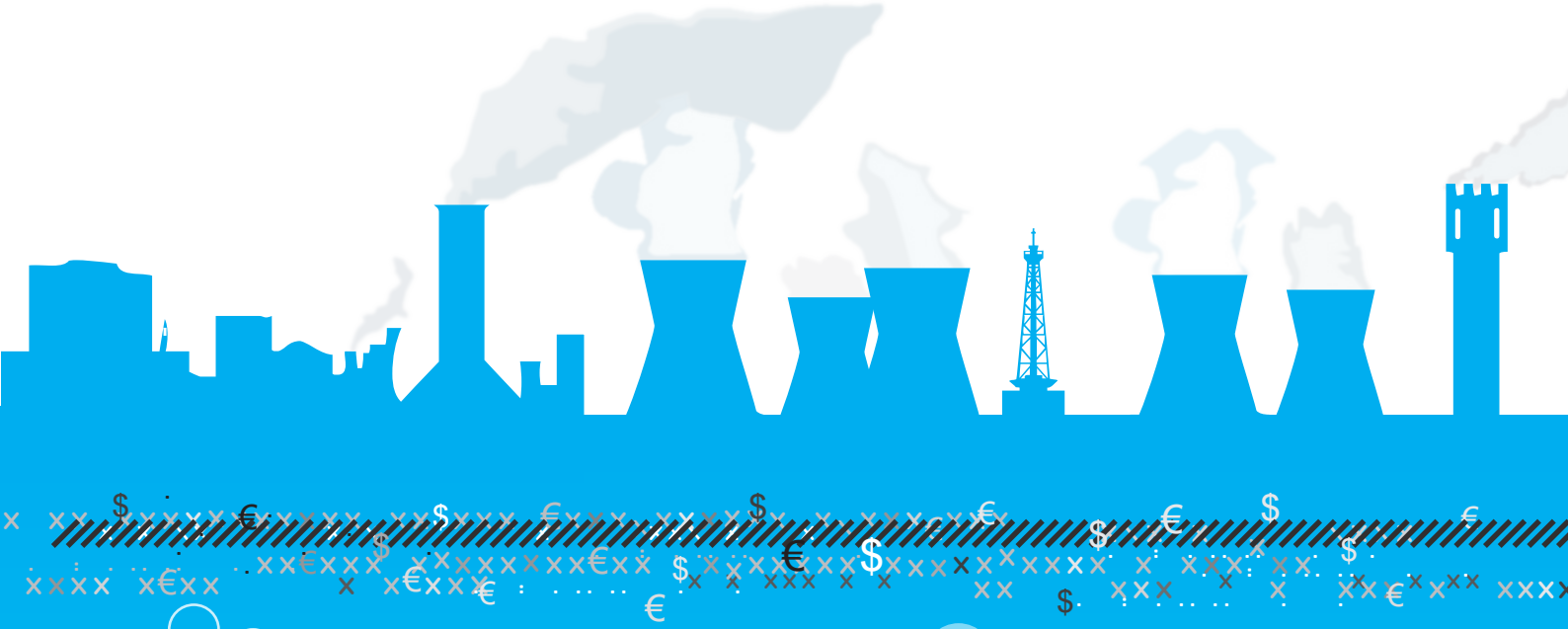


PAYING FOR A DECENT BURIAL

Funding options for an EU programme for full-scale demonstration of CO_2 capture and storage

BELLONA EUROPA

Acknowledgements

This paper was prepared as part of Bellona's work related to the EU Technology Platform on Zero Emission Fossil Fuel Power Plants (ZEP). Bellona would like to thank the Research Council of Norway and the Norwegian Ministry of Environment who have funded portions of Bellona's activity within ZEP.

It was written with valuable input from Aage Stangeland and Birgitte Laird. It was edited by Caroline Desvaux and Edwige Jamotte. Any errors or misrepresentations remain the author's responsibility.

Eivind Hoff
Director, Bellona Europa
eivind@bellona.org

Brussels, October 2008

Table of contents

Abbreviations

CCGT: Combined Cycle Gas Turbine

CDM: Clean Development Mechanism

EIB: European Investment Bank

EUAs: EU Emission Allowances

ETS: EU Emission Trading Scheme

GO: Guarantee of Origin

IGCC: Integrated Gasification Combined Cycle

JI: Joint Implementation

MW: Megawatt

RES: Renewable Energy Sources

RFCS: Research Fund for Coal and Steel

WACC: Weighted Average Cost of Capital

Executive summary

EU leaders have called for the building of 10-12 full-scale demonstration projects of CO_2 capture and storage (CCS) by 2015 – hereafter the Flagship Programme. At a CO_2 emission price of €35 per tonne, such a programme would cost approximately €13bn (net present value) in capital and operating expenditure if spread over 20 years. Annual costs would be approximately €1.3bn. There is at present no major financial benefit of CCS, which means that even cash-rich energy utilities will demand that the bulk of the costs of CCS be subsidised. The European Commission has thrown the ball over to the Member States to provide the funding. However, the UK is the only Member State that so far has committed itself to financing. As the first CCS projects are likely to be more complicated and expensive than subsequent projects, no one wants to be first.

This calls for at least a substantive share of EU-level funding for the projects. Such funding could trigger Member State and industry co-financing. A large number of funding options exist, falling into three main categories:

1) Those relying on carbon markets:
    - ETS auction revenues
    - Additional EUAs
    - Inclusion of CCS in CDM/JI
2) Direct public subsidies:
    - Member State aid
    - EU budget
3) Renewable energy-type of support measures:
    - Mandatory targets of CCS-generated electricity for Member States
    - Feed-in tariffs

While all funding options have benefits and disadvantages, Bellona believes that any options in categories 1 and 2 above could be designed to provide a complete Flagship Programme with maximum public value for money. Funding should be allocated based on competitive tendering and verified storage of CO_2. What is crucial is that a sufficiently large financing mechanism is put in place urgently. The only proposal on the table as of October 2008 that (1) can be adopted within the end of 2008/early 2009 and (2) can trigger investment decisions on a complete matrix of CCS plants, is to set aside EUAs in the 2013-2020 period, as supported by the European Parliament's Environment Committee on 7th October.

If the political situation were to change, e.g. if more Member States were confident about the advantages of being a first mover on CCS, other funding options would be more promising.

In any case, a variety of funding options in categories 1 and 2 is likely to be used for the Flagship Programme.

Introduction

EU leaders have committed themselves to stabilising global warming at no more than 2°C over pre-industrial levels (European Council, 2007). Energy scenarios which keep global warming within that limit are all based on large-scale deployment of CO_2 capture and storage (CCS) starting in 2015. As the cradle of the industrial revolution and the fossil economy, Europe has both a moral duty and the ability to play a leading role in establishing CCS as a tool to mitigate global warming.

