# VOLUNTARY AGREEMENTS WITH INDUSTRY

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## FOREWORD

This working paper is one of a series of eighteen studies carried out under the project: "Policies and Measures for Possible common action". The project was carried out by the OECD, together with the International Energy Agency, in 1996 and 1997 for the Annex I Expert Group on the United Nations Framework Convention on Climate Change (UNFCCC). The goal of the project was to assess a range of cost-effective greenhouse gas mitigation policies and measures for countries and Parties listed in Annex I to the UNFCCC. The eighteen working papers have been made widely available as analytical input to negotiations under the UNFCCC Ad hoc Group on the Berlin Mandate. The working papers may also provide input to national decision-making processes on greenhouse gas mitigation policies. The measures analysed do not necessarily represent policy preferences of Annex I Parties.

The project benefited greatly from substantial input from delegates. Three successive chairmen of the Annex I Expert Group provided outstanding leadership for the project: Doug Russell (Canada); Ross Glasgow (Canada); and Ian Pickard (United Kingdom). The work was supervised by Jan Corfee Morlot (OECD). Fiona Mullins (OECD) drafted the initial framework which was used to structure the eighteen working papers.

The Annex I Parties or countries referred to in this document refer to those listed in Annex I to the UNFCCC: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Czechoslovakia (now Czech Republic and Slovakia), Denmark, the European Community, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and United States. Where this document refers to "countries" or "governments", it is also intended to include "regional economic organisations," if appropriate.

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## EXECUTIVE SUMMARY

### Context

Voluntary agreements aim to encourage industries to set and meet environmental goals, while giving them the flexibility to achieve these goals in the manner which best meets their circumstances. Voluntary agreements also help to raise the profile of environmental issues in corporate decision-making. This policy tool is becoming increasingly important in many Annex I countries as an instrument for achieving improvements in energy efficiency and reductions in greenhouse gas emissions. Since the United Nations Framework Convention on Climate Change (UNFCCC) was agreed, the number of voluntary agreements related to energy efficiency or greenhouse gas reduction has increased significantly.

### Objective and approach

The objective of this working paper is to assess the potential of voluntary agreements to achieve greenhouse gas emission reductions through some form of common action among Annex I Parties. The paper presents a framework for assessing voluntary agreements, summarises the experience of Annex I countries with the implementation of voluntary agreements, and discusses the potential of voluntary agreements as a possible policy instrument for some form of common action among Annex I Parties.

The paper focuses on three industries that cover greenhouse gas emissions from a range of industrial sources: iron and steel ($CO_2$); aluminium ($CO_2$ and PFCs); and adipic acid ($N_2O$). Case studies by national experts that provide information on the experience of six countries with voluntary agreements in these and other industries are summarised in this paper. The case studies describe the programs, the number of participants, the regulatory context in which the voluntary agreements operate, and procedures for monitoring and reporting. Information concerning costs and performance evaluation of the programmes is also provided where available.

### Definition of the term "voluntary agreements"

The term "voluntary agreement" or "voluntary approach" has been used to describe a wide range of industry actions including industrial covenants, negotiated agreements, self regulation, codes of conduct, and eco-contracts. In this paper the term "voluntary agreements" is reserved for a subset of this broad group of voluntary approaches and is defined as:

> *An agreement between government and industry to facilitate voluntary action with a desirable social outcome, which is encouraged by the government, to be undertaken by the participant based on the participant's self interest.*

According to this definition, voluntary agreements do not include actions that are undertaken without government initiative or actions that are undertaken solely as the result of a government mandate.

There are several key characteristics that differentiate voluntary agreements. These include the manner of target or goal setting, the nature of participant commitment, the degree of regulatory (or fiscal) threat, and the mix of voluntary agreement participation incentives. Four major types of voluntary agreement policies can be identified:

- target-based: negotiated targets that are legally binding and/or which pre-empt future regulatory requirements, or are tied to a strong regulatory threat;
- performance-based: negotiated performance goals that are not legally binding nor explicitly designed to pre-empt future regulatory requirements;
- co-operative research and development: focus on spurring new technology developments that advance the best practice frontier; and
- monitoring and reporting: monitoring and reporting is a component of most voluntary agreements, but can also constitute a form of voluntary agreement in its own right.

In practice, voluntary agreements often have characteristics which fall into more than one category.

**Greenhouse gas reduction potential**

There is limited data with which to evaluate the performance of voluntary agreements in reducing greenhouse gas emissions. This is because many countries voluntary agreements have only recently been introduced and it is too early to assess the results of these programs. In addition, many of the voluntary agreements reviewed in this working paper do not target the reduction of greenhouse gas emissions directly, but rather related objectives such as the promotion of energy efficiency. Voluntary agreements rarely operate in isolation from other policy instruments, such as financial incentives or related legislation, so it is difficult to isolate the influence of voluntary agreements from other factors.

Nevertheless, some indication of the potential contribution of voluntary agreements to reducing greenhouse gas emissions can be obtained through an analysis of technical developments within the industry and their economic viability. For example in the case of the iron and steel industry, estimates of potential energy efficiency improvements provide a good indicator of the potential for a reduction in $CO_2$ emissions. Clearly, analysis of energy efficiency potentials must distinguish between different types of potential: market; economic; social; and technical (see Appendix II). Short term technical potentials for energy efficiency savings of between 15 per cent and 60 per cent in different Annex I countries have been estimated, but the market potential has been estimated as being some 10-15 percentage points lower.

The distinction between the different types of energy efficiency potential is an important consideration in assessing the potential of different types of voluntary agreements. Performance-based voluntary agreements often attempt to encourage the more widespread adoption of technology and practices when it is economically profitable for the participant to do so. This suggests that the potential for these types of voluntary agreements to improve energy efficiency is represented by the estimate of economic potential. In other cases however, it may be the objective of policy makers and industry to raise the level of current practice closer to the social potential (the economic optimum from the viewpoint of society). By definition, such an objective may require participants to go beyond “no regrets” measures and is, therefore, more likely to be associated with target based voluntary agreements which are legally binding

or associated with some type of regulatory threat or financial incentives. Co-operative research and development voluntary agreements which aim to advance towards the theoretical potential through technology innovation, may have a large impact on greenhouse gases in the longer term, but this impact can be difficult to estimate.

The effectiveness of the different types of voluntary agreement will depend on the specific economic circumstances of the industry and the type of potential which exists. For example, performance based voluntary agreements may be effective when significant "no-regrets" opportunities for energy efficiency (or greenhouse gas reduction) exist. When these opportunities are limited, target based voluntary agreements may be the more effective tool to go beyond "no-regrets" options to achieve greenhouse gas reduction or stabilisation targets.

**Possible forms of common action**

Common action on voluntary agreements can be pursued at different levels. Possible forms of common action range from an agreement on international co-operation for information-sharing, to harmonised action to pursue a certain type of voluntary agreement, for example:

- an umbrella action to exchange information on successful voluntary agreements and to develop methodological and analytical frameworks to assess performance and effectiveness of different types of voluntary agreements;
- a general agreement to implement voluntary agreements with countries retaining the freedom to develop and implement the type of voluntary agreements most suited to their economic , political, cultural and regulatory context;
- an agreement to adopt a particular kind of voluntary agreement;
- a group of countries pursuing similar types of voluntary agreements with similar goals may agree to work towards harmonising their voluntary agreement; or
- adoption of voluntary international standards.

**Rationale for common action**

Questions to be addressed in considering the potential for some form of common action include:

- What benefits may arise from jointly implemented voluntary agreements?
- Why should a country which has already successfully implemented a voluntary agreement at the national level wish to participate in a common action?
- Are there any potentially negative impacts that common action may have on existing voluntary agreements pursued by countries on a unilateral basis?

Answering these questions is difficult given the different types of voluntary agreements which exist, the different regulatory environments in which they operate, and the different types of common action which can be advocated. Nevertheless, from an environmental perspective there is a strong argument for common action, if, through the more widespread adoption of new technology and practices, further reductions to net greenhouse gas emissions were likely to occur. One example of this type of

environmental benefit from common action is in the adipic acid industry, where co-operation between the world's major adipic acid producers has facilitated the dispersion of technology for $N_2O$ abatement.

From an economic perspective, developing an argument for common action depends in part on whether the voluntary agreements are targeting "no-regrets" options, or whether their implementation would result in some net costs to participating firms. In the case of the former, some form of international co-ordination may assist industry to implement practices which are economically profitable and which also meet environmental objectives. In the case of the latter, an internationally co-ordinated voluntary agreement may help alleviate industry concerns of being put at a competitive disadvantage in relation to their international competitors. Companies may be more likely to invest in technology to reduce greenhouse gas emissions if their international competitors are committed to reach the same targets.

Some of the more general arguments in favour of voluntary agreements appear to be equally valid in the international context. That is, voluntary agreements aim to encourage industry-led initiatives to address environmental objectives and also to foster a co-operative approach between government and industry. Perhaps the attribute of voluntary agreements which makes them particularly promising for common action is their flexibility. Voluntary agreements can be designed to be implemented in several countries and yet allow for specifics to differ according to national circumstances. Furthermore, because they rely on the participation of industry, they have strong political viability as a policy instrument for common action.

**Possible participants and vehicles for action**

In principle, more co-ordinated action between countries in relation to voluntary agreements can be undertaken by any collective grouping of countries or industry. International industry associations could play an important role in promoting initiatives in response to climate change concerns, providing expertise and co-ordinating the exchange of information with their member companies.

The International Energy Agency's Energy Technology Collaboration Program provides a framework for experts to work co-operatively on energy technology research and development. Specific energy technology activities are set up under simple contractual arrangements called Implementing Agreements. The International Organisation for Standardisation (ISO) could be used as a vehicle to promote energy efficiency in industry on a voluntary basis. The recent agreement on the ISO 14000 standard is an example of a "voluntary" approach to environmental management for industry.

**Implementation issues arising from the case studies**

The six countries' case studies that are summarised in this working paper reflect a wide range of approaches to voluntary agreements. Three major issues arise from these case studies that are relevant to possible common action:

***1. The need for clarity on how targets/commitments are specified***

The voluntary agreements reviewed varied considerably in the nature of target-setting. For example, voluntary agreements with targets to improve energy efficiency or reduce greenhouse gas emissions targets often varied as to whether they were specified in absolute or specific (e.g., per unit output) terms.

The need for clarity on which production processes and energy inputs are to be covered by the voluntary agreements also arose, e.g., should feedstock use be calculated within an energy efficiency index.

### *2. The importance of clearly established monitoring procedures*

In nearly all the case studies reviewed the importance of monitoring procedures was highlighted. In some cases industries are encouraged to develop their own reporting programs. In others, the role of a third party organisation responsible for monitoring and reporting functions is stressed. The advantages of a third party organisation are that they can provide some confidentiality of information for participating industries, while at the same time contribute to the credibility of the voluntary agreement. The costs of monitoring and reporting have been identified as one of the most significant costs to industry of participating in voluntary agreements. Industry characteristics which appear to be helpful to the successful implementation of voluntary agreements at the international level include a relatively small number of participants, or the presence of representative industry associations.

### *3. The need for further development of criteria and methods for performance evaluation of voluntary agreements*

Methodologies are needed for evaluating the performance of voluntary agreements. A significant part of this paper has focused on evaluation issues. For example, the paper considers ways to compare performance of voluntary agreements against a "business as usual" baseline scenario or with historical trends, but also notes the difficulties and limitations of these methods. Information on the cost effectiveness of the programs reviewed is also limited. In addition many voluntary agreements have effects which are difficult to quantify but often very relevant, such as changing attitudes and awareness and generating and diffusing information. Performance criteria that take account of these varied objectives need to be developed. Competitiveness concerns, the presence of "free-riders", and how to ensure co-ordination with other regulatory measures are also issues which need to be addressed.

# 1. INTRODUCTION

## 1.1 Aim, approach and methodology

Voluntary agreements have attracted much interest among policy makers as a flexible tool for achieving reductions in greenhouse gas emissions from industry. Voluntary agreements vary considerably in their structure and approach. They may range from relatively informal statements of intent to highly structured agreements with well specified objectives and monitoring procedures.

