To the European Commission, DG XI,
Study contract B4-3040/98/000795/MAR/B1
Designing Options for Implementing an Emissions Trading Regime for Greenhouse Gases in the EC

**Scoping Paper No.5**

# Allocation of Greenhouse Gas Reduction Responsibilities Among and Within the Countries of the European Union

**June 1999**

This scoping paper was prepared primarily to provide background information to members of the Study Team on key issues related to the design of an European emissions trading scheme and to assist the "brainstorming" process. The views expressed in this paper are not necessarily those of CCAP who do cannot accept responsibility for the completeness or accuracy of the information and analysis contained herein.

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## I Introduction

Under the Kyoto Protocol the European Union (EU) has agreed to limit its average annual greenhouse gas emissions to eight percent below 1990 levels during the period 2008 to 2012. Each Member State of the European Community (EC) has also individually agreed to limit emissions to this level. Under the "bubble" provisions of Article 4 of the Protocol, however, the Member States have agreed to jointly fulfil their Protocol emissions limitation commitments. In June 1998 the EU decided on a burden sharing agreement (BSA) that allocates the EU target among the Member States (see . Trading can occur among the States either under EU rules, if the EU established a trading system, because of the European bubble, through Annex 1 trading under Article 17 of the Protocol, or via Article 6 Joint Implementation.

This paper deals with the issues relating to the allocation of emission allowances (or equivalently Parts of Assigned Amount, PAAs) among and within States. Allocation occurs in two ways. First, governments must allocate domestic reduction targets to their private sectors that actually emit, either directly through domestic tradable allowance system or indirectly through regulation aimed at limiting a sector's emissions. This 'allocation' might be more accurately described as 'distribution' by government. It is the primary focus of this paper. Second, if the allowances are tradable, the allowance market can reallocate allowances among and within sectors and countries.

Section Two of the paper outlines four basic options for State allocation of emission reduction obligations among sectors and sources: policies and measures (PAMs), including taxes, auctioned allowances, grandfathered allowances and output-based allocation of allowances. Then we step back to look at general issues relating to regulation under all forms of allocation. This discussion aids us in designing the details of the options as well as possible and helps us choose among options. The options will be evaluated against three criteria: economic efficiency, equity and administrative feasibility. Section Three lays out the efficiency implications of the three allowance systems. In particular we emphasise the importance of tradability of obligations and the advantage of auctioning that arises through the recycling of revenue.

In the fourth section we consider the distributional implications of greenhouse gas regulation as a whole, and how the different allocation methods a State could use will affect this distribution and address equity concerns. The fifth section discusses specific design details of the three allowance allocation systems and assesses their

[1] Dr. Suzi Kerr, Center for Clean Air Policy and Motu Economic Research, April 16, 1999 was the lead author of this paper, which draws heavily on Cramton and Kerr (1999). Dr. Kerr would like to thank Onno Kuik, Tim Hargrave and Fanny Missfeldt for helpful comments.

feasibility and administrative practicality. Throughout the paper we assume that the trading system will cover sources of energy-related carbon dioxide ($CO_2$) only. The feasibility of covering other sources and gases is discussed in an accompanying paper.

Finally, when we have looked in detail at allocation options at the State level, and their implications, we broaden our scope to look at EU wide issues. We consider issues at an EU level that should influence the model the EU would choose for trading. The three key EU-level issues are 1) maintaining competitive equality among industries in different States within Europe; 2) reducing the barriers to trade within Europe both of allowances and of directly regulated goods; and 3) balancing domestic sovereignty with the Community's interests. The two issues that need to be addressed at the EU level are, first, to what extent the EU will require common rules across States, and second, what these common rules will be. Will the trading programme be a Community-administered system, the opposite extreme - a set of linked national systems, or will it be somewhere in between with some common rules and some domestic flexibility? Should some countries be allowed to opt out of the common EU rules?

We conclude that the key EU-level issue is ensuring that industries in different States are regulated with similar intensity. An upstream allowance system that is comprehensive and has allowances that are fully tradable across States is the most transparent and feasible way to ensure this level-playing-field. Regardless of the method of government allocation, free unlimited trading ensures that all firms face the same opportunity cost of additional greenhouse gas use. We also conclude that auctioning allowances and returning the revenue through broad tax cuts is the most efficient and equitable method of allocation.

# II Domestic Allocation Options

In this section we look at the different ways the emissions reduction obligations can be distributed by governments within States. If these obligations are in the form of tradeable allowances the ultimate allocation will be determined by the market. If the EU chooses to impose common rules, the arguments that influence choices among these options are the same as those that relate to what rules the EU should impose. For a discussion of basic domestic permit system design see Fisher Kerr and Toman (1998 a and b). The details of the best ways to use each of these allocation options are discussed in section V.

***What is a Greenhouse Gas Emissions Allowance?***

Each allowance or part of assigned amount (PAA) is for one metric ton of carbon-equivalent usage. Each state is allocated PAAs for the commitment period. The allocations to each EU State is given in Table 1. All allowances are the same after their date of issue, and allowances are bankable; that is, a allowance issued for the year 2008 could be used in any later year. The number of allowances or PAAs available to each State for distribution is determined by the Kyoto agreement and the BSA. For example, Austria will have 78 million metric tons of allowances each year or 390m Mt for the commitment period as a whole. At the end of the commitment period each state must surrender allowances that equal or exceed its measured emissions over the entire five year period.

**Table 1 Allowances available to each State - CO2 equivalent***

| | Emissions in 1990 million Mt eq CO2 | Average allowances available each year of the commitment period. million Mt eq CO2 |
|---|---|---|
| Austria | 78 | 68 |
| Belgium (note 1) | 139 | 129 |
| Denmark (note 1) | 72 | 57 |
| Finland | 65 | 65 |
| France | 512 | 512 |
| Germany | 1204 | 951 |
| Greece | 104 | 130 |
| Ireland | 57 | 64 |
| Italy | 542 | 507 |
| Luxembourg | 14 | 10 |
| Netherlands (note 1) | 208 | 196 |
| Portugal | 69 | 87 |
| Spain | 302 | 348 |
| Sweden | 65 | 68 |
| UK | 775 | 678 |
| total EU | 4204 | 3867 |

Note 1 : $CO_2$ without corrections
*** $CO_2$ + CH4 + N2O**
Source: EEA – from Commission Communication to the Council and the Parliament "Preparing for Ratification of the Kyoto Protocol"

In a domestic upstream trading system, oil refineries, natural gas pipelines, natural gas liquid sellers, coal processing plants, and other fuel producers would surrender allowances to match the GHG emissions implied by their products. (See the paper on the point of regulation for details.[2]) Other non-trading sectors would need to have their emissions matched by allowances held by the government.

Allowances could be distributed by an existing government institution such as the environment or energy department which would also need to play a role in enforcing domestic compliance. The mechanical transfer and tracking of allowances could be carried out by a private entity or stock market with government supervision. Allowances can and should be distributed not only for the current year but also for future issue years. Thus, some allowances for 2012 could be allocated in 2008. This allows banking and reallocation of emissions to occur freely within the in the commitment period. States could even allocate domestic allowances for the next commitment period in advance although they could not be used before 2013. Early

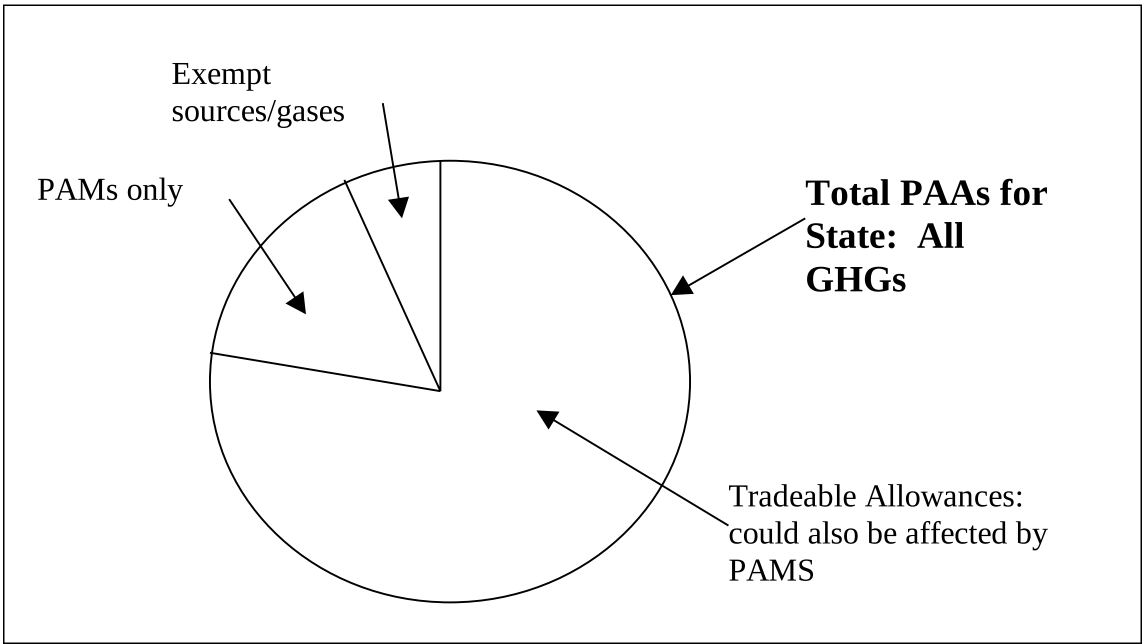
[2] Also see Hargrave (1997).

allocation would facilitate the development of an active futures and options market, thus improving risk allocation.

The homogeneity and bankability of allowances makes an auction and the secondary market very liquid. The more liquid the issue is, the lower is the transaction cost and the higher is the efficiency of allocation. Illiquidity increases the risk that some market players may have market power in certain circumstances.

The total amount of PAAs must be allocated across gases and sources – see Figure 1. Because total GHG emissions are capped, the allowance to one gas or set of sources affects those available for others. If some sectors are exempt from regulation or only have PAMs applying to them they are not capped; the government, however, still faces an effective cap on emissions from those sectors within its own PAA budget. It could ease this constraint by purchasing allowances externally.

**Figure 1 Allocation of PAAs among sources and gases**




For example, the Danes have recently announced an intention to create a quota system for the electricity sector.[3] Suppose for illustration that this was their post 2008 position. They would have a tradable quota system that covers 28% of their 1990 emissions (20.4m tons). They plan to allocate 23 m tons per year reducing to 20m tons from 2000 – 2003. 20m tons would be 35% of their PAAs and is close to 0% reduction from 1990. The Danes have committed to reduce GHGs by 21% overall. If this was their 2008 policy they would have to reduce emissions from other sectors and of other gases by nearly 29% or purchase external PAAs. Of course if other sectors are included in the trading system, and/or allowances are internationally tradeable, the electricity sector may elect to reduce emissions rather than simply returning to 1990 levels if the cost of doing so is lower than the allowance cost.

