T@W: Sustainable Energy Technology at Work

Sustainable Energy Technologies and RTD practice at the ETS and CDM markets:

An inspiration for the various market actors in Europe and the world

www.setatwork.eu

SUSTAINABLE ENERGY TECHNOLOGY AT WORK

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Contact details for the members of the T@W Consortium can be found on the inside back cover of this publication.

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Preface

The threat of climate change is a challenge for the global society and appropriate measures must be put in place to ensure environmentally sound development.

Undertaking efforts for the protection of the global climate are key elements in EU policy, including measures to be implemented in European society and in cooperation with third countries. Other pillars of the EU energy policy focus on increasing the EU's security of supply and competitiveness, including raising Europe's innovative industrial competence.

To this end, on 23 January 2008 the European Commission put forward an integrated proposal for Climate Action. This includes a directive that sets the following targets for the European Union by 2020, to be observed by all Member States:

- 20-30% Greenhouse House Gas reduction
- 20% energy efficiency improvement
- 20% renewable energy including 10% biofuels

The targets are accompanied by a number of policy instruments in the form of Directives and supporting measures to ensure their fulfilment.

Mr. José Garcia Fluxa speaks at the T@W Workshop in Cologne in May 2007

In 2003, the European Commission put in place the EU Emission Trading Scheme (ETS) as a cornerstone in the fight against climate change to help EU Member States achieve compliance with their commitments under the Kyoto Protocol. The ETS was the first international trading system for CO_2 emissions in the world and covers over 11.500 energy-intensive installations across the EU, which represent close to half of Europe's emissions of CO_2. These installations include combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp and paper. The first trading period of the ETS ran from 2005-2007, the second runs from 2008-2012, and the third will start in 2013.

In addition, International Treaties allow for joint actions on meeting climate change in the form of the project mechanism, the Clean Development Mechanism (CDM) and Joint Implementation (JI). The benefits of CDM for developing countries are new financial resources, better technology and achievement of its sustainable development objectives, while the benefits for developed countries include less expensive emission reduction opportunities and access to emerging markets for EU technology suppliers.

The **T@W Project - Sustainable Energy Technology at Work** took up the challenge of assisting European companies working under the ETS to handle their CO_2 situation by using renewable energy and polygeneration technology, either through 'in-house measures' or by entering into JI or CDM projects. The latter involved cooperation with organisations in Asia, especially China, Thailand, Malaysia and India, aimed at obtaining mutual benefits.

Meeting the challenges of climate change requires continuous effort. Therefore it is a pleasure to announce that the European Commission, through the FP7 programme, will support a follow-up project entitled **SETatWork** for thematic promotion of sustainable technology at carbon markets. This new project will run from 2008-10. As well as continuing the activities initiated by T@W in Europe and Asia, the new project will expand both its technology and geographical coverage to focus on energy efficiency in industry and will include the Latin America regions, especially Brazil and Chile.

With these words, I invite readers to take benefit from this publication by learning more about the carbon markets, its sustainable energy technology aspects and the lessons learnt from the T@W action, as well as encouraging you to become involved in the continuing activities of SETatWork.

Mr. José Garcia Fluxa
European Commission, Directorate-General for Energy and Transport

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1. The Sustainable Energy Technology at Work projects

1.1. Introduction

The world has entered a new energy era, where energy technology has a vital role to play. Reducing climate change and promoting technology innovations that support a sustainable future is a global challenge. Meeting this goal is a common responsibility. The EU is committed to tackling climate change as a party to the Kyoto Protocol. This requires not only political willingness but also commitments from private actors to see opportunities and help spur technology innovations.

The evolving carbon markets ensure new opportunities for suppliers of **Sustainable Energy Technologies (SETs)**, provide a portal for establishing new business relations and enhance dissemination of innovative energy solutions.

The mission of the T@W: Sustainable Energy Technology at Work project was to address the EU interests in the carbon markets by connecting EU policy goals on sustainable development to business opportunities within the carbon and climate markets. This was to be achieved by facilitating the entry of European know-how on Sustainable Energy Technologies (SET) into the emerging climate markets created as part of mechanisms under the Kyoto Protocol as follows:

European Union Emission Trading Scheme (EU ETS): a comprehensive scheme for trading of CO_2 emissions among large emitting companies within the EU, developed as part of the EU's commitment to reduce greenhouse gas emissions.

Clean Development Mechanism (CDM) market in Asia, which addresses the need for joint action between the industrialized and developing countries, to reduce emissions of greenhouse gases, allowing developing countries to take part in emission reduction initiatives, on a voluntary basis.

Joint Implementation (JI): a project-based mechanism, which can be reciprocally used by industrialized countries to reduce emissions of greenhouse gases.

1.2. Aims and objectives

The main objective of the T@W and SETatWork projects is the thematic promotion of SETs to these emerging markets in Europe, Asia and, from 2008 onwards, Latin America. The focus from 2006 to 2008 was on Renewable Energy Sources (RES); electricity, heating and cooling, as well as Polygeneration. From 2008 the emphasis will shift toward Rational Use of Energy (RUE) and Energy Efficiency in Industry. An additional aim is to exploit results from EU-funded projects supported by RTD Framework Programmes (FP6, FP7), Intelligent Energy – Europe (IEE), Synergy, etc within these markets.

Our key goals are to:

- Position European Sustainable Energy Technologies within emerging climate markets
- Facilitate a sound development within the EU Emission Trading Markets
- Support business cooperation between innovative actors within the climate markets
- Assist industry affected by the EU ETS in increasing its energy efficiency

by assisting EU ETS companies to:

- Reduce emissions and improve energy efficiency
- Develop CO_2 avoidance projects at their own installations
- Develop CDM and JI projects in Europe, Asia and Latin America

  and to

- Assist European SET suppliers in entering EU ETS, CDM and JI markets

T@W was supported by the European Commission's Sixth Framework Programme (FP6) from April 2006 to March 2008. It has been successful in paving the way for SET uptake in the EU ETS companies and industries and in the Asian CDM field, as well as raising a general awareness of high standard SET/RTD technologies, thereby helping European companies to comply with their CO_2 obligations, and providing markets for the SET in EU and Asia.

SETatWork: Sustainable Energy Technology at Work continues these activities from 2008 to 2010 with support from the European Commission's Seventh Framework Programme (FP7). The focus of SETatWork has been extended to cover energy efficiency in industry and the use of polygeneration in Europe, Asia and Latin America. SETatWork aims to generate a sustained effort addressing the EU interests in the carbon markets, including EU policy goals as well as business opportunities. The T@W team invites all EU actors and cooperation partners outside EU to join our mission and enhance Sustainable Technologies at Work.

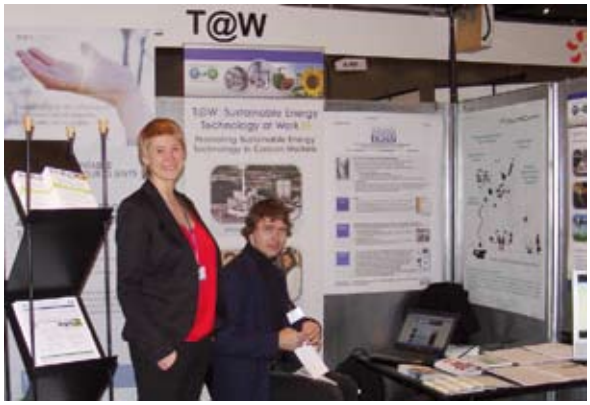
Full details of T@W and SETatWork Consortium members can be found on the inside back cover of this publication.

1.3. Activities

T@W activities commenced in 2006 with an overall assessment of SET opportunities and needs at ETS companies combined with review of relevant previous and ongoing FP RTD results in the field, as well as an overview of RE technology options and the policy framework in the targeted countries in Asia. Key stakeholders in the ETS markets and related technology implementation aspects were identified, along with suitable SET implementation concepts suitable for further exploitation.

Technology needs were identified in targeted companies, along with possibilities for technology transfer to EU ETS companies and CDM projects in Asia. Financing options offered by international financing institutions and local banks, including options for project financing via the Clean Development Mechanism (CDM) concept were examined and used to identify concepts for improved financial products for the SET sector.

T@W Workshop, Copenhagen 2008



T@W Stand, Copenhagen 2008

The project also investigated the market implications of the EU ETS from a company viewpoint combining this with advice on high standard/advanced SET solutions.

Results were used to produce Country Profiles for all T@W partner countries (Bulgaria, Denmark, Germany, Poland, Portugal, Slovak Republic, Spain and the Basque Country, China, India, Malaysia and Thailand), as well as to identify Good Practice EU ETS, JI and CDM projects (GPs) involving sustainable energy technologies. The GPs and Country Profiles are available on the project website.

T@W held Workshops in Cologne in May 2007 and Copenhagen in March 2008 with a view to encouraging specific SET projects in EU ETS companies. In addition, match-making workshops were held in each of the targeted Asian countries - China, India, Malaysia and Thailand – in January/February 2008, which facilitated specific agreements between local market actors and EU companies on business development.

In addition, T@W evaluated and assessed the development of the EU ETS and CDM markets during the project, as well as the potential for new technology intervention. Strategy reports covering project actions in the EU ETS and Asian CDM markets, as well as perspectives in the emerging JI market and the CDM market in Latin America, have been produced and are available for download from the project website.

This publication Sustainable Energy Technologies / RTD practice at the ETS and CDM markets evaluates and reviews the results of the T@W activity in order to extract lessons and compare observations in the targeted regions within Europe and Asia with a view to identifying the best ways to promote SET with an EU perspective. It aims to be an inspiration for EU ETS companies around Europe.

1.4. Services and Facilities

As part of its objectives to support EU ETS companies and technology providers, a number of services and facilities were developed during the T@W project. These are available on the project website **www.setatwork.eu**, have been promoted during T@W events and will be developed further during SETatWork. These include:

Good Practice projects involving EU ETS companies and European Technology and Service Providers, describing both European EU ETS and JI activities as well as CDM in Asia, are available on the website and are promoted during SETatWork events. Examples are included later in this publication.

Partner matching services which enable EU ETS companies interested in participating in projects to register with T@W and receive contact details for suitable technology and service providers and connect those interested in participating in EU ETS and CDM projects to relevant technology providers and interested partners in Europe and Asia.

Project Idea Notes (PINs) support the partner matching services by describing potential for collaboration in CDM projects in Asia and, from 2008, Latin America.

Assessment Tool developed to assist EU ETS companies to comply with their quota and to facilitate adequate SET uptake taking into account the knowledge of FP RTD, and the options of implementing SET at other EU ETS companies in New Member States, and the JI/CDM mechanism.

The Assessment Tool has been designed by the T@W team to help users find the most economical option to answer CO_2 emission problems. This in turn leads to **reduction of emissions** through investment in either internal or external projects. It also provides a cost overview for implementing and conducting CDM/JI projects, providing (for example) typical trading (fixed and variable) costs, as well as an overview of the CO_2 situation. The Tool also guides users to a wide range of resources that will help them make the right decision whether their company is considering **buying or selling carbon certificates** or just wishes to reduce its level of CO_2 emissions. It also facilitates the identification of the important steps required to reach targets, providing examples of good practice, as well as assisting users to calculate reduction measures.

Sample Screen from the T@W Assessment Tool

T@W Database, which contains summary information about the different types of organisation involved with links to third party websites as background and support for the Assessment Tool. A searchable database will be developed within the SETatWork project and will be available in Autumn 2008, as well as input forms enabling service and technology providers to add their information to the database. In the meantime, if you would like your organisation or website listed on these pages, please send an email with contact and link details, specifying the relevant database section(s), to web@setatwork.eu

The T@W Database currently contains information about:

- Technology Providers
- Brokers & Traders
- Funds & Finance
- Consultants including Project Developers
- Other Contacts
- Energy Studies including Energy Audits and Feasibility Studies
- Case Studies and Good Practices
- Links to information on EU ETS, CDM & JI

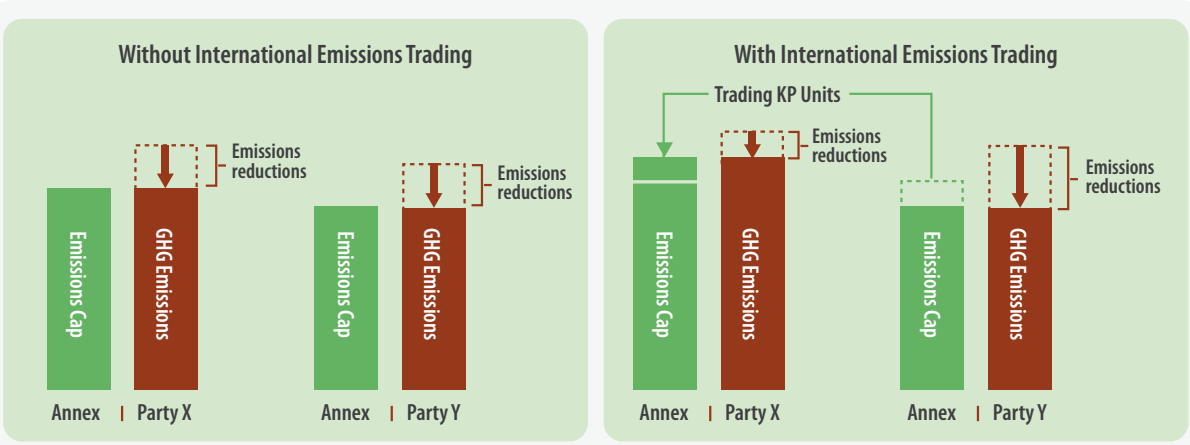
2. Sustainable Energy Technology at the European carbon markets

2.1 Background

The Kyoto Protocol defines three innovative "flexibility mechanisms" to lower the overall costs of achieving its emission targets. These mechanisms are Emissions Trading, Joint Implementation and the Clean Development Mechanism. These enable Parties to access cost-effective opportunities to reduce emissions or to remove carbon from the atmosphere in other countries.

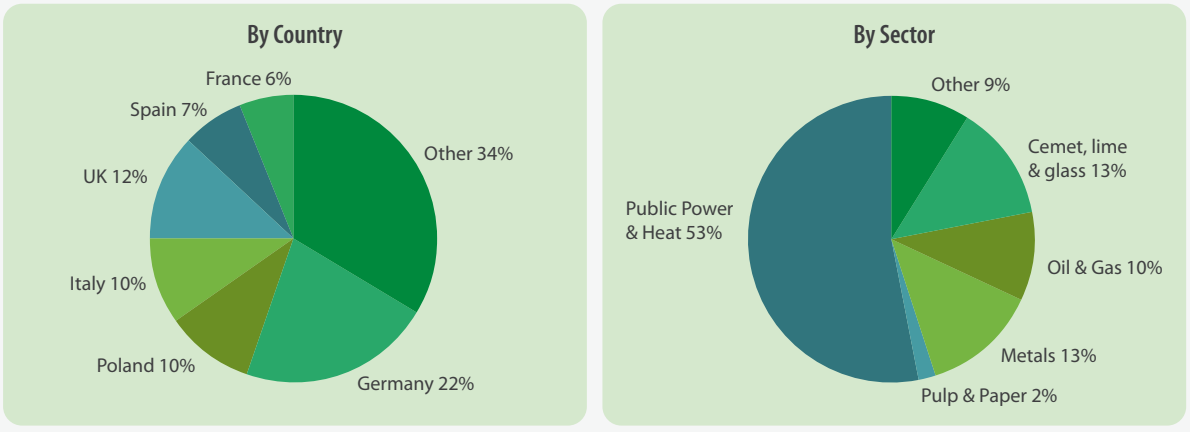
The joint implementation (JI) defined in Article 6 and clean development mechanism (CDM) defined in Article 12 of the Kyoto Protocol provide for industrial countries and their companies (so called Annex-I-Parties) but also local actors in non-Annex-I-Parties to implement project activities that reduce emissions in economies in transition and developing countries, in return for emission reduction units (ERUs) and certified emission reductions (CERs). The ERUs and CERs generated by such project activities can be used by Annex I Parties (i.e. states) to meet their emission targets under the Kyoto Protocol. They can also be used by companies under the European Union Emissions Trading Scheme (EU ETS).

