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Instruments for effective global climate policy: the carbon deposit system

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Instruments for Effective Global Climate Policy: the Carbon Deposit System

Gjalt Huppes

Presentation at the Symposium on the Occasion of
the 65th Birthday of Gjalt Huppes

Symposium

**Making Climate Policy a Global Reality:
Instruments, Mechanisms, Consequences
and Policy Process**

Leiden, 16 December 2011



Universiteit Leiden

Contents

Summary	3
WHY RECONSIDER CLIMATE POLICY INSTRUMENTATION?	5
Not enough and yet already too complex.....	5
Simplicity in global policy instrument design: how to get carbon priced?.....	5
WHAT IS THE SIMPLEST, MOST EFFECTIVE AND OPTIMAL SOLUTION?	7
Carbon substance flow analysis and carbon deposit	7
Multi-country application: border issues	9
HOW TO IMPLEMENT THE CARBON DEPOSIT SYSTEM?	9
Nation states: capable administration	9
Border corrections with non-participating countries	9
Border corrections with participating countries.....	11
2 APPLICATION TO TWO GLOBAL BLOCS	13
Level of the deposit	13
The deposit system quantified: <i>EU alone</i> and <i>OECD</i> ⁺⁺	13
Tax proceeds from the successful deposit system.....	15
Level markets, innovation, and competitiveness.....	17
COMPARING THE CARBON DEPOSIT WITH EMISSION TAX AND CAP-AND-TRADE	19
Comparing on the basis of completeness.....	19
Comparing administrative requirements	19
Comparing potential optimality.....	20
Comparing political feasibility.....	20
PROSPECTS.....	21
References	22

SUMMARY

Climate policy has been developed in many countries in the last decade using many different policy instruments. Often, over a dozen of them are applied for a given product or installation, including taxes, subsidies and all sorts of regulations. This proliferation of policy instruments has not halted the rise in CO₂ concentrations in the atmosphere. Global emission trends are steadily increasing, and by 2010 the rise had already recovered from the 2008 recession dip. A simpler, more comprehensive, and more powerful system needs to be developed to curb climate change, which implies substantial carbon pricing. One of the options is discussed in detail here, the carbon deposit. The principle is simple. A deposit is paid for any carbon entering a country, for instance by fossil fuel extraction or in imports, while a refund is paid for any carbon leaving the country in exports or by geological storage. Any carbon lost along the way, as CO₂ emissions, is thereby implicitly charged for, to an amount equal to the deposit paid. The carbon deposit thus functions as an indirect CO₂ emission tax, to be implemented at country level.

The implementation would be extremely simple at a global level, since it covers fossil fuel production and permanent storage only. In the case of implementation at national level, the border controls necessary to cover import and export flows may complicate the picture substantially, as very many products would have to be covered. International alignment can considerably simplify the implementation. If multiple countries join the system, they can function as a bloc, without product-level border controls between them. If the bloc covers the whole world, we are back at the simplest system. Though this is unlikely to happen, major countries like China, India, Indonesia, Russia and Brazil would be well able to join the system, unlike other global system options like cap-and-trade based systems. Such systems set a cap on total allowable emissions per country, distributed over all facilities in that country. They also require measurement of the emissions of each facility and controls on the trade in emission permits.

The border controls between the bloc implementing the deposit and the non-deposit bloc remain a key issue, which

must be resolved within the constraints of rules for open international trade. Essentially, two markets would be created, one with and one without carbon pricing. All products whose price includes a substantial share of deposit burden should be covered. Importers to the deposit bloc would not only have to pay for direct carbon content, but also for the indirect carbon emissions, which have gone unpriced in the non-deposit country. Refunding of the deposit for exports to non-deposit countries similarly should not only cover the direct carbon content but also the embodied carbon flows, as the deposit was paid for these emissions. Such border controls would not pose a serious problem for fossil energy carriers, as substantial taxes and regulations are already in place for most of them. Hence, there would be a substantial difference between “going it alone”, for example a bloc involving only the EU, with much external trade, and a near global system covering all industrialized and industrializing countries, with hardly any external trade. Border controls create a similar burden on deposit and tax systems, and are more tedious in cap-and-trade systems due to the varying permit prices.

The administrative implementation of the deposit system constitutes much less of a problem than that of any other effective carbon pricing, as these require in-country firm-level controls. The carbon deposit system can be implemented by capable taxing organizations, which already exist, even in developing countries, for collecting indirect taxes, duties, excises, tariffs and the like. This is all that is required for the carbon deposit system. The proceeds of an effective carbon deposit system, rising to the order of €625 per ton in 2040, would be limited to around one and a half percent of GDP.

The carbon deposit system can be compared to similar broad carbon pricing systems, especially emission taxes and cap-and-trade systems like the Emissions Trading System (ETS) in the European Union. It is conceptually related to a uniform carbon tax, with the added feature of a refund for carbon capture and storage (CCS). Whereas national implementation of a uniform tax at emission sources is more vulnerable to political pressures, with possible exemptions and

slack controls, border corrections with non-aligned countries would be similar to the emission tax.

National implementation of carbon emission taxes and cap-and-trade systems requires a very capable administrative organization to prevent emission fraud, with trading requiring further administrative capacities. Such capable administrations are not present in developing countries, nor even in several developed countries. The fixed price deposit system and fixed-price carbon taxes could make border corrections easier, as permit prices for cap-and-trade systems are variable and hence the basis for border corrections is variable. The deposit system has an incentive structure which does not involve a common interest in creating a paper reality.

Overall, it seems that the deposit system offers advantages over carbon taxes and cap-and-trade systems in its comprehensive applicability at national level, its nearly global applicability and its very much lower private transaction cost and public administrative burden, thus increasing its effectiveness and optimality.