[3] Danish Energy Agency (1999)

More generally, an allowance system that covered only energy industries would allocate around 28% of PAAs in the form of tradeable allowances if they allocated across sectors based on 1990 shares of GHG emissions. An allowance system that covered all CO2 emissions (excluding land-use and forestry) would allocate around 79% of PAAs as tradeable allowances. Table 2 shows the shares of CO2 emissions across sectors.

**Table 2 Key Sector shares of CO2 emissions in 1990**[4]

| | Fuel Combustion | | | | | Industrial process | Total |
|---|---|---|---|---|---|---|---|
| Country | Energy Industries | Industry | Small Combustion | Transport | Total Fuel combustion | | |
| Austria | 20.05% | 11.67% | 20.77% | 22.58% | 75.13% | 20.52% | 100% |
| Belgium | 24.24% | 26.73% | 22.62% | 17.20% | 91.24% | 7.91% | 100% |
| Denmark | 49.48% | 11.05% | 16.57% | 20.04% | 97.36% | 1.92% | 100% |
| Finland | 36.25% | 25.46% | 14.68% | 21.38% | 97.77% | 2.23% | 100% |
| France | 21.64% | 13.11% | 26.39% | 33.01% | 94.15% | 4.40% | 100% |
| Germany | 43.33% | 16.74% | 19.54% | 15.64% | 97.29% | 2.71% | 100% |
| Greece | 51.62% | 11.61% | 9.65% | 17.96% | 90.85% | 8.75% | 100% |
| Ireland | 35.36% | 17.68% | 25.58% | 15.90% | 94.53% | 5.30% | 100% |
| Italy | 34.35% | 18.08% | 17.77% | 22.00% | 92.47% | 6.37% | 100% |
| Luxembourg | 14.77% | 49.83% | 9.98% | 20.59% | 95.16% | 4.59% | 100% |
| Netherlands | 30.68% | 28.77% | 22.26% | 16.00% | 98.36% | 1.10% | 100% |
| Portugal | 36.11% | 15.33% | 9.48% | 29.84% | 91.85% | 7.26% | 100% |
| Spain | 33.21% | 21.19% | 11.56% | 25.73% | 91.68% | 7.81% | 100% |
| Sweden | 15.96% | 23.54% | 19.25% | 33.64% | 92.58% | 6.83% | 100% |
| U.K. | 39.74% | 16.62% | 19.14% | 20.20% | 96.60% | 1.77% | 100% |
| Total | 36.07% | 17.80% | 19.24% | 20.89% | 94.88% | 4.29% | 100% |

### *A. Policies and measures: e.g.: taxes, voluntary agreements, standards*

Many countries may choose to use non-allowance forms of regulation, especially for those gases and sources that are difficult to directly monitor at a sub-State level. For example, countries may choose to regulate small sources of $N_2O$ through equipment standards rather than directly controlling emissions. Similarly governments will probably find it infeasible to monitor agricultural sources of methane from individual farms so may subsidise feed additives or directly try to change farming practices. Some governments will simply prefer a tax system to allowances for historical or political reasons. These approaches implicitly allocate GHG abatement responsibility among sectors and actors. They will lead to a pattern of reductions and cost bearing though these may be hard to predict or even monitor *ex post*.

[4] Derived from UNFCC (1998) FCCC/CP/1998/11/Add.2 Tables A.1 - A.4

Governments will need to estimate the number of PAAs necessary to cover the emissions from these non-allowance activities and either the government a body that represents the sector will trade on their behalf if the sector falls short or has excess. The allocation issues are the same here as in allowance systems but are less transparent.

One key situation where many sources may be regulated (or not) outside of the allowance system would be where the allowance system was defined downstream (i.e. at the energy user level not the fossil fuel producer level). Because of the administrative complexity of such a system many small sources are likely to be excluded from the system. This is discussed further in the accompanying paper on point of regulation.

Another situation in which PAMs might be used is where there are policies complementary to the trading system. For example, labelling requirements for energy efficiency make it easier for consumers to respond efficiently to higher energy prices. Subsidies for renewable energy or for mitigation-related research are similar, as are investments in public transportation. These policies do not allocate additional abatement responsibilities but reduce (and possibly redistribute) the cost of achieving the existing ones.[5]

Existing examples of non-allowance systems are the Norwegian and Danish carbon taxes, the German voluntary agreements with industry and the recent Dutch covenant with heavy industry and the power sector which sets efficiency targets.

### *B. Auctioned Allowances*

In an allowance system, the simplest way to allocate allowances is for the government to sell PAAs through an auction. These could be sold periodically but also many could be sold years in advance of use. Suppose purely as an illustration, that Italy chose to have its Central Bank carry out the auction. The bank would run periodic auctions. The parties that bought the allowances could hold them for their own use but in addition, many would sell them on the secondary private market. Anyone could purchase allowances either in the auction or on the secondary market. For a detailed discussion of auctions see Section V and Cramton and Kerr (1999).

Existing examples of auctioned allowances are new quota allocations in the New Zealand Individual Transferable Quota system for fisheries, the Federal Commerce Commission auctions of the telecommunications spectrum in the US, and radio and television spectrum auctions in the UK. Government bonds are regularly auctioned in many countries including France, Germany and the UK.[6]

### *C. Allowances grandfathered based on historical emissions or activity*

Alternatively the government could allocate allowances on the basis of past emissions or activity, or simply to politically favoured groups. This alternative is known as

[5] A tax is not complementary to a allowance system and is in fact additional unless firms can choose whether to buy allowances or pay the tax. If allowances are internationally traded, their price is fixed and a higher tax will not lead to a lower allowance price. Firms could face double regulation.
[6] Valdez (1997)

‘grandfathering’. Again, once the allowances are in private hands they can, and often will, be sold on the secondary market. New entrants who do not receive allowances directly will have no difficulty purchasing allowances. The key characteristic of grandfathering is that the allocation is based either on past behaviour and data or on current indicators that are beyond the control of individual actors (or groups that collude).   Grandfathering provides a lump sum payment.  The value of the payment at the time the regulation begins is the sum of the expected values of the stream of allowances received discounted into present value.  In contrast to output-based allocation discussed below, the number of allowances grandfathered does not depend on anything that happens in the future though of course the value of those allowances is currently unknown.  Prominent existing examples of grandfathering are the US Acid Rain  programme, and the Reclaim  programme in Los Angeles.

### *D.  Output-based allocation*

Output-based allocation is similar to grandfathering with the key difference that the allocation is based on current activity or activity the year before.  It is not a lump sum payment.  Over time as activity patterns change, so does the allocation of allowances. Once allocated the allowances are tradable on the secondary market in absolute amounts – i.e. tons of CO2 equivalent.  A  programme that regulates the rate of emissions per unit activity rather the absolute level of emissions is allocating on an output basis.  Output based allocation is essentially an output subsidy.

If trading were not allowed, output-based allocation would have the advantage that new entrants receive allowances, and emissions can vary with changes in industry structure.  Allowances would very roughly be allocated to equalise marginal costs. When trading is allowed output-based allocation is unnecessary and inefficient.

An example of output based allocation was the trading  programme used in the phasedown of lead in gasoline in the United States (1982 – 1987).  In this programme, during 1983 and 1984 a refinery that produced another gallon of leaded gasoline received 1.1 grams of additional allowances to use lead additive.  The new covenant between industry and the Dutch government can be thought of as a loose form of output-based allocation though allowances are not clearly defined and are not tradable.

Most countries will probably use some combination of these four approaches.  They are not mutually exclusive.  For example, within a allowance system, some allowances could be auctioned and some grandfathered and the proportions could change over time.  Some sources could be included in a allowance system and others could be controlled by policies and measures and have their PAAs held by government.  This could change over time as monitoring technology improves and the government expands the scope of the  programme or as firms choose to opt in to the allowance system if this is allowed.

## III.  Economic Efficiency of Allocation Methods

Auctions are an unambiguously more efficient way to allocate allowances than grandfathering unless the revenue is wasted.  They are more efficient if they are used to reduce tax distortions in labour markets, increase returns to capital and hence attract more investment, and raise the return to businesses that find innovative ways to reduce GHG emissions. Trading leads to allocative efficiency regardless of allocation method (Tietenberg 1985).

Figure 2 illustrates, in a simple way, how the price of fossil fuels, and of goods directly or indirectly produced using fossil fuel, must rise to reduce the total demand for fossil fuel in a $CO_2$ system.[7] Q is the GHG cap translated into a fossil fuel cap. The price buyers pay for the representative fossil fuel rises from $P_0$ to $P_D$ and the price sellers receive falls to $P_s$. The allowance price is the difference between these prices.

These price changes occur under any efficient form of GHG regulation. The price changes, after a short transition period, will be identical under auctions and grandfathering. A less efficient form creates, on average, an even larger price wedge. The rise in marginal cost from GHG regulation implies a real cost of GHG regulation equivalent to the dead-weight loss from distortionary taxation (see Figure 2). This unavoidable real welfare cost corresponds to a loss of EU output estimated to be on the order of X percent of GDP which would have been $X billion in Y.

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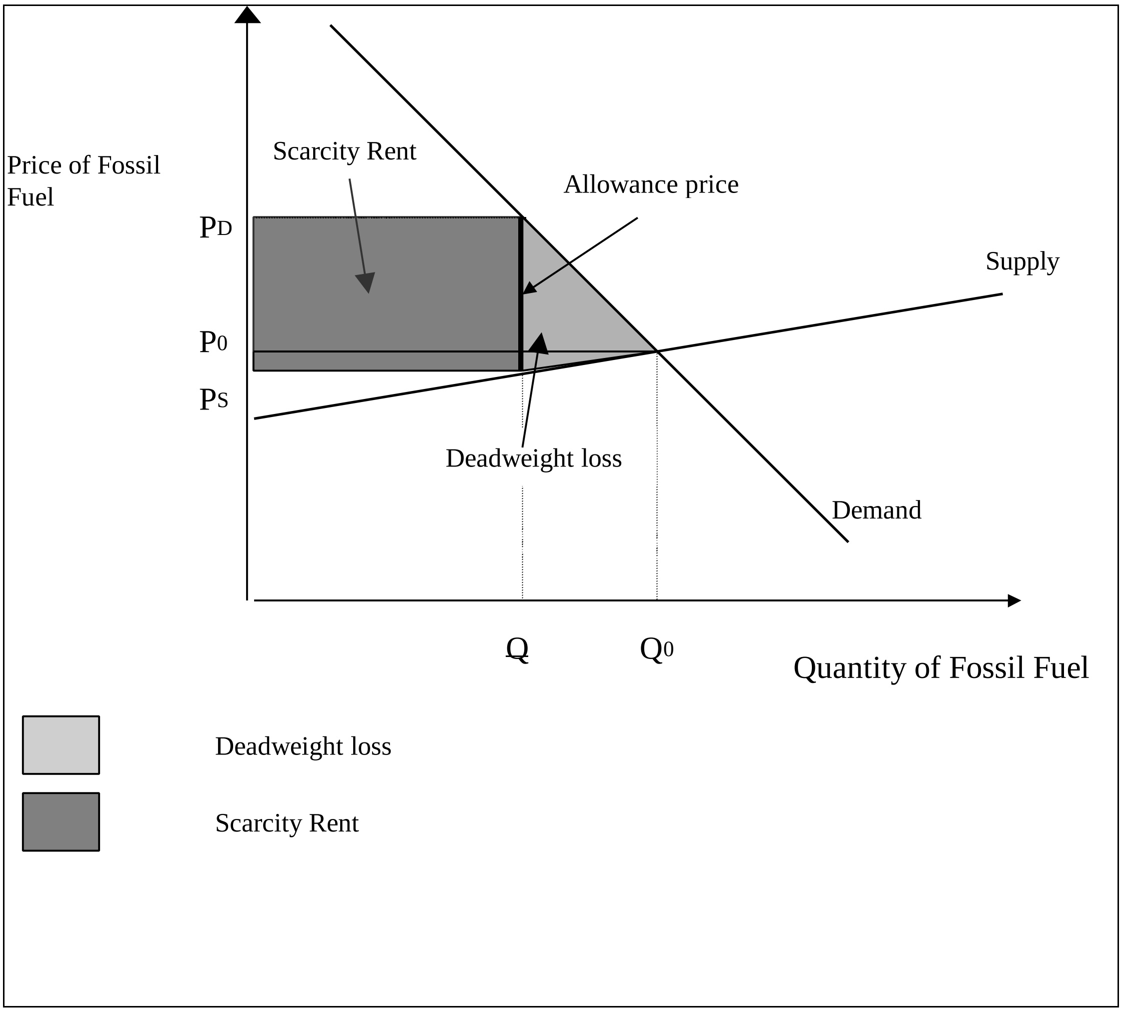
[7] This figure assumes only one fossil fuel, and that it is sold directly from producers to the ultimate consumers.

