the broader study of air emissions may not have fully understood the complementary roles of Pollution Reduction Programs (PRPs) and LBL fees. The response of licensees to LBL fees is possibly masked in their model by controlling for those licensees that had entered PRPs. The authors argued that the latter were independent regulatory undertakings. However the willingness of licensees to enter such agreements is likely to have been influenced in part by potential fee savings. Notably, only 7% of licensees discharging NOx had a PRP at the start of the LBL scheme in 2000, yet this increased to 62% by 2008-09.

12 UNSW Centre for Energy and Environmental Markets (2010)

13 For example, input or process changes may allow low cost reductions in pollutant loads, but may not reduce the concentration of pollutant emissions to the extent required to meet (overly restrictive) concentration based standards.

Graham and Wright (2012)

In this paper,[14] the authors look more broadly at the pollution licensing regulations, and argue that in practice the objects of the overarching regulatory framework are not being achieved given the degradation of many waterways as a direct result of industrial waste discharges.

They make a number of recommendations to reform the pollution licensing system, including greater consideration of cumulative impacts of key pollutants, broader coverage of licences, expanded use of market-based approaches, independent monitoring and enforcement, continuous improvement and enhanced public participation.

In particular, the authors argue that the costs of polluting under LBL are not high enough to provide a real incentive for cleaner production. The authors propose amendments to Schedule 1 of the *Protection of the Environment Operations (General) Regulation 2009* to include a much broader range of facility types in the list of those required to pay load based licence fees for water pollutants, to expand the list of pollutants to which load based licence fees apply, and to increase the pollutant fee unit.

***Strengths and weaknesses of the LBL incentive fees***

Development of the scheme in consultation with licensees and the broader community took a number of years, but resulted in a high level of scheme support. LBL operates in the context of a broader regulatory regime, with load fees designed to complement other regulatory controls.

The LBL scheme is efficient in that it provides an ongoing financial incentive to licensees to reduce pollution. Load fees are levied on total discharges at a facility rather than individual discharge points (which historically had been regulated via technology-based discharge concentration standards), allowing licensees flexibility to reduce discharges where most cost-effective at their facilities (essentially internal emissions trading).

Further flexibility is provided to licensees in that the fees take into account any environmental benefits with variations to the location or timing of discharges and allowing the use of offsets to take advantage of off-site opportunities to cost-effectively reduce pollution.

The fee scheme is very targeted, applying to a small number of major emitters and the structure of the scheme provides a targeted incentive by doubling the per kg pollutant load fee for that part of a licensee's emissions which exceeds a threshold that represents what can be reasonably achieved with modern technology

Importantly, the scheme has established pollution monitoring, reporting and enforcement infrastructure that has overcome the information asymmetry of traditional pollution management approaches, as well as providing the 'currency' for establishing emission trading or offset schemes.

14 Graham and Wright (2012)

Finally, the LBL fees contribute a significant level of income to NSW consolidated revenue, which it could be argued funds a number of programs which address broader environmental degradation in NSW which the pollution loads of licensed facilities are a contributor, albeit in many instances a small contributor.

Questions over its efficiency revolve on whether:

- the marginal fee rates are set high enough to induce substantial reductions in emissions, given the cost of pollution abatement and the benefits of reducing health and environmental impacts;
- liability thresholds are set appropriately. This concern is whether compliance costs for industry (including monitoring) are reasonably proportionate to the size (and variation) of the emission released to the environment; and
- concentration limits in licences have been amended to ensure they are targeted at managing acute and localised impacts, and not inhibiting the role of LBL to manage cumulative loads and more chronic regional environmental problems.

## 2.3 South Australian licence fee scheme

A new licence fee system incorporating a load based component was introduced in South Australia in 2009 based on the principles of user pays and polluter pays. The fee system was implemented through the *Environment Protection Regulations 2009* under the *Environment Protection Act 1993.* The objectives of the scheme are to:

- recover EPA costs for environmental management of licensees in an efficient and equitable manner; and
- provide an economic incentive to reduce pollution consistent with the polluter pays principle[15].

### *Type of incentive mechanism*

The load based fee represents a pollution fee, as it is based on the mass of discharged pollutants, with fee liabilities differentiated with respect to perceived health and environmental damages. Accordingly, the fees provide an incentive to licensees to reduce pollutant discharges from their regulated premises. However as the scale of incentive revenue is caped based on the level of licensing administrative costs, the incentive force of the instrument is highly constrained.

### *Type of emissions*

The scheme covers a range of pollutants from point sources to air and water from licensed premises, as well as heat in wastewater from specified activities.

15 SAEPA (2010)

### *Pollutants included*

Thirteen pollutants are included in the fee scheme, reflecting the most significant environmental issues that licensed discharges were impacting in the state. Table 2.8 shows the pollutants included in the load based component of the fee system.

**Table 2.8: Pollutants included in South Australian load based fees**

| Air pollutants | Water Pollutants |
|---|---|
| Lead, sulfur dioxide, particulates*, nitrogen oxides, volatile organic compounds | Nitrogen, phosphorus, suspended solids, organic matter, temperature, zinc, lead, copper |

* means particulate matter 10 micrometres or less in diameter, and includes red dust particulates

### *Emission estimation methodology*

Pollutant loads must be assessed in accordance with an approved estimation or monitoring technique for the activity that resulted in the emission.[16]

### *Assessment period*

Annual, based on emissions over the preceding year. Licence fees can be paid in quarterly instalments.

### *Fee structure*

The overall level of fees is capped at recovering the costs of the licensing system, estimated at around $9 million per year in 2008. Licence fees are the sum of three components:[17]

- a flat minimum fee - the user pays component covering the basic licence administration work common to all licences;
- an environment management fee - the user pays component reflecting the regulatory effort required for managing a specific activity;
- two types of resource efficiency fees apply once defined emission thresholds are exceeded:
    - load based fees apply for emissions of specified pollutants from the licensed site to air or water, and are levied on total discharges at a facility rather than individual discharge points; and
    - a water reuse fee applies for discharge of fresh water to the marine environment.

The fee model was determined so that the split between these components is:

- 1% flat minimum fee;
- 60% environmental management fee;

16 SA *Environment Protection Regulations 2009*, S31 (3)

17 SA EPA (2010)

- 39% resource efficiency fee[18].

Overall, the average fee is around $4,200 (with an average of $2,900 for those not paying load fees and $12,300 for those paying load based fees).

There are a number of ways to reduce licence fees in SA including by becoming an 'accredited licensee' [19], by treating wastewater to a defined standard or reusing wastewater instead of discharging it to the environment or by directly reducing pollutant load discharges.

The values of fee units for the financial year from 1 July 2013 to 30 June 2014 are[20]:

- flat fee component = $59
- environment management fee unit = $623
- pollutant load based fee unit = $5.80

A single formula is used to calculate fees for each load of pollutant and the fee varies depending on the type of pollutant and location of emissions / discharge. Box 2.2 shows the formula for the calculation of load based fees in SA.

**Box 2.2: Formula for calculating SA load based fees**

Pollutant load fee =

**Tonnes of pollutant emitted * pollutant weighting * zone weighting * fee unit**

where:

Pollutant weightings reflect the potential harm of selected pollutants

Zone weightings reflect areas of environmental stress in South Australia to ensure fees are targeted to reflect priority pollution load reductions from licensed facilities. Zone weightings greater than 1 only apply for certain pollutant / zone combinations; the default zone weighting is 1

Fee unit is the dollar value used in the load fee calculation formula for any licence fee period

18 http://www.epa.sa.gov.au/licensees/licence_fee_system, accessed 5/2/14

19 An accredited licensee must hold an EPA licence, demonstrate full compliance for a period of three years with the Environment Protection Act 1993, have an excellent environmental record, have in place an environment management system certified to ISO14001 standard, have in place a continuous improvement program that maintains the licensee's status as beyond compliance and demonstrate a commitment to excellence in environmental performance.

20 http://www.epa.sa.gov.au/page.php?page=642#pollutant, accessed 5/2/14

A licensee with emissions above threshold levels pays a fee for each liable pollutant. The air and water pollutant emission thresholds are shown in Table 2.9. The load based component only applies for emissions above the threshold levels shown in these tables. The load based component does not apply to the following:

- suspended solids from activities 7(4) dredging and 7(6) earthworks drainage; or
- ethanol emissions as volatile organic compounds from activities 6(2) breweries and 6(11) wineries and distilleries.

**Table 2.9: South Australian emission threshold levels**

| Pollutant | Emission threshold (level / pollutant / year) |
|---|---|
| **Air pollutants** | |
| Sulphur dioxide, nitrogen oxides | 10 tonnes |
| Particulates ($PM_{10}$)[2]*, volatile organic compounds | 1 tonne |
| Lead | 0.1 tonne |
| **Water pollutants** | |
| Heat | 10 MW (megawatt) |
| Suspended solids, total nitrogen, total phosphorus, organic matter as BOD5, zinc | 1 tonne |
| Lead, copper | 0.1 tonne |

* Particles include red dust particles.

If the pollutants on the list are not discharged from the licensed site or the discharge is less than the emission threshold, then pollutant load based fees do not apply.

Zone weightings are multipliers in the pollutant load fees that reflect the relative importance of reducing certain pollutants in specified areas. This provides a greater incentive for pollutant reductions in those areas.

All pollutant load based fee are multiplied by zone weightings. The default zone weighing is 1 except for the pollutant and zone combinations shown in Table 2.10.

Table 2.11 shows the pollutant fee units per tonne of pollutant (excluding zone weighting) for pollutants discharged to air and water respectively.

**Table 2.10: South Australian environmental zone weightings**

| Zone | Pollutants | Weighting |
|---|---|---|
| **Air pollutants** | | |
| Port Pirie | lead | 15 |
| Whyalla | red dust particulates | 4 |
| Adelaide metro airshed | volatile organic compounds | 1.5 |
| Adelaide metro airshed | nitrogen oxides | 2 |
| Outside council areas (very remote regional sites) | volatile organic compounds | 0.5 |
| Mount Gambier | particulates | 2 |
| **Water pollutants** | | |
| Port River | nitrogen | 3 |
| Metro coasts | nitrogen | 3 |
| Port River | phosphorus | 2 |
| Metro coasts | suspended solids | 2 |
| Upper Spencer Gulf | zinc, lead, copper | 2 |
| Lake Bonney (South East) | organic matter | 2 |

Source: *Environment Protection Regulations 2009*, S31 (3), (4)

**Table 2.11: South Australian pollutant weightings**

| Pollutant | Weighting |
|---|---|
| **Air pollutants** | |
| Sulphur dioxide, nitrogen oxides | 1 |
| Particulates ($PM_{10}$)[2]*, volatile organic compounds | 10 |
| Lead | 100 |
| **Water pollutants** | |
| Heat (per megawatt heat added to water) | 1 |
| Suspended solids, nitrogen, phosphorus, organic matter as BOD5, zinc | 10 |
| Lead, copper | 100 |

Source: *Environment Protection Regulations 2009*, S31 (3), (4)

### *Compliance / monitoring and evaluation mechanisms*

Licensees are required to submit an annual return to the EPA 90 days after the anniversary date of the licence. The annual return provides information used to calculate the annual licence fee and confirms licensee details.

The EPA undertakes inspection of licensees' premises to assess compliance with licence conditions. During 2012–13, the EPA inspected 242 high-priority sites, with a range of resultant actions, including formal written warnings and environment protection orders. For more serious cases of non-compliance, the EPA commenced investigation with a view to civil or criminal prosecutions under the offences and penalties of the *Environment Protection Act 1993*[21].

The EPA committed to reviewing the system one year after implementation. The review began in August 2009 and consisted of an internal analysis of the system and a survey of interested stakeholders, including all licensees, asking for their feedback on the system. The findings of the review are reported in SAEPA (2010); a description of the minor changes that were subsequently made can be found at http://www.epa.sa.gov.au/xstd_files/Licensing/Report/lfs_changes.pdf.

### *Industries / activities subject to the scheme*

The load based component is spread across approximately around 300 licences (or 14% of around 2,100 EPA licences) in the following industry sectors:

**Table 2.12: SA industry sectors subject to a load fee**

| | | |
|---|---|---|
| Breweries | Hot mix asphalt | Pulp or paper works |
| Cement works | Incineration | Rendering or fat extraction |
| Ceramic works | Listed waste generators | Sewage treatment |
| Chemical storage | Metallurgical works | Surface coating |
| Chemical works | Milk processing | Vehicle production |
| Crushing, grinding or milling | Oil refineries | Wood preservation |
| Extractive industries | Petroleum production | Wood processing |
| Ferrous and non-ferrous metal melting | Petroleum storage | Wool scouring or carbonising |
| Fuel burning | Produce processing | |

21 SAEPA (2013)

### *Application of revenues*

All fee revenue is paid into the state's consolidated revenue. There is no revenue hypothecation, earmarking of recycling.

### *Distinctive features*

The level of total fees has been capped at recovering the cost of administering the licensing scheme, with the incentive fees representing only 39% of the total fees. In addition, the incentive fees are split between the pollutant load fees and a water conservation fee (ie: the water reuse fee for discharge of fresh water to the marine environment). With total fee revenue at around only $11m annually,[22] the level of incentives to reduce pollution discharges is very modest.

### *Effectiveness*

The scheme has only been in place for a short period and there is no quantitative data or assessment available to determine the impact of the incentives.

### *Efficiency*

The fee system provides an ongoing economic incentive to reduce pollution. The fee incentives have been differentiated to reflect the harmfulness of pollutants, state of receiving environments and priorities for emission reductions from licensed premises.

However the level of fees has been capped at recovering the cost of administering the licensing scheme. There has been no attempt to establish or even move towards 'Pigovian' taxes where fee levels are aligned with estimated externality impact levels.

No assessments of the effectiveness or efficiency of the fee system have been undertaken by government or third parties, which is perhaps not surprising given it has only been in operation for some four years.

### *Comparison of the SA scheme with LBL*

The scheme has many similarities with the NSW LBL scheme. It applies to a similar licensed community, addresses priority pollutants (albeit a smaller suite of both air and water pollutants), requires emission loads to be assessed in accordance with an approved estimation or monitoring technique and with load annual reporting and liabilities.

As noted above, the fees are differentiated similar to the LBL fees to account for locational factors affecting the harmfulness of discharges as well as being reflective of priorities for emission reductions from licensed premises. However the fee system does not have other features provided in the LBL

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22 Environmental authorisation fee revenue. Notably, the largest revenue item is waste levies at around $39m. Source: SAEPA (2013)

scheme which enhance fee targeting and maximise licensee flexibility, such as allowances for the means and timing of discharges, fee rate thresholds, load reduction agreements and offsets.

Both fee schemes employ production thresholds by industry sector to determine whether a premise is liable for load fees. However the SA scheme also has thresholds on actual emissions, with fee liabilities only incurred for discharges above these. The SA approach therefore ensures all premises liable for load fees - and the administrative costs associated with load estimation and reporting - are responsible for a significant level of discharge. Under the NSW LBL scheme, premises with very low or even zero pollutant loads, but within industry production thresholds, would still face the administrative and cost burden in estimating and reporting loads, notwithstanding the role of emission factors to minimise these costs.

The key difference between the schemes is the level of fees. Total load fees under the SA scheme are capped at recovering the cost of administering the licensing scheme, and therefore fee rates are much more modest compared to the LBL fees. For example, the highest fee paid in SA for NOx emissions is $11.60 / tonne compared to $2,148 / tonne in NSW. Similarly, the highest fee for VOC is $87 / tonne compared to $1,575 / tonne and PM is $116 / tonne compared to $153 / tonne.

Finally, whereas the LBL scheme has a single administrative fee, the SA scheme has a small fixed administrative fee and a more significant environment management fee. This is likely to provide a better means to identify regulatory effort required for managing a specific activity and therefore a more robust basis to implement a user pays approach to licensing. However the proposed changes to the calculation of the NSW LBL administrative fees will substantially address this, and this component of the license fees is in any case outside the scope of this review.

## 2.4 Western Australian licence fee scheme

The Western Australian licence fee scheme has incorporated a discharge component, based on the amount and type of pollutants and the receiving environment since 1987.

The Western Australian licence fee system is contained in the *Environmental Protection Regulations 1987* made under the *Environmental Protection Act 1986*.[23] The objective of the scheme is to recover the costs of administering the licensing system and the overall level of fees is capped at recovering these costs. The scheme is administered by the Department of Environment Regulation.[24]

### *Type of incentive mechanism*

The load based fee represents a pollution fee, as it is based on the mass of discharged pollutants, with fee liabilities differentiated with respect to perceived health and environmental damages. Accordingly, the fees provide an incentive to licences to reduce pollutant discharges from their regulated premises.

23 Available at http://www.slp.wa.gov.au/Index.html

24 The material in this section, unless otherwise stated, is largely drawn from Western Australian Department of Environment Regulation (2014)

However as the scale of incentive revenue is capped based on the level of licensing administrative costs, the incentive force of the instrument is highly constrained.

### *Type of emissions*

The scheme covers a range of pollutants from point sources to air, water and land from licensed premises.

### *Pollutants included*

There are many pollutants covered by the discharge component of the fees (Table 2.13).

**Table 2.13: Pollutants included in Western Australian licence fee scheme**

| Air pollutants | Water Pollutants |
|---|---|
| Carbon monoxide, oxides of nitrogen, sulphur oxides, particulates*, volatile organic compounds, inorganic fluorides, pesticides, aluminium, arsenic, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, vanadium, zinc, vinyl chloride, hydrogen sulfide, benzene, carbon oxysulfide, carbon disulphide, acrylates, beryllium, cadmium, mercury, TDI[25] and MDI[26] | Organic matter, nitrogen, phosphorus, suspended solids, surfactants, colour alteration, temperature alteration, aluminium, arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, vanadium, zinc, pesticides, fish tainting wastes, manganese, e coli bacteria, oil and grease, dissolved solids, fluoride, iron, chlorine |

* Not defined in the Environmental Protection Regulations 1987 or the Department of Environment Regulation 2013, Guide to Licensing; Environmental Protection Act 1986

### *Emission estimation methodology*

Calculation of discharge fees are based on any of the following options:

(i) The rate at which waste is permitted to be discharged from the premises during the licence period, averaged over the licence period. This means fees are based on the licence emission limits and the maximum premises operating period and rate defined in the licence.

(ii) Measurements of waste discharged from the premises in the year immediately preceding the licence period. The fees calculated in this manner must allow for increased emissions due to foreseeable changes to the premises operation in the coming year, eg: additional operating hours or a new plant; or

(iii) Accurate calculations of the quantity of waste to be discharged from the premises during the licence period where the applicant or licensee has put in appropriate procedures for the accurate measurement of the waste quantity to be discharged from the premises.

[25] Toluene-2,4-diisocyanate

[26] Methylene diphenyl diisocyanate

Most licence annual licence fees are calculated based on actual measurements.

Applications for discharge fee refunds may be submitted within three months after the end of the term of the licence. Refunds of discharge fees may be given if the CEO is satisfied that the quantity of waste discharged from the premises during the term of the licence ('the actual discharge') is less than the quantities predicted under (ii) above; but refunds are not applicable for discharge fees calculated under (i) – the permitted amount based on the maximum licence limits.

***Assessment period***

Licence fees are paid for each 'licence fee period' of the licence. A licence fee period is the 12 month period from the date of licence issue until the anniversary of that date. Each subsequent 12 month period after that is also a licence fee period. Licence fees are charged on a pro-rata per day basis

***Fee structure***

Licence fees are based on two components specified in Schedule 4 of the *Environmental Protection Regulations 1987* – a premises fee based on the design throughput or capacity of the activity; and a discharge component based on the amount of assessable pollutants, types of pollutants and the receiving environment.

Fee units for the premises and discharges components in 2014 are $29.20 and $41.00 respectively. The total fee payable is the sum of the fees for both components = (premises component fee units x $29.20) + (discharge component fee units x $41.00).

The premises fee is based on the production or design capacity of the prescribed activity. The Regulations lists the categories of prescribed premises and allocates fee units to different levels of production or design capacity for each category.

The Regulations allocate discharge fee units to specified amounts of different kinds of waste that may be discharged into the environment. There are two discharge components:

- waste components (consisting of tailings, bitterns, water to allow for mining of ore, flyash, or waste water from a desalination plant); and
- discharge components (air, land and water discharges).

The discharge component fee is similar to the LBL load fees, in that the fee depends on the amount and types of prescribed waste that are emitted into the environment, as well as the location of the receiving environment.

Box 2.3 shows the formula for the calculation of the discharge component of licence fees.

**Box 2.3: Formula for calculating WA discharge component**

Discharge component =

Air pollutant discharge fee unit (pollutant weighting) * value of discharge fee unit * average grams per minute (either measured or allowed under licence conditions)
+
Water pollutant discharge fee unit (pollutant weighting) * value of discharge fee unit * average kilograms per day (either measured or allowed under licence conditions)

For discharges into air, fee units are applied to each gram of waste released per minute. For discharges to water and land, fee units are applied to every kilogram of waste type discharged per day. Exceptions to this are colour and temperature alteration and for E. coli bacteria where fee units are applied to each megalitre of effluent discharged per day.

The fee units for some pollutants vary by location, for example with higher values for some air pollutants discharged in the metropolitan region or Swan Coastal Plain and higher values for some water pollutants discharged in the Swan Coastal Plain (or in the sea south of the Tropic of Capricorn in the case of temperature).

From 2003, the fee unit has been progressively increased in a move towards full cost recovery of the administrative costs of the licensing system. The fee unit has increased from $15 in 2003 to $41 in 2014. As shown in Table 2.3, total fees collected in 2009/10 were around $15m, of which some $10m were from discharge fees. Total fee revenue in 2012/13 has risen to $18.4m.[27]

### *Compliance / monitoring and evaluation mechanisms*

The annual fee is required to be paid by the anniversary date of the grant of the licence. Annual fee submissions are made online. Copies of all licences are available on the Department of Environment Regulation's website, as are monitoring data and periodic reports.

In 2012–13, 480 inspections were carried out across licensed premises as part of the scheme's compliance management program.[28]

### *Industries / activities subject to the scheme*

A licence must be obtained before operating a premise in Part 1 of Schedule 1 of the Regulations. Part 1 premises are engaged in activities which produce emissions and discharges that have significant risk to the environment. There are some 89 categories of these prescribed premises including for example, cattle feedlots, mining, oil and gas production, chemical manufacturing, pulp and paper manufacturing,

27 Western Australian Department of Environment and Conservation (2013)

28 ibid

glass manufacturing, metal smelting, power generation, sewage treatment, etc. Production or design capacity thresholds apply to most categories.

### *Application of revenues*

All fee revenue is paid into the state's consolidated revenue. There is no revenue hypothecation, earmarking or recycling.

### *Distinctive features*

The Western Australian system has maximum fees, effectively capping the fees that are payable for air/land discharges and water discharges separately. The maximum annual fee for air/land discharges is currently $815,000 and for water discharges $850,000.

### *Effectiveness*

No quantitative information is available in relation to aggregate pollution loads over time from premises paying the discharge fee, let alone any analyses seeking to attribute any observed reductions.

### *Efficiency*

The WA fee system's primary objective is an equitable recovery of licensing costs. A limited direct economic incentive to reduce pollution exists for a licensee whose overall fee level is below the fee caps. There is no economic incentive for marginal abatement for those licensees operating above the fee caps. Further, the incentive for licensees where monitoring is not undertaken is not direct, as a renegotiation of the maximum allowable discharge would be required to reduce fee levels paid.

### *Comparison of the WA scheme with LBL*

This scheme also has similarities with the NSW LBL scheme, with a broadly similar licensed community, addressing of priority pollutants, requiring emission loads to be assessed in accordance with an approved estimation or monitoring technique and with load annual reporting and liabilities.

The discharge component fee is similar to the LBL load fees, in that the fee depends on the amount and types of prescribed waste that are emitted into the environment, as well as the location of the receiving environment. However the fee system does not have other features provided in the LBL scheme which enhance fee targeting and maximise licensee flexibility, such as allowances for the means and timing of discharges, fee rate thresholds, load reduction agreements and offsets.

And similar to the SA scheme, fee levels are set to only recover the costs of administering the licensing system rather than moving at least towards 'Pigovian' fee levels aligned with estimated externality impact levels.

Similar to the NSW scheme, no emission thresholds are employed. However unlike NSW, fees payable for individual premises are capped, and at relatively modest levels. This further weakens the incentive force of the load fees.

Another distinguishing feature of the WA system is the ability to receive fee refunds, where fees based on actual measured emissions are found to be less than estimated fees where the latter were initially used to determine fee liabilities.

# 3 SUMMARY OF INTERNATIONAL SCHEMES

Pollution charging schemes have been more common in Europe than North America, with some European charging schemes operating since the 1970s.

As noted in Section 1, some European countries have implemented pollution fees as part of "green tax reforms. Most often though, such fees are used as complements to existing command-and-control regulation by emission standards. In order to overcome political resistance to environmental fees, some countries have adopted a system of 'revenue-recycling' or 'earmarking' under which the revenues of the fees are returned to the aggregate population of liable firms.

There are many different approaches used overseas to set pollution charges. Some countries base fees on actual emissions, some on the number of discharge points at the premises, and some only on emissions above load limits - such that fees are directed primarily to encourage compliance (more like a penalty) than to encourage 'beyond compliance' emission reductions such as in the case of the LBL scheme.

To enable a comparison of international schemes with the NSW LBL scheme, a desktop literature review was conducted. This included a search of the Scopus database. Scopus is a bibliographic database containing abstracts and citations for academic journal articles. It covers nearly 21,000 titles from over 5,000 publishers, of which 20,000 are peer-reviewed journals. While this search identified almost 200 papers, few were of direct relevance for the project.

Of more immediate use was an OECD database of market-based instruments. This database,[29] contains information about a large number of environmental policy instruments in both OECD countries and about 20 selected non-OECD countries. As shown in Figure 1.1, the OECD experience with environmental taxes has been dominated with taxes on energy and transport, with taxes on pollution and recourses representing less than 5% of environmental tax revenues collected.

The database administrators advise that the information in the database is generally provided by contacts in relevant ministries in the respective countries, and that the information provided is validated by the OECD before it is published on the Internet.[30] Nevertheless, the scope, quality and timeliness of information reported is highly variable, and relatively limited.

Given the above limitations, targeted internet searches were then undertaken to supplement the information on the OECD database. This task was time-consuming, and although it allowed a significant number of useful reports and articles to be identified, significant information gaps remain. Notably, more information was available for schemes in northern Europe, in part due to the availability of English language government websites. Key reports and legislation only available in foreign languages have been selectively accessed given the resource intensive nature of translating these, and difficulties in accessing them in the first instance.

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[29] OECD (2014)

[30] OECD (2013)

In total, the literature review identified 17 OECD countries with water effluent charging schemes and 16 OECD countries with air emission charging schemes. A list of the countries with schemes is provided in Table 3.1, while summaries of the schemes are provided in Appendixes A and B respectively.

**Table 3.1: Countries with pollution charging schemes included in review**

| Water emission schemes | | Air emission schemes | |
|---|---|---|---|
| Belgium | Korea | Canada | Norway |
| Canada | Mexico | Czech Republic | Poland |
| Czech Republic | The Netherlands | Estonia | Slovak Republic |
| Denmark | Poland | France | Spain |
| Estonia | Slovak Republic | Hungary | Sweden |
| France | Slovenia | Italy | Switzerland |
| Germany | Spain | Japan | United States |
| Hungary | United States | Korea | |

In most instances, the charging schemes were levied at a national level. However in some countries, such as Spain, Canada and the US, schemes are levied at a state or provincial level. In these circumstances, only a sub-set of regional schemes have been included in the summaries provided in Appendices A and B.

## 3.1 Water pollution charging systems

Water pollution charging systems in OECD member states are designed to fulfil different functions. The schemes can be broadly categorised to fall under two categories. Schemes that are designed to act:

- mainly as an incentive for pollution abatement (Czech Republic, Denmark, Estonia, Germany, Poland, Slovak Republic, and Slovenia); or
- mainly as a financial instrument to fund pollution control, water quality measures, and infrastructure investments (Belgium, France, Hungary, the Netherlands, and Spain).

However, as revenues are generally used to fund wastewater infrastructure or other water quality improvement measures, the fiscal and incentive functions tend to overlap.

Boyd 2003 comments that as early as the 1960s, France imposed water charges on certain industrial polluters and the Federal Republic of Germany passed an effluent charge into law in 1976, and that early economic proponents of fee-based systems looked to the French and German experiments as strong evidence that such fees were practical institutionally. Boyd goes on to argue however, that subsequent analysis has led to a re-evaluation of these systems.

Key features in relation to the identified water pollution charging schemes are provided in Table 3.2, with observations subsequently provided.

### *Pollutants*

In general, only a small number of pollutants are liable for water effluent charges. The most common pollutants are measures of the amount of organic compounds in water (such as BOD, COD), phosphorus, nitrogen and suspended solids. AOX and metals are also frequently subject to effluent charges. Some countries such as Poland, Germany, the United States (Maine) and Korea charge for various other pollutants in effluent, including temperature, changes in pH, phenols and other contaminants. Other notable pollutants levied include fish toxicity in Germany and aquaculture discharges in Poland. A few countries include a catch-all pollutant, such as the inclusion of “contaminant not otherwise specified” in the British Columbian scheme. Aragòn (Spain) charges a pollutant fee categorized as “inhibiting matters.”

Effluent charges are most commonly calculated on the basis of measured quantities of specific pollutants in the effluent. Quantities are charged on the basis of weight (as in British Columbia, Denmark, Estonia or Hungary) or, less frequently, on specific pollutant units that correspond to the toxicity of effluent loads (as in Germany, the Netherlands or Slovenia). Schemes in the Czech Republic, Belgium, California and Maine also charge polluters according to the volume of wastewater produced. The Flanders region in Belgium used to levy nitrogen and phosphorous content as part of a manure fee, but this fee was discontinued in 2007.

### *Discharges to non-surface waters*

Most water effluent charge schemes cover only point source discharges to surface water but a few countries also regulate discharges to non-surface waters. France includes discharges into sewage systems, Denmark includes discharges to the sea and irrigated fields, and Poland also levies discharges to soil.