4

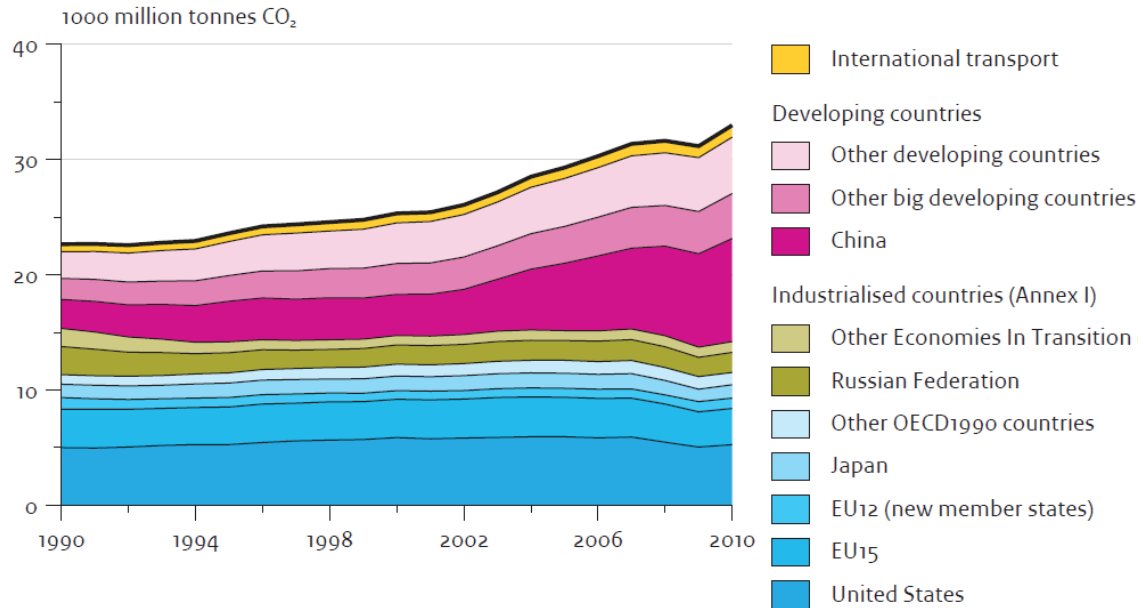


Figure 1. Medium-term trends in CO₂ emissions. Source: Olivier et al (2011)

WHY RECONSIDER CLIMATE POLICY INSTRUMENTATION?

Not enough and yet already too complex

As figure 1 shows, current climate policies have not been effective in curbing CO₂ emissions (Olivier et al 2011). Emissions have been rising, and even at an accelerating rate, in the last decade. Climate policy has been taking shape for decades now, resulting in a substantial number of implemented policies. These policies have diverse and overlapping domains of application, ultimately forming a “tangled web” of overlapping instruments. One essential key to successful climate policy is to price carbon, either by means of economic instruments or indirectly by physical regulations, as an option of second choice. The principles have been accepted in the UN Kyoto Protocol and have been most extensively implemented in the EU ETS, the European emissions trading system. Together, these various climate policies have certainly had an impact, but not enough to substantially curb and reduce climate changing emissions. Global CO₂ emissions are rising, only slightly delayed by incidental recessions, so concentrations are also rising, and the same is true for global temperature.

The limited effectiveness has both political and policy instrumentation causes. Increased competition in a globalizing economy constrains national policy efforts, as national industries will be hurt by effective unilateral actions. The applicability of the most comprehensive instrument available today, the EU ETS, is limited to less than 50% of EU emissions, with special exemptions for many industries to safeguard their international competitiveness. In addition, the post-Kyoto process has come to a halt in Copenhagen, Cancun and Durban, with no new obligations and no new countries entering the trading system. In the US in particular, there is substantial debate on carbon taxes as an alternative to Kyoto-type cap-and-trade systems, with climate scientists like Nordhaus (2011) and Hansen (2009) arguing against cap-and-trade. Both proponents of carbon taxes and of cap-and-

trade systems agree on one point: without substantial carbon pricing, effective climate policy will remain an illusion.

Simplicity in global policy instrument design: how to get carbon priced?

Simplicity requires one carbon price for any emission from any source, anywhere. This clearly relates to optimality. Leaving out some sources or covering them twice or three times will raise the cost of equally effective policy. For reasons of optimality, the carbon price should also be predictable in the long run. Carbon pricing would reduce the need for most of the current policy instruments, at least in all domains where markets are functioning reasonably well. Of course this is true only if the carbon price becomes high enough to reach a long-term goal like “80% emission reduction by 2050”.

There are already many policies in place that focus on market activities. An example is that of the policies relating to the supply and demand chain across the electricity sector, involving several renewables policies in terms of subsidies and physical regulations, supply chain regulations on investment decisions, technical requirements on electricity production facilities, and energy taxes and price regulations, which differentiate between final users. Most of these could be replaced by carbon pricing at a level required to meet the goals behind all these policies, not only climate goals but also security of supply goals. One approach to achieve such simplification is the cap-and-trade system in place in the EU, in the form of the ETS (European Emissions Trading System) which is currently in a start-up phase, moving towards full auctioning of the ETS permits. Its implementation requires measuring emissions at the level of firms and plants or installations. Although the ETS has had a number of start-up problems, it is now by far the most comprehensive climate policy system operational. However, it faces three major challenges:

- broadening its range of application to all or nearly all emission sources, compared to less than 50% now;
- stabilizing its permit prices on a long-term rising

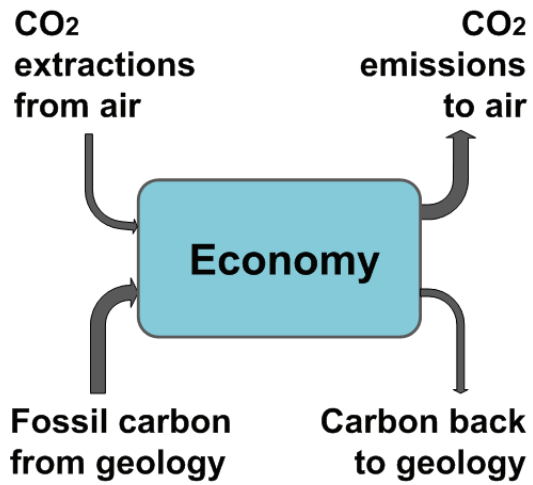


Figure 2. Carbon flows through the economy of global society; outer boundaries only.

curve, so as to attract the necessary research and development and investments;

- having most other countries join the system.