**Figure 2 Price, scarcity rent and dead-weight loss from carbon regulation**




The constraint on the quantity of fossil fuel used (and more generally GHGs) also creates a scarcity rent, the solidly shaded area in Figure 2 (Tietenberg 1996). In the EU, the regulation of $CO_2$ alone would create scarcity rents on the order of $76 billion per year, assuming a carbon price of $100 per tonne. The regulatory design determines who receives these rents. If allowances are auctioned, the government receives these rents on behalf of taxpayers. If allowances are grandfathered, the recipients capture the rents.

### *A. Revenue Recycling*

Auction revenue can replace distortionary taxes. Distortionary taxation creates a dead-weight efficiency loss by inserting a wedge between marginal cost and price. By lowering taxes and reducing these distortions auction revenue can offset part of the cost of the GHG regulations (dead-weight loss).[8]

Careful use of this scarcity rent can significantly lower total costs. Ballard et al. (1985) estimate that each additional $1.00 of government revenue, raised through

[8] See Bovenberg and Goulder (1996) and Parry (1995). Those who believe in a double dividend believe that it can more than offset the cost.

distortionary taxation, costs society $1.30. These estimates are for the US tax system and economy. Tax distortions in Europe are almost certainly greater, implying even higher potential gains from revenue recycling.

If we can gain revenue with no additional distortion, by auctioning rather than grandfathering, we can achieve significant efficiency gains. The revenue raised in the auction could be used to cut taxes and reduce the deficit. If the auction raises $76 billion annually, compensating tax cuts could increase EU GNP by up to $23 billion. European studies have emphasised the positive impacts on employment from reduced taxes on labour. Jensen and Rasmussen (1998) estimate that in Denmark the scarcity rent and hence the revenue that can be raised from auctions would amount to around 5 percent of Danish GNP. They estimate that using an auction and recycling this revenue through tax cuts would reduce the costs of greenhouse gas regulation by 95 percent from the cost with grandfathered allowances.

Revenue can be recycled in a large number of ways. Three considerations could affect the choice of recycling method, efficiency, equity and politics. The most efficient way to recycle revenue is to cut the most distortionary taxes. In Europe this may be labour and capital taxes. The revenue could also be used to payoff government debt and hence reduce pressure on interest rates. The estimates of efficiency gains given above depend on these most efficient options being chosen.

Lump sum payments to consumers or workers (e.g.: through increasing the income level below which income is tax-free) do not create efficiency benefits. Returning the equivalent amount to these groups through a reduction in their marginal tax rate, and the rate at which welfare payments are reduced as welfare recipients begin to work, will not only give them more income but also a greater return from extra work. Some of the revenue could be used to create a fund for pensions in future years when demographics mean that the ratio of retired people to workers is high. Auctions create revenue that can improve equity.

Alternatively the revenue could increase government expenditure. If there are productive expenditures for government in health, education, public amenities or infrastructure this could also be efficiency improving. If, however, government uses this revenue poorly, efficiency could actually be decreased.

One criticism of the efficient revenue-raising argument is that government spending is not exogenous. Private sector actors often express concern that government will not use the revenue well. Raising revenue through carbon taxes or auctions may not lead to equivalent tax cuts. Preliminary work by Becker and Mulligan (1997) suggests that more efficient tax systems are associated with larger governments. If this is the case, the efficiency gain from auction revenue will depend on the actual size of the tax cuts and what is done with the additional government spending. With potential revenue of about $300 billion (calculated assuming $100 per allowance and approximately 3 billion tons of $CO_2$ emissions) annually in the EU, however, governments may be forced to use the revenue in transparent and hence relatively socially beneficial ways. GHG regulations could be explicitly linked to tax reform.

In Europe the debate on the 'double dividend' which may be available from eco-taxes has been extensive. The benefits of revenue recycling are the economically positive side of eco-taxes. The existence of a double dividend is contentious. If the regulation will be carried out anyway, however, the cost of the regulation is a sunk cost. Whether we allocate allowances with an auction or a well designed grandfathering system the cost to the economy before revenue recycling is the same. Auctioning the allowances and recycling the revenue and hence offsetting at least part of this sunk cost will always reduce the cost to the economy as a whole. A double dividend is not necessary for auctions to be preferred to grandfathering.

### *B. Inefficiency of Output-based Allocation*

The most efficient strategy to control emissions involves a combination of reduced emissions per unit output and reduced output of goods that involve emissions. Output based allocation creates a allowance system that encourages emissions reductions per unit output but creates a perverse incentive for output; extra output is rewarded with extra allowances. By saying that increased output should not be encouraged we are not anti growth. Output needs to move toward less GHG intensive goods. Increased output of GHG intensive goods means that for a given target greater reductions have to be achieved through reductions per unit output – this is inefficient especially as these rate reductions become more and more expensive to achieve (Fischer 1997). In the short run output-based allocation may lead to lower consumer prices because more costs are borne by firms but in the long run the increased inefficiency will lead to higher consumer prices as well as greater overall cost of emissions reduction.

### *C. Policies and Measures*

The plethora of non-allowance regulatory options has different designs, levels of feasibility and effects on efficiency. From the point of view of the allowance system, the key issue is whether the sector as a whole is allocated an efficient number of allowances. Within an allowance system, allocation is irrelevant for efficiency because trading will equalise marginal costs of abatement. When non-allowance systems are used, allocation affects efficiency.

If one sector is treated more leniently its emissions will be higher than is efficient and either other sectors will need to abate more or the country as a whole will need to purchase more (sell fewer) allowances abroad. If one sector is treated more leniently it will face a lower greenhouse gas price which gives it a competitive advantage over others regulated under a more stringent regulation. Similar problems arise with more stringent regulation through non-allowance systems. In addition, the form and stringency of non-allowance regulation will affect the incentives for future inclusion in the trading programme if the opportunity arises. Marginal stringency will be transparent in a tax system (if emissions rather than intermediate inputs are taxed) so it might be more easily adjusted, but will be non-transparent under most non-allowance measures. Allocation to non-allowance sectors needs to be done with concern for efficiency as well as politics and equity.

### *D. Investment Implications of Allocation Method*

Auctions, in contrast to grandfathering, do not provide wealth to firms. This wealth may have been invested. However, by allowing tax cuts auctions raise the return to capital within the country, thus encouraging savings and investment and attracting more foreign investment. Although auctions do not provide direct investment funds to firms, they may increase investment even more in the economy as a whole through higher returns.

### *E. Technological Change Implications*

Fischer, Parry and Pizer (1998) show that when allowances are auctioned (or a tax is used) the return to a firm that innovates to lower its cost of abatement is higher than when grandfathering is used.[9] Thus technological innovation is encouraged. Essentially if allowances are grandfathered and innovation lowers the value of allowances by reducing the cost of abatement throughout the economy, the innovating firm loses in that the allowances it owns drop in value. If, in contrast, allowances are auctioned, the innovating firm wins because the cost of the allowances it needs to buy falls. A firm always wins by innovating and lowering its direct costs of abatement, but it wins even more if it does not own a large stock of allowances because of grandfathering.

In sum, auctioned allowances are the most efficient option for many reasons, while output-based allocation is the least efficient trading option.

## IV. Distributional Issues

In this section we consider the distributional impacts of GHG regulation both in the short and long run and then look at how different allocation methods change the distribution.[10]

### *A. Distributional Implications of Climate Regulation*

The distributional effects have two parts, the effects that arise through changes in prices and returns to factors, and the wealth effects from changing ownership of a resource. Ownership is being transferred from the commons to either the taxpayer, under auctions, or the recipients of grandfathered allowances. The price effects, which are the most complex effects, are the same regardless of the form of carbon regulation. In particular, they are unaffected by whether allowances are auctioned or grandfathered.[11] The aggregate distributional effects depend on the sum of price and wealth effects.

#### *1. Who Bears Taxes/Regulatory Costs?*

Three groups ultimately bear costs: consumers, workers (owners of human capital), and capital owners, especially current owners of physical capital. Consumers suffer loss of consumer surplus, workers suffer a fall in income, and capital owners suffer a fall in the value of their capital. The legal incidence of the regulation, -that is, the point of regulation, upstream or downstream - does not affect prices or cost bearing.

Increased costs, due to the need to purchase a allowance or pay a tax, are passed forward to consumers, and backward to factor suppliers, capital owners and workers. How the prices throughout the economy adjust depends on the elasticities of supply

[9] See also Milliman and Prince (1989)

[10] For a good general reference on distributional effects of environmental policy see Christiansen and Tietenberg (1985).

[11] The effects may occur slightly faster under auctions but this is a transitory difference. It is easier to see why the price effects occur under auctions but it is misleading to think that they are different under grandfathering.

and demand at all levels in the economy. Prices will rise most where behaviour is most inelastic. In Figure 2 we illustrated one possibility. The relatively inelastic demander faces a large price increase while the elastic supplier suffers only a small price decrease. Given a set of consumption price changes, different consumers will bear costs in proportion to their expenditures on goods produced using fossil fuels.

In the short run, fossil-fuel-specific capital stocks such as oil-fired electric utilities, and the human capital and location of workers in industries such as coal mining, will tend to be inelastic. Some of the existing capital stock will be inappropriate when GHG regulation is introduced and will fall in value. These inappropriate physical and human capital stocks are known as stranded assets. When they were acquired their owners did not anticipate the regulation. Some capital owners and workers will suffer high short-term costs. How these costs translate into distributional effects depends on the distribution of ownership of physical and human capital. The effects on physical capital will be diffused across many shareholders when the companies are publicly owned. The effects on workers tend to be heavily concentrated in relatively few individuals and communities.

