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Elements for an *Agreement on Climate and Energy Technology Development* (ACT!)

Some long-term elements in an applied protocol to meet the challenge of climate change. How to harvest the promises of new technologies to solve the climate problem

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Abstract: : Economists have, since the climate change problem appeared at the international scene some decades ago, focused very much on cost effective control policies, e.g. CO_2 taxes and emission trading schemes. After some years with experiences with these types of control policies, one can ask: Do they work as intended, or has reality conspired to expose practical weaknesses in a theoretically nice construct? We will argue that the latter is the case. A main concern is that the relatively short commitment periods used so far do not encourage long-term research and development. A good repair strategy is to complement cap-and-trade systems á la the Kyoto Protocol (or the EU Emission Trading System) with treaties giving direct public support to research, development and demonstration (RD&D) of the carbon-lean energy technologies that are needed in the longer term. This report seeks to contribute to the debate on the structure of a climate treaty based on support to technological development as a supplement to the Kyoto track now followed.

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1 Background and objectives: Why we need a technology-based treaty as a supplement to a cap-and-trade treaty

The urgency of formulating climate policies for the period after 2012 is highlighted by the fact that we probably already have exceeded the level at which we need to stabilize the greenhouse gas concentration in the atmosphere if we want to be reasonably sure that we can keep the increase in global mean temperature under 2 degrees Celsius in the future – the official goal of EU and Norway in climate policy.

Using standard (and probably conservative) assumptions about the climate sensitivity1, it is likely that we will have to reduce global emissions between 50 and 80 per cent compared to today's level by the middle of the century, with further reductions thereafter. Any fair burden sharing of, say, a conservative requirement of 50 per cent reduction then indicates that emission levels in the rich countries will have to be reduced by about 80 per cent, while the poor countries will have to reduce their emissions by 5 to 10 per cent2.

The requirement of around 80 per cent reduction in emissions from the rich part of the world sends a strong signal that the 2 degree target really implies a near zero emission vision of future societal development. In other words, we are going to try to eliminate all emissions of greenhouse gases that can reasonably be expected to be removed. This means that we will have to learn to produce steel, aluminium and all other basic materials without emissions of greenhouse gases. Furthermore, we will have to learn to transport ourselves, on land, on sea and in the air, without emissions. All power and heating requirements will have to be fulfilled without emissions. This clearly calls for new ways of doing things; that is, we must develop and implement new technologies. While market-based instruments like greenhouse gas taxes and cap-and-trade systems are efficient tools for securing the *implementation* of new technologies, they fall short when it comes to giving incentives for technology *research, development and demonstration (RD&D).*

We argue that an important part of the solution to this problem is to recognize that public funds will have to carry a substantial part of the research and development costs of new climate friendly technologies. This is because promises of future rewards to private investors in technology development and demonstration are not in themselves entirely convincing, in particular when governments more or less directly control the rewards. Thus, government support, in the form of direct subsidies to (RD&D) and other means such as setting standards and goals for the future, are necessary supplements to a cap-and-trade regime (Alfsen and Eskeland, 2007).

At the international level, coordination of such support can be attained through a technology (RD&D) treaty for a 'coalition of the willing', incorporating a long time horizon (perhaps 15-20 years). Financing and other measures included in the treaty should be verifiable, and a system with a central 'research council' might be preferable. Each party to the treaty should be assured to get a proportional share of the resources in the form of research contracts, testing facilities, etc., but the teams carrying out the research and development should be international in scope, securing access to knowledge and technology transfer between the parties to the treaty. The technology treaty should thus secure substantial long-term public funding for research, development and testing of key technologies in accordance with the preferences and comparative advantages of each participating country. Taken together, we

[1] Climate sensitivity is defined as how much the equilibrium temperature would change if greenhouse gas concentrations were allowed to double over pre-industrial levels. The standard (and likely conservative) estimate is 3 degrees Celsius.

[2] These numbers refer to equal per capita emission allowances, not taking future population growth into account. Other reasonable burden-sharing rules give similar numbers.

believe such a RD&D based treaty should have a fair chance of being self-enforcing and also be attractive to nations outside the core industrialised countries. This is because RD&D cooperation will attract participants interested in (a) energy security and climate benefits; (b) sharing in research contracts and technology cooperation, and (c) increased competitiveness and trade access.

We would like to underline that greater emphasis on RD&D efforts is in no way a substitute to supporting emission reductions through cap-and-trade or emission taxes. Rather, the two approaches are logically complementary and mutually supportive. A problem for a cap-and-trade system alone is to rally broad participation in emission limits (or high mitigation rewards). This is a problem that is addressed by an RD&D program through its promise to bring down future mitigation costs. Likewise, a problem for a stand-alone RD&D program is to stimulate the implementation of already existing climate friendly technologies, which is exactly what a cap-and-trade program can provide. Since this weakness of a stand-alone RD&D programs also jeopardizes its effectiveness in providing future technologies, the complementarities between RD&D and cap-and-trade are fundamental.