The following figure illustrates the functionality of the international emissions trading (IET). The total amount of emission cap of Annex B parties will not change. Without an IET in place for countries or companies, the emission targets will be achieved with an environmental tax or certain regulatory requirements. With an IET in place, Party Y can trade (sell) Kyoto Protocol units to Party X if Party Y has reduced emissions under its specific cap. The main difference for the EU ETS is that assigned amount units (AAUs) for the greenhouse gas (GHG) CO_2 are transferred into EUAs.

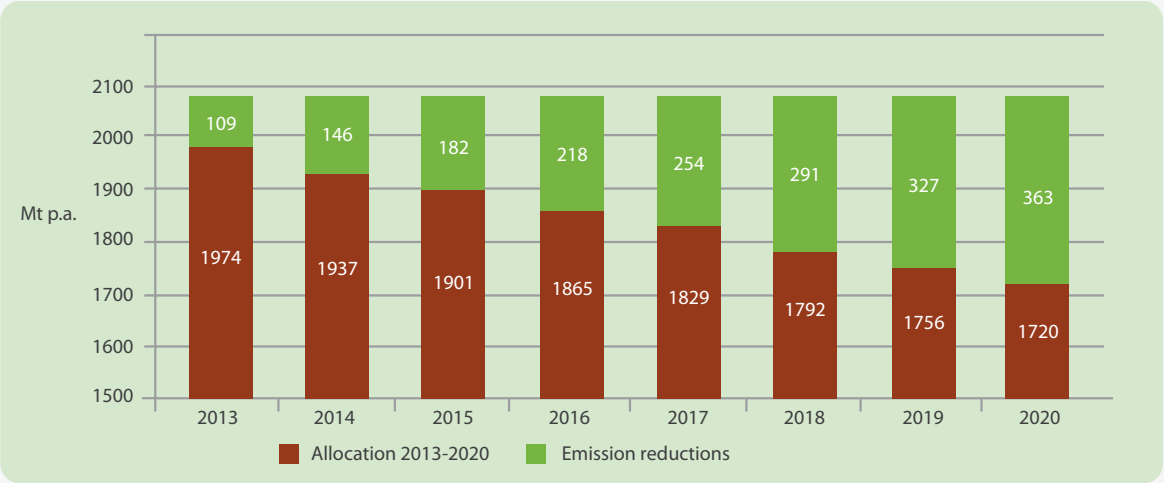


International Emissions Trading (IET) *Source: IGES – CDM in charts (version 5)*

The following figure shows the distribution of allowances of EU ETS for 2008 – 2012 by countries and sectors on the basis of NAP decisions of the EC. Germany has a major fraction of the Europe-wide allocations and the public power & heat sector has the highest amount of emissions.



Distribution of allowances of EU ETS for 2008 - 2012 *Source: PointCarbon*



Emission reductions proposed by the EC *Source: FutureCamp based on European Commission, DG Environment figures*

On 23 January 2008, the European Commission published its proposal for amendments to the emissions trading directive for 2013-2020. The proposal encompasses more harmonization and predictability for investors, an increase of efficiency by extension of scope (installation types, GHGs), prevention of "Carbon Leakage", taking into account of disproportionate growth rate in new member states as well as more influence for the Commission. The main objective is the boost for international negotiations. Moreover there are extended definitions of combustion and exclusion of small installations (<10 000 t CO_2 per annum and capacity below 25 MW). Opt-in remains possible (member states can include more installations and GHGs), waste incineration plants remain excluded, ceramic industry from now on only according to size of oven and air traffic shall be treated like industry.

The European Commission proposal fixes the total quantity of certificates for ETS, which are to be reduced in a linear manner from 2013 until 2020 (1.74% per year). The figure above shows the step-wise approach how the emission cap is lowered from 2012 (2080 Mt.) to 2020 (1740 Mt), i.e. realization of a 21% emission reduction compared to 2005.

According to the proposal mentioned above, auctioning will be a basic principle from 2013 on with a minimum of two-thirds of overall amount of EUAs. Electricity producers are faced with full auctioning for electricity in contrast to heating systems and process heat that will get a free allocation, possibly along the lines of industry procedures. Similar arrangements for other sectors could follow. Sanction payments will be unchanged (100 €/t) and will be indexed according to rates of inflation. Member states may issue EUAs for projects inside the EU but outside the ETS, on the basis of uniform rules, but there will be a restrictive treatment of JI/CDM (depending on a post-2012 agreement). An agreement for linkage of emission trading systems shall be concluded.

The mechanisms and procedures underlying these proposals are described in more detail below.

2.2. Overview of the EU Emissions Trading Scheme (EU ETS)

Introduction

Based on its commitment under the Kyoto Protocol to reduce greenhouse gas emissions, the European Union has developed a comprehensive scheme for trading of Carbon Dioxide (CO_2) emissions among large emitting companies within the EU. The EU greenhouse gas emissions trading scheme (EU ETS), which involves all 27 EU member states, started on 1st of January 2005, from which approximately 12,000 installations across the 27 Member States of the European Union were required to surrender allowances for each tonne of their annual emissions.

The EU ETS is the first CO_2 Trading Scheme in the world and is considered by many economists to be the most cost-effective way to reach the Kyoto target. The Community Independent Transaction Log (CITL) records the issue, transfer, cancellation, retirement and banking of allowances that take place in a 'Registry'.

The provision of a 'National Registry' is mandatory for each Member State. The number of Registries that have gone online can be seen on the Europa website dealing with CITL matters[1] These Registries aim to ensure the accurate accounting of all units under the Kyoto Protocol plus providing an accurate accounting of allowances under the Community scheme for greenhouse gas emission allowance trading.

[1] *http://ec.europa.eu/environment/ets/registrySearch.do*

The aim and functioning of the EU ETS market

The EU ETS is a cap-and-trade system based on the idea that creating a price for carbon through a market-based system provides the most economic way for EU member states to meet their Kyoto obligations. EU Member State governments are required to set an emission cap for all installations covered by the Scheme.

The allocation of allowances to each installation for any given period is to be stated in the National Allocation Plans (NAPs) that the national governments are responsible for delivering to the Commission before each allocation phase. The first phase ran from 2005-2007 and the second phase is running from 2008-2012 to coincide with the first Kyoto Commitment Period.

The EU ETS initially covers energy activities, production and processing of ferrous metals, mineral industry and pulp and paper production. It only applies to emissions of CO_2 in the first allocation phases. However, the design of the scheme allows for subsequent inclusion of other greenhouse gases in future allocation periods.

Emissions trading allows companies to emit in excess of their allocation by purchasing allowances from the market. Similarly, a company that emits less than its allocation can sell its surplus allowances on the market. In addition, the Linking Directive, Directive 2004/101/EC[2], that allows companies covered by the EU ETS to use carbon credits generated from the project based flexible mechanisms (this means Joint Implementation and Clean Development Mechanism), provides new opportunities for companies to fulfil their emission reduction commitment.

Market trends

Ever since carbon became a commodity with a direct financial value, the market trend indicates increasing innovation and new capital entering into the field. Reducing climate change risk and promoting investment in clean energy systems has proved to be a long-term venture that requires billions of dollars of annual investment.

The allocation of Phase I of the EU ETS had to cope with a number of problems, but it is important to keep in mind that this phase was a trial period during which Member States had to submit National Allocation Plans within a short timeframe. In the second phase, the results of several lessons from the pilot phase are already being implemented; examples are the harmonization of allocation rules across the Member States by the European Commission and the tightening of the carbon constraint.

The EU ETS has been operating since January 2005, although bilateral forward trades for EU allowances had already started in spring 2003. However, the number of exchanged allowances in 2005 was very low at 262 million tonnes (Mt). The market

Eskiltuna District Heating Plant, Sweden. Source: KanEnergi AB

nearly quadrupled in the year 2006 with 809 Mt and reached maturation in 2007, when almost 1,500 Mt were traded. This significant increase in transactions included a rising number of Phase II contracts. These contracts, covering future deliveries in the period 2008 to 2012, accounted for around 4% of total exchanges in 2005 but had risen to nearly 85% of market exchanges in 2007.

In 2005, the value of allowance transactions totalled €5.97 billion with an average price of €22 per tonne. The total transactions increased to €15.2 billion in 2006 and reached €24.1 billion in 2007. According to the World Bank, these totals represent about 80% of the value of the world carbon market[3].

From the average price of €22 in 2005 the allowance prices for phase I fell under 1 €/tCO_2 in February 2007 and ended 2007 at 0.02 €/tCO_2 reflecting the allowance surplus 2005-2007 and led to a total disconnection between the first and the second period prices.

The prices for European Union emission Allowances (EUA) for the second period 2008-2012 remained relatively steady and rose to €25 as reaction to the European Commission's stricter review of second period National Allocation Plans (NAP II) as well as to the European Council's decision to reduce EU emissions to 20% below 1990 levels by 2020 (compared to 8% below 1990 in 2008-2012)[4].

Because installations may bank allowances between the second and third periods, the anticipated balance between the supply and demand of carbon emission rights between 2008 and 2012 will be significantly impacted by post-2012 expectations.

[2] *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0101:EN:NOT*

[3] *World Bank, May 2007, State and Trends of the Carbon Market 2007*

[4] *The European Carbon Market in Action: Lessons from the First Trading Period: http://www.aprec.net/documents/actualite/08-03-25_interim_report_en.pdf*

2.3. Overview of JI in Europe

Joint Implementation (JI) is a project-based mechanism of Kyoto Protocol, which can be used on a reciprocal basis by industrialized countries to reduce emissions of greenhouse gases.

The emissions credits generated from these climate-related activities can be deployed by participants in order to comply with their emission reduction targets or can be retailed to other industrialized countries.

At the same time the aim of JI projects is to deliver sustainable development and to supply innovative technological solutions to industrialized countries. JI projects will be allowed to be registered for the first time in 2008.

The mechanism comprises two objectives. These are first, the generation of tradable emission credits (so-called Emission Reduction Units – ERUs), which provide in return revenue streams and second, transfer of environmentally friendly technologies.

JI procedures are based on two alternative 'Tracks'. Host countries with full eligibility[5] are qualified for Track 1 and can apply their own national regulatories. For Track 1 JI eligibility requirements are as follows:

(a) Party to the Kyoto Protocol

(b) Allotted volume has been calculated and recorded

(c) National system for assessment of emissions/sinks installed

(d) National register for tracing of installed transactions

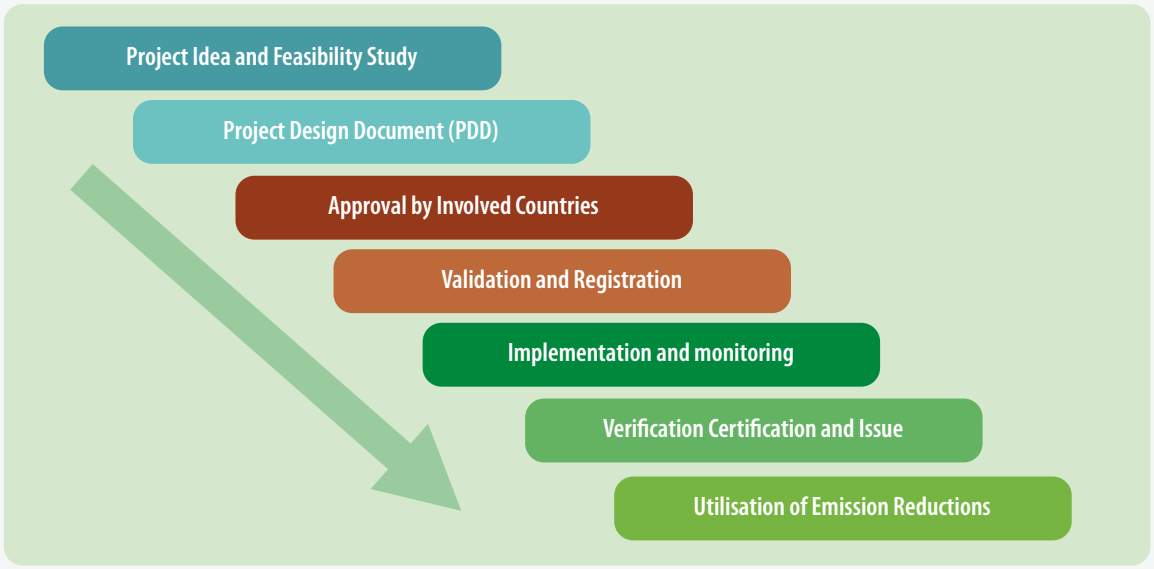
(e) Submission of the current annual inventory

(f) Submission of additional information for calculation of allotted volume

Where a host Party does not meet all of the eligibility requirements, but meets at least the requirements (a), (b) and (d), listed above "Track 2" has to be applied under the rules of procedure of the JISC (JI Supervisory Committee) of the UNFCCC (United Nations Framework Convention on Climate Change)[6]. The "Track 2" procedure is as follows.

The JI project activities start with an idea described by a project participant (PP) in a project idea note (PIN) which is the first part of the JI project process. The project participant asks the government representatives for a letter of endorsement to start the project design document (PDD). The PDD will be validated by Accredited Independent Entities (AIE) and needs approval in order to be registered by the designated national authority (DNA) of the host and investor country. After the project is implemented the emission reduction has to be monitored and verified by an AIE that recommends the issue of the ERUs. The DNA decides if the project follows the recommendation and finally issues the ERUs.

For some participants there is a choice between "Track 1" and "Track 2".