The broader objective of this working paper is to consider the possibilities for the use of voluntary agreements at the international level to achieve greenhouse gas reductions. Due to the relatively recent implementation of voluntary agreements in many countries, the approach chosen to do this was to undertake a series of case studies of the experience of Annex I countries, with the implementation of voluntary agreements by energy intensive industries. Case studies were prepared by Germany, the Netherlands, the United States, Canada, Japan and New Zealand. The case studies include a description of the different characteristics of voluntary agreements and information on their effectiveness in achieving reductions in greenhouse gas emissions, and the different regulatory environments in which they are employed. The working paper summarises this information then discusses possibilities for common action.

This working paper focuses on voluntary agreements in three industrial sectors which give a broad coverage of the range of greenhouse gas emissions from industrial sources: iron and steel ($CO_2$); aluminium ($CO_2$ and PFCs); and adipic acid ($N_20$). However, because the use of voluntary agreements in these industries is still relatively limited, information on voluntary agreements in other industries is also used.

## 1.2 Outline of the paper

Following the introduction, Section 2 of this paper presents a framework for assessing voluntary agreements. Included in this section is a definition of voluntary agreements, a discussion of the main characteristics of voluntary agreements, and a taxonomy of voluntary agreements. The section also discusses some of the issues for assessing the performance of voluntary agreements.

Section 3 summarises the country case studies and uses the information they provide to assess the main characteristics of voluntary agreements. Section 4 discusses possibilities for common action and some of the main issues for successful implementation of voluntary agreements at the international level.

Appendix I provides background information on the three industrial sectors under review in this working paper, including a summary of production processes and production trends in different countries. Appendix II outlines an economic framework for examining the performance of voluntary agreements.

# 2. FRAMEWORK FOR ASSESSING VOLUNTARY AGREEMENTS[1]

## 2.1 Definition

Many different definitions of what constitutes a voluntary agreement exist. The term voluntary agreement has been used to describe a wide variety of policy instruments and approaches including:

- industry covenants;
- negotiated agreements;
- self regulation;
- codes of conduct; and
- eco-contracts.

For the purposes of this working paper, an environmental voluntary agreement is defined as:

> *An agreement between government and industry to facilitate voluntary action with a desirable social outcome, which is encouraged by the government, to be undertaken by the participant based on the participant's self interest.*

This definition reflects some of the issues that the policy-maker must address to assess the role of voluntary agreements for climate change environmental policy e.g., "desirable social outcome", "encouragement", and "self interest". Typically, voluntary agreements encourage desirable outcomes in a variety of ways, ranging from, for example, incentives to remove barriers to cost-effective investments, to regulatory pre-emption in return for voluntary agreement participation. Self-interest concerns industry perceptions of what is best for them and this perception may vary by industry and by type of voluntary agreement. For example, in the case of voluntary agreements based on negotiated targets that are legally-binding, the self interest of the participant may be to pre-empt other less desirable measures. On the other hand, in the case of voluntary agreements based on performance goals with little or no implicit threat of regulation, the concept of self interest may be profit, or the benefits associated with public recognition for environmental achievements, or simply the desire to be a good environmental steward.

Voluntary agreements vary greatly. Voluntary agreements typically incorporate a wide mix of mechanisms ranging from regulatory relief, to economic incentives, to public recognition to encourage or support industry participation. Many of these mechanisms may cross over into other policy areas. An important definitional issue concerns the extent to which an agreement is "voluntary". In cases where the incentive for industry to participate may be to pre-empt some regulatory threat or a financial incentive

1. Sections 2.1, 2.2 and 2.3 of this chapter are largely based on a paper prepared for the OECD by Gale Boyd of the Argonne National Laboratory and Jeff Dowd of the U.S. Department of Energy. It draws heavily on a working paper on the subject by the authors.

several countries have preferred to use the term "negotiated agreement". This term for example, is probably a more precise definition to describe the Dutch Long Term Agreements (LTA). However, since the term voluntary agreement is commonly used to describe this type of agreement in many Annex I countries these types of agreements are included within the definition used in this paper.

Voluntary agreements and regulatory strategies may be, and often are, complementary strategies. Voluntary programs do not eliminate the need to consider regulatory strategies. Even with regulatory strategies in place voluntary agreements can encourage participants to go beyond regulatory requirements or to reduce regulatory cost burdens. Voluntary agreements often incorporate some regulatory mechanisms.

## 2.2 Characteristics of voluntary agreements

One can identify several characteristics that differentiate voluntary agreement policies. These include: the manner of target or goalsetting, the nature of participant commitment, the degree of regulatory (or fiscal) threat, and the mix of voluntary agreement participation incentives. Within each of these dimensions, a range of key characteristics can be examined, as discussed below.

### *Manner of target or goal setting*

For example:

- negotiated targets e.g., Dutch Long Term Agreements;
- a performance goal set by the voluntary agreement program, e.g., United States Green Lights; or
- self-selected performance goal within an overall societal goal e.g., United States Climate Wise, and Voluntary Aluminum Industry Partnership.

### *Nature of participant commitment*

For example:

- legally binding under civil law;
- not legally binding e.g., a Memorandum of Understanding[2] (MOU); or
- informal agreement (in which participant commitment and declaration of intent is open-ended).

2. An MOU is a non-binding contract between two parties to commit to declarations of intent to undertake mutually supportive actions. An MOU differs from a legally-binding agreement that has, for example, penalty consequences for non-compliance. Under an MOU, a participant can withdraw from the agreement at any time without penalty. If a participant does not achieve agreement goals over a certain timeframe, they may be asked to leave the VA programme.

***Degree of regulatory (or fiscal) threat***

For example:

- strict pre-emption against regulatory or fiscal measures (e.g., waiver permitting regulation, waste heat regulations, or energy/$CO_2$ tax);
- implicit threat of future regulation; or
- no regulatory threat.

***Type of incentives to participate***

There is a wide range of incentive or support mechanisms for voluntary agreements programs, including: education and training services; technical assistance; demonstration and field tests, early equipment retirement incentives; product or professional certification; and economic incentives (e.g., subsidies, grants, tax breaks).

## 2.3 Major types of voluntary agreements

Different types of voluntary agreement policies or programs can be identified, taking into account the above-mentioned key characteristics of voluntary agreements described above. In this paper four major types of voluntary agreements are defined: target-based; performance-based; co-operative research and development; and monitoring and reporting.

***Target-based voluntary agreements***

Target-based voluntary agreements have negotiated targets that may be legally binding or which pre-empt future regulatory requirements, or are tied to a strong regulatory threat. This type of voluntary agreement is often referred to as a negotiated agreement. Key elements of this type of voluntary agreement include:

- negotiated alternatives to enforcement action where there are strict enforcement provisions (backstop legislation) or a strong regulatory threat if the voluntary actions do not meet the agreement objectives;
- setting of specific, targets, with long-term commitments by industry to improve energy efficiency or reduce emissions per unit of output within a certain time frame; and
- legally-binding agreements and contracts.

Exemption from existing or future fiscal regulation (e.g., tax breaks) is often a key motivation for industry to participate in this type of voluntary agreement. The Dutch and the Germany programs are examples of this category of voluntary agreement.

***Performance-based voluntary agreements***

Performance-based voluntary agreements typically have negotiated performance goals that are not legally binding nor explicitly designed to pre-empt future regulatory requirements. Performance can have some similar elements as targets, i.e., to meet some reduction goals in emissions or energy efficiency. Typically

they include a broader set of actions. For example, the goal to adopt certain targeted technologies that are economically viable or simply to implement an upgrade/evaluation plan. Participation is primarily motivated by the direct economic benefits (i.e., profits) that they had not before investigated, and secondarily by the perceived market and corporate credibility benefits associated with being viewed as environmentally responsible. There are at least two identifiable forms of performance voluntary agreements.

### *1. Program-Determined Goals*

Under this form of performance-based agreement, participants agree to adopt the specific performance goals determined by the voluntary agreement program. Performance goals are designed to contribute to overall national performance goals for reduction in greenhouse gas emissions. The Canadian Industry Program for Energy Conservation and the United States Green Lights program could be said to belong to this class of voluntary agreement.

### *2. Participant-Determined Goals*

Under this form of performance-based agreement, the voluntary agreement encourages or requires participant performance goals to be consistent with program goals. The voluntary agreement program goals are, in turn, designed to contribute to overall national performance goals. However, participants set their own performance improvement goals over a certain time frame. The United States Climate Wise and VAIP programs, and the New Zealand program could be said to fall into this category.

### *Co-operative research and development voluntary agreements*

Co-operative research and development voluntary agreements aim to encourage new technology developments that advance the best practice frontier.[3] Advancing the best practice frontier involves the modification or development of new, higher performance products. This may include management practices, as well as adoption of newly developed products that may have been demonstrated are not yet in widespread use in the industrial market. In this type of voluntary agreement, the government uses market mechanisms or incentives to encourage manufacturers or research institutions to make innovations to existing designs or create new products.

A co-operative voluntary agreement policy instrument differs from traditional research and development. In traditional research and development the government directly supports research institutions or provides economic stimuli to increase private sector investment in research and development. The emphasis is typically on technological advances that require longer research time-horizons, so the technological advances are more likely to be radical rather than incremental improvements. The technologies that are developed may require an extended period of testing and demonstration before market introduction. Under a co-operative voluntary agreement, however, the government is more likely to use innovative market mechanisms to encourage research and development, and the emphasis is likely to be on incremental or near-term technological improvements. The technology that is produced is likely to have a short to immediate time-frame before being introduced into marketplace. An example of this type of voluntary agreements is the United States Industries of the Future program which seeks to match

3. The term “best practice” refers to both the use of the best commercially available technology as well as management practices that are proven to lower emissions in actual business operating environments.

technology and development priorities to the needs of United States industries through an active government-industry dialogue and partnership process.

***Monitoring and reporting voluntary agreements***

Monitoring and reporting can be done in tandem with voluntary agreements, or it can itself be a form of voluntary agreement. Alternatively it can be linked to a non-voluntary agreement reporting mechanism based on detailed "process" reporting guidelines (e.g., United States 1605b reporting program).

While this taxonomy helps to differentiate between the range of types of voluntary agreements found in Annex I countries, it should be noted that many voluntary agreements fall into more than one of these categories. For example, monitoring and reporting activities in one form or another underlie all voluntary agreements.

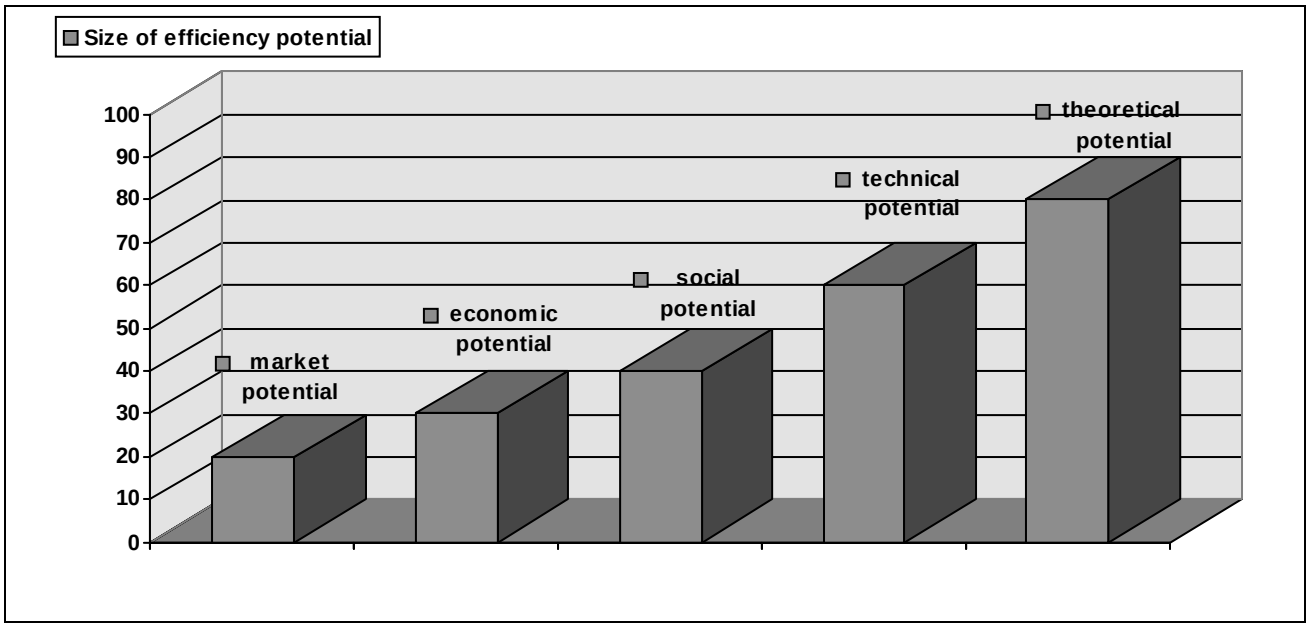
## 2.4 The role and potential effectiveness of the different types of voluntary agreement

The following discussion relates the role and potential for effectiveness of the different types of voluntary agreement to the different categories of energy efficiency (or greenhouse gas reduction) potential. This discussion suggests that the different types of voluntary agreements will have different roles to play depending on the type and extent of energy efficiency (or greenhouse gas reduction) potential which exists.