CCS – a bridge to the renewable economy

CCS is an essential and pragmatic solution in a world that by 2050 will need to cut greenhouse gas emissions by 50-85 percent from current levels and yet, due to rising energy demand, will remain partly dependent on fossil fuels. The critical contribution of CCS has been identified by the Intergovernmental Panel on Climate Change (IPCC) for its potential to substantially reduce global greenhouse gas emissions (IPCC, 2005). The Bellona Foundation has published an article in the International Journal of Greenhouse Gas Control which estimates that CCS alone could reduce annual global CO_2 emissions in 2050 by 33 percent compared to emissions in 2007 (Stangeland, 2007). Even Nicholas Stern, known for his technology-neutral approach, has embraced the opportunities CCS represents (Stern, 2006).

Climbing out of poverty will require higher energy consumption in most of today's emerging economies, and their claim for more energy is certainly fair. Coal is the only readily available and abundant energy resource for many of these countries – including India and China. Developing countries have until recently contributed very little to greenhouse gas emissions, and introducing clean fossil energy production in developing countries should therefore be facilitated by developed countries. If world leaders seize the opportunities CCS represents, the technology has the unique advantage of allowing these countries to develop without adding to climate change.

Energy efficiency and renewable energy will be vital in curbing emissions. But the International Energy Agency (IEA) estimates that even if policies currently being considered to increase renewable energy generation and energy efficiency are implemented, there will still be a 20 percent increase in CO_2 emissions by 2030 (IEA, 2008). In other words, renewable energy and energy efficiency will not curb emissions quickly enough to prevent climate change. This makes CCS an essential bridge between today's energy system, which is mainly based on fossil fuels, and the long-term goal of relying solely on renewable energy.

Mandatory CCS

The Bellona Foundation welcomes the European Commission proposal of 23rd January 2008 for a directive to enable safe and environmentally sound geological storage of CO_2 (EC, 2008a). Such a clear and predictable legal framework is the very foundation for enabling CCS.

Staying below 2°C global warming will require fast global CCS deployment. One possibility for fast and wide deployment is to mandate CCS[0] (de facto through an emission ceiling for power generation, or de jure through a CCS obligation) for all new fossil fuel power plants in the EU. Soon thereafter, existing power plants should be retrofitted with CCS.

The bill for introducing CCS should be borne by the consumers, according to the polluter pays principle. However, economic modelling of the different ways of reaching the EU's 20 percent emission reduction (from 1990) and 20 percent renewable energy targets by 2020 shows that *mandating CCS will not result in any*

electricity price increase by 2030 (EC, 2008c) compared to other options for reaching the same targets. It should furthermore be noted that the EU has committed to a 30 percent emission reduction target provided that a global agreement is signed to succeed the first period of the Kyoto Protocol. Such an increase in the level of ambition will make mandatory CCS an even more cost-effective instrument.

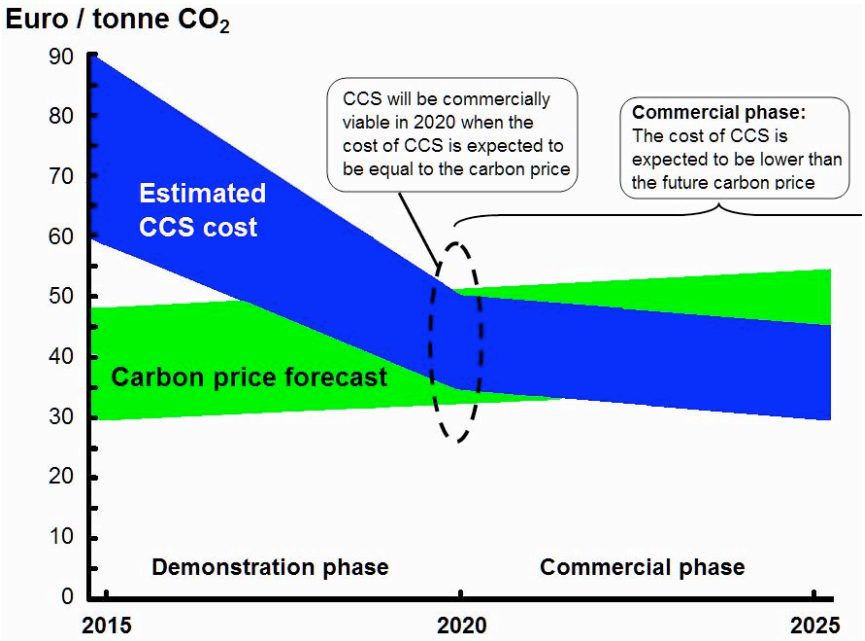
Incentives for demonstration needed

Technology for CCS already exists. However, commercial scale power plants with CCS have not been built yet, so we do not know exactly how costly it will be, or which technologies are most viable. That is why we need demonstration of CCS in full-scale power plants. EU leaders at their spring summit in 2007, which set the EU's climate targets, called for a mechanism to stimulate the construction and operation of up to twelve large scale demonstration projects by 2015 to test out different combinations of technologies, fuels and geographical locations for CCS.

CCS represents an additional cost for the power plant operator, both at the investment and the operations stage. Even if many companies want to position themselves as first movers on CCS, and despite the fact that CCS reduces the amount of EU emission allowances (EUAs) needed by utilities, there is currently limited financial incentive for constructing full-scale power plants with CCS.

The EU ETS carbon price is estimated to be €30-48 per tonne of CO_2 in the period 2012-2015 (McKinsey, 2008). There is no good prediction on the carbon price beyond 2015, but there is a strong belief that the carbon price will increase further until 2030. In the figure below, the carbon price is compared to the CCS cost as estimated by McKinsey (McKinsey, 2008). This figure shows how CCS could be commercially viable in 2020 as the CCS cost is believed to come down to the level of the CO_2 price. This figure also shows that there is a gap between CCS cost and CO_2 price in the demonstration phase. Mechanisms for financing this gap need to be established.

Figure 1 CCS cost and EUA price projections



The objective of this paper is to explore financial support mechanisms needed to get 12 full-scale CCS demonstration projects operational by 2015. The paper's scope is the role of the EU and its Member States in realising these demonstration projects (hereafter referred to as the "Flagship Programme").

The financial needs for the demonstration phase are explored in Section I, and financial mechanisms are identified in Section II. Finally, conclusions are given in Section III.