Over time, capital is mobile and workers will make appropriate choices of education and location. This will lower their costs as well as total costs. Some capital may leave the country if other countries face less stringent regulation. Empirical evidence suggests however that this effect is slight (Jaffe et al (1995)) even where environmental regulations are very different and there is no trading to equalise marginal opportunity costs. In the long run, in a competitive industry, supply is perfectly elastic and producers bear no costs. How long this requires depends on the rate of obsolescence of capital and how quickly individuals and communities can adjust. The outlook for some coal-mining areas is not promising. After capital and labour have adjusted, consumers bear the ongoing costs of carbon regulation.

### *B. What Does the Empirical Evidence Show?*

There are no academic studies of the distributional effects of greenhouse gas regulation as a whole. All academic models of carbon tax (or equivalently allowance market) incidence assume that the tax or allowance price is fully passed through to consumers. Thus they focus on effects across the income distribution rather than the shares borne by owners, workers and consumers in the short run.[12]

All the models agree that the impact of the tax will be relatively, but not dramatically, regressive, that is the increase in cost resulting from the regulation will be a higher percentage of the income of poorer people than it is of richer people. When the models include the effects on the prices of non-fuel products the regressivity tends to

[12] Jorgenson et al. (1992) use a general equilibrium model to consider the lifetime incidence of carbon taxes through all possible channels. Dowlatabadi et al. (1994) allow for partial equilibrium responses to energy prices but consider only effects on fuel prices not on products that indirectly involve fuel use. Casler and Rafiqui (1993) consider the relative expenditure shares directly devoted to energy across the expenditure distribution. They also use an input–output framework to estimate indirect incidence through the purchase of goods produced using energy. Poterba (1990; 1991) looks simply at the relative expenditure shares on energy products.

be reduced. Consumer incidence varies significantly by region. These models say nothing about loss of capital income and therefore loss of capital value. To do this a model would need to identify the mobility of capital in specific industries, and the owners of capital. None of the models say anything about the effects of carbon regulation on labour markets.

A number of studies of distributional effects have been done for other OECD countries using a variety of methodologies. These include Cornwell and Creedy (1996) in Australia, and in Europe, Johnson et al. (1990), OECD (1995), Smith (1992), and Barker and Köhler (1999). The weak regressivity of carbon regulation appears to hold across countries and modelling techniques.

Identifying the cost distribution is a non-trivial exercise. The empirical evidence suggests that costs will be slightly regressive across consumers. Theory suggests that carbon regulation will reduce the wealth of shareholders in parts of the energy sector, and will have impacts on immobile workers in the energy sector. Clearly more research is needed to clarify these relative effects on individuals.

### *C. How do the Distributional Effects Depend on the Allocation method? Auctioned vs. Grandfathered Allowances*

The effect of regulation through consumer prices and factor returns distributes costs in the same way in an auctioned allowance programme as in a grandfathered programme. All efficient forms of regulation lead to a distribution of costs that is determined by general equilibrium cost incidence, factor endowments and consumption patterns. The wealth effects from grandfathering and the use of tax/auction revenue determine how the ultimate distribution of costs varies among the options.

As discussed above, auction revenue can be used in a multitude of ways, benefiting many different groups. Labour, sales or capital taxes could be cut. The deficit could be reduced or debt repaid. Expenditure could be targeted at afflicted workers and communities to compensate and assist during the transition to a less carbon–intensive economy. Only the political process and the normal constraints on redistribution limit the flexibility of compensation under auctions. In addition, the revenue-recycling benefits reduce total costs.

Figure 3 shows the way costs are distributed through the economy in an auctioned system. Directly regulated firms, such as producers and importers of fossil fuels in an upstream system, make direct payments to the government for auctioned allowances. They pass part of this cost on to the industries and consumers they provide products to through higher prices. These industries in turn pass part of this cost on to their consumers. They also pass part of the cost on to their workers in the form of lower wages. In an auctioned system, these costs are partly compensated by tax cuts funded from auction revenues. These tax cuts can benefit all firm owners, consumers and workers.

In contrast, grandfathering allowances redistributes wealth only to shareholders. Only those who directly receive allowances gain because it produces a pure wealth effect.

In Figure 4 the allowance recipients do not pay for allowances, though they still pass on the higher prices; workers, consumers and other firm owners gain no tax cut.

Grandfathering is usually used to compensate some owners of stranded assets. These owners can be adequately and more efficiently compensated, through targeted tax breaks. These not only provide direct compensation, but also increase the efficiency of the industry by reducing tax distortions. It would be theoretically possible to grandfather the allowances to a wide range of workers, consumers and capital owners. This would be costly and complex to administer, however, and would forsake the efficiency benefits of a auction  programme that returns the revenues through broad–based tax cuts.

Auctioned allowances are more likely to lead to equitable outcomes than grandfathered allowances. Cost bearing is widely spread and, in the long run, all costs are borne by consumers. Therefore compensation should also be widely spread. Poorer people tend to be workers and consumers more than they are shareholders, so they are unlikely to benefit from grandfathering.

**Figure 3 Direct and indirect costs and revenue recycling**

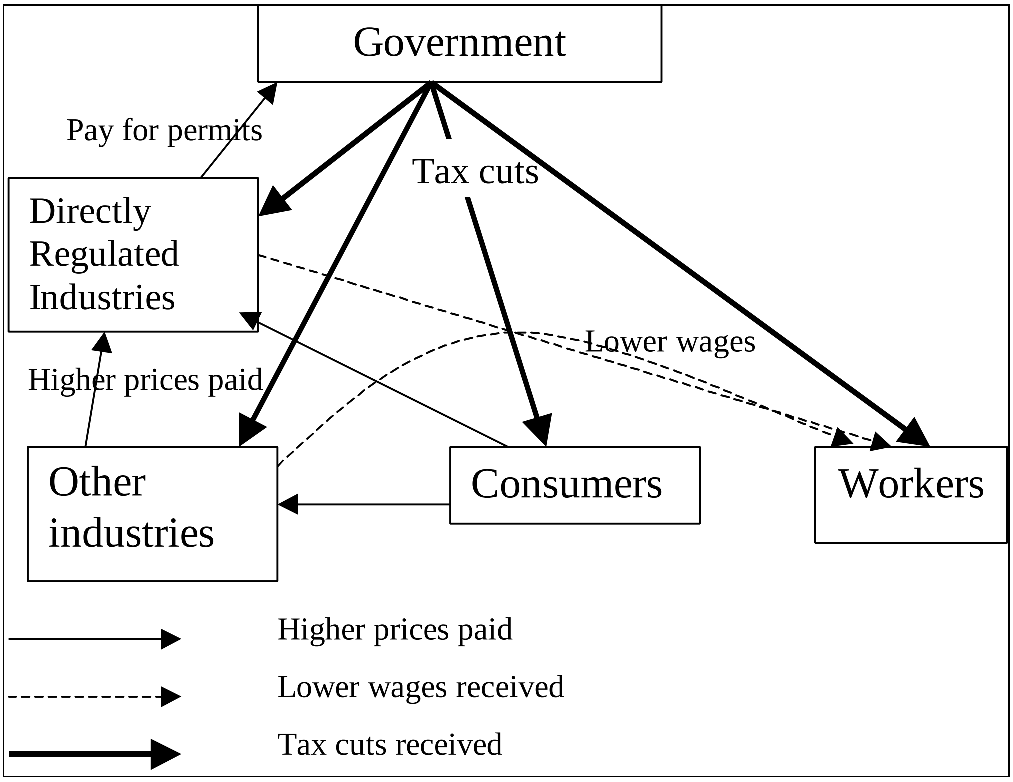
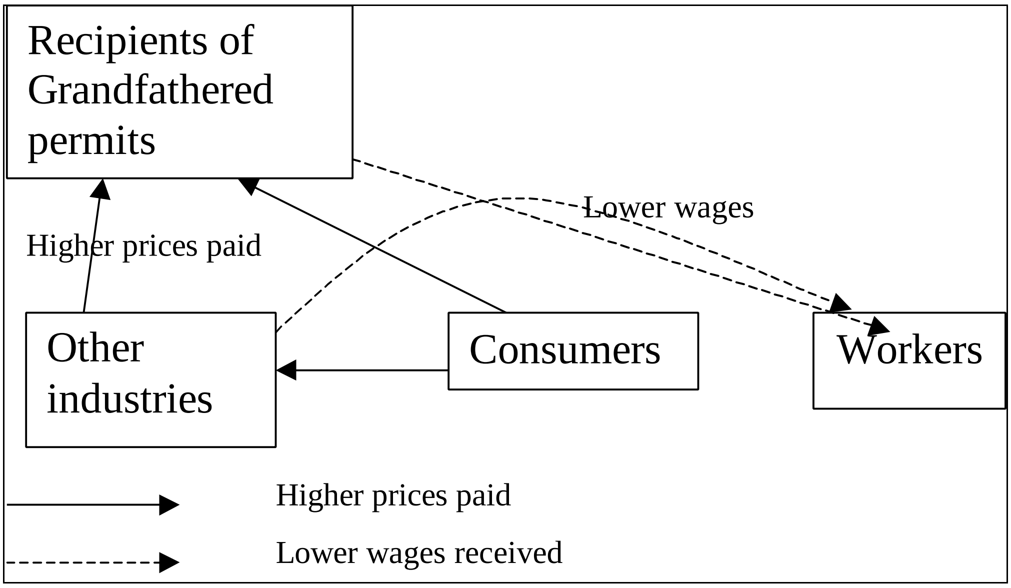


**Figure 4 Direct and Indirect costs under grandfathering**




## V. Design and administrative feasibility of domestic allocation systems

### *1. Market Power in Allowance Markets*

Market power should not be a concern in an auction in an EU GHG allowance market. Even in an upstream programme, there would be a large number of direct allowance buyers. Most importantly, even the largest buyers would constitute just a tiny fraction of the EU market. The table shows the shares of allowances each part of the energy sector would have demanded if an upstream carbon allowance market had been introduced in 1995. No one firm will control more than a few percent of the market. In addition, in the active secondary market many more buyers will participate as speculators as long as government does not restrict the market. For example, electric utilities and large energy users such as the steel industry might find it in their interests to participate. The coal industry participates actively in the United States $SO_2$ market although it is not directly covered by the regulation. It is inconceivable that any private party would be successful in exercising substantial market power in an EU market for carbon allowances.

This may not be true in smaller countries with more concentrated industries if they had isolated markets. Even here though, substantial distortions from market power are unlikely even with only a few traders (Tietenberg 1985). Market power will disappear completely if actors are enabled to freely participate in the Annex 1 trading market and CDM.

### *2. New Entrants*

Policy makers are frequently preoccupied with the fate of new entrants into allowance markets. From an efficiency and equity point of view this concern is misplaced. With an unrestricted secondary market in allowances a new entrant can always purchase allowances. They will face the same marginal opportunity cost of emitting as existing firms so have no competitive disadvantage. New firms do not have any stranded assets so do not face costs from regulation if the industry is competitive. They only enter if they expect to make profits and will take the environmental regulation into account as an additional cost. The costs to firms from climate regulation relate to their investments before the regulation was imposed not to their ongoing activities.