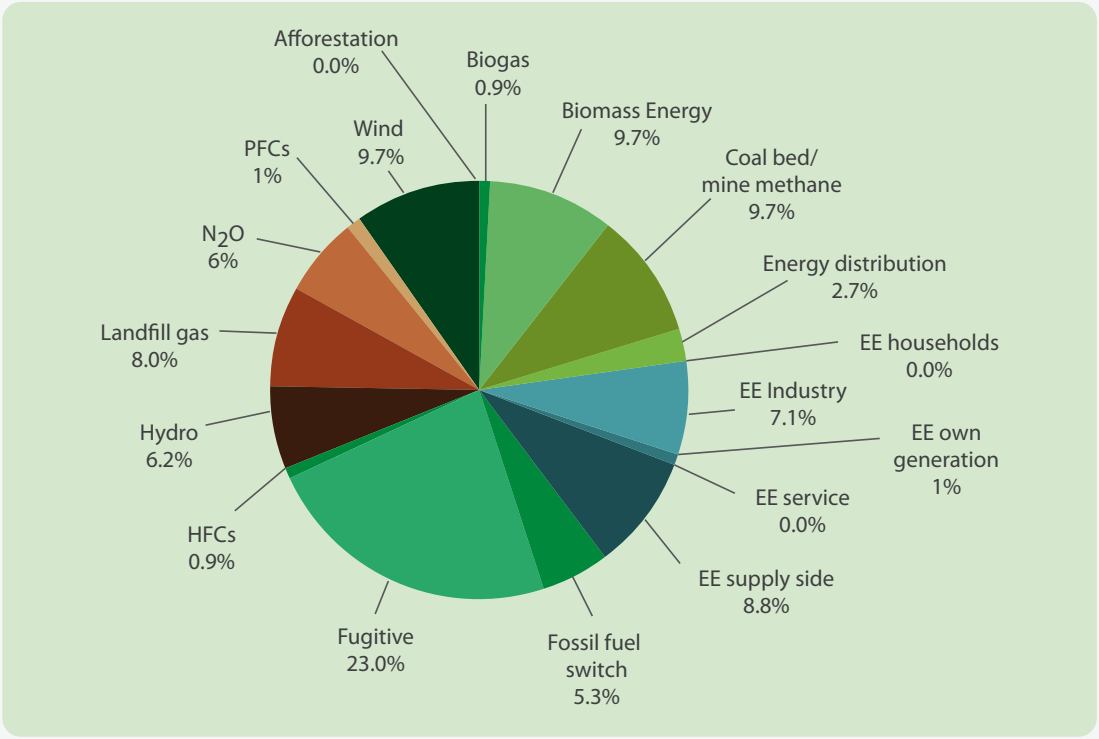


CDM/JI Project Stages *Source: FutureCamp, January 2007*

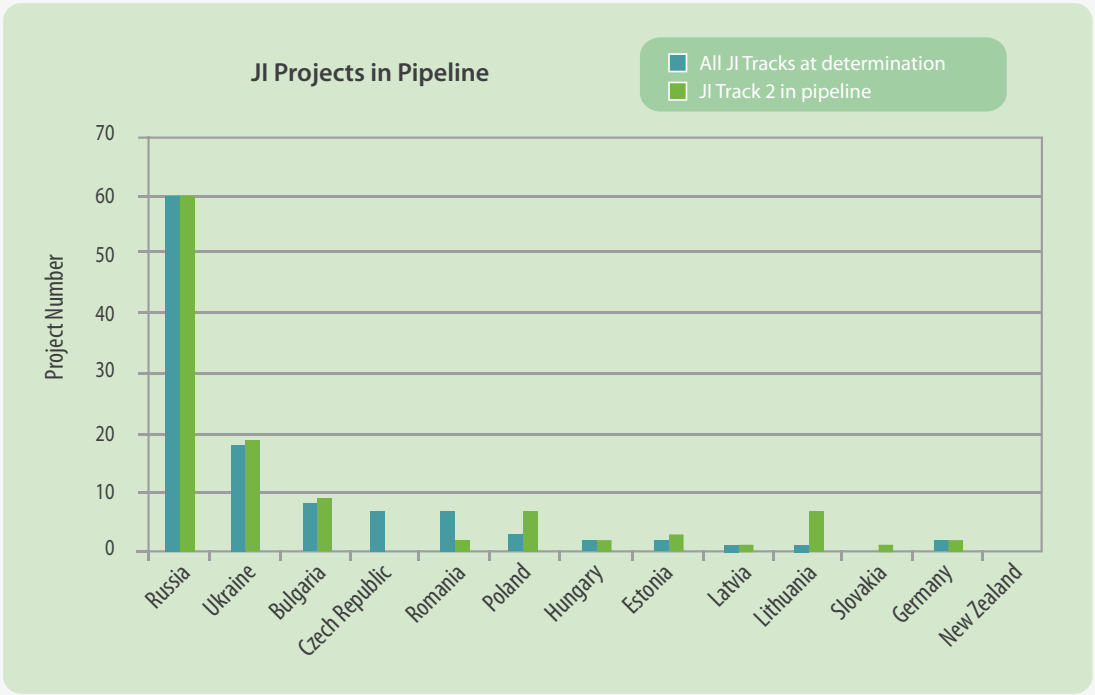
[5] *Fulfil requirements (a) – (f)*

[6] *http://unfccc.int/*

The following charts show the share of JI projects on the basis of scope and country within the EU following "Track 2". Currently there is only one JI project registered, but more than 110 projects in the pipeline; Eastern European countries represent the major fraction of host countries, particularly Russia and Ukraine. The scope "energy efficiency" is subdivided into households, industry, own generation, service and supply side, in order to illustrate the potentials of each sub-scope.

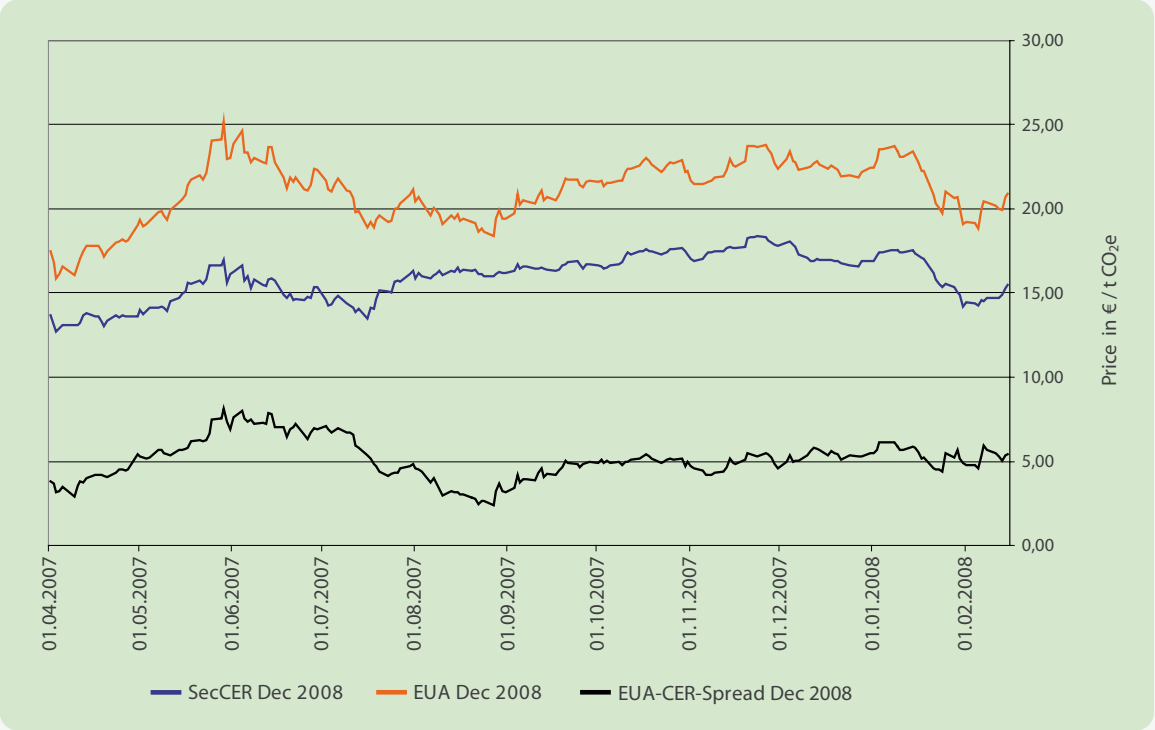


JI pipeline: project distribution per scope
Source: FutureCamp, UNEP RISO CENTRE (last update 1 February 2008)



Overview of JI projects
Source: FutureCamp, UNEP RISO CENTRE (last update 1 February 2008)

The figure below shows EUA and CER prices and the spread between these. No official and transparent price indication exists yet for ERUs, but it is foreseen that they will follow the EUA prices with a discount. The spread between EUAs and CERs appears as a result of restrictive treatments and financial aspects such as counterpart risks.



EUA and CER prices and the EUA-CER Spread, December 2008
Source: Datenquelle: ECX, Reuters, FutureCamp, Stand: 18 February 2008

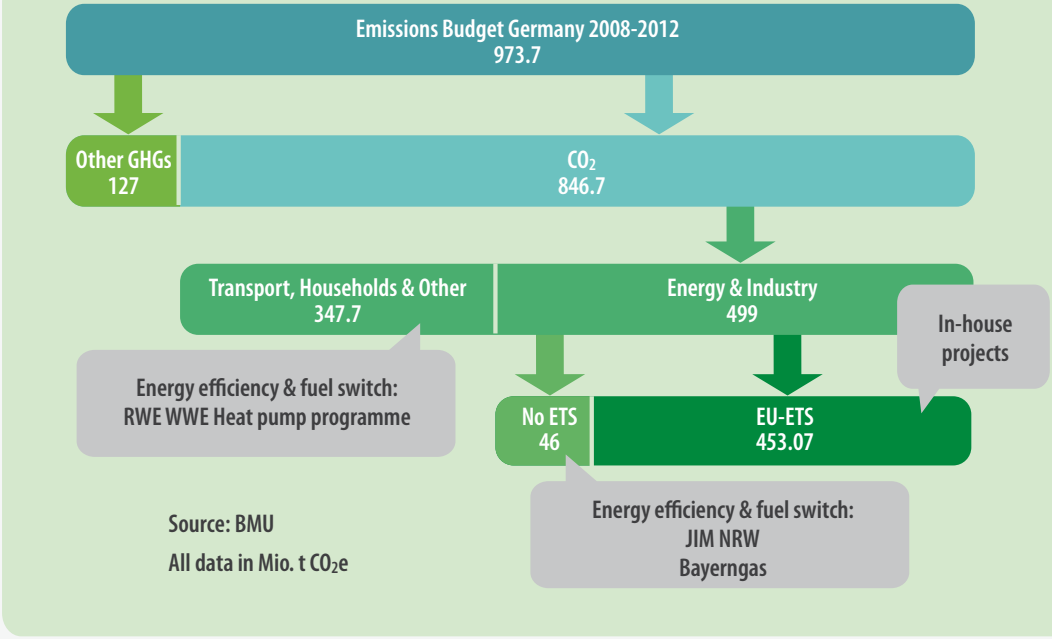
2.4 Technology implications of the EU ETS scheme

The on-going second commitment period of the European Emission Trading Scheme is affected by missing national allocations within the EU because of the delayed connection of CITL (Community Independent Transaction Log - EU) with ITL (Independent Transaction Log - UNFCCC). Therefore, only Denmark and Austria have carried out any trades, and these are few in number. These transactions have occurred since the authorities of these countries decided to allocate EUAs earlier. Other EU member states will probably initiate activities in autumn 2008 as a consequence of remaining uncertainties regarding EUA pricing.

Biogas power plant

Energy Efficiency and Rational Use of Energy

Companies have generally four possible options to meet their reduction obligation through the flexible ETS, JI and CDM mechanisms. They can implement measures at their own installations (so-called in-house projects), trade certificates within the EU ETS, undertake JI & CDM project activities or invest into Carbon Funds. From an economic viewpoint internal emission reduction costs (abatement costs) should be determined before the implementation of in-house projects and compared to the price of purchasing certificates. In addition to these options, JI project activities that are not covered by the EU ETS can also be elaborated and undertaken. The following figure indicates the categories JI and in-house projects within the German National Allocation Plan (NAP) with CO_2 emissions.



German potential for energy efficiency project activities within the EU ETS *Source: FutureCamp*

Project activities in the field of energy efficiency, fuel switch to renewable energy, non-CO_2-GHG and renewable energy within the heat market (esp. for Germany) are seen to have a significant potential, with the number of projects undertaken expected to increase up to 2012. In addition to single projects, bundling and programmatic approaches are expected to contribute to a further increase in project activities.

For example, FutureCamp has developed, with German project partners, three programmatic energy efficiency JI projects that reduce emissions but are not covered by the EU ETS:

- RWE WWE Electrical Heat pump program
- JIM.NRW in the German region Nord Rhine-Westphalia
- Bayerngas Energy efficiency and fuel switch to gas powered heat pumps

Renewable energy technologies

All three activities aim for energy efficiency, fuel switch and promote innovative technologies such as electrical and gas powered heat pumps.

Renewable energy technologies, although falling outside the scope of the EU ETS appear as the most straightforward answer for industry and power producers wishing to lower their CO_2 emissions. By displacing fossil combustion processes, installations would either fall below the 20 MW thermal input threshold (fossil fuels only) or would see their fossil-related CO_2 emissions reduced, and hence would have excess allowances to sell on the market.

However, very few renewable technologies have been able to capitalise on the incentives provided by the EU ETS.

Several factors contribute to this state of affairs:

1. Many renewable technologies are ill-suited for industrial sites and processes (e.g. hydropower or wind)

2. Renewable energy technologies are often not competitive with their fossil alternatives and require long paybacks periods (e.g. solar photovoltaic)

3. Phase-1 EU ETS allowances prices have been too low to make most RES technologies competitive without public support.

4. Most installations received an over-allocation of allowances during phase-1 of the EU ETS as a result of grandfathering and exaggerated projected growth estimates.

BioPower Plant, Sweden. Source: KanEnergi AB

The EU ETS has, however, had a positive impact on the penetration of biomass both in power plants and industrial installations. Since 2005, a large number of installations have upgraded their combustion equipment in order to facilitate co-firing of biomass and solid fossil-fuels (mainly coal).

This has been made possible for several reasons:

1. Biomass heat and biomass power are both relatively mature technologies with low operational risk

2. Biomass is a readily available and cheap fuel (although the price of biomass has increased substantially over the past few years)

3. The cost of adapting equipment to run on biomass is low

4. The impact in terms of reduced CO_2 emissions is significant, making the shift to co-firing profitable despite relatively weak allowance prices.

In addition to co-firing (mostly in large installations), a number of sites have also adopted biomass-only boilers that fall outside of the scope of the ETS. These biomass-only boilers, while slightly more costly than natural gas-fired boilers, are nonetheless attractive economically, especially as such investments are eligible for state aid. These biomass-only boilers are limited in size however and are often complementary to industrial natural-gas boilers.

Polygeneration

As an energy efficiency technique delivering unparalleled conversion efficiencies and hence CO_2 savings, cogeneration was expected to see its competitive position greatly enhanced by the introduction of the EU ETS scheme.

While phase-1 national allocation plans (NAPs) often included special provisions[7] rewarding cogeneration installations as a way to spur investments and maintain high utilisation rates for high efficiency cogeneration installations, the sheer level of over-allocation across sectors meant that such incentives had only a marginal impact on investment trend; a fact compounded by the design paradigm of the EU ETS which, by focusing on point source emissions, does not properly account for the displaced emissions by high efficiency cogeneration[8].

