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Background and Study Objectives

The Kyoto Protocol[1] introduced the concept of emissions control to a global audience. Under this agreement, in 2005 the EU established a European Trading Scheme (ETS)[2] for trading carbon dioxide (CO2).

But 'cap-and-trade' programs were already in operation in the US, where nitrogen oxides (NOx) and sulphur oxides (SOx) had been traded since 1994. In fact, in Los Angeles ships can also participate, exchanging credits with land installations. US EPA proclaims their success.

Emissions trading schemes such as ETS or the US equivalent naturally have critics and supporters. Each program operates under a different frame, according to the ambition level, the environmental effects of the gasses and other parameters of fermentation.

The European Union's Emission Trading Scheme (EU ETS) currently covers most large industrial installations, but not as yet transport. However, the European Commission is currently preparing a report on how aviation could be brought into the EU ETS. The other transport sectors including maritime will also come into the spotlight as consideration is soon given to expanding the EU ETS after 2012. There are many options for how emissions trading could be applied to the transport sector(s). Such a scheme could cover all transport sectors or separate schemes for sub sectors such as road or maritime transport. The scheme could be 'open' i.e. linked to the EU ETS and other trading systems, or 'closed' i.e. restricted to the sector itself. Then there are a wide number of other design options and criteria to consider. Maritime transport is being accounted for the first time for its emissions – mainly NOx and SOx- regulation and policy are being formed.

The main objective of this study is to:

1. Introduce the principles of carbon trading schemes

[1] The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions .These amount to an average of five per cent against 1990 levels over the five-year period 2008-2012.

[2] In January 2005 the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) commenced operation as the largest multi-country, multi-sector Greenhouse Gas emission trading scheme world-wide. The scheme is based on Directive 2003/87/EC, which entered into force on 25 October 2003.

2. Review different ongoing carbon trading schemes around the world by referring to, the regulated sectors, their ambition level as well as their success rate in providing a cost-effective solution
3. Examine European transport and localised environmental problems with special focus to the prospect of shipping participating in the scheme, within the environmentally sensitive seas of the European North, as currently examined by policy- makers.

Target Stakeholders

1. Transport professionals in industrial sectors currently regulated by an emission trading scheme
2. Policy makers analysing different policy alternatives
3. Professionals offering environmental consulting and environmental management services
4. Decision makers and strategists working (middle management) in the transport sector and European supply chain sector
5. Researchers

Approach – Methodology

The study will be introduced by the theoretical framework of emission trading, followed by examples of trading schemes around the world for regulated sectors, followed by potential options for a Maritime transport trading scheme particularly within the environmentally sensitive seas of the European North.

The study will consider:

1. *Environmental* studies, models and measurements on emission outputs and depositions in order to frame environmental necessities, policy ambitions and possible caps for new schemes
2. The conceptual foundation of this market based mechanism as opposed to the traditional command-and-control or other economic instruments
3. *Theoretical* foundations behind the concept of cap-and-trade
4. *Sectorial specific issues* examining emission scenarios for a gas or sector and/or presenting case studies

Glossary

1. *Greenhouse gases (GHG)*-GHGs in the earth's atmosphere absorb and re-emit infrared radiation. The Kyoto Protocol lists six major greenhouse gases, which vary in their relative warming effect. The six gases are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFCs (hydrofluorocarbons), PFCs (perfluorocarbons) and sulphur hexafluoride (SF_6).
2. *Carbon dioxide (CO_2)*-The most abundant of the greenhouse gases, produced as a by-product of oil and gas production, burning fossil fuels and biomass. All animals, plants, fungi and microorganisms also produce CO_2. It has a global warming potential of 1.
3. *Carbon credit* :A generic term to assign a value to a reduction or offset of greenhouse gas emissions. A carbon credit is usually equivalent to one tonne of carbon dioxide equivalent (CO2-e). A carbon credit can be used by a business or individual to reduce their carbon footprint by investing in an activity that has reduced or sequestered greenhouse gases at another site.
4. *Allowance (or permit):* Permission to emit one credit of the gas within a specified time
5. *Cap:* the maximum allowable emissions over a regulated area and within a specified time, often tautological with the regulated (capped) area
6. *Emission reduction credit:* a tradable emission unit deriving from reducing further than the requirement
7. *Banking:* the possibility to carry over unsold emission reduction credits from one period to another.
8. *Hot air*: excessive allocation of allowances often due to loss of industrial output or de-industrialization
9. *Hot spot:* localised high emissions due to trading and/or due to a geographical swift to where emissions are physically reduced

Emission Trading Schemes Framework

Externalities

In environmental economics, pollution is understood within the concept of externalities. An externality is a spillover effect associated with production or consumption that extends to a third party outside the market (Thomas/Callan). It may be negative, which means that it generates a cost to the third party but it may also be positive by generating a benefit. Pollution is an unintentional by-product with a negative effect towards human health and the physical environment, thus it is a negative externality.