Literature in the subject area of energy efficiency distinguishes between several different categories of energy efficiency potential (Carlsmith, Chandler, McMahon & Santino, 1990, Schipper & Meyers, 1992, Worrell, 1994). These definitions include market, economic, economic with eternality cost adjustment (referred to here as ‘social’), and technical potential. Figure 1 illustrates these concepts schematically. Further discussion of these concepts is provided in Appendix II.

Market potential is defined as the potential savings that can be expected to be realised in practice (Worrell 1994). The market potential therefore reflects what is seen to be technically and financially viable by business. The economic potential is defined as the potential savings that can be achieved by completely optimising costs, relative to best practice. Social potential is defined as the potential savings that can be achieved at a net positive economic effect. In this context, the economic effect is taken to mean the net economic effect to society. This represents internalising the social and environmental costs of energy use. The technical potential is defined as the achievable savings resulting from the maximum energy efficiency improvement available in the period under investigation, regardless of cost considerations (Worrell, 1994). This represents the best that can be achieved under current technology knowledge and is an upper bound for energy savings in the period under investigation. The theoretical potential of energy efficiency improvement for a certain process is determined by thermodynamic laws and is defined as the difference between the current energy consumption and the thermodynamic minimum energy consumption.

**Figure 1. Schematic Diagram of Potential for Energy Efficiency Improvement**




The difference between the level of energy efficiency that can be expected to be realised in practice (the market potential) and the level judged to be cost effective at prevailing prices (i.e., the economic potential) is often referred to as the "efficiency gap" (Howarth and Andersson, 1993). The presence of such an "efficiency gap" is sometimes also described as representing a "no-regrets" potential: that is, measures which are worth undertaking whether or not there are climate related reasons for doing so[4] (IPCC, 1996). The reasons why a "no regrets" potential may exist (i.e., why energy savings investments which would appear to be profitable are not undertaken) have been explained mostly in terms of market barriers to efficiency, such as; lack of awareness of energy efficiency opportunities distortions in fuel prices; supply infrastructure limitations and limited access to capital. A considerable amount of literature discusses these barriers and the extent to which they are significant or not (Carlsmith *et al.*, 1990, Sutherland, 1990).

Distinctions between the different categories of potential energy improvement are important in considering the potential of voluntary agreements to increase energy efficiency or to reduce greenhouse gas emissions. The effectiveness of the different types of voluntary agreements depends in part on the type of energy efficiency (or greenhouse gas reduction) potential which is being targeted. For example, voluntary agreements aimed at 'no regrets' options, such as performance based voluntary agreements, attempt to encourage the more widespread adoption of technology and practices when it is economically profitable for the participant to do so. In relation to the discussion above, this suggests the potential for these types of voluntary agreements to improve energy efficiency is represented by the gap between the current average practice and the economic potential.

4. Economists often refer to the need to account for the positive side effects of mitigation strategies. For example the introduction of a technology to reduce GHG emissions may at the same time reduce the net energy costs of the firm. To the extent that such positive side effects may totally offset the gross costs of a mitigation strategy they represent what is called a "No regrets" potential. More detailed discussions of these concepts is available in the Working Group II contribution to the IPCC Second Assessment Report (IPCC, 1996).

In other cases, however, it may be the objectives of policy makers and industry to raise the level of current practice closer to the social potential. One means of doing this may be to specify an internal rate of return (IRR) investment criteria for energy that is lower than industry would normally apply in investment decisions. By definition, such an objective may require participants to go beyond "no regrets" measures, and is therefore more likely to be achieved through target based voluntary agreement programs such as those described above.[5] These measures may be justified in economic terms if external environmental costs are taken into account in order to arrive at the economically efficient level.

Co-operative research and development voluntary agreements aim to directly advance all of these potentials closer to the theoretical potential through technology innovation. The presence of all types of voluntary agreements may also encourage such technology changes indirectly via a market pull mechanism.

Therefore, the type and degree of potential energy improvement within the participating industry will influence (along with other social and economic factors) the relative effectiveness and merits of the different types of voluntary agreement. If, for example, a government sets a target of a 20 per cent improvement in energy efficiency by the year 2010, for some industries this level may correspond to the economic potential and therefore a performance based voluntary agreement is likely to be a cost effective policy instrument to achieve this potential. If, however, the economic potential is lower than the 20 per cent target, those voluntary agreements which aim to raise the commitment closer to the social potential would be the more effective mechanism for achieving this target.

## 2.5 Performance evaluation of voluntary agreements

An evaluation of the policy performance of voluntary agreements is a complex task. There are several reasons for this: in many countries voluntary agreements have only recently been introduced, and it is too early to assess the results of these programs; Voluntary agreements rarely operate in isolation from other policy instruments, such as financial incentives or regulations making it difficult to isolate the influence of voluntary agreements from these other factors; Voluntary agreements often have multiple objectives; and the effectiveness of different types of voluntary agreements is influenced by a range of factors including the political and economic context in which they are designed to operate. Nevertheless, as countries increasingly look towards voluntary agreements as an alternative policy instrument it is necessary to be able to evaluate their performance in relation to a set of well defined criteria.

### *Criteria for evaluation of voluntary agreements*

An evaluation of any policy instrument must be done with reference to a set of well defined criteria. One possible set of criteria is outlined below (OECD 1997):

- environmental effectiveness -- this relates to the environmental impact and performance of the voluntary agreement, i.e., how much the instruments contributes to the achievement of the objective;
- economic efficiency; refers to the extent to which the instrument has enabled a cost effective achievement of policy objectives;

5. It should be noted in this context that definitions of "no regrets" measures vary, and in the opinion of some governments "no regrets" measures may correspond to the "social potential".

- administration and compliance costs;
- wider economic effects include impacts on the price level, employment and trade;
- dynamic effects and innovation; and
- "Soft effects"; which refer to effects that are difficult to quantify but which are often important, such as changes in attitude and awareness and the generation and diffusion of information.

Developing more specific guidelines on how to evaluate voluntary agreements against these broad criteria is a difficult challenge for policy makers. This task is further complicated by the different types of voluntary agreements as discussed above. Some methods of evaluation in relation to these criteria are discussed below:

***Environmental effectiveness***

For many voluntary agreements, a common measure of performance is to monitor the extent to which the targets are being met. However, for this to have meaning it is preferable to establish the significance of the targets compared to previous behaviour and their likely environmental impacts. One methodology to do so is to compare the targets or commitments of a voluntary agreement with a "business-as-usual" baseline scenario. To compare voluntary agreement targets with a business-as-usual baseline scenario is to ask the question, to what extent do the reduction targets or commitments of a voluntary agreement differ from what would be expected to happen in the absence of the voluntary agreement? A business-as-usual forecast therefore allows for economic growth effects, structural changes resulting in different consumption and production patterns and improvements due to technical progress (Ramesohl 1996). Conceptually defining a business-as-usual scenario and evaluating the performance of a voluntary agreement against it, is difficult and somewhat contentious. Nevertheless, performing this exercise can help to evaluate the extent to which voluntary agreements lead to any real change in the business behaviour of industrial participants.

In the absence of this type of information, it may be appropriate to compare the commitments and reduction targets of the voluntary agreement with historical trends. Targets for energy efficiency for example, may be compared with trends in energy efficiency improvement in recent decades. Care needs to be taken in performing this sort of comparison to stress the different conditions which industry may have been facing in different time periods.

***Economic Efficiency***

Another important criteria for the evaluation of voluntary agreements is the extent to which they achieve climate change or other objectives in a cost-effective manner. Due to the above mentioned difficulties in measuring the performance of voluntary agreements it is difficult to determine the cost-effectiveness of these programs. However, to the extent possible this report has tried to collect information concerning the costs both to industry and government of participating in voluntary agreement programs. The challenge for policy makers is to link this type of information with recognised measures of performance in order to determine cost-effectiveness.

***"Soft Effects"***

For some voluntary agreements less emphasis is placed on reaching certain targets and more emphasis is placed on raising the profile of the environment in managerial decisions or the public opinion, or on maximising participation in voluntary agreements. For others, the diffusion of information is an important objective. While often difficult to quantify, these so-called "soft-effects" of voluntary agreements are likely to be very significant in many cases.

# 3. SUMMARY OF CASE STUDIES

The case studies from six countries that are summarised below reflect a wide range of approaches to voluntary agreements.

## 3.1 Summary of the programs

### *Germany*

Germany's voluntary agreement with industry on climate protection measures (Erklärung der deutschen Wirtschaft zu Klimavorsorge, Selbstverpflichtungserklärung, or SVE) is an example of a target based voluntary agreement. In March 1995, the Federal Association of German Industries (BDI) published a "Joint Declaration of the German Industry on Climate Protection" together with five other trade and industry associations, stating their intention to reduce specific $CO_2$ emissions or their specific energy consumption by up to 20 per cent in the period up to the year 2005 (with a base year of 1987). This first declaration was agreed to by 15 industrial associations including the steel and non-ferrous metals industries.

In March 1996, the German business community presented an updated and extended version of this declaration. The most significant changes to the original declaration include:

- a change in the base year from 1987 to 1990.
- the declaration of the individual sectors specify absolute emission targets as well as specific (per unit output) targets (although this may not the case for all sectors);
- a monitoring process was established; and
- the declaration to reduce emissions "by up to 20 per cent" in the period up to the year 2005 was changed to read to reduce emissions "by 20 per cent" in the period up to the year 2005.

Since the original agreement, another four association have joined this initiative. The participants now represent over 71 per cent of industrial energy consumption in Germany and more than 99 per cent of public power generation (BDI 1996).

### *The Netherlands*

In the Netherlands, the Second National Environmental Policy Plan formulates the national policy for the reduction of greenhouse gas emissions. The national target is a reduction of $CO_2$ emissions by 3 per cent by the year 2000, compared to the 1989 level. One of the means to achieve this goal are the Long Term

Agreements on Energy (LTAs). As by far the largest part of the Netherlands' energy supply is based on fossil fuels, reducing energy consumption is seen to be largely congruent with reducing $CO_2$ emissions.

The first LTAs were signed in 1992, and as of September 1996, there were 31 LTAs with industry associations, and about 1 000 industrial companies participating within these LTAs. These agreements currently cover more than 90 per cent of industrial primary energy consumption. The average target of the LTAs in the industrial sectors is a 20 per cent increase in energy efficiency by the year 2000, from 1989 levels. As part of the LTAs, broad areas of action to improve energy efficiency are noted, with indicative contributions to be made from measures such as energy management, combined heat and power, improvement in power generation, heat integration, and modernisation of processes. Some LTAs also specify that the effect of energy efficiency improvements should be translated into future $CO_2$ emissions, to be compared with 1989 levels, according to agreed formulae.

The government, for its part, assures some consistency and protection from new regulations aimed to reduce energy efficiency, and also provides financial and technical support in exchange for voluntary participation. Each LTA is a contract under civil law.

***The United States***

The United States employs a broad portfolio of voluntary actions in the industrial sector. Current and past United States programs include three of the four major types of voluntary agreements discussed in Section 2 of this report: performance-based; co-operative research and development; and monitoring and reporting. Target-based voluntary agreements, which rely on legally binding targets and pre-empt future regulatory requirements or are tied to a strong regulatory threat, are not used in the United States.