At the same time, in addition to the in-built difficulties facing cogeneration installations under the EU ETS scheme, investment has been hampered by the lack of predictability in terms of the impact of such schemes.

Industry has indicated that 3-year and 5-year time horizons are insufficient for multi-million investments in a capital intensive technology that is affected by public policies.

This problem has been compounded by the lengthy adoption of the so-called Cogeneration Directive 2004/8/EC, resulting in an uncertain legislative and regulatory framework for cogeneration installations across Europe and hindered investments over the course of several years.

At the time of writing, the legal framework for cogeneration installation (i.e. Directive 2004/8/EC) has been mostly clarified. However, as they enter phase 2 of the EU ETS, fewer Member States have included provisions safeguarding the preferential allocation to existing installations compared to phase-1 as a result of a European Commission-led efforts to curb over-allocation.

In the meantime, the 2013-2020 phase outlook, based on the European Commission's proposal COM(2006)16final, foresees full auctioning of allowances for power generation and the

[7] *Allowed under the EU ETS as a way to reward "early action" and "clean technologies" (cf Annex of Directive 2003/87/EC)*

[8] *A cogeneration installation, by producing both heat and electricity in one single process will typically avoid the production of electricity in a distant, centralised power plant. However, as the electricity is produced on-site, emissions at the plant level will increase, while the central power plant will see its demand reduced. Under the EU ETS, the high efficiency cogeneration installation will see its emissions increase and is likely to suffer from under-allocation while the power plant has extra allowances as a result of lower output. This fundamental flaw in the design of the ETSZ could be overcome through benchmarks for electricity and heat but only a handful of Member States have resorted to this solution in phases 1 and 2 and the Community-wide allocation methodology for phase-3 has yet to be defined.*

establishment of a Community-wide methodology for free allocation to other sectors up to 2020.

High efficiency cogeneration installations will therefore benefit, on the heat side only, from similar treatment to that for industrial boilers. This will effectively put cogeneration installations at a disadvantage as they displace mid-merit fossil power plants but have to compete on the electricity side with the entire generation portfolio of large utilities which include nuclear and renewables. This, combined with the increased capita expenditure and operational (or site) risk, will prove a strong deterrent to investment in high efficiency cogeneration installations, unless revenue recycling is adequate to overcome the financial obstacle and, most importantly, the psychological barrier that extra allowance purchases imposes on potential investors in cogeneration.

2.5. Intervention of T@W in the EU ETS market

A key objective of the T@W action has been to encourage the uptake of sustainable energy technologies, focusing on renewable energy and polygeneration technologies within the EU ETS.

The focal points of these efforts have been:

Investigating the appropriate use of research results within the ETS market and disseminating good practice examples

Encouraging companies operating on the ETS to use high standard/advanced SET solutions

Developing SET implementation concepts, partly focused on concepts entailing co-operation between companies in former EU-15 and New Member States

The following sections summarise some of the findings from these activities.

Implications of involving investors in JI projects in Bulgaria

Bulgaria is a new Member-State and NAPs have been prepared since 1 January 2007. The First NAP for the year 2007 has been approved and by now most of the big installations have submitted their verified reports on emissions to the government. A problem occurred with the Second NAP (2008-2012) proposal as it has been rejected by the European Commission (EC) due to very loose allocations submitted by the Bulgarian government.

By May 2008, this Second NAP had not been approved, while there was a continuing argument between the Bulgarian Ministry of Environment and Waters (MOEW) and the EC. Due to this big Bulgarian emitters are uncertain if they are in a position to be buyers or sellers. On the other hand, the other Kyoto mechanism, relevant to Bulgaria – JI, is not allowed for emitters falling under ETS obligations, by MOEW (Ministry of Environment and Water) due to the question of direct double counting. So in the course of the T@W project the focus was more on initiation of small projects with potential to be bundled and presented for future JI implementation.

From a technology viewpoint the most interesting applications for the above type of projects are small biomass-to-heat installations, CHP (including those based on biomass), wind and small hydro power generation, as well as fuel switch to natural gas from coal.

In terms of future activities, the Second NAP is expected to be approved by the EC within a few months. With the approval of the new NAP large Bulgarian emitters of CO_2 will finally have a clear picture of their obligations and need to implement SET in order to comply with ETS requirements. This will help to promote emission reduction possibilities during the course of the new SETatWork project. The large Bulgarian emitters of CO_2 are now better informed and more aware of the issues of ETS as a result of contacts and dissemination activities undertaken by SEC as part of the T@W project activities. With the aid of the on-line assessment tool and future promotional activities it is expected that further SET projects will be initiated.

CHP Plant, India. Source: COGEN Europe

Project intervention in Portugal

Taking into account the implementation of JI projects in Bulgaria, the Portuguese T@W partner IDMEC tried to make a link between the Bulgarian and the Portuguese entities, but this was not achieved during the T@W project as Bulgaria was in a transition phase as a result of which governmental decisions for the continuation of the JI implementation in Bulgaria were uncertain. Following the approval of the Second NAP there is a chance for cooperation possibilities between Bulgarian and Portuguese entities which will be examined by the SETatWork project partners.

In addition to project intervention in Europe the Portuguese potential for the development of partnerships in Asian Countries was analysed and promoted to:

- Technology providers
- Project Owners
- Credit buyers

This resulted in matchmaking between Portuguese and Asiatic partners which will be intensified during the SETatWork project.

Prospects of involving investors in projects in Slovakia

It is expected that due to the closure of various obsolete power and heat production facilities in Slovakia in the coming decade (1370 MW to 2010), the number of new power and heating plants will increase. The associated need for supply of equipment and design options will create market opportunities for EU15 suppliers. At the same time, in the areas of large-scale coal or coal/biomass firing projects, Slovak technology will be exported to the EU15 countries (based on the current trends).

In 2007, many projects were under preparation in the industrial and DH sectors. These mostly targeted co-firing of coal with biomass, fuel switch from coal to natural gas or biomass and biomass gasification. While for large-scale biomass firing (co-firing) domestic technology is mostly used (boilers and equipment produced in SES Tlmače Company), a German technology is under consideration for biomass gasification (for a project where ECB provided an input within the T@W framework). For small scale biomass firing or co-firing, Danish, Austrian, Czech and Slovak technologies are mostly used. Regarding natural gas CHP, a range of technologies have been used.

As EU15 SETs are very well known in Slovakia through subsidiaries of producers in the country, these technologies are used quite widely.

Within the scope of T@W intervention, EU15 high tech (gasification, turbines, biomass CHP, biogas CHP etc) technologies were brought to the attention of project proposes. In respect of EUAs transfer, intensive discussion was started with potential Danish EUAs buyers with the local T@W partner ECB working to facilitate the interaction between Slovak and EU partners.

Specific fields where the latest RTD results are to be implemented in Slovakia include Gasification CHP, biogas CHP (with associated bio fuel production) and photovoltaic (expected in the coming decade), together with large scale biomass co-firing and utilisation of energy crops. At the small scale, pelletising and briquette technologies developed as a result of RTD activities continue as a topic for further research (agricultural pellets and briquettes) or market implementation (sawdust and woodchip pellets). Innovations are also expected to be implemented in the field of industrial energy efficiency.

T@W activities in Slovakia have produced reasonable results in terms of increased awareness within the industries or project holders that have been contacted. Five actual projects were initiated and others are on the way. The potential for "closing" the project cycle with EUAs transfer facilitated from Slovakia to the EU-15 has been discussed.

At the same time Slovakia will maintain and increase use of nuclear and traditional coal burning technologies. This may offer a potential for carbon sequestration projects, subject to availability of suitable sites. Natural gas-based steam- cycle generation will continue to be important over the next decade, as will hydropower.

Prospects of involving investors in projects in the Basque country in Spain

The companies in the NAP initially saw the ETS more as a threat than as an opportunity due to their lack of information. This has been changing as the NAP2 2008-2012 has provided, in general, a level of permits that met the reasonable expectations of the companies, with associated financial benefits that are also adequate. There is now an opportunity for many companies to implement energy saving, use renewables and carry out emission reduction projects, and thus obtain a financial benefit from the resulting emission credits.

The local T@W partner EVE has carried out energy and CO_2 audits on ETS companies in the Basque Paper Sector along 2006 and 2007. As there has been an excess in the carbon emission permit assignment with respect to the needs (around 10% in 2005) most of the Paper Sector ETS companies did not look into the implications of this market during the early phase. They now see that the carbon market is solid, and that there is a possibility of obtaining a benefit from actively participating in it. At the same time, the limited size of these SMEs means that they prefer buying or selling in standard ETS markets rather than promoting or buying CDM project credits.

Energy and CO_2 auditing is an important tool for identifying CO_2 emission reduction potentials for ETS companies. The conclusion was that the situation is very different for each of the paper factories. Some are integrated facilities where the raw material is wood and the final product paper; others involved in recycling use scrap paper as raw material. The potential to reduce in-house emissions is based on the substitution of fossil fuels by biomass.

Among the integrated facilities, some have really low emissions because they already use biomass, but there is still some potential for additional reduction. In some facilities, there is a possibility of installing new biomass (wood bark) boilers. In other cases these boilers already exist, but they do not exploit the full benefits of the use of biomass. Other integrated facilities that do not have bark-fired boilers have a greater potential for improvement. In

this case new de-barking equipment would be required together with boiler refurbishment.

When recycled paper is used as raw material, residues are generated (sludge, plastics...). These can be burnt; resulting in an increase in the utilisation of boilers that can burn both sludge and plastic scrap.

Where the raw material used is virgin fibre, the margin for improvement is low. Potential measures for energy use reduction are related to the use of variable speed drives for various types of electrical equipment. These measures, which are also applicable to other facilities, do not directly reduce the CO_2 emissions within the facility, but reduce the energy bill and hence associated CO_2 emissions.

It was concluded that in some of the facilities there is a potential for 20-25% of CO_2 emission reductions with a payback period of less than 5 years. In a scenario of high energy prices the payback period could be even shorter.

Approaches for project development in Germany

In Germany project activities in the field of energy efficiency and fuel switch to renewable energy have a high potential in terms of cost savings, independency from foreign energy supply and positive impact on the environment. Such activities, including those developed as in-house projects, help companies that are subject to EU-ETS obligations. However, before such in-house projects are implemented the overall emission reduction costs should be determined since an alternative approach would be the purchase of certificates.

Another approach for corporations would be participation in a JI project or a domestic offset project as partner, investor or primary buyer of the generated certificates. Specific activities can be highlighted by JIMNRW, the first registered programmatic JI project world-wide. This is located in North Rhine-Westphalia (NRW/Germany). The programme of activities (PoA) comprises preterm renewal and modernisation of heating and steam boilers with and without fuel switch to renewable energy. The Project agency is the EnergieAgentur NRW which started the project in June 2007 with the support of FutureCamp[9]. The project participants are small and medium sized companies as well as public facilities in North Rhine-Westphalia that have no obligations under the ETS. Currently there are ongoing discussions to extend such activity to other Federal States in Germany.

Prospects of joining forces within the ETS industry – the Danish case

It is interesting to observe that, as the ETS develops, market actors and public bodies are joining forces, recognising that meeting the challenge of climate change requires more effort than can be undertaken by a single industry or segment of society. Developments in Denmark show how such joint initiatives, including public-private partnerships, are developing. Examples include:

Energy Camp: The idea of an Energy Camp is to gather some 48 individuals from various types of organisation (industry, research etc.) for two days of intensive discussion of key issues in relation to development of a sustainable energy sector. A programme of such meetings started in 2004 with similar camps held each year since then.

Copenhagen Climate Solutions:[10] Copenhagen Climate Solutions has been formed as a response to climate change and the holding of the Climate Summit COP15[11] in Copenhagen in 2009. It serves mainly as a showroom indicating responses that are available to meet the climate challenge. It includes production of a Climate Solutions Handbook. A conference was held September 2007. The initiative has now been extended to become Nordic Climate Solutions, which is developing a new conference for November 2008.

Klimakonsortiet (The Climate Consortium): This is a partnership between the Danish State and national associations for industry, the building sector, agriculture, the energy sector and Dansk Energi, Landbrugsrådet og Vindmølleindustrien (Danish Wind Industry Association). It will serve as a platform for cross-sector initiatives up to COP15.

Bright Green: An associated initiative has been launched under the heading of "Bright Green - Danish Technologies for Sustainable Growth". This is a publication covering Danish strengths in the field of sustainable energy and their potential contribution to the climate change challenge[12].

A key actor in fostering these initiatives is the Confederation of Danish Industry (DI), representing the major share of Danish companies including ETS companies and SET suppliers. In 2005, DI formed 'Energi Industrien' (Danish Energy Industries Federation) with a view to strengthening the Confederation's efforts in the field of sustainable energy, not least spurred by the challenge of climate change.

The T@W team has developed cooperation with DI/Energi Industrien in order to assist Danish ETS companies and SET suppliers wishing to become involved in the carbon markets. This included the invitation of Danish market actors to the T@W Facilitation workshops in Asia, as well as DI hosting the T@W Conference 'Business Opportunities for Sustainable Energy Technologies in Asia' on in March 2008[13].

This cooperation resulted in DI joining the new project SETatWork which focuses on exploring the energy efficiency aspects of the carbon markets.

[9] *http://www.energieagentur.nrw.de/emissionshandel/page.asp?TopCatID=2177&CatID=6358&RubrikID=6358*

[10] *See more at: www.copenhagenclimatesolutions.com*

[11] *COP stands for Conference of Parties. It is the highest body of the United Nations Climate Change Convention and consists of environment ministers who meet once a year to discuss the convention's developments.*

[12] *"Bright Green - Danish Technologies for Sustainable Growth" can be downloaded in PDF format from: http://ei.di.dk/NR/rdonlyres/2BE5B8DD-190A-4FAA-8ABB-39B697EE560F/0/brightgreenwww.pdf*

[13] *www.setatwork.eu/events/0803cmi.htm*

3. Sustainable Energy Technology at CDM markets

3.1. Overview of Clean Development Mechanism (CDM) in Asia

The Kyoto Protocol, signed in 1997 under the United Nations Framework Convention on Climate Change, includes the first joint action between the industrialized and developing countries aimed at the reduction of emissions of greenhouse gases.

The Protocol sets out emission reduction targets for emissions of greenhouse gases from industrialised countries and countries in transition (Annex 1 countries); whilst at the same time allowing developing countries (non-Annex 1 countries) to take part in emission reduction initiatives on a voluntary basis. The Clean Development Mechanism (CDM) as one of the flexible mechanisms under the Kyoto Protocol provides Annex 1 countries with the opportunity of reducing the overall costs of complying with its Kyoto obligations whilst providing a portal for the developing countries to participate in the international climate change activities on a voluntary basis.