I. What is the financial need?

Financial instruments for the Flagship Programme are needed to cover two rather different needs.

i. First mover risks and costs

As noted above, CCS represents an additional cost for power plant owners, both to build the stacks, compressors, pipelines etc. at the investment stage, and increased fuel consumption as CCS reduces plant efficiency. The first demonstration projects are also likely to be the most risky and expensive CCS projects. This leads to a classic collective action problem, where no individual utility wants to be first. To overcome this barrier, governments need to provide the appropriate financial incentives.

ii. Market risk

While CCS in itself does not generate revenue, it does reduce the amount of EUAs needed by utilities, as their emissions decrease. The European Commission has proposed to leave the deployment of CCS to the ETS market forces (EC, 2008b). Even if the EUA price may not be sufficient to trigger CCS demonstration projects, it will compensate for parts of the costs. However, the EUA price volatility adds a risk to the cost of CCS. Utilities will either integrate a risk premium in their bids for building demonstration projects, or this risk could be transferred to financial institutions. As a significant part of the risk is related to EU decisions on the ETS, there could be a case for the European Investment Bank (EIB) to underwrite the risk and guarantee EUA prices for the demonstration projects. Indeed, the EIB has championed the first post-2012 climate fund, offering existing CDM/JI projects forward contracts up to 2022 (Swiss Re, 2008).

I.A. External factors

I.A.1. CO_2 price

When CO_2 emissions have a price tag, the net cost of CCS is reduced because the alternative to not capturing and storing CO_2 is to pay for emission allowances. In this paper, we use McKinsey (2008) estimates for the cost per tonne of CO_2 abated (i.e. non-emitted CO_2 compared to conventional coal power for a similar electrical output). If the cost of emitting a tonne of CO_2 increases by €1, this will therefore reduce the net cost estimate for abating a tonne of CO_2 through CCS by the same amount.

CO_2 prices for EU power generators are highly uncertain, not only due to price fluctuations of EUAs (October 2008 estimates are in the range of €30-79 in the period 2013-2020), but also because power generators in the EU are expected to effectively be confronted with two CO_2 prices – one for EUAs, and one for Kyoto Protocol-type flexibility mechanisms (CDM/JI). In the debate as of October 2008 on the revision of the ETS directive, the access of EU installations to CDM/JI credits is unclear, but is expected to be significant – in the range of 40 percent of the installation needs. CDM credits are trading in 2008 at €8-14 in the primary market, with 12-month forward delivery at around €17-18. CDM prices after 2012 (when the first CCS projects are planned to be operating) are very uncertain, as no international agreement has been reached for the post-2012 period.

In conclusion, the average cost of CO_2 emissions will be somewhere in the range between the EUA and the (successors to) CDM/JI price – which means huge uncertainty about CO_2 prices.

I.A.2. Commodity prices

Transportation by pipeline will require significant amounts of steel. The capture plant itself will not be too sensitive to the cost of materials, but more important is its operation which will be very energy intensive and thus its cost highly dependent on fuel prices. The plants will be fuelled by gas or coal; any increase in their price will be directly reflected in operational costs.

The recent (2008) McKinsey report on the economics of CCS discusses sensitivities i.e. of coal, steel and engineering prices and finds these to be limited. For each of these inputs, if the price remains stable at mid-2008 levels instead of returning to somewhat lower (20-30 percent) levels, their impact on total cost of CCS in 2020 will only be about €1 per tonne CO_2 abated (out of a total of about €50 at that time).

I.B. Internal factors to be considered

I.B.1. Content of Flagship Programme

There is a range of technologies and other options for the different elements of the CCS chain. It is important that all of these are tested in the Flagship Programme to validate all options for future CCS projects. Criteria for the portfolio of demonstrations projects should include:

- Fuel options: Coal, natural gas and biomass
- Capture technology: Pre-combustion, post-combustion and oxy-fuel
- Transport: Pipeline and shipping
- Storage: Onshore and offshore, including enhanced oil and gas recovery and various storage site geologies
- Applications: Both power generation and industry (e.g. steel, refinery or cement)

In the above-mentioned CCS options, there is a relative lack of studies on gas and biomass as well as industrial applications. While CCS for gas and biomass plants will be more expensive than equivalent coal plants, the picture is much more mixed for industrial applications. Some, for instance those with a greater CO_2 concentration in flue gases, may be cheaper than coal plants per tonne of abated CO_2.

I.B.2. Size of plants

Economies of scale entail a lower cost per tonne of CO_2 captured and stored the larger the plant is. McKinsey estimates that CCS coal demonstration projects of 200 MW would have a capture cost of €60-90 per tonne CO_2 abated, decreasing to €45 for a 600 MW plant. Capture cost is the dominant cost factor. Transport by pipeline and storage costs (€10-25 per tonne) have large fixed cost elements. The larger the amount of CO_2 handled, the lower the cost will be per tonne abated.

I.B.3. Economic lifetime of project

As explained above, public subsidies will be necessary to make the demonstration projects financially viable. The projects will be the first of their kind, which adds a lot of uncertainty. On this basis, McKinsey (2008) stipulates a financing period 20 years, which is less than half the lifetime of a commercial fossil fuel power plant.

I.B.4. Average cost of capital

The McKinsey reference scenario has used an 8 percent weighted average cost of capital (WACC), while others like Climate Change Capital (CCC, 2007) have chosen 10 percent given the risks of first-of-a-kind full-scale demonstration projects. In the McKinsey sensitivity analysis, the choice of WACC has the largest impact on the cost of CCS in 2020 – increasing the cost with from about €50 to about €59 per tonne CO_2 abated if the WACC is increased from 8 to 10 percent.

I.C. A cost-scenario for the Flagship Programme

We have chosen to use the latest publication on the topic, *Carbon Capture and Storage: Assessing the Economics* by McKinsey (2008) to estimate the net cost of the Flagship Programme. It builds upon a large amount of input from stakeholders and its conclusions are broadly comparable to earlier studies.

In its reference scenario for demonstration projects, these are defined as coal-fired power plants of 300 MW, with a 10 percent efficiency penalty, 80 percent utilisation rate, 8 percent WACC and a 100-200km transport distance with 80 percent of storage onshore and 20 offshore. The economic life of the project is 20 years. Based on these assumptions, abatement costs are estimated to be in the range €60-90 per tonne CO_2.

Assuming an average CO_2 emission price of €35 per tonne, McKinsey concludes that there is an 'economic gap' of €25-55 per tonne CO_2 abated. This corresponds to about €0.5-1.1bn expressed as net present value for each of these projects over a 20 year lifetime with a WACC of 8 percent. As gas and biomass CCS projects are expected to be more expensive, and as at least some plants should be made larger, our assumption will be that €1.1bn must be mobilised for each project. Multiplying this by 12, the entire Flagship Programme would require €13.2bn (net present value). This corresponds to annual payments of €1.3bn based on an 8 percent discount rate.