Broader coverage by cap-and-trade systems requires including diffuse sources. This may be possible only by having more upstream measurements and indirect emission permits, which may easily result in gaps and overlap. Price stability in permit markets might be obtained, for instance, by adapting the number of permits so as to reach a predetermined price level, leaving the fixed cap at least for the time being, or by combining with adjustable taxing systems. More elaborate proposals have been developed as by McKibbin (2007).

Combining such elements would go very much in the direction of an emission tax administered upstream, for example applied to the producers of the fuels used in a heating installation, which is only one step away from a third system, besides cap-and-trade and emission tax, which we call the carbon deposit. In this sense, the three carbon pricing systems are close enough to gradually transform into one another.

The third challenge is that of broader international participation, which is necessary for global effectiveness and for avoiding unjustified international inequalities in competitiveness. One obstacle for major developing countries which might like to join the cap-and-trade system is that they currently lack the capacity for reliable implementation, and it is uncertain whether they will be able to build it up in the next decades.

The ETS-type cap-and-trade system (assuming full auctioning of the permits) and the emission tax system will remain the major references for comparison in this paper, which ends with a look at the prospects. With any comprehensive, stable system, a simultaneous step would be to reduce, rearrange and simplify the web of policy instruments which is currently in place and is still rapidly developing.

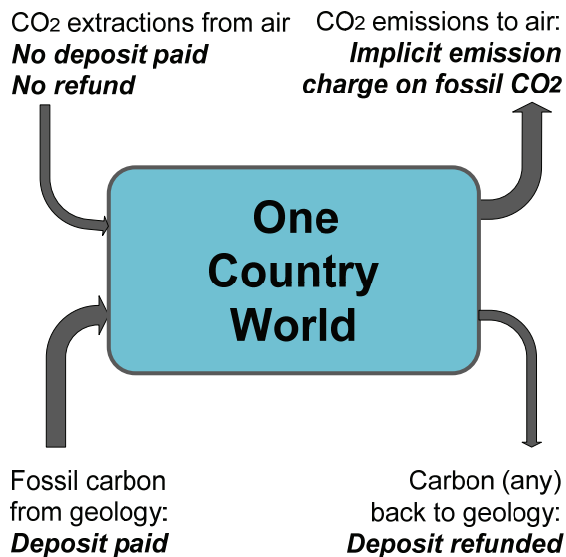
WHAT IS THE SIMPLEST, MOST EFFECTIVE AND OPTIMAL SOLUTION?

Carbon substance flow analysis and carbon deposit

The first step toward simplification is to examine the carbon flows at a highly aggregated level, in a Substance Flow diagram for the world like that shown in figure 2. It depicts the inflows and outflows of carbon in the economy, using a basic tool of industrial ecology called SFA (SFA/MFA, Substance Flow/Material Flow Analysis). For a stable atom like carbon, mass conservation implies that what comes in accumulates or goes out. As fossil fuels hardly accumulate over the years, *carbon in* equals *carbon out*, as depicted in figure 2. The principles of instrument development are simple as well. Carbon emissions have to be uniformly priced, and the polluter has to pay. A key problem with CO₂ is that it is almost impossible to use direct emissions measurements that are precise enough for taxing purposes.

The core feature of the instrument proposed here, the carbon deposit, is indirect emission measurement using SFA, not per facility or installation, firm or consumer, but for the world economy as a whole, as if we had a one country world (see figure 3). Fossil carbon that is extracted and enters the economy would be paid for, while a refund would be paid upon delivery of carbon *back to geology*, stored for a geological period of time. All carbon lost in between would not get a refund and is therefore paid for. A further simplification is to leave out the CO₂ extractions from the air through photosynthesis. Bioproducts like food mostly have a short cycle and do not have a net influence on CO₂ emissions, unless they are taken out of their short-term dynamics by putting them in geological storage. Most importantly from an instrument point of view, they cannot be measured precisely enough for taxing, deposit or permitting purposes. They would be disregarded at the inflow side but are included in refunds for permanent storage, creating a clear incentive for replacing fossil energy by bio-energy.

In an administrative sense, the system is extremely simple. The only actors involved in the instrument would be the



8

Figure 3. Carbon deposit in a One Country World.

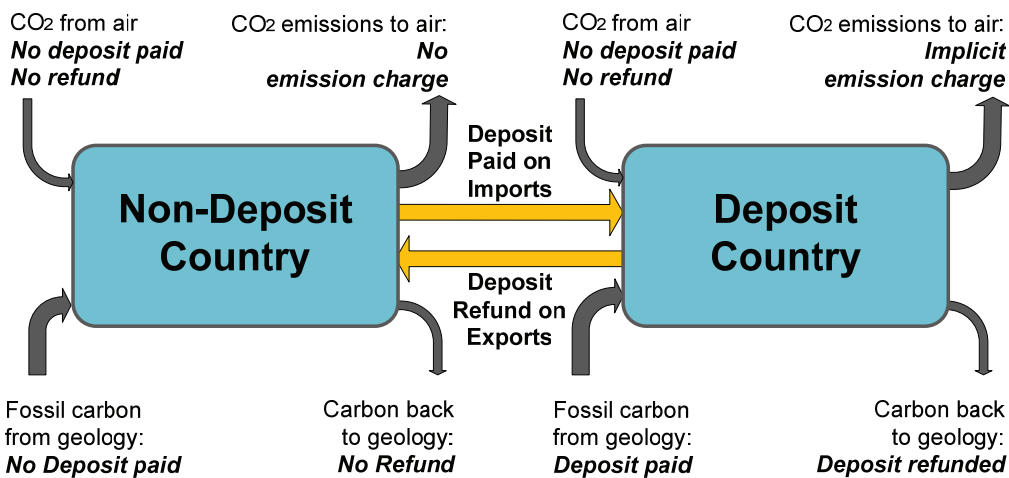


Figure 4. Carbon deposit in a country trading with a non-deposit country.

producers of fossil fuels and those bringing carbon *back to geology*, usually referred to as Carbon Capture and Storage (CCS) but here referring to the storage activity only.