In the next sections we discuss the details of how to allocate homogeneous allowances in a competitive environment.

## *A. Auctioned Allowances*

An auction can allocate emission reductions efficiently, maximise revenue to the government and reveal information about marginal costs of abatement.

### *1. How to Design Carbon Allowance Auctions*

Auctioning many identical items is a common, relatively well understood situation. In the allowance market setting, a seller is offering a fixed supply of identical items. The buyers submit bids at auction to express their willingness to buy various quantities at various price levels. Auctions need to be held frequently enough to reduce cash flow problems and ensure that firms will have a good idea of their likely needs. Monthly auctions, as in French government bond (OATS) auctions, would more than suffice. Of course, with an active secondary market, firms can buy almost any quantity of allowances at any time.

We first discuss the more familiar sealed-bid auctions. We then explain the advantages of ascending-bid auctions, and specifically the standard ascending-clock auction. With a liquid market and in the absence of market power, almost any auction will operate in a satisfactory way but some have advantages relative to others.

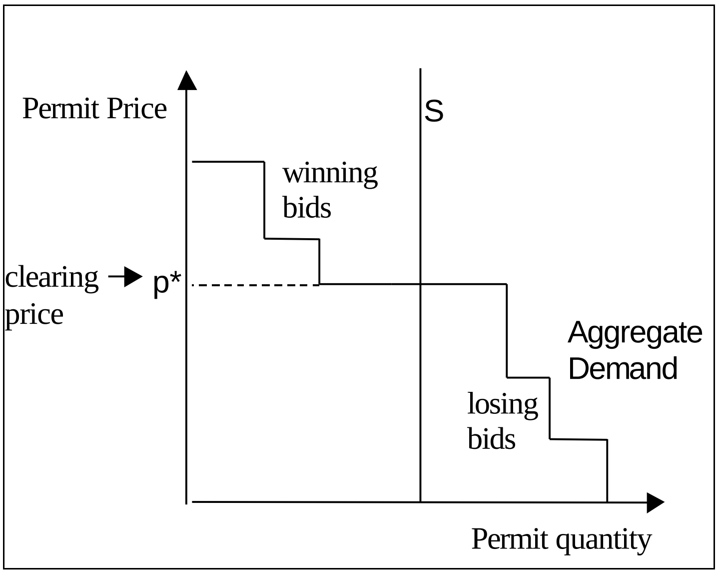
**Sealed-bid Auctions**

In sealed-bid auctions, the bidders simultaneously submit demand schedules. The auctioneer adds these demand schedules to form the aggregate demand curve. A sample demand curve appears in Figure 5. The intersection of the aggregate demand curve and the supply curve determines the clearing price. All demands above this clearing price are filled, those at the clearing price are rationed, and those below are rejected.

The two most common pricing methods are uniform pricing and pay-your-bid pricing. Under uniform pricing, each winner pays the clearing price $p^*$ for each allowance. With pay-your-bid pricing, each winner pays its bid. The two approaches lead to quite different bidding behaviour, which affects efficiency when there is market power.[13]

[13] With a uniform price, bidders with market power may bid below their true value in an attempt to influence the market price. With pay-your-bid pricing, the bidder attempts to guess where the clearing price is likely to fall and then bids slightly above it. Bids in excess of the clearing price are money left on the table. With uniform pricing, predicting the clearing price is less important, since every winner

**Figure 5 Sample Demand Curve**




Relative to pay-your-bid pricing, uniform pricing has the benefit that everyone pays the same price. Uniform pricing is strategically simple for small bidders and they benefit from the demand reduction by the large bidders. This encourages participation by small bidders. In contrast, pay-your-bid pricing exposes small bidders to strategic risk, since they may be less able to gauge the probable level of the clearing price. Hence, among the sealed-bid auctions, a uniform-price auction probably is best for the case of carbon allowances.

**Ascending Auctions**

Multi-unit ascending auctions can be conducted in two basic ways: with demand schedules or with an ascending clock. The demand schedule approach is a multi-round version of the sealed-bid auction. In each round each bidder enters a schedule, as in sealed-bid auctions. The auctioneer determines the market clearing price and makes it public. Then bidders can improve their bids (i.e. demand more or bid a higher price). Iterations stop when no bidder is willing to improve its bids.[14] Everyone buys the quantity they want at the final price. The ascending-clock auction, however, is simpler and even more efficient in this situation.

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pays the clearing price regardless of how high it bids. Allowances will not be fully efficiently allocated under either pricing rule. Buyers will not always truthfully reveal their valuations. This strategic bidding leads to inefficiency. Comparing these sealed-bid auctions is difficult, even in the setting with private values. The inefficiency from uniform pricing depends on the extent of market power. When no bidder has significant market power, uniform pricing is nearly efficient in a private value setting.

[14] Pricing can be either uniform or pay-your-bid as in sealed-bid auctions. Here, however, the market power problems arising from the use of a uniform price are exacerbated by the undesirable ability to use bids to signal during early rounds. The strategic risk arising from pay-your-bid pricing is diminished by the price discovery process. Thus, of the two, the pay-your-bid is preferred.

A primary advantage of ascending auctions is a reliable process of price discovery. Both price and allocation are determined through a process of open competition. Each bidder has every opportunity to improve its bids, changing losing bids into winning bids. In the end, all buyers have good information about price and those willing to pay the most win the allowances. An ascending process is especially desirable when bidders' valuations depend on information held by others. Then the bidding process reveals information, which improves the bidders' valuation estimates.

In the early years of carbon regulation, when elasticities are uncertain, and the feasibility and cost of new technologies is changing rapidly, improved information will have major efficiency impacts. Despite its failures, one benefit of the government-conducted $SO_2$ auction, in the US Acid Rain programme, was to focus attention on the allowance price and reveal information (Joskow et al. 1996).[15] The auction price was much lower than expected but ended up being a much better predictor of future allowance prices than any of the model estimates.

**Ascending-clock Auction**

In each round, the bidders submit the quantity they are willing to buy at the price indicated by the clock.[16] The clock is increased if the total quantity bid exceeds the quantity available. The bidding continues until the quantity available exceeds the quantity bid. The allowances are then allocated at the prior price, and are rationed for those who reduced their quantity in the last round.

This design shares all the price discovery advantages of all ascending auctions, and has several additional advantages relative to the pay-your-bid ascending auction.[17] Because a buyer only bids a single quantity, rather than a schedule, it is easier to implement. It yields a single market-clearing price.[18]

**Table 3 Characteristics of Different Auctions**

| | **Auction Form** | | |
|---|---|---|---|
| **Characteristic** | Common price sealed-bid auction | Ascending demand-schedule | Ascending clock |
| Efficient | √ | √ | √ |
| Easy to implement | √ | √ | √ |

[15] This was a very poorly designed auction so we do not discuss it here. We do not recommend it as a model for the EU.

[16] An activity rule is needed to promote reliable price discovery. The activity rule forces the bidders to bid in a way that is consistent with a downward-sloping demand curve. This prevents bidders from holding back initially and then submitting large bids after the other bidders have revealed their information. The activity rule in this case is simply that each bidder cannot increase its quantity as prices rise.

[17] It avoids the undesirable bid signaling which is possible with uniform-price ascending auctions. It is still not perfectly efficient, if there is market power, because buyers shade their bids to lower the price. They will shade them differently depending on their size. Large bidders win too little and small bidders win too much. However, in this setting where market power is apt to be slight, the inefficiencies from a standard ascending-clock auction are likely to be insignificant.

[18] It avoids the mechanism for collusion under a sealed-bid uniform-price auction.

| | | | |
|---|---|---|---|
| Single market price | √ | √ | √ |
| Price discovery | | √ | √ |

In conclusion, auctioning carbon allowances is simple and efficient. As a result of communications advances, ascending auctions are now easy to implement through the Internet. We prefer the ascending-clock auction, primarily because of its advantages in price discovery, but a sealed-bid uniform-price auction will also operate well.

## *B. Allowances grandfathered based on historical emissions or activity*

### *1. To whom can a government grandfather allowances?*

Grandfathering is simply giving away resources in a lump sum way. They could be given once at the beginning of the programme or allocated each year. In theory, at least, allowances could be given to anyone. The recipient does not need to be directly regulated – i.e. they do not have to be one of those required to surrender allowances at the end of each period to match some measure of emissions. The recipient can simply sell the allowances they are given to those who require them.

Allowances could be given to workers in affected industries, vulnerable consumer groups and/or firm owners. For some groups, alternative forms of resource transfer may be easier, especially for groups that do not have established institutions to represent them – i.e. non-unionised labour or vulnerable consumer groups.

### *2. What is the purpose of grandfathering?*

Grandfathering can be used for two main purposes. The first and most important is to build political support for passage of the legislation to implement the new environmental reduction requirements or at least to reduce opposition to it. The second is to counteract, for equity reasons, potential short term costs (for the life time of the current capital stock or the lifetime of workers trained with obsolete skills), and long run costs to consumers.[19] These things can also be achieved through strategic recycling of auction revenue.

[19] A third reason is to ease the transition into a new regulation that will alter the price structure within the industry. Otherwise the group that is directly affected by the regulation may face a sharp, though transient, price shock. In the very short run those who are directly regulated may suffer some acute costs. They need to surrender allowances which raises their production costs but they may not be able to pass on the cost. This is especially true if they have long-run contracts with customers and if there is a delay while different upstream players strategically pass on the costs. The extent of these transient costs depends on the difference between short and long run price elasticities in the industry - how quickly does the economy adjust to a change in basic prices. In addition, the directly regulated face costs of administering the compliance system which may require additional computer systems to track the regulated quantities. These costs are likely to be concentrated in the first year of the programme. The group affected is clearly identifiable though the scale of the costs would be harder to estimate. These costs may be reasonably though of as proportional to the regulated quantities (oil refined, coal processed...) but may be proportionately higher for smaller companies.

A classic example of how grandfathering can facilitate passage of new environmental requirements is the passage of the sulphur dioxide trading program in the 1990 U.S. Clean Air Act of 1990. Prior to the inclusion of trading and grandfathered allowances to fossil fuel-fired electricity generating units, companies who faced little or no prospect of additional control requirements took little interest in the legislation. With the prospect of receiving some new wealth transfers in the form of allowances based on past environmental performance, these companies and the Congressional representatives from their states became supporters of the legislation. The development of roughly 30 different formulas for allocation (based on past emission rates and types of fuel burned) allowed a careful creation of a powerful coalition that insured the passage of the legislation. Formulas took care of perceived inequities – for example, states and companies who had taken action to reduce sulphur emissions unilaterally prior to consideration of federal legislation argued successfully for formulas rewarding them for previous action. Interestingly, very little was provided to the potential "losers" such as mineworkers and power companies in high sulphur coal–producing states, because these groups and their representatives fought the legislation until its passage became a foregone conclusion. They received a few minor allowance "benefits" in the closing phases of the legislative negotiation to save face. The bottom line for those interests, however, was that the costs of the new regulation were perceived as far exceeding any benefits of higher allowance allocations – hence, their opposition until it was too late.