Externalities have been studied since the time of Pigou and are an important form of market failure. According to theory, a market fails when it cannot accomplish the Pareto efficiency, that is, a situation in which nobody can be made better off without making somebody else worse off. In the case of pollution, the general public and the physical environment are threatened, where as the general public is entitled to healthy living conditions and to sustainable development, if not as a responsibility to posterity.

Externalities are settled with some sort of compensation to the third party that behold property rights, and who is harmed. The problem which often arises is the absence of well-defined property rights, especially in the case of abstract public goods, such as clean air, let alone the also abstract moral of responsibility to the future generations. Therefore, a system of direct compensation has been problematic.

Environmental Policies

Against the threat of pollution, policy enforces rules concerning prevention, regulation and compensation. Control of pollution policy normally follows two directions, the traditional command-and-control or economic instruments. These two different approaches will be presented and compared.

Command-and-control

The command-and-control approach directly regulates the polluting sources. It does so by for example, putting restrictions on which technologies may be used, or setting inflexible limits to the polluters. This approach is conventional and universally dominates environmental policy. It seems to have evolved from an attempt to gain immediate control of what was initially an

unfamiliar and urgent dilemma. It is a well intended policy, often criticized because it imposes uniformity across all polluters (Thomas/Callan).

Economic instruments

Given the fact that often not all polluters bear uniform conditions of operation, or bear uniform economics, a market-based mechanism was developed.

An emission trading scheme is a market-based mechanism used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants.

A central authority (usually a government or international body) sets a limit or *cap* on the amount of a pollutant that can be emitted. Companies or other groups are issued emission *permits* or *credits* to emit a specific amount limiting total emissions to the cap. Companies that need to increase their emission allowance must buy credits from those who pollute less. The transfer of allowances is referred to as a trade. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for producing reduced emissions. Thus, in theory, those who can easily reduce emissions will do so, achieving the pollution reduction at the lowest possible cost to society.

In its most general use, a tradeable permit can be defined as a transferable right to a common pool resource (Ellerman)[3].

Prerequisites for trading schemes

Measurement

Emission trading schemes require that emissions are measured per installation. The *measurement* of emission is precise and it is conducted by the installation itself, which reports the measurements to the pool. The processes of measuring emissions are pre-set by the authority supervising the scheme and they are standard. Monitoring takes place by a third party and the traded volumes are ready for transaction. The command-and-control approach is different to this respect, as it determines particular technologies or equipment to operate at site or imposes particular processes during production. It is obvious that measuring and monitoring emission may lift up the costs of emission trading schemes. It was rather thanks to the development of information technology and of various sensors that measuring and monitoring emissions is not a handicap.

[3] http://www.springerlink.com/content/x0803032hqk78447/fulltext.pdf

Allocation of emission rights

A vital arena for debate is the *allocation of emission rights* to the pool of installations which are regulated under the emission trading scheme. Allocating emission rights determines the tradable quantities per installation. Allocated emission right distributed for free to the participants or they may be auctioned. Apparently, installations benefit when emission rights are granted for free and there is also the issue of how to utilize the revenues (of what is referred to as the scarcity rent).

The result of allocating emission rights has economic effects on the installations, concerning their position in the emissions market or, for example, investments on cleaning technologies. It may handicap (or assist) an industrial sector with abatement costs against competing installations, which may operate outside the radius of the scheme. Emission rights (or the lack of them) determine an overhead on production costs against competing and in a globalised free market, this is something to consider.

There are pros and cons in deciding to allocate emission rights for free or auction them and policy makers may have to look to the side effects. There are models of allocating emission rights among similar and dissimilar industrial installations. There is literature which examines benefits and problems for each model. Fermentation, negotiations and participation of industrial associations in the discussion, is necessary to achieve some consensus over the prospective rents, as one can see in the forming of the European trading scheme (2002). In the command-and-control system, the issue of scarcity rent is not raised.