Ideas along these lines need to be explored in more detail, and more concrete examples and suggestions for a technology-based climate treaty should be developed. This policy note is meant to be a modest contribution in this direction.

The policy note is organised as follows. First we very briefly go through some aspects of the United Nations Framework Convention on Climate Change (UNFCCC) related to technology development and diffusion (section 2). In the following section (section 3), a number of technology-related international efforts are listed, before we go on to discuss in section 4 cases of international cooperation involving technology development outside the climate or energy area. Section 5 discusses ways to organize an international effort to develop climate friendly technologies, while section 6 outlines a possible technology treaty. We end in section 7 with suggestions for the way forward in this important work.

Box 1: Non-global participation in mitigation weakens the case for cost effectiveness

When economists study cooperation in providing a public good (like emission reductions), the challenge is to prevent 'free-riding'. In the case of greenhouse gas emission reductions – the supply of a global public good – free-riding means letting others undertake the emission reductions.

Economists often propose studying cooperation through 'repeated games', in which free-riding is prevented because future gains from cooperation are more tempting to a player than are the immediate gains from not cooperating. If the discount rate is low so that the future matters a lot, high levels of cooperation can be attained. The theory is often difficult to apply in practice, however. Most importantly, the theory presumes that cooperation is sustained by threats. But a threat that free-riding will be met by non-cooperation forever may not be credible.

For greenhouse gas emission reductions, there have been strategies announced which use, to some extent, the insights from repeated games. First, the US position, adopted in the Senate before the Kyoto negotiations, was 'we'll not reduce emissions unless other big countries do', with a clear address to India and China. Second, Europe has recently said 'by 2020, we'll reduce emissions by 20%, or by 30% if others contribute', with clear address to the United States.

It is not, however, clear that these US and EU strategies reflect the true nature of the 'games nations play'. These perspectives do not, for instance, give any support for an idea of 'leadership' in which an agent contributes to a public good without conditions, hoping that others will follow. Could the theory miss something important? Sweden is a country that has decided to unilaterally reduce emissions by more than its international obligations. The country has also decided to undertake all these reductions 'at home', against the advice of many economists. Economists would prescribe emission reductions to be bought abroad if they are cheaper. But the economists have no perspective on leadership in the logic behind this advice. Could it be that leadership is not a flawed idea, but that it requires 'action at home'?

There are some simple ways in which 'taking a lead' can cause others to follow (Alfsen and Eskeland, 2007). Perhaps tellingly, these ways do question whether the cost effectiveness criterion – through emission trading – should be given prominence. First, if a country invests in climate friendly technology development, it makes emission reductions cheaper for others. This kind of leadership can thus generate followers, without relying on the threats in repeated games. Second, if a rich country reduces its own emissions with surprising effectiveness, it can generate followers by example. Third, social norms may support following suit when some provide public goods voluntarily.

In a world of non-global participation in mitigation treaties, the question of how 'a coalition of the willing' can generate 'followers' and expand is different from how 'leaders' can cut cost effectively. Cost effectiveness in what is done by the coalition is likely important, but technological development and leadership by example and illustration will likely be important, too. Thus, as compared to a world with global participation, and as compared to a world with no learning, the cost effectiveness criterion is weakened.

Box 2: Is cooperation on technology easier to sustain?

An important argument behind technology efforts is that a climate regime in terms of 'cap and trade' will fail to provide sufficient incentives for long-term investments in future emission reductions. The lack of incentives are related to the fact that (i) expected prices (for emission free cars, for instance), not actual prices, motivate investors; and (ii) expected sales worldwide – of emission free cars – represent the global benefits of innovation, whereas the investor may expect failing interests from some countries.

A part of the 'lacking incentives' can be envisaged as follows. Say Sweden, or a Swedish company, invests in emission-free cars. Other countries that do not invest in the technology could get those cars cheaply when the Swedes have succeeded, by failing to provide a tough regime for emissions from cars domestically. A country with a weak regime on emissions from cars would give Swedish cars a price high enough to sell in that country, but a margin too thin to reward Swedish investors for their investments.

One way for Sweden or Swedish investors to avoid this risk would be to invest with others in a way that locks both to the same faith. As when nations invest together in military technology ('I do the wings, you do the wheels'), a nation cannot gain from backing out without harming itself. Thus, the technique solves a problem of dependence and thus vulnerability by creating co-dependence. It is a way of addressing a 'hold-up problem' (Hart and More). Montgomery and Smith (2004) pointed out that technology investments to solve the climate problem may be vulnerable to the hold-up problem, implying that expected emission prices will be low, and so will be technology investments.