**Table 3.2: Water pollution charge scheme in OECD countries**

| Country | Start date | Liable activities | Incentive basis | Thresholds / exemptions | Rebates | Revenue $US |
|---|---|---|---|---|---|---|
| **Belgium** (Flanders, Wallonia) | 1990 (Wallonia), 1991 (Flanders) | | Flat charges based on pollution units. determined according to flow, COD, SS and thermic pollution. | Exemptions for sewage treatment plants & industrial plants with <7 employees. In Wallonia agricultural polluters that emit <45 pollution units/ha are taxed at domestic levels. | | Revenues fund general policies & investments in waste water infrastructure. |
| **Canada** (British Columbia) | 1992 | Industrial effluent | Base fee + flat discharge fees that vary by pollutant. | Exemptions for government permit holders. Certain industries are exempt if they operate according to an approved industry code of practice. | | $9.4m in 1998 for both water & air emission fees. 100% earmarking for environmental programs. |
| **Canada** (Quebec) | | Wastewater treatment plants | Flat discharge fee of CAD $2 per pollutant * weighting factor ranging from 1-1000. | | | $64.8m in 1998. 100% earmarking for environmental funds. |
| **Czech Republic** | 1979 | | Discharge volume fee * flat pollutant charges that vary by pollutant. | Fees payable if pollutant concentration & volume thresholds are exceeded. Volume threshold is 30,000 m$^3$ per year. Exemptions for reconstruction drilling, steam turbine cooling systems, water used in thermal energy generation & polluted groundwater abstractions that have been partially treated Reduced rates for pulp and textile manufacturers | Reductions up to 80% for LRAs. Polluters may also offset pollution reductions from total pollution in discharged water.. | $12.7m in 2011. 100% earmarking to State Environment Fund. |
| **Denmark** | 1996 | Wastewater treatment plants & | Flat discharge fees that vary by pollutant. | Exemptions for storm water, rainwater and process water from fish farms. | Fee reductions between 70-80% for certain | $32.5m in 2011. Revenues used to finance municipal |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | industrial effluent. Point & diffuse effluent. | | | industries, including aquaculture, sugar & cellulose. | waste water treatment plants. |
| **Estonia** | 1991 | Wastewater treatment plants | Flat discharge fees that vary by pollutant.<br>Higher rates for sensitive receiving water; lower rates where permit conditions met.<br>Rates to increase between 5-30% annually to 2015. | | Fee reduction of up to 25% for LRAs. Other reductions available if permit conditions met. | $8.4m in 2010. Revenues earmarked for environmental programs. |
| **France** | 1964 | Non-municipal effluent where >200 population equivalents of effluent per annum. Includes direct and indirect discharges . | Varies by regional water agency. Charge rates are calculated to fulfil revenue needs of agencies.<br>Fee per pollutant varies according to user, regional variations, emission permits, industrial standards employed. | Fees apply if effluent volume exceeds 6,000 $m^3$ per year.<br>Sewage treatment plants are exempt. | Some agencies reduce charges to large industrial indirect emitters.<br>Subsidies provided in the form of grants & loans up to 80% of total costs. | Revenues earmarked to promote water management activities and investments.<br>Majority of revenues recycled to polluters via grants and subsidised loans based on pollution abatement investment expenditures, not pollution performance.<br>€2.124m in 2009 |
| **Germany** | 1981 | Industrial effluent | Differential charges based on pollution units. Charges vary according to pollutant, plant size and facility type. | Exemptions for rainwater discharges from industrial plants not exceeding the size of 3ha, water used for mining and discharged into artificial waters, certain rainwater discharges, and water that has not been changed in character by use | | $390m in 2010. All revenue earmarked to finance programs to improve water quality, infrastructure, & administrative costs. |
| **Hungary** | 2004 | Industrial | Differential charges across range | Exemptions for pollutants in wastewater | Fee reduction of | $36.5m in 2008. Not |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | effluent | of pollutants.<br>Fees based on emission volume * specific pollutant rate * area sensitivity * sludge disposal factors. | existed originally and rainwater diversions. | up to 50% for LRAs. | earmarked. In 2010 ~40% was reimbursed as allowances & investments, less than 50% for infrastructure and pollution schemes. |
| **Korea** | 1983 | Industrial effluent | A flat levy system applies to organic substances and SS.<br>An excess levy charge applies to other pollutants if emissions exceed 30% of maximum allowed effluent limits.<br>Excess levy charges: differential charge per pollutant * quantity of pollutant exceeding the standard * coefficient of the frequency of violation | Small companies are exempt. | | $4.2m in 2012. 90% to central and 10% to local government. Central government revenue earmarked for environmental investments. |
| **Mexico** | 1995 | Industrial effluent | Fees differentiated according to assimilative capacity, pollutant and concentration.<br>Polluters with discharge < 3000m$^3$/month have option of paying a fixed flat charge. | | Rates reduced if adopt pollution abatement measures. Rebates if water quality exceeds standards. | $20.6m in 2011. 100% is earmarked to finance water treatment programmes. |
| **Netherlands** | 1970 | Industrial effluent. Direct and indirect discharges. | Fees for discharges into regional waters vary by water board.<br>Fees for discharges into state waters based on pollution units that vary across several pollutants. Fees are differentiated according to annual emission volumes. | Municipal treatment plants are exempt for discharges into regional waters. | Municipal treatment plants pay a reduced rate for discharges into federal waters. | All revenues earmarked for water quality management, sewage systems, & administration costs.<br>. |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Poland** | 1990 | Industrial effluent | Flat discharge fees that vary by pollutant. Fees are also differentiated by geographical region and industry type. | Exemptions if total annual amount of all charges for air, water or waste is equal to or less than 800 Polish Zloty (~A$290). | | 100 % earmarked for environment protection & water resource management. |
| **Slovak republic** | 1996 | Industrial effluent | Flat discharge fees that vary by pollutant.<br>Fees are raised in certain geographical locations. | Polluters that discharge <10,000 $m^3$ per year or <1000 $m^3$ per month or meet pollution concentration and mass load limits are exempt. | Construction of water treatment plants or other investments can attract up to 50% reductions. | All revenue earmarked for investments in water treatment & related measures. Revenues amounted to $4.3m in 2000. |
| **Slovenia** | 1996 | Industrial effluent & public waste water companies | Differential charges based on pollution units. | Exemptions for quarry operations, liquid waste produced as a result of titanium dioxide production, farming with organic fertilisers in accordance with agricultural regulations. | Investments in wastewater treatment facilities can attract reductions. | $38.3m in 2012. All revenues earmarked for environmental programs. |
| **Spain** (Aragón) | 2002 | Industrial effluent | Flat discharge fees that vary by pollutant. | Exemptions for agricultural effluent into surface waters, and discharges from certain cattle operations. | | $47m in 2011. All revenue earmarked for reparation and purification works. |
| **US** (California) | | Certain manufacturing dischargers | Base fee + flat fee based on permitted effluent volume emitted.<br>Permit surcharges between USD$5,000-15,000 apply to industrial dischargers depending on the threat or complexity rating of the facility. | Industries only charged if identified by federal category of “Division D-Manufacturing” (33 USC Sec. 1362).<br>Many additional state exemptions, including for treated effluent that meets water quality standards, facilities associated with wastewater treatment plants, and certain discharges for land. | | |
| **US** (Maine) | | Industrial effluent | Base fee + flat licence fee and flat discharge fees that vary by pollutant. | Surcharges for water quality improvements | | Revenues earmarked for a Water Quality Improvement Fund. |

### *Exemptions*

Korea and the Slovak Republic both levy charges only where firms exceed maximum allowable effluent limits. In Korea, discharge fees are only payable if emissions exceed 30% of the maximum allowable limits. In the Slovak Republic and Czech Republic polluters must simultaneously exceed pollutant concentration limits and mass load limits in order to be subject to their charge system.

Many countries offer exemptions for small businesses or polluters that discharge modest effluent volumes. Korea and Wallonia (Belgium) exempt small companies, while the Czech Republic and the Slovak Republic exempt polluters where volume thresholds are not met (30,000 $m^3$ per year; and 10,000 $m^3$ per year or 1,000 $m^3$ per month, respectively). Poland exempts polluters when combined air and water charges amount to less than 800 PLZ (~A$300) in any given year. France's scheme combines both volume and pollutant load thresholds. In France facilities that discharge into the public sewage system are liable only if discharges are in excess of 6,000 $m^3$ per year. For direct dischargers, there is an effluent concentration threshold of at least 200 population equivalents of effluent a year before charges are payable.

However, other countries such as Denmark, Estonia, Germany and Slovenia do not exempt polluters according to firm size or effluent volumes.

It is also common across schemes to exempt certain industries and facilities. This is seen in the exemptions for the aquaculture and textile industries in Denmark, thermal energy generation in the Czech Republic, and various agricultural exemptions in Denmark, France, Slovenia and Spain (Aragòn). In British Columbia firms can be entirely exempt from the permit discharge system if they operate according to an approved industry code of practice.

### *Fee structures*

Most schemes differentiate fee rates according to industry type, plant size, effluent volumes or the receiving area's sensitivity. In fact, it is rare for countries to charge flat fees irrespective of these differentiating features. Of the schemes analysed, only British Columbia, Denmark and Slovenia imposed flat fees across all liable premises.

Estonia, Hungary, Mexico and the Slovak Republic increase charges according to the region or environmental sensitivity of the receiving body of waters. The Dutch and Mexican systems preferentially charge firms that release smaller volumes of effluent. The Mexican scheme allows smaller polluters to choose a flat rate while larger polluters must pay charges according to a load based rate. Germany and Maine (United States) differentiate by plant type and size, and Germany offers reductions in pollutant charges of up to 75% where polluters adhere to strict technology standards.

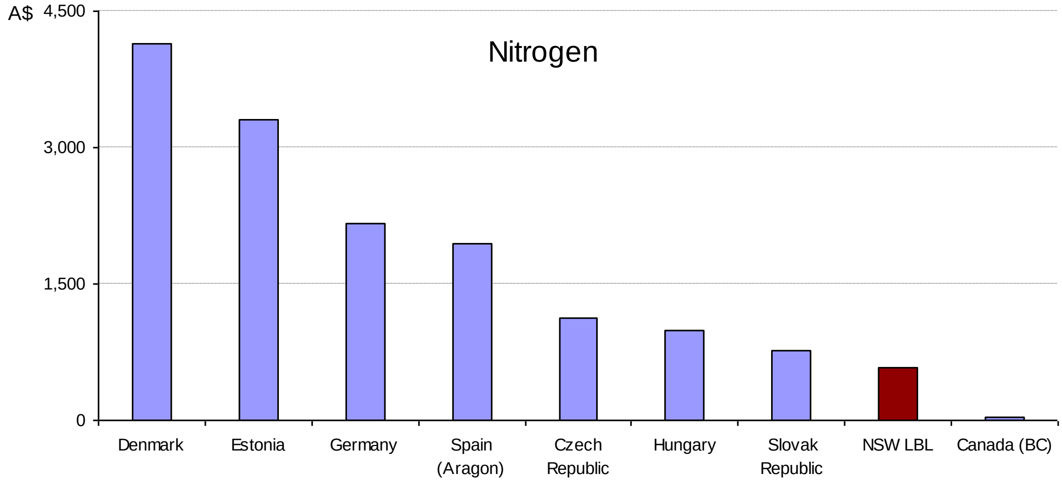
Charge rates in many countries are revised and adjusted regularly to guard against slippage in charge rates as against inflation. For example, all state permit schemes in the United States have adjusted their fee rates annually since 1990 to keep pace with consumer price index movements. However, the regulations governing the Estonian scheme have set significant annual fee increases through to 2015 in order to give their charges a greater incentive effect. Initial charges in the 1990s were set at very low rates but decades of stable economic growth have emboldened Estonian policy makers to increase rates for all its levied pollutants 5-30% annually (with the exception of phosphoric compounds which were increased 50% by 2012 and then are to increased a further 30%) by 2015.

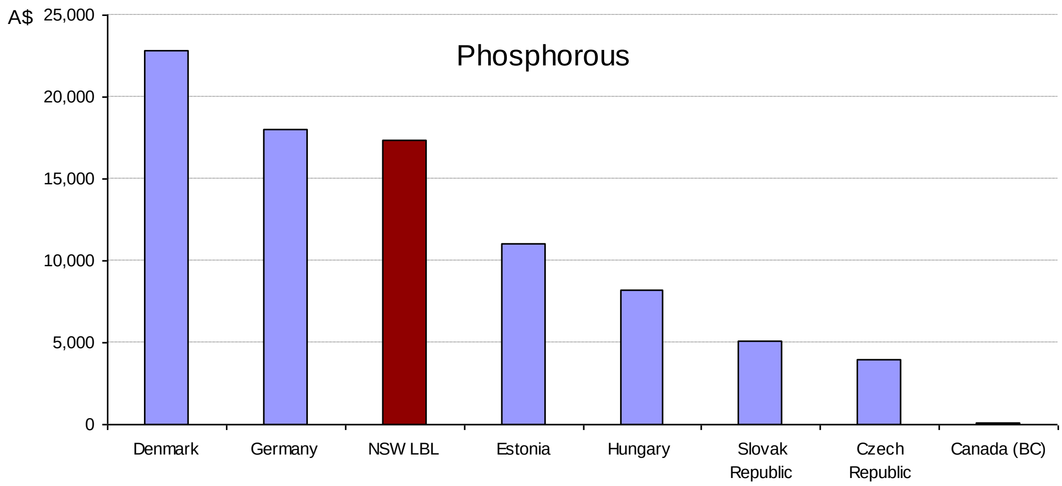
In addition, non-compliance fees have to be paid for discharges in several countries, for example Bulgaria, Estonia, Poland and Slovakia, when the pollution concentration exceeds permitted levels[31].

***Fee rates***

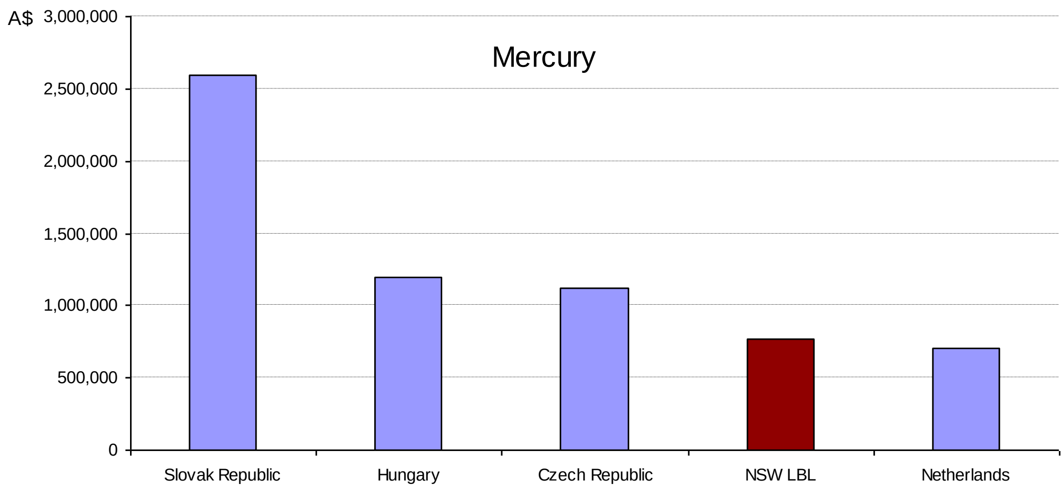
Figure 3.1 compares in A$ the fee rates per tonne of nitrogen, phosphorous and mercury emitted for countries that charge levies on these pollutants. The rates shown are the highest payable taking into account the receiving environment, but excludes any differentiation countries may subsequently apply to account for industry type or firm size. The fee payable under the NSW LBL scheme is highlighted in red.

**Figure 3.1 Selected water pollutant fees by country** (A$ / tonne)




31 European Environmental Agency (2005)




Rates for nitrogen and phosphorus are highest in Denmark, where a tonne emitted of each will attract a charge of A$4,144 and A$22,794, respectively. Rates are also high in Germany and Estonia. The Czech Republic, Hungary, Slovak Republic and Spain appear to represent a middle ground for rates. These countries charge between A$770-$1,131 for one tonne of nitrogen and A$3,958-$8,195 for one tonne of phosphorous. For both, the noticeable outlier is the Canadian province of British Columbia, which only charges A$41.81 per tonne of nitrogen emitted and A$104.47 for phosphorous.

Comparisons of fees for lead, mercury and heavy metals reveal that European countries again charge significantly higher rates for metal emissions compared to Canada.

### *Rate reductions*

Reductions in pollutant charges are often tied to improvements that reduce effluent loads. Reduced charges are levied when plants agree to adopt best available technologies, implement new procedures or engage in pollution reduction programs generally; or where firms bring their emissions below relevant effluent limits. Germany offers reductions in pollutant charges of up to 75% where polluters adhere to strict technology standards. Estonia, Slovak Republic, Slovenia, Hungary and Mexico offer rebates where polluters implement a pollution reduction program. For example, the Slovak Republic offers rebates of up to 50% for this purpose. Frequently, such as in the case of Estonia, abatement measures will need to be implemented within 3 years in order for any preferential fees to be realised.

The Czech Republic and Estonia also offer reductions when polluters exceed lower effluent thresholds. In France, some water agencies offer grants and loans for investments that can reach up to 80% of total charges levied. Given the availability of rate reductions, rebates, or grants available, the Dutch scheme is rare in that it allows no reductions or offsets against expenditures.

### *Indirect discharges*

Most countries collect charges only for direct discharges. Notably, operators of sewage treatment plants are left to pass on the costs of pollutant loads to indirect emitters through levies. And typically, charges to source polluters who discharge effluent to public sewers are charged according to discharge volume, not pollutant load (as is the case in Hungary). This means there are no incentives for source firms to reduce their effluent loads into public sewers, and the costs of water treatment and pollution are borne by all customers.

A few countries, such as the Netherlands and France, also levy charges on indirect emitters and then exempt the operators of sewage treatment plants from paying the effluent charges (France) or apply generous reductions to them (the Netherlands).

***Application of revenues***

The vast majority of schemes earmark revenues to finance improvements to water supply and treatment infrastructure. Countries often allocate revenues to a general state environmental fund.

Denmark, Wallonia (Belgium), France, Germany, Mexico, the Netherlands, the Slovak Republic, Slovenia, Aragòn (Spain) and Maine (United States) set aside all or most revenues to fund improvements to water treatment plants, municipal water supply infrastructure or other programs to improve water quality.

In British Columbia, Quebec, the Czech Republic, Estonia and Korea revenues accrue to a state environmental fund to be used for general environmental protection and improvement programs. In Flanders (Belgium) revenues are used for both municipal water supply improvements and general environmental purposes. Of the schemes reviewed, only Hungary's scheme directed fees to the country's consolidated budget that was not earmarked for any specific purpose.

***Revenues***

Revenues can be less than regulators anticipate. For example, in Hungary fee payers significantly exploited a rebate system intended to finance pollution abatement investments and the purchase of metering devices. [32] The Czech Republic has a policy of fiscal neutrality and practices revenue recycling such that any additional revenues from the effluent fees are accompanied by commensurate decreases in other taxes or increased state budget expenditures.

One noteworthy comment on the French system is that the centralised Ministries of Finance and Environment and the regional water authorities had misaligned interests in regards to revenue raising that negatively impacted the scheme's effectiveness. According to ECORYS (2011) analysis, the central Ministries had a mandate of austerity and were loath to impose extra taxes which would necessitate greater spending. On the other hand, the regional water authorities sought to increase effluent fees as revenues would have been accrued within the regions for the purpose of financing improvements to municipal wastewater systems. As it was, effluent fees were kept low and a general perception of the scheme having had a limited effect on pollution abatement.

32 EPI Water (2011)

#### *Compliance and monitoring*

Many countries allow for self-monitoring of discharges and self-assessment of charges. The schemes in the Czech Republic, France, Germany, Hungary, the Netherlands and Poland place the onus on polluters to monitoring discharge volumes and pollutant concentrations. In Hungary and Poland the polluters are also expected to calculate the charges due.

Kathuria (2006) writes that self-monitoring and self-assessment is one of the weakest implementation factors in the Polish system of discharge permits. Provincial inspectorates lack staff resources and face a huge burden monitoring and verifying self-reported discharges. Some firms violate the scheme by not acquiring permits in the first place, as they know regulators are under-staffed and under-financed.

#### *Effectiveness / Efficiency*

A common criticism of many schemes is that charges have been set too low to act as an incentive for effluent abatement. The French system is generally assessed to have had limited effect on pollution abatement due to low charge levels, however, it is difficult to isolate the impact of the French effluent charges due to concurrent instruments that work against pollution reduction. For example, agricultural producers in France can use sector subsidies to compensate for water charge levies, thus reducing their incentive to adopt or invest in water pollution abatement strategies. [33]

## 3.2 Air pollution charging systems

Air emission charges for industry were first implemented by the Czech and Slovak Republics in 1967. France introduced its first charging scheme in 1985 and Sweden in 1992. Charges for emission of air pollutants have also been implemented in various other countries since then.

Most schemes were designed to cover licensing costs, such as in the United States, or to raise revenue for pollution prevention programs, such as in the Slovak Republic. Some schemes, however, were designed to provide an incentive to reduce air pollution, such as those in France, the Czech Republic, Italy, Korea and Sweden. Indeed, the Norwegian NOx fee was motivated by the need to quickly reduce Norway's emissions in order to meet the country's obligations under the 1999 Gothenburg Protocol. Yet the level of incentives varied significantly and whether many countries' emissions reductions have been due to emissions fees independent of command-and-control measures is debatable, if not intractable.

Key points in relation to the identified air pollution charging schemes are provided in Table 3.3, with observations subsequently provided.

33 ECORYS (2011)

**Table 3.3: Air emission charges in OECD countries**

| Country | Start date | Liable activities | Incentive basis | Thresholds / exemptions | Rebates | Revenue ($US) |
|---|---|---|---|---|---|---|
| **Canada** (BC) | 1992 | Industrial premises | Base fee + flat discharge fees | Exemptions when permit holders are the British Columbian or Canadian governments. | | $9.4m in 1998 for combined water and air discharge schemes. 100% earmarking for environmental protection programs. |
| **Canada** (Quebec) | | | Flat discharge fees, multiplied by a weight between 1 and 1000 ac. | | | 100% earmarking for environmental protection programs |
| **Czech Republic** | 1967 major overhaul 2012 | Stationary sources | Flat discharge fees | Fees are not collected if annual fees <50,000 CZK (~A$2800). Combustion sources <50kW are exempt. | | $25.6 m in 2011. 100% to the State Environmental Fund. |
| **Estonia** | 1991 | Stationary industrial sources | Discharge fees differentiated by above / below permitted levels. Polluter location fee weights. Charge rates to increase substantially 5-30% annually between 2010-2015 | | Up to 25% if pollution reduction measures implemented | $12.7m in 2012. Majority used for environmental programs. |
| **France** | 1985 major overhaul 2000 | Stationary sources | Flat discharge fees | Exemptions where annual emissions <150 tonnes; combustion sources <20MW. Fees not due where < €450. | Abatement subsidies & grants for air quality monitoring. | $284m in 2008. Revenue recycling program, earmarking for abatement subsidies and grants. Prior to 2000 75% of revenue used for abatement subsidies and grants and 25% on air monitoring activities. |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Hungary** | 2004 | | Flat discharge fees | Exemptions available if country in electricity crisis | Up to 50% rebate with pollution reduction programs. | $31.6m in 2010. |
| **Italy** | 1997 | Combustion plants | Flat discharge fees | Combustion plants <50MW exempt. | | $18m in 2012. |
| **Japan** | 1974, reformed in 1987 | | Fees based on current & historical emissions of $SO_x$. Based on emissions volume, not concentration. Geographical differentiation. | Fees only apply to plants that were emitting $SO_x$ before 1 April 1987. Facilities emitting less than 5000-10000Nm$^3$/h (depending on geographical zone) are also exempt. | | $420m in 2009. All used to fund compensation for victims of air pollution. |
| **Korea** | 1983 | Industrial premises | Fees only apply to discharges exceeding 30% of maximum allowable limits. Fees based on mass emitted * coefficient of ratio in excess of allowable standards * frequency of violation. | | | $6.3m in 2013. 90% earmarked for environmental investments. |
| **Norway** | 2007 | Petroleum & manufacturi ng | Flat discharge fees. Increase with inflation | Fees do not apply to motors, boilers and turbines <10MW | If polluter enters into emission reduction agreement | $18m in 2011. |
| **Poland** | 1990 | Industrial boilers | Flat discharge fees. | Fees not collected if total air, water and waste fees <800 PLN (~A$290) | | $210m in 2009. 100% earmarked for environmental funds. |
| **Slovak Republic** | 1967, expanded 1992 | Stationary sources | Flat discharge fees. | | | $27.2m in 2004. 100% earmarked . |
| **Spain** (Galicia) | 1996 | | Increasing rates according to annual emission volume | Fees not collected if emissions <101 tonnes per annum. | | $4.2m in 2011. 100% earmarked to finance damages caused by environmental disasters. |
| **Spain** (Andalusia) | 2004 | | Increasing rates according to annual emissions volume | | Deductions up to 25% if pollution | $6.6m in 2012. 95% earmarked for environmental |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | abatement systems installed | programs, 5% environmental catastrophes. |
| **Spain** (Murcia) | 2005 | | Increasing rates according to annual emissions volume. | | Deductions up to 50% if pollution abatement systems installed | $0.6m in 2011. 100% earmarked for environmental protection programs. |
| **Sweden** | 1992 | Stationary combustion plants with an energy production > 25 MWh | Flat discharge fees for NOx only | Exemptions for power plants with energy production <25MWh. Exemptions exist for many industries including: cement & lime, coke, mining, refineries, blast furnaces, glass & biofuels. | Some rebates available for certain industrial processes that achieve reductions. | $111m in 2012 . All revenue refunded to power plants according to energy output after administration fees are covered. |
| **Switzerland** (Zurich, Geneva, Berne airports) | 1997 | Emission-related aircraft landing charge | Variable surcharge based on aircraft emission values and individual airport tariffs. | | | Zurich airports: $3.5m in 2010. 100% earmarked for anti-pollution measures around airports. |
| **US** (California) | | Major stationary sources | Discharge fees increase according to annual emissions volume for 'criteria pollutants'. 'Toxic air contaminants' and ozone depleters are charged flat discharge fees | Fees if emissions > 4 tonnes, except for CO threshold of > 100 tonnes. Toxic air contaminants and ozone depleters all have individual emission thresholds. | | Main purpose of revenue is to fund scheme administration. |
| **US** (Maine) | | Major stationary sources | Discharge fees increase according to annual emissions volume for 'criteria pollutants'. Differential air quality fee surcharge (based on pollutant toxicity and emissions volume) for hazardous air pollutants. | Fees if emissions > 100 tonnes for most criteria pollutants; >50 tonnes for VOCs; >10 tonnes for hazardous air pollutants.<br>$250 minimum annual emission fee, $153.63 minimum annual air quality surcharge. | | $1.8m from criteria pollutants and $0.6m from hazardous air pollutants in 2001. 100% earmarked for air pollution control. |
| **US** (Oregon) | | Major stationary sources | Base fee + flat discharge fees. | Charged if emissions > 100 tonnes. Exemptions exist for many industrial and non-industrial activities. | | Revenues fund scheme administration. |

### *Pollutants*

Countries either design targeted air pollution charging schemes or schemes that encompass a range of air pollutants. Examples of the latter are British Columbia's scheme that covers 15 air pollutants (including a catch-all in 'contaminant not otherwise specified') and the Polish scheme that includes some 63 pollutants. Individual state permitting schemes in the United States (further detailed in Section 4) generally target a handful of 'criteria pollutants' ($NO_x$, $SO_2$, carbon monoxide, PM and lead), with some further states opting to impose charges for additional pollutants from 187 'hazardous air pollutants' identified by the US EPA.

Countries that opt for targeted schemes tend to focus mostly on nitrogen oxides (Norway, Sweden), sulphur dioxide (Japan) or both (Italy, Hungary, Galicia and Andalusia); or they widen their ambits to include selected pollutants such as VOCs or PM (Maine, Hungary). A few countries such as France, Estonia and Korea have schemes that levy charges on between six to nine pollutants.

One trend that may be emerging is a reigning in of pollutants in order to simplify policy administration and overall efficiency. For example, the Czech Republic used to impose charges on more than 20 pollutants, but in 2012 fees were simplified and the number of pollutants was reduced to just four - $NO_x$, $SO_2$, VOC and PM. At the same time stricter emission limits were introduced and fees for the remaining pollutants were significantly increased. And although the air pollution charge scheme in Armenia is not explored in this report, it is noteworthy that this country reformed its scheme and decreased the number of its liable air pollutants from 51 to 10 in 2000.[34]

### *Fee structures*

The majority of schemes impose a standard charge on pollutants and measure emissions from large stationary sources, and then either exempt smaller emitters on the basis of combustion capacity (Italy, France, Poland, Czech Republic, Norway, Sweden) or charge estimated or flat fees for operators of small sources of emissions (Slovak Republic, Poland). For example, Sweden exempts stationary combustions plants with capacity <25MWh, while France imposes charges only when stationary sources have maximum combustion capacities >20MWh and annual emissions exceed 150 metric tonnes. Poland estimates emissions from small boilers (<5MWh capacity) based on design, thermal power and fuel type.

On the other hand, the Spanish regions of Galicia, Andalusia and Murcia and the state of Maine in the United States differentiate fee rates according to annual quantity of emissions, while the schemes in British Columbia and Estonia do not appear to exempt or preferentially charge smaller sources of emissions.

Some schemes apply coefficients to basic pollutant charges in order to account for the location of the polluters and the assimilative capacities of the surrounding environment, for example in the Estonian, Quebec and Japanese schemes.