Scheme ambition

Last but not least, the level of ambition of the scheme, the definition of *sustainable levels* and the *definition of pollution* are important to establishing a cost-effective scheme. This is a difficult task as depositions of a pollutant must be counted, and projections of future contamination must be 'real' rather than 'surreal'. Harmful effects are examined according to their special distributions and their temporal relations of the discharges. If these measurements are not correct, either inflated or seriously underestimated, the scheme runs the risk of becoming costly or ineffective. The result of these measurements determines an appropriate technology to be benchmarked in allocating emission rights.
The measuring the discharge of the pollution and projecting the environmental effects does not automatically achieve a sustainability consensus (as the negotiations of greenhouse gases

have every so often exhibited) but setting off to the right path and continue to work towards a more efficient consensus.

Types of tradable permits

The main types of tradable permits are:

1. *Credit trading* awards tradable units to installations which reduce their emissions more than is required by a pre-existing conventional regulation or other benchmark. But the regulator certifies the credits for trade. The certification is based on the notion that these emission reductions are the result of effort, of 'exemplary behaviour' on behalf of the installation. Certification ensures that reductions which would have been achieved anyway are not counted in as a tradable quantity. Certifying reductions is considered costly and may off-set the gains of putting only the 'right' credits on the emissions market (Ellerman), cost may explain why this feature is not widely used in emission trading schemes. Credit trading is regarded an 'extension to command-and-control' system because the regulator directly makes decisions concerning the installation.
2. *Rate-based or Averaging Programs*. When emission reductions automatically become tradable credits, this is called 'averaging'. In Europe the term includes the word 'relative' in some form. The regulator does not directly intervene to decide which quantities are tradable and which should be counted out of the trade. As long as they are below a pre-existing standard. To set this pre-existing standard a best available technology is benchmarked and the reductions are 'relative' to the benchmark.
3. *Allowance trading (cap-and-trade)* sets an absolute cap on emissions below which all achieved reductions are traded. With cap-and-trade the compliance requirement is different. Compliance is not determined by 'reference to a common standard' (and the deviations from it). Installations surrender a permit for every unit of discharge. Although the cap may be very constraining in the aggregate, no firm is expected to meet any specific standard. It must only obtain and surrender an allowance that can be readily bought or sold in the market. In effect, allowances have become essential inputs into production subject to the same marginal cost calculations as other inputs'[4].

[4] Ellerman March 2003 - http://www.springerlink.com/content/x0803032hqk78447/fulltext.pdf

Critique of trading schemes

Cost-effectiveness criterion

The primary aim of an emission trading scheme is to mitigate abatement costs for a given environmental target. Emissions trading schemes consist of another approach to emission reduction, one that is flexible enough to reduce the overall costs as compared to other policy instruments. The setting of the environmental target is entirely the responsibility of the policy maker but complications in allocating permits may compromise an emission trading scheme. Generally, trading schemes are accepted as potentially cost-effectiveness instruments for limiting emission with questions arising as in what situations they can be applied successfully.

Two aspects of economic efficiency need to be distinguished in evaluating cap-and- trade programs. The first concerns trading between installations has realized full cost savings. The second aspect relates to whether the environmental constrain generates revenues for broader welfare effects, as explained by Ellerman[5]. From this standpoint, full economic efficiency can be achieved by auctioning the allowances

.

A vast majority of the relevant empirical studies in the US have found the traditional command-and-control systems to be more expensive than the emission trading schemes. Tietenberg states that ‘’this is an important finding because it provides the motivation for introducing a reform program; the potential social gains (in terms of reduced control cost) from breaking away from the status quo are sufficient to justify the trouble’’.

Emission trading schemes in the US are said to have exploited the lower control costs in order to achieve stricter environmental targets or earlier deadlines, as is the case of the lead program.

Geographic shift in emissions

A common criticism for emission trading schemes refers to localized increase in a pollutant due to geographic shift in emissions, what is called hot spots. This is relevant to pollutants with local effects rather than global effects, such as the greenhouse gases. For the case of NOx and SOx, wind transports and diffuses emissions along a large grid and little is deposited locally. Experience from the US NOx and SOx trading schemes showed that there was no

[5] http://tisiphone.mit.edu/RePEc/mee/wpaper/2003-003.pdf

case of hot spots created by trading. It was in fact the large polluters which achieved the larger volumes of reductions (US EPA).