At a greater scale too, and in other ways, nations can through coordination make technology investments attractive at higher levels (and at longer time perspectives). One way is by matching investments not in one technology but in terms of policy that includes a trade perspective. What, for instance, if the European countries agree with the United States that the Europe develops emission-free electric power plant technology and the United States develops emission-free cars. This would give investing countries on both sides of the Atlantic some assurance. The noncooperative act that Europeans could fear from the United States would be US policies that are tougher on car emissions than on power plant emissions. Thereby, US government would keep its 'promises' to US investors but fail to honour promises to European ones. The matching investments would make such opportunistic government behaviour less attractive to the United States because then its cars would face similar unfavourable policies and low profits in Europe. Because of this co-dependence, each party can invest more and with greater confidence.

Finally, take the concern that developing countries would have that development of new technology in rich countries will raise barriers for their industrial success. And consider the concern that US investors in car technology would be given slim profits, if any at all, in emerging economies' climate policies. If a large emerging economy is part of the power plant technology investment consortium, so that its workers learn and its turbine factories grow, confidence on both sides will be stronger, and r&d investments can be higher and more successful.

2 Climate technologies and the UNFCCC

Technology issues directly related to climate change are found in several Articles of the UN Framework Convention on Climate Change (UNFCCC). Most of them address transfer of technology, but development of technology is also included, for instance in Article 4.1(c): [All Parties, …, shall:] "Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and process that control, reduce or prevent anthropogenic emissions of greenhouse gases…"

Transfer of technology is mentioned in several Articles, with Article 4.5 as perhaps the most important: "The developed country Parties … shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention."

Technology development has been very little discussed under the UNFCCC. Transfer of technology has, however, been a contentious issue in the climate change negotiation process, where developing countries claim that the developed countries have not implemented their commitments in the Convention in this area. Without taking a stand on what is right or wrong, there is clearly a large gap between developing countries' expectations and what developed countries have delivered.

In order to advance and facilitate the implementation of Article 4.5, an Expert Group on Technology Transfer (EGTT), with a total of 19 members, was established in 2001. Important work has been undertaken, for instance by facilitating development of technology needs assessments by developing countries. During the last years, discussions about Intellectual Property Rights (IPRs) and a proposal to develop a fund to buy IPRs have been in focus, as have also proposals to give EGTT a higher "status". At COP 13 in Bali, it was decided that EGTT should continue its work, with particular regard to the need for adequate and timely support and development of performance indicators for monitoring and evaluating indicators for technology transfer. An increased awareness among developed countries about the importance of transfer of technology may help to advance the work, but due to the very high expectations in this area, one may expect difficult work ahead.

3 Ongoing initiatives for development of climate friendly technology

Various international cooperative initiatives related to development and deployment of climate friendly technologies exist, and could possibly form a basis for a strengthened technology component in or connected to a future climate change regime. Some of the existing cooperative arrangements are briefly described below.

3.1 IEA Technology Collaboration

To support work on its core issues, the International Energy Agency (IEA) has created a legal contract (Implementing Agreement) and a system of standard rules and regulations that allow interested member and non-member governments to pool resources for collaboration on research, development and deployment of particular technologies (www.iea.org). The collaboration must fit into the IEA shared goals: energy security, environmental protection, and economic growth. In 2007, there were 41 collaborative projects working, with several thousand participants from 72 countries, organisations and companies. Several of the Implementing Agreements are of direct relevance to climate change mitigation. Examples are Advanced Fuel Cells, Climate Technology Initiative (CTI), Efficient Electrical End-use Equipment, Greenhouse Gas RD Programme, Renewable Energy Technology Development, Photovoltaic Power Systems, and Wind Energy Systems.

The collaboration can be financed on a cost-shared or task-shared basis, as long as the signatories agree and follow the guidelines as set out in the Implementing Agreement. Some use common funds to cover the costs of central administration; others rely entirely on task-sharing to reduce administrative costs.

The IEA Secretariat provides legal advice and support to the technology collaboration and report on activities through its various publications. Every five years, the IEA Committee on Energy Research and Technology reviews the effectiveness, achievements and strategy of each Implementing Agreement.

3.2 CSLF – Carbon Sequestration Leadership Forum

The CSLF is an international climate change initiative focused on development of cost-effective technologies for the separation and capture of CO2 for its transport and safe storage, and to make such technologies broadly available (www.cslforum.org). CSLF was initiated by the United States, and the CSLF charter was signed in 2005. Membership is open to national governmental entities, and it has 22 members. Both developed and developing countries participate in the partnership. The charter will stay in effect for 10 years.

A Policy Group, with representatives of all members, govern the overall framework and policies of the CSLF. Decisions are taken by consensus. A Technical Group, reporting to the Policy Group, review the progress of collaborative projects. Secretariat services are provided by the US Department of Energy, which may also use services of personnel employed by members.

The basic funding rule is that any costs arising from CSLF activities will be borne by the Member that incurs them.

Another US led partnership of relevance to climate change is the Methane to Markets Partnership (www.methanetomarkets.org). This has so far focused more on deployment of existing technologies than on development of new technologies.