The result is very similar to what we are accustomed to as consumers: a deposit, which is why we call it the **carbon deposit**, as one application of the substance deposit as described by Huppes et al (1987).

Multi-country application: border issues

The above description was based on a one country world. However, we do not have a one country world. The system would have to be implemented at country level, for all sorts of political reasons and to ensure effective implementation. Once again, we have to set uniform and comprehensive indirect measurement boundaries, but not for the world as a whole but coinciding with the geographic boundaries of policy implementation: the nation states. Indirect measurement of emissions is not only based on carbon inflow from fossil resources but also on carbon imports in products, and on outflows not only in the form of geological carbon storage but also of exports in products. Again, whatever is lost “in between” is emitted. This measurement design can be made to correspond directly to the policy instrument: payment of an excise, duty or tax on an inflow of carbon, that is, a deposit, with a repayment upon carbon storage or export, that is, the deposit refund. If one country introduces the deposit system, its trade with another country becomes part of the instrument implementation (see figure 4). Such a carbon deposit system would create an economic driver for emission reduction in the countries introducing it.

HOW TO IMPLEMENT THE CARBON DEPOSIT SYSTEM?

Nation states: capable administration

In our world, which is based on nation states, implementation is not “by the world” but by country level administrations. If the world were one country, life would be simple, as there would not be any imports or exports. The carbon deposit system would then be levied on fossil fuels only, and repaid when any carbon is stored “forever”, for instance through storage in deep saline aquifers. However, there are many countries in the world, and several of them would presumably join in the carbon deposit system while several would not. Those joining the system would have a relatively simple agreement to make, to implement the same level of carbon deposit. No other obligations, such as caps per country specified in time, would be required. This would allow for free trade, free from deposit refund and payment, between countries joining the system. Thus, imports and exports would be treated differently if they take place within the bloc of participating countries (see figure 5) as opposed to transactions involving non-participating countries (see figure 4). Trade with non-participating countries would require border adjustment per product.

Border corrections with non-participating countries

The relation with non-participating countries would be based on border corrections, with deposit paid by importers to the authorities of the importing country and refunded to exporters by that country upon export of carbon in their products. Let us first have a look at exports from the country participating in the deposit system, for which some further refinement is needed. The refund is paid for the carbon in each product. For carbon emissions in the deposit country, however, the deposit functions implicitly as an emission tax, as no refund can be given for emitted carbon (as CO₂). For these embodied emissions there thus needs to be a refund upon export as well, refunding the deposit that had already been paid on that carbon. Hence, upon export of a product

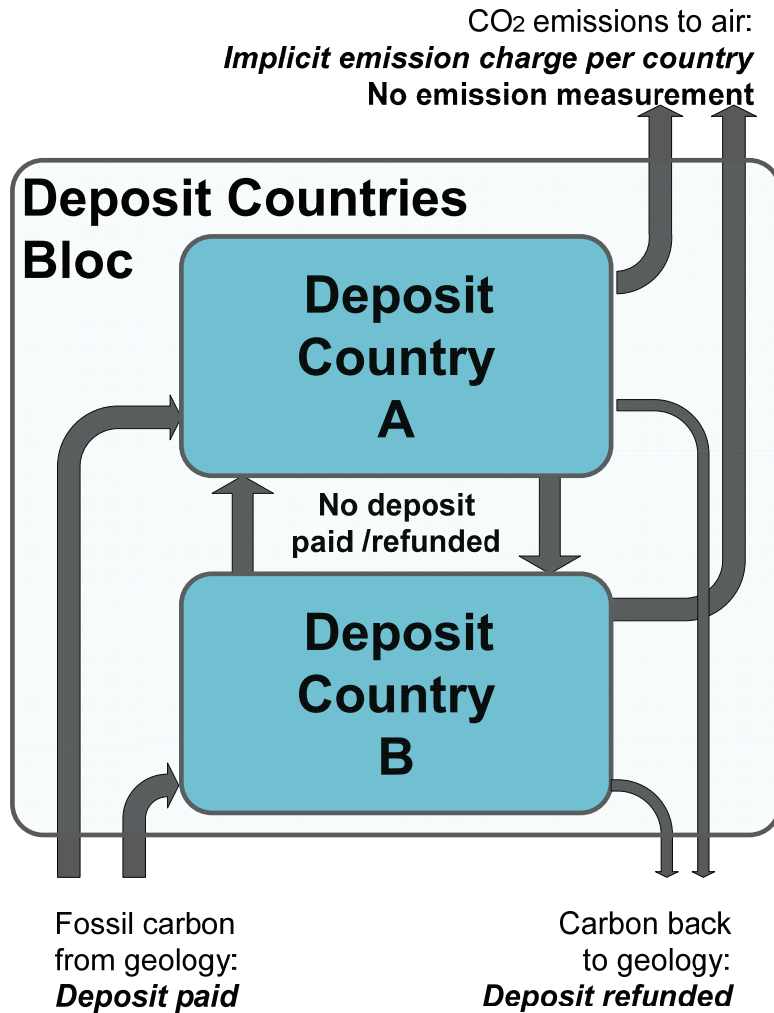


Figure 5. Carbon deposit in a bloc of aligned countries.

from the participating country, the exporter gets a refund on embodied carbon, as the sum of the carbon in the product plus its upstream CO₂ emissions. On the imports side, the deposit is similarly charged on carbon in products, including fuels, and on embodied CO₂ emissions, as no deposit has yet been paid.

These border corrections would create two level playing fields. One is in the deposit bloc, where prices are higher as they include a deposit component, but where other taxes are lower. The other is in the non-deposit bloc. Firms from any bloc can operate in both blocs without distorted competition.

In the deposit system as proposed here, there is only compensation for the relatively easily determined transfer costs, based on embodied carbon. In addition to the returning of these transfer payments, there are the real costs that firms incur for the behavioral changes for emission reduction induced by the deposit system. Increases in real cost induced by the deposit system (or any other effective system) would be extremely difficult to determine. This is true especially in the longer term, as the additional costs have to be compared with a virtual situation without climate policy or with a different climate policy. In a comprehensive global system, only one technology would tend to emerge, so these costs would be very small. A stepwise policy implementation, based for example on 4% steps over a period of 25 years, would mean that the cost differences in the first years would be very small anyway.