The critique on emission trading does not refer to the potential cost-effectiveness but question the situations, where a scheme can apply. There is concern on trading some pollutants, as is in the case of mercury. The US EPA has received petitions to reconsider the Clean Air Mercury Rule (CAMR) as there is social concern over possible localized mercury emissions, which could travel up their way through the food chain for the local community.

Uniformly mixed pollutants match with emission trading schemes. Non-uniformly mixed pollutants, whose location is important as is, for example mercury, require a more complex design to ensure the neutralization of dangerous 'hot spots'. Implementing such scheme is, of course, much costlier in administration and the difference between the traditional and the market approach in policy is not so clear. An improvement is the second-best choice of design, which is compromise.

Regressive as allocations of permits

Another criticism is that the permit system is regressive as allocations of permits to old (and highly polluting) installations holds sway against the new (and environmentally friendlier) installations. It also grandfathers old installations for depositions which occurred in the past especially when emission rights are distributed gratis. This argumentation considers fairness as a key. If or not emission trading schemes are regressive and distort the results competes with argumentation, such that trading schemes initiate cleaner technologies and environmentally friendlier installations (Ellerman May 2003)

Pollution taxes vs. tradable emission permits

Taxes as well as tradable permits give each installation more flexibility in deciding on production processes and abatement technologies. In USA taxes are considered as a 'non-starter', whereas in Europe taxes are generally used. Political economy is different between the two sides of the Atlantic. It is interesting to remember that policy follows the dynamics of society, technology and economy through time. Ellerman notes some differences concerning the past and the present.

Previously:

- sources of pollution were easily identifiable in being mostly large and stationary, which made it easier to prescribe appropriate abatement
- faith in the capability of expert government agencies was greater

At present:

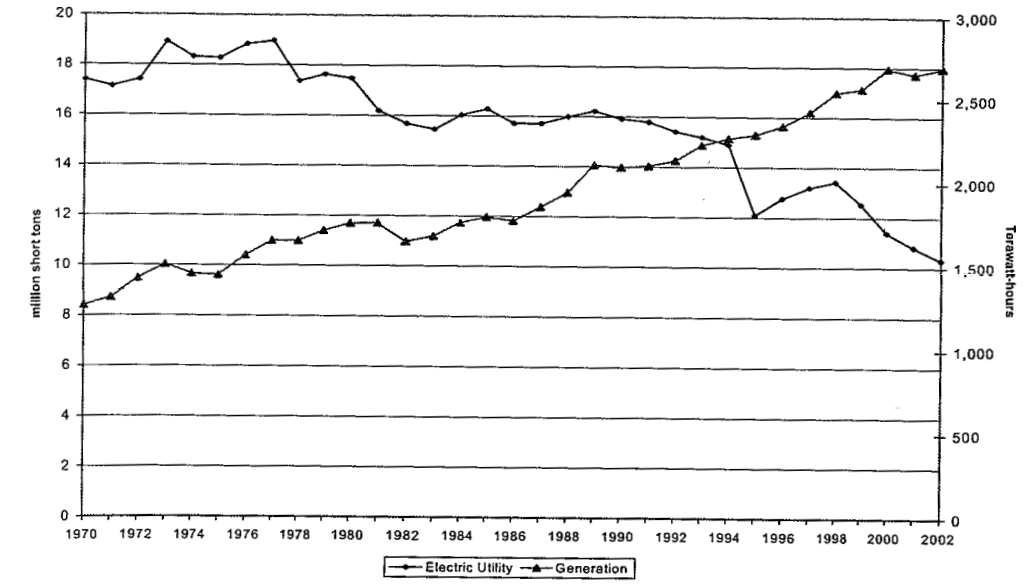
- ability to measure emissions at relatively low cost has been greatly reduced by improvements in sensing and information technology
- big, initial pollution problems have been satisfactorily addressed, and the
- problems now facing modern post-industrial societies are far more complex and less obvious
- experience and the rise of public choice literature has diminished confidence in the efficiency and equity of direct government intervention and led to a search for more effective, efficient and equitable approaches

Experience from emission trading schemes

Acid Rain Program - US

In the US between 1985 and 2002 emissions have mainly decreased by reducing the rates at existing units, that is, less emissions per unit of energy. Installations with lower emitting rates –new or existing- displaced higher emitting ones, contributing to the total reduction. But as demand has continuously grown, the reductions alone would not have not been enough. The reduction in electric utility is substantial, realizing that fossil-fuel-fired generation of electricity has grown substantially since 1970 (Figure 1).