3.3 Asia-Pacific Partnership on Clean Development & Climate – APP

Australia, Canada, China, India, Japan, Korea, and the United States participate in this partnership, initiated by the United States in 2005 (www.asiapacificpartnership.org). Its objective is to address energy needs and associated issues of air pollution, energy security, and climate change. The intention is inter alia to accelerate development and deployment of cleaner and more effective technologies.

A Policy and Implementation Committee (PIC) has been established to oversee APP as a whole and guide eight Task Forces that deal with issues identified in eight sectoral areas: Aluminium, buildings, cement, cleaner fossil energy, coal mining, power generation and transmission, renewable energy and distributed generation, and steel. An Administrative Support Group, currently hosted by the United States, provides support to the PIC and undertakes other secretariat functions.

3.4 The World Bank Funds

The World Bank is working on the establishment of a Clean Technology Trust Fund as one of a portfolio of strategic Climate Investment Trust Funds. This is an initiative to govern and coordinate significant pledges from Japan, the United Kingdom and the United States on climate change. The idea is to have separate funds to address forest/deforestation issues and adaptation, in addition to technology.

The objective of the Clean Technology Trust Fund is to provide scaled-up financing to assist developing countries transforming to low carbon economies. The Fund would provide concessional financing to facilitate deployment of low carbon technologies. It is not yet decided to what extent this fund will focus on proven technologies only, or whether "unproven" technologies will also be covered.

3.5 EU research programmes

The EU undertakes significant research programmes, which are open for participation also for organisations and researchers based outside Europe. The Research programme includes several activities that are focused on technologies for reducing greenhouse gas emissions. This includes carbon capture and storage, various projects on renewable energy, hydrogen and fuel cells, and technologies for improved energy efficiency.

4 Other global challenges

4.1 Food security - CGIAR

The world has been confronted with other global challenges before, for instance in relation to population growth and food security in the 1970´s. The international response at that time was creation of CGIAR – The Consultative Group on International Agricultural Research, established in 1971. This way of reacting may provide a model or useful elements for the climate change challenge. The following description is taken from their web-page (http://www.cgiar.org).

CGIAR is a strategic partnership open to all countries and organizations that share a commitment to achieving sustainable agricultural development and are willing to invest financial, human and technical resources toward this end. Its 64 Members support, through member fees and sometimes more restricted contributions, 15 international Centres, working in collaboration with many hundreds of government and civil society organizations as well as private businesses around the world. CGIAR Members include 21 developing and 26 industrialized countries, four co-sponsors as well as 13 other international organizations. Today, more than 8,000 CGIAR scientists and staff are active in over 100 countries throughout the world. CGIAR expenditures amounted to US$506 million in 2007.

The CGIAR generates cutting-edge science to foster sustainable agricultural growth that benefits the poor through stronger food security, better human nutrition and health, higher incomes and improved management of natural resources. The new crop varieties, knowledge and other products resulting from the CGIAR's collaborative research are made widely available to individuals and organizations working for sustainable agricultural development throughout the world.

In addition, the CGIAR implements several innovative "Challenge Program" designed to confront global or regional issues of vital importance. Implemented through broad-based research partnerships, Challenge Programs mobilize knowledge, technology and resources to solve those and other problems such as micronutrient deficiencies, water scarcity, and climate change.

The primary institutions in the System are:

- the Consultative Group on International Agricultural Research (CGIAR/the Group);
- an independent Science Council; and
- fifteen international agricultural research Centres.

The three components of the CGIAR System are interdependent. They are supported by the Executive Council (ExCo) of the System, a broad range of partners, various standing committees, and the System Office, a "virtual" combination of service units.

The "Charter of the CGIAR System" sets down the roles, responsibilities and functions of the main organs of the CGIAR, including eligibility for Membership in the Group and conditions of Membership. The Annex to the Charter contains the Rules of Procedure of the main organs, which includes rules on the need for consensus to reach decisions.

4.2 Vaccines

Another global challenge is the development of medicines, and vaccines in particular, for the poor part of the world where the need is high, but ability to pay for development and production of the pharmaceuticals low. This situation is similar to the one involving use of climate friendly technologies in the poor countries. In case of the pharmaceuticals, an option that has been tried is for the governments of the rich world to commit to buying a certain amount of e.g. malaria vaccines at a given price, thus securing an incentive for private development of such vaccines.

While it is possible to view the 'vaccines' efforts and other pharmaceutical development efforts as gifts to the poor world, it is also possible to view them simply as public goods, or the diseases as 'public bads'. (See Barrett, 2007, for instance, on public goods that are 'weakest link' problems, etc.). If it is the case, for instance, that disease prevention is most critically dependent on the 'weakest link', then all countries would in self-interest spend resources to support preventive efforts in the country which is the weakest link.