***Performance-Based voluntary agreements***

These voluntary agreement programs encourage a specific action by industry based on some agreed upon criteria. Examples include Green Lights, Climate Wise, Motor Challenge, and the Voluntary Aluminum Industry Partnerships (VAIP). The actions are typically to implement cost-effective technologies from some well defined set of feasible technologies. These programs offer a variety of support mechanisms such as public recognition incentives, coupled with education and training, information systems and database support.

Climate Wise, a joint program run by the Environmental Protection Agency (EPA) and the Department of Energy (DOE), encourages participants to identify and implement actions to reduce greenhouse gas emissions. Participants in Climate Wise are given recognition, technical assistance, and financial assistance. Climate Wise companies undertake specific actions that they identify (such as process changes, fuel switching, and new product designs). Participants are also encouraged to participate in various end-use specific greenhouse gas related programs, e.g., Green Lights or Motor Challenge.

The EPA Voluntary Aluminum Industry Partnership is a program to engage the aluminium industry in voluntary reductions of PFCs. The program has two elements. The first is the voluntary commitments, the second is an information collection and measurement program. The program aims to accelerate some of the replacement of equipment and practices that directly impact anode effects. The program goal is a 45 per cent reduction in national PFC emissions by the year 2000, but the targets are set by the industry participants on a plant by plant basis. The program currently has support from 12 of the 13 primary aluminium smelter companies in the United States.

The CE-189 program was a mandatory reporting program, with voluntary energy efficiency performance targets set by the participating companies. Performance goals were established by industry as a reduction in energy per unit of output. The program began in 1977 and ended in 1985.

***Co-operative research and development voluntary agreements***

The DOE Industry of the Future program is an example of an co-operative research and development voluntary agreement. Under this program, the DOE is working with seven industries to develop and implement a common research agenda aimed at addressing industries' vision of their future markets and research needs. Aluminium and steel are two of the seven participating industries.

***Monitoring and reporting voluntary agreements***

The Energy Policy Act of 1992 established a mechanism for the voluntary reporting of achievements towards greenhouse gas reductions through the 1605b Voluntary Reporting program. Any entity (company, plant, or individual) in any sector can report emission reductions to DOE through the 1605b reporting system. The 1605b program is not a voluntary agreement program, since no agreements to take greenhouse gas reduction are required to voluntarily report to 1605b. However, 1605b can be a vehicle for monitoring and reporting requirements for voluntary agreements.

***Canada***

The Canadian Industry Program for Energy Conservation (CIPEC) is a voluntary agreement with Canadian industrial producers which is run as part of the Industrial Energy Efficiency Initiative (IEE) of Natural Resources Canada. CIPEC was set up in 1975 in response to energy security issues and refocused in 1992 following the Rio accord with a greater emphasis on environmental issues. The program provides a sector-level focus to help industry identify energy efficiency barriers and opportunities, to forecast and set cost-effective energy efficiency targets, and to develop and implement action plans to realise the targets. At present 30 associations and company groups representing more than 3,000 companies and over 85 per cent of secondary industrial energy end-use are involved in the CIPEC program.

The CIPEC structure includes:

- Task Force Working Groups representing associations and companies from the key industrial sectors in Canada;
- an Industry Council consisting of the chairs of the task force working groups which provides a forum for the chairs to discuss issues and opportunities for programs and services to help companies within the sectors become more energy efficient;
- an Executive Council of CEOs representing the various associations participating in CIPEC;
- a Secretariat responsible for co-ordinating activities and providing support services to the task forces, councils and policy board.

Between 1975 and 1990 under the old CIPEC structure, 700 participating companies showed accumulated energy efficiency improvements of 26.1 per cent per unit of output. This amounted to an average improvement of 1.6 per cent per year with the improvements being estimated to translate into an on-going reduction of $CO_2$ of some 30 million tonnes per year. Results as of the end of 1994 indicate that

participating sectors on an aggregate basis have continued to maintain $CO_2$ stabilisation through energy efficiency improvement and fuel switching.

***Japan***

In Japan, voluntary agreements between industries and the national government aimed specifically at reducing $CO_2$ emissions have not been adopted. However, voluntary agreements between local authorities and factories have been widely used to reduce emissions of conventional pollutants such as $SO_x$, $NO_x$ and particulate matter. Between October 1992 and September 1993, approximately 2,220 environmental pollution prevention agreements were negotiated between local authorities and industry. These included agreements with 62 iron and steel factories and 54 non-ferrous metal factories. In several environmental pollution prevention agreements, residents take part as parties or witnesses to the agreement. A few of these agreements include articles related to $CO_2$ emissions.

In addition to these voluntary agreements with local authorities, the Environment Agency of Japan has established a voluntary "Program of Evaluation of Environmental Performance of Businesses". In this program, companies are asked to estimate emissions of $CO_2$ and other greenhouse gases caused by business activities and establish a program to mitigate environmental burdens including $CO_2$.

***New Zealand***

In July 1994, the New Zealand Government announced that in addition to other policies relating to energy efficiency and energy sector reform, it would seek voluntary agreements with industry to reduce $CO_2$ emissions. As of March 1996, 17 voluntary agreements had been signed. The agreements included undertakings with the New Zealand steel and aluminium industries. All but one of the nine agreements are with a single company (this reflects the case that for most of these industries there is only one company in New Zealand in that field of activity). The agreements are signed by the companies and the Minister of Energy representing the New Zealand Government.

Targets are specified as savings achieved or planned over the period 1990-2000 to coincide with the Government set national stabilisation objective. Within this framework the actual texts of the agreements vary widely reflecting different company and sector processes and technologies, widely varied opportunities for achieving $CO_2$ savings, views about the agreements themselves and the relationship of $CO_2$ savings activities to the company objectives.

The agreements are specifically not legally binding, and avoid penalty for under achievement. There is an expectation that they will be re-negotiated if annual reporting shows a major variation from what was expected to be achieved.

### 3.2 Commitments/targets

The specification of commitments and targets used by the various types of voluntary agreement reviewed in this working paper vary widely. Some types of voluntary agreements do not have targets as such but rather commitments to monitor and report information. For some types of voluntary agreement, targets and goals are expressed only in very general terms and participants are encouraged to set their own targets

as is the case with the United States Climate Wise Program. For other types of voluntary agreements, participation involves the commitment to meet an agreed target set at the sector level.

In cases where targets are used they often vary according to whether they are specified:

- in terms of energy consumption (efficiency) or emission reduction targets;
- in specific (e.g., per unit output) or absolute terms (e.g., tonnes $CO_2$, MJ energy).

From the perspective of climate policy, there is an argument that targets should preferably be expressed in absolute terms of greenhouse gas emissions (Ramesohl, 1996). However, absolute reduction targets raises the problem of how to deal with the dynamics of business cycles and economic growth. For example, reductions in the absolute level of emissions due to reduced production as a result an economic recession may not represent a sustainable improvement in the practices of industry. On the other hand, it will be difficult for industries to fulfil their obligations in times of an economic boom.

Specific reduction targets in relation to units of output exclude the dilemma of economic growth but they incorporate the danger, that specific efficiency and reduction gains may be offset by the growth of total production. Further, specific reduction targets may be based on physical units or on monetary units. In the case of specific figures based on monetary terms, it is preferable for a voluntary agreement to specify how to deal with the following variables (Ramesohl, 1996):

- inflation;
- changes in the product mix leading to new price structures and possibly new energy intensity profiles;
- price increases due to quality improvements.

Participants in Canada's CIPEC have a commitment to seek an annual average improvement in energy efficiency of 1 per cent (this is subject to natural industrial growth not exceeding 2 per cent per year). Underneath this broad commitment industrial participants can specify further targets if they wish. For the Dutch LTAs, targets are also specified as improvement in energy efficiency. The average targets of the LTAs is a 20 per cent improvement in energy efficiency by the year 2000, (from 1989 levels) or approximately 2 per cent yearly. Energy efficiency is defined as "the ratio of energy consumption and industrial production for the year in question, divided by the same ratio for the year in reference.

In Germany, commitments and objectives of the different sectors within the SVE vary according to whether they specify reduction in $CO_2$ emissions or energy consumption, or whether emission reduction targets are to be achieved through changes to final products or changes to production processes, or whether reduction targets are specified in absolute or specific terms.

In the United States, most of the commitment and targets sought from industry participants in the various voluntary agreement programs are based on the overall goals of the United States Climate Change Action Plan. United States voluntary agreements offer a variety of ways for participants to establish commitments and targets. Specific performance goals or targets are not always required for the individual participants in the programs. For example, participants in Climate Wise are encouraged to establish their own goals, as are participants in VAIP. Some programs such as the VAIP have an industry wide goal, e.g., VAIP seeks a 45 per cent reduction in PFCs. On the other hand, the Green Lights program sets a goal that is very specific to individual Green Lights partners.

In New Zealand, targets are specified as $CO_2$ savings over the period 1990-2000 and may be further specified either as:

- $CO_2$ emissions per unit of production, calculating a percentage reduction target between 1990 and 2000;
- $CO_2$ emissions per unit of production, calculated in relation to a 2000 base year equivalent; or
- an absolute reduction in $CO_2$ emissions.

***Accounting for different types of energy inputs***

Related to the specification of targets, is the question of how production processes are covered in voluntary agreements. An example of this arises with the Dutch LTA with the steel industry. In this case, coke which is used in the blast furnace stage of steel production as feedstock is not included in the calculations of energy efficiency improvement.[6] This raises some issues, since using a higher amount of recycled metal in the steel making stage which would contribute to an energy efficiency improvement will not be accounted for in the energy efficiency targets. A more general point arising from this example is the need for detailed knowledge of how these type of production processes are accounted for in setting targets, especially if there is to be any comparability of these targets with past trends, or with the targets of other countries.

## 3.3 Regulatory context

Voluntary agreements rarely operate in isolation as a policy instrument. They are sometimes combined with other measures, such as regulatory mechanisms, of financial incentives (Solsbery & Wiederkehr, 1995). In other cases, the presence of a regulatory mechanism may not be explicit but can still be influential as a potential threat if voluntary agreements are not successful in achieving significant goals.

Three clear examples of voluntary agreements operating within the context of potential regulatory instruments appear in the case studies for Germany, the Netherlands and New Zealand. In Germany, in return for industry's offer of voluntary special efforts, the industry expressed their expectation, that the federal government would defer to their private initiative before resorting to regulatory and fiscal measures. These expectations were referring to two potential policy measures in particular:

- introduction of an energy/$CO_2$ tax as a first step towards ecological tax reform; and
- introduction of a regulation on waste heat use (Wärmenutzungsverordnung, WNVO).

In the Netherlands, the government assures some consistency and protection from new regulations aimed to improve energy efficiency or reduce greenhouse gas emissions in return for industry's participation in the LTAs.

6. In the integrated steel making process carbon is introduced into the blast furnace in the form of metallurgical coke to reduce iron ore to molten iron (see Appendix I). Energy which is consumed in this process is said to be related to metallurgical purposes rather than "energy related" purposes.

In New Zealand, although not directly linked to the performance of voluntary agreements, the New Zealand Government threatened to introduce a carbon charge in late 1997, if by mid-1997, it did not appear that emissions were on track to achieve the target of stabilising net $CO_2$ emissions at 1990 levels by 2000.

## 3.4 Monitoring procedures

In many of the case studies, monitoring procedures are a critical component of the voluntary agreement. The political acceptance of voluntary agreements depends on public confidence in the effectiveness of voluntary agreements. To satisfy public expectations for access to information and for transparency, and in order to enable a control of the pursuit of reduction targets, a detailed monitoring system is needed. The questions of type, degree of details and other features of a monitoring system also need to be established. United States experience indicates that monitoring requirements are likely to be one of the most substantial costs faced by industry in participating in a voluntary agreement.

### *Confidentiality concerns and the role of a third party organisation*

A voluntary agreement needs to address the confidentiality concerns of participating companies. The case studies illustrate that these concerns can be addressed by the use of an independent agency responsible for receiving and monitoring company information. In practice, the appropriate balance between protecting the commercial interests of the company and the need for publicly available information for verification and support, appears to be a critical issue to be resolved at the point of design of voluntary agreements. An independent third party can also play an important role in providing an independent assessment of voluntary agreement commitments and the extent to which they contribute to meeting the objectives of the program. Such an assessment can help to provide credibility for voluntary agreements.