II Financing models for the Flagship Programme

II.A. The role for public support

II.A.1. Co-funding by industry

The impact assessment for the Commission Communication on Supporting Early Demonstration Fossil Fuel Power Plants (EC, 2008b) refers to a 50/50 split between industry and government. However, it is uncertain whether industry will co-fund any of this beyond the pilot projects in operation or under planning (Schwarze Pumpe, Maasvlaakte, etc.). The only full-scale CCS ventures agreed upon so far are Norwegian: For the Kårstø gas-fired power plant, a 100 percent State-owned company has taken on responsibility to equip the plant with CCS. At Mongstad, StatoilHydro has a 20 percent stake and the State 80 percent in the joint venture company responsible for equipping a combined heat and power gas power plant with CCS.

Clear and credible regulation setting out a timetable for making CCS de facto mandatory (e.g. through a California-style emission performance standard for power generation) will clearly be important to encourage industry to co-finance CCS. On October 7th 2008, the European Parliament's environment committee voted in favour of such an emission performance standard of 500 grams CO_2 per kilowatt-hour for plants above 300 MW capacity. It would be applied for new construction or operating permits granted from 2015, and a review clause. This would make CCS de facto mandatory for all fossil fuel power plants save CCGT gas plants.

II.A.2. Predictability of public policy interventions

Support should be conditional on delivery (i.e. verified safe CO_2 storage) – not investment. Otherwise, the industry will lose its incentive to achieve the target of maximal CO_2 storage. It means that upfront (before the investment decision is made), there should only be a guarantee to provide public financial support provided a number of requirements are fulfilled. The promised support itself should be annualised and provided when storage is verified and its safety proven. The support could extend to the whole life of the investor's loan (normally 20 years) – or possibly until CCS plants become cost competitive in the electricity market.

The costs of CCS will only be revealed once the demonstration projects are operating and safe CO_2 storage is proven. The level of support could be determined in advance (ex ante) or once the costs are known (ex post). Both options have their drawbacks.

If decided ex ante, the level of public support may be higher or lower than the real incremental costs. Industry will demand a risk premium for this in terms of public support that must exceed the central ex ante cost scenario. An ex ante determination of support levels should be accompanied by a competitive tender, as is being done in the UK for its full-scale post-combustion demonstration project for CCS. Criteria are needed to ensure that a complete matrix of criteria[1] of CCS options is tested. For the rest, public support should be committed to the most competitive bids.

If the level of public support is decided ex post, there is a need for the authorities to specify precisely what they want as a result. This will limit the ability of investors to

[1] Criteria will be defined by the European Technology Platform for Zero Emission Fossil Fuelled Power Plants (ZEP) in the Flagship Programme. The report is due to be published in November 20008.

identify the 'smartest' solutions on their own without incentives to limit costs. The risk, in other words, is to end up with suboptimal demonstration projects that do not test out the most promising CCS solutions.

The purpose of the Flagship Programme is primarily to discover the real costs and feasibility of various options for CCS. In such a situation, the downside of paying slightly more than incremental costs in public support is preferable to the risk of building a suboptimal set of demonstration projects. Of course, this does not mean that support measures for subsequent CCS plants need to be determined in the same manner, but that support levels for the Flagship Programme should be decided ex ante.

II.B. Financing options for the Flagship Programme

There are several options for funding the Flagship Programme. It should be stressed that none of the funding options are exclusive; a mixture of several of them is likely to be used.

Policy interventions are divided amongst:
1) Those relying on carbon markets:
   - ETS auction revenues
   - Additional EUAs
   - Inclusion of CCS in CDM/JI
2) Direct public subsidies:
   - Member State aid
   - EU budget
3) Renewable energy-type of support measures:
   - CCS quota obligations for Member States
   - Feed-in tariffs

II.B.1. Carbon markets

II.B.1.a. ETS auction revenues

On January 23rd 2008, the Commission proposed a revised directive on the EU emission trading system (ETS). Key provisions are a phase-in of auctioning of EU emission allowances (EUAs) through the third phase of the ETS (2013-2020) and the earmarking of 20 percent of these revenues for climate change measures (including both mitigation and adaptation). The pace of phasing in auctioning is not clearly set out in the Commission proposal, as it suggests conducting an assessment in 2010 of the need to give special treatment to energy intensive sectors exposed to international competition. It may be that the phase-in will thus be slowed down. On the other hand, additional sectors are expected to be added to the ETS, and this will increase the amount of EUAs to be auctioned. In addition to uncertainty about the number of allowances that will be auctioned, there is also considerable uncertainty about the price of EUAs. The current price of EUAs (for the second phase - 2008-2012) hovers around €25, while Deutsche Bank foresees a price of €40 for 2013-2020 and Société Générale predicts a price of €79 for 2020. Furthermore, the proposed earmarking of 20 percent of revenues to climate change measures has met with considerable scepticism from Member States, who want complete freedom to spend these revenues as they wish.

Table 1 and 2 show total revenues from auctioning in the third phase of the ETS provided the Commission proposal is not amended, no sectors are exempted and no additional sectors are included. This shows that auction revenues will be considerable – in the range of €300-500bn throughout the period. If 20 percent of revenues are earmarked for climate change measures, this will represent €66-106bn for the entire period. Even in the lower EUA price scenario, annual payments of €1.3bn for the Flagship Programme would not represent more than about 3 percent of annual auction revenues

Table 1 Projected ETS auction revenues (billion €) at €25 EUA price

(Based on phasing in of auctioning of EUAs as proposed by the Commission proposal for revision of the ETS directive.)

	2013	2014	2015	2016	2017	2018	2019	2020	Total
Auction revenue from power generation	45,0	44,2	43,4	42,6	41,8	41,0	40,2	39,4	**337,4**
Auction revenue from other industries	11,6	15,5	19,3	22,9	26,4	29,7	32,9	35,9	**194,1**
Total auction revenue	58,5	61,7	64,7	67,5	70,2	72,7	75,1	77,3	**547,6**
Earmarked for climate measures (20 percent)	11,7	12,3	12,9	13,5	14,0	14,5	15,0	15,5	**109,5**

Table 2 Projected ETS auction revenues (billion €) at €25 EUA price

(Based on phasing in of auctioning of EUAs as proposed by the Commission proposal for revision of the ETS directive.)