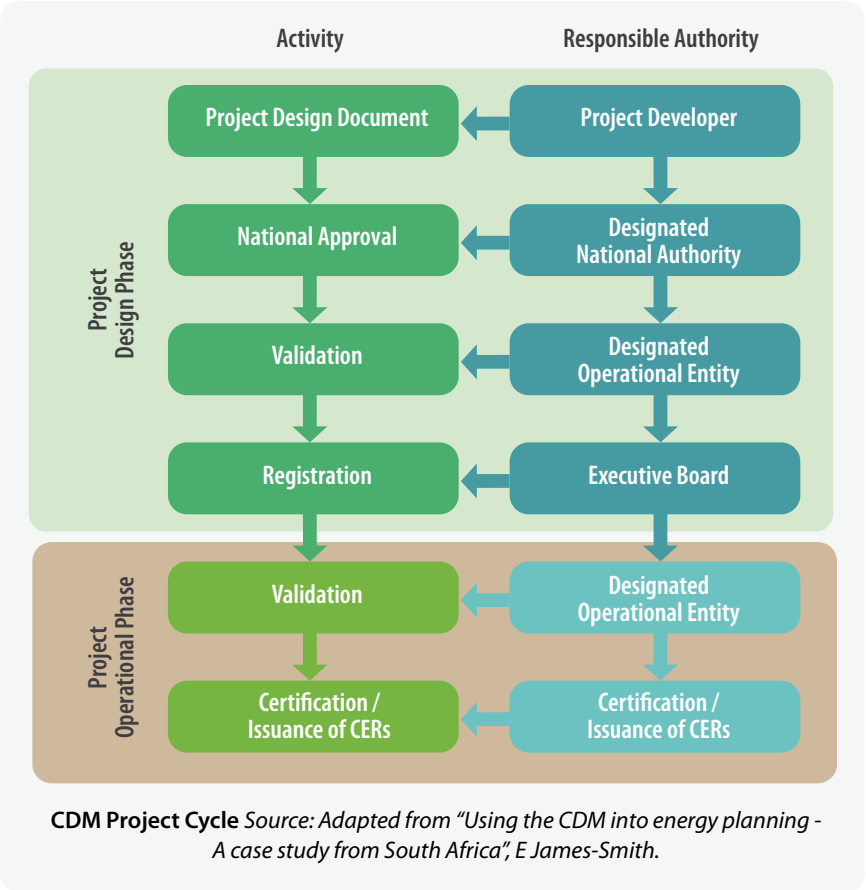
This mechanism allows credits generated from greenhouse gas emission reduction activities in developing countries to be purchased by Annex 1 countries in order to comply with their emission reduction target. At the same time CDM projects must deliver sustainable development impacts in the host country that go beyond pure emission reductions and help the country to improve its current development patterns.

The link between the dual objectives of the CDM is the generation of carbon credits (Certified Emission Reductions – CER) as a tradable commodity that is provided by the project activity in return for new revenue streams as well as support in kind for transfer and diffusion of environmentally-friendly technologies. Provided that projects fulfil the eligibility requirements, as set out in the Kyoto Protocol, and subsequently refined in later negotiations, the CDM offers good opportunities for establishing new business cooperation and trading of carbon credits.

CDM project cycle

Establishing a CDM project and receiving final registration by the CDM Executive Board requires multiple steps. These steps are known as the CDM project cycle, and are put in place in order to ensure the climate benefits of CDM project activities.

The project cycle is shown in the following figure:



CDM Project Cycle *Source: Adapted from "Using the CDM into energy planning - A case study from South Africa", E James-Smith.*

Project Design

The first step involves developing a Project Design Document (PDD), based on a standard format describing how the activity aims to fulfil the pre-requisites for registration as a CDM project. The PDD consists of a general description of the project, its proposed baseline methodology, a timeline and crediting period, a monitoring methodology, calculation of GHG emissions by source and stakeholder comments. The host country Designated National Authority (DNA) must issue statements on the PDD indicating that the government of the host country participates voluntarily in the proposed activity and that the project assists the host country in achieving sustainable development.

Validation and Registration

Validation involves an independent evaluation of the project by an external auditor known as a Designated Operational Entity (DOE), that is hired by the project participants (a list of DOEs can be downloaded from the UNFCCC website[14]). The DOE reviews the PDD in order to determine whether the project meets CDM requirements.

Once a project activity has been validated by a DOE a validation report is forwarded to the Executive Board (EB) for registration as a CDM project. The registration of a project will, in general, be finalised within eight weeks after the date of receipt by the EB unless at least three members of the EB request a review of the project.

Monitoring

Once the project is operational the emissions that occur from the activity must be monitored. This is done according to a monitoring plan submitted and approved in the PDD. This indicates the method used for measuring emissions from the project and how data relevant for these calculations will be collected and archived. The information on emission reductions must be included in a monitoring report estimating the amount of CERs generated and submitted to a DOE for verification.

Verification and Certification

Verification is through an independent review of the monitoring report submitted by the project participants. The DOE that carries out verification differs from that involved in the validation process. This DOE must ensure that the CERs have been generated according to the guidelines and conditions agreed upon during the validation of the project. A verification report is then produced.

The same DOE that verified the project also certifies the CERs generated by the activity.

Certification is the written assurance from the DOE that the project achieved the stated level of emission reductions and that these reductions were real, measurable and additional. The certification report constitutes a request to the EB for the issue of CERs. Unless a project participant or at least three members of the EB request a review within fifteen days the EB will instruct the CDM registry to issue the Cars.

Legal documents for CDM project development

In order to comply with the modalities and procedures for CDM project validation and registration by the CDM Executive Board, the project developer must ensure completion of the right documentation.

Project Idea Note: The first step is to receive national approval by the host country DNA. Some countries might require the elaboration of a Project Idea Note (PIN), a document that aims to describe the initial project idea, including anticipated emission reduction measures and estimated investment costs. This document is not a legal requirement in order for a project to be eligible under the UN. Hence, it is recommended that a project developer studies the specific requirements for CDM project development as defined by its host country.

Project Design Document: The Project Design Document (PDD) creates the basis for the validation and registration process under the UN. The PDD contains all relevant information regarding the project activity, including a thorough description of the proposed emission reduction activity and a justification of the additionally requirement. In addition the PDD should contain a monitoring plan to explain how the emission reductions will be monitored.

Emission Reduction Purchase Agreement: In order for sellers and buyers of carbon credits to enter into a trade agreement the Emission Reduction Purchase Agreement (ERPA) is commonly used. The ERPA sets forth the terms and conditions of credit delivery and payment between the seller and the buyer.

This document may vary in format, but should cover the legal aspects of credit ownership, the terms of payment and delivery and the management of risks inherent to the transaction.

Key institutions under the CDM

Conference of the Parties/Meeting of the Parties (COP/MOP): The COP/MOP is the overall authority of the intergovernmental system for dealing with climate change under the UN and thus

[14] *http://cdm.unfccc.int/DOE/list*

also the superior body handles the CDM. The COP/MOP makes decisions and provides guidance of relevance to the CDM. This includes taking decisions relating to recommendations and suggestions provided by the Executive Board, as well as providing guidance covering further activities under the CDM

Executive Board (EB): The EB is the core institution of the CDM responsible for supervising the CDM process under the authority of the COP/MOP. The EB plays a vital role in the CDM and is responsible for maintaining the integrity of the CDM and for exercising regulatory functions by contributing to the development of guidelines and procedures, as well as provide guidance on how specific regulations should be interpreted. In addition, the EB has the responsibility of registering CDM project proposals as well as issuing Cars.

Designated National Authority (DNA): All parties wanting to participate in the CDM must establish a Designated National Authority (DNA) in order to approve CDM projects and assist by providing guidelines and procedures for CDM activities in accordance with national regulation and priorities. For non-Annex 1 countries the DNA is the key institution involved with CDM and is responsible for ensuring that the host country maintains control over its national CDM, being responsible for ensuring that CDM activities meet the sustainable development objectives determined by the host country.

Designated Operational Entity (DOE): The DOE can be any independent private companies or consultants accredited by the EB to function as external controllers of the CDM activities. They are responsible for ensuring that all required procedures and documentation for a CDM project comply with the rules and modalities established under the mechanism and in particular to confirm that a given project activity is additional.

Eligible CDM project types

In order to comply with the overall framework for CDM project development, the type of project must be eligible under the framework of the Kyoto Protocol. In general all projects that reduce greenhouse gas emissions, while at the same time complying with the host country sustainable development criteria and the additionally requirements as stated under the Kyoto Protocol, are eligible as CDM.

In order to ensure the actual climate benefits of CDM projects, it is essential to prove that CDM projects are additional. Hence, it should be possible to demonstrate that the proposed project activity lies outside the 'business as usual scenario' and that the emission reductions are additional to any reductions that would have occurred in the absence of the project. This can be done by demonstrating that the CDM can help overcome any existing barriers for implementation of a given emission reduction activity.

Some examples of eligible energy-related CDM project types are listed below:

- End-use energy efficiency improvement
- Supply-side energy efficiency improvement
- Renewable energy
- Fuel switching
- Industrial processes
- Solvent and other product use
- Waste management

Small-Scale projects

Small scale CDM projects can fall into any of the following categories:

> ***Type (i) project activities:*** renewable energy projects with a maximum output capacity up to or equivalent to 15 megawatts.
>
> ***Type (ii) project activities:*** energy efficiency improvement projects that reduce energy consumption, on the supply and/or demand side, up to or equivalent to 15 gigawatt hours per year.
>
> ***Type (iii) project activities:*** other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kilotonnes of carbon dioxide equivalent annually.

In order to reduce transaction costs for developing small-scale projects, simplified rules and modalities have been developed.

CDM project development costs

Various costs will be incurred in registering a CDM project before the tradable CERs can actually be generated. These include costs related to the validation of the CDM activity that requires the use of external experts (DOE) as well as payment of registration fees to the Executive Board under the UNFCCC and fees for receiving national approval by the host countries, if this is required. These costs can vary from US$ 40,000 to as much as US$ 150,000 per project.

Costs do not necessarily reflect the size of the project. Hence, large projects are often preferred in order to reduce the transaction costs relative to the project costs. In order to reduce the transaction costs for projects that fall into the category of 'small-scale projects' as defined under the CDM framework, such projects may utilize simplified rules and procedures.

Average tonne of carbon dioxide equivalent reductions per year over the crediting period (estimated/approved)	$US
<= 15,000	5000
>15,000 and <=50,000	10000
> 50,000 and <=100,000	15000
>100,000 and <=200,000	20000
>200,000	30000

Indicative prices related to the registration of CDM projects by the EB
Source: data compiled from the UNFCCC website

Information on additional costs related to specific national procedures for CDM project approval in the host countries can be obtained by contacting the relevant national CDM authority.

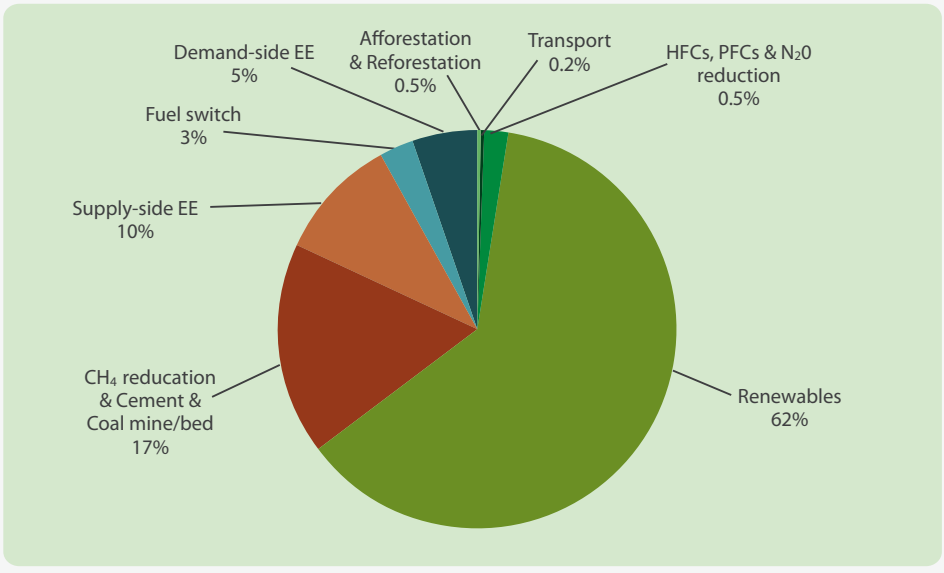
Programmatic CDM

A new concept under development relates to Programmatic CDM or Programme of Activities (PoA). It has been agreed under international agreements (COP/MOP) that project activities included within a programme of activities can be registered as a single CDM activity. This requires approved baseline and monitoring methodologies to be used that, inter alia, define the appropriate boundaries, avoid double-counting and account for leakage, as well as ensure that the emission reductions are real (measurable and verifiable), and additional to any that would otherwise occur.

Currently, various initiatives covering the further development of the methodology and practical testing are taking place. There are expectations that Programmatic CDM will play an important role in future CDM activities. The Programmatic CDM concept could be of special relevance in terms of incorporating energy efficiency projects in CDM development. The future prospects for this approach this will be examined in connection with the FP7 project SETatWork.

Actual CDM project development

As shown in the following figure, the majority of the projects developed so far has been focussed on use of renewables and/or CH4 reduction with only a minor contribution from energy efficiency projects. One third of the energy efficiency projects are demand side projects in industry while presently two thirds of the industrial CDM projects under validation are energy supply projects. However, if is expected that further development of the CDM market, including integration of concepts such as Programmatic CDM, could lead to a higher share of energy efficiency projects in the future.



Number of CDM project by type, 1 April 2008
Source: UNEP/Riso http://cdmpipeline.org/cdm-projects-type.htm

3.2. Intervention of T@W in the CDM markets in Asia

Introduction

A key activity of the T@W action has been to exploit opportunities within the sustainable energy markets in Asia. The main result of these efforts has been to create a 'win win' situation for participants in Asia and the EU, driven by the desire in Asia for local sustainable energy and commercial development, as well as a desire in the EU to gain access to CO_2 credits (CERs from CDM projects). European technology suppliers are also attracted by the rapidly growing market for sustainable activities in Asia.

The focal points of T@W action have been:

Identifying SET needs for sustainable energy development in Asia with a focus on China, India, Thailand and Malaysia, including possibilities for bringing EU know-how into these markets.

- Facilitating SET/CDM projects and financial concepts for accelerated implementation of SET
- Strengthening relations, including initiating specific business co-operation, between companies in Asia and EU
- Prospects for sustainable energy technologies in Asia

Though the focus has been on China, India, Thailand and Malaysia the T@W project team has followed development in the entire Asian region in order to help EU organisations enter these wider markets.

Speaker at Facilitation workshop in Guangzhou

Asia has the potential for developing a large number of renewable energy systems. The most obvious areas where European experience can be transferred immediately, and where the technologies in most cases can compete with conventional energy production, include biomass, biogas, wind and hydropower:

- **Hydropower** is to a large extent seasonable but during the dry season, which is also the hottest with the highest demand for electricity (cooling/air conditioning/ irrigation), the power production from the hydropower plants go down.
- **Biomass** is also seasonal, largely available in the form of raw materials from agricultural processing industries such as rice mills, sugar mills, saw mills and tapioca starch mills. As many forms of biomass differ from that utilised in Europe some technical modifications may have to be made in order to adapt the European systems to local conditions.
- **Wind energy** is another promising renewable energy source, especially for countries such as India, China and Vietnam. Both India and China have started exploiting wind energy and have established manufacturers of wind turbines. Vietnam is slowly becoming aware of the potential, though there are still barriers hindering the development of wind energy in some areas.