In the Netherlands, LTAs involve three principal parties, the industrial association representing the individual companies, a Government agency (Novem) and the Government (The Ministry of Economic Affairs). Novem has an important role in negotiating the targets for energy efficiency and in monitoring the progress of participants. An energy saving plan and annual monitoring reports are mandatory for each company. Failure to provide one or the other is a valid reason to terminate the LTA with that company.

In Germany, the importance of independent third party organisation has also been recognised. The revised declaration by German Industry of March 1996 announced the introduction of a $CO_2$ monitoring process. Monitoring reports will be collected and reviewed by an independent scientific institute (BDI, 1996). The institute in turn will produce a summary report for public information detailing what progress has been made and how this has been achieved.

In the United States, monitoring and reporting is an essential component of all types of voluntary agreements. Reporting is done by individual voluntary agreements (e.g., Green Lights and VAIP have their own built-in reporting functions). Monitoring and reporting may also be linked to the United States 1605b reporting program. The 1605b program allows for confidentiality through third party reporting, e.g., trade associations. This helps satisfy the concerns of industry but at the same time dilutes the public recognition element of voluntary agreements (Boyd 1996). If the energy costs of plants and companies are strategic business information then this is a serious barrier to voluntary agreements since some type of monitoring or reporting is necessary to verify performance targets. In this case a third party auditor could address this problem, but would add an additional level of administrative cost and complexity to the agreements.

## 3.5 Evaluation

Section 2.4 introduced some of the analytical issues which arise in attempting to evaluate the performance of voluntary agreements. In the case studies presented in this working paper, only limited critical evaluation of the voluntary agreements was possible. This is in many case due to the relatively recent introduction of many of these measures, and the difficulty of assessing the performance of voluntary agreements. This difficulty reinforces the need for further work to be done on criteria for evaluation discussed in Section 2.4. The main results from German, Dutch and United States case studies are highlighted below.

***Comparison of target/results with a "business-as-usual" scenario***

Two of the case studies attempt an evaluation of voluntary agreement targets and results compared to a "business as usual" scenario. In Germany, the industry targets of a 20 per cent reduction (from a 1990 base year level) in specific energy consumption was compared to a business-as-usual reference scenario (Table 3). According to the reference scenarios for these industries, specific energy consumption is forecast to fall by more than 30 per cent by 2005 (from 1990 levels). These estimates suggest that the proposal incorporated in the SVE is likely to contribute less to the national $CO_2$ abatement policy than can be expected from business-as-usual. This conclusion is supported by the findings of other authors (Jochem & Eichhammer 1996, Kohlhaas, M. Praetorius, B. & Ziesing,H.J., 1996), who found that in most cases the targets formulated in 1995 and 1996 do not reflect any extra efforts by industry beyond business as usual.

In the Netherlands, as of July 1994, results based on monitoring reports from 18 LTAs (representing 70 per cent of industrial energy consumption) show that these industries had increased energy efficiency by 9 per cent compared to the 1989 baseline and are well on course to meet their final target of a 20 per cent improvement in energy efficiency by the year 2000 (Ministry of Economic Affairs). It is difficult to compare these results with a "business as usual" scenario because of how the energy efficiency index for the LTAs is specified. Nevertheless, both Government and industry estimate that at least half of the 20 per cent efficiency improvement would have taken place in the absence of the agreements.

***Comparison of targets with historical trends***

When compared to historical trends in specific energy consumption, the current targets of the German SVE do not look ambitious. The current targets, a 20 per cent cut in specific energy consumption (or specific $CO_2$ emissions) by the year 2005, (compared to 1990) equate to an annual reduction of approximately 1.3 per cent. In comparison, between 1970 and 1993, specific energy consumption by West German industry fell by 42 per cent, an annual average of 2.3 per cent (Kohlhaas *et al.*, 1996).

Some care should be taken in comparing German targets with trends during the reunification period in Germany as this was a period of considerable restructuring within industry. For example, between 1987 and 1993, absolute $CO_2$ emissions fell by approximately 22.5 per cent, half of which is attributed to restructuring, modernisation and the drop in steel production in the former East Germany (BDI, 1996).

In the case of the Netherlands, for the basic metal industries, past trends show low annual efficiency improvements, less than 0.5 per cent yearly. However, this reflects the specific fixed ratio of energy and physical output mentioned above. Adjusting for the definition of energy consumption used in this agreement would show an annual average energy efficiency increase of more than 1 per cent yearly. This

analysis would support the argument made above that the Dutch LTAs (which equate to an annual average energy efficiency improvement target of 2 per cent a year) have been successful in achieving targets for energy efficiency which represent an improvement over baseline trends.

In the case of the United States, it was estimated that Department of Energy industrial research and development programs raised the underlying trend in energy intensity decline from a forecast 1 per cent decline to a forecast 1.3 per cent decline. Based solely on the reported improvement in energy intensity and the targets set by industry, the CE-189 program appears to have been successful. However, a United States Department of Energy study of the costs and benefits of industrial reporting and voluntary targets for energy efficiency concluded that the reported improvements in energy efficiency were likely to have been primarily the result of market response to the escalating energy prices of that time period (USDOE, 1994). Statistical analysis undertaken by the study found no discernible energy savings benefits that could be directly attributable to the CE-189 program. Industries without targets had levels of efficiency improvement similar to those who had voluntarily set targets.

***Costs***

Because of the difficulties of evaluating the performance of voluntary agreements, it is difficult to estimate their cost-effectiveness. Nevertheless, some information on costs to government and the participating industries is available and in some case estimates of returns have also been made.

In the United States**,** voluntary agreements tend to be targeted towards "no-regrets" actions. In other words, voluntary agreements are normally only undertaken if they provide financial benefits, typically energy savings, which provide an economic internal rate of return. Under a voluntary agreement in the United States, the measures of cost-effectiveness are usually industry defined but this is not always the case. For example, Green Lights requires all lighting projects with a 20 per cent or greater internal rate of return to be undertaken. This is considered an adequate return to be a no-regrets approach.

Since United States voluntary agreements are assumed to be (at least) cost neutral, it is relevant to consider other costs that may be imposed by participating in a voluntary agreement. The United States case study finds that the primary cost for short term - energy efficiency oriented programs is reporting. Reporting greenhouse gas emission reductions are a cost that the industry would not undertake in the absence of the voluntary agreement.

United States programs use information and recognition as the main "carrots" to offset the costs of participation in voluntary agreement programs. This is apart from the profit opportunities that the programs seek to encourage. If the action is at least cost neutral (i.e., no net cost or profitable), then the participation cost (reporting) must be less than the perceived benefit of the recognition and regulatory good will. The United States study comments that it is not possible to value these intangibles, even though the companies must consider these intangibles in their decision to participate. In fact, it is the valuation of these intangibles that is likely to be the primary determinant of program participation, while the economics of the greenhouse gas reduction is the primary determinant of undertaking the action.

Federal program costs of Green Lights are projected[7] to be US$ 98 million, from 1994 to 2000 about US$ 16.3 million per year. Reporting costs and data collection are estimated to average about US$ 2 000, but this includes some non-reporting elements of the program, such as surveying facilities for upgrade opportunities. The Climate Wise program budget request is US$ 2 million in financial year (FY) 96,

7. Actual budget levels are highly uncertain, due to ongoing debate over the US federal deficit.

rising to a request of US$ 3.4 million in FY97. The budget for the Industry of the Future program was US$ 42 million for 1996 rising to a requested level of US$ 74 million in 1997. The current steel industry research budget is about US$ 4 million, with about US$ 1.5 million for aluminium.

The United States CCAP has requested US$ 3 million of federal expenditures for the VAIP program from 1994-2000. This program has an estimated public cost of about US$ 1.5 million per year. Participants in the VAIP commit to a fairly detailed level of reporting. The costs of reporting the anode effect information have been estimated to be approximately US$ 2000 per establishment per year (DOE 1994) although, EPA and industry estimates suggests that costs are in fact lower than this, as this reporting involves once-a-year submission of data already routinely collected by industry.

The total annual budget of the Netherlands government for the LTA program amounts to ECU 33 million (US$25.74 million). The overhead costs for industry of participating in the LTAs were estimated to be of the same order of magnitude (van Dril, 1996). Total investments related in some way with the agreement program are estimated to amount to 250 million to 500 million ECU (US$ 195 million to US$ 390 million) although the difficulty of separating out investments which are due to the LTAs from investments which are autonomous of these programs is noted.

These estimates of costs of the LTA program should be viewed in the context of expected cost savings resulting from the program. An improvement of energy efficiency of 20 per cent on primary energy input is expected to yield a saving of 150 petajoules. Based on current price levels for energy this is estimated to represent a value of about NLG 1500 million (US$ 860 million) (The Netherlands, 1996).

### 3.6 The adipic acid industry

The adipic acid industry provides a good example of how co-operation between the worlds major adipic acid producers has facilitated the dispersion of technology to reduce greenhouse gas emissions. In 1991 major adipic acid producers formed an inter-industry group to share information on technologies being developed for $N_2O$ abatement (Reimer *et al.*, 1994). The major adipic acid producers agreed to substantially reduce $N_2O$ emissions by 1996-98. It has been acknowledged that this goal has been facilitated by the co-operative sharing of information. For example, basic design data for developed $N_2O$ control technologies of one major company were made available to other manufactures willing to share in the cost of development.

The success of the adipic acid production industry in reducing $N_2O$ emissions appears to reflect a case where the economic potential (defined in Section 3.4) is close to the theoretical potential for reduction of emissions, which in turn is very close to a complete reduction of $N_2O$ emissions from this industrial process.

# 4. POSSIBLE COMMON ACTION

## 4.1 Possible forms of common action

Common action on voluntary agreements can be pursued at different levels. The following are some possible forms of common action ranging, from an agreement on international co-operation for information sharing, to harmonised action to pursue a certain type of voluntary agreement.

### *1. An umbrella action to exchange information on voluntary agreements and to develop methodological and analytical frameworks to monitor and assess their performance.*

The analysis and study of voluntary agreements is very much in its early stages even though the use of voluntary agreements as a policy instrument is growing rapidly in most Annex I countries. An important first step towards the more widespread adoption of voluntary agreements and more co-ordinated action internationally is to encourage the exchange and dissemination of information between countries concerning the operation of voluntary agreements. This could be achieved through the exchange of information on the characteristics and performance of voluntary agreements issue which have been addressed in this working paper, including:

- the type of voluntary agreements , e.g., target based or performance-based,
- how targets and goals are specified;
- implementation issues; and
- monitoring and reporting procedures.

This type of information sharing is also being undertaken in several other fora. For example the International Energy Agency has released a survey of voluntary actions to mitigate energy related $CO_2$ emissions in IEA countries (IEA, 1996a) and the European Commission recently funded a Workshop on "EU experiences in Environmental Voluntary Approaches" in Paris, 1996. However, further and more specific information is needed if voluntary agreements are to be considered as a legitimate mechanism for implementing international commitments to reduce greenhouse gas emissions. In particular, there is a need to develop methodological and analytical frameworks to assess performance and effectiveness of different types of voluntary agreements. An expert group could be set up to develop guidelines and methodology. Annex I Parties could agree to make such information available through their communications to the Conference of Parties to the UNFCCC.

A good example of this type of information is the need to develop generally accepted methodologies for international comparisons of energy efficiency as reviewed in the case studies for this working paper several of the voluntary agreements specify reduction in terms of an improvement in energy efficiency. However, because of differences in how energy efficiency is measured these targets can not be directly compared. Considerable work is being undertaken to develop these methodologies (Phylipsen *et al*,

forthcoming). Further support and progress of this work would be an important step towards the adoption of voluntary agreements at the international level.

### *2. A general agreement to promote and implement voluntary agreements*

Under this approach, countries would retain the freedom to develop and implement the type of voluntary agreements most suited to their economic, political, cultural and regulatory context. Such an approach would amount to the international endorsement of voluntary agreements as a useful policy instrument that can potentially contribute to reductions in greenhouse gas emissions, while allowing countries the flexibility to implement the type of agreement which is best suited to their own national circumstances.

### *3. An agreement to adopt a particular kind of voluntary agreement*

This option would involve a group of countries agreeing to implement a specific type of voluntary agreement although stopping short of full harmonisation. For example a group of countries could agree to start negotiating with their own industries on energy efficiency targets, to be achieved over a given time frame while leaving each country flexibility to set their own targets. Such co-ordination would reduce possible opposition from industry on grounds of competitive disadvantage of the measure, and thus facilitate the negotiation with industry in each country. Another example could be an agreement between countries to establish monitoring and reporting procedures for greenhouse gas emissions and to make this information available.