	2013	2014	2015	2016	2017	2018	2019	2020	Total
Auction revenue from power generation	28,1	27,6	27,1	26,6	26,1	25,6	25,1	24,6	**210,9**
Auction revenue from other industries	7,2	9,7	12,0	14,3	16,5	18,6	20,6	22,4	**121,3**
Total auction revenue	37,3	39,3	41,2	42,9	44,6	46,2	47,7	49,1	**348,3**
Earmarked for climate measures (20 percent)	7,5	7,9	8,2	8,6	8,9	9,2	9,5	9,8	**69,7**

Power plants are likely to be subject to 100 percent auctioning of EUAs from 2013. The Commission's impact assessment estimates that the entire set of legislative proposals of January 23rd 2008 (notably the proposed revisions to the ETS directive and a new directive to more than double the share of renewable energy in EU final energy consumption to 20 percent by 2020) will lead to a 23.0-25.8 percent increase

in electricity prices with an EUA and CDM/JI credit price of €30-35.[2] It is likely that power companies will exert considerable pressure to ensure that a sizeable share of earmarked auction revenues is recycled back to the power sector. Support for CCS would be an obvious candidate for climate change measures in the power sector.

The problem with this financing option is the possibility that the Commission proposal to make earmarking mandatory is not adopted. Also, there is no guarantee that Member States will spend funds on CCS as they may prefer more revenue-generating options. Finally, Member States are likely to give preference to domestic demonstration projects and not agree to fund demonstration projects outside the EU.

II.B.1.b. Rewarding projects with EUAs

It has been suggested to create incentives for the Flagship Programme by handing out EUAs for storage of CO_2. The Commission has chosen not to propose this option, as it is hardly justifiable from a strict technology-neutral point of view. Storing CO_2 will be rewarded by the reduced need to purchase emission allowances, which conventional fossil fuel power plants will need to do from 2013, according to the Commission's proposed revision of the ETS. People may ask, why not hand out free EUAs for the development of other promising technologies, for instance renewable energy?

The rationale for selecting CCS is that the Commission proposal for a renewable energy directive skews the playing field in favour of renewable energy. Were it not for the renewable energy directive, the Commission's own impact assessment indicates that CCS would be as widespread (as a result of the ETS) by 2030 as if it were made mandatory for fossil fuel power plants. A limited incentive for demonstration of CCS – a safe emission reductions technology – would thus simply compensate for some of that distortion in favour of renewable energy.

If coal-fired power plants are built after 2020 without CCS, there is virtually no chance of reducing greenhouse gas emissions by the 50-85 percent needed by 2050 (IPCC, 2007). There is thus a crucial public good aspect of demonstrating CCS. This is the background for the amendment to the ETS directive approved by the European Parliament's environment committee on October 7th 2008 to set aside 500 million EUAs for the Flagship Programme. With an EUA price of €20-30 this equals €10-15bn.

EUAs or other credits for storage from the demonstration projects could be in the shape of bankable certificates given to projects upon selection as part of the Flagship Programme. These certificates could then be traded as EUAs upon verified storage of CO_2.

The great advantage of creating incentives for demonstration projects through free EUAs is that this instrument can more easily be managed at the EU level. There is no need to increase the amount of credits in the ETS. Instead, the amount of EUAs to be auctioned can be reduced – in other words reduce auction revenues. The net effect will be similar to the recycling of auction revenues to CCS in the power sector, as explained in previous sections. The difference is that, realistically, the EU can more easily decide the allocation of EUAs (effectively a new 'currency') than it can force Member States to spend their EUA auction revenues (which treasuries will want to consider as other revenue streams).

---

[2] Brussels, 27.2.2008 SEC(2008) 85 VOL. II, COMMISSION STAFF WORKING DOCUMENT *ANNEX TO THE IMPACT ASSESSMENT accompanying the* Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020

The fact that the free allocation of EUAs could be decided at the EU level also makes it easier to include demonstration projects in China or other emerging economies in the Flagship Programme. They would receive EUAs upon storage of CO_2 and be able to redeem these in the EU ETS just like European demonstration projects.

II.B.1.c. CDM credits for CCS in non-Annex I countries

In the UNFCCC negotiations, it is being discussed whether and on what conditions CCS projects could be made eligible for Clean Development Mechanism (CDM) credits. Key Non-annex I countries are clearly opposed to this. If such eligibility for CCS were to be achieved under the CDM or any other similar post-2012 flexibility mechanism, the CDM price would play the same role as the ETS price as an incentive for CCS in non-Annex I countries.

In the absence of a global post-2012 climate agreement, it is, however, impossible to make any qualified guesses about the future CDM prices. Both supply and demand are wholly uncertain. In the first Kyoto commitment period (2008-2012), forward CDM prices are relatively flat around €17-18. While this price *may* increase after 2012, observers concur that it will remain significantly below the EUA price. In other words, CCS projects in China will be far more reliant on supplementary financing than similar projects in the EU.

II.B.2. Direct public subsidies

II.B.2.a. State aid

Member State subsidies – known as state aid – are strictly regulated by EU law in order to prevent competitive distortions in the internal market. Yet in its Communication on Supporting Early Demonstration of Sustainable Power Generation from Fossil Fuels (EC, 2008b), the Commission makes it clear that state aid to such demonstration projects will be considered favourably. But will state aid be sufficient to support the Flagship Programme?

State aid has traditionally been used to support mainly ailing industries (such as coal and mining) in order to preserve employment. Much has been done to reduce state aid and also to shift subsidies towards more forward-looking aims, such as the development of renewable energy. Still, substantial amounts of state aid continue to be paid out – even to some of the most egregiously polluting sectors such as coal mining, as can be seen from Table 3.

Table 3 Sectoral distribution of aid by Member State, 2006 (source: European Commission, DG Competition)

	State Aid Budget (Million €)								
	Manufacturing sectors[3]	Financial services	Other services	Agriculture	Fishe-ries	Coal	Other non-manufa-cturing sectors[4]	Transport excl. railways	Total
EU-25	**38,848**	**2,169**	**2,810**	**16,289**	**287**	**3,475**	**601**	**2,243**	**66,723**
Belgium	855		29	306				36	**1,225**
Czech Republic	553	1	30	164	3			5	**755**
Denmark	986		34	127	54			87	**1,289**
Germany	13,268		537	4,032	9	2,187	10	175	**20,219**
Estonia	8		3	43					**54**
Ireland	372		120	473	23			1	**988**
Greece	272	11	32	204	8		5	26	**556**
Spain	2,398		393	884	58	1,051	19	75	**4,879**
France	6,747		635	2,405	43			559	**10,389**
Italy	3,319		518	1,177	40		6	451	**5,511**
Cyprus	30		40	39				2	**111**
Latvia	25			194				73	**291**
Lithuania	45		9	74	1				**128**
Luxembourg	32		13	65					**110**
Hungary	772		16	474	1	45		99	**1,407**
Malta	85		3	22				4	**115**
Netherlands	1,208	2	59	430	19			147	**1,865**
Austria	448	750	102	739	3		251	18	**2,310**
Poland	1,073			1,074		154	3	6	**2,310**
Portugal	185	1218	15	15	16			2	**1,45**
Slovenia	120		11	107		15	1		**254**
Slovakia	191		3	24		4			**223**
Finland	555		31	1878	1		4	83	**2,552**
Sweden	2,761		115	436	5		13	184	**3,515**
United Kingdom	2,541	187	62	905	3	18	288	212	**4,215**