Scope of T@W activities in target regions

Asian and EU partners of the T@W action have worked together on promoting the use of sustainable energy technologies/ RTD in China, India, Thailand and Malaysia.

A key action has been the promotion of 'good' CDM projects. These are defined as projects that support local sustainable development as well as providing matchmaking opportunities for EU actors in order to help CER buyers and promote technology transfer.

The T@W team applied a practical approach to integrate the various positive elements indicated above, with the work culminating in Facilitation Workshops held in each of the target countries between January and March 2008. These addressed key activities of the project and arranged matchmaking between Asian and EU stakeholders.

Facilitation workshop in Guangzhou

Achievements in China

T@W activities in China were managed by the local partners GIEC and ZERI and concentrated on supporting CDM project development in south and east China. The project activities concentrated on helping project developers that needed technical assistance, as well as finding European CER buyers and arranging technology transfer. In Guangdong Province, this was done in conjunction with the opening of a CDM Centre hosted by the T@W partner GIEC.

The T@W Facilitation workshop held in Guangzhou was a big success, with 160 participants on the first day (*pictured above*) and 88 participants on the second day. The highlights of the workshop are summarized in the table below.

Key points of CDM development in China

- Strong government support and active market participation could possibly contribute to the booming development of CDM projects in China and a large number of projects are under development.
- Top priorities of CDM projects are renewable energy, energy efficiency and recovery of methane.

Facilitation workshop in Guangzhou, 17-18 January 2008	
Market and financial aspects The first part of the workshop addressed the policy & market aspects of CDM development in China, including presentation of high-level officials. This provided documentation of, and established interest in, using CDM as a key instrument for sustainable development. In addition, local financiers provided information on the financial side of CDM project development.	**Technology/RTD aspects** The Facilitation workshop included the following sessions: • Co/Polygeneration: EU partners provided information about European achievements in this field and their relevance for China • Bio energy: This session presented relevant European technology, concentrating on biomass boilers and how to adapt these to the Chinese situation.
CDM project development The workshop marked the official opening of the CDM Centre Guangdong, a centre that will serve a focal point for CDM project development in the region. The local T@W partners ZERI and GIEC have identified a number of CDM projects in a broad range of areas and, in cooperation with the EU partners, helped to develop these projects further.	**Matchmaking** Europe was represented by partners from Slovakia, Germany and Denmark as well as other invited participants. From the Chinese point of view, the interest covered both the opportunity to find partners in order to sell products outside China as well as to find EU investors/financiers for projects. On this basis matchmaking was organised between those interested and then followed up within T@W.

Achievements in Thailand

The T@W activities in Thailand were carried out in close coordination with the relevant Thai authorities. Thus the action has included interaction with the national RE Promotion and Development Plan while part of action has been to process validated CDM projects.

The Facilitation workshop turned out to be very successful with 86 participants on the first day and 97 on the second.

The highlights of the event were as follows:

Key points of CDM development in Thailand

- The Thai CDM institutional framework includes well defined criteria covering projects on the basis of economic, environmental and social dimensions.
- Based on this there is a sound development of CDM projects. Hence, the T@W activities were compatible with the present state of progress.

Facilitation workshop in Bangkok, 25-26 February 2008	
Market and financial aspects The Facilitation workshop presented the current initiatives promoting sustainable energy development in Thailand where an essential instrument concerns the RE Promotion and Development Plan entailing specific targets for relevant technologies. These aspects were presented by the key actors involved in the development, including both local and international/EU financiers.	**Technology/RTD aspects** Reflecting the key needs of the Thai sector the event was divided into two thematic workshops; a workshop on biomass & biogas (25/2) and one on municipal solid waste (26/2). There is a significant potential for exploiting resources in these areas. Hence, the workshop addressed the prospects of bringing into play EU know-how for such development.
CDM project development By March 2008, there was a pipeline of 27 CDM projects (~2 million ton CO_2/year) in Thailand – the majority being biogas projects - of which 10 had been officially registered. The T@W action helped to identify projects leading to 10 PINs that formed the basis for the project's matchmaking activities.	**Matchmaking** The workshop included a well-organised set-up for matchmaking (illustrated right) based on information from local stakeholders. On this basis, matchmaking was organised for the participating contractors, developers, consultants, CDM project owners, financing institutions and CER buyers.

Business-to-business meetings during Facilitation workshop in Bangkok

Achievements in India

The T@W activities in India have taken place within the dynamic environment that characterises the Indian sustainable energy sector.

The technology scope of T@W activities in India has included initiation of large-scale biomass gasification, as well as large wind turbine and municipal solid waste management projects, concentrating on the areas where European actors could play a role in bringing in high-end technologies.

The T@W Facilitation Workshop (illustrated), which took place in New Delhi in February 2008, showcased selected EU technology in renewables and enabled interaction between Indian industries and the technology providers from EU countries.

The highlights are shown below:

Key points of CDM development in India

- India is a fast growing economy and also in terms of CDM there is a rapid development.
- Indian companies already have good technical expertise to develop qualified CDM projects and in many cases Indian technology in the field of sustainable energy is able to compete on the world market.

Wind turbines near Jaisalmer, Rajasthan. Source: CPL Press

Facilitation workshop in New Delhi, 21-22 February 2008	
Market and financial aspects The workshop documented a promising market development within biomass and biogas, including co-/polygeneration technology, small hydro and wind energy. Representatives of Ministries and the local financial sector attended and presented information about the regulatory and financial framework for projects.	**Technology/RTD aspects** The workshop comprised presentations of state-of-the-art in India covering wind power, biomass, municipal solid waste and hydro power. Europe was represented by the EU Biomass Industry Association and partners from Portugal and Denmark with the discussion revealing opportunities for technology transfer in the given areas.
CDM project development India is at the forefront of climate change abatement policies and is the country with the largest number of CDM projects. The key scope of T@W intervention has been to facilitate the involvement of EU actors in this development.	**Matchmaking** The second day was dedicated to matchmaking. The technology-focused partner matching/search mainly covered biomass: biomass drying, biomass and RDF from MSW, pelletising and biomass combustion. Possibilities for technology transfer as well as involvement of EU CER buyers were discussed.

Achievements in Malaysia

T@W activities in Malaysia have been undertaken in close cooperation with the national CDM framework. In addition these activities were linked with related bilateral activities including CDM programmes.

The Facilitation workshop took place immediately following the Thai workshop and hence many of the same EU partners participated. These included T@W partners from Portugal, Germany and Denmark, as well as associated actors such as financiers/CER buyers, industry associations and individual companies. In total, there were 80 participants at the two-day workshop which had the following highlights:

Key points of CDM development in Malaysia

- Malaysia has a well-integrated institutional framework for CDM. The development is steered by the National Committee on Climate Change under which Technical Committees for Energy, Forestry and Agriculture operate.
- The T@W partner PTM was appointed by the DNA of Malaysia to serve the CDM Energy Secretariat providing support to the Technical Committee on CDM.

Facilitation workshop in Kuala Lumpur, 27-28 February 2008	
Market and financial aspects The workshop included presentations covering the Malaysian CDM framework and model examples of CDM project activities developed so far. There was representation by local as well as EU financiers such as the German KfW Carbon Fund.	**Technology/RTD aspects** The main potential in Malaysia is associated with bioenergy. Hence, a major issue has been the technology implications of exploiting biomass resources, including making use of EU know-how. The workshop included exchanges covering these aspects, including discussion of lessons learned from the previous technology transfer activities.
CDM project development By February 2008, there were 48 PINs and 61 PDDs in the Malaysian CDM pipeline. These projects mainly relate to biogas, especially in relation to the palm oil industry	**Matchmaking** The workshop resulted in fruitful matchmaking between local and EU stakeholders. From a technology provider viewpoint this concerned aspects such as gas cleaning technologies or biogas for super-heated boilers for steam generation, as well as matchmaking between local CDM project developers and EU CER buyers.

Conclusion – Observations - Future

T@W project activities in China, India, Thailand and Malaysia have served as a high-value learning process, as well as leading to initiation of numerous specific initiatives. It has become clear that there are some similarities in the CDM pattern and focus for all the participating countries resulting in recognition of a number of aspects that can be incorporated into future activities.

In setting priorities, the CDM activities have concentrated on the projects capable of generating the highest volume of CERs. These include biogas projects based on animal manure, industrial wastewater from food and agricultural product processing and the capture and use of landfill gas.

All the participating Asian countries have a hydropower potential. With the increasing prices on fossil fuel more and more mini hydro projects become of interest. Hydropower projects are often environmentally sensitive and may have to be implemented in close cooperation with National Environmental Authorities, as the hydropower potential is often found in national parks or restricted areas, thus making access for private developers difficult.

Once the biogas and landfill gas potential of the resources indicated above have been utilised, developers are expected to move their focus to include other biomass residues from processing or production of agricultural products. Residues from agriculture, such as rice straw, cane trash, tapioca heads and other similar materials show a significant potential as fuel, but due to the way cultivation takes place, collection and handling of the residues in an efficient and feasible way is difficult. If such residues could command higher prices as an energy source this might help to increase their use and reduce in-field burning.

Both India and China have a very large wind potential, and it would be obvious to include CDM as standard in new wind farm projects.

Examples of Small Hydro Power (SHP) Technology in use in Asia
Top left: Chinese Pico Turbine (*Copyright ESHA*), Top Right: Chinese SHP workshops (*Copyright IT Power*), Bottom left: 5.4 MW SHP in China (*Copyright IT Power*), Bottom right: 5 kW Low cost crossflow turbine in India (*Copyright IT Power*)

4. Good Practice Examples

By the end of the T@W project in April 2008, 42 Good Practice case studies had been identified by partners. Examples of these covering a range of technologies in both Europe and Asia are illustrated below. Further information can be found on the website at www.setatwork.eu/gp.htm

Europe: Biomass for Heat - Bulgaria

T@W Good Practice No 14
Construction of biomass boiler plant and extension of existing heat supply network in Bansko, Bulgaria

This project in Bansko, Bulgaria, consists of the construction of boiler facilities and a heat supply network for production of heat from biomass (wood wastes) to supply industrial and tertiary consumers with space heating and domestic hot water production. Boiler facilities include a water heating boiler imported from Austria for biomass combustion of 5 MW capacity, working pressure 6 bar and working temperature 110/65° C.

The wastes used include dry barks, tree branches, chips, shavings, etc, received from production and mechanical wood processing in the district of Bansko. The main sources of wood wastes are regional forestry departments performing necessary remedial felling of forests in the mountains of Rilla and Pirin. Wood processing plants in the neighbourhood can be used as an alternative source of wood wastes.

Project capital costs are about 2 MEuro with a calculated pay-back of 6 years.

The environmental effect of the biomass boiler is calculated based on the following main assumptions, using the methodology given in Operational Guidelines for Joint Implementation Project design documents:

- Emissions from biomass combustion are zero;
- Emissions savings come from substitution of light fuel oil with biomass;
- There are emissions incurred from transportation of biomass and from electricity consumption for the boiler itself.

Based on the above annual combustion of 4869 tons wood wastes replacing 1197 tons light fuel oil, annual savings of CO_2 emissions amount to 3319 tons. This amounts to 20466 tons CO_2 for the period 2006-2012. The net effect of the project is 16646 tons of saved fossil CO_2 for the period 2006-2012.

The project has been financed through EBRD Bulgarian Energy Efficiency and Renewable Energy Credit Line (BEERECL). It will receive a 20% grant of the total capital costs after project completion. Part of the capital costs has been provided as a loan from HVB Bank Biochim (one of the banks operating the credit line in Bulgaria) and part is project host equity.

Europe: Programmatic Joint Implementation (JI) Project – Germany

T@W Good Practice No 36
JIM.NRW – First German programmatic JI-project

Within the scope of the project-based Kyoto-mechanism, the Ministry of Economics of the Federal State of North Rhine-Westphalia intends to implement a pilot programmatic Joint Implementation (JI) project. It is intended to offer an incentive for the advanced renewal and modernisation of heating and steam boilers, both with and without fuel switch, although the latter is not covered by the EU-Emission Trading Scheme (EU-ETS).

Target groups are small and medium sized companies as well as public facilities in North Rhine-Westphalia.

The implementation of the JI-project is in accordance with the Track1- procedure and within the terms of the "Programmatic CDM". As a result new participants can be admitted on a continuing basis to the JI-project (provided that they comply with the participation criteria) without the need to pass through the (JI) authorisation process again.

This means that the applicant to the programme is credited with the proceeds of emission reductions, in the form of ERUs that result from those actually measured.

Emission reductions can be a result of:

- improvements in the overall annual efficiency of use
- changes in the boiler plant
- reduced CO_2-emissions due to lower specific emission values in the case of fuel switch

The EnergieAgentur.NRW **www.energieagentur.nrw.de** also functions as applicant general and conducts the entire process. The participants in the JI-project put specific reduction measures into practice and receive a refund according to their achievements. The actual reduction volume is determined by an independent organisation.

The potential emission reduction volume of each project is, in general, too small to justify the implementation of a separate project. This makes it reasonable to assume that without the involvement with the programmatic project reduction measures would be delayed in many cases and might not materialise at all. Linking separate measures in a Programmatic JI Project avoids this problem. However, this approach requires the development of a feasible standardized calculation scheme in order to assess the reduction volumes plus monitoring of the participants.

JIM.NRW: Source Bosch Thermotechnik GmbH

Europe: Biogas for Heat and Electricity - Portugal

T@W Good Practice No 38
Landfill biogas to produce electricity and heat (Sermonde, Portugal)

The Sermonde landfill receives municipal solid waste (MSW) from Vila Nova de Gaia and Santa Maria da Feira municipalities. The landfill has been operated since 1999, with the capacity to accept around 1.5 million tonnes of MSW. It is managed by SULDOURO SA.

The use of landfill gas, the natural result of the anaerobic decomposition of organic matter, to produce electricity and heat was not considered in the first instance. However, following an assessment by ENERGAIA (Gaia Municipal Energy Agency), that evaluated the energy potential of the gas and the economic feasibility of the process SULDOURO decided to proceed with the design and the implementation of an energy production centre that uses the gas to produce electricity and heat.

The electricity is sold to the national electricity grid while the heat generated is used for space and water heating.

This project provides significant economic benefits to the landfill management and increases the environmental quality of the installation as a result of the efficient gas extraction and hence reduction of local greenhouse gases emissions.

Capital costs of 1.3M€ were financed by the European Cohesion Fund

Europe: Solar Collector – Spain

T@W Good Practice No 29

50 MW Parabolic Collector Solar Project in Sanlúcar, Spain

Cylindrical parabolic collectors. Image reproduced with the permission of Abengoa-Solucar.

During a seven-year period from April 2006, Solúcar will build the biggest solar platform in Europe in the surroundings of Sanlúcar la Mayor (Seville). Nine plants will be installed using different technologies, such as the thermoelectric tower and heliostat field, parabolic cylinder, Stirling disk and photovoltaics with high and low levels of solar concentration. Total power capacity will be 302 MWe. Among these technologies, of special relevance is the parabolic cylinder collector plants described in this good practice case study, which were completed in 2007.