The border controls with non-deposit countries would constitute a major administrative burden on the system. Most countries, including developing ones, have the capacity to tax primary production and put tariffs on imports, and are similarly capable of refunding upon export and controlled storage. But the number of products involved is very large if a substantial number of countries do not join, and the computation of embodied carbon per product is somewhat tedious.

Border corrections with participating countries

The product flows between participating countries would be on the same level playing field. From an economic optimality point of view, there is therefore no reason to have any border corrections at import or export. For the firms involved in intra-bloc trade, no border controls or registrations are required and no deposit payment or refund is involved. However, the question may then arise to which country the proceeds of deposit levying would accrue. An uneven situation may occur, for instance, when bulk imports from non-deposit countries with high carbon content are entering through a transit country, and similarly for exports. The basis for the distribution of net proceeds in the bloc would be the location of emissions, as it would also be if an equivalent emission tax had been implemented or a comprehensive cap-and-trade system existed (which is not possible for both these instruments). For countries as a whole, the emission volume is a figure easily established, for instance based on UN-standardized emission inventories. No supranational bodies are needed for this task. The administrative burden of this corrective payment between governments is extremely limited. The bloc functions as one unit for the deposit system based climate policy, with outside borders only.

If no corrective payment between countries takes place, the deposit system starts to function as a resource tax.

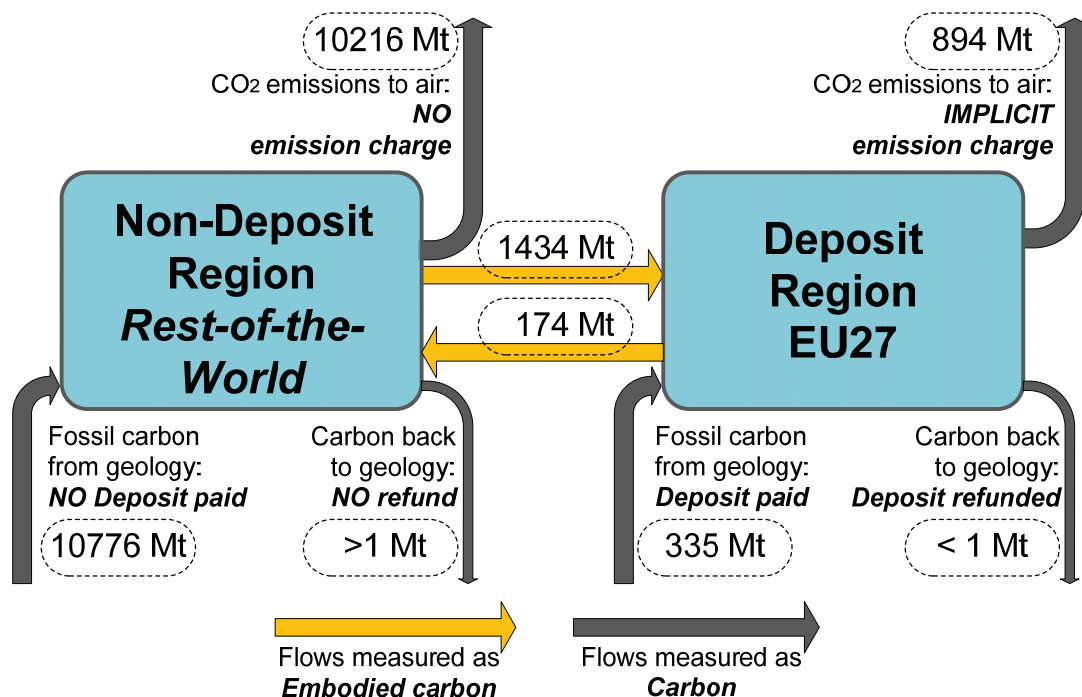


Figure 6. Scenario 1 *Global Policy Failure*: Carbon flows for EU27 and Rest of the World, 2030. Source: see table 1.

APPLICATION TO TWO GLOBAL BLOCS

Level of the deposit

There would be two basic approaches to setting a level for the deposit, similar to that for an emission tax. One is to set the level equal to the environmental damage caused by an additional unit of emission (the Pigouvian tax). The other is to set the level high enough to reach an agreed target (the Baumol tax). Damage levels are widely disputed. The best-known proposal, in the Stern Review (2006), is regarded as unacceptably high by traditional mainstream economists; see the survey by Tol (2008). Within the mainstream, however, there is serious debate over the irrelevance of the traditional outcomes, a debate opened by Weitzman (2009). This irrelevance is due to the low-chance high-impact outcomes of climate change. Runaway effects of climate change, which is the *fat tail* in the probability distribution of outcomes, may lead to a disaster with possibly billions of victims. Such effects are not amenable to traditional economic analysis.

Establishing the tax so as to reach a predefined target is also hard to achieve, as modeling the far-reaching innovations required for substantial emission reductions is extremely difficult. We just do not know if there will be a breakthrough in photovoltaics, geothermal energy or carbon capture and storage. Nor do we know how far the end users will go in reducing their energy demand.

It is clear, however, that substantial change is required and that emissions from fossil fuels will have to be reduced by at least 80% by 2050 and by a higher percentage if we delay emission reductions any further. Both lines of argumentation have been followed in the Stern report, leading to a carbon price of the order of €300.

As the introduction of the deposit system would be done in small steps, we would have gone through many innovations and learning curves well before the full level is reached. If there is a real danger by then of overshooting the mark, the increase to full level can be postponed. This danger, though real, is not a serious risk and should also be considered in relation to the

reduction of all other greenhouse gases. Non-fossil energy sources will have been substantially developed by then, easing the pain of further reduction of fossil fuel use. In cap-and-trade systems, the cap per year might be set based on similar reasoning, to an annually decreasing level that would lead to predictable, slowly rising permit prices. The expected price rises would induce innovation in the cap-and-trade system, then similar to the predetermined increases in the deposit or emission tax system.