It is primarily state aid in the columns 'manufacturing sector', 'coal' and 'other non-manufacturing sectors' that is related to the power sector and CCS. It will therefore be these categories of state aid that can most easily be shifted towards CCS demonstration projects. Overall, support in these categories totals €43bn per year. If CCS demonstration projects were a political priority across the EU, state aid should thus be sufficient. The planned demonstration projects in UK and Norway will be financed by state aid, which is clear evidence that CCS in fact is a political priority.

The problem is that the situation varies considerably between the Member States. While a key country for CCS such as Germany hands out more than €2bn per year to the coal industry, which it could be argued quite easily should be directed towards CCS, Poland – another key country for CCS – pays out just above €1bn per year in

[3] *Incl. aid for* steel, shipbuilding, other manufacturing sectors, aid for general economic development and aid for horizontal objectives including research and development, SMEs, environment, energy saving, employment and training

[4] *Incl. aid for* mining and quarrying, oil and gas extraction, aid for electricity gas and water supply and aid for construction

non-agricultural state aid. It will be an uphill struggle to argue for sufficient funding for a full-scale CCS demonstration project from such a small state aid budget.

State aid is not likely to be a reliable source of funding for a coherent Flagship Programme. Just as in the case of EU ETS auction revenues, it will also be politically fraught to convince Member States to channel their limited funds to demonstration projects outside their own territory – both within the EU, let alone in China or India.

All this makes state aid at most a supplemental funding source.

II.B.2.b. EU budget support

The seven-year 'financial framework' determines the EU budget allocations. The current financial framework runs from 2007 to 2013. Under the EU's regional policy, which accounts for about 35 percent of its annual budget of about €120bn, demonstration projects could be supported in the EU's poorer Member States. Still, this would need to be reflected in recipient countries' national operating plans and cannot be decided centrally by the EU. Smaller amounts for research and development are also available for CCS, but these sums are minor compared to the needs of the Flagship Programme.

Consequently, sufficient EU support for 12 demonstration projects to be built by 2015 cannot be secured through a single EU budget reallocation. Instead, funds would need to be pulled together from a variety of available sources.

i. The Research Fund for Coal and Steel programme (RFCS)

When the European Coal and Steel Community Treaty expired in July 2002, €1.6bn was left in its treasury. These funds were used to set up the Research Fund for Coal and Steel programme (RFCS), which spends accrued interests (about €60mn per year) to support research projects in the areas of coal and steel. €60mn will not be sufficient to trigger demonstration projects, but given the RFCS priorities it could be argued that the fund should be liquidated in order to finance the Flagship Programme. Indeed, its priorities are those of three technology platforms on coal and steel – one of which is the Zero Emissions Fossil Fuel Power Plants European Technology Platform (ZEP).

ii. EU budget under-spending

Every year, overall EU spending is lower than the budget. The amount of the EU under-spending fluctuates, but is always substantial. In 2007 it amounted to €1.8bn, and the year before, €2.4bn. The largest single share of the EU budget is spent to fill the 'gap' between agricultural market prices and the prices the EU guarantees its farmers. Recent price hikes in agricultural commodities will thus lead to a significant increase in the under-spending in 2008. Most observers expect food prices to remain high, and so will likely the under-spending.

Unused funds will normally be carried into the general pot of the following year's budget and reduce Member States' contributions correspondingly. However, an interesting precedent was recently set for reallocating unused funds to a political priority – Galileo, the European satellite navigation system. Due to the impossibility of finding a concessionary to operate the system and take on parts of the costs, the public support needed increased from about €1bn to €3.4bn. Given the high political prestige of Galileo, it was agreed in November 2007 to fill the gap primarily by

unspent funds of the EU common agricultural policy, and that the financial framework 2007-2013 would be adapted accordingly.[5]

A similar argument could be made for demonstration projects. There is hopefully little doubt about the EU's political will to show global leadership on climate change or about the EU's commitment to CCS. If EU leaders are ready to put their money where their mouths are, a political agreement could be reached to set up a financing vehicle operated by a public financial institution (e.g. the European Investment Bank – EIB) to pay for the incremental costs of CCS demonstration projects. The political agreement would allocate a minimum share or amount of unused budget appropriations in the current financial framework to these financing vehicles. Apart from the political difficulty of securing such a financing option, its downsides are (1) that the Galileo precedent was extremely fraught politically, with the currently influential Ireland particularly negative, (2) that such a political agreement carries an element of unpredictability (a political deal can be undone) and (3) that under-spending fluctuates.

iii. Shift priorities in next financial framework (post-2013) towards CCS

In the next financial framework, covering the period 2014-2020, significantly larger funding for climate change measures, including CCS, can be expected. It is in this period that payments to operators will need to be made. Yet no investor will make a decision based on second-guessing the next financial framework, which may not be agreed upon until 2012 (the present framework was agreed upon in June 2005).

Investment decisions must be made by 2009 in order to have the demonstration projects operating by 2015. Thus, the major EU funding sources that may be politically feasible to mobilise for the Flagship Programme (i.e. that can be committed by the end of 2009) are limited to the capital of the RFCS mentioned above (€1.6bn) and a substantive share of unused funds in the 2008 budget (say €1-2bn). This sum, approximately €3bn, could make a substantial contribution to financing the Flagship Programme.

Similarly to the use of EUAs to support the Flagship Programme, direct subsidies decided at the EU level will enable the demonstration projects to be built. It will also make the inclusion of projects in emerging economies in the Flagship Programme more realistic.

II.B.3. Renewable energy-type of support measures

II.B.3.a. Mandatory CCS quotas for Member States

The EU has a long record of adopting directives that set out specific targets for Member States, without specifying the means. The Commission proposal of January 23rd 2008 for a directive on renewable energy sources (RES) is the most recent example. Its logic could be transposed to the Flagship Programme: An overall RES target for 2020 is set for the EU, and divided among the Member States by taking into account their GDP/capita.