This approach could also be undertaken at the sectoral level. Individual companies could agree to work to achieve international energy efficiency reduction targets, or the adoption of certain types of technology within their industry, without direct involvement of their governments. Governments may, however, participate in the discussion on identifying appropriate international emission reduction or energy efficiency targets. Governments may need to be involved at least to agree to maintain a stable regulatory environment, and to establish monitoring and audit procedures for reporting. An example of this approach is provided by the agreement of the major producers of adipic acid to share information to facilitate the adoption of technology to reduce $N_2O$ emissions (see Section 3.6).

### *4. A group of countries pursuing similar types of voluntary agreements with similar goals agree to work towards harmonising their voluntary agreement.*

This option would represent a further step with countries agreeing to pursue a similar type of voluntary agreement including the possibility of agreeing to implement similar measures or pursue agreed targets internationally. Similarly a group of countries could agree to negotiate identical or differentiated targets on energy efficiency with their respective industries. The advantage of harmonising action in this way is that it may reduce competitiveness concerns of industrial participants if they know their international competitors are required to meet similar targets. This type of approach would appear to be most congruent with the "target based" type of voluntary agreements or "negotiated agreements" which have been discussed in Sections 2 and 3.

### *5. Adoption of voluntary international standards.*

A variation of this approach for common action would be for industries to voluntarily undertake to meet internationally agreed standards or codes of environmental practice relating to energy efficiency or greenhouse gas emissions. There are several examples of international programs which specify environmental management systems and auditing processes. Examples include the Chemical Manufacturers Association (CMA) Responsible Care Program, the Coalition for Environmentally Responsible Economies principles and the international environmental management standard, ISO 14,000 (Nash and Ehrenfeld, 1996). If a body such as the ISO could develop guidelines or standards relating to reduced greenhouse gas emissions or energy efficiency, industries could choose whether to voluntarily adopt these guidelines.

## 4.2 Possible participants and vehicles for action

The discussion of possible participants and vehicles for action depends on the type of "common action" being advocated. In principle, more co-ordinated action between countries in relation to voluntary agreements can be undertaken by any collective grouping of countries or industry. The CMA Responsible Care program mentioned above was set up to encourage industry led initiatives to improve the public perception of the chemical industry (Nash and Ehrenfeld, 1996). International industry associations could play an important role in promoting similar initiatives in response to climate change concerns, providing expertise and co-ordinating the exchange of information with their member companies. However, international industry or trade associations should not be the sole participants. To the extent possible individual companies should also be involved.

At intergovernmental level the European Union already has some experience in voluntary approaches with industry, including eco-management and audit schemes for large companies, and eco-labelling schemes for washing machines and dishwashers, although the latter has become a directive. Another example of international co-ordination is the above mentioned agreement between European ministers of transport and the automobile industry. The agreement has two main objectives: "substantially and continuously reduce the fuel consumption of new cars sold in ECMT (European Conference of Ministers of Transport) countries, and obtain tangible and steady reductions in total $CO_2$ emissions from car transportation. No common targets were set because of different levels in per-vehicle consumption among countries.

The European Commission is currently reviewing the use of voluntary agreements in their member states and in particular addressing the question of their compatibility with other European Community legislation and the extent to which they are a legitimate policy instrument to meet European Union international commitments on climate change. An important example of this is the question of whether countries which have implemented target-based voluntary agreements would be exempt from a possible future Directive on $CO_2$/energy taxes by a member country.

For those forms of common action mentioned above which are likely to require some form of third party participation, the following are two examples of organisations that could play a role:

- The International Energy Agency's Energy Technology Collaboration Program provides a framework for experts to work co-operatively on energy technology research and development. Specific energy technology activities are set up under simple contractual arrangements called Implementing Agreements (IEA, 1996b). The Implementing Agreement provides the legal mechanism for establishing the commitments of the participants, the management structure to guide the activity, and the distribution of the

benefits derived from the co-operative work. These could be a vehicle for action among member countries of the IEA and other countries willing to participate. Once signed, implementing agreements become legally binding.[8] However, the specific subject of the agreement might be to agree to put a "voluntary" process in place.

- The International Organisation for Standardisation (ISO) could be a vehicle to promote energy efficiency in industry on a voluntary basis. The recent agreement on the ISO 14000 standard is an example of a "voluntary" approach to environmental management for industry. A company which wants to obtain ISO 14001 certification has to contact an accredited certifier. The certifier will, after audit, deliver (or not deliver) the ISO 14001 certificate. Monitoring is also scheduled to assess whether certified companies respect the standard. Although standard-setting is not at all equivalent to a voluntary agreement, this standard is optional. Companies comply in order to have their good environmental management practices recognised, according to a widely recognised international standard. Another possible contribution of the ISO to energy efficiency international agreements could be to establish a norm to measure energy efficiency.

### 4.3 Rationale for common action

Voluntary agreements offer a number of advantages. From the perspective of industry they are flexible policy instruments which allow companies the freedom to implement measures to achieve environmental objectives in a manner which best suits the economic circumstances of the individual company and/or industry. In the case of voluntary agreements aimed at identifying "no regrets" options, participation in voluntary agreement may allow industry to overcome certain barriers to implement economically profitable practices. In the case where targets or performance goals present net real costs to industry if they are to be met, a voluntary agreement allows industry the flexibility to pursue the most cost- effective options.

From the perspective of government and society voluntary agreements encourage industry-led initiatives to address environmental objectives as opposed to 'government led' initiatives. Investment options targeted at meeting environmental objectives may increase in priority over other investment options through the more widespread adoption of technology and practices aimed at improving energy efficiency voluntary agreements can contribute to reductions in greenhouse gas emissions.

The disadvantages of voluntary agreements in relation to other policy instruments are that:

- they provide limited potential for achieving reductions in greenhouse gas emissions beyond what is profitable from industry's view point;
- they are time consuming to implement (although a counter argument is that they are less time consuming to implement than traditional regulatory approaches);
- they create more political uncertainty for business than traditional regulation; and
- they create greater uncertainty in achieving environmental targets.

8. There is ongoing discussion of an implementing agreement on Energy Efficiency Policies and Programs. If signed, this implementing agreement would contribute to international norms for designing, verifying and evaluating the benefits associated with developing recognition and corporate commitment activities.

To a large extent the validity of these arguments depends on the particular circumstances in different countries. For example, the issue of how time-consuming voluntary agreements are to implement, in comparison to regulatory approaches, will depend on the particular legal processes and social characteristics of different countries. Nevertheless, information reviewed in many of the case studies suggests that many of the proposed advantages of voluntary agreements listed above may eventuate following their implementation. In particular, emphasis is often placed on some of the less quantifiable advantages such as the promotion of a co-operative approach between industry and government towards attaining environmental objectives and the flexibility voluntary agreements may provide to meet specific technical and economic situations. While there appear to be good reasons for implementing voluntary agreements at the national level, the following questions need to be addressed in considering the rationale for some form of common action with voluntary agreements:

- What benefits are there to countries which participate in jointly implemented voluntary agreements?
- Why should a country which has already successfully implemented a voluntary agreement at the national level wish to participate in a common action voluntary agreement?
- Are there any potentially negative impacts that common action voluntary agreements may have on existing voluntary agreements pursued by countries on a unilateral basis?

Answering these questions is difficult given the different types of voluntary agreements which exist, the different regulatory environments in which they operate, and the different types of common action which can be advocated (see Section 2.1). Nevertheless, from an environmental perspective there appears to be a strong argument for common action, if through the more widespread adoption of new technology and practices, further reductions to net greenhouse gas emissions are likely to occur. Perhaps the most relevant example of this environmental payoff raised in this working paper, is in the adipic acid industry where co-operation between the world's major adipic acid producers has facilitated the dispersion of technology for $N_2O$ abatement.

From an economic perspective developing an argument for common action depends in part on whether the voluntary agreements are targeting cost-effective "no-regrets" options, or whether their implementation would result in some net costs to participating firms. In the case of the former, some form of international co-ordination may assist industry to implement practices which are economically profitable and which also meet environmental objectives. In the case of the latter, an internationally co-ordinated voluntary agreement may help alleviate industry concerns of being put at a competitive disadvantage in relation to their international competitors. That is to say companies may be more likely to invest in technology to reduce greenhouse gas emissions if their international competitors are committed to reach the same targets.

In addition, some of the more general arguments in favour of voluntary agreements appear to be equally valid in the international context. That is, voluntary agreements aim to encourage industry-led initiatives to address environmental objectives and also to foster a co-operative approach between government and industry. Perhaps the most important attribute of voluntary agreements which make them particularly promising for "common action" is their flexibility - they can be designed to be implemented in several countries and yet allow for specifics to differ according to national circumstances. Furthermore, because they rely on the participation of industry they also have strong political viability as a policy instrument for common action.

## 4.4 Further issues concerning the implementation of voluntary agreements

### *The "Free rider" problem*

Linked to the above issue of competitiveness concerns is the issue of how to deal with "free-riders' in a voluntary agreement. "Free-riding" occurs when one or more companies are able to benefit from a voluntary agreement (e.g., in terms of the good publicity which the whole industry may benefit from) without making any real contribution themselves. For example, a single company may do little to contribute to the meeting of a particular greenhouse gas reduction target, but may benefit from the positive publicity benefits the program generates. A counter argument however, is that for those voluntary agreements which emphasise "no regrets" actions, e.g., actions which reduce greenhouse gas emissions, and also directly benefit the enterprise concerned through energy savings - the free rider issue is not of particular concern. Companies that do not take up "no-regrets" actions may be doing a disservice to themselves rather than "free-riding".

### *Co-ordination with other regulatory measures*

There is a need for voluntary agreements to be co-ordinated with other regulatory measures including permitting requirements, and energy taxes. At the international level, the question arises as to whether voluntary agreements are acceptable as valid policy instruments in the place of regulatory measures. For example, the Dutch Government has maintained that Dutch companies that are at a competitive disadvantage because of their participation in LTAs should not pay the levies proposed by the EC in 1991.

The European Union Commissioner on the Environment has suggested some conditions for voluntary agreements to be used to comply with EU environmental legislation. These shed some lights on the political acceptability of such tools in Europe:

- the objectives should be clearly defined, and quantified whenever possible;
- there should be a timetable for the implementation of objectives;
- the implementation should be monitored and reported;
- there should be a means to discourage free-riders; and
- the agreements, and reports on their implementation should be published and open to public scrutiny.

At a higher level of co-ordination, if there is an agreement among countries to each implement voluntary agreements with industry, each country has to work out the necessary conditions to attract broad participation from its industry. The use of other regulatory measures to assure political acceptability is up to each government.

### *Adequate time frame*

One of the principal advantages of voluntary agreement noted above is that they provide companies with the flexibility to introduce measure to make investment decision in a manner most suitable to their economic circumstances. While some management practises can be implemented instantly, major investment decisions such as the switching to alternative processes and replacement of capital goods are

often made within a ten year horizon. If industry is to be encouraged to take investment decisions beyond the "business as usual" they should be given a suitable planning time in which to do so. Agreements which specify structural measures therefore should match industries' time horizons.

Different types of industries may adopt different time frames in a voluntary agreement. The lifetime of the capital stock (30 years in production) in the electric utility sector makes it possible to address longer time frames, without adding much uncertainty, unless the structure of industry is fundamentally changing. In the case of electricity, the product delivered over the course of the agreement would remain essentially the same (end-use energy, electricity and in some cases, heat). Other manufactured goods, with much shorter product life-cycles require shorter time frames, because previous energy efficiency indicators may not be appropriate for the new products.

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## APPENDIX I: PROFILE OF INDUSTRIES

### 1.1 Iron and Steel

The iron and steel industry is proposed for analysis as an example of energy intensive industry because it is one of the largest single energy consuming processes in the world, consuming approximately 15 EJ or nearly 5 per cent of the annual world energy demand. This energy use leads to the emissions of approximately 5 per cent of global anthropogenic emissions (Worrell, 1995). There is also a relatively small number of manufacturers in the industry and the processes and product mix are somewhat more homogenous than those of other energy intensive processes. Iron and steel companies in different countries are at different stages of development and are evolving in different ways, but many are in the process of adopting new technology and undergoing structural change towards smaller, more flexible plants. According to industry representatives, further significant improvements will require new processes and new products (e.g., lighter weight steel products), which are unlikely to be commercially feasible for some time. New technologies are being developed to improve steel making processes and products, but more research and development is needed to hasten the development and commercialisation of new technology.