Clearly, grandfathering can be used to move resources to build support for action, to compensate those with stranded assets or specific obsolete skills, and to ease the impact on vulnerable consumers. In all likelihood, it promises to have limited effectiveness in reducing the opposition of the most adversely affected interests. At the same time it needs to avoid creating perverse incentives for firms or individuals to game the system to capture additional grandfathered allowances. It also needs to be able to be negotiated in a reasonable time frame and to be able to be implemented in an unambiguous way.

### *3. General efficiency effects of the method of grandfathering*

Grandfathering will have no adverse efficiency effects through marginal costs if it is based on previous, non-manipulable data. If allowances are allocated on the basis of things that cannot be altered they have no effects on the costs of production; they are simply a transfer of wealth. A firm that wants to produce more output, and that will therefore emit more pays the same opportunity cost of emitting whether they were given a stock of allowances or not. If they have allowances, additional emissions means they have fewer to sell. If they do not have allowances, additional emissions mean they have to buy more. The marginal costs of production are the same in each case.

The reallocation of wealth across and within industries could affect efficiency if there is imperfect capital mobility. Firms that receive allowances will be wealthier and therefore may have a cheaper more liquid source of finance available than firms that must rely on their usual sources of finance. The extent to which this matters depends on the difference in cost between different sources of finance. If all firms have sufficient access to low cost sources of debt and equity financing the extra wealth will not alter their real behaviour. The additional wealth will reduce their borrowing or allow them to invest elsewhere in the economy; it will not alter their capital or output decisions. Small firms often have limited access to cheap finance so the wealth transfer could significantly affect some of them. Whether this is efficiency-improving depends on the value of the capital to the firms that receive it and what would have happened to the resources if they had not been given away in grandfathering (see revenue recycling). Grandfathering could give resources to relatively less efficient firms, or to firms in industries that are declining and do not need new capital.

### *4. To whom do we allocate allowances?*

**On what data would we like to base a grandfathering formula?**
The first reason for grandfathering, building support for action, may not be related to any observable data, although in general those seeking allowances can usually construct an equity argument premised on historic emissions, investments etc.. Where grandfathering is for this purpose, it is basically a matter of negotiation with the powerful groups. Distribution within the groups that receive allowances is likely to be based on some measure of past emissions, relative costs and hence data.

The distributional implications of greenhouse gas regulation, and hence the basis of the equity argument for grandfathering, were discussed in detail above. Briefly, short term costs are borne by those with assets that were appropriate when there was no cost of emitting but become less valuable with regulation, e.g., coal mines and coal fired electric utilities. Short run costs are also borne by workers who have skills that become less valuable, e.g., coal miners, or who live in areas where employment falls e.g.: the Ruhr Valley. These costs can be significant and though they decrease with time they occur potentially over the remaining life of the worker or asset. Those who have long-lived assets and skills that are relatively new and now very inappropriate and those who are geographically immobile suffer most. In the long run all costs are borne by consumers.

As noted earlier, grandfathering could be used to ameliorate the most concentrated losses. For example, key unions could be allocated a share of total allowances that they could use to assist the transition of their workers out of declining industries. Alternatively the government could directly provide retraining and relocation assistance. Analysis could identify the industries and hence the workers that are likely to be most acutely affected (e.g.: coal, steel) and grandfathering negotiations could be based on this. We want to identify the losses borne if firms and individuals respond to actual and anticipated regulation in an efficient way.

Similarly data could be collected on the location of different types of assets and their ages in heavily affected industries. An estimate of the loss in value of these assets as a result of the regulation could be calculated. This data could also be used in grandfathering negotiations.

It is difficult, however, to compare the losses to owners of firms associated with holdings of different assets of different types and ages and across different sectors. A number of proxies might be used instead. Two obvious proxies that might relate quite closely to the costs a firm might bear under greenhouse gas regulation are pre-regulation emissions and energy use. Firms that will need to change their capital stock and who will still have high emissions relative to their competitors during the early years of a allowance program, will face high costs of buying (or opportunity costs of not selling) allowances that they cannot pass on to their consumers. They will tend to have had high emitting capital stocks before the regulation. They may have this high-emitting capital stock because of the fuel available to them (primarily related to location) and because of their sheer size (how much output they produce). Those who emitted more in the past were not necessarily anti-social; they simply found it most profitable to use certain fuels and technologies that in the past were considered acceptable by society. $CO_2$ has not previously been identified as a pollutant. Giving more allowances to those who emitted more is not rewarding high emissions; it is simply recognising that high historical emissions are probably closely related to high costs under climate regulation.

Another reason that firms may have high historical emissions is high energy consumption relative to output (low energy efficiency.) Grandfathering based on emissions will quite closely track costs though it will also reward energy inefficiency; grandfathering based on energy use would still reward inefficiency but not the different sources of that energy so would not track costs so closely.

Of course, for a given level of emissions some firms will have high-emitting capital that is almost obsolete and would have been replaced anyway. They do not face costs from carbon regulation - while others will have just invested in what is now inappropriate technology. Allocation based on emissions is relatively close to tracking real costs across sectors and different geographic regions but not across different firms within the same sector and region. Emissions may be a reasonable proxy for relative costs, but they do not determine the absolute level of cost, or tell how this level changes over time. Not all regulatory costs are borne by firm owners, and their share falls to zero over time.

Emissions levels are also likely to be a basis for arguments to receive allowance allocations from firms who have taken action to reduce emissions before the beginning of the first commitment period. The current debate in the U.S. and Canada over early reduction credit legislation marks the beginning of this process in those countries, and the voluntary agreement programs in Germany and the Netherlands could form a similar basis, should those countries choose to grandfather allowances to firms. As noted above, such arguments coming from firms who are likely to support adoption of legislation are likely to bear more weight than arguments advanced by interests who oppose the adoption of greenhouse gas controls.

Grandfathering is a negotiated process and could depend on data such as patterns of asset holdings, historical emissions and the factors that drove variation in emissions such as differences in local fuel availability, the distribution of non-transferable industry-specific skills and the geographical distribution of seriously affected local economies. It could also depend on estimates of the expected changes in value of assets, worker incomes and local economies as a result of regulation. For firm owners emissions may be the closest proxy to cost, while for workers years of industry-specific training and experience may proxy costs.

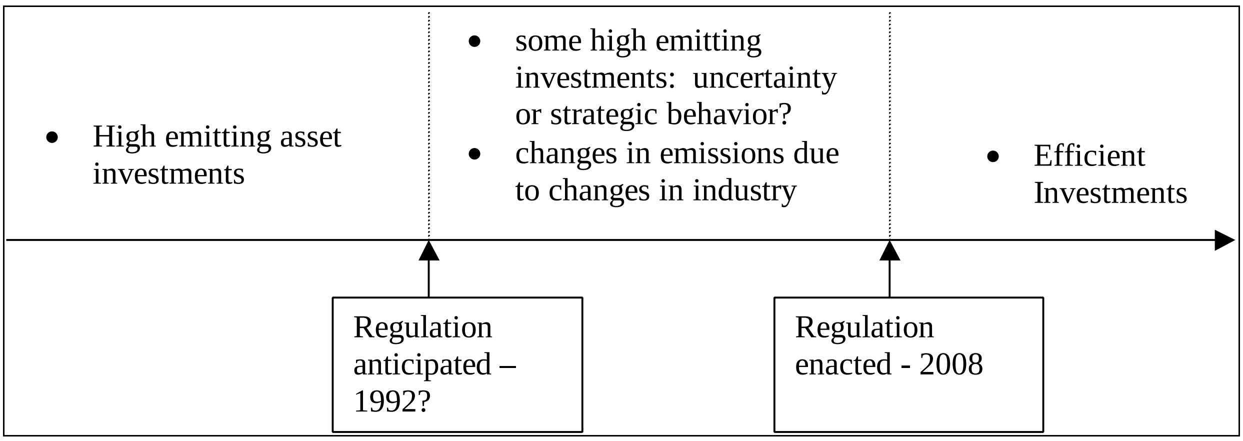
### *5. What perverse incentives could grandfathering create and how can they be avoided?*

In the previous section we concluded that basing grandfathering on assets, emissions and industry-specific experience has some merit. However, use of these data can potentially lead to some perverse incentives. There may be a trade-off between accurately compensating costs and creating perverse incentives that damage both equity and efficiency.

**What year and for what level of aggregation should the data be used?**

A grandfathering formula should be based on data that cannot be deliberately changed to advantage any group, i.e. publicly available data, and from previous years or at an aggregate level. If grandfathering is for equity reasons or negotiations are based on costs, we want to base them on the costs that would be borne if firms responded to the anticipated and actual regulations in an efficient way. If firms go beyond this to take socially responsible actions we may want to reward them and certainly don't want to punish them. We do not want to reward firms for socially irresponsible actions.

**Figure 6 Regulatory Time Line**




In the case of greenhouse gases, and particularly $CO_2$, firms have known about the possibility of regulations, and have been encouraged to reduce emissions, since the Rio Conference if not before. This is represented in Figure 6 as the date where regulation is anticipated. Ideally, therefore, if emissions or capital asset data is used it should be pre-1992. This will reward rather than penalise those who have acted to abate emissions since 1992. Although emissions are a good proxy for cost, it may be better to base grandfathering on the causes of emissions (asset stocks, availability of different fuels, output, energy use) rather than emissions themselves, unless the emissions data used are very old. If grandfathering is based on emissions after 1992, firms that emit more will be rewarded with more allowances; this may be perverse because their increase in emissions may have been induced by anticipation of the reward. For example, the current Danish plan to update electricity's share of reductions based on experience 2000-2003 may lead to strategic behaviour, including less than efficient banking. This is also true for rewards based on assets after 1992, though these are more costly to manipulate.

The same factors apply to worker skills (human capital) as to physical capital. If grandfathering is going to workers (or unions that represent them) it should be based on employment before the regulation was envisaged. This avoids rewarding those who choose to stay in the industry, or worse, encouraging a new generation to enter.

On the other hand, most industries have changed in many ways since 1992 for reasons unrelated to climate change. The distribution of activity and assets across firms in 1992 may bear little resemblance to the distribution of costs from emissions reductions in 2008. Many firms will have gone out of business or started up and others will have shrunk or grown in the intervening period. Investments made between the anticipation and the actuality of regulation are made under conditions of uncertainty. It may be rational and efficient for a firm to make a high-emitting investment even though it knows that regulation is a possibility. Any data-based grandfathering formula involves a trade-off between accurately reflecting costs from stranded assets and avoiding rewarding poor recent asset decisions or lack of action to control emissions.

As we can see in Table 4, economies are continuously changing. In France, in only 5 years, the share of the energy industries in total $CO_2$ emissions has changed by 19%. If permits were allocated to sectors according to emissions this would imply a 19% change in permits grandfathered to that sector.