A practical perspective on setting the ultimate level of the deposit might be to take current duties and excises on fuels as a reference. Current average levels of gasoline taxes in the OECD are of the order of 50 Eurocents per liter, mostly much lower in the US and much higher in the EU and Japan. This is the equivalent of €625 per ton of carbon, roughly twice as high as Stern proposed (Stern 2006). We will use this ultimate deposit level as a reference in the quantifications.

To avoid unnecessary short-term costs of transition, a gradual introduction can reduce these short-term costs. We assume a 25-year build-up to the full level, in four percentage point increases per year. As long-term decisions are influenced by expectations about long-term prices, the predictability of the longer-term deposit levels is a key condition for dynamically achieving the lowest costs of transition to a low-carbon society. If we optimistically assume that the carbon deposit can be started in 2015, the full deposit level would be reached in 2040, in steps of €25 per ton per year.

The deposit system quantified: EU alone and OECD⁺⁺

The quantification of course depends on the year that is chosen. Let us take a year somewhere in the mid-term of the transition, with a deposit level of €300 per ton carbon, around the year 2030. We use this mid-term year as modeling toward the final year is extremely difficult. The deposit system would start to reduce carbon emissions by 2030, but not yet substantially, as major redirections in the technologies of supply and demand will require one to two decades before substantial application can start. By 2030, global GDP and

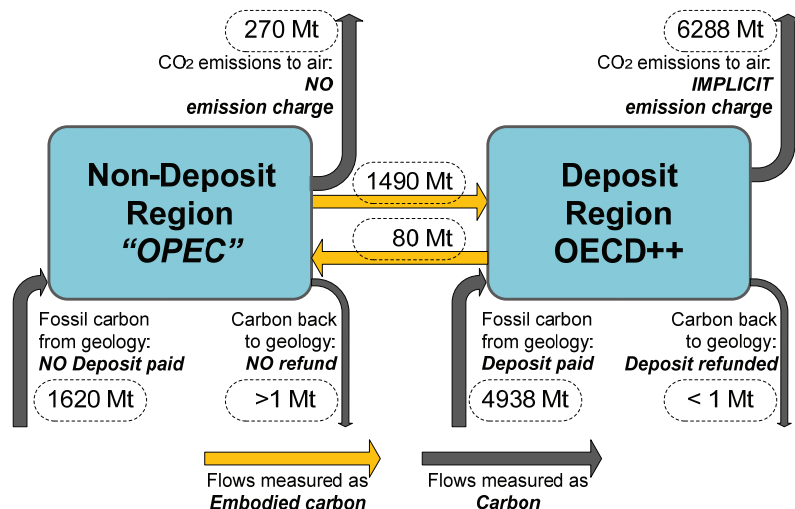


Figure 7. Scenario 2 Global Policy Success: Carbon flows for OECD++ and "OPEC", 2030.
Source: see Table 2.

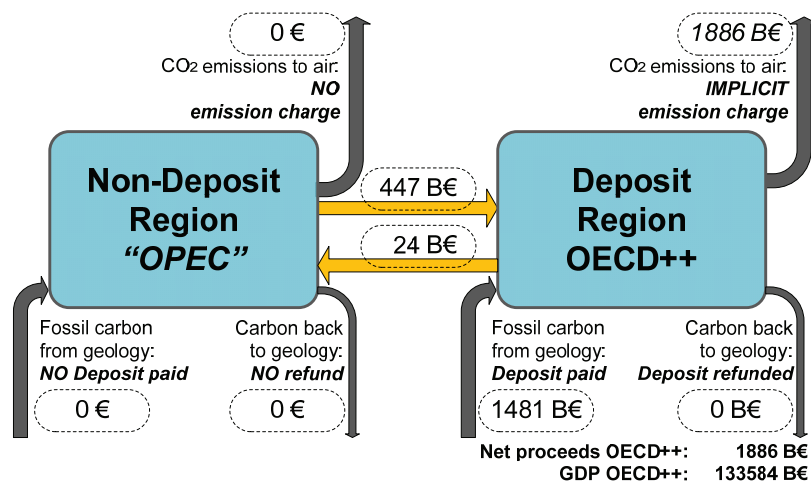


Figure 8. Scenario 2 Global Policy Success: Money flows of OECD++ and "OPEC", 2030.
Source: see Table 2.

global population will have risen, assuming that longer-term trends hold. The trade flows between countries will also increase, more so than global GDP increases. We now depict two scenarios regarding global climate policy. One is where the international policy process breaks down and the EU goes it alone. This is the global Policy Failure Scenario. The deposit bloc in this scenario consists only of the EU 27 countries. It has very substantial trade with non-participating countries, rising to around 15% of EU GDP. We enter reasonable figures for GDPs and trade flows, and calculate carbon flows and the resulting deposit levels. The second scenario is Global Policy Success, depicting a highly successful international climate policy, with all industrializing and industrialized countries joining the deposit system and only a bloc like OPEC remaining outside the system. The external trade would then be very limited, and would involve a number of fossil products and the imports to “OPEC” financed with the proceeds of their fossil exports.

In the *EU alone* scenario, the emissions of the rest of the world would continue along the rising trend of CO₂ emissions of the last decades, by 1.9% a year. In fact, this seems a low estimate, as this excludes the EU, one of the regions that have already shown slower emissions growth in the past. EU emissions would decrease, we assume, by around 20% in 2030. Higher decreases would be achieved in later years, as technology and investments would be geared to lower emissions, a development which starts as soon as the scheme becomes convincing. A survey of the data is presented in table 1, with deposit-relevant flows depicted in figure 6. Even if the EU were to reduce its direct emissions by 20%, which would be really fast, the emissions due to EU consumption would rise substantially, by nearly 50%. This is due to the assumed economic growth in the EU and to the rising share of “dirty” imports, not compensated by the cleaner ticket of EU exports. Global emissions would rise by around a third. We can thus rightfully call this scenario the Global Policy Failure scenario.