4.3 Nuclear power, gas turbines and weapons

In other cases the technology developments have been driven mainly by military needs. Besides basic weapons research, examples are gas turbines (used in the development of jet fighters) and nuclear power. Here, the governments have usually been the controlling agent from inception to finalisation of the products. International cooperation occurs among allies. The usual mode of operation has been to subcontract components of the final system, whether a weapon system or a reactor of fusion or fission type. This creates mutual dependency among the participating parties, encouraging a self-enforcing type of cooperation.

4.4 Summarizing the examples

The three examples given above (agriculture, pharmaceuticals or nuclear power/weapons) have some interesting features distinguishing them from each other.

In the case of CGIAR the actual research, development and demonstration is distributed among public research centres in both rich and poor countries with a common service centre and a common science committee providing services and guidance to the individual centres. Intellectual property rights to discoveries and technologies developed seems to reside in the individual centres (details may be worth pursuing).

When government seeks to give incentives to pharmaceutical development by promising to buy the final products at fixed prices, the actual development will take place in different entities, including private firms, presumably mainly in the rich part of the world. The guaranteed amount is paid for by the rich countries. The product will then be sold at a lower price in the developing world. A way to look at this is that it represents a gift from the rich to the poor world. Another way is that one relieves a costly constraint when allowing the fixed costs of discovery (a public good, in fact) to be financed in ways other than by charging users on a per unit basis. In this perspective, it is a two-part tariff, and it is a form of price discrimination that is economically efficient[3]. This other view is supported, of course, by the

[3] In textbook economic terms, the following constraints are costly – efficiency wise – under economies of scale (as with discovery): (i) only per unit charges provide resources to producers; (ii) per unit charges are constant and uniform across users or markets. Removal of the first is often seen in industries with scale economy – like roads and utilities – when these get a subsidy from the state. The latter is also seen in those contexts, but also in other contexts when the market allows price discrimination. In the case of pharmaceuticals (and some other markets), price discrimination by country of sale is facilitated by preventing resale, by trade restrictions, etc. For personalized items such as air tickets, school admissions and hotel rooms, price discrimination is standard fare, even in unregulated markets, without government facilitation.

quite general observation that many countries use public resources to fund (or subsidize) medical research.

The last type of model, regarding weapons and nuclear power, represents mainly cooperation among rich countries and for rich countries. Both in weapons development and in other defence cooperation (alliances, for instance), modes of cooperation have features of interest. One special feature is that in defence, the cooperative gains may be such as to attain the desired results (peace, freedom) at lower overall levels of spending. For climate technology, while there may exist such gains to *cooperation itself* (like from sharing of results), the more important gains likely arise from raising overall investment levels (I'll spend more if you spend more). Another is that in defence cooperation, like in CGIAR, individual countries do what they can do best. In agriculture, rice research is in Manila, potatoes in Peru. In NATO, Norway plays an important role in the North East Atlantic, while wealthy countries like UK and the United States can move forces to any corner of the alliance's sphere. Cooperation, then, basically credits and supports each type of effort, making it more meaningful on its own, and making sure the outputs are shared. A third is that – due to the 'distributed efforts' in defence cooperation – energy must be put into assuring that that no-one pulls out, shirks, or refuses to share when an effort is successful or necessary. Joint development (you do the wings, I do the wheels) is one such mechanism. Barter trade (you'll buy my bombers, equipped with your missiles) is another.

The summary can be illustrated as in the table below.

	Where is R & D taking place?	**Where are resources coming from?**	**Where is the technology implemented?**
CGIAR	Rich + poor	Rich	Rich + poor
Pharma	Rich (private)	Rich	Poor
Weapons/Nuclear	Rich (government + private)	Rich	Rich

What type of approach would work best in the case of developing climate friendly technologies? Given that an important consideration is how to allow developing countries to grow without increasing their greenhouse gas emissions, implementation must certainly be as broad as possible[4]. There are also strong arguments related to development needs for establishing a fair part of the needed technology centres in the developing world. Thus, CGIAR model seems to lend important features to a climate technology agreement.

On the other hand, quite possibly, for rice research, the case for placing it in the Philippines, basically adding rich country funding for researchers, and a global network, likely is stronger than it is for, say – solar technology or low-carbon cars. For the latter, it may be more essential to work closely with modern manufacturing enterprises, perhaps also in places such as the San Francisco Bay area, the Boston Cambridge area, Stuttgart, Toyota or Detroit.

Quite likely, for development of future energy- and climate friendly technology, several arguments are valid for specific and close 'North-South' partnerships, for instance linking Detroit and MIT's Boston-Cambridge with Sao Paulo. We may call them EE partnerships, for Emerging and Established. On the 'industrial side' a 'Northern' (or established) centre of builders and academics that are working well together is obvious. Equally obvious are

[4] Stern (2008) emphasizes as a prerequisite for global participation (in emission ceilings) 'proof that low-carbon development is feasible.

arguments from the funding side and in incentives: an established industrialized country is more willing to invest in new technology if it is channelled through and boosts returns to its present manufacturing and human capital. The industrial side arguments for closely integrating 'Southern' (or emerging) centres are equally strong: future manufacturing capacity, future car sales, and so on will be growing faster in emerging economies than in established ones. Incentives for such links are also strong both in the established and in the emerging economies. Economic and financial returns will be higher to all if products can be sold in both places, and joint investments will represent commitments to the policies allowing such markets to develop.