**Table 4 Percentage change in key sector shares 1990 - 1995**[20]

| | Fuel Combustion | | | | | Industrial process |
|---|---|---|---|---|---|---|
| Country | Energy Industries | Industry | Small Combustion | Transport | Total Fuel combustion | |
| Austria | -11% | 2% | 5% | 13% | 3% | -11% |
| Belgium | -1% | -14% | 12% | 5% | -1% | 9% |
| Denmark | 7% | -8% | -12% | -5% | 0% | 14% |
| Finland | 7% | -5% | 6% | -7% | 1% | -33% |
| France | -19% | 4% | 0% | 6% | -2% | -6% |
| Germany | -4% | -15% | 6% | 22% | 0% | 4% |
| Greece | 0% | -3% | -8% | 6% | 0% | -3% |
| Ireland | 10% | -43% | 7% | 15% | 0% | -1% |
| Italy | -7% | 5% | -2% | 13% | 1% | -17% |
| Luxembourg | -41% | -28% | 51% | 74% | 0% | -7% |
| Netherlands | 6% | -10% | 0% | 3% | 0% | -1% |
| Portugal | -7% | -8% | 5% | 11% | 1% | -7% |
| Spain | -1% | 4% | 1% | 0% | 1% | -9% |
| Sweden | 13% | -1% | -11% | -1% | -1% | 12% |
| U.K. | -8% | -2% | 11% | 9% | 0% | -4% |
| Total | -6% | -5% | 4% | 11% | 0% | -4% |

[20] Derived from UNFCC (1998) FCCC/CP/1998/11/Add.2 Tables A.1 - A.4

The more resources are transferred through grandfathering the greater will become the inequity of basing resource transfers on data at a fixed date long before the regulation is certain. Instead of simply using a previous date the formula could be updated to the date where the regulation is enacted using the change in the industry size to take account of changes in relative industry sizes. If some industries are sufficiently concentrated and organised, such as coal, updating grandfathering based on industry output could discourage shutdown of mines and other industry wide shrinkage that would be optimal for climate change. In these cases updating could be based on regional or even OECD figures.

This approach would not deal with change within the sector however. As we will discuss further below there is no way to update grandfathering at the firm or individual level even before the regulatory period without creating perverse inefficient incentives. Given that grandfathering is useful in building support and can be used to correct short term and transient equity issues, the better solution may be to make grandfathering a limited option and set up a planned phase out over the first years of the programme.

***6. Costs and difficulty of negotiation of grandfathering***

The major challenge in any grandfathering programme which deals with many different industries across the economy will be to negotiate a deal that is regarded as fair across sectors and between workers and firm owners. Our empirical knowledge of the distribution of costs of abatement is not good enough to provide a strong objective basis for allocation. We cannot even measure output or assets across industries in a standardised way. The greater the number of allowances grandfathered, and the longer the time period for grandfathering, the greater are the rents at stake and the more difficult the negotiations will be.

In the US Acid Rain programme, where only one industry (power generation) participates, negotiation took several years. In the US telecommunications industry the parties could not agree to an allocation and eventually supported the use of auctions to allocate licenses. Good independent research may be the best bet for providing a relatively fair starting point for negotiations. Potentially the negotiations could begin as those among sectors (as negotiations have already taken place among States) and the separate negotiations could proceed within each sector. This may be more manageable. Sectors that cannot agree on an allocation or use of the allowances by a date close to 2008 could simply be required to purchase them at auction.

In summary, the feasibility of grandfathering largely depends on the extent of the resources grandfathered and on the time period over which they are grandfathered. The more resources are included, the more contentious the negotiations will be and the greater the risks of inefficient and inequitable manipulation. The longer the time period, the more inequitable any allocation based on historical data will appear. A programme that is limited in time and scope however would be feasible and could be based on data on historical emissions, major asset holdings and industry-specific training and experience.

ISSUES FOR FUTURE DRAFTS:

- What different formulas could be used for grandfathering?

- How would grandfathering affect stock turnover?
- Do source-level data exist for grandfathering based on 1992 emissions?

### C Output- based allocation

Output-based allocation is closely related to grandfathering except that it is updated over time based on new data relating to output. If the grandfathering programme is going to continue for a long time it can address the perceived inequity of allocations based on historical data that exclude new firms and do not take changes in industry structure into account. Note that this inequity is only perceived, because in a competitive industry, the owners of new firms do not bear any costs from regulation when they enter an industry that is already regulated. New firms will have appropriate technology and will only enter if it is profitable to do so. The costs are incurred because of existing assets at the time of regulation.

The major problems with output-based allocation are first, that it creates inefficiency though perverse incentives to increase output and hence raises the costs of greenhouse gas policy and second, that it is administratively complex. The serious inefficiency problems from output-based allocation were discussed above.

The practical details of meeting a target (or engaging in international allowance trading) with output-based allocation are themselves formidable. First, if there is no trading each country (or the EU as a whole) must meet the target set. This means that allocations cannot be based on current output. The year's output is unknown when the rate of allowances per unit output is set. If output is higher than expected, emissions would also rise and emissions would exceed the target. The country would be out of compliance. To hit the target exactly a rate must be chosen and allowances allocated on the basis of the previous year's (or an even earlier year's) output. This rate and the allowance allocation would need to be updated each year. Firms would face a allowance allocation that is highly uncertain from year to year. If the country or the EU is involved in trading, allowances could be allocated based on the current year's output. In this case, the government or EU would bear the risk of output fluctuations and purchase allowances to cover any shortfall.

Even if the government is willing to bear the risk of output fluctuations itself or allocate allowances based on the previous year's output and impose the risk on the private sector, we still have to define 'output'. If the emissions trading programme is to cover all $CO_2$ emissions a large number of sectors are involved. Taking the case of a downstream system, a common metric must be found for comparing steel, cars and corn. There is no 'correct' way to do this. In a sense these comparisons must be done in a grandfathering system as well, because allowances are allocated across sectors. In a grandfathering system, however, it might be based on estimates of the one-off costs of stranded assets in different sectors, which is more objective. In output-based allocation, this comparison determines ongoing output subsidies and will be more likely to be seen as unfair and be contested repeatedly.

Initially output-based allocation seems attractive because it relates to familiar programmes such as controls on rates of emissions from industry. Many countries such as the Netherlands and Germany already have efficiency agreements with industry. These programmes, however, deal with different problems and aim to roughly equalise marginal costs of abatement within the industry. This is important for them because they are not usually trading programmes so that the allocation of rights to emit determines the distribution of emissions. Where trading is allowed, the industry is often regulated so that costs cannot be passed on or output cannot easily increase because of other regulations. For example, in the US lead phasedown the trading programme provided an incentive to increase leaded gasoline production but at the same time another regulation made the stock of cars able to use leaded gasoline fall rapidly, so the demand and hence output fell.

If grandfathering is used to buy support at the time that legislation is passed, there is no need to alter those allocations in the future to benefit new groups. Output-based allocation gives less to the existing players and more to ones that emerge in the future, so it is less effective in building support. If grandfathering aims to address the real costs that firms bear, we need to recognise that the costs are only borne by firms in existence at the time the regulation starts. In addition they are borne in proportion to their past assets and emissions. There is no equity reason to compensate new firms or to compensate firms for growth. The initial allocation of allowances only determines how wealth is distributed, but does not affect who can emit $CO_2$ – anyone can buy allowances on the secondary market. Output-based allocation is complex and unnecessary.

*ISSUES FOR FUTURE DRAFTS:*

- *How would output-based allocation be implemented in sectors other than power generation?*

*Biggest challenge may be allocation among sectors not just within. Why design something fundamentally flawed anyway?*

- *Which industries would win and lose if output-based allocation were used?*

*All 'industries' lose on average because of inefficiency both from loss of revenue recycling and from output subsidy. Individual shareholders may gain from grandfathering. Industries do not actually win or lose – people within them do. Relatively speaking, owners of capital and to a lesser extent other people involved in growing industries gain and those in slow growing or contracting industries lose. There is no relationship with costs.*

## VI European Union Level Issues

At the EU level, three basic decisions need to be made on allocation: the allocation of allowances among Member States within the EU Bubble; the extent to which there are common rules on domestic allocation of allowances in EU countries; and what these common rules are. The first has been already determined by the June burden sharing agreement; the second and third are open to debate.

### *A. Allocation of allowances among States*

In June 1998, the Member States agreed to a division of the overall EU target of reducing emissions eight percent from 1990 levels. Estimates suggest that business-as usual-emissions would be 6% higher than 1990 levels by 2008.[21] The allocations under the BSA are presented in Table 1. Thus the PAAs have already been allocated among States, at least for the 2008 – 2012 commitment period. The allocation of allowances within any EU trading system would be determined by this allocation. Any system is compatible with maintaining this division.

In a single EU system with common rules where allowances were auctioned, the auction revenues would be divided among States based on the allowance allocations implied by the burden sharing agreement (BSA). Each State owns a certain number of allowances and hence also owns the revenue from their sale. The auction could be implemented at a national or EU level by either a government agency or even a private body under contract. The allowances of course would end up in countries based on their marginal cost of abatement just as they would in any trading system once trading has occurred. The BSA is about distribution among States of responsibilities to control emissions and hence bear costs of emissions reductions

**Table 5 EU Burden Sharing Agreement**

| Member State | Percentage Emissions Reductions in 2010 compared to 1990[1.] |
|---|---|
| Austria | -13 |
| Belgium | -7.5 |
| Denmark | -21 |
| Finland | 0 |
| France | 0 |
| Germany | -21 |
| Greece | +25 |
| Ireland | +13 |
| Italy | -6.5 |
| Luxembourg | -28 |
| Netherlands | -6 |
| Portugal | +27 |
| Spain | +15 |
| Sweden | +4 |
| UK | -12.5 |
| **Total EU** | **-8** |

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whether carried out domestically or abroad; it is not about the ultimate distribution among States of emissions.

If, in a Community-level system, some grandfathering were used, a common grandfathering formula might be used across different countries. As long as this formula, combined with the overall level of grandfathering, does not lead to a grandfathered allocation that exceeds the total allocation of any country, this does not raise issues of allocation among States. Each country's remaining allowances could be auctioned or held by the government to cover non-allowance-regulated emissions.