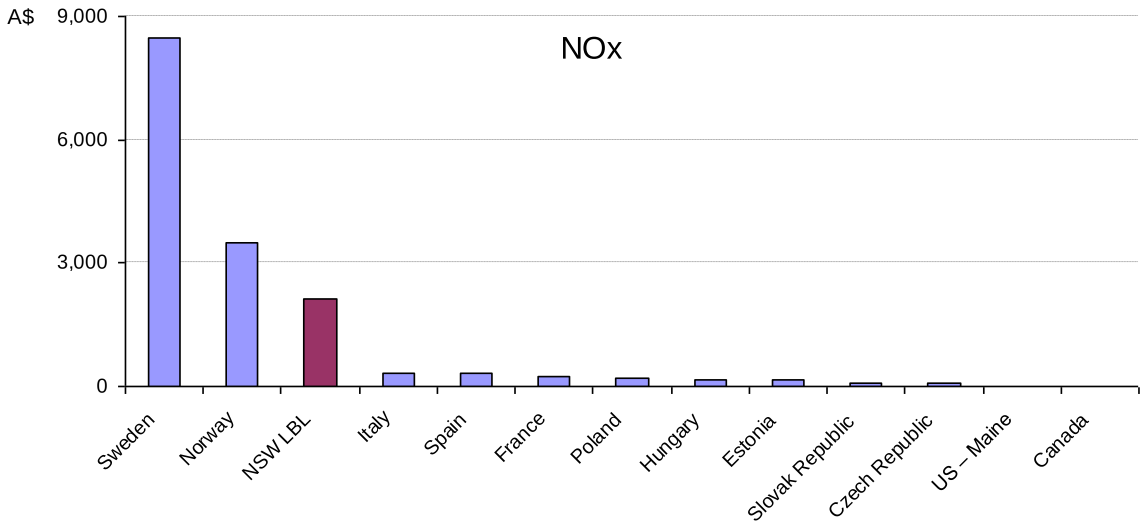
34 OECD (2004)

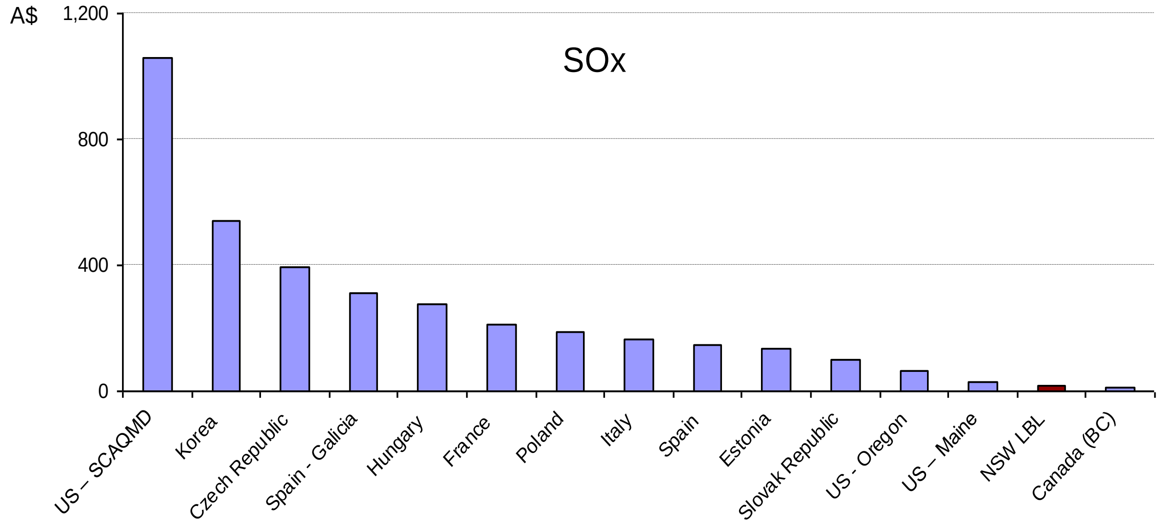
***Fee rates***

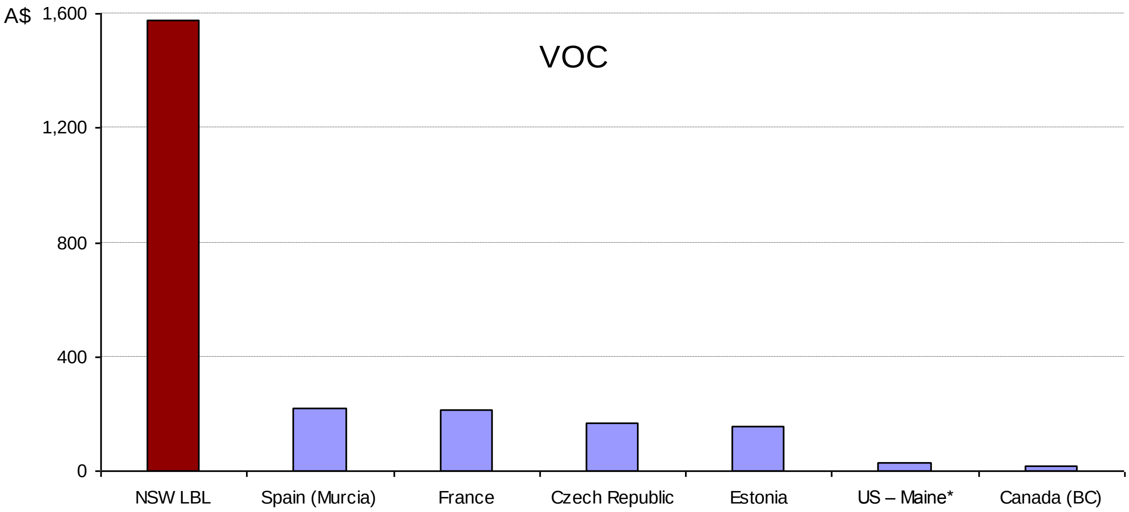
The level of fees varies significantly. For example, Figure 3.2 shows the highest rates levied on selected air emissions, excluding any differentiation countries may subsequently apply to account for industry type or firm size. The fee payable under the NSW LBL scheme is highlighted in red. The figure shows that the NSW fees for NOx and VOC emissions are high by international comparisons. This is perhaps not surprising, given for example, the recent reforms to the LBL pollutants weights which directed a greater proportion of the incentive force of the fees towards these pollutants.

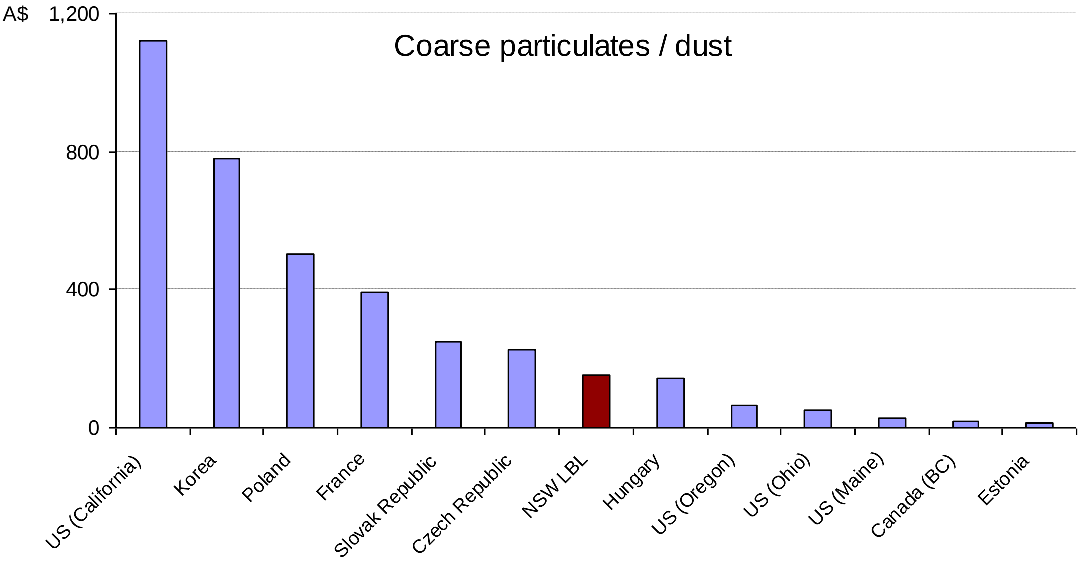
In general the highest fees for sulphur oxides and VOCs are witnessed in Europe and Korea, and the lowest fees are found in Canada and the United States. An exception to this is Californian South Coast Air Quality Management District (SCAQMD). This District encompasses greater Los Angeles and sets the highest air emission charges in the United States, and its fees are comparable or even higher than its European counterparts for the pollutants it levies.

**Figure 3.2 Selected air pollutant fees by country** (highest fee payable; A$ / tonne)






***Exemptions***

Many companies allow exemptions based on the size of combustion plants or when annual emissions fall below a threshold. Other countries waive fees if annual fees are modest. For example, France does not charge combustion sources with less than 20MW capacity, Italy exempts combustion plants with less than 50MW capacity and Sweden plants with less than 25GWh capacity. France also exempts polluters that emit less than 150 tonnes of emissions per annum whereas Galicia (Spain) does not collect fees if emissions are less than 101 tonnes. In the United States emissions are frequently only charged once they start to exceed 100 tonnes.

Exemptions for certain industrial processes are also common; either the fee policies specifically allow for exemptions (such as in Sweden or Oregon) or the policies set up to target only a specific subset of industry or manufacturing (Norway).

**Rate reductions**

Reductions in pollutant charges tied to pollution abatement or subsidies for new investments are relatively common. In Estonia charges may be offset if the polluter implements emission reduction schemes that result in a 25% pollution reduction (compared to the year prior). The Hungarian scheme is particularly generous - dischargers are eligible for a 50% rebate if they implement an approved pollution reduction program. France offers generous investment subsidies for new technological investment.

Norway has a unique approach. Polluters that are captured by its $NO_x$ scheme (which largely targets shipping and petroleum activities) are offered the option to opt-out of the flat fee scheme applicable to NOx emissions, and instead enter into an environmental agreement with the Norwegian government and contribute to a special state NOx fund. Polluters contribute approximately a third of what they would pay under the NOx fee into the fund and the fund is used exclusively to support pollution abatement measures for participants. Reports suggest investments from the fund have supported a 12% reduction in Norway's emissions between 2008-2011.

**Application of revenues**

Revenues are overwhelmingly applied to national environmental programs or anti-pollution measures. In the United States the main purpose of revenues is to cover administrative costs, but in most other countries revenues tend to be earmarked for general environmental investments or programs (Estonia, and Korea) or they are funnelled into state environment funds (Canada, Czech Republic and Slovak Republic) or both (Poland).

Japan's $SO_2$ scheme was established to fund an air-pollution compensation scheme, so all of its revenues are collected by a compensation fund that supports people suffering from air-pollution related illnesses.

Sweden practices revenue recycling. Once administration costs are covered (0.2-0.3% of total revenues), revenues from its NOx fee are refunded to polluters in proportion to their share of total energy output. In effect, the scheme transfers income from high emitting facilities to low emitting facilities. The Czech Republic employs revenue recycling for its water emission effluent fee, but not in relation to air emissions fees. France also practices revenue recycling, and earmarks its revenue for pollution abatement subsidies and grants.

***Revenues***

It is difficult to meaningfully compare overall revenues due to the disparate information available, variations in scheme structures and difference in country size and industrial bases. Excluding Japan (which sets fees according to anticipated compensation fund requirements), the highest overall revenues were collected in France (US$284m in 2008), Poland (US$210m in 2009) and Sweden (US$122.5m in 2011). It is not surprising that the state of Maine in the US had one of the smallest revenues (US$2.4m in 2001) considering its very modest fees, but it also a small state with a small population.

***Effectiveness / Efficiency***

The effectiveness of the air pollution charging schemes is difficult to gauge as they often operate concurrently with strict regulatory measures and/or emissions trading programs. Ambient $SO_2$ concentrations have fallen significantly in Japan since the 1980s, but it is unclear to what extent this is due to stricter regulations or the $SO_2$ fee. Korea's charge for $SO_2$ exists alongside an emissions trading scheme for $SO_2$ (and a trading scheme for PM is also set to be implemented shortly). Moreover, ex-post analyses that seek to disaggregate the effects of fee schemes are rare.

Data on French NOx and $SO_2$ emissions from 1990-1998 indicates its fee had a significant impact on reducing emissions. However because revenues were refunded to polluters through subsidies for pollution abatement technology and the fee levels were low relative to the subsidies available, Millock and Nauges (2006) found that the net effect of the French scheme was to *increase* total emissions to an extent that it generally dwarfed the incentive impact of the fee (see Section 4.2).

Stavins (2002) argues that the Swedish NOx fee is the only fee in Western Europe to have caused emission reductions on its own accord. After the fee was introduced, facilities covered by the fee reduced their nitrogen oxides emissions by 35% within the first 20 months. Emission intensities in regulated plants decreased by 67% between 1992 and 2007. The fee has clearly stimulated demand for new technologies in combustion, monitoring and energy efficiency. However, it is important to note that only 6.5% of the country's NOx emissions are covered by the fee (see Section 4.1).

# 4 POLLUTION CHARGING SCHEME CASE STUDIES

Four OECD pollution charging schemes have been chosen to provide additional contextual information, as well as a fuller analysis of incentive strengths and weaknesses, effectiveness and efficiency.

The case studies were chosen based on the following criteria:

- they have been operating for long enough to assess their performance;
- they were designed to provide an incentive rather than solely to raise revenue or as a penalty;
- information is readily available to assess the outcomes of the schemes, especially the availability of third-party assessments; and
- together they provide a mix of approaches and settings, including at least one air and one water pollution fee scheme

The case studies chosen are:

- Swedish NOx fee;
- French industrial air emission fees;
- Danish wastewater fees; and
- US National Pollution Discharge Elimination System (NPDES) fees to air and water.

The international schemes, typical of broader OECD schemes, are generally revenue focussed and employ revenue-recycling or earmarking to redirect fee revenues to a range of environmental programs, sometimes broader than addressing environmental damages associated with the emissions from the regulated premises.

The US state-based schemes have the least third-party information available and most schemes embody relatively weak incentives. However the US has employed these fee systems for several decades, and variations in scheme settings across the states is of interest. For these reasons, the US case study is more descriptive than the others presented.

## 4.1 Swedish NOx fee for large energy users

As Sweden generates most of its energy from nuclear and renewable sources, gas and coal use and associated nitrogen oxides (NOx) emissions are relatively small in comparison to Australia. Nevertheless, by the 1980s, NOx emissions were a significant contributor to acidification and eutrophication causing widespread damage to forests and lakes.

In response, in 1985 Sweden adopted a strategy to reduce NOx emissions by 30% by 1995 (compared to 1980 levels), To this end, NOx emission limits were introduced in 1988 for stationary combustion sources. However it soon became clear that these limits by themselves would be insufficient to achieve the policy objective.

In 1992, Sweden introduced a charge on emissions of NOx from energy generation at combustion plants, with the aim of the charge to promote large reductions in NOx emissions cost-effectively and without damaging the competitive basis of liable industries.[35] In 2003, the emissions from plants included in the scheme represented around 8% of total NOx emissions in Sweden[36]

#### 4.1.1 General overview

The charge is payable on emissions of NOx from boilers, stationary combustion engines and gas turbines in certain sectors. Table 4.1 shows the sectors that have been included as well as those excluded from the scheme (due to concerns about cost impacts on competitiveness).

**Table 4.1: Scope of application of Swedish NOx charge**

| Sectors included | Sectors excluded |
|---|---|
| Power and heat production | Cement and lime industry |
| Chemical industry | Coke production |
| Waste incineration | Mining industry |
| Metal manufacturing | Refineries |
| Pulp and paper | Blast furnaces |
| Food and wood industry | Glass and isolation material industry |
| | Wood board production |
| | Processing of biofuel |

Source: Höglund-Isaksson and Sterner (2009)

The charge initially applied to combustion plants with greater than 50 GWh capacity (around 124 plants), but was extended in 1997 to those with greater than 25 GWh capacity due to its effectiveness in reducing emissions and easing cost concerns. In particular, monitoring costs, a significant component of overall costs, had fallen markedly.[37]

As shown in Figure 4.1, by 2012 around 287 plants (430 production units) were subject to the charge. Most of the units covered by the charge are boilers and half of the energy produced from these boilers is based on biofuel.

The uniform charge introduced in 1992 was SEK 40 per kilogram of NOx (A$6.60). The value of external damage costs were not estimated for the purpose of fee setting. The charge level was based on

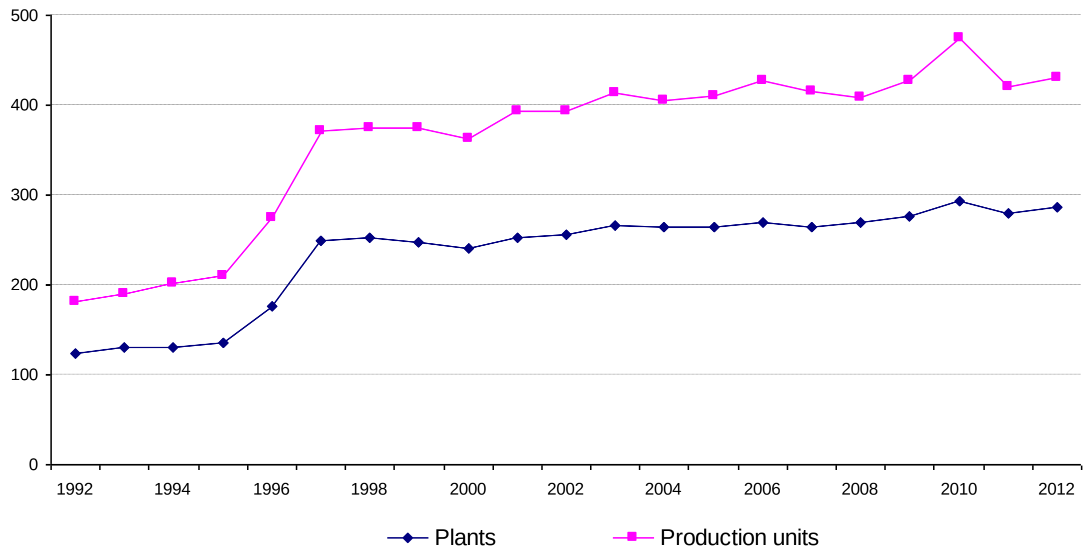
35 OECD (2013)

36 Swedish EPA (2006)

37 OECD (2013)

engineering data on the expected effectiveness and costs of NOx abatement at power stations and heating plants (estimated to range from 3–84 SEK per kg NOx reduced (or A$0.50-$13.85).[38]

**Figure 4.1: Plants and production units liable for the Swedish NOx charge**




Source: Swedish EPA (2013)

In 1992, the first year the fee applied, total revenues were SEK 612m (A$101m). The charge was held constant in nominal terms until 2009 (with a depreciation in real terms of 28%), when the charge was raised to SEK 50 per kg NOx (A$8.25). In 2012, revenue from the charge was SEK 674m ($A111m).[39]

Given the complexities of NOx formation, it was considered crucial to have direct, continuous emission monitoring at plants[40]. The charge is levied on measured emissions (requiring installation of measuring equipment) or presumptive emissions levels (set by the regulator). The EPA has issued regulations (NFS 2004:6) and general guidelines on how to measure NOx emissions. Presumptive emissions are 250 milligrams per megajoule (mg per MJ) for boilers and 600 mg per MJ for gas turbines. [41]

In most cases the presumptive emissions levels are substantially higher than the actual emissions, so measurement is generally preferred. The presumptive levels are also applied when the measuring equipment has been out of order, or does not comply with the specifications required by the Swedish EPA. To allow time for maintenance and calibration of the measuring equipment, operators may estimate emissions for a maximum of 37 hours each month, on the basis of emissions under similar

38 OECD (2013) state that the fee rate was based on the estimated marginal abatement cost expected to deliver a reduction of 5,000 to 7,000 tonnes of NOx per year, the amount required to achieve the 1995 30% NOx reduction target.

39 Swedish EPA (2013)

40 OECD (2013)

41 Swedish EPA (2006)

operating conditions. For another 60 days (1440 hours) the emissions can be calculated as the emissions from similar operating conditions multiplied by 1.5. [42]

For plants choosing to measure NOx emissions, new continuous monitoring systems were required with the introduction of the scheme. It is also necessary to monitor the amount of energy produced, however monitoring equipment for this generally already existed for other purposes.

All revenue is returned to the participating plants (except for an administration fee of < 1% [43]) in proportion to their production of energy. The refundable feature[44] was introduced to minimise distortions in competitiveness relative to those plants not included, and was the key feature used to increase stakeholder acceptance, aid implementation and moderate the compliance costs of the scheme. The feature encourages plants to reduce their emissions of NOx per unit of energy produced. Plants with high emissions relative to their energy output are net payers to the system, and sources with low emissions relative to energy output are net recipients.

The Swedish EPA administers the system and manages the revenues. Plants must submit a return each year showing the amount of NOx emitted and the energy produced. The EPA checks the returns and calculates the payment/refund for each company. Monitoring equipment must be checked at least once a year by an independently accredited inspector and the company return must include the inspection report[45].

There are currently around 15 inspectors accredited by a government agency (the Swedish Board for Technical Accreditation). The Swedish EPA scrutinises returns, administers incoming and outgoing payments and audits plants subject to the charge. In 2009 these administrative costs were estimated at SEK 6.4 million, equivalent to A$1.1m (or 0.9% of the total revenues). Five full time staff were involved and fee audits of 30 facilities were carried out.

#### 4.1.2 Outcomes

Figure 4.2 shows the NOx emissions and emissions intensity for plants paying the NOx charge.

Many plants actually introduced NOx abatement measures shortly after the legislation was passed in 1990, such that emissions from plants subject to the charge fell from 25,000 tonnes to 15,000 tonnes by 1992 (a 40% reduction). Emissions fell further to some 12,500 tonnes by 1995 (a 50% reduction on 1990 levels). After the expansion of the scheme to smaller plants in 1996, total NOx emissions subject to the scheme increased to around 16,000 tonnes, but then fell until 2000.

Also while total emissions have remained fairly constant since 2002, energy output has almost doubled between 1992 and 2012. As shown in Figure 4.2, this has resulted in a sustained fall in NOx emissions

[42] ibid

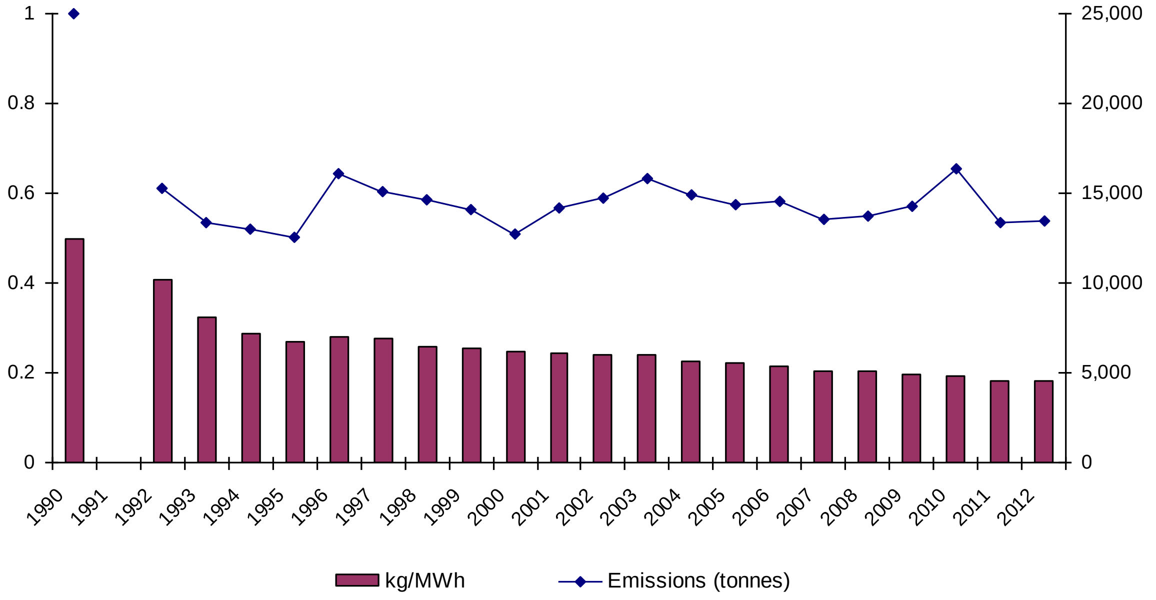
[43] OECD (2010)

[44] The feature is referred to as output-based refunding of emission payments in the economics literature

[45] Swedish EPA (2006)

per unit of energy output from around 0.5kg NOx/MWh to under 0.2kg NOx/MWh between 1990 and 2012 .

**Figure 4.2: NOx emissions - total and per unit of energy output from plants paying charge** (kg/MWh)




Source: Swedish EPA (2006, 2013)

Industry sectors had varying degrees of success in reducing NOx emissions. Heat and cogeneration plants were particularly successful as they started to invest in NOx reduction measures at an earlier stage than the pulp and paper and chemical sectors. It was more difficult to optimise operations with respect to NOx emissions for industry boilers - where the energy output varies significantly. Energy sector boilers tend to be operated at a more even level.

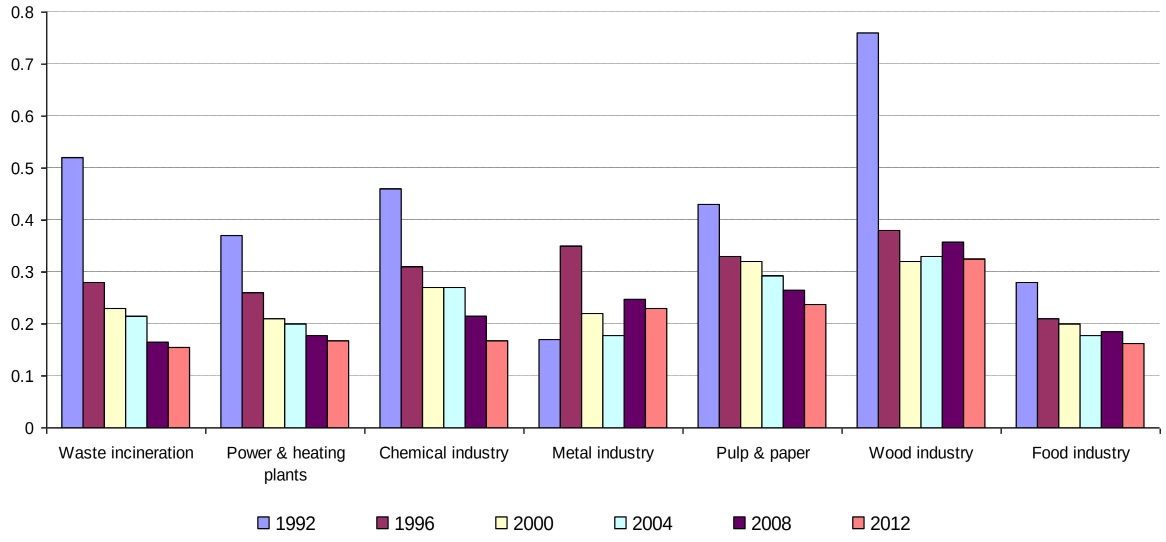
Figure 4.3 shows the reductions in discharges of NOx per MWh achieved across industry sectors. The metal industry is the only sector that didn't achieve a reduction.

The reduction in emissions of NOx per MWh cannot solely be ascribed to the effect of the NOx fee system. In a survey of plants included in the first five years of the fee, Höglund-Isaksson (2005) found that the adoption of NOx control technologies was a combined effect of the fee and the individual emission standards that the plants had been subject to since 1988.

She found that out of 162 NOx-reducing measures undertaken, 47% would not have been implemented without the introduction of the fee, 22% were undertaken primarily to meet the quantitative emission standards, and 31% primarily for other reasons (eg: improved cost-effectiveness or compliance with emission standards for other pollutants - predominantly SO2). Thus, the NOx fee appears to have been the most important, but not the only, factor for NOx abatement.[46]

[46] OECD (2013)

**Figure 4.3: NOx emissions per unit of energy output by industry sector** (kg/MWh)




Source: Swedish EPA (2012) and earlier editions

One study estimated the economic costs of the charging scheme during its first five years[47]. The average total cost of emission reductions was estimated at 25 to 40 SEK per kg of NOx abated (A$4.10-$6.60). Table 4.2 shows a breakdown of components of the total economic cost.

**Table 4.2: Breakdown of economic costs of Swedish NOx charging system**

| Cost component | Percentage of total cost |
|---|---|
| NOx abatement | 50% |
| Damage value for increased emissions of CO, VOC, $N_2O$ and $NH_3$ | 23% |
| Monitoring and calibration of equipment | 20% |
| Welfare loss arising from recycling revenue based on energy output | 3% |
| Plant administration | 2% |
| Regulator administration | 1% |

Source: Höglund 2000 in Höglund-Isaksson and Sterner 2009

As would be expected the greatest proportion of the costs relates to the cost of reducing NOx emissions at plants. The other significant costs are increased emissions of other pollutants and the cost of monitoring and calibration of equipment. No further information is available on the magnitude of increases in other emissions or the damage values assigned. However, this breakdown does highlight that the impact on other emissions can be a significant issue with narrowly targeted emission fees.