The aim was to install five 50 MW plant each having 360 collectors cylindrical resulting in a structure 150 m long as illustrated here. The reflecting surface consists of a series of highly reflective mirrors of parabolic shape mounted on a structure that is moved to follow the sun's path. The mirrors concentrate the solar radiation on a thermal fluid, from which the heat results in with electricity generated through a steam turbine. The estimated electricity production is 114.6 GWh/year.

The surface area is 1 500 m^2/plant. There are no CO_2 emissions from the plant and 90 000 tonnes CO_2 equivalent/year/plant of GHG emissions are avoided. The investment of 200 M€/plant was financed through bank credits and the commercial selling of the electricity at a subsidised price in the Spanish electricity market.

Europe: Wind Power - Voluntary Gold Standard – Turkey

T@W Good Practice No 35

Yuntdag 42.5 MW Wind Power Project: Gold Standard large-scale voluntary offset project in Turkey

The Yuntdag wind farm project is one of the first Voluntary Gold Standard Projects. The expected emission reductions amount to 113,000 tCO_2eq per annum. This project is located in the Izmir region of Western Turkey. It will include seventeen 2.5 MW wind turbines providing a total capacity of 42.5 MW.

The electricity produced will be fed into the national power grid. The emission reductions result from replacing electricity generated from conventional sources. The project is currently being validated process with commissioning planned for May 2008. The crediting period covers the first 7 years with an option for this to be extended. As a Gold Standard Voluntary Emission Reduction (GS-VER) project, premium credit quality is assured. It is one of the first four projects attempting to achieve the requirements for Voluntary Gold Standard Projects (www.cdmgoldstandard.org).

Should Turkey ratify the Kyoto Protocol in the future, it is expected that the project will be re-evaluated as a CDM or JI project (depending on the eventual status of the country), thus increasing the value of the emission reduction credits.

Source: FutureCamp, Germany

Europe: Energy Efficiency – Portugal

T@W Good Practice No 37

Plan for Promoting Electrical Energy Consumption Efficiency (PPEC), Portugal

Within the scope of the Kyoto Protocol, taking into account the European commitments, Portugal expects to limit the growth of its greenhouse gas (GHG) emissions by 27% during the period 2008-2012, taking values of 1990 as a baseline.

In this context, the National Programme for Climate Change (PNAC) was adopted by the Ministers' Council Resolution No. 119/2004 of July 31.

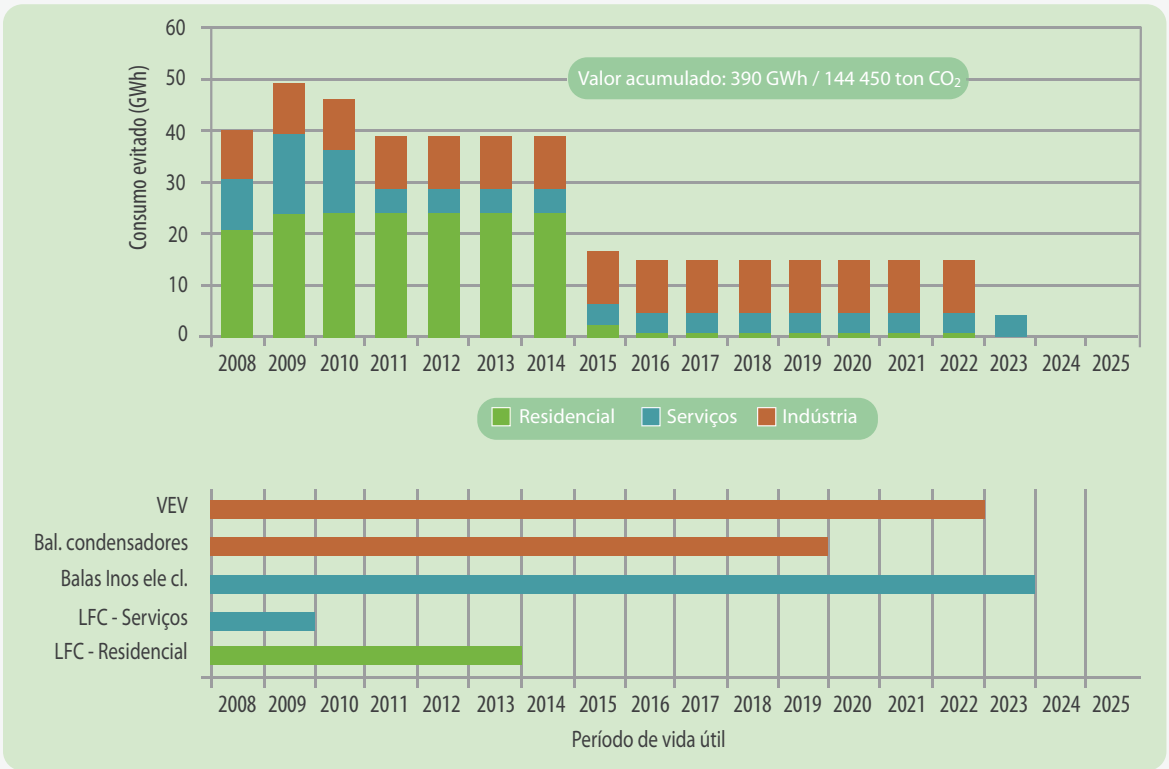
More recently, in 2006, the PNAC approved the Ministers' Council Resolution No. 104/2006 of 23 August that quantified the national effort in respect of GHG emissions and integrated a wide range of policies and measures that cover all the relevant activities. In this respect the Energy Services Regulatory Authority (ERSE) has the responsibility of defining mechanisms that promote energy efficiency on the demand side.

The regulation and liberalization of the electricity and natural gas market increased efficiency on the supply side. However, as far as the demand side is concerned, the growth in efficiency was blocked by various barriers related to the participation of electricity utilities in energy efficiency activities.

One way to promote electrical energy efficiency is to create tariffs that encourage the rational use of energy and its associated resources. On this basis, ERSE established a competitive mechanism for the promotion of demand management actions within the Tariff Regulation of the electric sector. This is known as the Plan for the Promotion of the Electrical Energy Consumption Efficiency (PPEC). The implementation of the measures approved within PPEC 2007 impacts the market for energy efficiency equipment and services and also results in a reduction in energy consumption.

The following graphs show the electricity saved, each year, as a result of the implementation of PPEC measures. Due to the type of actions approved in the residential sector (such as use of compact efficient light bulbs) the effects are short-term and will cease to have a further impact after a few years, while within the service and industrial sectors the measures to be applied are more varied, resulting in savings over a longer period.

The benefits from the implementation of PPEC measures should, by 2023, result in an accumulated electrical energy saving of about 390 GWh, and consequently a produce a reduction of 144000 tons of CO_2 emissions. It is important to note that the results showed relate only to the implementation of the PPEC 2007 measures. With the implementation of future PPEC initiatives the energy savings will increase.



Europe: Biomass and CHP Solutions for Coal Mining Regions – Slovakia

T@W Good Practice No 27

Coal bed methane utilisation, Handlová, Slovakia

Coal mining results in the release of significant amounts of methane gas to the atmosphere. The gas produced naturally in association with coal deposits seeps into mine shafts and must be removed to ensure the safety of the mineworkers. At present in the Slovak mines such Coal Bed Methane (CBM) is usually vented to the atmosphere.

The following demonstration project used specialized technology from local suppliers to capture the mines gas and use it for production of heat and electricity thus eliminating the negative impact of coal bed methane released into the atmosphere. The combined heat and power (CHP) unit was established through construction of a degassing system resulting in electricity production for consumption in the mine (40% of the captured CH4) together with heat production (50%).

During the project, amounts of gas recovered were monitored continuously. It was found that approximately 10% of the gas was not captured reflecting the efficiency of the equipment used.

Further results are not available; however, the following results were anticipated at the start of the project:

- Coal bed methane collection should amount to around 1.264.000 m3/year
- Two CHP Units (of 160 kWel) were expected to substitute for grid electricity by approximately 2560 MWh per year.

Coal bed methane utilisation, Handlová, Slovakia
Photo Source: HBP, a.s. Handlová

Biomass combustion system from another fuel switch project in Handlová, Slovakia (T@W Good Practice No 25)
Source: Handlovská Energetika, Slovakia

T@W Good Practice No 26

Fuel switch from fossil fuel to biomass combustion, Hriňová, Slovakia

Prior to this project, which commenced in 2005, brown coal and natural gas were used for district heating in the city of Hriňová. In this project, some of the fossil fuels have been replaced with biomass which has decreased the emissions of CO_2 and other pollutants such as SO_2 and PM, as well as reducing the fuel costs and helping to decrease the solid waste from coal combustion.

The original Hriňová heating system consisted of three brown coal boilers, one R10H with the capacity of 15.3 MW and two Praga 250 with the capacity of 7.7 MW each. The boilers were equipped with precipitators, just before the stack inlet. In order to change the fuel mix toward the biomass the R10H boiler has been replaced with a 2.2 MW VESKO-B boiler for biomass combustion. The flue gases are cleaned from PM emission by a multicyclone precipitator. There is also a 10.86 MW NG boiler with a RAY 250 burner type. The flue gases are exhausted through a 27 m high stack.

By the completion of the fuel switch in 2006, 30.8% of heat was generated from biomass combustion. In addition, the total thermal input had decreased from 41.56 MW before the project to 28.46 MW after conversion.

Asia: Biomass Cofiring of Agri-Pellets - China and India

T@W Good Practice No 41 and 42
Co-firing in carbon power plant with agri-pellets, China and with agri-pellets and ethanol production, India

A new technology that enables pelletisation of mixed and humid biomass without (thermal) drying makes low energy pelletising of agricultural residues possible. Pelleting is important for large biomass projects, where collection and transport costs become significant, as it enables a higher bulk energy density to be achieved and improves storability of the biomass.

Co-firing such pellets with coal in power plants is relatively easy, requiring low investments: 100 - 8 Euro/kW in the EU for the plant adaptation plus investment for the agri-pellets production plant. Only a few pelletisers are required to have a significant effect since one pelletiser of 10 ton/hour can contribute 16.6 MWhe to a coal power plant which would represent 10% cofiring for a 166 MWe installation. The pelletisers can be located decentrally in areas rich in biomass resources from where pellets can be transported conveniently to the power plants. This approach can lead to large scale projects, justifying overhead costs for CDM with ROI benefits of at least 0.15.

Partners from the T@W project (ETA, FutureCamp, ZERI and EUBIA) are investigating a number of potential projects in China. In addition, a combination of ethanol production and co-firing in power plants is planned in India. The co-firing will be done with the (abundant) residues of the ethanol production from Sweet Sorghum, leading to the optimal utilisation of the biomass and therefore minimum consumption of land, water and other resources.

Sweet Sorghum. Source: EUBIA

Sweet Sorghum is a promising ethanol crop since it needs less water than sugar cane and has less climatic (tropic) requirements. In addition to producing sugar (6 ton/ha, needed for alcohol) it can also provide also grain for feed/food as well as stalks and leaves that can be pelletised. Using the complete crop to produce a range of products helps to reduce the cost of an individual product when compared to other sources. Considering that Brazil can produce ethanol at a low cost without fully exploiting all of the sugar cane it is evident that this total utilisation would have a positive effect on overall economics.

Agriculture in China. Source: CPL Press

Agri-Pellets from various types of biomass. Source: EUBIA

Asia: Small Hydropower – India

T@W Good Practice No 8

Varja and Chaskman small hydro projects, Maharashtra, India

The Vajra small hydro project (SHP) is a run-of-the-river small power project, where water from the river is diverted through the power house to generate renewable power. In contrast, Chaskaman SHP is a dam to electricity project set up on an existing dam. The water released through the canal for agriculture use is routed through the power house to generate electricity. Small hydro power plants of Vindhyachal Hydro Power Ltd (VHPL) are installed in the existing water bodies. Hence, there is no water reservoir constructed as part of the project activity.

The project sites Vajra and Chaskaman are located in the Thane and Pune districts of Maharashtra state respectively. Together these projects have an installed capacity of 6 MW (3 MW each). The project activity is generating electricity and supplying it to INOX Air Products Limited through the Maharashtra state electricity grid. The project proponent has signed power supply agreements with Maharashtra State Electricity Board (MSEB) and Power Purchase Agreement (PPA) with INOX Air Products limited.

The purpose of the project activity is to generate electricity by using the renewable hydro resources to meet the ever-increasing demand for energy in the region. The development of these projects results in a reduction of GHG emissions produced by the western regional grid generation mix, which is at present mainly dominated by fossil fuel based power plants.

The projects will also contribute to the following:

a) Sustainable development, through utilisation of renewable hydro resources available in the project region

b) Rural area development

c) An addition to the present installed capacity increasing overall energy availability

d) Create additional employment

The project will result in a total CO_2 emission reduction of 191,322 tons over the period of the project.

A mountain stream in Maharashtra - a natural energy source that can be harnassed by small hydro power plants.
Source: CPL Press

Asia: Biomass and Waste for Heat and Electricity – Thailand

T@W Good Practice No 11

Dan Chang Bio-Energy (DCB) Cogeneration project in Suphanburi Province, Thailand

This project (Registered UNFCCC: 19/10/2007) consists of a biomass-based cogeneration plant using agricultural residues such as bagasse (biomass residue from sugar cane production) as primary fuel. Other biomass residues such as cane leaves or rice husk may be used to compensate for any shortfall in sugarcane availability.

The project is based on expansion of the capacity of the existing biomass co-generation system located next to the sugar mill of Mitr Phol Sugar Corporation (MPSC). It will enable DCB to increase its electricity export to the grid from 6 MW on a non-firm year-on-year contract to 27 MW on a 21-year firm contract. DCB expects to export net electricity to the grid of approximately 195,129 MWh per year which results in GHG emission reduction approximately 92,177 tonnes CO_2 equivalent/year.

A sister project, the Phu Khieo Bio-Energy plant, involves the extension of an existing co-generation plant installed at the Phu Khieo Sugar Mill, a subsidiary of Mitr Phol Sugar Corporation (MPSC). (Registered UNFCCC: 19/10/2007).

Dan Chang Bio-Energy Cogeneration Project
Source: EC-ASEAN COGEN Programme Phase 3

Dan Chang Bio-Energy Cogeneration Project
Source: EC-ASEAN COGEN Programme Phase 3

Phu Khieo Bio-Energy project
Source: EC-ASEAN COGEN Programme Phase 3

T@W Good Practice No 9
A.T. Biopower (ATB) Rice Husk Power project in Pichit Province, Thailand.

This Project (Registered UNFCCC: 18/06/2007) is designed to use rice husks for electricity generation; the husks would otherwise be burned in the open air or left to decay in field. The project involves the construction and operation of a new rice husk power plant of 20 MW net generating capacity. Electricity will be sold through a 25-year power purchase agreement (PPA) with the Electricity Generating Authority of Thailand (EGAT) who guarantee a minimum purchase of 80% of the contracted capacity equivalent to 132,864 MWh/year.