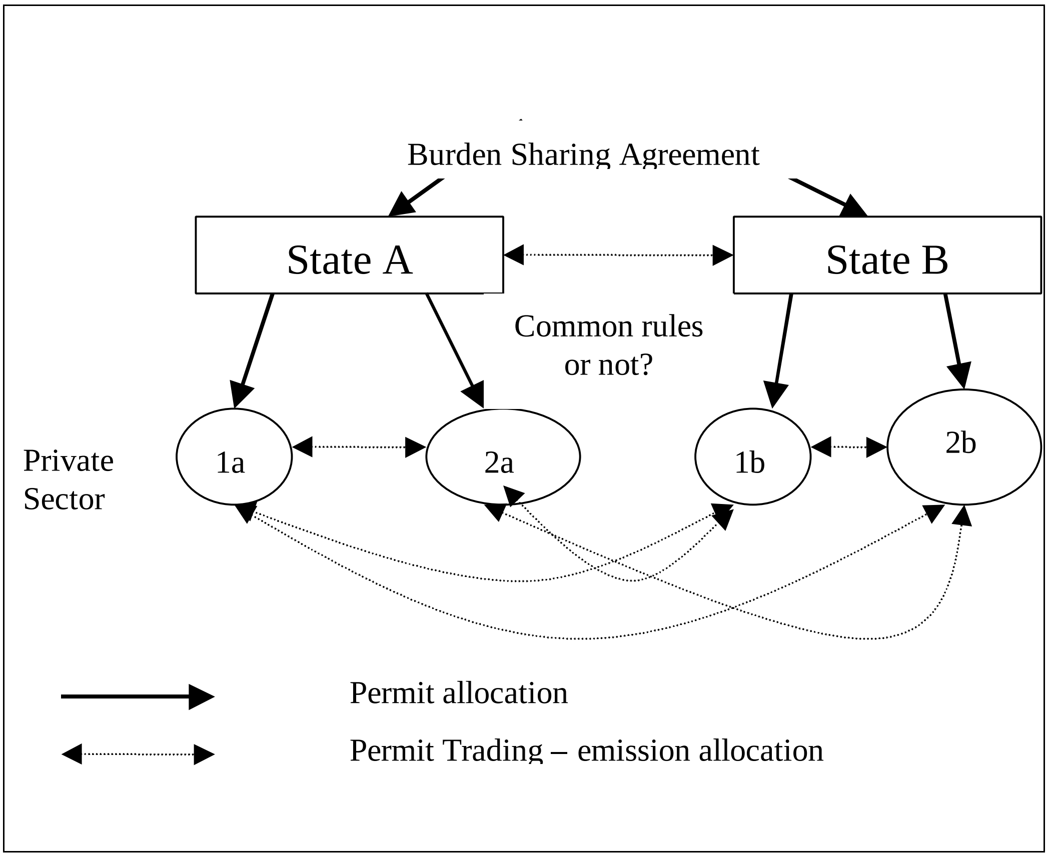
[21] Commission (1999)

Any other allocation of auction revenues or a grandfathering formula that changes allocation among States would violate the BSA.

In a system of linked national programmes with no common rules, the allocation among States would again be based on the BSA and the allocation within States would be at the discretion of each State. An intermediate EU system would be a combination of these two. Any system with opt in for Member States could not alter the BSA. Otherwise States would make choices about opting in purely on the basis of the changes in allocation rather than on the considerations about improvements in market efficiency that are of real value from an EU perspective.

If trade among EU States is unlimited (i.e., no binding quantitative limits on trade within the EU) and States choose equally efficient abatement policies where source level trading is not possible (gases and sources not covered by allowance systems – see below) the allocation among States has no implications for efficiency. If trade is limited then the allocation of responsibilities also determines the ultimate distribution of emissions and is critical for efficiency and competitive equality.

**Figure 7 Allocation and Trading of Allowances**




Allocation does, however, have major effects on the distribution of cost bearing across States. These distribution effects depend, however, on the already agreed allocation of PAAs among States and not on the specific form of EU-level design chosen.

## *B. Harmonisation Issues within the EU*

The second EU issue is whether the Community should set common rules for allocation of allowances within countries. Two issues are key here, whether the form of allocation has competitiveness effects, and whether it has effects on the administrative and transaction costs involved in GHG regulation.

### *1. Competitiveness*

The effects of GHG regulation on competitiveness within the EU derive primarily from the comprehensiveness of regulation within each State and the freedom of trade. A competitiveness problem arises when a regulation raises the costs of production of one firm more than that of another firm in the same industry in another country. If the price of carbon is internalised through an allowance programme in every firm in all countries and firms are able to trade allowances freely, the price of a allowance and hence the marginal cost of emitting carbon will be equal across all firms in the EU. No competitiveness problems will arise. The allocation of allowances among the States of the EU has no effect on the marginal cost of regulation to each firm. If however some firms are exempted from the allowance programme and do not face equally stringent alternative regulation some firms will face a competitive disadvantage relative to others.

In a comprehensive, unrestricted tradable allowance programme the following is true in every country. The allowance price will be the same in all countries.

marginal cost with regulation = marginal cost without regulation + GHGs produced * allowance price

**Effects of regulatory form on competitiveness**
Some people believe that if some firm are grandfathered carbon allowances rather than having to buy them in auctions, they will have a competitive advantage *vis-à-vis* those who must buy allowances or pay carbon taxes. This is based on a misunderstanding of allowance markets and grandfathering.

Grandfathering gives allowances to firms based on past behaviour, not current or future behaviour. It is a lump-sum payment. If a firm increases its production to export more, and emits more greenhouse gases in doing so, it requires more allowances. If allowances were auctioned, the expanding firm would need to buy more or draw down banked reserves. If allowances were grandfathered, it would need to use up some of the stock it holds and would have fewer to sell or use in the future. In every case, the opportunity cost of increasing output is the cost of the allowance. If the firm reduces production, it saves the opportunity cost of the allowance price, it avoids the need to buy allowances, or can sell the allowances it was grandfathered. The grandfathering of allowances makes the owners of the firm wealthier, but does not change their marginal production costs.

In fact, the economy of the State as a whole will be disadvantaged if grandfathering is used because of the loss of efficiency gains that could have been achieved through revenue recycling if the allowances were auctioned (see discussion below). Grandfathering would lower that State's overall productivity and make it harder for their firms to compete. Some firms will be wealthier, but all will face higher production costs because their taxes will be higher than they would have been if the auction revenue had been recycled into tax cuts.

Thus common EU policies on how allowances are allocated within domestic trading programmes are not critical. Common policies, however, on the comprehensiveness of the regulation and banning limitations on tradability of allowances are critical for ensuring competitive equality.

The trading system is unlikely to cover all sources and gases, at least initially. As noted, for this paper we have assumed that the system covers energy-related $CO_2$ emissions only. This limitation raises the issue of how Member States allocate assigned amount between sources covered by the trading system and those covered through PAMs, and whether a competitive advantage can be derived through this allocation. As noted above, a Member State cannot give a competitive advantage to one of its industries by allocating that industry a disproportionate share of allowances, because doing so would not change the industry's marginal costs. It is possible, however, that a State could provide a competitive advantage to an emissions sector covered by PAMs rather than trading. It could do this by imposing very lenient regulation on the sector and compensating by placing very strict PAMs on other sectors. For instance, a Member State that decided not to control methane emissions from livestock might provide a cost advantage to its farms over farms in other States. This problem will exist as long as the trading system provides less than full comprehensive coverage of all emissions. The problem can be addressed through harmonised PAMs, though this solution raises sovereignty concerns.

Of course, this discussion only refers to competitiveness within the EU. Competitiveness with countries outside the EU depends primarily on the level of regulation other countries face, and the freedom of international permit trading. Even if levels of commitment vary, marginal costs of GHG abatement, and hence the costs of using fossil fuels in production, will be equalised across countries. The only way the design of the EU compliance system can affect external competitiveness favourably is by making the system as efficient as possible within the EU and facilitating trade with countries outside the EU.

### *2. Co-ordination/Transaction Costs*

The other argument for common EU-wide rules on allocation is that it might facilitate allowance trading and make it easier for multinational firms facing regulation in several different States. To facilitate trading the key requirement is a common definition of allowance (e.g.: ton of carbon dioxide equivalent issued between 2008 - 2012), a consistent tracking system, comprehensiveness of the trading system and no limitations on trade. These are not government allocation issues and thus are not dealt with here any further. The need for consistent carbon accounting is also discussed in the companion paper on the point of regulation in an EU trading system.

## VII Conclusion

Two key decisions need to be made at the EU level. The first is the extent to which common rules about allocation of emission allowances should be agreed among States. The second is what, if any, those common rules should be.

Allocation has two aspects.  The first is the initial allocation of property rights to PAAs both among and within States. Second is the final allocation of allowances to emit, which is carried out in the secondary allowance market. Excluding a sector from regulation, or regulating more leniently, is effectively allocating non-tradable allowances to that sector.  If the market covers all sources and the market is able to function efficiently, the initial allocation has no efficiency implications only distributional implications.

For the market to work efficiently across the EU, the regulation of GHGs needs to be comprehensive and allowances need to be freely tradable among and within States. The only way this can realistically be achieved (even just for energy-related $CO_2$, let alone other gases) is to have the point of regulation upstream, i.e. at the level of fossil fuel producers and importers (or at the upstream/downstream hybrid defined in the companion paper on incidence of regulation).  This avoids leakage and applies equal regulatory pressure to all sources.  This does not mean that allowances need to be allocated to these upstream groups, simply that this is the point at which $CO_2$ equivalents would be measured and allowances surrendered.

The debate over allowance distribution is fundamentally about the allocation of the enormous rents created by the limitation of GHG emissions.  While there are some short run costs to some powerful groups, it is important not to let these obscure the value of an efficient system and the fact that consumers bear all costs in the long run. Negotiations for rent will tend to masquerade as claims for efficiency or equity. Although the arguments of some groups in favour of exemptions, extensive grandfathering or output-based allocation may sound intuitive they do not generally hold up in reality.  What seem on first sight like second order effects often dominate the direct costs of regulation.

Efficiency can be gained by building in the following features of allocation:

- The same form of regulation for same sectors in different States
- Allowances freely tradable among States
- Harmonisation of point and form of regulation, which reduces transactions costs for firms trading across EU borders and eliminates the need for border adjustments to avoid leakage
- Auction allowances and recycle the revenue through tax cuts.

- The first two ensure that the marginal cost of greenhouse gas abatement will be equalised across sectors within the EU thus avoiding competitiveness concerns.

Equity can be addressed by:

- Auctioning allowances and recycling most revenues to the general public, focusing on poorer more vulnerable groups, through tax cuts.
- Providing short run compensation to owners of stranded assets at the time regulation is introduced.
- Providing short run compensation and/or transition assistance to workers and communities that are hardest hit by regulation.

An auction is a highly feasible option from an administrative point of view, as is an upstream system.  The acceptability of different options is largely a judgement call. Have the most powerful groups been adequately compensated (preferably through tax cuts but alternatively through short term grandfathering)? Is domestic sovereignty satisfied? Is it easier to negotiate for an upstream, fully tradable, auctioned market once at an EU level and allow States to determine the other details, or have separate negotiations in each State and have a series of linked but different systems where competitiveness may be a concern?

From a purely economic standpoint the ideal system would be a series of linked domestic systems with common EU wide rules on the following issues: which gases and sources are covered, the point of regulation (preferably upstream), no barriers to tradability within the EU, allowances initially allocated by auction within each country, financial penalties for non-compliance that exceed the marginal cost of emission reduction. A linked registry system would facilitate trading. Each country could recycle its revenues differently depending on its own tax system, political and equity concerns and debt levels, as long as they do not subsidise output of emissions intensive industries.

If compromises need to be made from this ideal, the critical things to hold firm on are:

- that control is upstream (or upstream/downstream hybrid) and hence comprehensive and consistent across countries;
- that allowances are fully tradable across States;
- that consistent domestic financial penalties, exceeding the marginal cost of emission reductions, are imposed for non-compliance by firms; and
- at least some allowances are auctioned.

This system is not only efficient from an EU perspective but also efficient for each individual State. Hence if negotiations were difficult, it would be possible to allow an individual State to opt out of the common rules rather than compromising the entire system to include them. Pressure could then be applied to bring them into the system, recognising that it is in each State's aggregate economic interest.

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