The Swedish charging system for NOx emissions has also been examined in a number of recent studies and is widely accepted as successful[48]. As noted above, NOx emissions per unit of energy produced by

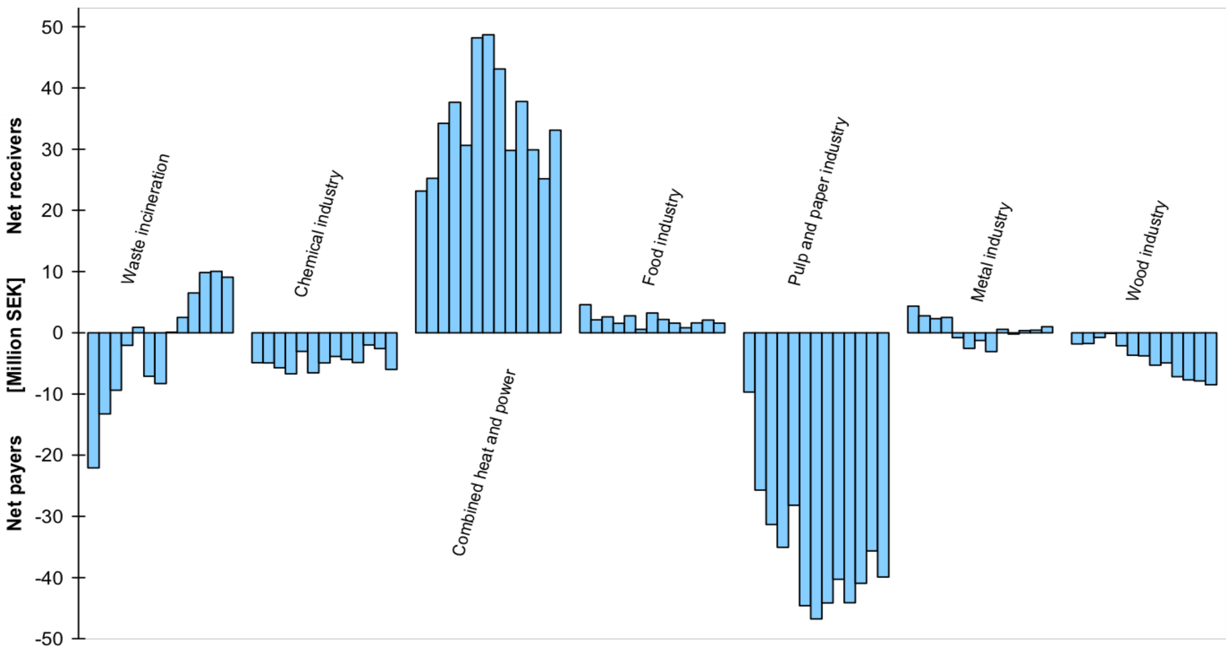
47 Höglund 2000 in Hoglund and Sterner (2009)

regulated plants has fallen by 50% since 1992. This is considered significant for NOx which is usually considered technically difficult to control due to its complex formation processes. Experience with the Swedish scheme has shown it is not just the installation of equipment but the fine tuning of operations that facilitates NOx reductions.[49]

Reductions in emission intensity were rapid during the first 3-4 years then slowed. Both innovation as well as the spread and adoption of existing technology were found to have played a substantial role. For example, plants quickly adopted the available technology, with 62% of plants having NOx abatement equipment in 1993 compared with only 7% the previous year.[50]

Then, over a relatively short period, innovations significantly reduced the cost of NOx abatement. For example, Höglund-Isaksson (2005) derived marginal NOx abatement cost functions for the energy sector in Sweden between 1991 and 1996, and identified significant cost reductions were achieved. For example, a firm with an emission intensity of 200kg of NOx per GWh in 1991, the marginal cost of reducing emissions was close to SEK 130. By 1996, this cost had fallen to less than SEK 20.[51] Figure 4.4 shows the net payers and receivers by sector for the period 1992-2004.

**Figure 4.4: Net payers and net receivers by sector 1992-2004**




Source: Swedish EPA (2006)

Notes: Each bar represents one year with the years increasing towards the right.

48 See foe example, Swedish EPA (2006), Sterner and Höglund-Isaksson (2006), Sterner and Turnheim (2008), Höglund-Isaksson and Sterner (2009), OECD (2010, 2013)

49 Sterner and Hoglund (2006)

50 OECD (2010)

51 cited in OECD (2013)

The industry sectors that were more successful in reducing NOx emissions had a positive financial impact from the scheme after revenue recycling. The combined heat and power sector and food industry were net receivers in all years, whereas the pulp and paper and chemical sectors were net payers in all years shown. The extent to which the revenue recycling approach can produce 'winners', is illustrated by one plant in the heat and power generation sector receiving about SEK 27m ($A4.5m) in net refund in 2010. In contrast, only three plants in that year had net charge liabilities approaching (and barely exceeding) SEK 5m ($A0.8m).[52]

From a broader social perspective, due to the refund mechanism, there was hardly any net cost increase for industry as a whole. And given the small net liabilities faced by those plants which were payers, virtually no impact on product prices. This in turn meant that there is no negative income distribution impact from the scheme.[53]

#### 4.1.3 Assessment from an economic efficiency perspective

Notwithstanding uncertainty over likely NOx emission externality values, the emission charge appears to have been established close to a level that would constitute a 'Pigovian' tax, ie: a level commensurate with estimated externality impacts. Although the externality value was not estimated at the time the charge was established in 1992, at 40 SEK per kg of NOx it would be equivalent to 52 SEK in current prices - and the current charge is 50 SEK - approaching a recent estimate of the NOx emission externality value in Sweden of 65 SEK per kg[54].

The design of the fee scheme promotes pollution abatement at least cost by providing flexibility to plant operators in how emission reductions are achieved. Prior to the introduction of the scheme there was thought to be significant scope for NOx reduction through various technical measures including changing the shape, temperature, oxygen and moisture content of the combustion chamber, fuel switching and various other strategies such as adding reduction agents or passing exhausts through catalytic converters. The potential for emission reductions was reflected in a variation in emission per unit of production coefficients among plants estimated to be at least twenty-fold[55].

The Swedish charge has been used as an example of an instrument promoting dynamic efficiencies, as it provides a continual incentive to reduce emissions and maximum flexibility in how this can be achieved[56]. It has created strong incentives for fuel switching, modifications to combustion engineering and the installation of specific abatement equipment such as catalytic converters and selective non-catalytic reduction. There is strong empirical evidence for the innovation effect of the charge with a

52 OECD (2013)

53 ibid

54 Ahlroth (2007)

55 Sterner and Hoglund (2006)

56 Harrington and Morgenstern (2003)

statistically significant downward shift in the marginal abatement cost curve over time for 55 power plants from 1992-1996[57].

The only drawback of the scheme structure from an efficiency perspective is that the refunding mechanism prevents regulated parties from paying the full environmental cost of emissions. From an economic first principles basis, and as noted by the OECD (2010), the refund resembles a subsidy from society to the producers. This leads to a welfare loss to society since too much productive resources are allocated to polluting production relative to cleaner production.

However the charges are not levied in isolation, with liable plants also subject to other regulations as outlined earlier. If the collective policies resulted in firms producing at socially optimal levels, then it could be argued that the refunds were not creating efficiency losses, rather they would be preventing them by ensuring more production from the less NOx intensive plants.

#### 4.1.4 Comparison of the Swedish NOx charge with LBL

The scheme, at least in its early years, has many similarities with the NSW scheme. Like LBL, the Swedish scheme targeted the larger facilities where gains were likely to be significant relative to administrative costs. While the scheme covers only some 13,000 tonnes of NOx emissions currently, it covered closer to 30,000 tonnes when the scheme was introduced in 1990 (inclusive of the emissions of the second tier facilities brought in from 1996). These emission would have represented around 20% of total Swedish NOx emissions, and represented a priority source for emission reductions.

There appears to be public trust in the integrity of the process (supported by independent accredited inspectors as well as regulator audits), with the scheme generating publicly available information each year on the performance of each plant in terms of their NOx emissions per MWh.

The scheme has provided compliance flexibility to plant operators, created a culture of continuous improvement, and it is widely accepted that the scheme has been cost-effective. There has also been flexibility by the regulator with the scheme extended over time in response to lower abatement and monitoring costs.

One factor thought to contribute to the success of the Swedish scheme, is the mandatory requirement for continuous monitoring of emissions from regulated plants. Notably, the continuous emissions monitoring enabled plants to recognise where and how to optimally calibrate instruments and equipment to maximise the power-generation-to-emissions ratio.

Beyond its sole focus on one pollutant, a key point of difference with the LBL scheme is the level of fees. The current Swedish NOx fee rate is in line with available estimates of externality damage costs, and provides a much stronger incentive for emission reductions. This has resulted in a marked reduction in NOx emissions (particularly in the early years of the scheme), and there is strong empirical evidence

57 OCED (2010)

for the innovation effect of the charge with a statistically significant downward shift in the marginal abatement cost curve over time.

In contrast, the effectiveness of the lower LBL fees in promoting emission reductions is uncertain. However the context is important. The total emissions from the Swedish plants at the beginning of the scheme is less than the current NOx emissions from the largest NSW power station (Bayswater), and only some 15% of emissions from all NSW plants paying NOx LBL fees in 2011/12. Therefore the potential impact of emission fees on energy prices would be greater in NSW.

A higher per kg emission charge in Sweden has also been assisted with the use of the refund mechanism. The type of revenue recycling adopted requires a single output on which refunding can be based, and each plant's output needs to be small enough relative to the total output of regulated plants to form a competitive situation. These conditions were met for the Swedish NOx charge with the largest fraction of total output ever produced by a single owner in one year being 12%. In cases where there are small numbers of firms or oligopolies with large output shares this approach may not have the desired outcome.

A refunded emission charge makes it politically easier to set charges high enough to generate an environmental improvement compared with a straight emission charge. It can be budget neutral and the loss in competitiveness compared to non-regulated plants will be lower. The Swedish experience suggests that a refunded charge can be designed to ensure it does not compromise flexibility to participants in their response to the incentives, and provide a continuous incentive, with plants competing to reduce emissions in response to the refunding mechanism.

The scheme has however created a perverse incentive in that the charge levied on a single pollutant has resulted in increases in other urban air pollutants, which as shown in Table 4.2, comprise a significant social cost. The impact on other emissions can be a significant issue with narrowly targeted emission fees.

## 4.2 French industrial air emission fees

France introduced an air pollution fee in 1985 to provide an incentive to regulated plants to reduce emissions. The French fee on air pollution partly resembles the Swedish NOx charge in that revenues were rebated back to industry to minimise the cost of installing pollution abatement technologies, although in a more indirect manner.

### 4.2.1 General overview

The initial fee was on sulphur dioxide ($SO_2$) emissions, then it was extended in 1990 to include nitrogen oxides (NOx) and hydrochloric acid (HCL), and again in 1995 to include volatile organic compounds (VOCs). The 1995 extension also included small particulate matter, however the fee rate was initially set at zero.

The fee applied to:

- entities with a combustion capacity ≥ 20 MW;
- entities with annual emissions ≥ 150 tonnes of either $SO_2$, NOx, HCL or VOCs; and
- household waste incineration plants with a capacity ≥ 3 tonnes per hour.

The sources covered included power stations and household waste incineration plants, with the total number of sources paying fees at around 1,200 in 1990 increasing to 1,500 in 1999.

In 1990, the fee targeting $SO_2$, NOx, and HCL emissions was set at a rate of approximately EUR 23/tonne (A$35). It was increased in 1995 to EUR 28/tonne (A$43), and again in 1998 to EUR 38/tonne (A$58) for NOx and VOC only. If the total fee due was less than EUR 153 (A$233) for a unit, no fee was levied.[58]

The fee was administered by the French Environment and Energy Management Agency (ADEME). Seventy five percent of the revenues from the fee were earmarked for subsidies for abatement investments or research and development. Plants paying the fee could apply for a subsidy. The level of the subsidy related to the size of the fixed capital investment proposed and was distributed at rates of:

- 15% for standard abatement technologies;
- 25% for innovative technologies;
- 35% for very innovative technologies; and
- additional 10% for small and medium sized companies.

ADEME received 6% of the revenues towards its administration costs. The remaining funds were used for air quality surveillance systems.

Firms could choose between using direct emissions monitoring (by installing equipment or paying a consultant to monitor emissions) or using emission factors set by the regulator to calculate emissions from fuel consumption data.

In 2000 the French fees on air pollution were unified with a range of other fees as part of an ecological fee reform program to form a new General Fee on Polluting Activities (or TGAP). The revenues from the TGAP were used for the reduction of fees on employment.

The information and evaluation in this case study relates initially to the separate air pollution charges implemented by ADEME up to 1998 (prior to the TGAP). Following this, comment is provided on the reforms introduced with the TGAP.

#### 4.2.2 Outcomes

ADEME reports that over 90% of fees due were paid. However, the regulation was based on self-reporting of emissions from the previous year and no auditing results are available in the literature. One

58 Millock, Nauges and Sterner (2004)

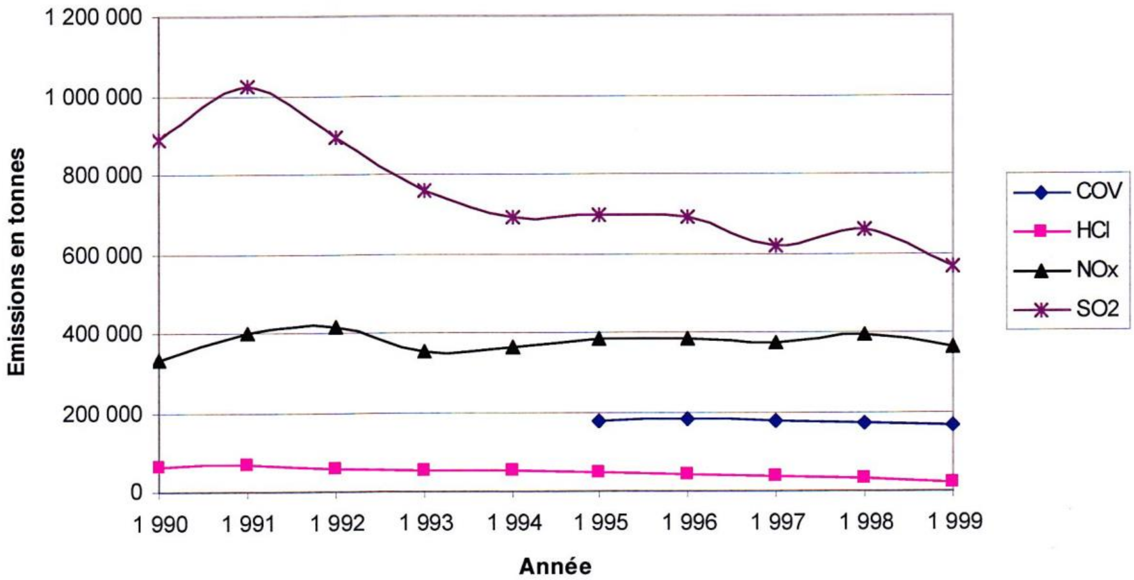
observer has commented that the lack of real emissions monitoring severed the link between the fee base and actual emissions and diluted the incentive effect of the fee.[59]

The revenues collected increased from around FF 115 million in 1991 (A$23m) to FF 219 million in 1997 (A$46m).

In most cases industries did not actually measure emissions but used the rule of thumb coefficients. All applications for subsidies were funded, resulting in an automatic refunding of revenues to the group of plants affected and almost all plants received a subsidy of 15% of the capital works investment. Examples of technologies that were subsidised for abatement of $SO_2$ include the injection of alkaline chemicals, combustion on sulphur-removing fluidized beds, and wet and dry flue gas desulfurisation. NOx abatement subsidies included for exhaust gas recirculation and low NOx burners, selective non-catalyst reduction, and selective catalyst reduction.

Emissions of $SO_2$ from all industry sources in France fell by around 30% over the 1990s and emissions from other air pollutants remained fairly steady. Figure 4.5 shows these trends.

**Figure 4.5: Evolution of industrial air pollution in France**




Source: Riedinger and Hauvy (2003)

Notes: COV = the compounds (organic volatile)

An empirical analysis[60] has been carried out of the impact of the French air pollution fees and subsidies over the period 1990-1998 (Table 4.3).

The analysis covered 226 plants from three industrial sectors. The key results were:

59 ibid

60 Millock and Nauges (2006)

- the fee in itself had a significant impact in reducing emissions in these sectors and the reduction was larger for $SO_2$ than for NOx emissions;
- all else equal, the higher the fees paid, the higher the probability that the plant applied for an abatement subsidy;
- the effect of the subsidy, however, was to increase total emissions from these plants significantly and to an extent that generally dwarfed the negative impact of the fee, and in contrast to steady or declining emissions of NOx and $SO_2$ form all industry sources (as shown in Figure 4.5).

**Table 4.3: Estimated impacts of French air emission fee / subsidy system by sector**

| Sector / Pollutant | Estimated emission fee elasticity | Overall effect of fee on emissions (ton) | Overall effect of subsidy on emissions (ton) |
|---|---|---|---|
| NOx | | | |
| Iron and steel | -2.27 | -808 | 4,566 |
| Coke | -0.59 | -857 | 2,070 |
| Chemicals | -2.67 | -578 | 2,660 |
| $SO_2$ | | | |
| Iron and steel | -1.82 | -1,486 | 10,937 |
| Coke | -0.21 | -2,019 | 5,787 |
| Chemicals | -2.26 | -957 | 5,587 |

Source: Millock and Nauges (2006)

The larger impact for $SO_2$ compared with NOx has been attributed to the monitoring procedures for emissions. Firms could choose between using direct emissions monitoring or using emission factors to calculate emissions from fuel consumption data. For $SO_2$ emissions the use of emission factors constitutes a good proxy.

Emission factors do not work as well for NOx emissions since they originate from the combustion process and depend on operational factors, such as combustion temperature and oxygen intake. For NOx emissions, actual emissions monitoring is more important since emissions vary strongly with fine-tuning of plant operations.

Estimated emission fee elasticities vary across sectors with plants in the coke industry least responsive to the fee. The estimates of the overall effect of the fee show that generally the positive effect of the subsidies outweighed the negative effect of the fee.

#### 4.2.3 Assessment from an economic efficiency perspective

From an economic efficiency perspective, the level of the French charges were not significant compared with damage values. The charge for $SO_2$ of 28 EUR (A$43) per ton by 1998 compares with estimated damage costs of over 8900 EUR (A$13,550) per ton and the charge for NOx of 38 EUR per ton by 1998 compares with estimated damage costs of over 15,300 EUR (A$23,300) per ton[61].

One study has also suggested that the estimated marginal cost of $SO_2$ abatement by French firms from 1995-1999 was several times the value of the French fee rate[62]. Therefore the fee alone would not have been expected to provide any incentive effect for reducing emissions. This finding however conflicts with the later study by Millock and Nauges (2006) who separated the effect of the fee and subsidy components of the scheme, and as reported in Table 4.3 attributed a significant $SO_2$ emission reduction in three sectors to the fee.

Another concern with efficiency was that the design of the fee scheme did not promote pollution abatement at least cost or provide flexibility to plants. Eighty per cent of the equipment subsidised were end of pipe technologies.[63] With subsidies set as a fixed percentage of the capital investment cost, this may have created a bias towards end of pipe technologies. Investment costs for these technologies are generally easier to quantify compared with clean technologies that often include management reorganisation and possibly higher variable costs.

Millock, Nauges and Sterner (2004) concluded that:

> *'By comparison with Scandinavian environmental taxes, the French fee on air pollution was set at a relatively low level. It is likely that this level was too low to warrant most of the relevant and effective abatement technologies. This is a fundamental problem when it comes to NOx emissions where abatement is fairly costly and the fee level thus needs to be very high in order to provide a real incentive for firms to abate. It implies that the political economy of the instrument chosen is very important. It appears that the automatic and full rebating of the Swedish fee made it politically easier to set a sufficiently high fee level and this may be a vital advantage of that form of rebating'.*

#### 4.2.4 Reforms under the TGAP

The new system of emission fees, TGAP, was broadened to include the storage and disposal of household waste; disposal and transfer of hazardous industrial waste; introduction of lubricants, introduction of some washing and softening laundry products; materials extraction; issuance of printed papers; and the manufacture or importation into the national market of paints, varnishes, solvents, detergents, mineral oils, pesticides, herbicides, fungicides and other chemicals that may pose a significant risk to human health and the environment. The TGAP did include pesticides used in agriculture, however this has been replaced by a levy on non-point pollution administered by water agencies.

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61 Spadaro and Rabl (1998)

62 Riedinger and Hauvy (2003)

63 Millock and Nauges (2006)

Some commentators argue that there was no attempt to set rates equal to marginal damage costs, and that while the new activities affected by TGAP were polluting, the fee was clearly revenue driven. For example, the charge on high and low sulfur oil was the same, as was the fee whether or not a fuel was burned with or without pollution control equipment[64].

Classified premises subject to the emission charges fall in the same categories previously prevailing (shown Section 4.2.1), as well as facilities discharging more than 50 tons dust total in suspension. The fee is based on the weight of substances emitted into the atmosphere and the rate varies by pollutant. The current fee rates are shown in Table 4.4.

**Table 4.4: French general fee on air pollution, rates for 2014**

| Pollutant | Unit | Charge in 2014 | |
|---|---|---|---|
| | | EUR | A$ |
| Sulfur oxides and other sulfur compounds | Tonne | 138,60 | $211.10 |
| Hydrochloric acid | Tonne | 47,17 | $71.80 |
| Nitrous oxide | Tonne | 70,77 | $107.80 |
| Nitrogen oxides, with the exception of nitrous oxide (expressed as nitrogen dioxide equivalent weight) | Tonne | 167,30 | $254.80 |
| Non-methane hydrocarbons, solvents and other volatile organic compounds. | Tonne | 138,60 | $211.10 |
| Total airborne dust. | Tonne | 264,80 | $403.30 |
| Arsenic | Kg | 509,50 | $775.90 |
| Selenium | Kg | 509,50 | $775.90 |
| Mercury | Kg | 1019,00 | $1,552.20 |
| Benzene | Kg | 5,10 | $7.80 |
| Polycyclic aromatic hydrocarbons (PAHs) | Kg | 50,95 | $77.60 |
| Lead* | Kg | 10 | $15.20 |
| Zinc* | Kg | 5 | $7.60 |
| Chrome* | Kg | 20 | $30.40 |
| Copper* | Kg | 5 | $7.60 |
| Nickel* | Kg | 100 | $152.0 |
| Cadmium* | Kg | 500 | $761.70 |
| Vanadium* | Kg | 5 | $7.60 |

* The thresholds of liability are set at 200 kg per year for lead, 200 kg per year for zinc, 100 kg per year for chromium, 100 kilograms per year for copper, 50 kg per year nickel, 10 kg per year for cadmium and 10 kilograms per year for vanadium.

Source: French Customs (2014)

64 Desaigues and Rabl (2001)

The fee is paid in three instalments. If the amount of the TGAP due is more than 7600 EUR (A$11,578), its payment must be made directly to the Treasury. The documents establishing annual fee liabilities must be retained for three years. An example of how TGAP fees are estimated can be found at Annexure 15 of Ministry of Economy and Finance (2013).

The TGAP rates applicable to NOx, were subsequently doubled in 2011 and tripled in 2012. The TGAP was then amended in 2013 to increase its contribution to improving air quality by:

- extending the TGAP to emissions of five new air pollutants - benzene, arsenic, selenium, mercury and polycyclic aromatic hydrocarbons (PAHs),
- tripling the TGAP rates in force in 2012 on emissions of SOx, non-methane hydrocarbons and VOCs, and on emissions of total suspended particles or TSP;
- The liability threshold for emissions of total dust was reduced from 50 to 5 tonnes/year. [65]

#### 4.2.6 Comparison of the French industrial air emission fees with LBL

The French air fees during the 1990s applied to a much more limited range of pollutants than the NSW LBL scheme. Similar to the LBL scheme, fee rates were significantly less than estimated emission impact values and firms could choose between using direct emissions monitoring or using emission factors. The key point of differentiation was the use of revenue-recycling under the French scheme, which saw 75% of the revenues from the fee earmarked for subsidies to participating plants for abatement investments.

Although emissions of $SO_2$ across all industry sectors fell by 30% during the 1990s, empirical analysis has found that the positive effect of the subsidies on emissions *outweighed* the negative effect of the fee on emissions in some key sectors. That is, the scheme may have had the perverse effect of increasing pollutant emissions. Further, the program for allocating subsidies based on the capital cost of the investment serves to reduce compliance flexibility to the incentives, and is likely to have reduced emission reductions whilst increasing overall compliance costs.

A further point of comparison is that unlike the LBL scheme, the apparent lack of an effective auditing program and self-reporting of emissions did not encourage emissions monitoring. Monitoring of actual emissions is a necessary pre-requisite to the effective targeting of incentives, particularly for NOx - it is not simply the installation of abatement equipment that matters but its fine-tuning and continued adjustment to the production process.

The new fee provisions applicable to air emissions under the TGAP appear more promising. Fee rates have increased substantially, and as shown in Figure 3.2, are among the higher rates across OECD countries.

65 http://www.citepa.org/en/news/736-16-january-2013-general-fee-on-pollution-generating-activities-table-of-2013-rates

## 4.3 Danish wastewater fee

The Danish wastewater fee was introduced in 1997 with the dual objective of reducing wastewater discharges of pollutants as well as financing general reductions in personal income tax.

### 4.3.1 General overview

The wastewater fee was part of broader 'green tax' reforms in Denmark. The wastewater fee rate was not developed with regard to any valuation of the externality impacts of discharges, rather the rates were set based on a target revenue in line with the desired shift to a broader tax base. The fee was also expected to improve compliance with the discharge standards of the Danish Plan for the Aquatic Environment.

The fee applies to discharges of organic material (biological oxygen demand), nitrogen and phosphorus from direct discharges to waters. Direct dischargers include wastewater treatment plants (around 135), industries with direct discharges into the sea, lakes or streams (around 100) and dwellings not connected to the sewerage network (scattered buildings in rural areas).

Fee exemptions apply to protect the competitiveness of certain industrial dischargers. Eligibility applies only if more than 80% of the fee payment is related to the selected industries. Some analysts have commented that the rationale for exemptions is questionable and deserves more careful analysis[66].

The original exemptions reduced the annual fee liability above 20,000 DKK (around A$4,100) by either 97% or 70% for the industries shown in Table 4.5. The 97% exemption was reduced to 80% from September 2008.

**Table 4.5: Original Danish wastewater fee exemptions**

| Industries | Fee reduction |
|---|---|
| Fish processing, cellulose, sugar beet | 97% |
| Organic pigments, pectins, vitamins | 70% |

Source: European Commission (2001)

The national Customs and Tax Agency is responsible for collection of the fee from most dischargers. Fees for dwellings that are not connected to the sewer network are collected by the local municipalities.

The fee was phased in with rates in 1997 at 50% of the full level that came into effect in 1998. The fee rates have remained constant up to 2013 (and are shown in Table 4.6). The fee rates were to have increased by 50% from 2010[67], but as of 2014 EU approval is still being sought.[68]

66 ECOTEC (2001)

67 Nordic Council of Ministers, Copenhagen (2009)

68 www.kpmg.com/DK/da/nyheder-og-indsigt/nyheder/energi-og-forsyning/Documents/Satsoversigt%202013-2014.pdf

**Table 4.6: Danish wastewater fee rates, per kg 2013** [69]

| Pollutant | Fee rate (DKK) | Fee rate (A$) |
|---|---|---|
| Nitrogen | 20 | 4.10 |
| Phosphorus | 110 | $22.60 |
| BOD | 11 | $2.25 |

The revenue from the fee were expected to be DKK 540 million per year (A$111m), but actual revenue was around DKK 300 million (A$61.5m) in 1998, falling to DKK 276 million (A$56.6m) by 2000.[70] Revenue in 2011 is reported at only A$32.5m. [71]

Of the revenue from the scheme, some 70 million DKK per year (A$14.4m) has been hypothecated to an independent Water Fund to finance projects to protect and secure future water supply.

For industrial dischargers, the fee is calculated either based on the monitoring of discharges or according to a table of hydraulic discharge standard values. No new monitoring was required for most large dischargers, sewage treatment plants, and industries as their environmental permits already required continuous monitoring of the pollutants included in the fee scheme.

Dwellings not connected to the sewerage network have the option of paying the fee according to metered water consumption coupled with standard rates according to the type of treatment applied[72]. Water consumption for dwellings is generally already metered for the purpose of collecting water tariffs.

### 4.3.2 Outcomes

The Danish Ministry for the Environment conducted an economic assessment of the fee in 2005 to determine the environmental effects, the costs that have resulted from the fee, and whether the fee has provided an economic benefit for Danish society[73]. The analysis found that twenty two wastewater treatment plants had responded to the fee by 2000, representing 16% of all plants. For industrial dischargers, 14% of those paying the full fee responded by reducing their pollutant loads. Although few had changed their behaviour because of the fee, those that did had reduced discharges significantly.

Figure 4.6 shows the estimated reduction in pollution loads as a result of the fee between 1996 and 2000 – a 5% reduction for nitrogen, 17% for phosphorus and 3% for organic matter.