The Clean Air Act Amendments of 1990, Title IV, have set a limit on SO2 emissions to approximately 9 million tons across country. They established a cap-and-trade program for utility generating units where the cap is equal to the issued allowances. Installations can decide on their compliance strategy. Title IV did not replace the source-specific limits and technology mandates of the 1970 amendments, so the cap-and-trade scheme is on top of a pre-existing structure of regulation. The study done by Ellerman and Dubroeucq indicates that the cap-and-trade scheme, called the Acid Rain Program, has been more effective between 1995 - 2002 than the command-and-control approach between 1985 -1995.



Figur 1 - US fossil fuel fired generations and SO2 emissions, 1970-2002
Source: Ellerman and Dubroeucq

The installations with lower emitting rates did not by rule displace coal-fired installations. This displacement reduced abating costs and not the total SO2 emissions. Concerning competing fuels the displacement ironically assisted coal-fired installations. The final beneficiary was the end-user of electricity, who benefited from slightly reduced bills without any change in environmental performance.

In the beginning of the scheme, trading activity took place mostly between installations under the same organization, with trading to expand between non-affiliated installations as the scheme matured and the participants familiarized themselves with the advantages of the market mechanism.

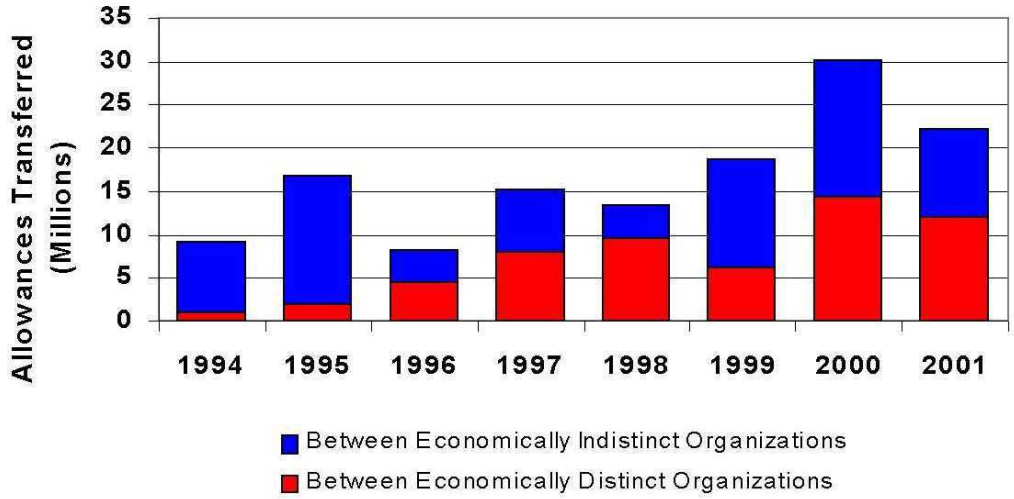


Figure 2 - Annual Allowance Trading Activity

Source: US EPA (Ellerman) http://tisiphone.mit.edu/RePEc/mee/wpaper/2003-003.pdf

Experience from phase 1 of the European Emissions Trading Scheme (ETS)

EU – ETS started in January 2005 by trading CO2 and consists of two phases. In Phase I (pilot phase from 2005 to 2007) only CO2 is traded covering 45% of Europe's emissions, with about 11,500 installations participating (rated thermal input exceeding 20MW). Overall, Phase I has been widely criticized for over-allocation of emission permits, wind-fall profits of the power industry and volatility of the carbon price.

Regarding the allocation of emission permits, these where covered by the National Allocation Plans (NAPs). Scientific work, the press and NGOs have noted that almost all member states (with the exception of the UK and to a lesser degree of Germany) were 'generous' in allocating permits. The UK protested to the 'comparative disadvantage' of its national industries against competitors. European Commission has marked Phase I as 'educative' and subsequently rejected all but one National Allocation Plans (UK) for Phase II. Still, there is some criticism that NAPs are immoderate.