There are also deeper and more indirect reasons to build new research initiatives (which could be centres, or twin centres, in a physical sense) through integrated efforts involving both established and emerging economies. From the point of view of emerging economies (which on their own may have little interest and resources (financial and knowledge) for individual RD&D efforts, an effort including only by the established economies can easily appear non-inclusive. It will therefore risk not earning global support. RD&D invested with and in emerging centres of academics and manufacturers will represent a credible commitment to ensure inclusiveness and 'Southern' access to the gains.

5 How to organise an international effort

An agreement on development of climate friendly technologies should fulfil certain criteria, such as

- being open to all countries;
- having a long term perspective;
- being connected to the UNFCCC; and
- taking into account the special circumstances of developing countries.

None of the ongoing activities discussed above fulfil all these criteria, although the possible new World Bank funds may be an opportunity that could be used. However, there would be many advantages in establishing a separate agreement, but at the same time avoid duplication and seek cooperation with ongoing activities. Work under the UNFCCC, for instance as expressed through the "Dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention" (FCCC/CP/2007/4), clearly calls for increased efforts related to deployment and development of technology. That is an indication that existing initiatives are not considered sufficient, and that strengthened efforts are needed.

An improved framework for strengthened international cooperation on developing climate friendly technology should in principle be open for broad participation from all countries that are interested in contributing. Requirements for input from participants to the cooperation should take this into account. Furthermore, it should address a broad range of technologies, but subject to priorities based on e.g. resources available.

Strengthened international cooperation on technology development and demonstration will have to be based on some sort of a binding agreement: a protocol or a charter. A very relevant option might be to develop a framework or "umbrella" agreement that specifies the general obligations of the members, and to supplement the framework agreement with additional agreements with different subsets of members for specific projects and/or technologies, see Figure 1. Examples of such additional agreements may be carbon capture and storage (CCS), renewable energies (which may even be split further in one agreement on wind, one on solar, etc.), and energy-efficient appliances. A system with a framework agreement and multiple specific agreements would have some similarity to IEA's use of Implementing Agreements. It would also have similarities with defence cooperation in an alliance, where separate sub-agreements are formed for purposes such as developing a new weapons system, intervening in a given area/situation, joint exercises, education, etc.

It may be realistic to assume that the best way to initiate work would be to start with one agreement with a limited number of participants, e.g. the Nordic countries in an initial phase. This agreement might take one or two shapes. One possibility is that this agreement is meant to be one of the future 'sub-agreements', supported by a global supra-treaty on RD&D. The supra-treaty might very well start as a general formulation in Copenhagen in support of RD&D collaboration. In this case, the Nordic agreement starts work on a favoured field (low-energy buildings, say), while calling for a supra-treaty under which it would like to fit. Another possibility is that the Nordic agreement is intended to morph – via enlarged participation – into the global supra-treaty. Then, in formulating the agreement one should take into account that it may later be desirable to add on separate agreements for specific projects.

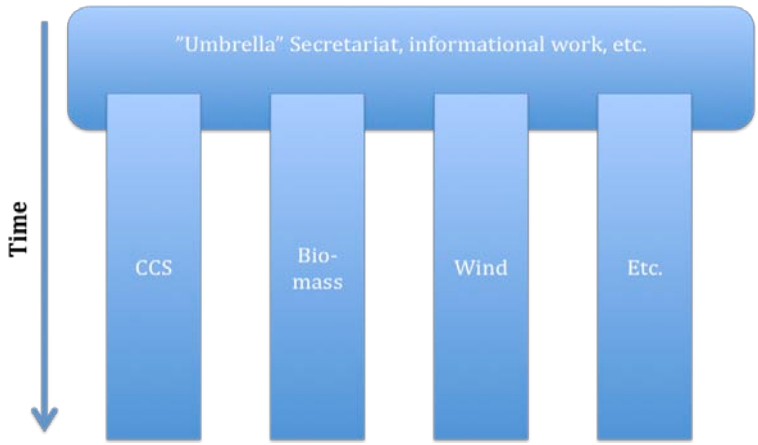

Figure 1. Possible structure of the development of a technology based treaty.

A very simplified illustration of how the cooperation might function is that resources flow into the agreement from member countries, and the resources are then redistributed to agreed projects which are open for research proposals from organisations, companies, consortia and individuals in the member countries. This would be equivalent to how a research council normally functions.

Alternatively, one might base the cooperation on task-sharing, where member countries come with national projects and seek cooperation with similar or complementary projects in other countries. This would have the advantage that members are certain that they will be directly involved in projects, and do not run the risk of providing money to the international effort without getting an equivalent amount back as funding to their national research entities. To many, this mode of operation may also serve as assurance against bureaucracy and unpleasant aspects of politics.