GHG emission reduction will come from the amount of electricity supplied to Thailand's electricity grid generation reflecting the amount of rice husk used in the project. The GHG emission reduction of this project is approximately 77,292 tCO_2eq/year.

Source: A.T. Biopower Co, Ltd, Thailand

Khorat Waste to Energy (KWTE) Project, Thailand.
Source: Asia BioGas Co, Ltd

T@W Good Practice No 12
Khorat Waste to Energy (KWTE) Project, Thailand

Khorat Waste to Energy (KWTE) is an anaerobic digestion project, treating wastewater from the starch industry at the Sanguan Wongse Industries (SWI) facility in Nakhon Ratchasima Province, Thailand. (Registered UNFCCC: 16/06/2007).

An Anaerobic Baffled Reactor (ABR) is used to remove the organic material in the wastewater, thus reducing the Chemical Oxygen Demand (COD) and subsequent CH_4 emissions from the existing open lagoon.

The biogas produced is used in the SWI facility as a substitute for fuel oil. Biogas is fed to gas engine-generators of 3 MW capacity to produce electricity, and displace grid-based electricity. GHG emission reduction from the project activities are approximately 314,959 tones CO_2 equivalent/year.

5. Recommended Measures and Future Prospects

Taking into consideration all renewable project categories, the CDM-JI-related RoI is especially high where non-CO_2-gases are reduced. The "Non-CO_2-Projects" in the renewable energy field are in many cases "low hanging fruits"[15] (especially landfill projects); but this does not mean that other projects are not also attractive. In all cases the revenues from CERs and ERUs are substantial and often of crucial relevance in terms of the overall economic performance of renewable energy projects.

The CDM market has started to become more mature, more global and will continue to grow in future. Since many areas regarded as "low hanging fruits" have already been exploited in the near future more "difficult" projects will have to be undertaken. This is especially true of energy efficiency projects, Programmes of Activities and (project) bundling. Energy efficiency projects, especially within the subcategories of industry and in-house (power) generation are expected to keep pace with other non-energy efficiency activities, indicating a future trend.

The next two sections of this report present a forward-looking discussion indicating what the recent policy developments in the EU ETS and CDM markets could mean for long-term cogeneration and renewable energies.

The future for SETatWork activities between 2008 and 2010 are then discussed.

5.1. Looking Forward – the EU ETS Markets

The political pressure to find a long-term solution to the climate change problem will remain high in Europe. At the same time, competition distortion for companies with legal bindings under the EU-ETS is growing as companies located in countries without emission reduction commitments have an easy access to the European market.

As mentioned above, many projects that are "low hanging fruits" are being or have been realized and hence the EU ETS project portfolio is getting more and more complex. Moreover as new sectors will or could be added to EU ETS (e.g. aviation, aluminium, navy) new opportunities for project activities will occur.

The European Commission recently presented its proposal for amendments to the Emissions Trading Directive for the period 2013-2020. The proposal is part of the wider climate and energy package that also includes a proposal for a new burden-sharing agreement to distribute the overall EU reduction target at Member State level as well as directive proposals on the promotion of use of renewable energy and carbon capture and storage. The level of allowances issued will be reduced, new sectors and gases added and CERs accepted only from countries that have also agreed to a binding commitment.

These important challenges and targets require increased institutional support and business participation in innovating energy systems, equipment and technologies.

On the consumption side, the need to extend technological / energy improvements in fragmented industries (housing, small industry, commerce, services, road transport, etc.) makes it necessary to implement new energy regulations, especially in the area of rational use of energy. Improving the efficiency of the energy facilities (furnaces, boilers, motors, lighting, domestic appliances, insulation, etc.) must be viewed as an ongoing strategy, the benefits of which will be reaped in the long term. The strengthening of new systems and applications for self-consumption of renewable energy (such as biofuels, solar thermal, photovoltaic, etc.), must also be promoted within a programme of technological development addressing the area of market application.

On the supply side, technological innovation is basically geared towards immediate, critical and local targets. The development of new more advanced systems for CHP and micro generation, the introduction of efficient generating equipment and technological development of wind potential are all examples of priority lines of innovation.

As the basic conditions vary throughout the European Union, so does the RTD situation. Specific fields where the latest RTD results are to be implemented, for example in Slovakia, include natural gas CHP, biogas CHP (in connection with biofuel/biomass production) and photovoltaics (in coming decade), together with large scale biomass co-firing and utilisation of energy crops. At the small scale, pelletising and briquetting technologies are a topic for further research (agricultural pellets and briquettes) or market implementation (sawdust and woodchip pellets). In addition, innovations have to be implemented in the field of industrial energy efficiency. This could include the substitution of coal-based for natural gas-based steam – cycles for power generation in the coming decade, as well as increased investment in hydro power.

[15] *This term is quite widely used to refer to something that is relatively easy to acquire. Here it refers to potential projects that are fairy easy to implement and convert into profitable enterprises.*

In Bulgaria, on the other hand, the most relevant areas are CHP (including CHP based on biomass), biomass-to-heat production, wind and small hydro power generation. With the help of the Assessment Tool and further promotional activities, the initiation of SET projects by large emitters is anticipated. Future activities in Bulgaria may include an updated 'country picture of Bulgaria' that includes the implications of Second NAP, contacts and discussions with major ETS companies and associations of industries in Bulgaria. Project initiation will focus both on large emitters and on JI in small site.

Renewable energy technologies

With increased scarcity of allowances projected (i.e. under-allocation to installations) and expected increase in the price of EUAs in phases 2 and 3 (post-2012) under the EU ETS, biomass-based energy technologies are expected to continue to increase their share of the electricity and heat markets along with biofuels as the blending of transport fuels becomes mandatory.

However, while the EU ETS has proven, is proving and will continue to prove to be a strong driver for investments in biomass-based technology, biomass resources are limited in Europe and this limited availability will eventually cap the growth potential of these technical solutions.

Co/polygeneration

The combined generation of electricity, heat and/or cooling is very efficient in energy production and CO_2 savings. So cogeneration was expected to see its competitive position greatly enhanced by the introduction of the EU ETS scheme. However, due to the uncertain legislative and regulatory framework for cogeneration installations across Europe and the short timeframes of regulations (3-5 years) investments have been hindered for several years as these aspects were being resolved.

For the future outlook in the 2013-2020 phase, full auctioning of allowances for power generation is expected together with the establishment of a Community-wide methodology for free allocation to other sectors until 2020.

High efficiency cogeneration installations will therefore benefit –on the heat side only- from similar treatment to industrial boilers. This will effectively put cogeneration installations at a disadvantage as cogeneration installations displace mid-merit fossil power plants but will have to compete on the electricity side with the entire generation portfolio of large utilities that include both nuclear power stations and other and renewables.

This, combined with the increased capital expenditure and operational (or site) risk will prove a strong deterrent to investment in high efficiency cogeneration installations, unless revenue recycling is adequate to overcome the financial obstacle and – most importantly- the psychological barrier that extra allowance purchases imposes on potential investors in cogeneration.

5.2. Looking Forward - the CDM Markets

The T@W project has been implemented along with the dynamic development of the CDM markets in Asia. It is clear that CDM is a driver in overcoming the barriers that have hindered the growth of renewable energy and polygeneration in the region such as lack of industrial awareness, perceived high risk, high up-front cost, lack of confidence in the technologies, fuel supply issues and lack of financing capability.

To accelerate RE and EE&C penetration, efforts must be made to strengthen and develop a comprehensive approach by formulating and implementing a coherent national RE policy framework and related policy instruments as well as financial tools and mechanisms.

The scope of the T@W intervention has been to promote such development and integrate EU stakeholders in the process aiming for mutual benefits of parties in both Asia and the EU.

In the early stage of CDM development the focus has been on the 'low fruits', e.g. on projects expected to generating the highest amount of CERs. As an example a lot of attention has been given to biogas projects from animal manure, industrial wastewater from food and agricultural product processing industries and capturing of landfill gas, in all the countries.

In the subsequent phases, the developers are expected to expand the focus to incorporate all relevant resources. A key area will be to use biomass residues from processing of agricultural products. Residues from agriculture, like rice straw, cane trash, tapioca heads and others have a significant potential, but due to the way cultivation takes place, collection and handling of the residues in an efficient and feasible way is difficult. Higher prices for the residues might help to increase use and prevent field burning of agricultural biomass residues. In addition there are considerable unexploited potentials in areas such as solar, hydro and wind power as well as in improved energy efficiency in all areas of society.

The project team concludes that T@W has helped to encourage such developments on which future activities can be built. Thus the action has helped to create strong contacts between researchers and market actors in Asia and EU in view of the common challenge for ensuring a sustainable energy system.

SETatWork, supported by FP7 as a follow-up project, will ensure continuity in the promotion of sustainable energy solutions and address the challenges given by the market development, including making use of emerging concepts like Programmatic CDM.

5.3 SETatWork activities during 2008 to 2010

Under the Seventh Framework Programme (FP7), the European Commission will support a new thematic project for the promotion of sustainable energy technologies at carbon markets. This project is entitled SETatWork (short for 'Sustainable Energy Technologies at Work'), and aims to meet the challenge of climate change through a collaborative partnership of organisations in the EU, Asia and South America. It is expected that the project will run from the summer 2008 for a period of two years.

The technology focus of SETatWork will be on energy efficiency and polygeneration in the industry sector, building on the experience obtained under the T@W project. While the continuity is ensured by the involvement of many of the same partners, the industry dimension of the project has been strengthened by the direct participation of industry associations.

The core project activities will be:

- Undertaking training of selected European ETS industry sectors based on prior need assessment. The training is to help the industries on handling the complex of energy and CO_2 management and will be performed in Portugal, Bulgaria, Slovakia / Czech Republic, Poland, Germany, Denmark and Sweden - aiming for a total of 14 workshops.
- An integrated part of the performed training will be to identify opportunities for specific action in the industries for CO_2 reduction measures. This is to be achieved by local partners (facilitators) in coordination with relevant industry organisations.
- Another key project task will consist in identifying Clean Development Mechanism (CDM) projects in markets in China, India, South East Asia (focus on Thailand and Malaysia) and Latin America (focus on Brazil and Chile) in combination with the transfer of European technology and know-how. Part of this activity will be to promote concepts like CDM programmatic approaches that imply good perspectives for improving the CDM, especially in the field of energy efficiency.
- With regard to both European industry and the CDM markets, the efforts will be accompanied by matchmaking activities in order to facilitate the realisation of the identified opportunities, e.g. to match stakeholders involved in energy efficiency and savings in European industry sectors with project owners and emission rights buyers (in Asia and Latin America) with European technology and service providers.
- In parallel, the project team will observe the energy efficiency and carbon market development and disseminate the findings as inspiration for market actors and carbon market regulators.
- The project results will be disseminated via the website and an E-Newsletter for distribution via an extensive mailing list. Among the planned dissemination highlights will be the organization of side event(s) with a technology focus in connection with the UNFCCC climate conferences in Poznan 2008 (COP14) and Copenhagen 2009 (COP15), encompassing promotion of technology transfer and partner-matching.

A contact list of project partners of SETatWork and T@W can be found inside the back cover of this publication.

You are all invited to follow our progress online at **www.setatwork.eu**, where you can also register to receive the SETatWork E-Newsletter.

Abbreviations and Glossary

AAU	Assigned Amount Unit
AD	Anaerobic Digestion
AIE	Accredited Independent Entity
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CHP	Combined Heat and Power
CITL	Community Independent Transaction Log
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
COP/MOP	Conference of the Parties to the United Nations Framework Convention on Climate Change serving as the Meeting of the Parties to the Kyoto Protocol
DG-TREN	European Commission Directorate-General for Energy and Transport
DNA	Designated National Authority
DOE	Designated Operational Entity
EB	Executive Board
EC	European Commission
EE	Energy Efficiency
EE&C	Energy Efficiency & Conservation
ERPA	Emission Reduction Purchase Agreement
ERSE	Energy Services Regulatory Authority
ERU	Emission Reduction Units
ETS	Emission Trading Scheme
EU	European Union
EUA	European Union Emission Allowance
FP6	The EU's Sixth Framework Programme for Research and Technological Development (2002-2006)
FP7	The EU's Seventh Framework Programme for Research and Technological Development (2007-2013)
GHG	Greenhouse gas
GS-VER	Gold Standard Voluntary Emission Reduction
IEE	The EU's Intelligent Energy - Europe Programme (2003-2006 and 2007-2013)
IET	International Emissions Trading
ITL	Independent Transaction Log
JI	Joint Implementation
MOEW	Bulgarian Ministry of Environment and Waters
MSW	Municipal Solid Waste
Mt	Megatonne – one million metric tonnes
MW	Megawatt
MWe	Megawatt electrical
NAP	National Allocation Plan (2005-2007)
NAP_2	Second National Allocation Plan (2008-2012)
NOx	Nitrogen oxides
PDD	Project Design Document
PG	Polygeneration
PIN	Project Idea Note
PM	Particulate Matter also known as particle pollution - a complex mixture of extremely small particles and liquid droplets
PNAC	Portuguese National Programme for Climate Change
PoA	Programme of Activities
PP	Project Participant
PPEC	Plan for Promoting Electrical Energy Consumption Efficiency, Portugal
PV	Photovoltaic
RDF	Refuse-Derived Fuel
RE	Renewable Energy
RES	Renewable Energy Systems or Sources
RTD	Research and Technological Development
RUE	Rational Use of Energy
SET	Sustainable Energy Technology
SETatWork	A sustainable energy project (2008-2010) supported under FP7 that follows on from T@W
SHP	Small Hydro Power
SME	Small and Medium Enterprise(s)
SO_2	Sulphur dioxide
T@W	A sustainable energy project (2006-2008) supported under FP6
t/year	Tonnes per year
tCO_2	Tonnes carbon dioxide
ton	The United States "short ton" equal to 2,000 pounds, not to be confused with the British "long ton" equal to 2,240 pounds.
tonne	A metric tonne - a unit of weight equal to 1,000 kilograms, or 2,204.6 pounds.
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VER	Voluntary Emission Reduction

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The world has entered a new energy era, where energy technology has a vital role to play. T@W: Sustainable Energy Technology at Work (a project supported by the European Commission's Sixth Framework Programme (FP6) from April 2006 to March 2008) aimed to address the EU interests in the carbon markets by connecting EU policy goals on sustainable development to business opportunities within the carbon and climate markets. This would be achieved by facilitating the entry of European know-how on Sustainable Energy Technologies (SET) into the emerging climate markets created by the European Union Emission Trading Scheme (EU ETS) and the Clean Development Mechanism (CDM) in Asia.

This publication *Sustainable Energy Technologies / RTD practice at the ETS and CDM markets* evaluates and reviews the results of the T@W activity in order to extract lessons and compare observations in the targeted regions within Europe and Asia with a view to identifying the best ways to promote SET with an EU perspective. It aims to be an inspiration for EU ETS companies around Europe.

In addition, this publication introduces the SETatWork: Sustainable Energy Technology at Work project, which continues these activities with support from the European Commission's Seventh Framework Programme (FP7), with an extended focus on energy efficiency in industry and the use of polygeneration in Europe, Asia and Latin America.

Further information can be found online at: www.setatwork.eu

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