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69 ibid

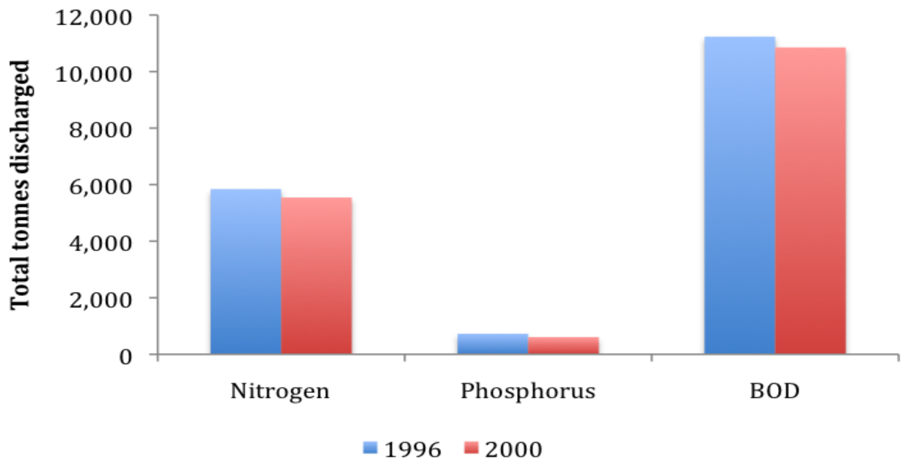
70 Danish Ministry of the Environment (2005)

71 OECD (2014)

72 Treatment types and fee rates can be accessed at http://www.energiviborg.dk/forside/spildevand/priser/1880-spildevandsafgift-2014

73 Danish Ministry of the Environment (2005)

**Figure 4.6: Estimated reduction in pollutants attributable to the wastewater fee 1996-2000**

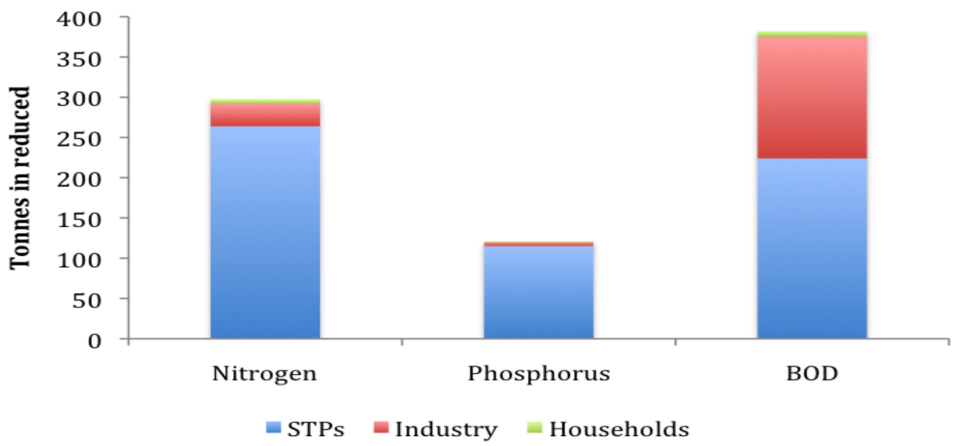



Source: Danish Ministry of the Environment (2005)

Wastewater treatment plants contributed around 90% of the nutrient reductions and around 50% of the reductions in loads of organic matter (BOD). The reductions were achieved through increased use of chemical precipitation (for bonding phosphorus in particular) and through investment in measurement and control systems for treatment processes.

Figure 4.7 shows the breakdown of the estimated pollution reductions by source. The estimates are considered conservative as the full impact of the fee was not felt until 1998 and many plant operators may not have made changes by 2000.

**Figure 4.7: Breakdown of reduction in pollutants from wastewater fee 1996-2000[74]**




Source: Danish Ministry of the Environment (2005)

74 The figure includes the estimated (small) impact of passing the fee on to households in water charges, and the impact of subsequent reductions in water consumption on wastewater discharges.

The total economic cost of the wastewater fee has been estimated at DKK 19.4 million per year (A$4m). A breakdown of the estimated economic costs is shown in Table 4.7.

**Table 4.7: Breakdown of estimated economic costs of wastewater fee per annum**

| Category | DKK million (2005) | A$m (2014) |
|---|---|---|
| Marginal costs to wastewater treatment plants | 7.7 | 1.6 |
| Marginal costs to industry | 0.8 | 0.2 |
| Administrative costs to wastewater treatment plants | 1.2 | 0.25 |
| Administrative costs to industry | 1.2 | 0.25 |
| Administrative costs to government | 2.5 | 0.5 |
| Distortion loss | 6.0 | 1.2 |
| **Total economic cost** | **19.4** | **4.0** |

Source: Danish Ministry for the Environment (2005)

The 'distortion loss' covers the welfare loss resulting from the water utilities who manage the wastewater treatment plants passing on their costs to households through higher water prices, leading to reduced water consumption.

The Danish Ministry for the Environment estimated the monetary value of the environmental externality benefits of the wastewater fee using a range of values from other studies and recognised that the values are subject to great uncertainty. Sensitivity calculations across the different studies result in a total value for the pollutant reductions of between DKK 20-83 million per year (A$4.1m - A$17m per year).

**Table 4.8: Range of values for environmental effects of wastewater pollutants**

| Pollutant | DKK per kg | A$ per kg |
|---|---|---|
| Nitrogen | 8 - 141 | 1.6 - 29 |
| Phosphorus | 141 - 580 | 29 - 119 |

Source: Danish Ministry for the Environment (2005)

The Ministry concluded that a conservative estimate of the economic benefit of the wastewater fee is around DKK 5 million per year (A$1 million per year). This is considered a conservative estimate as it only includes benefits realised during the first four years of the fee. This conservatism is supported by the trend in discharges of nutrients after 2000, with industry reducing nitrogen by 17% and phosphorus by 15% between 2000 and 2003. Wastewater treatment plants have also reduced nutrients by 3% and 6% respectively over this period.

Additional benefits of the scheme that were not quantified include the contribution of the fee to improving compliance with discharge permits. In 1996 there was a 30% non-compliance among wastewater treatment plants and this was reduced to 16% by 1998.

#### 4.3.3 Assessment from an economic efficiency perspective

From an economic efficiency perspective the Danish wastewater fee covers the major sources discharging nitrogen, phosphorus and organic matter. The fee levels for nitrogen and phosphorus appear to be at the lower end of the range of estimates of externality damage values shown in Table 3.8.

Clearly the exemption to protect the competitiveness of certain industries reduces the efficiency of the fee. The exemptions were not part of the original proposal for the fee. Two other factors have been thought to limit the impact of the fee:

- restrictive administrative regulations operating alongside the fee (the detail of this is not clear from the literature – it may have been concentration standards limiting the ability to reduce loads in response to the fee); and
- the nature of the wastewater treatment industry.

Most of the wastewater treatment plants are run by publicly owned monopoly water utilities. This means the economic incentive to reduce discharges in response to the fee is moderated, as they can simply pass additional costs on to consumers whose demand is not price sensitive. Consumers are not aware of the composition of the fee as it is passed on in general charges for water consumption[75].

Indeed the Danish Ministry for the Environment suggests a number of wastewater treatment plants have not acted to minimise their costs. Given the low response to the fee, the Ministry expected the marginal costs of wastewater treatment to be similar to or higher than the fee. However, they found that cost functions do not seem to be systematically different for the plants that have not implemented measures compared with plants that have.

The lack of price regulation meant the charges were automatically passed on as part of water prices without any attempt to firstly improve treatment to minimise charges that needed to be passed on, or secondly encourage reduction at source by passing on charges in a transparent manner to consumers.

#### 4.3.4 Comparison of the Danish wastewater fees with LBL

The Danish wastewater fee, similar to the NSW LBL fees, has been applied widely, covering wastewater treatment plants and industries with direct dischargers. However the Danish fee levels have been applied at much higher rates, approaching estimated externality impact values. As shown in figure 3.1, the Danish fee rates for some pollutants (such as N and P) are the highest identified across OECD

75 Danish Ministry for the Environment (2005)

countries. It is not surprising then that rhe Danish wastewater fee has achieved a modest reduction in pollution loads.

While the fee has provided an incentive to reduce pollution, as noted above it has been suggested that the administrative regulations operating alongside the fee may have reduced flexibility for dischargers in responding to the fee. Also, the ability of the public wastewater utilities to simple pass the higher costs back to wastewater generators will have lessened the incentive force of the fees.

Both these issues may be pertinent in the case of LBL incentives, although regulatory pricing oversight for public utilities in Australia may be more successful in ensuring discharge incentives are being passed back to generating sources.

Finally, the impact of the Danish fee was limited by exemptions (Table 4.5) to protect the competitiveness of industries. Exemptions are not a feature of the NSW LBL scheme.

## 4.4 US experience with pollution charges

The United States does not generally rely on load based emissions charges to control air or water pollution. Instead, the prevailing policies rely on regulatory standards (technology or water-quality based) or in some instances, tradeable permit schemes. Nevertheless, pollution emission charges to both water and air have been in place across most states for several decades. The following sections provide some background on the US approach as well as the key features of a number of specific fee systems.

### 4.4.1 State water effluent controls

The Federal *Water Pollution Control Act 1972* provides for the regulation of point-source discharges through a system of national effluent standards that are promulgated by EPA. All point sources must obtain National Pollution Discharge Elimination System (NPDES) permits in order to discharge effluent. By 2012, the EPA had authorized 46 states to issue NPDES permits (Idaho, Massachusetts, New Hampshire, New Mexico and the District of Columbia remain unauthorised).

NPDES permits rely on effluent discharge standards as the primary mechanism for controlling discharges of pollutants to receiving waters. States set wastewater standards according to federally specified minimum levels or higher according to the states' own regulations. When developing effluent standards for an NPDES permit, state officials consider both best available technology standards and water quality standards, and apply the more stringent of the two when setting permitted effluent limitations. Most states issue general permits for wastewater discharges associated with common activities or industries (such as concentrated animal feeding operations or stormwater discharges from industrial activity) and individual permits to address the specific conditions of the facility or activity needing authorisation.

States decide how to calculate permit fees and their quantum. The US EPA last reviewed the NPDES permit scheme in 2001[76]. The review states that the primary purpose of the fees is to raise revenue and that water pollution abatement is only a secondary purpose. The EPA notes that state fee structures fall into one of three categories:

- flat or varies only according to industry or size of permit holders;
- varies according to discharge volume; or
- varies according to discharge volume and toxicity.

Other criteria sometimes used in setting fees include the purpose of the water use, the characteristics of the receiving water, and the type of facility releasing the discharge. Some states use point or class systems with various criteria to determine the fee levels for different dischargers. The primary purpose of NPDES permit fees is to raise revenue to finance the administration of the permitting program. This rationale explains why fees are often based on the complexity of the permit, a reflection of the administrative effort required to get the permit in place. In a number of states, fees are set to attain revenue targets. A secondary purpose is to discourage water pollution.

Of the states that set fees according to discharge volume and toxicity, the EPA notes that many states base fees not on measured discharge characteristics, but rather on more easily measured parameters that are related to discharge characteristics. For example, some fee structures have broad classes for characterizing discharge volume, toxicity levels, or both. These structures impose the same fee within a given volume or toxicity class. In such cases, polluters have no incentive to limit discharges unless they can move from one fee class to another.

The discharge fees are also modest compared to control costs. The USEPA (2001) concluded that although the incentive effect of discharge fees in the United States had not been studied comprehensively, the above factors limited the likelihood that fees based on discharge characteristics have had a great impact.

#### 4.4.2 Selected state effluent permitting fees

As it is beyond the scope of this report to describe the water effluent fees for all individual states, examples from Louisiana, Montana, California and New Jersey and Maine should illustrate typical characteristics of the state NPDES programs. All states are noted in the US EPA (2001) report as differentiating permit fees according to volume and toxicity of discharge, and current fee rates have been identified and reported below.

Louisiana administers general and individual permitting scheme for point source discharges into state waters. Polluters may apply for general permits if the facility type and industrial process is covered by the General Water Permit scheme, which currently includes 23 industrial processes. Annual fees for general permits range from US$0 (small construction, certain pesticide releases) to US$2,640 (certain

[76] USEPA (2001)

petroleum activities). These general permit fees are akin to administrative fees as they do not appear to account for actual discharge volumes or toxicity. [77]

If industrial processes are not covered by the General Water Permit scheme, polluters must apply for individual permits that are calculated by a point system determined by several factors:

- facility complexity;
- flow volume and type;
- pollutants released;
- heat load;
- potential public health threat; and
- the designation of a facility as major or minor, depending upon how many people it employs.

The estimated points are then multiplied by a rate factor of US$148 for municipal facilities and US$272 for industrial facilities, to determine total annual fees. The minimum annual fee is US$345, and the maximum annual fee is US$90,000. In addition to annual fees, Louisiana imposes application fees for new, modified, or reissued permits. In most cases, these fees are 20% of the annual fee.[78]

In Montana the state Department of Environmental Quality administers general and individual permits for point source discharges into state surface waters. As with Louisiana, general permits are applicable where the proposed discharge falls under a predetermined discharge category according to facility type and process, of which there are currently ten. General permit fees comprise of an initial application fee and ongoing annual fees. Application fees are collected to fund the processing of the application while annual fees are collected to cover the costs of administering the permits during their five-year term, including any compliance monitoring and sampling, technical assistance and inspections. Individual application fees range from US$600 (concentrated animal feeding operation) to US$11,000 (municipal storm water sewer system for populations greater than 50,000). The maximum groundwater application permit fee for industrial waste is US$5,000. [79]

Annual fees for individual permits are differentiated by industry or activity type and total discharge volume. Minimum fees apply (ranging from US$600 - $3000) and permit holders for selected industries are also charged flat effluent fees per millions of gallons of effluent released per day (MGD). The highest effluent fee is US$3000 per MGD, and this fee appears to only be applicable to sewerage treatment plants and industrial wastewater discharges. [80]

In California, the State Water Board establishes water quality policies and regulations while Regional Water Boards (based on watershed boundaries) monitor and enforce state and federal plans, policies

77 Louisiana Department of Environmental Quality (2013)

78 ibid

79 Montana Department of Environmental Quality (2011)

80 Montana Department of Environmental Quality (2013)

and regulations. Each Regional Water Board has some autonomy in making critical water quality decisions for its region and it is also responsible for compliance and enforcement actions. While both the State Water Board and Regional Water Boards are able to issue NPDES permits, in practice the vast majority are issued by the Regional Water Boards.[81]

Californian annual NPDES fees are based on the threat to water quality and the complexity of the permit:

- Categories I, II, and III for the level of threat to water quality; and
- Categories a, b, and c for the complexity of the permit.

Permit holders with a I-a rating (the greatest threat to water quality and the most complex permits) pay the highest fees of US$92,593 a year. III-c permit holders pay the lowest fees of US$1,772 a year. Revenue from these fees fund State Water Board programs.[82]

Annual surcharges for ambient water quality monitoring apply, and these are set at 9.5-21% of annual permit fees. In addition, industrial polluters with a threat/complexity rating of I-a, I-b or I-c rating pay an additional surcharge of US$15,000, US$10,000 and US$5,000, respectively.[83]

The New Jersey scheme resembles a load based licensing scheme, at least in parts. Fees are based on an individual facility's potential environmental impact, the billing rate for the category of discharge, and the minimum fee for the category of discharge. However, as the Department of Environmental Protection can only charge permit fees that are 'reasonable' and based upon the costs of processing, monitoring and administrating the NPDES scheme - and fees must not exceed these costs - the incentive effect based on load based permit fees is weak.[84]

Maine's NPDES scheme also contains components similar to the NSW LBL scheme. It charges industrial polluters an annual license fee that incorporates three fees - an administrative base fee, a license fee (differentiated by industry and facility type) and a discharge fee. The discharge fee is levied on oxydizeable matters (BOD or COD,) flow and heat. Effluent loads can be based on measured or estimated flows. Flow and heat discharge fees are flat (although flow fees do differentiate between process and non-process discharges), while BOD and COD fees per pound discharged are calculated by dividing US$21 by the licensed effluent concentration. Revenues are collected by the state Treasury and are earmarked for a special Water Quality Improvement Fund. Due to a lack of published studies, it is not clear whether the discharge fees in this scheme have had an incentive effect.

81 California EPA State Water Resources Control Board (2013a)

82 California EPA State Water Resources Control Board (2013b)

83 California EPA State Water Resources Control Board (2013c)

84 New Jersey Department of Environmental Protection (2013)

#### 4.4.3 State air emission controls

As in the case with water pollution, there are no national air emissions fees. However, the Clean Air Act Amendments of 1990 require states to impose permit fees for certain 'regulated pollutants' (as defined by the Clean Air Act) emitted by significant stationary sources under its Title V Permit Program. States have significant discretion in granting exemptions for emission source categories if the state administrators believe that permit compliance will be "impractical, infeasible or unnecessarily burdensome."[85]

The primary intention of the Title V Permit Program was not to provide an economic incentive for pollution control, but rather to enhance nationwide compliance with the Clean Air Act and to provide a basis for better emission inventories.[86] States set fees in order to cover the administrative costs of their EPA-approved permit program. Such fees must "adequately reflect the reasonable costs of the permit program"[87] and should not exceed program operating costs. Although states can meet the revenue-raising requirement through flat fees or other types of fees, most have chosen incremental per-ton fees. Some states have differentiated their fees based each pollutant's potential harm to the environment.[88] New Mexico, for example, levies fees of US$186.25 per tonne for air toxics but only US$29.30 per tonne for criteria pollutants.[89] Fee structures in Oregon, California and Maine are discussed below for illustrative purposes..

#### 4.4.4 Selected state air emission fees

***Oregon***[90]

Annual Title V emission permit fees in Oregon comprise of a base fee and emission fee. Base fees are currently US$7,657 per annum and regulated pollutants are levied a flat US$57.90 per tonne. Hazardous air pollutants are not subject to emission fees. Permit holders are also subject to ad hoc "specific activity fees" assessed when a source owner or operator modifies a permit (US$1,867 - $28,016, depending on the complexity of the application) or when they are required to report emissions to the Department of Environmental Quality (US$3,735 to provide an ambient air monitoring review).

Assessable emissions are based either on permitted emissions or actual emissions. Actual emissions can be calculated on the basis of continuous emission monitoring, verified emission factors or material balance for sulphur dioxide (for fuel use) and VOCs (for solvent and coating uses).

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85 U.S. Code Chapter 85, Subchapter V, § 7661a - Permit programs, section A

86 Bay Area Air Quality Management District (2013)

87 U.S. Code Chapter 85, Subchapter V, § 7661a - Permit programs, section b (B) i

88 USEPA (2001)

89 New Mexico Environment Department (2014)

90 Information in this section has been drawn from Oregon Secretary of State (2014); Oregon Department of Environmental Quality (2014); and Oregon Department of Environmental Quality (2012)

One interesting feature of the Oregon scheme is fee liabilities extend only to emission fees up to (and including) 7,000 tonnes per annum from *all* regulated pollutants from any source. This implies that the maximum emission fee payable from any one source is US$405,300 per annum, regardless of the pollutant mix or whether or not the quantum of emissions exceeds 7,000 tonnes. This actually represents a lowering of potential fees as prior to 2010 emission fees were assessed up to (and including) 4,000 tonnes per annum on *each* regulated pollutant from each source.

A final note on the Oregon scheme is that it excludes approximately 60 activities from fee liabilities under its “categorically insignificant activities” exclusion. These activities are diverse and cover such broad categories as office activities, temporary construction activities and warehouse activities, to the more pointed pharmaceutical packaging and industrial cooling towers that do not use chromium-based water treatment chemicals. These exclusions are still subject to mandatory emissions reporting.

***California***[91]

Stationary source air pollution in California is the responsibility of regional Air Pollution Control Districts and Air Quality Management Districts. These agencies develop and implement regional air quality management plans in order to comply with air standards set by national and state legislation.

The South Coast Air Quality Management District (SCAQMD), located in Southern California levies the highest fees per unit of air emissions in the United States. Its scheme is relatively unique in that it levies individual fees on regulated pollutants. Emission fees for so-called ‘criteria pollutants’ are shown in Table 4.9 and these fees are differentiated by pollutant and total annual emission load. The remaining HAP pollutants are charged at a flat rate once an annual emission threshold is exceeded. These fees are shown in Table 4.10. Emission fees for both are adjusted for inflation and budgetary needs of the SCAQMD every May. The main purpose of these fees is to recover the administrative costs of SCAQMD’s activities.

**Table 4.9: Criteria pollutant emission fees in California** (US$ / tonne)

| Annual emissions | Organic gases | Specific organics | Nitrogen oxides | Carbon monoxide | Sulfur oxides | Particulate matter |
|---|---|---|---|---|---|---|
| 4−25 tons | $559 | $100 | $327 | - | $388 | $428 |
| 25−75 tons | $907 | $158 | $520 | - | $627 | $693 |
| >75 tons | $1,359 | $238 | $783 | - | $941 | $1,037 |
| ≥100 tons | - | - | - | $6.68 | - | - |

91 Information in this section has been drawn from South Coast Air Quality Management District (2005)

Facilities that temporarily exceed their allowable emissions levels must also pay excess emissions fees. For most pollutants, the excess emissions fees are about the same as the regular fees. For carbon monoxide, however, they are approximately twice as high. In addition, SCAQMD imposes fees for visible emissions and various administrative procedures.

Fees for some air toxics have escalated rapidly, far faster than the fees for criteria air pollutants. Between 1996 and 2000, emission fees for asbestos; cadmium; hexavalent chromium; chlorinated dioxins; 1,3 butadiene; and lead rose by 50% to more than 100%.

The EPA (2001) notes that given the presence of traditional forms of regulation and other factors that might influence air pollutant emissions, the incentive effect of the SCAQMD emissions fees is difficult to determine. In most cases, these fees are lower than the marginal costs for pollution abatement.

**Table 4.10: Air toxics and ozone-depleting chemicals emission fees in California** (2010)

| **Pollutant** | **Fee US$ / lb** | **Annual Emission Threshold lbs** |
|---|---|---|
| Ammonia | 0.03 | 200 |
| Asbestos | 5.85 | 0.0001 |
| Benzene | 1.97 | 2.0 |
| Cadmium | 5.85 | 0.01 |
| carbon tetrachloride | 1.97 | 1.0 |
| Carbonated dioxins and dibenzofurans | 9.74 | 0.00002 |
| Ethylene dibromide, ethylene oxide, Vinyl chloride, lead | 1.97 | 0.5 |
| Ethylene dichloride | 1.97 | 2.0 |
| Formaldehyde, perchloroethylene | 0.43 | 5.0 |
| Hexavalent chromium | 7.79 | 0.0001 |
| Methylene chloride | 0.08 | 50.0 |
| 1,3 Butadiene | 5.85 | 0.1 |
| Inorganic arsenic | 5.85 | 0.01 |
| Beryllium | 5.85 | 0.001 |
| PAHs | 5.85 | 0.2 |
| 1,4 Dioxane | 0.43 | 5.0 |
| Trichloroethylene | 0.16 | 20.0 |
| Chlorofluorocarbons | 0.37 | - |
| 1,1,1-trichloroethane | 0.05 | - |

***Maine*** [92]

Maine charges air emission fees on the discharge of sulfur oxides, nitrogen oxides, VOCs, and particulate matter. Fees are differentiated by the scale of emissions and are indexed for inflation. The current fee schedule is shown in Table 4.11. Minimum and maximum annual emission fees of USD $250 and $150,000 apply.

Maine also imposes an air quality surcharge based on the toxicity of a further 197 hazardous air pollutants. Theses pollutants include the 187 federal HAPs as well as other toxic chemicals such as dioxin, furan and PCBs. US$2.19 is added to the annual permit fee for every 1,000 air quality units of these pollutants emitted. Air quality units are determined by multiplying the toxicity score of the air pollutant by the estimated emission on that pollutant.

**Table 4.11: Air emissions permit fees in Maine 2014**

| Amount Emitted Fee | (US$ / ton) |
|---|---|
| Up to 1,000 tons | 8.40 |
| 1,000-4,000 tons | 16.83 |
| More than 4,000 tons | 25.21 |

Sources are required to pay a minimum air quality surcharge of USD $154 up to a maximum of USD $77,429. In 2001 approximately 85 facilities were subject to this additional fee. The surcharge is meant to act as an incentive on polluters to reduce emissions of their most toxic substances.

The EPA (2001) reports that the surcharge has had a slight incentive effect. In 2001 permit fees produced approximately US$1.8 million in revenues, and toxicity surcharges netted US$0.6 million in revenues. Revenues are used for the air permit program and other air quality activities.

92 Information in this section has been drawn from Maine Department of Environmental Protection (2013, 2014)

# 5 ASSESSMENT OF ECONOMIC INCENTIVE SCHEMES

The purpose of this section is to draw together the observations and lessons from both the case studies and broader review of OECD pollution incentive schemes so as to distil pertinent issues for the NSW context.

## 5.1 Overview of economic incentives employed for reducing industrial pollution

A description of the range of schemes and key features was provided in section 3. In this section, key economic issues associated with the air and water emission fee schemes are canvassed, including the scope and scale of fees, incentive targeting, revenue recycling, compliance flexibility and the pollution abatement responses.

### 5.1.1 Scope and scale pollution fees

The case studies have included schemes of different breadth, ranging from the Swedish NOx scheme covering a single pollutant to the WA licence fee scheme covering over 57 air and water pollutants / classes of pollutants. In the broader review of OECD schemes it was identified that typically only a small number of pollutants were included in water effluent charging schemes, while coverage in the air emission schemes was much broader.

In terms of liable parties, of the case study schemes the French fees for industrial air pollution included the greatest number of facilities (around 1,500) while the SA pollution discharge fees apply to the smallest number of facilities (around 100).

A narrow coverage in terms of pollutants and facilities can still deliver significant improvements if the incentives are well targeted and the liable parties are key contributors to the overall pollutant loads creating the environmental problem. However efficiency losses could arise where incentives impact the competitiveness of liable parties with other producers (in that jurisdiction or elsewhere) or if the incentives lead to perverse impacts through increases in other pollutants (such as with the Swedish NOx fee).

### 5.1.2 Incentive targeting

The fee levels in the Danish wastewater scheme were found to approach estimated externality damage impact values, as is the Swedish NOx fee. Water pollutant fee rates were also found to be high in Germany and Estonia (with rates in the latter increasing significantly further over the next couple of years). Apart from a NOx fee on a rather limited base of activities in Norway, no other air pollution fees appear of a scale equivalent to that in Sweden. So in general, fee rates across OECD countries are likely to fall well short of externality impact values.

In addition, the French air pollution fees are not only low compared with estimated damage costs, they have largely been uniformly set. Accordingly, the French fees provide little incentive targeting, further undermining the efficiency of the scheme. That is, for the same overall fee revenue, a greater reduction in environmental damage costs is likely to have been possible had the fees been differentiated according to *relative* externality impact values.

The Australian schemes on the other hand have more modest fee levels and a greater range of pollutants included, but provide far greater targeting of fees relative to emission impact values. The NSW and WA schemes differentiate fees to reflect the harmfulness of the different pollutants relative to each other and in different locations. The NSW fee regime also adjusts fees where the means or timing of emission discharges significantly impacts the likely scale of environmental impacts. These features were also found to be employed in a number of OECD schemes.

The use of a fee rate threshold in NSW which doubles the fees payable above a reasonably achievable discharge level, places a greater incentive on the worst performers who are likely to face the lowest marginal costs in reducing emission loads. In this way, the incentive force of the fees and overall effectiveness and efficiency of the scheme is enhanced. This feature is less common overseas, although in several instances fees are only payable for discharges above a minimum level, and in a few instances fee rates are differentiated by the scale of discharges.

More common are differentiated rates according to industry type or plant size, as are a range of exemptions to various industries and facilities. Clearly the environmental impacts of discharges is unlikely to vary based on industry type, and so these concessions serve to diminish the incentive force

### 5.1.3 Revenue recycling

Recycling revenues to minimise the cost burden on regulated parties may be pursued for equity reasons, to minimise distortions in competitiveness relative to those plants not included (and prevent production shifting to unregulated sectors or to other jurisdictions), or sometimes plainly for political support of a regulation. The use of revenue recycling mechanisms in the Swedish and French schemes were important to win stakeholder support.

Whilst revenue recycling has played a useful role in assisting implementation of some international schemes, it can undermine the efficiency of the economic tax instruments. As noted by Sterner and Isaksson (2005), a tax instrument has four different effects:

- an abatement effect;
- an output substitution effect;
- a fee-interaction effect; and
- a revenue-recycling effect.

The abatement effect is the main concern of an emissions fee. It includes all efforts to reduce emissions. The second is the fall in demand caused by the rise in price of the regulated industry's product due not only to abatement costs but also due to fee payments. In principle, this is part of an efficient response in a 'first-best' setting.

The tax interaction effect relates to changes in 'deadweight' welfare losses related to the interaction between the jurisdictions' taxation regimes and production and consumption changes due to the environmental policy instrument.

The revenue-recycling effect is the efficiency gain / loss from using the emissions fee revenue. In some instances, emission fees have been introduced as part of broader 'green' tax reforms where environmental fee revenues are used to finance cuts in (distortionary) labour and profit taxes. Where revenues are recycled back to regulated parties, the impact will be comprised of second round abatement, output and tax interaction effects, depending on exactly how revenues are returned.

Different fee instruments will variously embody these four effects. The primary purpose of environmental fees will be the abatement effect, as the output effect will typically be seen as a negative by communities. For example, communities may desire a reduction in pollutant emissions from say the electricity sector, but may look unfavourably on lower output of electricity or electricity-using industries. As noted by Sterner and Isaksson (2005), typically governments go to great lengths to make sure that there are no detrimental effects on output, employment and competitiveness of national industry.

When environmental fee revenue is recycled in the form of output subsidies, as with the Swedish NOx scheme, it will generate a positive output effect, with an associated increase in pollutant emissions. In this way, output based recycling sacrifices some of the first round efficiencies of an emission fee.

For example, a study by Resources for the Future (Fischer 2001) analysed schemes that combine a fee on emissions with a subsidy to output. The study found that the result of recycling revenues based on output share was a shifting of emissions control efforts towards greater emission rate reductions and less output contraction, with higher marginal costs of control and lower output prices compared to the social optimum, given any targeted level of abatement. Fischer also discusses some additional disadvantages with output-based allocation of environmental fee revenue: the difficulty to define output and the relevant sector coverage, and unexpected entry and exit effects following manipulation of eligibility for an output subsidy.

The revenues of the French fee on air pollution were refunded through subsidies for investment in pollution abatement technology. While this will have an additional abatement incentive effect, it will also have an output effect. Pollution abatement subsidies can increase pollution if the output-increasing effect of the subsidy exceeds its pollution abatement effect, which similar to output-based revenue recycling would serve to undermine the first round efficiencies of the emission fee.

Indeed in the case of the French air fees, an empirical analysis by Millock and Nauges (2006) has suggested that not only have the pollution abatement subsidies accompanying the air fees had a negative impact on emissions, this impact has been much greater than the emission reductions attributable to the fee. That is, the combined fee/subsidy has increased polluting emissions in the sectors examined.

The authors believe that this result is:

> *'… explained by the low level of the French air pollution fee compared to the levels of abatement subsidies as well as a low effectiveness of the subsidized technologies, which led the input-use increasing effect of an abatement subsidy to dominate the pollution-reducing effect of the subsidy'.*

While it should be noted that the study applied only to three industrial sectors (iron and steel, coke, and chemistry) and that the derived model had a poor explanatory power (the overall fit as measured by the R-square was 0.11), the results suggest caution in the use of revenue recycling tools.