During Phase I, European Associations representing Energy Intensive, and in particular power intensive,Industries (cement, ceramic, chlor-alkali, lime, glass, paper, non-ferrous metals and steel industries) drew attention to an increase in electricity prices[6]. The increase in electricity prices was accredited to the newly-introduced European Emissions Trading Scheme, and was

[6] http://www.cembureau.be/Cem_warehouse/2-INDIRECT%20IMPACT%20OF%20EMISSIONS%20TRADING%20ON%20ELECTRICITY%20PRICES.PDF

criticized as unjustified, since the emission permits were given gratis. Chartier and Holdsworth comment that **'a**lthough it may be true that windfall profits did occur in some jurisdictions during Phase I of the ETS, this was due primarily to a number of unique factors in certain EU electricity markets – inadequate policy architecture, lack of market players, etc – rather than to any inherent problems with emissions trading or the free allocations of emissions[7].'

Concerning the volatility of the carbon price, this peaked at 30 Euros per ton in April 2006, only to sink shortly after. Explanations connect the sinking of the carbon price with the over-allocations[8] of permits in the national registries (the carbon price started to falter when the last NAP was submitted to the European Commission). In 2005 and early 2006 'the explanations for the higher than expected prices cited fundamental factors: a cold late winter in early 2005, a dry summer in southern Europe, and high natural gas and oil prices that made coal more attractive'. Nevertheless and in retrospect, [Ellerman notes that] in 2005 and early 2006 the companies which were short of allowances were disproportionally present in the emissions market, compared to the companies that held long positions (sellers), creating a buying pressure. Potential sellers ('non-power companies in the EU15 and all companies in Eastern Europe') were either small installations, which were 'not inclined to trade anyway', many adopting a 'wait-and-see' policy. The installations located in Eastern Europe could only sell after their national registries were into place.

Emission trading schemes and transportation

Transportation is considered to be a net buyer of CO2 credits due to its attachment to fossil fuels and the CO2 abatement costs. Therefore, it is widely expected that in a carbon market, there will be little change in fuel consumption from transport and subsequently in carbon emissions. For road transportation, a carbon market will have little impact on prices compared to the existing fuel taxation. It has been discussed that if the existing taxes in fuel are

[7] http://www.environmentalmarkets.org/galleries/default-file/EF0608_Marketview.pdf

[8] http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2S-4MBT1P7-1&_user=646099&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1003551370&_rerunOrigin=google&_acct=C000034699&_version=1&_urlVersion=0&_userid=646099&md5=be218fecc03d65cfd0107cb4950acf93

withdrawn, as a prerequisite to enter the European Emission Trading Scheme (ETS), there is danger that carbon emissions may increase.

Another concern for road transport has been the complexity on capping such a large number of relatively small polluters, denoting high transaction costs. For this reason in 2006, LIFE and LETS projects gave low priority in including road transport within a universal European carbon trading scheme.

Concerns have also been noted on the impact of transport to energy-intensive industries, or to industries globally competing, fearing that this may result in compromising the environmental targets due to political pressure. Instead, the Swedish Environmental Protection Agency has proposed a trading scheme only for transport. There is an on-going discussion on establishing a global tax levy on fuels in place of an emissions market.

Aviation has been long discussed to be part of the European carbon Trading Scheme (ETS). Conflicts arose when emissions would be attributed to commercial flights with origin/destination outside the EU-member states, as many countries considered this to be unilateral. In January 2009 Directive 2008/101/EC included aviation in the EU Emissions Trading. Due to traffic increase and little available alternatives, aviations is considered to be a net buyer of carbon credits.

Regarding shipping global carbon emissions account between 2-4% of global anthropogenic emissions with the IMO consensus to be at 2,7%. Shipping has also been the discussed to be part of the carbon trading scheme and like aviation emissions from shipping were counted under the Kyoto Protocol and for 'statistical purposes'. Within the present year (2009) if IMO is does not reach an agreement, the EU is expected to take unilateral action. Supplementary to a carbon emission trading scheme including shipping, is a discussion over port dues and the mandatory IMO CO2 index. The Federal German Environmental Agency has proposed a Maritime Emissions Trading Scheme (METS), where emissions are attached to the ship, irrespective of operation, ownership and flag, while part of the allowances are auctioned. An EU scheme is not opposing the UNCLOS convention since participation to the scheme may apply as a precondition for a ship to call EU ports.

Regarding air pollution, EU has recently called on a pilot project to establish a voluntary emissions trading scheme for sulphur dioxide and nitrogen oxide emissions in the Baltic Sea. The aim is to achieve greater emissions reductions in shipping than currently required by the IMO, or to attaining faster emission reductions than it can be expected under current international legislation.

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