In principle, economic operators will be free to trade guarantees of origin (GOs) for RES within the EU. Imported GOs will count against the Member State's target, and

[5] http://ec.europa.eu/dgs/energy_transport/galileo/whatsnew/index_en.htm
http://ec.europa.eu/dgs/energy_transport/galileo/documents/doc/com_2007_0535_en.pdf

exported GOs will be deducted. Member States are free to reach their target by means of their own choice.

Similarly, the power generation objective of the Flagship Programme – 10-12 power plants with a 300-800 MW capacity by 2015 – is equal to approximately 2 percent of EU electricity generation.[6] This objective could be shared across Member States taking into account GDP/capita. A majority of Member States would not have a single demonstration project by 2015. These would need to fulfil the target by purchasing "guarantees of origin" for CCS from Member States with demonstration projects.

This option is seemingly simple but has a number of drawbacks as long as the number of CCS-equipped plants is small:

1) Actors would have an interest in using those technologies that are cheapest today, as the CCS GOs would all have the same value. It is unclear how a co-ordinator could force a Member State to apply a specific CCS technology, in order to palliate this problem.
2) The market for CCS GOs would not be a liquid one as there would only be 12 plants to invest in. Yet investors must be certain there will be a buyer: This financing option would require Member States to collaborate on joint projects, whereby a utility in Member State A makes an investment decision on the basis of a utility in Member State B (or the Member State B directly) committing to purchase the CCS GOs. The price should then be set beforehand, in order to reduce risks for the investor.

II.B.3.b. Feed-in tariffs

Regulated tariffs for RES have become successful in a majority of Member States – known as 'feed-in tariffs'. They guarantee RES suppliers a certain price for the electricity they generate; reflecting (and often exceeding) what is necessary to make RES investments commercially viable. Tariffs are set at different levels for different RES, are guaranteed for a long time period (generally 10-20 years) with a certain reduction scheduled over time.

Feed-in tariffs exist in two main variants: In, for instance Germany, a guaranteed tariff is set. It effectively eliminates all uncertainty for the investor on the revenue side – except for the number of hours the wind blows or the sun shines, of course.

The other variant, exemplified e.g. by Spain, regulates only the level of the 'RES premium' that comes on top of market electricity rates. The difference of tariffs with conventional energy sources is thus guaranteed, while the effective tariff paid to suppliers will vary.

A similar system could be introduced for the Flagship Programme: Member States would guarantee investors in the selected CCS projects a certain tariff for their electricity. As for other feed-in tariffs, the cost would be carried on to electricity consumers.

There are several drawbacks with such a system: Firstly, it tends to over-compensate investors. It would be immensely challenging to set ex ante feed-in tariffs at the appropriate level for 'first-of-a-kind' power projects whose purpose is notably cost

---

[6] 600 MW x 8000 hours x 12 = 57.6 TWH. EU27 gross inland electricity generation in 2005: 3319 TWH (http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-PC-07-001/EN/KS-PC-07-001-EN.PDF)

discovery. Secondly, the cost of CCS demonstration would not be split on all Member States but fall on the consumers of those with CCS projects. Just as with state aid, this system depends on the political priorities of the individual Member States. At present, these will clearly not deliver a Flagship Programme.

II.B.4. Reducing political risks for investors

As noted above, the cost and revenue uncertainties for building and operating CCS demonstration projects are immense. On the cost side, no one has actually built and operated a full-scale CCS power plant, and on the revenue side there is no certainty about the future carbon market or future electricity prices.

In order to reduce the risk premium that investors will demand, risks can be taken on by a third party acting as a guarantor or insurer. Some of the risks can be appropriately underwritten by existing financial instruments, e.g. by futures contracts for the supply of commodities such as steel.

There could be a role for public financial institutions such as the European Investment Bank (EIB) for underwriting political risks that depend on EU and Member State decisions. This means that the EIB could underwrite political risks associated with most of the support measures described above. In particular, the EIB could guarantee future EUA prices by signing long-term forward purchase contracts of EUAs from the demonstration projects. If EUA prices are higher than guaranteed, the gains would fall to the EIB. Conversely, it would need to shoulder lower prices. This seems a politically opportune way to prevent windfall profits to the Flagship Programme.

Another political risk that could be insured by the EIB is the long-term stability of any public support measures of the EU or the Member States. Such stability is crucial if support is to be paid upon storage, given the long lifetime of power plants. As we have seen above, the EU will be unable – before investment decisions on the demonstration projects have to be made in 2009 – to make decisions that can guarantee sufficient funds for the duration of the projects. Ordinary state aid of Member States is also prone to changes in the course of power plants' lifetime.

In order to reduce this risk for investors, the EU or the Member States could enter into legally binding agreements with the EIB (or other financial institutions) about long-term financing of the Flagship Programme. The EIB could in turn issue guarantees to investors that stored CO_2 will be supported with a given amount per tonne for the entire period of down-payment of loans for a Flagship Project. Operators would also need to provide a financial security to the grant-awarding authority to ensure it is able to reimburse in the case of CO_2 leakage.

In practical terms, the EU would not be able to commit any funding for CCS beyond 2013, when the current EU long-term budget ends. Only the Member States would be able to make a longer-term funding commitment in a credible manner. Indeed this is the model that the seven countries behind the International Finance Facility for Immunisation (IFFIm) – six of whom are European – are using in order to leverage private capital (IFFIm issues bonds based on the commitments of the donor States) to be invested in immunisation efforts in developing countries.

The EIB or other public financial institutions can play an important role in eliminating both upside and downside risks associated with most of the potential public funding sources of the Flagship Programme, provided public authorities are ready to commit themselves to long-term financing. The only exception would be feed-in tariffs, which is inherently predictable.

III. Conclusion: The Flagship Programme and beyond

CCS represents a 'Catch 22' situation: Everybody agrees it will be an essential climate change mitigation option to curb greenhouse gas emissions quickly enough in a cost-efficient manner, yet it is too expensive in the short term. As a result, investments in the technology fall far short of the needs.

Providing funding or other incentives for a full-scale matrix of CCS demonstration projects is the first step to break out of the present deadlock. This paper has shown that a multitude of funding options exist. It has also shown that at least an element of EU funding is needed to trigger Member State and industry co-financing. All of the funding options have benefits and disadvantages, and a variety of funding mechanisms is likely to be used for the Flagship Programme. Bellona believes that most of the options could be designed to provide maximum public value for money. It is for instance preferable that they be allocated based on competitive tendering and verified storage of CO_2.