Finally, revenue recycling is not a component of any of the Australian schemes, with all revenue collected from the more modest fee rates directed to consolidated government revenues.

However the NSW Load Reduction Agreements serve a similar purpose, in that some future fee liabilities are put aside if the licensee commits to pollution load reductions (these type of agreements were found to be common across the OECD schemes). The fee 'offsets' are applicable to any nominated (and approved) means of reducing emissions and the offset cannot exceed the future fee liability. Therefore the agreements are unlikely to have a perverse impact as they merely bring forward fee savings from emission reduction action, increasing the viability of such actions and hence increasing the incentive force of the fee and overall emission reductions.

### 5.1.4 Compliance flexibility

Regulated facilities will face a range of means to reduce on-site emission discharges, ranging from changes in the use of inputs, production processes and end-of-pipe emission controls. Facilities may also have flexibility in where production is undertaken and emissions discharged, along with the means and timing of discharges or perhaps whether complementary actions are undertaken which can lessen the harmfulness of emissions. It may also be possible for facilities to reduce off-site emissions or emission impacts through product redesign (for example fuels can be reformulated to discharge lower emissions when used in vehicles) or commissioning offsetting actions (such as where a wastewater treatment plant funds diffuse-source nutrient runoff from nearby agricultural land).

Efficiency gains will be maximised where facilities have flexibility as to how they can reduce emissions and comply with the pollution fee regulations.

Importantly, all the case study schemes apply emission fees at the facility level rather than at individual discharge points, providing flexibility as to where at facilities and how emission reductions can be made. Most OECD schemes also provide some flexibility as to whether emission discharges have to be measured or estimated, allowing the regulated entity to determine whether potential fee savings through monitoring to demonstrate reduced emission loads is worth the investment. Typically emission factors that can be used are conservative, to provide an incentive for the liable facilities with larger emissions to adopt emission monitoring and to measure actual loads.

Beyond this, the NSW scheme is relatively unique in providing a number of other measures aimed at increasing compliance flexibility, such as recognising the contribution that changing the means or timing of discharges can have on environmental impacts and allowing for offsets to be negotiated.

Alternatively, broader regulatory settings can work to limit compliance flexibility. An example is where broader regulatory settings are not adjusted in line with the pollution fee incentives. Administrative regulations operating alongside the Danish wastewater fees are believed to have reduced flexibility for dischargers in responding to the fee. Similarly, some licensees in NSW and SA were concerned that when pollution load (mass) fees were introduced that technology-based discharge concentration standards would not be amended. Concentration standards have typically been employed to ensure the proper and efficient operation of pollution control technology and to manage the localised and acute impacts of emissions. However in some instances, concentration standards along with maximum discharge flow rates, were also used as a coarse means to regulate the mass of emission discharges to assist the management of cumulative regional emission loads.

As also mentioned in relation to the Danish wastewater fees, price regulation of publicly owned monopoly water utilities may not be developed to a stage that allows (indeed demands) that fee liabilities on pollutants discharged from wastewater treatment plants be 'passed' back to industry and households generating the wastewater. In the absence of such oversight, pollution abatement at source is not encouraged. In this regard, it is noted that IPART has approved the passing on of LBL fees for both Sydney Water and Hunter Water. The ‘trade waste’ scheme operated by Sydney Water with ‘polluter pays’ fees based on ‘risk’ and the ability of the treatment plant to process (and meet EPA discharge requirements) is a good example of how facilities subject to LBL have adapted to the incentive fees.

### 5.1.5 Pollution abatement response (price elasticity)

Identifying pollution reductions attributable to pollution emission fees is difficult. Total emissions subject to an emissions fee may be a poor indicator, as the underlying number of liable premises and scale and mix of production can change over time. In addition, the various exemptions, subsidies, rebates, etc that can be available to liable premises through the fee or other schemes can also mask the true incentive effect of the fees.

The available data shows that significant overall emission reductions from fee liable premises were observed for the Swedish NOx and Danish wastewater schemes. [93]

The Swedish EPA found that average NOx emissions per unit of energy produced for plants initially subject to NOx emission fees fell by around 50% in the first four years of the scheme, and has attributed around half the emission reduction to the NOx fee. Further, a study by Höglund-Isaksson (2009) reported:

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93 Boyd (2003) also indicates that econometric analysis suggests that the Dutch effluent fees have been responsible for a significant improvement in water quality. However the source studies are quite dated, current fee rates are modest and no other commentators have argued the success of this scheme.

> *'The introduction of the NOx charge was found the single most important reason for adoption of NOx mitigation measures in 1990 to 1996 by 114 regulated plants. In a survey of 73 plants regulated by both quantitative standards and the NOx charge in 1997 and 2001, actual emission intensity levels in 2001 were found on average 40% lower than the emission intensity limits specified by the quantitative standards.'*

The study by Millock and Nauges (2006) of the French air emission fees provides the only available empirical analysis of pollution abatement price elasticities for the case study schemes (see Table 4.10). The study found emission discharges for NOx and SOx emissions were price responsive in the iron and steel and chemical industries, but inelastic in the case of the coking industry.

### 5.1.6 Other factors impacting scheme efficiency

The scheme that was most successful in contributing to reductions in its targeted pollution loads appears to be the Swedish NOx scheme, as a result of the high per unit discharge fee made feasible by the revenue recycling mechanism. The requirement for continuous monitoring was also identified as a key factor in its success.

The success of the NSW load based licensing scheme has been attributed to its design which maximises incentives for incremental improvements by focusing on the major contributors to pollutant loads, and the pollutants and discharge locations causing the greatest environmental impacts. The doubling of fees above a threshold level of emissions also serves to increase fee incentives for facilities where the most cost-effective emission reductions are likely.

More broadly and summarising key issues raised, the main factors identified limiting the efficiency of the case study schemes are:

- the low level of fee rates (for the French, NSW, SA, and WA schemes);
- exemptions and fee caps to protect industry competitiveness (for the Danish and WA schemes);
- efficiency losses from the recycling of revenues through end of pipe subsidies (for the French scheme);
- lack of price regulation of public utilities to ensure cost-minimisation and cost pass through to promote source pollutant reductions (in the case of the Danish and possibly Australian schemes);
- lack of monitoring of emissions for fee calculation purposes (for the French and WA schemes); and
- focus on a single pollutant may result in increases in other pollutants (for the Swedish scheme).

## 5.2 Successful system characteristics

Various stakeholders will have differing views as to how particular schemes perform. Even third-party assessments as to scheme effectiveness and efficiency must give weight to the regulatory purpose and scheme objectives. As outlined in this report, schemes have typically been introduced for multiple purposes, including administrative cost recovery and to provide an incentive for pollution abatement. Accordingly, success is context specific and hence care is needed in making generalisations across disparate schemes.

Nevertheless, below we draw on our observations and third-party commentary to highlight key features that have affected scheme performances .

***Real incentives require fee levels to exceed the cost of emission abatement***

Notwithstanding the generally low level of fee rates observed, behavioural changes in emission management are unlikely if voluntary action by facilities will result in a net cost to them - that is, fee savings will not outweigh expenditures in pollution abatement.

ECORYS (2011) when comparing the French and German water effluent charging schemes argue:

> *'Despite the fact that the charges in Germany are relatively higher than in France, in both cases, the level of charges was considered to be too low to induce investment beyond the set minimum. For companies, it was cheaper to pollute (pay the charge and make symbolic investments just to meet the minimum standards) than to invest in smarter abatement solutions. This is particularly obvious when comparing France and Germany to the Netherlands, which set effluent charges at a much higher level, and motivated further investment. The main lesson learnt here relates to the "right" level of the charges that should be placed in a way that creates incentives to industries, ie:. by making the cost of new investment lower than the charge.*

And the right level of fees need not be punitive. As argued in section 5.1.2, the targeting of incentives with priority emission reductions and providing maximum compliance flexibility to liable facilities can provide real incentives within a modest overall level of charges.

***The environmental effects of incentives are compromised by the existence of exemptions***

It was noted in section 3 that exemptions are common in both air and water emission schemes to exclude either small facilities that are unlikely to have significant emission loads, or larger facilities that are able to keep emission loads low.

More problematic is that it is also common across schemes, particularly in relation to water effluent fees, to exempt certain industries and facilities. This is seen in the exemptions outlined in the Danish case study, as well as various agricultural exemptions in Denmark, France, Slovenia and Spain (Aragòn). Exemptions can also be found in other scheme provisions. For example, EPI Water (2011) when commenting on the German wastewater scheme, argue that a "hardship clause" has provided exemptions for certain facilities which was important for political acceptance but impacted the effectiveness of the scheme.

ECOTEC (2001) argue that exemptions to affected sectors have been granted too regularly, often based on a static cost assessment and without reference to the potential dynamic efficiency effects. The effect of broad exemptions is to render the fee less significant both in terms of environmental effects and in terms of promoting structural change in the economy. They go on to argue that dynamic adjustments which minimise exposure to the fee are usually possible, and these have environmental benefits. Further, ECOTEC argue that the rationale for exemptions would be reduced where all or part of the revenues generated by a levy were earmarked for the provision of information to support the environmental objectives of the levy. Interestingly, this could encourage development of a more competitive industry.

***The incentive force of fees needs to be maintained in real terms***

Many schemes, such as in the Czech Republic and Poland provide for fee rates to be increased in line with general price movements in the country (ala CPI). But this has not always been the case, including initially with the NSW LBL scheme.

EPI Water (2011) commented in relation to the German wastewater scheme, that the charges were not adjusted for inflation, while the costs of measures for mitigation and avoidance increased with inflation. Stagnation of the nominal discharge fee in combination with clauses which allowed polluters to offset fee payments over time, has led to a real depreciation of the fee burden and effectiveness of the scheme.

***Be judicious and cautious with rebates***

The vast majority of schemes earmark revenues to return to liable industries / facilities (revenue-recycling) or to fund broader environmental expenditures by the government. As discussed in section 5, revenue-recycling can create significant efficiency losses when tied to pollution abatement subsidies as in the case of the French fee on air pollution.

Other examples exist, such as in the case of the water load fee revenues in Hungary. In this case, EPI Water (2011) argue that the incentives were a failure as the revenues achieved were far less than expected, primarily because the fee payers significantly exploited the system of allowances set aside for instrument purchases.

Another example cited by ECORYS (2011) is Germany. They argue that the effectiveness of the water effluent fee has been limited and obscured by rebates to assist facilities conform with *best available technology* standards. This has significantly weakened the effectiveness of the fee and reduced its primary incentive function.

On a more positive note, Gosar and Muri (2005) note that rebates of 60% were made available under Slovenia's waste water fee and rebate structures introduced in 2004, but that the subsidy rate was set to fall to 40% from 2008. This tapering in the subsidy level provided an incentive for early investment and lessened the ongoing erosive effect of the subsidies on the fee incentive.

***Ensure incentives are complementary to broader regulatory settings***

In almost all OECD countries examined, emission fees sit alongside regulatory standards that variously dictate the abatement technology that is to be employed and / or concentration-based emission standards. In several instances commentators have argued that success in reducing pollutant loads requires incentives to be effectively integrated in broader regulatory settings.

For example, Kathuria (2005) in relation to the Polish water pollution charges argues:

> *'The most important lesson learned from the Polish example is that it did not rely exclusively on charges; rather it is the combined use of discharge permits based on environmental quality standards with fees and fines, public environmental subsidy schemes and widely publicized list of the worst polluters that brought the pollution problem in control; and these were complemented by long-term consistency, gradual tightening of enforcement and limited administrative discretion.'*

Similarly, Earnhart and Lizal (2008) who undertook an econometric analysis of firm-level air pollutant emissions from a panel of Czech firms over the years 1993–98, concluded that it was the combined effect of raising emission charge rates and imposing stringent emissions limits on new facilities and gradually imposing the same emissions limits on old facilities that prompted real emissions reductions:

> *'The findings indicate that the Czech Republic did not reduce its air pollutant emissions simply by reducing output or by driving older facilities out of the market while replacing them with new facilities. Instead, the Czech Republic may have induced even older facilities to improve their air pollution controls.'*

However not everyone is in agreement. EPI Water (2011) in relation to the effluent fee in Germany argue that as the cost of abatement measures increased with inflation and emission standards became more stringent, *'the effluent fee could not develop its full potential for encouraging innovation to abate residual pollution. While good results have been achieved in terms of environmental outcomes, the policy mix has been deprived of the effluent fee's essential contribution to achieve its objectives'.*

As noted in section 5.1.4, broader regulatory settings can work to limit compliance flexibility in response to fee incentives, and examples were given, firstly in relation to technology-based discharge concentration standards limiting compliance options, and secondly in relation to price regulation of publicly owned monopoly water utilities.

The conclusion is that incentives can be complementary or conflicting with broader regulatory settings. There is no absolute, incentives need to be designed appropriate for each regulatory context.

***Large emission reductions are typically associated with emission measurement***

OECD (2010) observe that continuous (and correct) measurement of emissions is important for bringing attention to low-cost emission reductions that can be achieved simply by "trimming" production processes. In a number of countries, continuous measurement of a broad spectrum of pollutant emissions is now compulsory for many sources.

As noted in section 5.1, the lack of monitoring of emissions for fee calculation purposes appears a weakness of the French scheme, while the mandatory requirement for continuous monitoring of emissions from regulated plants is thought to be a key factor contributing to the success of the Swedish NOx scheme include.

On the other hand, emission monitoring can be expensive and it is therefore common for liable facilities to be provided a choice between monitoring and measuring emission loads with that of estimating loads with the us of emission factors based on easily observed factors such as fuel use or production levels. A seemingly successful approach in these instances has been to set emission factors conservatively, to provide an incentive to employ emission monitoring. In this way, the facilities with the largest pollutant loads will have the greatest potential savings.

## 5.3 Scheme evaluations and reforms

Several schemes have been subject to major amendments since their introduction, including those in France, the Czech Republic and Slovenia.[94] However any evaluations of the initial schemes undertaken by or for governments to guide subsequent amendments are not in the public arena.

Nevertheless, the nature of the amendments provide an indication of new priorities and therefore insight into likely evaluation conclusions and recommendations.

### *French air emission fees*

The initial French air emission fees introduced in 1990 were overhauled in 2000. As described in section 4.2, the new system continued to levy emission fees on the same classified premises and subject to the same thresholds. However while some have argued that the focus remained revenue driven, applicable fee rates were increased, with rates for some pollutants increased 2-3 fold in 2011/12. In 2013 the scheme introduced fees for emissions of five new air pollutants - benzene, arsenic, selenium, mercury and polycyclic aromatic hydrocarbons (PAHs) - and the liability threshold for emissions of total dust was reduced from 50 to 5 tonnes/year.

The new fee regime now places the French emission fees towards the upper end of fee rates across the OECD. While these rates are still modest compared to likely externality damage values, there has been a clear move following the review of the old scheme to strengthen the incentive force of the fees and to improve its targeting through the inclusion of additional pollutants and reduction in the dust threshold.

### *Czech air emission fees*

On the other hand, the Czech air pollution fee scheme was simplified in 2012 and reduced the number of liable pollutants from more than twenty to four. Maca (2013) describes the reforms:

94 There has also been significant revisions to the Japanese levy to stationary and mobile sources of sulphur oxides. As described in this report, the scheme is unique in that levy rates are calculated to fund a compensation fund for victims of air-pollution related illnesses. A description of changes to the scheme can be found in OECD (2010).

*The last reform took in part account of various analyses showing very low effectiveness of the fees. According to new air pollution law only 4 polluting substances are charged (while before the reform 9 main pollutants and 2 pollutant classes were charged) and the fee is only due if it exceeds CZK 50,000 per year for a pollution source (before this threshold was CZK 500).*

*The new Air Protection Act increases the fee rates by around 50% for 2013 (i.e. CZK 4,200/t for particulates, CZK 1,350/t for SO2, CZK 1,100/t for NOX, and CZK 2,700/t for VOC) and from 2017 to 2021 a gradual increase in rates should follow (with about 4 times overall increase in rates). The revenues from the fees amounted to CZK 370 million in 2011 (i.e. prior the last reform).*

*The effectiveness of former setting were explored by Ritschelová et al. (2008) in their analysis of effects of environmental charges in CR, concluding that the share of air pollution fees on total revenues of firms subjected to these fees was almost invariably below 0.5%. The biggest payers recruit from two sectors – energy generation and metals production. In a scenario of 7- 16 fold increase of the fee rates the share of air pollution fees on total revenues will stay below 1% for 97% of firms and for the remaining 3% of firms would fall between 1-5%.*

*Based on an empirical survey conducted in 2005, Jílková et al. (2006) show that administrative costs of air pollution fees for large emission sources amount to about 2.5-3% of revenues, but administrative costs of fee collection from medium-sized sources (e.g. combustion sources between 0.2 and 5 MW of thermal output) exceed revenues by more than 40%. This finding was later used in support for abolition of air pollution fees from medium and small sources. A very similar picture was also shown for compliance costs for firms indicating relatively fixed costs of fee administration and consequently high transaction costs of charging small- and medium-sized polluters.*

*In the parliamentary debate on the new Clean Air Act one of the options discussed was a complete abolition of the air pollution fees, the alternative one was a radical reduction in pollutants charged and substantial increase in rates and the latter option was later adopted (though in a slightly modified version).*

### *Slovenia waste water fee*

In 1996, Slovenia imposed flat emission fees for a range of pollutants across all liable premises. As part of a national environmental action program, revisions were made in 2004 to the wastewater fee scheme. Under the revisions, rebates will be provided for approved technologies / programs that align with the Government's action program. Liable facilities will continue to pay emission fee liabilities, but rebates of 60% initially tapering to 40% after 2008 will be paid directly to realisation of approved investments.[95]

Each local authority has to adopt a local action program of measures for wastewater reduction in line with the national action program of measures for collection, treatment and discharge of wastewater adopted by the Government.

95 Gosar and Muri (2005)

## 5.4 Emerging trends

Most of the identified schemes have been in operation for many years, with only a small handful being overhauled since their introduction. In addition, no pending OECD pollution fees, fee proposals or reviews of fee designs have been identified to indicate future directions.[96]

Nevertheless, some observations on possible trends are provided below:

- there appears to be increasing attention to the selection of pollutants. Some schemes such as the French air emission fees have been broadened recently to include more pollutants, whereas other schemes such as in the Slovak and Czech Republics have reduced the number of liable pollutants (as well as an Armenian scheme which reduced liable air pollutants from 51 to 10 in 2000).
- the use of thresholds to determine liable activities remains common and subject to little change. Thresholds to determine liable facilities have been the subject of reform, typically to lower production thresholds for inclusion in a scheme. A number of schemes have also refined thresholds to exempt fee liabilities on emissions below minimum quantities, fee levels or associated with best practice pollution management. In this way regulatory burdens have been lessened with minimal environmental implications.
- no fee rates appear to have been reduced, while many jurisdictions have increased pollutant fee rates. As indicated above, increases in France and the Czech Republic have been significant, such that it would be reasonable to term the fee rates as 'towards' externality pricing.
- a number of jurisdictions have also sought greater differentiation in fee rates based on the receiving environment. This is consistent with the other trends towards increased targeting and higher rates, to sharpen the incentive force of incentives.
- fee waivers, similar to load reduction agreements under the NSW LBL scheme, are a common feature of schemes. There is little information on the success or otherwise of these agreements, or whether they are becoming more broadly available. On the other hand, there do not seem to be instances where access to the agreements has been discontinued.
- also, there appears to be a greater targeting of rebates and subsidies, now that evidence has emerged from France, Germany and Hungary that rebates have significantly reduced the effectiveness and efficiency of incentives.

Finally, the OECD in its 2010 review of environmentally related taxation conclude:

> *'In looking towards the horizon, there are three significant trends that will likely continue to drive development on environmentally related taxation.*

96 Outside of the OECD, China is notable in recently announcing a plan to fee SOx emissions to air and some water pollutants

*'The first is the greater utilization of environmentally related taxation to address a wider range of pollutants. Extending the role of taxation to new pollutants beyond taxes on motor fuel and vehicles will be driven by the desire to more efficiently address environmentally harmful activities that have generally been constrained by regulations or not a at all. This will be aided by new technologies that should make monitoring easier and more cost effective. Such taxes will likely be on smaller bases, thereby not leading to significant revenue increases for governments.*

*'The second trend is countries looking to reform existing taxes to make them more effective at meeting environmental targets. This entails ensuring that taxes are not simply levied on bases to raise funds but are structured to more adequately address environmental challenges. Such reforms can be structured to be revenue neutral to governments while brining about significant environmental benefits.*

*'Finally, the third trend is the significantly larger role of climate change in government environmental policies'* [97]

[97] OECD (2010, p. 59)

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## APPENDIX A: Water effluent fee schemes

Information on individual effluent charge schemes has been sourced primarily from the OECD Database on Instruments Used for Environmental (http://www2.oecd.org/ecoinst/queries/).

Additional references that augment the OECD Database information are noted. '**Scheme'** refers to the current operational scheme and '**Year introduced'** refers to commencement of water effluent charges and not necessarily the commencement of the current operational scheme.

### 1. Belgium

#### 1.1: Waste water charge (Wallonia), water pollution fee (Flanders).

**Year introduced:** 1990 (Wallonia), 1991 (Flanders).

**Pollutants**: SS, BOD (Flanders), COD, nitrogen, phosphorus, heavy metals.

**Rate:** Pollution units are determined according to waste water flow, chemical oxygen demand, amount of suspended solids and thermic pollution. A charge of €8.92 per pollution unit applies to Wallonia, €41.33 in Flanders.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Exemptions apply to direct discharges from sewage treatment plants and industrial plants with less than 7 employees. In Wallonia agricultural users with pollution charges amounting to less than 45 pollution units per hectare are feed at domestic waste water user levels.

**Rate reductions**: Information not available.

**Revenue:** Used to fund general environmental policies and investments in municipal waste water infrastructure in Flanders. Financing of waste water and sewage infrastructure and water protection policies in Wallonia.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy.

#### 1.2: Manure fee (Flanders)

**Year introduced**: 1991 – 2007 (discontinued).

**Pollutants**: Manure.

**Rate**: A basic manure fee of 0.01€ per kilogram of nitrogen and phosphor produced, and a higher fee of 0.99€ per kilogram of nitrogen and phosphorous production above regulated limits. Imported manured was feed at 2.48€ per tonne.

**Emission estimation methodology:** Measured.

**Operation:** Fee on manure production and importation.

**Rate reductions**: Information not available.

**Revenue**: €10.1 million in 2006. 100% was allocated to an extra-budgetary environmental fund.

**Effectiveness:** Information not available.

**Compliance:** Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy.

## 2. Canada

### 2.1 British Columbia

**Scheme:** Waste discharge regulation.

**Year introduced:** 1992.

**Pollutants**: Ammonia, AOX, arsenic, BOD, chlorine, cyanide, fluoride, metals, nitrogen, oil and grease, other petroleum products, other solids, phenols, phosphorus and phosphates, sulphates, sulphides, surfectants, SS, other contaminants not otherwise specified.

**Rate:** Polluters pay a base administration fee of $100 Canadian dollars (CAD) plus discharge fees. Fees per tonne in Canadian dollars: ammonia $102.91, AOX $273.24, arsenic $273.24, BOD $20.64, chlorine $273.24, cyanide $273.24, fluoride $102.91, metals $273.24, nitrogen $41.13, oil and grease $68.61, other petroleum products $68.61, other solids $13.66, phenols $273.24, phosphorus and phosphates $102.91, sulphates $4.01, sulphides $273.24, surfactants $68.61, SS $13.66, other contaminants not otherwise specified $13.66.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Polluters require a permit to release point and non-point water pollutants. Certain industries are exempt from discharge fees if they operate according to an approved industry code of practice that regulates water effluent discharge. No fees are payable if the permit are held by the governments of British Columbia or Canada. Fees are collected annually.

**Rate reductions**: Not applicable.

**Revenue:** $9.4 million USD was collected in 1998 for both water and air discharge schemes. 100% is earmarked to finance various environmental protection programs.

**Effectiveness:** Information not available.

**Compliance:** Ministry of Environment Compliance Division oversees compliance, investigation and penalties. Possible penalties include fines and court prosecution.

**Key references:** OECD Database on Instruments Used for Environmental Policy, British Columbia Ministry of Environment (2007) *Waste Discharge Regulation Implementation Guide.*

### 2.2 Quebec

**Scheme:** Water effluent charges

**Year introduced:** Information not available.

**Pollutants**: Information not available.

**Rate:** $2 Canadian dollars per tonne of pollutant multiplied by a weighting factor ranging from 1 – 1000.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Information not available.

**Rate reductions**: Information not available

**Revenue:** $64.8 million USD in 1998, used to finance government environmental funds.

**Effectiveness:** Information not available.

**Compliance:** Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy.

## 3. Czech Republic

**Scheme:** Fee for discharge of waste water into surface water.

**Year introduced:** 1979.

**Pollutants**: AOX, COD, ammonia nitrogen, cadmium, dissolved inorganic salts, nitrogen, mercury, phosphorus, undissolved substances, organic substances.

**Rate:** A discharge volume fee is calculated at 0.1 Czech Koruna (CZK) per 1m$^3$ in addition to pollutant charges. Pollutant charges in CZK per kg: AOX 300, COD in untreated waste water 16, COD in treated waste water 3, dissolved inorganic salts 0.5, undissolved substances 2, phosphorus 70, ammonia nitrogen 40, nitrogen 20, mercury 20 000, cadmium 4000.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Polluters must obtain discharge permits if waste water exceeds both pollutant concentration and volume thresholds and an overall discharge volume threshold of 30,000 m$^3$ in a calendar year. Exemptions exist for waste water discharges from reconstruction drilling, steam turbine cooling systems, water used in thermal energy generation and polluted groundwater abstractions that have been partially treated through usage.

Pollutant volume and concentration thresholds are as follows: AOX 15kg/yr and 0.2mg/L; COD (non-purified waste water) 20,000kg/yr and 40mg/L; COD (purified waste water) 10,000kg/yr and 40mg/L; dissolved inorganic salts 20,000 kg/yr and 1200mg/L; undissolved substances 10,000kg/yr and 30mg/L; phosphorus 3000 kg/year and 3 mg/litre; ammonia nitrogen 15,000kg/yr and 15mg/L; nitrogen 20,000kg/yr and 20mg/L, mercury: 0.4 kg/year and 0.002 mg/litre; cadmium: 2 kg/year and 0.01 mg/litre.

**Rate reductions**: Reductions of up to 80% are available if polluters adopt measures to lower effluent discharges to or below effluent limits. Polluters may also offset pollution reductions from total pollution in discharged waste water. Reduced rates apply to the pulp and textile manufacturers.

**Revenue:** $12.7 million USD in 2011 and all revenues go the State Environment Fund. The government has a policy of fiscal neutrality and seeks to accompany environmental fee revenues with decreases in fees or increases in other state expenditures.

**Effectiveness:** Information not available.

**Compliance:** Polluters are obliged to monitor pollutants and volume discharges. Only authorised laboratories selected by the Ministry of Environment may carry out actual analysis. Czech Environmental Inspectorate supervises compliance and fines range from CZK 10,000 - 10,000,000 for illegal discharges of waste water.

**Key references:** OECD Database on Instruments Used for Environmental Policy, *Water Act* (2001), Sauer et al (2008) 'Policy Issues and Consequences of Environmental Tax Reform Implementation in the Czech Republic,' *European Financial and Accounting Journal*, 3(4), pp. 92-106.

## 4. Denmark

**Scheme:** Duty on waste water.

**Year introduced:** 1996.

**Pollutants**: BOD, phosphorus and nitrogen.

**Rate:** BOD 1.48€/kg (11kr/kg), phosphorus 14.8€/kg (110kr/kg), nitrogen 2.7€/kg (20kr/kg).

**Emission estimation methodology:** Measured or estimated. Minor dischargers pay on basis of standard rates based on water consumption.

**Operation:** Charges are paid for waste water discharges into any type of natural water (freshwater or ocean) and irrigated fields. Discharges of rainwater and storm water are exempt, as is process water discharged from fish farms. Charges are calculated quarterly for major dischargers, annually for minor dischargers.

**Rate reductions:** Aquaculture plants and producers of cellulose, cane and beet sugar producers can obtain a 80% reimbursement. Producers of organic pigments, peptic substances, gelatin, starch and vitamins can obtain a 70% reimbursement of 70%.

**Revenue:** $US32.5 million in 2011 was received by the State. Revenues are used to finance costs of municipal waste water treatment plants.

**Effectiveness:** Information not available.

**Compliance:** Self-monitoring by discharger. Regional counties are responsible for water quality monitoring. The permit-issuing authority (regional or local council) inspect on occasion. Penalties range from fines, imprisonment and withdrawal of licence.

**Key references:** OECD Database on Instruments Used for Environmental Policy, *Sewage Tax Act 2013*, TemaNord (2006) *The Use of Economic Instruments in Nordic and Baltic Environmental Policy 2001-2005.*

## 5. Estonia

**Scheme:** Water pollution charge.

**Year introduced:** 1991.

**Pollutants**: BOD, phosphorus, nitrogen, SS, sulphates, monophenols, oil and oil products, wastewater with pH>9 or pH<6.

**Rate:** Per tonne: BOD €1406, phosphorus €7109, nitrogen €2137, SS €456.96, sulphates €6.45, monophenols €16893, oil €3465, pH €0.1900 per 0.1 pH unit above or below the limit values for each m³ of the effluent,

**Emission estimation methodology:** Measured or estimated.

**Operation:** Polluters must obtain discharge permits. Pollutant rates can increase 1.2 to 2.5 times the basic rate depending on the sensitivity of the receiving water body. Pollutant rates are to increase annually at predetermined rates until 2015. BOD, SS, sulphates and pH charge rates to increase 5-10% annually; nitrogen and phenols charge rate to increase 15-20% and charges for phosphorous compounds 50% between 2010 and 2011 and 30% afterwards.