#### *Production Processes*

Iron and steel production is an energy intensive industry[9] that currently uses two basic processes to produce a wide range of steel products. Integrated steel production converts iron ore, coke, and some scrap in a sequential process to create high quality steel products. Minimills typically produce lower value carbon steels, like construction grade products, from scrap in an electric arc furnace (EAF). Each of these two industry segments have different implications for greenhouse gas emissions.

#### *Integrated Steel Production*

The basic stages of integrated steel production are coke-making, iron-making, steel-making, and casting/forming. Each of these stages have environmental impacts, of which $CO_2$ is but one. Coke-making is the process through which the volatile compounds are driven from the coal by heating the coal in a sealed oven, or coke battery, at high temperature. The result is a carbon rich fuel that is used to melt the iron ore in the iron-making stage. By-products of coke-making, coke oven gas and breeze, are recovered and used as energy. Coke-making has major environmental impacts. In the United States, new

9. Since most of the environmental impacts arise in the primary processing stage, this working paper concentrates on Standard Industrial Classification (SIC) 331, *Steel works, Blast Furnaces, and Rolling and Finishing Mills.*

requirements under the United States Clean Air Act Amendments may force the closure of some of the few remaining coke oven batteries, increasing pressure to find alternatives.

Iron-making occurs in the blast furnace, where coke is used to reduce iron ore to molten iron. Like the by-products from coke-making, gases produced by the blast furnace are recovered, cleaned and burned to provide energy in other plant operations. Molten iron from the blast furnace, along with alloy materials, flux, and scrap are placed in the basic oxygen furnace (BOF),where it is melted and refined by injecting oxygen. At this stage, the molten steel can be cast into ingots and cooled or cast continuously into semi-finished shapes. Continuous casting avoids the need to re-heat the ingots for finishing into the required products. In the United States, continuous casting accounts for 86 per cent of all raw steel production in 1992 and is much more energy efficient than the old ingot casting methods.

***Minimills***

Minimills use a ferrous scrap in an Electric Arc Furnace (EAF), which melts and refines the scrap metal, and continuously casts the molten steel to produce semi-finished products directly. There is no coke or iron-making stage at a minimill, which allows for smaller, less capital-intensive plants. The absence of coke and iron-making means that minimills can produce steel from recycled feedstocks using one-fourth to one-half as much energy as from primary materials. These plants are also more likely to be located near urban centres, where scrap is available. Minimills are not without environmental issues, but the major issues are solid waste from the EAF steel-making process. The greatest impediments to the expanded use of EAF are contaminants in scrap that can make the resulting product unsuitable for the lucrative sheet steel market.

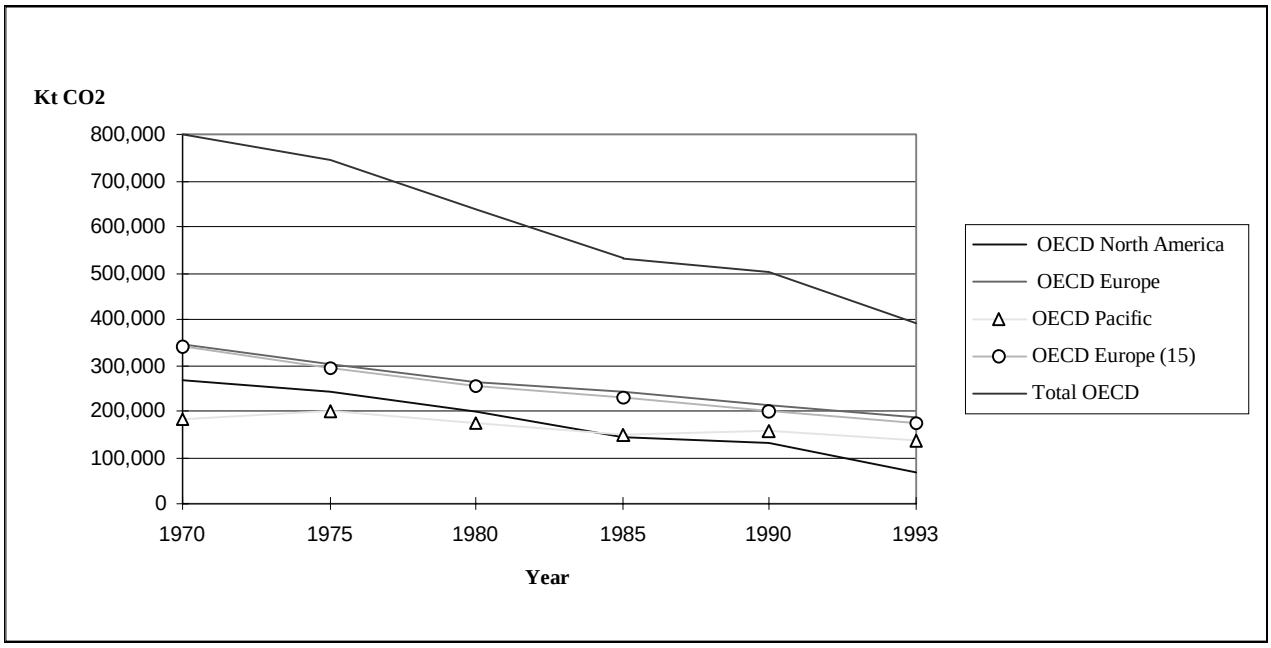
***Production and emission trends***

Total world steel production in 1993 was estimated to be 730 million tonnes (IEA, 1996c). World steel production has historically been concentrated in the Annex I countries. In 1973 the OECD and Former Soviet Union (FSU)/Central and Eastern Europe (CEE) countries produced 67 and 25 per cent of world steel production, respectively. By 1993, however, these figures were 52 and 17 per cent, respectively (IEA, 1996c).

World steel production is projected to increase to around 980 million tonnes in 2010, equivalent to an annual average growth rate of approximately 1.7 per cent from the 1993 level. The annual average growth rate of steel production in the OECD countries is projected to be just 1 per cent during this period, while for the FSU/CEE countries it is projected to grow at approximately 2 per cent per annum (IEA, 1996c).

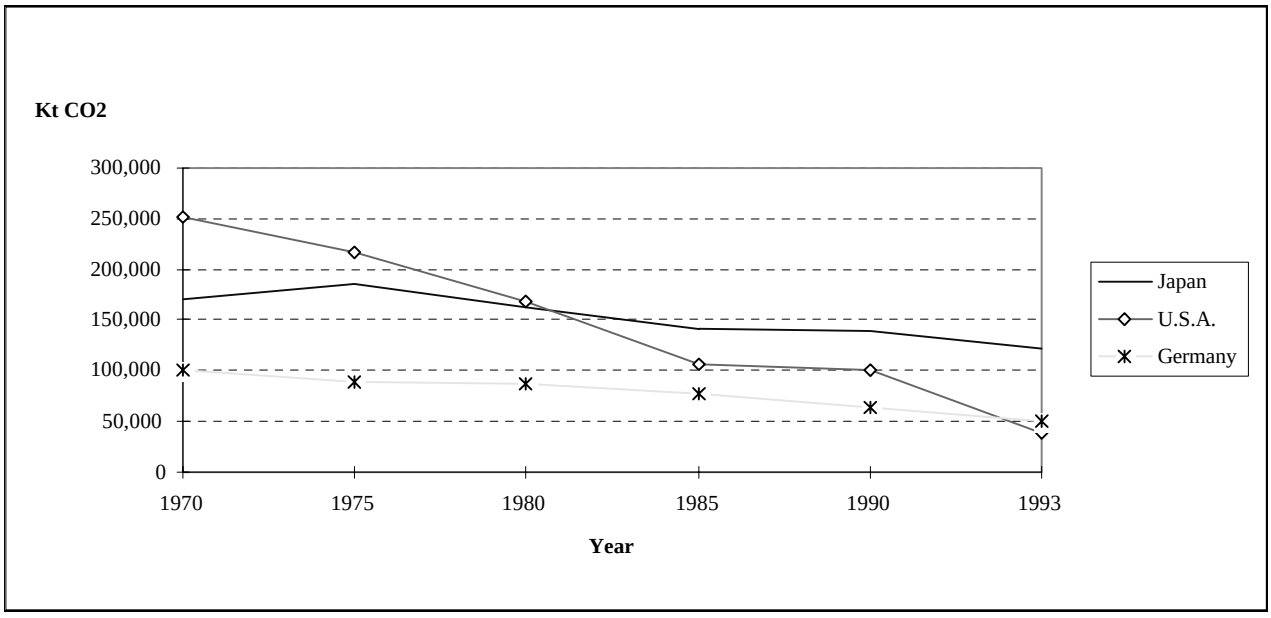
Trends in Total $CO_2$ emissions (measured in kilotonnes) for OECD regions are presented in Figure 2. Trends for three of the countries are covered in the case studies in Figure 3.

**Figure 2: Trends in Total CO2 Emissions from Iron And Steel: OECD**




Source: IEA

**Figure 3: Trends in Total CO2 Emissions from Iron And Steel: *Japan, the United States and Germany***




Source: IEA

***Potential for reduction of greenhouse gas emissions***

Because the iron and steel sector is an energy intensive industry, the potential for improvements in energy efficiency is an important indicator of the potential for reduction in $CO_2$ emissions. A study by Worrell

(1995) examined the potential for improvement of energy efficiency in steel making. A summary of this study's findings on short term (to the year 2000) technical potential for energy efficiency improvement (in PJ) for several countries and regions is shown in Table 1.

### Table 1: Technical potentials for energy efficiency improvement

Units measured in PJ in the short term (to the year 2000) in the steel industry for several countries and regions, expressed as primary energy

| Country/Region | Share World Steel production 1990 ( per cent) | Savings Primary Energy (per cent) |
|---|---|---|
| **European Union** | **17.8 per cent** | **38 ±4 per cent** |
| **France** | **2.5 per cent** | **37±4 per cent** |
| **Germany** | **5.0 per cent** | **34±4 per cent** |
| **Italy** | **3.3 per cent** | **45±5 per cent** |
| **Netherlands** | **0.7 per cent** | **16±2 per cent** |
| **United Kingdom** | **2.3 per cent** | **36±4 per cent** |
| **USA** | **11.5 per cent** | **51±6 per cent** |
| **Japan** | **14.3 per cent** | **26±3 per cent** |
| **Czech republic** | **0.9 per cent** | **46±6 per cent** |
| **Poland** | **1.8 per cent** | **57±6 per cent** |

Source: Worrell 1995[10]

The short-term technical potential savings vary between 15 per cent and 60 per cent (average of 30 per cent) of the current primary energy demand for various countries. The profitable, or market potentials are estimated by Worrell to be 10-15 percentage points lower, taking current energy prices into account.[11] Those measures which are identified as having high potential savings are dry coke quenching, top gas power recovery at the blast furnace, the recovery of BOF-gas and the switch from continuously casting and direct rolling.

In the longer-term (i.e., by the year 2020) the Worrell study recognises that major new technologies can be made commercial. The major developments are found in iron-making (e.g., smelt reduction) and shaping (e.g., near net shape casting). This could possibly reduce the specific energy consumption by a further 50 per cent (compared to the potentials in the short term). It is also recognised that, besides the major opportunities for energy efficiency improvement, a structural shift towards the production of secondary steel may reduce the energy demand even further.

Some care should be taken in interpreting these estimates, as many country estimates of potential improvements for energy savings are lower than the figures estimated in the Worrell study, particularly in relation to estimates of market potential. The guidelines for market potential being 10-15 points lower than the short term technical potential used by Worrell is based on analysis of the Dutch steel industry.

10. These estimates are based on technical measures of Specific Energy Consumption (SEC) supplied in the Worrell study. The uncertainty range is estimated on the basis of the reliability of data sources (Worrell, 1995).