In the second scenario, all industrializing and industrialized countries (i.e. the *OECD++* countries) join the deposit system, using climate policy also for taxing purposes. We assume that only OPEC would stay outside the system, although with a near global coverage of climate policy, there would be clear incentives for them to join as well. Even if they do not, however, their share in global GDP would already be limited and would be further reduced due to oil prices dropping as a result of substantially reduced demand. We assume that OPEC would keep production at the current level, but at somewhat lower prices. With nearly global coverage of the deposit system, the rising trend in CO₂ emissions would be reversed, with emissions reduction by 2030 also assumed to be of the order of 20%. For the world as a whole, the emissions due to consumption would also drop by 20% in 2030, with faster reductions occurring in the subsequent decades. This is why this second scenario can be called the Global Policy Success scenario.

15

Tax proceeds from the successful deposit system

The carbon deposit system would create net proceeds for governments, as would carbon taxes and auctioned permits. What governments would do with such proceeds is up to them. They may use them to reduce budget deficits or taxes, or they may spend more, on whatever outlays they deem most useful, including transfer payments to less developed countries or poorer parts of their population. How large the proceeds would be depends on the level of the deposit and the amount of carbon entering and leaving the economy. Assuming a level of the deposit by 2030 of around €800 per ton of carbon allows the proceeds for the world to be specified. Per-country proceeds would differ, depending on the emission intensity of their economy. For the world as a whole, they would be of the order of 1.5% of GDP, thus constituting a few percent of total tax proceeds, an interesting option. For the EU, with its lower carbon intensity to begin with, the proceeds would be somewhat lower, at 1.2%, the same as if the EU should *go it alone*.

Table 1 GDP and Trade and Carbon Flows in and between two blocs:									
Scenario 1 Global Policy Failure: EU27 and RoW in 2010 and 2030.									
Year 2010									
GDP		12257	B€						
Trade		1400	B€, I& E averaged						
Trade share in GDP		11,4%							
Embodied C in imports		982	rough estimate, fossil carbon + upstream C emissions						
Embodied C in exports		218	rough estimate, fossil carbon + upstream C emissions						
Primary fossil C EU		335	Mton				EU net fossil imports:	783	
Primary fossil C RoW		7795	Mton				Upstream emissions imports	199	
Carbon emissions EU		1118	Mton				Emissions for exports	218	
Carbon emissions RoW		7012	Mton						
Carbon emissions total		8130	Mton						
C emissions EU consumption		1099							
Year 2030									
Trade share		15%	Assumed						
Trade		3309	B€						
GDP 3%pa		22063	B€, +80% over 20 years						
Trade rise relative to 2010		236%							
Embodied C in imports		1434	Mton	up ~ emission increase					
Embodied C in exports		174	Mton	down ~ emission reduction					
Primary fossil C EU		335	Mton				EU net fossil imports:	559	
Primary fossil C RoW		10776	Mton				Upstream emissions imports	874	
Carbon emission EU		894	Mton	minus 20%, assumed			Emissions for exports	174	
Carbon emissions RoW		10216	Mton	Trend 1.9%, growth total	46%				
Carbon emissions total		11111	Mton						
C emissions EU consumption		1594							

The money flows involved in deposit payment and refunding for imports and exports with OPEC would be highly asymmetric. The deposit paid on oil and gas imports would be of the order of half a trillion Euros, while refunding on exports would be of the order of 25 billion Euros. Rent incomes in these oil producing countries would fall substantially.

Level markets, innovation, and competitiveness

Large-scale application of the deposit system would remove most competition issues with non-participating countries. Although they may have a certain advantage now when exporting their products to the deposit bloc, a slow build-up of the deposit level would mean that this advantage might become substantial only decades from now. By then, their technologies would lag greatly behind. This would not give them a chance to really compete, as technologies in the deposit bloc would have developed by then reckoning with prices as changed by the deposit system.

Comprehensive carbon pricing with a predictable long-term price development is the policy instrument most conducive to focused innovation. As regards competitiveness within the deposit bloc, there is no reason to assume that one country would be unduly favored over another by the carbon deposit system. Other factors would be determining their performance, such as the quality of education and research, and entrepreneurial excellence. Countries can create institutions to foster innovation and competitiveness, and the most successful countries would become the most affluent ones. Successful climate policy will not alter that.

Table 2. GDP and Trade and Carbon Flows in and between two blocs:							
Scenario 2 Global Policy Success: OECD ⁺⁺ and OPEC, 2010 and 2030 .							
Year 2010							
GDP OECD ⁺⁺	60720	B€					
GDP OPEC	2324	B€ share: 3,7%					
Trade	1014	B€, exports					
Trade share in GDP	1,7%						
Embodied C in imports	1490	rough estimate, fossil carbon + upstream C emissions					
Embodied C in exports	100	rough estimate, fossil carbon + upstream C emissions					
Primary fossil C OECD ⁺	6510	Mton			OECD ⁺⁺ net fossil imports	1350	
Primary fossil C OPEC	1620	Mton			Upstream emissions imports	140	
Carbon emissions OECD	7860	Mton			Emissions for exports	100	
Carbon emissions OPEC	270	Mton					
Carbon emissions total	8130	Mton			OPEC exports 29 Million Barrels per day		
C emissions OECD⁺⁺ consumption	7900	Mton					
Year 2030							
Trade share	0,5%	Assumed as oil prices down, volume equal					
Trade	668	B€					
GDP 4%pa	133584	B€, +120% over 20 years					
Trade decrease relative to 2010	34%						
Embodied C in imports	1490	Mton	up ~ emission increase				
Embodied C in exports	80	Mton	down ~ emission reduction				
Primary fossil C OECD ⁺⁺	4938	Mton			OECD ⁺⁺ net fossil imports	1350	
Primary fossil C OPEC	1620	Mton			Upstream emissions imports	140	
Carbon emission OECD ⁺⁺	6288	Mton	minus 20%, assumed		Emissions for exports	80	
Carbon emissions OPEC	270	Mton	Remains equal				
Carbon emissions total	6558	Mton					
C emissions OECD⁺⁺ consumption	6348	Mton					

COMPARING THE CARBON DEPOSIT WITH EMISSION TAX AND CAP-AND-TRADE

Judgment on any policy instrument is not just absolute but also relative to other options. There are a number of key issues in the carbon deposit implementation which have their counterparts in any other instrument for effective climate policy. These issues are the system boundary in terms of the completeness of flows covered; administrative implementation; and the optimality of induced emission reductions. After comparing the three instruments, the section ends by examining political feasibility, with a look at post-Kyoto options.