**Rate reductions:** Pollution charges can be reduced if the polluter implements environmental protection measures that reduce effluent by 25% compared to the year prior. Measures must be implemented within 3 years. The rates can also decrease by half if effluent indicators meet permit conditions and the other ancillary conditions. Pollution charges may also be substituted if polluters finance environmental protection measures that result with at least 15% pollution reduction (compared to the year prior to the implementation of these measures). The period for taking these measures is a maximum 3 years.

**Revenue:** $8.4 million USD in 2010. Revenues are earmarked for regenerating natural resources, environmental preservation and repairing environmental damage. Any remaining revenues go to the general state budget.

**Effectiveness:** Information not available**.**

**Compliance:** Non-compliance fees are generally ten times the basic effluent charge when discharges above permitted levels. Fees are fifteen times the basic charge when discharges are made without a permit. Special correction factors are applied to non-compliance fees depending on the location of the discharge (e.g., if the receiving water body is a protected groundwater).

**Key references:** OECD Database on Instruments Used for Environmental Policy, *Pollutant Charge Act 1999*.

## 6. France

**Scheme:** Water effluent charges.

**Year introduced:** 1964.

**Pollutants**: BOD, COD, nitrogen, nitrates, phosphorous, SS, toxic metals.

**Rate:** Varies by water agency. Fees are based not on perceived environmental costs of discharge but revenue needs of basin authorities (US EPA 2004).

**Emission estimation methodology:** Measured or estimated. Discharges are estimated based on the emissions class and activity level of the polluter, or are calculated on the basis of actual measurements at the request of basin authorities or polluters (the costs of which are borne by whoever makes the request).

**Operation:** Charges apply to non-municipal facilities that directly discharge at least 200 population equivalents of effluent a year. For facilities connected to a public sewerage system, the charge only applies if discharges exceed 6,000 $m^3$ per year. Sewage treatment plants are exempt from effluent charges. Small and medium-sized dischargers (indirect dischargers) do not directly pay an effluent charge but the price is passed on to them through water companies. Agricultural water pollution is either managed as domestic wastewater or through charges added to the price of water services in the case of run-off. The French water management system is decentralised and structured around six river basin authorities.

**Rate reductions:** Some water agencies offer reduced charges to large industrial indirect emitters and other subsidies are also provided by water agencies in the form of grants and loans that can reach up to 80% of total costs.

**Revenue:** €2.124 million in 2009. Revenues are collected by water agencies and are used for reinvestment in water infrastructure, pollution control and improving drinking water quality.

**Effectiveness:** Low effluent charge rates have lead to a general perception of limited effectiveness. However, subsides available for good environmental performance means it is difficult to isolate the impact of the charges. Misalignment of interests and tensions between regional water agencies and the central environment and finance ministries has been the primary reason why effluent charges have been kept low. The regional authorities have an interest in increasing charges but central ministries have been concerned with keeping revenue raising and spending low in accordance with austerity measures (Ecorys 2011).

**Compliance**: Regional Directorates for Industry and Environment (DRIRE) are responsible authorities for industrial dischargers. Polluters self-monitor and DRIRE makes occasional inspections.

**Key references:** OECD Database on Instruments Used for Environmental Policy, US EPA (2004) *International Experiences with Economic Incentives for Protecting the Environment*, Ecorys (2011) *The Role of Market-Based Instruments in Achieving a Resource Efficient Economy*.

## 7. Germany

**Scheme:** Waste water charge.

**Year introduced:** 1981.

**Pollutants**: AOX, COD, phosphorus, nitrogen, heavy metals, fish toxicity.

**Rate:** Direct discharges are charged according to pollution units that correspond to the 'toxicity' of effluent expressed as pollution units. 1.5 pollution units reflect the toxicity of untreated waste water of one inhabitant per year. Each pollution unit is charged €35. A pollution unit of nitrogen is 25kg, phosphorus 3kg, COD 50kg. However, permit charges vary according to the pollutant, industrial plant size and type of discharger. Effluent charges from STP are calculated in a similar manner as direct industrial discharges. STPs pass on the cost of indirect effluent charges to farmers and small-medium enterprises. The average cost to firms is usually 3% of their total operation and investment costs in water pollution control (Ecorys 2011). No reductions or exemptions apply.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Industrial polluters require permits for discharges. Permits are only granted if minimum requirements laid down in Waste Water Ordinance 1997 are met and discharges do not exceed pollutant limits based on best available technology standards. Authorities issuing permits consider substances discharged, industrial plant size and the industry. Exemptions apply for rainwater discharges from industrial plants not exceeding the size of 3 hectares, water used for mining and discharged into artificial waters, discharge of rainwater under certain conditions, and water that has not been changed in character by use.

**Rate reductions:** Not applicable.

**Revenue:** $390 million USD in 2010. The Lander (State Environment Ministries) collect charges but can delegate to municipalities. All revenue is earmarked for the Lander. Revenues are used to finance programs to improve water quality, water infrastructure, and to cover administrative costs of the scheme.

**Effectiveness:** The quantity of overall discharges of pollutants into waterways was reduced by 4%, while discharges of private emitters were decreased by 18%. The harmfulness of effluents was decreased substantially. Mercury discharges were reduced by 99% from industrial dischargers and by 65% by municipal treatment plants in 2003-2005, when compared to the baseline of 1987. Nitrogen discharges from point sources were reduced by 76% in 2003-2005 when compared to the baseline of 1987 (EPI Water 2011). Waste water treatment plants were upgraded to state of the art. Industries, such as the paper industry, developed production processes that required less wastewater development. Others, like the chemical industry, invested in effluent abatement measures and considerably reduced the discharge of pollutants (EPI Water 2011).

**Compliance:** Self-monitoring by polluters. Permit issuing water authorities undertake inspections, the frequency of which depends on the authority. Possible penalties include fines, prison sentences up to 5 years, and withdrawal of licence.

**Key references:** OECD Database on Instruments Used for Environmental Policy, EPI Water (2011) *WP3 Ex-post Case Studies: Effluent Tax in Germany*, Ecorys (2011) *The Role of Market-Based Instruments in Achieving a Resource Efficient Economy*.

## 8. Hungary

**Scheme:** Water load fee.

**Year introduced:** 2004.

**Pollutants**: Cadmium, chromium, COD, copper, lead, mercury, nickel, inorganic nitrogen and phosphorus.

**Rate:** The fee is based on the multiplication of four factors: (1) the total amount of the annual discharge of the contaminant measured in kilograms; (2) multiplied by a specific rate per pollutant; (3) a measure of area sensitivity; and (4) sludge disposal factors. Pollutant rates per kilogram: cadmium €156.8€, chromium €31.40, COD €0.32, copper €15.70, inorganic nitrogen €0.64, lead €31.40, mercury €783.90, nickel €31.40, phosphorus €5.30.

**Emission estimation methodology:** Measured or estimated**.** Industries that discharge into public sewers are charged by volume of wastewater, not actual pollutant load.

**Operation:** Industrial discharges are subject to water load charge. Industries that discharge into public sewer pay by volume of wastewater and not pollutant load. Exemptions: where pollutants in wastewater existed originally in the water used by the polluter and rainwater diversions.

**Rate reductions**: Polluters are eligible for a charge rebate up to 50% if they implement a pollution reduction program.

**Revenue:** $36.5 million USD in 2008. Water service providers pay the collected fees into the central budget and revenues are not earmarked. In 2010 approximately 40% of revenues were reimbursed as allowances and investments. Less than 50% was used for water infrastructure and pollution schemes. Revenues have been far less than expected as polluters have exploited the system of allowances intended to finance investments and the purchase of metering devices: EPI Water (2011).

**Effectiveness:** Evidence suggests charge levels have not been high enough to act as a disincentive for industries directly discharging effluent. However, policy effectiveness is difficult to gauge as total pollutant emissions are not registered. Industries that discharge into the public sewer are charged by wastewater volume and have no incentive to decrease pollutant loads: EPI Water (2011).

**Compliance**: Self-assessment and self-monitoring

**Key references:** OECD Database on Instruments Used for Environmental Policy, EPI Water (2011) *WP3 Ex-post Case Studies: Water Load Tax, Hungary*.

## 9. Korea

**Scheme:** Water pollution charge.

**Year introduced:** 1983.

**Pollutants**: Arsenic, cadmium, chromium, chromic (IV) compounds, copper, cyanogen compounds, floating matter, lead, manganese, mercury, nitrogen, organic substances, organophosphoric compounds, phenol, phosphorous, polychlorinated biphenyl, tetrachloroethylene, trichloroethylene, zinc.

**Rate:** The excess charge is calculated according to the following formula: charge per kilogram of pollutant * quantity of pollutant exceeding the standard * coefficient of the frequency of violation (0.5 – 4 million Korean Won according to the business type).

Basic Levy charges per kilogram: matter €0.17, organic substances €0.17. Excess discharge charges per kilogram: arsenic €69.10, cadmium €345.50, chromium €51.80, chromic (VI) compounds €207.30, copper €34.60, cyanogen compounds €103.60, floating matter €0.17, lead €103.60, manganese €20.70, mercury €863.70, nitrogen €0.35, organic substances €0.17, organophosphoric compounds €103.60, phenol €103.60, phosphorus €0.35, polychlorinated biphenyl €863.70, tetrachloroethylene €207.30, trichloroethylene €207.30, zinc €20.70.

**Emission estimation methodology:** Measured or estimated.

**Operation:** The scheme is divided into a Basic Levy System and Excess discharge System. The Basic Levy System is applied to organic substances and suspended solids and discharge standards vary by region. Excess discharge fees are payable if emissions exceed 30% of maximum allowable effluent limits. Very small companies are exempt from the basic levies.

**Rate reductions**: Not applicable.

**Revenue:** $4.2 million USD in 2012. 90% of revenue accrues with the central government and 10% with local governments. All central government revenue is earmarked for environmental investments.

**Effectiveness:** Information not available.

**Compliance**: Penalty fees, assessed on emissions above the allowable maximum, equal the expense of treating actual volume of emitted pollutants: Stavins (2002).

**Key references:** OECD Database on Instruments Used for Environmental Policy, Stavins (2002) *Experience with Market-Based Environmental Policy Instruments*.

## 10. Mexico

**Scheme:** Waste water charge.

**Year introduced:** 1995.

**Pollutants**: COD, SS.

**Rate:** Charges vary according to the (a) assimilative capacity of the water body and (b) concentrations of either COD or SS, depending on which pollutant is more concentrated in the wastewater.

**Emission estimation methodology:** Measured or estimated

**Operation:** Polluters must obtain discharge permits and comply with specified discharge standards. Polluters with a monthly discharge less than 3000m$^3$ have the option of paying a fixed flat charge determined by receiving water authority. New standards were introduced in 1996 and existing plants can continue operating following pre-1996 discharge permits or new standards, depending on polluter's choice.

**Rate reductions**: Discharge rates are reduced if facilities adopt pollution abatement measures such as new technology or treatment plants. If the quality of the discharge exceeds the emission standards, the user can apply for a rebate against water abstraction charges.

**Revenue:** $20.6 million USD in 2011. 100% is earmarked to finance water treatment programmes.

**Effectiveness:** Information not available.

**Compliance**: National Water Commission administers levy collection and compliance.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Garduno, H, 'Chapter 4: Institutional Design Lessons from Implementing Water Rights in Mexico' in International Food Policy Research Institute (2005) *Water Rights Reform: Lessons for Institutional Design Lessons*, Da Motta et al, 'Wastewater Effluent Charge in Mexico" in UNEP (2000) *Economic Instruments for Environmental Management: A Worldwide Compendium of Case Studies*.

## 11. The Netherlands

**Scheme:** Levy on water pollution (local waters), fee on pollution on surface waters (federal waters).

**Year introduced:** 1970.

**Pollutants**: COD, nitrogen, phosphorus, and heavy metals (mercury, cadmium, arsenic, copper, zinc, lead, nickel and chromium). Some local water boards charge sulphate and chloride.

**Rate:** Charges for effluent into local waters are same for indirect and direct effluent discharges and vary by region according to the costs of treating wastewater. Charges for effluent discharges into federal water are based on pollution units charged at €46.06 per unit. For oxygen-consuming substances, a pollution unit is defined as the average amount of oxygen-consuming material produced by one person in one day, which is further defined as 136g of oxygen-producing material. For heavy metals discharged, one pollution unit is defined as 100g of the sum of mercury, cadmium and arsenic, and 1,000g of the sum of copper, zinc, lead, nickel and chromium.

**Emission estimation methodology:** Measured and estimated. Federal water fee: small and medium dischargers use flat or industry coefficients to determine charges; large industrial facilities measure discharge outputs.

**Operation:** Polluters are grouped into three groups for the federal water fee. (1) Small dischargers (<5 pollutant units/day) are charged a fixed 3 pollution units. (2) Medium dischargers (<1,000 pollution units (in some industries, the maximum is 100 pollution units) of organic pollutants per day) are charged according to an industry coefficient and on water quantity used. Facilities that believe they are being overcharged can, at their own expense, conduct sampling and measurement and be charged according to the findings. (3) Industrial facilities and municipal sewage treatment plants generating more than 1,000 pollution units per day of organic pollutants or more than 10 pollution units of heavy metals are charged according to actual discharge, which they are expected to measure.

Municipal treatment plants are exempt for discharges into regional waters.

**Rate reductions**: Municipal treatment plants pay a reduced rate for discharges into federal waters.

**Revenue:** The state collects revenue for discharge into federal waters and local municipalities collect levies for discharges into local water. All revenues at both federal and local levels are earmarked for the financing of water quality management, upgrading sewage systems, and for paying administration costs of the program. Small dischargers account for 65% of federal charge revenues, medium dischargers account for 15%, and industrial facilities and municipal sewage treatment plants account for 20%. Local municipalities collected $1,494 million USD in 2010 for discharge into local waters. The cost of administering the federal water fee is estimated at 3.5% of revenues.

**Effectiveness:** Effluent fees are believed to have a significant effect on the quantity of pollution discharged by large industrial facilities and municipal sewage treatment plants. According to European Environmental Agency (2005): effluent fees in conjunction with investments in treatment facilities have provided a cost-effective outcome in meeting pollution reduction targets as opposed to countries where the primary focus has been on capital investments.

**Compliance**: Monitoring is responsibility of polluters with occasional verification by government authorities.

**Key references:** OECD Database on Instruments Used for Environmental Policy, US EPA (2004) *International Experiences with Economic Incentives for Protecting the Environment*, European Parliament (2001) *Effluent Charging Systems in Member States*, EEA (2005*) Market Based Instruments for Environmental Policy in Europe*.

## 12. Poland

**Scheme:** Water effluent charges.

**Year introduced:** 1990.

**Pollutants**: BOD, COD, SS, heavy metals, chlorate and sulphate ions, volatile phenols, cooling water, aquaculture discharges.

**Rate:** Charge rates are differentiated by geographical region and industry type. Base charges per kilogram: BOD €0.98, COD €0.39, heavy metals €28.50, SS €0.12, chloride and sulphate ions €0.01, volatile phenols €10.40. Cooling water is charged €0.16-0.97 per 1000 $m^3$ (depending on temperature) and water discharged from aquaculture is charged €0.06 per 100 kg increase in the weight of the water's organism. Higher rates (~2x) are applicable when pollutants are discharged into lakes. Polluters are expected to calculate charges due.

**Emission estimation methodology:** Measured.

**Operation:** Polluters must obtain permits for discharges into surface water or soils**.** Charges are based on the total volume of pollutants present in the wastewater and a company only pays the charge for the pollutant where the payment is the largest taking into account BOD, COD, SS, total chloride and sulphate. Polluters are exempt from charges if the total annual amount of all charges for air, water or waste is equal to or less than 800 Polish Zloty (PLZ) (~€200). There is an upper charge rate ceiling of ~ €60 per kilogram of pollutant but charge rates are revised annually and are adjusted for projected inflation.

**Rate reductions:** Enterprises can treat environmental charges as normal production expenses and can deduct the amount paid from taxable income**.**

**Revenue:** 100 % is earmarked for environment protection and water resource management. Revenues are allocated as follows: 20% for municipal government, 10% for county government, 46%% for provincial ecological funds and 24% for the National Ecological Fund.

**Effectiveness:** Waste water requiring treatment reduced from 32.5% in 1990 to 10% in 1998. Waste water intensity (calculated as the amount of waste water in a cubic meter per million PLZ of GDP) declined by over 25% between 1990 and 1996. (Kathuria 2005).

**Compliance**: Emissions are self-reported. The State Inspectorate is responsible for enforcements, non-compliance penalties (for discharges beyond permitted levels and overall monitoring. Fines are generally equal to the difference between the actual and permitted pollutant levels multiplied by a fine rate, which is simply a multiple of the charge rate.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Kathuria (2005) 'Controlling Water Pollution in Developing and Transition Countries: Lessons from Three Successful Cases,' *Journal of Environmental Management*, 78(4), p.405-426.

## 13. Slovak Republic

**Scheme:** Charge for discharging of wastewater.

**Year introduced:** 1966.

**Pollutants**: Ammonia, AOX, cadmium, COD, dissolved inorganic compounds, mercury, phosphorus, nitrogen, SS.

**Rate:** Per kilogram: ammonia 15Sk, AOX 200Sk, cadmium 3,000Sk, COD 3-12Sk depending on industry and concentration, dissolved inorganic compounds 0.5Sk, mercury 15,000Sk, phosphorus 100Sk, nitrogen 15Sk, SS 3Sk. Charge for suspended solids SS is paid only if fee for COD is not paid or if SS is more than three times COD concentration.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Discharge wastewater must meet water quality standards and emission standards. Producers of wastewater that (a) discharge more than 10,000 $m^3$ per year or 1000 $m^3$ per month, and (b) simultaneously exceed pollutant concentration limits and mass load limits are levied pollutant charges. The pollutant charges can be raised in certain cases (e.g. where receiving waters are intended for drinking purposes). If discharged waste water meets emission and water quality standards no charge is payable.

**Rate reductions**: Construction of water treatment plants or other investments for pollution reduction can cause up to 50% reductions in charges until the beginning of operation of the investment.

**Revenue:** All revenue is directed to national budget where they are earmarked for investments of water treatment plants, waste water collection systems and other investment measures related to water protection. Revenues amounted to $4.3 million USD in 2000.

**Effectiveness:** Information not available.

**Compliance**: River Basin Authorities are responsible for control of the wastewater quality and for collection of the charges. The Slovak Environmental Inspection is responsible for monitoring and compliance with the permit. Penalties for discharge without a permit can be up to threefold the annual water charge. Minimum penalty is 30,000 Sk, maximum penalty is 5 million Sk.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Dritl et al (2005) 'Wastewater Treatment and WFD Implementation in CEE Danube Countries'.

## 14. Slovenia

**Scheme:** Wastewater pollution fee.

**Year introduced:** 1996.

**Pollutants**: AOX, cadmium, chromium, COD, copper, lead, mercury, nickel, nitrogen and phosphorus.

**Rate:** €26.41 per unit of pollution. Pollution units are calculated from annual sum of unit loads.

**Emission estimation methodology:** Measured.

**Operation:** Industrial polluters and public waste-water companies are subject to the pollution fee. Pollution units for industrial waste water are calculated on the basis of data provided in annual monitoring reports. Pollution units are equal to the share between the total water used (as measured) and 50 m³. Exemptions exist for quarry operations, liquid waste produced as a result of titanium dioxide production, farming with organic fertilisers in accordance with agricultural regulations.

**Rate reductions**: Investments in wastewater treatment facilities can attract reductions.

**Revenue:** $38.3 million USD in 2012. All revenues are collected by local municipalities and are earmarked for environmental programs, water-related infrastructure and sewage treatment facilities.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references**: OECD Database on Instruments Used for Environmental Policy, Gosar and Muri *(2005) National Action Plan for Slovenia: For the Protection of the Mediterranean Sea against Pollution from Land-based Sources*.

## 15. Spain

**Scheme:** Tax on water pollution (Aragón).

**Year introduced:** 2002.

**Pollutants**: Oxydizeable matter (BOD or COD), heavy metals, inhibiting matters, nitrogen, SS, soluble salts.

**Rate:** Oxydizeable matters €0.64/kg, heavy metals €6.29 per equimetal, inhibiting matters 14.96 per kiloequitox, nitrogen €1.26/kg, soluble salts €5.18 per Siemens per cm and m³, SS €0.46 kg.

**Emission estimation methodology:** Information not available.

**Operation:** National ministries and river basin authorities set national emission standards and regional authorities and committees set charge rates for water pollution. Exemptions exist for agricultural effluent into surface waters, and water discharges from cattle operations that do not deliver waste water into municipal sewage system.

**Rate reductions**: Information not available.

**Revenue:** $47 million USD in 2011. All revenue collects with the regional government and is 100% earmarked to finance the works of reparation and purification carried out by the Community of Aragón.

**Effectiveness:** Information not available.

**Compliance**: River basin authorities are responsible for detecting non-compliance.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Water 2011, Case-study for Valencia (Eastern Spain), in EPI Water (2011) *WP3 Ex-post Case Studies: Water Load Tax, Serpis River Basin.*

## 16. United States

### 16.1 California

**Scheme:** Waste Discharge Requirements Program

**Year introduced:** Information not available**.**

**Pollutants**: Not applicable.

**Rate**: Permit fees are $1,704 plus the permitted flow in millions of gallons per day (MGD) multiplied by 3,013. The maximum fee is $426,064. Surcharges between $5,000-15,000 apply for certain industrial dischargers depending on the threat or complexity rating of the facility.

**Emission estimation methodology**: Not applicable.

**Operation**: Point discharges into surface, ground or coastal waters that are not subject to the Federal Water Pollution Control Act need to obtain Waste Discharge Permits from a Californian Regional Water Quality Control Board. Only industrial discharges that are identified by the Federal Standard Industrial Classification Manual, Bureau of Budget, 1967 under the category “Division D-Manufacturing” (33 USC Sec. 1362) are covered by the scheme.

There are many state exemptions also, including exemptions for sewage and treated effluent that meet water quality standards, facilities associated with wastewater treatment plants, discharges for wastewater to land (including ponds) as long as discharges meet water quality standards, injected underground discharges that meet applicable regulations, drilling waste. Permits specify water quality standards and processes that must be adhered to depending on facility.

**Rate reductions**: Information not available.

**Revenue**: Information not available.

**Effectiveness**: Information not available.

**Compliance**: Information not available

**Key references**: California EPA ‘Waste Discharge Requirements Program’

### 16.2 Maine

**Scheme:** Annual waste discharge fees.

**Year introduced:** Information not available.

**Pollutants**: Oxydizeable matters (BOD, COD), flow, heat and other pollutants.

**Rate:** Oxydizeable matters (BOD, COD) license rate $2.4 USD/lb, discharge rate $1.25 USD/lb. The discharge rate per pound is $21 divided by the licensed effluent concentration in milligrams per litre. Flow (nonprocess) from industrial or commercial sources $175 per million gallons, flow (process) from industrial or commercial sources $630 per million gallons, heat $0.045 USD per million BTU.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Industries are separated according to class and discharge volume. Fees are calculated by the sum of (a) an administrative base fee, (b) licence fees, and (c) measured or estimated effluents in wastewater (the discharge fee). There are also water quality improvement surcharges. Maximum annual fees are $150,000, and the maximum annual fee surcharge is $50,000. Exemptions exist for many industry types and processes.

**Rate reductions**: Not applicable.

**Revenue:** Revenues are collected by the Treasurer of State and are earmarked for the Water Quality Improvement Fund.

**Effectiveness:** Information not available.

**Compliance**: Failure to pay an annual fee is sufficient grounds for revocation of the license or permit.

**Key references**: OECD Database on Instruments Used for Environmental Policy, Maine Revised Statutes, Title 38: Waters and Navigation, Chapter 2. Department of Environmental Protection, Subchapter 2. Maine Environmental Protection Fund, §353-B. ‘Annual waste discharge license fees

### 16.3 Louisiana

**Scheme:** Louisiana Pollutant Elimination Discharge Scheme (LPDES).

**Year introduced:** 1996 (approval for federal NPDES participation).

**Pollutants**: Not applicable.

**Rate:** General annual permit fees range from USD $0 - $2,640 depending on industrial activity and not on actual emissions. General permit fees do not account for actual discharge volumes or toxicity. Individual permits are determined by a worksheet that assigns points according to: (1) facility complexity; (2) flow volume and type; (3) pollutants released; (4) heat load; (5) potential public health threat; and (6) the designation of a facility as major or minor, depending upon how many people it employs. The points are multiplied by a rate factor of $148.00 per point for municipal facilities and $271.96 per point for industrial facilities to determine total annual fees. The minimum annual permit fee is $345.00, and the maximum annual fee is $90,000.

**Emission estimation methodology:** Not applicable.

**Operation:** General and individual permitting system for industrial waste water discharges. General permits exist for approximately thirty industrial processes. Exemptions exist for many industry types and processes.

**Rate reductions**: Not applicable.

**Revenue:** Fund scheme administration.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references**: Louisiana Department of Environmental Quality 2013, LPDES Permit Fees-Louisiana Water Pollution Control Fee System Regulation
http://www.deq.louisiana.gov/portal/tabid/2660/Default.aspx)

### 16.4 Montana

**Scheme:** Montana Pollutant Discharge Elimination Scheme (MPDES).

**Year introduced:** 1974 (approval for federal NPDES participation).

**Pollutants**: Not applicable.

**Rate:** Initial application fee and annual permit fees. Individual application fees range from USD $600 (concentrated animal feeding operation) to $11,000 (municipal storm water sewer system for populations greater than 50,000). Annual fees for individual permits are differentiated by industry or activity type and total discharge volume. Minimum annual fees apply, ranging from $600 - $3000 depending on the activity. Permit holders for selected industries are also charged flat effluent fees per millions of gallons of effluent released per day (MGD). The highest effluent fee is $3000 per MGD, and this fee appears to only be applicable to sewerage treatment plants and industrial wastewater discharges.

**Emission estimation methodology:** Not applicable.

**Operation:** General and individual permitting system for industrial waste water discharges. Application fees fund the processing of the application. Annual fees cover the costs of administering permits during their five-year term, including compliance monitoring and sampling, technical assistance and inspections.

**Rate reductions**: Not applicable.

**Revenue:** Revenues fund scheme administration.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references**: Montana Department of Environmental Quality 2013, 'Montana Pollutant Discharge Elimination System' http://deq.mt.gov/wqinfo/mpdes/default.mcpx, Montana Department of Environmental Quality 2011, 'Water Quality Permit Application, Nondegradation Authorization, And Annual Permit Fees' http://deq.mt.gov/wqinfo/MPDES/RULES09/pdf/FeeSummarySched10.pdf.

### 16.5 New Jersey

**Scheme:** New Jersey Pollutant Discharge Elimination System (NJPDES).

**Year introduced:** 1982 (approval for federal NPDES participation).

**Pollutants**: Not applicable.

**Rate:** Permit fees are calculated with the formula = (individual facility's potential environmental impact * billing rate for the category of discharge) + the minimum fee for the category of discharge. Environmental impact is calculated according to pollutant and heat loads. The billing rates and minimum fees are based on Departmental budgetary needs. Minimum fees range from $450 (general permit) to $11,150 (major domestic treatment works individual permit).

**Emission estimation methodology:** Not applicable.

**Operation:** Permitting system for industrial and municipal waste water discharges to surface and groundwater, point and non-point. The Department of Environmental Protection can only charge permit fees that are 'reasonable' and based upon the costs of processing, monitoring and administrating the NJPDES scheme; fees must not exceed these costs.

**Rate reductions**: Not applicable.

**Revenue:** $19.7 million in 2012. All revenues fund the administration of the NJPDES scheme.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references**: New Jersey Department of Environmental Protection 2013, 'NJPDES Permit Fees,' http://www.nj.gov/dep/dwq/njpdesfees.htm, New Jersey Department of Environmental Protection 2013, 'NJPDES FY2013 Annual Fee Report and Assessment of Fees,' http://www.nj.gov/dep/dwq/pdf/fee_rpt_2013.pdf

## APPENDIX B: Air emission fee schemes

Information on individual effluent charge schemes has been sourced primarily from the OECD Database on Instruments Used for Environmental (http://www2.oecd.org/ecoinst/queries/).

Additional references that augment the OECD Database information are noted. '**Scheme'** refers to the current operational scheme and '**Year introduced'** refers to commencement of air emissions charges and not necessarily the commencement of the current operational scheme.

## 1. Canada

### 1.1: British Columbia

**Scheme:** Waste Discharge Regulation.

**Year introduced:** 1992.

**Pollutants**: Ammonia, asbestos, carbon monoxide, chlorine and chlorine oxides, fluorides, hydrocarbons, hydrogen chloride, metals, nitrogen oxides (expressed as nitrogen oxide equivalent), phenols, sulphur and sulphur oxides, total particulate, TRS, VOCs, other contaminants not otherwise specified.

**Rate:** Discharge fees per tonne in CAD: ammonia $16.78, asbestos $16.78, carbon monoxide $0.45, chlorine and chlorine oxides $11.29, fluorides $673.60, hydrocarbons $16.78, hydrogen chloride $11.29, metals $673.60, nitrogen oxides $11.29, phenols $16.78, sulphur and sulphur oxides $13.07, total particulate $16.78, TRS 561.33, VOCs $16.78, other contaminants not otherwise specified $16.78.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Industrial polluters must obtain discharge permits and pay annual fees. Fees are a combination of a base administration fee of $100 (CAD) and a variable fee based on contaminants from the authorised discharges identified in the permit. Annual fees are Fees are not payable where the permit holder is the Canadian or British Columbian government. The scheme will not apply within the Greater Vancouver Regional District once the regional district establishes its own permit and licence fees for air contaminants.

**Rate reductions**: Information not available.

**Revenue:** $9.4 million USD was collected in 1998 for both water and air discharge schemes. 100% is earmarked to finance various environmental protection programs.

**Effectiveness:** Information not available.

**Compliance**: Ministry of Environment Compliance Division oversees compliance, investigation and penalties. Possible penalties include fines and court prosecution.