To what extent members should be guaranteed project funding or the organisation should distribute the money to the best qualified is likely to be a sensitive issue. First priority for rewarding project applications should be quality. But at the same time it is important to bear in mind political realities: It is likely to be more difficult for a government to agree to significant funding without a reassurance of a return. One may therefore have to include for instance a clause saying that over a given time period (10-15 years?) a member country may expect to get project funding equivalent to x % of their input, where x might be 50 for an industrialized country.

An advantage of the cost-sharing model is that it would be more effective in getting the best-qualified project participants and thereby achieving good results. It may also provide better opportunities for participants from developing countries to get engaged in and obtaining funding for specific projects.

The organization will in both cases need a competent body that can define, prioritise, and select areas for research and development. For the cost-sharing model the organisation would need a "machinery" to evaluate applications and develop recommendations for funding. Most likely, the agreement will allow for both forms. A jointly funded research organization could pursue priority projects with a global perspective. The agreement that establishes it also provides for agreements in which countries (and companies?) cooperate more directly. Such cooperative agreements – say between the Nordic countries on efficient buildings – would need to satisfy certain requirements to be 'credited' in the global agreement. These requirements would probably be Southern participation, as well as more general provisions for sharing and access and suitability. A sketch of such a structure is given in Box 3.

6 Structure of a Agreement on Climate and Energy Technology Development (ACT!)

The framework agreement would need the following Articles:
Objective: To facilitate increased efforts as well as international cooperation on development and demonstration of technologies that may contribute to reductions of emissions of greenhouse gases in support of efforts to reach the ultimate objective of the UNFCCC.

Membership: All Parties to the UNFCCC may become members of this agreement. After entry into force, any Party to the UNFCCC may apply for membership. Membership shall be decided by the Steering Committee by consensus, and shall become effective immediately after the decision by the Steering Committee. The Steering Committee may decide on whether and how membership of and participation by entities other than countries (corporations) is appropriate.

Organization:

1. All members may participate in a Steering Committee/Policy Committee to oversee the overall implementation of the agreement, decide on project funding, and assess annual reports from the Technical Committee/Implementation Committees. Decisions of the Committee are by consensus or by other rules to be established (one might take account of countries share in the interest (population size) or in contributions etc.
2. *Alternative A*, one agreement: A Technology Committee is established to evaluate proposals received, assess progress of projects, etc. The Technical Committee report annually to the Steering Committee/Policy Committee. Decisions are by consensus or other rules to be established (may differ for different decisions). *May be open for all members or only a sub-group of members?*
   Alternative B, a framework agreement and separate agreement for various technologies/challenges/purposes: An Implementation Committee is established for each supplementary agreement, consisting of representatives from members to the supplementary agreement. A supplementary agreement may allow for programs pursued with contributed funds, in more direct research cooperation (joint centres, for instance) or both. All Implementation Committees report annually to the Steering Committee/Policy Committee. Decisions are taken by consensus.
3. A secretariat is established to organize meetings, prepare documents to committee meetings, administration of resources (receive and disburse money), receive requests for new memberships, communications, etc. If an alternative with several supplementary agreements is chosen, it may be necessary to establish an administrative unit for each of the supplementary agreements.

Funding/cost sharing: A choice has to be made between voluntary contributions or mandatory assessed contributions. Mandatory contributions would be the preferred option, first of all because that would provide certainty for funding. A simple way of sharing costs could to agree on a specified percentage (0.1 %?) of GDP, possibly with a lower percentage for developing countries. Alternatively, one may apply the UN Assessment scale. One way may be to establish as a soft norm the 0.15% target (at least one third through monetary contributions). This may develop into a 'harder norm', or it may prove to work well as a soft norm, for instance in a context in which different countries do different things (flexible framework: as when Norway protects trees, Japan funds adaptation in the South).

Application for funding: All entities in member countries may apply for project funding. The project funding to entities in member countries shall over any five-year period be no less than {50%} of the total contribution from that country during the same five-year period.

Box 3: Elements of an Agreement on Climate and Energy Technology Development (ACT)

i) Purpose: to stimulate the investment in and incentivizing of knowledge for far-reaching technological change while also ensuring dissemination of and affordable access to technology.

ii) Relation to other agreements/instruments: ACT is supplemental to and mutually supportive with treaties/instruments for greenhouse gas emission reductions, such as the cap-and-trade arrangements of the Kyoto Protocol and Europe's emission trading system (ETS). ACT addresses the need for investments in technologies providing *future* emission reductions.

iii) Modes of operation: ACT shall allow drawing on several types of policy instruments to invest in and stimulate technological research and development, inter alia:

- standards
- procurement contracts
- direct funding of research, including through prizes
- public/private partnership; industry/university; South-South; North-South, etc
- technology funds
- coordination of individual country (and company) research, including instruments to expand access to and rapid and economical employment of technology

iv) Governance and means of participation
A *governance structure* with representation of participating countries is to be established, taking into account participation and contributions in different forms:

A basic energy and climate technology fund (GECTF) has *universal contributions* of budgetary funds from members, and is governed directly by the ACT.