What is crucial at this point in time, however, is the speed with which a major financing mechanism can be put in place. The only proposal on the table as of October 2008 that (1) can be adopted within the end of 2008/early 2009 and (2) trigger investment decisions on a complete matrix of CCS projects is the set-aside of EUAs in the 2013-2020 period, as supported by the European Parliament's environment committee on October 7th.

In order to maximise co-financing by industry, it is important to look beyond the Flagship Programme. Companies will only want to invest their own assets if they are confident that there will be a large market for CCS in the future. The best way of doing so is to set out a regulatory roadmap for banning coal- and gas-fired power plants that are not equipped with CCS. As has been shown time and time again, regulation is the 'mother of inventions' (Taylor et al. 2005). This is effectively what California and Washington have understood by setting an emission performance standard - effectively a ceiling on how much CO_2 can be emitted per kilowatt-hour of electricity generated. This approach was endorsed by the European Parliament's environment committee on October 7th 2008. Such an emission performance standard should apply initially – and with immediate effect – to all new plants, with a clear timetable to retrofit (or close) existing plants.

Not only will this regulatory 'stick' that complements a public financial 'carrot' maximise industry co-funding of the Flagship Programme. It will also ensure that CCS projects are built beyond the demonstration projects of the Flagship Programme. As pointed out by McKinsey (2008), the real challenge for making CCS 'take off' is to get several tens of projects built so that costs are reduced through learning effects. If a hundred CCS projects are built by 2030, CCS could be commercially viable at a CO_2 price of €30-50 per tonne – which most observers believe to be a rather conservative prediction.

Despite the promising prospects for CCS, no major funding commitments for CCS have been made since the EU heads of state and government committed themselves to construction of the Flagship Programme by 2015. There will be no commitments from industry unless there are political leadership and effective measures adopted at the EU level. For every day full-scale demonstration of CCS is delayed, we make the challenge of meeting our climate change targets harder. The time to act is now.

References

- **CCC, 2007:** *ZEP: Analysis of funding options for CCS demonstration plants*, Climate Change Capital, November 2007.

- **EC, 2008a:** Proposal for a *Directive of the European Parliament and of the Council on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006*, European Commission COM(2008) 18 final, January 23rd 2008.

- **EC, 2008b:** *Supporting Early Demonstration of Sustainable Power Generation from Fossil Fuels,* European Commission COM(2008) 13 final, January 23rd 2008.

- **EC, 2008c:** *Impact assessment - accompanying document the Proposal for a directive of the European Parliament and of the European Council on The Geological Storage of Carbon Dioxide* (January 23rd 2008).

- **European Council, 2007:** Presidency Conclusions of the Brussels European Council (8/9 March 2007).

- **IPCC, 2005:** *Special report on carbon dioxide capture and storage,* Intergovernmental Panel on Climate Change, available on arch.rivm.nl/env/int/ipcc/pages_media/SRCCSfinal/IPCCSpecialReportonCarbondioxideCaptureandStorage.htm. Accessed 10 October 2008.

- **IEA, 2008:** *World Energy Outlook 2007,* International Energy Agency, 2008.

- **Stangeland, 2007:** *A model for the CO_2 capture potential,* International Journal of Greenhouse Gas Control, Vol 1 (2007) 418-429.

- **Stern, 2006:** Stern Review of the Economics of Climate Change, HM Treasury, 2006, available on http://www.hm-treasury.gov.uk/stern_review_climate_change.htm. Accessed on 10 October 2008.

- **Swiss Re, 2008;** *Swiss Re subsidiary Conning becomes fund manager of pioneering post 2012 Carbon Credit Fund*, press release, 28th April 2008. Available on www.swissre.com/pws/mediapercent20centre/news/newspercent20releasespercent202008/swisspercent20repercent20subsidiarypercent20conningpercent20becomespercent20fundpercent20managerpercent20ofpercent20pioneeringpercent20postpercent202012percent20carbonpercent20creditpercent20fund.html. Accessed 10 October 2008.

- **Taylor et al. (2005):** *Regulation as the Mother of Innovation: The Case of SO2 Control*.Margaret R. Taylor, Edward S. Rubin and David A. Hounshell. *in Law & Policy,* Vol. 27, No , p.348-378, April 2005. Available online at www.iecmonline.com/ESRubin/esrpercent20papers/2005epercent20Taylorpercent20etpercent20alpercent20LPpercent20Apr.pdf. Accessed 10 October 2008.

FROM POLLUTION TO SOLUTION : ABOUT THE BELLONA FOUNDATION

The Bellona Foundation is an international environmental NGO based in Norway. Founded in 1986 as a direct action protest group, Bellona has become a recognised technology and solutions-oriented organisation with offices in Oslo, Brussels, Washington DC, St. Petersburg and Murmansk. Altogether, some 60 engineers, ecologists, nuclear physicists, economists, lawyers, political scientists and journalists work at Bellona. Bellona endeavours to identify and implement sustainable solutions to the world's most pressing environmental problems. These include the fight against global warming, the environmental impact of the oil and gas industry in Europe and Russia, and the cleanup after the legacy of the Cold War in Russia. In all of its pursuits, Bellona understands that it is important to cooperate with scientific, business and political leaders to find more ecologically sound methods of operation. Bellona strongly believes that through such cooperation, new solutions to environmental problems can be found and implemented.

BELLONA HEADQUARTERS
Web site: www.bellona.org
or www.bellona.no
E-mail: info@bellona.no
Tel: +47 23 23 46 00
Mail: PB 2141 Grünerløkka, 0505 Oslo, Norway
Visiting address: Nordregate 2, Oslo

BELLONA MURMANSK
E-mail: russbell@polarcom.ru
Tel: +7 81 52 44 06 32
Mail: PB 4310, 183038 Murmansk, Russia
Visiting address: Lenin prospect 41, apt. 62

BELLONA ST. PETERSBURG
[The Environmental Rights Centre Bellona]
E-mail: bellona@ecopravo.info
Tel: +7 81 22 75 77 61
Mail: PB 15, 191015 St. Petersburg, Russia
Visiting address: Suvorovsky prospect 59

BELLONA USA
Mail: PB 42090, Washington DC 20014, USA

BELLONA EUROPA
E-mail: europe@bellona.org
Tel: +32 2 64 83122/ Mob.: +32 47 39 78760
Mail/visiting address: Rue du Trône 61,
1050 Brussels, Belgium

Bellona Europa aisbl
rue du Trône 61
1050 Brussels, Belgium

Tel: +32 (0) 2 648 31 22
Fax: +32 (0) 2 646 81 22

www.bellona.org

BELLONA
EUROPA