11. Profitable energy savings are calculated by Worrell using a simple payback period (PBP) of 7 years and energy prices in the Netherlands in the year 1990 (Worrell, 1995). Accepting a PBP of 7 years is exceptional for most industrial sectors (e.g., 2-3 years in the chemical industries) but occurs more often in the steel industry.

The United States, for example, suggests a maximum potential improvement in energy intensity of 10 per cent for minimills and 14 per cent for integrated producers. By way of further comparison, ETSU figures of the UK iron and steel industry, which take into account cost effectiveness, give a projection of 5 per cent reductions in energy intensity for the period 1990-2000. Country estimates for potential energy savings will also vary according to the base year starting point for the analysis, which in the case of the Worrell study was 1988.

## 1.2 Aluminium

The aluminium industry is an energy intensive industrial sector. World-wide aluminium production amounted to 25 million tonnes in 1990, including both primary (about 19 million tonnes) and secondary aluminium (about 5 million tonnes) (Metallstatistik, 1993). The primary aluminium industry is the largest source of two PFCs, $CF_4$ and $C_2F_6$ which are extremely long-lived and potent greenhouse gases. Because the manufacture of aluminium is an electricity intensive process it is also a major source of $CO_2$ when the emissions from electricity are considered.

### *Production processes*

Aluminium production can be separated into primary and secondary processes. In the primary aluminium industry, the main processes are alumina production and aluminium production. After mining, bauxite (aluminium containing ore) is converted to alumina by treating it with sodium hydroxide at elevated temperatures and pressure (Phylipsen *et al.*, forthcoming). Subsequently, alumina is electrolytically reduced to primary aluminium in the Hall-Heroult process. After electrolysis, the electrodes are partly recycled. About 20 per cent of the feedstock for anode production are from recycled anode material (Spin, 1992).

Finally the crude aluminium can be cast into intermediate products. The most energy-consuming processes are the production of alumina, the production of anode, and the electrolysis. Of these, electrolysis is by far the most important, accounting for about 85 per cent of primary energy consumption (Phylipsen *et al*., forthcoming).

PFCs are formed during anode effects, a disruption in the primary production process caused by too little alumina being added to the process, fluctuations in current density, or process temperature drops. Anode effects have an adverse effect on the smelter efficiency and so are undesirable to the aluminium industry regardless of the greenhouse gas emissions. PFC emissions, which occur as a by-product of the smelting process, can be reduced by reducing the frequency and duration of anode effects. As the reduction of anode effects also improves the operational efficiency of the smelting process, this measure can also reduce energy requirements of aluminium production.

The secondary process involves the recycling of aluminium scrap. Because both alumina production and electrolysis are omitted from this process (and therefore also anode production), much less energy is needed to produce secondary aluminium (aluminium from recycled scrap can made with about 5 per cent of the direct energy).[12] Secondary aluminium accounts for almost one-third of the supply of aluminium. Secondary aluminium processing also produces no PFCs.

12. This does not include the full life cycle, including collection, sorting, etc.

***Production and emission trends/forecasts***

As noted above, world-wide production of aluminium in 1990 was 25 million tonnes. A breakdown of these totals in various regions is provided in Table 2.

**Table 2: Production of aluminium in various regions in 1990**

| Country/region | Production of Aluminium | | |
|---|---|---|---|
| | Total | Primary | Secondary |
| Canada | 1651 | 95 per cent | 5 per cent |
| USA | 6441 | 63 per cent | 37 per cent |
| Japan | 1124 | 3 per cent | 97 per cent |
| West Europe (OECD) | 5302 | 68 per cent | 32 per cent |
| CIS | 3582 | | |
| Eastern Europe | 760 | 93 per cent | 7 per cent |
| Oceania | 1530 | 98 per cent | 2 per cent |
| **World** | **25132** | **77 per cent** | **23 per cent** |

Source: Metallstatistik, 1993 cited in Phylipsen et. al, forthcoming.

***Potential for the reduction of greenhouse gas emissions***

As is the case with the steel industry, an important indicator of the potential for reduction of $CO_2$ emissions in the aluminium industry is the potential for improved energy efficiency. Comparative information on energy efficiency potentials for the aluminium industry is, however, limited. The potential for reducing PFC emissions through the adoption of anode reducing technology appears to be considerable.

## 1.3 Adipic Acid

Adipic acid is one of the largest volume synthetic chemicals produced in the world each year, with a current annual global production of 1.8 million metric tonnes (Reimer *et al.*, 1994). The primary use for adipic acid is as raw material for the production of nylon. Other uses include its incorporation in plastics, lubricants, resins, plastics foams and foods. During the acid production process, $N_2O$ is produced as a by-product. At present, net emissions of $N_2O$ by the adipic acid industry account for approximately 5-8 per cent of world-wide anthropogenic $N_2O$ emissions[13] (Reimer *et al*, 1994).

***Potential for the reduction of greenhouse gas emissions***

Based on technology developments which are occurring within the industry, the potential for reduction of $N_2O$ emissions from adipic acid manufacture is very high. Technology developments currently being developed and designed by producers include improved thermal destruction, conversion to $NO_x$ for recycling and catalytic $N_2O$ destruction. Two of the four United States plants producing adipic acid

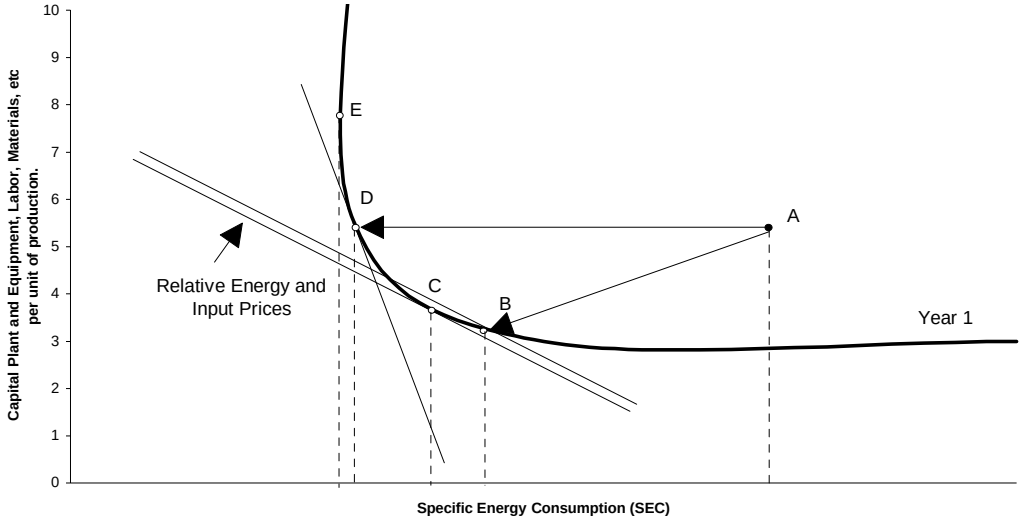
13. $N_2O$ emissions from adipic acid are fairly well known and easy to estimate, whereas the other major source is agricultural soils. In the case of agriculture the estimation of emissions is still highly uncertain because of lack of understanding of the different processes and their contribution to agricultural emissions. As a result percentage shares may be misleading.

currently decompose and capture $N_2O$ with reported control efficiency at 99 per cent. In Germany there are two plants which produce adipic acid. The introduction of a catalytic decomposition facility at one plant has led to a 99 per cent reduction in $N_2O$ emissions. The remaining plant plans to install a similar facility.

## APPENDIX II: AN ECONOMIC FRAMEWORK FOR EXAMINING THE PERFORMANCE OF VOLUNTARY AGREEMENTS[14]

The distinctions between the different types of potential energy improvement were introduced in chapter 2 (Figure 1). These distinctions are important in considering the potential of voluntary agreements to increase energy efficiency or to reduce greenhouse gas emissions. The effectiveness of the different types of voluntary agreement program will depend on the specific characteristics of the industry and the type of energy efficiency potential which is being targeted. Figure 4 illustrates these concepts with a curve that represents the unit energy and other costs under currently available technology.

**Figure 4: Theoretical Framework for Assessing voluntary agreements**



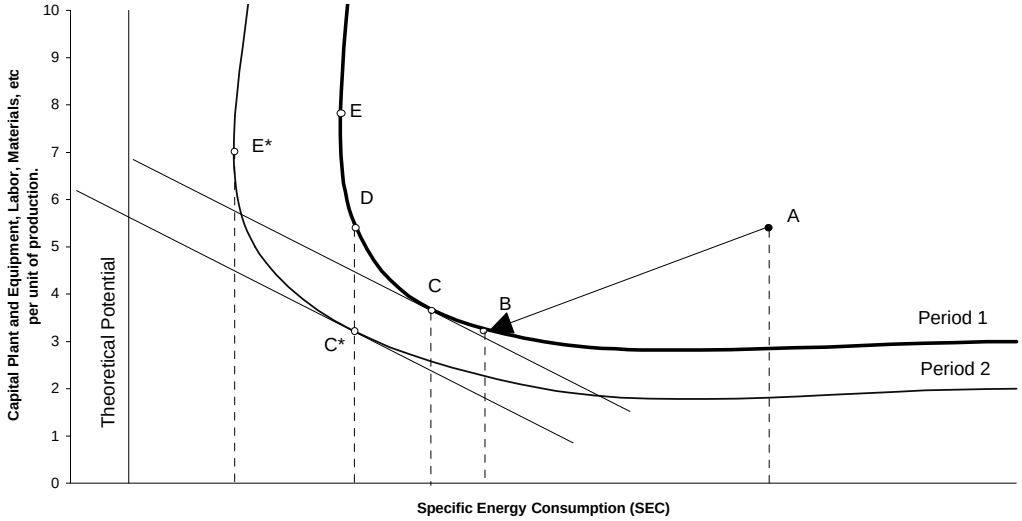

Market potential is defined as the potential savings that can be expected to be realised in practice. The market potential therefore reflects what is seen to be technically and financially viable by business. The market potential is determined by the difference between average and best practice under prevailing market conditions. Figure 4 represents market potential as moving from point A (current average practice) to point B. In this example it represents a proportional reduction in all costs, i.e., improving the overall efficiency of the process. The economic potential is defined as the potential savings that can be achieved by completely optimising costs, relative to best practice. Figure 4 represents this as an incremental movement from B to C. The relative prices of energy and other inputs are represented by the line tangent to point C. Capital, labour and materials substitutions are made for energy to lower energy use and lower total costs. This is analogous to a conservation supply curve (Stoft 1995).

14. This appendix was prepared for the OECD by Gale Boyd of the Argonne National Laboratory and Jeff Dowd of the US Department of Energy. It draws heavily on a working paper on the subject by the authors.

Social potential is defined as the potential savings that can be achieved at a net positive economic effect. In this context, the economic effect is taken to mean the net economic effect to society. This represents internalising the social costs of energy use. Figure 4 represents this as a shift in relative energy costs and a movement from C to D. Private costs are higher, but total social costs are optimised. The technical potential is defined as the achievable savings resulting from the maximum energy efficiency improvement available in the period under investigation, regardless of cost considerations. In Figure 4 this is achieved at point E, the lowest unit energy use that is feasible using current technical knowledge. This represents the best that can be achieved under current technology knowledge and is an upper bound for energy savings in the period under investigation.

Energy efficiency potentials are not static, but depend upon the state of technology development and knowledge. This last case is illustrated in Figure 5. The new technical potential E* is close to the theoretical potential.[15] In addition, it is possible through technology innovation to shift the economic potential. In Figure 5 the new economic potential, C*, has achieved the same level of energy efficiency as the old social potential, D. Voluntary agreement oriented policy must determine where the starting point, A, is. This does not simply mean quantifying current average practice, A, but understanding how close A is to B. As shown, the market potential is large, but this need not be the case. Average practice may be quite close to B, indicating a small market potential savings. The shape of the technology curve is also needed for effective voluntary agreement evaluation. In other words, one needs to know how close B is to C, C to D, etc.

**Figure 5: Impact of Technological Development on voluntary agreements**




15. The *theoretical potential* of energy efficiency improvement for a certain process or product is determined by the thermodynamic laws and is defined as the *difference between the current energy consumption and the thermodynamic minimum energy consumption.* This is a useful concept since it can reveal if current practices are close to this limit. If so, then reductions in GHG would require changing the level of use of the product or process, rather than optimising energy efficiency.