ACT also establishes *a basis for a family of member funds* (MECTFs), through which member countries can attain partial credit for research and development not funded directly through ACT. MECTFs are recognized and credited under requirements established by ACT. An MECTF can be formed by one or several countries for more specific purposes. ACT`s concerns will relate to the global benefits of the research efforts, and concentrate on coordination, access and dissemination.

ACT also establishes *a basis for agreements* along lines such as standards, procurement contracts etc, in which countries and other parties can participate;
ACT is envisaged with a *sunset clause*, existing in a dynamic fashion until global participation in mitigation is seen as giving sufficient stimulus to energy and climate technology development and demonstration.

Establishment of supplemental agreements for specific technological developments:
Relationship between the framework agreement and supplemental agreements has to be elaborated.

Signature
An authorised representative of a Government should sign the treaty.

Entry into force
The agreement enters into force immediately after signature.

Withdrawal
A member may not withdraw from the agreement before five years after its entry into force. After that period, a member may withdraw from the agreement with a 12 month notification to the Steering Committee.

Relationship to UNFCCC
The UNFCCC will be regularly informed about the activities under this agreement. This should preferably be under a separate agenda item of the Subsidiary Body for Scientific and Technological Advice (SBSTA) at its regular sessions. In case it will not be possible to inform the Conference of the Parties or any of its subsidiary bodies, information may be provided through side events at the regular sessions of the UNFCCC.

7 The way forward – How to gain broad international support for a technology agreement

It is expected that gaining international support for an agreement on technology development and demonstration may require significant efforts. Some are already planned, e.g. the Club de Madrid/Hafslund/Bellona meeting taking place in Norway in early June 2008, and a side event at the SBSTA/SBI negotiations in Bonn, Germany, later the same month. A possible scenario for further actions to achieve eventual agreement may be to follow the sequence set out below:

1. The Norwegian government will have to consider the proposal to launch the idea of a technology agreement internationally and a decision must include economic support to the initiative. A Norwegian grant to the initiative could be 0.1 % of GDP per year. With a GDP of 150,000 million Euros, the Norwegian contribution would be 150 million Euros or 1.2 billion NOK per year. In addition, Norway may consider offering to take responsibility for secretariat functions for an initial period.
2. After a decision by the Norwegian government, support should be sought from a few like-minded countries. As early as possible, perhaps even before the Norwegian grant is formally decided, the initiative should be presented informally to the Nordic countries and key EU members like Netherland, Germany, France and United Kingdom and perhaps Saudi Arabia, China, India or South Africa.
3. If positive support is received through the first informal contacts mentioned above, the initiative should be presented to the UNFCCC. The most appropriate forum to launch the initiative would be the group working on strengthening the long-term cooperation under the Convention (AWGLCA).
4. Like-minded countries should be invited to negotiations on the agreement, based on a draft text developed by Norway.
5. The agreement could be signed at a ministerial conference organised by Norway. This could either be at a separate conference in mid-2009, or in connection with the climate conference in Copenhagen in December 2009.
6. It is essential that a proposal on an agreement on technology development will be perceived as supporting a post-2012 agreement under the UNFCCC on strengthened emission reductions, and not as an alternative to a UNFCCC instrument. The idea of an additional agreement on technology agreement should therefore be introduced as early as possible in the negotiations, and efforts should be made to include text in a

post-2012 agreement that allows recognition of supporting agreements and opens for cooperation and interaction.

"Selling" the idea of a new international agreement on development and demonstration of climate friendly technology will require significant efforts from Norwegian authorities, at both the political and administrative level. It will be particularly important to get support from a core group of likeminded countries (see point 2 above). The most effective way of achieving this might be make this a core theme in bilateral meetings between ministers. See also Box 4 below.

Box 4: Possible Norwegian initiatives: A Member Fund, as an illustrative example:

Norway has itself started energy technology development and demonstration efforts, most prominently in the field of carbon capture and storage, and is prepared to channel these efforts into a climate and energy technology fund (MECTF).

Norway's aim should be to equip this fund not only with its existing investments in this area, but to raise these investments to a level of z billion Euros over the coming 10-15 years, with the intention of expanding it further;

Norway's aim should be to allow this fund to be open for international cooperation in one or two ways:

- Norway should invite other countries to participate in the fund, and to reformulate mandate and governance structure accordingly (a 'Nordic Energy and Climate Technology Fund (NECTF)', or a 'Fossil Fuel Exporter's Energy and Climate Technology Fund' may be the first developments)
- Norway should be prepared to 'submit' its fund into a family of funds supported by (and to some extent governed by) a Global Energy and Climate Technology Fund (GECTF).

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