Comparing on the basis of completeness

System boundaries are clear in geographical terms, and are also clear in terms of fossil carbon extracted, though some debate is possible on what constitutes permanent storage, as with CO₂ in clathrates in the deep sea. The deposit system is unique in its fully indirect measurement, covering any emission from fossil sources. Source-oriented emission taxes and cap-and-trade systems would only be able to cover part of these emissions and may easily lead to overlapping implementations, as in fuels taxed and then used in installations which are taxed directly as well.

Other system boundaries are more open, as in CO₂ from other sources than fossil fuels. Around 5% of CO₂ emissions result from carbon carbonate reduced for cement production. Also, CO₂ is a major greenhouse gas but not the only one. Those emissions that are not included will require other policies. Such issues are very similar for emission tax and cap-and-trade systems. Carbon taken from the atmosphere by current photosynthesis is disregarded in the deposit system, as described above. Some of these flows are included in the emission computations by the Intergovernmental Panel on Climate Change (IPCC), and also function in the Clean Development Mechanism (CDM), but are problematic there. Other, mostly non-carbon pricing policy instruments will be

required in climate policy to reduce emissions from biomass production and other natural sources, also covering non-CO₂ emissions like methane and nitrous oxide.

Overall completeness for CO₂ is one characteristic in which the carbon deposit system is clearly superior to emission taxes and cap-and-trade systems.

Comparing administrative requirements

Administrative implementation of the carbon deposit system would be very similar to that for alcohol excises, implemented by stable organizations with a very long tradition in most countries, including most developing countries. The procedures at import and export differ between countries but may easily be set up in a uniform way for the carbon deposit system. The administration of primary production and border controls on fossils are almost in place already, for current tax and royalty purposes. Such administrative procedures are incomparably simpler than those for source-oriented emission tax and cap-and-trade systems, which have some intermediate boundary for measurement within the economy. Both national and international carbon trading would be fully avoided in the deposit system. Since even administratively advanced developing countries like China and India do not have the capacity to effectively implement a cap-and-trade system in the next decades, this is a clear advantage of the deposit system.

One key issue for all effective carbon-pricing policies is that of border corrections with non-policy countries. The carbon deposit system, as well as the carbon tax system, would have a well-defined quantitative specification as a clear basis for border corrections. The inherently unstable price of carbon permits would make such corrections more problematic in cap-and-trade systems.

Overall, the administrative burden of the carbon deposit system and the transaction costs induced broader in society would be substantially lower for a deposit system than for an emission tax system, and very substantially lower than for a cap-and-trade system.

Comparing potential optimality

Optimality is based on comprehensive implementation of an equal market correction for any emissions, at long-term predictable levels. In the electricity chain, the emerging web of overlapping policy instruments already comprises a few dozen instruments, including several types of subsidies, tax reductions, feed-in tariffs, emission taxes and tradable permits, and many non-economic regulations. Most of these could be replaced by the carbon deposit system, improving both effectiveness and optimality. As compared to taxes and cap-and-trade systems, the superior optimality results from wider coverage, and as compared to cap-and-trade from the stable predictable price level. Optimality from a supranational point of view results from broad global applicability, both in an administrative sense, since many countries are unable to join a cap-and-trade system, and from a longer-term political perspective, as discussed below. Optimality is also based on a long-term stable expected carbon price, which is best safeguarded by an international agreement on long-term evolution of the carbon deposit level. Such stable expectations are difficult to realize in cap-and-trade systems, as there will always be substantial price fluctuations due to unstable global and regional economic developments. There will also be unpredictable and possibly substantial transfers of income between countries due to their uneven economic development, the fast growing ones, mainly developing countries, having to buy permits from the slower growing ones.

Overall, the deposit system could achieve the intended emission reductions at lower costs than either of the other systems.

Comparing political feasibility

Political feasibility is very much related to conditions for optimality, as equal treatment is a condition for acceptability to different stakeholders. The first issue is that the administrative capacity for cap-and-trade implementation seems lacking in developing countries, at least in China and India. Also, the more clientelistic types of governance in some developed

countries will lead to difficulties in implementing cap-and-trade systems, as their policy implementation is based on special treatment of interest groups. By contrast, all countries, including developing ones, have well-established traditions in implementing indirect taxes like charges and tariffs on products, which would be the only capacity required for implementing the deposit system.

Special treatment always remains possible of course, for instance through subsidies. The comprehensive and equal deposit system, however, has no connection to special interests, which would make the subsidies very visible. With sectoral application as in cap-and-trade, the boundaries are never fully clear, and political string-pulling remains an attractive option for special interests.

At an international level, the overall advantage of the carbon deposit system in terms of political feasibility would result from the low level of international political commitment required, and at a national level from the inherently equal nature of its application.

PROSPECTS

Although a balanced judgment of the deposit system is not fully possible at this stage of conceptual development, it seems that economic optimality would be better served by this system, in view of its more general and equal coverage and its stronger basis for border corrections. And in terms of administrative implementation, the deposit system has the advantages of being simpler and also being feasible for developing countries. All countries need tax proceeds, with emerging countries having to create a broader tax basis anyway, and several rich countries having to compensate their deficits. Finally, after the introduction of the deposit system has started with a substantial core group, countries could join on the well-founded expectation that almost all would join the same system, and that their future economic development would not be hampered in unforeseen ways.

The global feasibility of the system depends very much on the way the post-Kyoto debate develops. A situation in which all countries join the cap-and-trade system seems highly improbable. If there is a complete breakdown in the post-Kyoto process, an entirely new system will be needed, like the carbon deposit system. Reality, however, will be somewhere in between, making the question one of evolution. The carbon deposit system might, for example, function side-by-side with a bloc of countries with cap-and-trade installed, especially if permit prices and deposit levels are aligned. Or the cap-and-trade system might evolve in the direction of upstream measurement which, combined with a stabilized permit price, would turn it into something very similar to the deposit system. The deposit system could then supply conceptual guidance to such an evolutionary process. Such strategic considerations are, however, beyond the scope of this paper.

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