**Key references:** OECD Database on Instruments Used for Environmental Policy, British Columbia Ministry of Environment (2007) *Waste Discharge Regulation Implementation Guide*

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### 1.2: Quebec

**Scheme:** Charge on air pollution.

**Year introduced:** Information not available.

**Pollutants**: Several pollutants.

**Rate:** $2 CAD per tonne, multiplied by a weight between 1 and 1000.

**Emission estimation methodology:** Information not available.

**Operation:** Information not available.

**Rate reductions:** Information not available.

**Revenue:** 100% is earmarked to finance various environmental protection programmes.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy,

## 2. Czech Republic

**Scheme:** Air pollution fee.

**Year introduced:** 1967 (major sources), 1991 (medium and small sources).

**Pollutants**: Nitrogen oxides, PM, sulphur dioxide, VOC.

**Rate:** Per tonne emitted: nitrogen oxides €43.8, PM €167.25, sulphur dioxide €253.76, VOC €107.51.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Stationary sources of emissions must pay air pollution fees. Combustion sources with capacity <50kW are exempt to the air pollution fee. Fees are not collected if annual fees amount to less than 50,000 CZK. Fees are set to gradually increase from 2017- 2022. The scheme was simplified in 2012 and reduced the number of charged pollutants from more than twenty to the present four.

**Rate reductions:** Not applicable.

**Revenue:** $1.1 million USD from medium sources in 2010; $24.5 million USD from major sources in 2011. All revenues go to the State Environmental Fund and are used for the protection of the environment.

**Effectiveness:** Emissions have decreased substantially between 1993-1998 as a result of higher emission charges and new stringent emission limits. As the two policies acted concurrently, it is impossible to ascertain the causal effect of the air pollution fees alone (Earnhart and Lizal, 2008).

**Compliance**: Ministry of Environment administers scheme.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Earnhart and Lizal (2008) 'Pollution Reductions in the Czech Republic,' *Post-Communist Economies*, 20(2), pp. 231-252

## 3. Estonia

**Scheme:** Air pollution charge.

**Year introduced:** 1991.

**Pollutants**: carbon monoxide, mercaptans, metals, nitrogen oxide and other inorganic nitrogen compounds, PM, sulphur dioxide and other sulphur compounds, VOC.

**Rate:** Per tonne permit base rates / rates for discharges above permitted levels / rates without permit: carbon monoxide €6.35 / €31.75 / €63.50; mercaptans €28,830 / €288,303.5 / €576,607; metals €1,252 / €1252,00 / €250,400; nitrogen oxide and other inorganic nitrogen compounds €101.1 / €1,011 / €2.022; PM €86.47 / €432.4 / €865; sulphur dioxide and other sulphur compounds €86 / €861 / €861€; and VOC €101 / €1011 / €2022. Charge rates are multiplied with coefficients from 1.2 to 2.5 depending on the location of polluters (polluters located in larger towns and recreational areas pay more).

**Emission estimation methodology:** Measured.

**Operation:** Stationary sources of air pollution must calculate emissions and pay pollution charges quarterly. Charge rates for carbon monoxide, nitrogen oxide, VOC, metals and mercaptans are set to increase 5-10% annually; sulphur dioxide and PM charge rates are set to increase 30% annually. Some geographical regions charge higher rates.

**Rate reductions**: Charges may be offset if the polluter implements emission reduction measures at own expense that result in at least a 25% pollution reduction compared to the year prior.

**Revenue:** $12.7 million USD in 2012. Revenues are paid into the state budget. Until 2009 all revenue was earmarked for regenerating natural resources, preserving the state of the environment and repairing the environmental damage through the Environmental Investment Centre. From 2010 onwards the majority of revenue is used for environmental purposes.

**Effectiveness:** Information not available.

**Compliance**: Ministry of Environment verifies calculations. If emissions are released without a permit, fines run 5-100 times the charge rate depending on the pollutant.

**Key references:** OECD Database on Instruments Used for Environmental Policy, *Environmental Charges Act 2005.*

## 4. France

**Scheme:** General tax on polluting activities.

**Year introduced:** 1985.

**Pollutants**: hydrogen chloride, nitrogen oxides except for $NO_2$, $NO_2$, sulphur dioxides, VOC, TSP, arsenic, selenium, mercury, benzene, PAHs, lead, zinc, chromium, copper, nickel, cadmium, vanadium.

**Rate:** Per tonne: hydrogen chloride €47.17, nitrogen oxides except for $NO_2$ €70.77, $NO_2$ €167.30, sulphur dioxides €138.60, VOC €138.60, TSP €264.80, arsenic €509,500, selenium €509,500, mercury €1,019,000, benzene €5100, PAHs €50,950, lead €10,000, zinc €5000, chromium €20,000, copper €5000, nickel €100,000, cadmium €500,000, vanadium €5000. If the fee is less than €450, it is not due.

**Emission estimation methodology:** Measured or estimated with emission factors.

**Operation:** Fee is imposed on fixed sources that fulfil either of two criteria: (a) maximum combustion capacity equal to or exceeding 20 MW, or (b) annual emissions of more than 150 metric tonnes of either sulphur dioxide, nitrogen oxides, hydrogen chloride or VOC. Emission permits required for all such sources.

**Rate reductions**: Revenues are recycled to polluters in the form of grants and subsidised loans for pollution abatement investments.

**Revenue:** $284 million USD in 2008. Revenues collected by the customs authorities and are earmarked for abatement subsidies and the financing of air quality surveillance systems.

**Effectiveness:** Data on $NO_x$ and $SO_2$ emissions from three industrial sectors 1990-1998 indicates the fee had a significant negative impact on emissions. But because revenues were refunded to polluters through subsidies for pollution abatement technology, the net effect was to increase total emissions significantly to an extent that generally dwarfed the negative impact of the fee. This was because low levels of pollution fee relative to levels of abatement subsidies, and low effectiveness of subsidised technologies: Millock and Nauges (2006). However fee rates have been substantially increased with introduction of a new General Tax on Polluting Activities in 2000.

**Compliance**: Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Millock, K and Nauges, C (2006) 'Ex Post Evaluation of an Earmarked Tax on Air Pollution,' *Land Economics*, 81(1), pp.68-84.

## 5. Hungary

**Scheme:** Air load charge.

**Year introduced:** 2004.

**Pollutants**: Non-toxic dust, nitrogen oxides, sulphur dioxide.

**Rate:** Per kilogram: non-toxic dust €0.11, nitrogen oxides €0.11, sulphur dioxide €0.18. The measure of the air load charges is determined by the basic of the heat charges (in natural measure determined mass of the whole amount of the air loading substance emitted yearly) and the unit charges of the air loading substances

**Emission estimation methodology:** Measured or estimated.

**Operation:** Polluters must pay pollutant charges quarterly. Exemptions exist if the country is in an electricity crisis.

**Rate reduction**: Dischargers are eligible for a charge rebate of up to 50% if they implement a pollution reduction program.

**Revenue:** $31.6 million USD in 2010.

**Effectiveness:** Information not available.

**Compliance**: The National Ministry of Environment and Hungarian Tax and Financial Control Administration administer the scheme.

**Key references:** OECD Database on Instruments Used for Environmental Policy.

## 6. Italy

**Scheme:** Sulphur dioxide and nitrogen oxide tax.

**Year introduced:** 1997.

**Pollutants**: Sulphur dioxide and nitrogen oxide.

**Rate:** Sulphur dioxide €106 and nitrogen oxides €209 per kilogram emitted.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Fee applies to combustion plants equal to or higher than 50 MW capacity. Charges are paid quarterly.

**Rate reductions**: Information not available.

**Revenue:** $18 million USD in 2012.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy.

## 7. Japan

**Scheme:** Pollution load levy.

**Year introduced:** 1974.

**Pollutants**: Sulphur oxides.

**Rate:** The government estimates the amount of compensation payable in a fiscal year and sets levy rates accordingly. The fee rate varies between regions, and is higher in regions with high historic incidence or air-pollution illnesses. Taxes are paid in proportion to emissions volume, not pollutant concentration. The levy rate on the current emissions and past emissions is determined so that revenue on emissions during 1982-1986 amounts to 60% of revenue, with the other 40% being composed of revenue levied on annual emissions.

**Emission estimation methodology:** Estimated. Based on emissions volume.

**Operation:** Levy applies to stationary and mobile sources of sulphur oxides. The levy was designed to fund a compensation fund for victims of air-pollution related illnesses. Companies that had plants or other facilities that emitted sulphur dioxide as of 1 April 1987 are obligated to pay the levy. If an existing company installs new sulphur dioxide producing equipment in an existing plant or new worksite, the company is still obligated to the conventional levy. Exemptions exist for facilities that emit less than 5,000 $Nm^3/h$ in the former Class 1 regions, or less than 10,000 $Nm^3/h$ in other regions.

**Rate reductions:** Not applicable.

**Revenue:** $420 million USD in 2009. All revenues to compensation fund for air-pollution related illnesses.

**Effectiveness:** There was a sharp decline in sulphur oxides emissions in Japan from the early 1970s to the mid 1980s which can be attributed to the levy. However current sulphur oxide emitters incur excessive burden because the levy is not applied to nitrogen oxides, particulate matters or other air pollutants (past or present) that also impact on respiratory health: OECD (2010).

**Compliance**: Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy, OECD (2010) *Taxation, Innovation and the Environment* (Annex I: Japan's Tax on SOx Emissions).

## 8. Korea

**Scheme:** Charge on air pollution.

**Year introduced:** 1983.

**Pollutants**: Ammonia, carbon bi-sulfide, chlorine, dust, fluoride, hydrogen chloride, hydrogen cyanide, hydrogen sulfide, sulphur oxides.

**Rate:** Excess emission charges are calculated as: charge per kg of pollutant * quantity of pollutant exceeding the standard * coefficient in the ratio of excess emission over standard * coefficient of the frequency of violation. Excess charges per kilogram: ammonia €0.97, carbon bi-sulfide €1.11, chlorine €5.11, dust (basic + excess) €0.53, fluoride €1.59, hydrogen chloride €5.11, hydrogen cyanide €5.04, hydrogen sulfide €4.15, sulphur oxides (basic + excess) €0.35.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Charges are assessed on emissions exceeding 30% of maximum allowable limits. No charges are payable for companies that meet Korean air emission standards or those that emit below 30% of the permissible emission standards. Penalty fees are only assessed on emissions above the allowable maximum, and should equal the expense of treating actual volume of emitted pollutants. Basic charges are to be paid semi-annually.

**Rate reductions**: Not applicable.

**Revenue:** $6.3 million USD in 2013. Revenues accrue with central government and 90% is earmarked for environmental investments.

**Effectiveness:** Information not available.

**Compliance**: Ministry of Environment oversees the scheme.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Stavins (2002) *Experience with Market-Based Environmental Policy Instruments*.

## 9. Norway

**Scheme:** Tax on NOx emissions in petroleum activities on the continental shelf.

**Year introduced:** 2007.

**Pollutants**: Nitrogen oxides.

**Rate:** €2.28 per kilogram. Fee rates are to increase with inflation.

**Emission estimation methodology:** Measured or estimated on the basis of source-specific emission factors or standard emission factors set by the Regulations on Special Taxes.

**Operation:** Tax applies to emissions emitted from ships, fishing vessels, air traffic and diesel railways, onshore oil and gas installations; engines, boilers and turbines in the manufacturing industries; offshore flares; motors, boilers and turbines with a total installed capacity of more than 10 MW; and propulsion machinery (engines) on ships with a total installed capacity of over 750 kW. Exemptions apply to emission sources covered by environmental agreements with the State concerning the implementation of measures to reduce nitrogen oxides in accordance to predetermined environmental targets.

**Rate reductions**: Polluters subject to the fee may instead choose to enter an environmental agreement with Norwegian Government and pay charges into a $NO_x$ fund instead at rate of €0.5/kg (except for oil and gas producers who must pay €1.4/kg). The Fund has about €70 million available for support of nitrogen oxide reducing measures each year and participants in the fund can apply for grants to finance abatement measures. According to Nortrade (2011) companies contribute into the fund about one third of what they would normally have paid in $NO_x$ fee.

**Revenue:** $18.0 million USD in 2011.

**Effectiveness:** According to the $NO_x$ Fund, the grants have boosted investment in $NO_x$ abatement techniques, such as engine modification onboard ships.

**Compliance**: Polluters have reporting obligations. Climate and Pollution Agency evaluate abatement measures and if emissions reduction obligations (less than 90%) are not met by participants to the NOx fund and environmental agreements, then all taxes remain payable.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Asen (2013) 'Norway: The NOx Tax Scheme' (presentation http://www.unece.org/fileadmin/DAM/env/documents/2013/air/wgsr_51/6_NOx-tax-Norway-geneva-april2013.pdf); Nortrade (2011) 'The $NO_x$ Effect: Using a Fund to Reduce Emissions' (http://www.nortrade.com/sectors/articles/the-nox-effect-using-a-fund-to-reduce-emissions/)

## 10. Poland

**Scheme:** Charge on air pollution.

**Year introduced:** 1990.

**Pollutants**: 63 pollutants including aliphatic hydrocarbons, arsenic, asbestos, benzene, cadmium, chrome, carbon monoxide, carbon dioxide, cobalt, dioxins and phurans, dust, halon (1211, 1301 and 2402), lead, manganese, mercury, methane, molybdenum, nickel, nitrogen oxide (recalculated as $NO_2$), sulphur oxides, tin and zinc.

**Rate:** Per kilogram: aliphatic hydrocarbons €0.03, arsenic €87.20, asbestos €87.20, benzene €2.00, cadmium €43.60, chrome €12.50, carbon monoxide €0.03, carbon dioxide €0.07, cobalt €12.50, dioxins and phurans €87.20, dust varies from €0.08 (for fuel combustion dust) to €0.34 (siliceous dust), halon (1211, 1301 and 2402) €43.60, lead €9.97, manganese €4.99, mercury €43.60, methane €0.07, molybdenum €2.94, nickel €87.20, nitrogen oxide (recalculated as $NO_2$) €0.12, sulphur oxides €0.12, tin €1.31, and zinc €1.30.

**Emission estimation methodology:** Measured or estimated. Emissions from small boilers (thermal power less than 5 MW) are charged according to type of furnace, thermal power and type of fuel.

**Operation:** Applies to industrial emissions. If total annual charges for air, water and waste fees amount to 800 PLN or less then there is no obligation to pay the charge.

**Rate reductions**: Not applicable.

**Revenue:** $210 million USD in 2009. All revenues are used to financing provincial and national ecological funds, and local governments. 20% of revenues are allocated to municipal government, 10% to county government, 46% to provincial level ecological funds and 24% to the National Ecological Fund. Local governments must revenues environment protection measures and water management.

**Effectiveness:** Information not available.

**Compliance**: Ministry of Environment oversees scheme.

**Key references:** OECD Database on Instruments Used for Environmental Policy.

## 11. Slovak Republic

**Scheme:** Air pollution charge.

**Year introduced:** 1967 (small sources), 1992 (medium and large stationary sources).

**Pollutants**: Nitrogen oxides, sulphur oxides, carbon monoxide, PM, and organic carbon. Other substances are organised into pollutant classes: 1st class – asbestos, benzo(a)pyren, beryllium, dinebzo(a,h)anthracene, cadmium, 2-naphtylamine, mercury and thallium; and compounds of such substances; 2nd class – acrylonitrile, antimony, arsenic, benzene, tin, ethylene oxide, fluorides, phosgene, chromium, cobalt, cyanides, manganese, copper, nickel, lead, propylene oxide, selenium, tellurium, vanadium, vinyl chloride, zinc; and compounds of such substances; 3rd class – acetaldehyde, aniline, benzyl chloride, biphenyl, bromine, diethylamine, ethyl acrylate, phenol, fluorine, formaldehyde, chlorine, methyl acrylate, pyridine, carbone sulfide, tetrachlorethane, toluidine, trichloroethylene, trichloromethane; 4th class – acetone, alkyl alcohols, ammonia, anorganic gaseous chlorine compounds, benzaldehyde, chlorbenzene, chlorethane, acetic acid, methyl acetate, naphtalene, olefins, paraffins except methan, styrene, tetrachloretylene, toluene, vinyl acetate, xylene.

**Rate:** Small sources: rates vary according to municipality. Municipalities determine annual flat charges for specific operators of small sources according to the amount and structure of produced emissions. Medium and large sources per tonne: Nitrogen oxides €48.01, sulphur oxides €64.01, carbon monoxide €32, PM €160, and organic carbon €128.02. Pollutants by Class per tonne: Class 1 €1,280, Class 2 €640, Class 3 €320, and Class 4 €64. There is a maximum charge amount of 20,000 SKK per year for medium and large sources.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Annual emission charges are payable by medium to large stationary sources, and quarterly for smaller stationary sources. Charges for small sources are levied by local authorities and vary according to municipality. Charges for medium and large sources are levied by the state.

**Rate reductions**: Not applicable.

**Revenue:** Medium-large sources: $27.2 million USD in 2004. The Ministry of Environment collects revenues and they accrue towards an extra-budgetary environmental fund (the Slovak Environmental Fund). Resources were divided according to the needs in the protection of the environment and not according to amount of revenues in individual sectors. Small: all revenue accrues to local government where it is earmarked to support the collection, separation, and treating of waste.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy.

## 12. Spain

**Scheme:** Tax on air emissions.

**Year introduced:** 1996 (Galicia), 2004 (Andalusia), 2006 (Murcia).

**Pollutants**: Sulphur oxides, nitrogen oxides, ammonia (Murcia), VOC (Murcia).

**Rate:** Galicia – sulphur oxides and nitrogen oxides are expressed as $SO_2$ and $NO_2$. If emissions are <101 tonnes per year then no taxes payable; between 101-1,000 tonnes per year €36/tonne, between 1,001-3,000 tonnes per year €50/tonne; between 3,001-7,000 tonnes per year €70, between 7,001-15,000 tonnes per year €95, between 15,001-40,000 tonnes per year €120; between 40,001-80,000 tonnes per year €150, greater than 80,000 tonnes per year €200/tonne. Andalusia – taxes are based on pollution units where one pollution unit is equal to 150 tonnes of sulphur oxide or 100 tonnes of nitrogen oxide. Murcia – taxes are based on pollution units where one pollution unit is equal to 150 tonnes sulphur oxide, 100 tonnes nitrogen oxide, 100 tonnes ammonia, and 100 tonnes VOC. Rates vary depending on pollution units emitted per year and are charged as follows for both Andalusia and Murcia: emissions per year <10 units, €5,000/unit; between 10-20 units, €8,000/unit; between 20-30 units, €10,000/unit; between 30-50 units, €12,000/unit; emissions >50 units, €14,000/unit.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Annual taxes are payable if emissions meet threshold levels.

**Rate reductions**: Deductions between are available in Andalusia (up to 25%) and Murcia (up to 50%) for the installation of environmental management systems and installations for the control, prevention or abatement of air pollution.

**Revenue:** Collected by regional governments**.** Galicia: $4.2 million USD in 2011. 100% is earmarked to finance extraordinary damages and emergency situations caused by environmental disasters. Andalusia: $6.6 million USD in 2012. 95% is earmarked for financing environmental expenditure programs, 5% to a fund for environmental catastrophes. Murcia: $0.6 million USD in 2011. 100% is earmarked to finance environmental protection actions.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy.

## 13. Sweden

**Scheme:** Tax on $NO_x$ emissions.

**Year introduced:** 1992.

**Pollutants**: Nitrogen oxides.

**Rate:** €5.54 per kilogram emitted.

**Emission estimation methodology:** Measured or estimated.

**Operation:** Nitrogen oxides from stationary combustion plants with energy production >25 MWh are taxed annually. Exemptions exist for the following industries due to concerns about unfeasibly high costs: cement and lime industry, coke production, much of the mining industry, refineries, blast-furnaces, the glass and isolation material industry, wood board production and biofuel processing. The tax is revenue neutral and the entire revenue (less administering costs) is automatically refunded to the industries that paid the tax on the basis of their energy use.

**Rate reductions**: Some tax refunds/rebates are available for certain industrial processes that achieve emission reductions.

**Revenue:** $122.5 million USD in 2011. Revenues are used to cover the administrative costs of the National Protection Agency for handling the charge and the remainder is refunded to the combustion plants in proportion to their share in total energy output. Administration costs amount to 0.2-0.3% of revenues: Millock, Nauges & Sterner (2004).

**Effectiveness:** Stavins (2002) says the Swedish tax is the only fee in western Europe to have reduced emissions. Facilities covered by the fee reduced their nitrogen oxides emissions by 35% within the first 20 months after the implementation of the fee. Emission intensities in regulated plants have decreased by 67% between 1992 and 2007. In 1992 plants were producing 3,000 GWh of energy while emitting around 550 kg nitrogen oxide per GWh. In 2007, the plants were able to produce the same amount of energy while emitting less than 181 kg per GWh. The design of the Swedish NOx tax has also stimulated demand for new technologies driven demand for several new technologies for pre-combustion, combustion, post-combustion and monitoring, as well as energy efficiency: OECD (2013). However, only 6.5% of total nitrogen oxide emissions are covered by the fee: US EPA (2004).

**Compliance**: Accredited laboratories must inspect measuring equipment each year.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Stavins (2002) *Experience with Market-Based Environmental Policy Instruments*, OECD (2013) *The Swedish Tax on Nitrogen Oxide Emissions: Lessons in Environmental Policy Reform,* US EPA (2004) *International Experiences with Economic Incentives for Protecting the Environment*, Millock, Nauges & Sterner (2004) *Environmental Taxes: A Comparison of French and Swedish Experience from Taxes on Industrial Air Pollution*, CESifo DICE Report 1/2004.

## 14. Switzerland

**Scheme:** Emission related landing charge (airports).

**Year introduced:** 1997 (Zurich), 1998 (Geneva), 2000 (Berne).

**Pollutants**: Nitrogen oxides from landing aircraft.

**Rate:** Emission is calculated as the product of Aircraft Emission Value * Airport tariff. Aircraft Emission Values are based on individual Engine Emission Factors, calculated as the quotient of nitrogen oxide and hydrocarbon load over the landing and take-off cycle and the engine thrust of an aircraft model. Airport tariffs in Swiss francs (CHF) are as follows: Zurich CHF 2.50, Geneva CHF 1.40, and Berne CHF 3.30.

**Emission estimation methodology:** Measured. (Or estimated more appropriate?)

**Operation:** A variable emission charge is added as a surcharge to aircraft landing fees in participating Swiss airports.

**Rate reductions**: Not applicable.

**Revenue:** Zurich airport: $3.5 million USD in 2010 and all revenues are used for anti-pollution measures around airports.

**Effectiveness:** Information not available.

**Compliance**: Information not available.

**Key references:** OECD Database on Instruments Used for Environmental Policy, Federal Office of Civil Aviation (2013) 'Emissions Landing Charges,' (http://www.bazl.admin.ch/experten/luftfahrzeuge/03319/index.html?lang=en)

## 15. United States

### 15.1: California

Scheme: Annual operating permit emissions fee (South Coast Air Quality Management District, California)

**Year introduced**: Information not available.

**Pollutants**: Gaseous sulfur compounds (expressed as sulfur dioxide), nitrogen oxides (expressed as nitrogen oxide), PM, carbon monoxide, total organic gases, specific organic gases. There are 25 other toxic air contaminants and ozone depleters that are taxed separately from the above pollutants.

**Rate**: Threshold is 4 tonnes per annum for each pollutant, except for carbon monoxide which has a threshold of 100 tonnes. Any facility emitting more than 250 tonnes of any pollutant must also pay an annual Clean Fuels Tax. Rates are differentiated according to annual emission in tonnes per year: 4-25 tonnes / 25-75 tonnes / more than 75 tonnes. Rates for individual pollutants per tonne in USD: organic gases $559.14 / $907.82 / $1,358.90; specific organic $100.04 / $158.51 / $237.75; nitrogen oxides $327.12 / $519.62 / $782.56; sulfur oxides $387.82 / $626.94 / $941.26; PM $427.56 / $692.81 / $1037.31. Carbon monoxide is charged $6.68 for every tonne emitted above 100 tonnes. 25 other toxic air contaminants and ozone depleters are charged at a flat rate once an annual emission threshold is exceeded.

**Emission estimation methodology:** Measured or estimated – polluter may choose.

**Operation:** Stationary sources emitting more than 4 tonnes of a pollutant (except for carbon monoxide) each year must obtain permits for emissions. The threshold for carbon monoxide is 100 tonnes per year. Facilities emitting more than 250 tonnes of any pollutant must also pay an annual Clean Fuels Tax. Individual emissions fees are differentiated according to annual emission volumes.

**Rate reductions:** Not applicable**.**

**Revenue**: Information not available.

**Effectiveness:** Information not available.

**Compliance:** South Coast Air Quality Management District oversees scheme. California is divided into Air Pollution Control Districts and Air Quality Management Districts. These agencies are the regional governing authorities that have responsibility for controlling air pollution. Criminal and civil penalties under state and federal laws for breaches.

**Key references:** AQMD Rule 301 'Permitting and Associated Fees'

### 15.2: Maine

**Scheme:** Annual air emissions license fees.

**Year introduced:** Information not available.

**Pollutants**: Nitrogen oxides, sulphur oxides, VOC, PM. 187 other hazardous air pollutants are taxed under a toxic air pollutant surcharge.

**Rate:** Emission fees are determined according to total annual emissions. Nitrogen oxides, sulphur oxides, VOC and PM: emission<1000 tonnes, $8.40 USD/tonne; 1001-4000 tonnes, $16.83 USD/tonne; emissions>4000 tonnes, $25.21 USD/tonne. There is also a toxic air pollutant surcharge of $2.19 USD added for every 1,000 air quality units of a further 187 hazardous air pollutants emitted. Air quality units are a toxicity score for the pollutant multiplied by the estimated emissions of that pollutant. The minimum annual emission fee is $250 and the maximum annual emission fee is $150,000. The minimum annual surcharge is $154.63 and the maximum annual surcharge is $77,429.

**Emission estimation methodology:** Information not available**.**

**Operation:** Polluters must pay license fees for emissions, which are a combination of emission fees based on total annual emissions and emission fee surcharges.

**Revenue:** All revenues collected from licence fees must be used solely for air pollution control activities. In 2001 permit fees produced approximately USD $1.8 million in revenues each year, and toxicity surcharges netted USD $0.6 million in annual revenues.

**Effectiveness:** The EPA (2001) reports that the hazardous air pollutant surcharge has had a slight incentive effect.

**Compliance**: The Maine Department of Environmental Protection oversees operation of the scheme. Failure to pay an annual fee is sufficient grounds for revocation of the license or permit. Criminal and civil penalties under state and federal laws for breaches.

**Key references**: OECD Database on Instruments Used for Environmental Policy, Maine Revised Statutes, Title 38: Waters and Navigation, Chapter 2. Department of Environmental Protection, Subchapter 2. Maine Environmental Protection Fund, §353-A. Annual air emissions license fees.'

**15.3: Ohio**

**Scheme:** Title V Permitting Program.

**Year introduced**: 1994.

**Pollutants**: PM, sulfur dioxide, nitrogen oxides, organic compounds and lead.

**Rate**: $47.52 per tonne. Fee rates are adjusted for inflation.

**Emission estimation methodology:** Measured (actual amounts of emissions).

**Operation:** Major sources of air emissions are obliged to buy permits for their emissions. Major sources are defined as polluters that emit more than 100 tonnes of a criteria pollutant or 10 tonnes of a single hazardous pollutant or 25 tonnes of any combination of hazardous air pollutants. All polluters who emit greater than 1 tonne of pollutant per annum (or 0.5 tonnes of lead) must report their emissions.

**Rate reductions**: Not applicable.

**Revenue**: All Title V revenues are used exclusively to manage the Title V permitting program.

**Effectiveness:** Information not available.

**Compliance:** Polluters are required to self-monitor and keep records and reports. Criminal and civil penalties under state and federal laws for breaches.

**Key references:** Ohio EPA (2013) 'Title V Permitting Program.'

## 15.4: Oregon

**Scheme:** Annual Oregon Title V Operating Permit Fees

**Year introduced**: Information not available.

**Pollutants**: Criteria pollutants: sulfur dioxide, nitrogen oxides, PM, lead, carbon monoxide.

**Rate**: Emission fees are $57.90 per tonne of pollutant. A base fee of $7,657 is also payable. The fee rates are adjusted annually to account for inflation. Specific activity (administrative) fees are levied on an ad hoc basis: permit modification (USD $1,867 - $28,016, depending on the complexity of the application) and ambient air monitoring review (USD $3,735). Emission fees are only assessed up to (and including) 7,000 tonnes of all regulated pollutants from any one source per annum. This implies a maximum emission free of USD $405,300 for any one source per annum. Prior to 2010 emission fees were assessed up to (and including) 4,000 tonnes per annum on *each* regulated pollutant from each source.

**Emission estimation methodology:** Estimated using emission factors or measured.

**Operation:** Major sources of air emissions are obliged to buy permits for their emissions. Major sources are defined as polluters that emit more than 100 tonnes of a criteria pollutant. Polluters must pay a base fee, emission fees and specific activity fees that cover administrative and monitoring charges. A number of industries and activities are exempt, including 'warehouse activities' and pre-treatment of municipal water. Polluters can choose to pay rates based on their permitted emissions, actual emissions or a combination of both.

**Rate reductions:** Rebates are available to polluters emit less than permitted and fees have already been paid.

**Revenue**: Revenues must fund Title V administration according to stipulations of Title V of Clean Air Act. Oregon sought to increase fees in 2012 because it was at risk of being unable to pay staff to administer the program.

**Effectiveness:** Approximately 120 sources are currently permitted under the Oregon Title V Operating Permit program.

**Compliance:** Self-monitoring of emissions. The Department of Environmental Quality issues permits, makes periodic inspections, reviews annual emissions reports and takes enforcement action when appropriate. The US EPA can give $5,000 fines for minor violations and administrative penalty orders of up to $25,000 per violation. The DEQ can administer fines of up to $1 million or imprisonment of up to 15 years for where release of air toxins causes 'knowing endangerment.' Citizen lawsuits are also available.

**Key references: '**Annual Oregon Title V Operating Permit Fees,' Oregon DEQ (2013) 'Title V Operating Permit Program'.