GERMAN GHG MITIGATION LIGHTHOUSE PROJECT GAOBEIDIAN (CHINA)

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EXECUTIVE SUMMARY

In 2006, the Technical University Braunschweig (Dept. Waste and Resources Management) designed a biological treatment plant for municipal solid waste (MSW) for the City of Gaobeidian (Hebei province/China). A German-Chinese joint venture had contracted the project; KFW development bank was providing financial assistance. The project identified mitigation measures reducing the methane emissions from decay of organic waste components at landfills. The greenhouse effect of methane, which is generated at landfills, is 21 times higher than the effect of CO_2. Due to biological treatment, organic components are being stabilized, which reduces decay after final disposal significantly. The consultants proposed a MBT plant designed for a capacity of 40.000 t/year. The MBT output should be utilized as a methane oxidation layer. This facility design was investigated in a feasibility study. The residual waste had been analyzed and treated in a pilot plant. In addition to the technical appreciation, the project's social and financial components were considered.

In June 2009, the German Federal Ministry of Environment granted a fund to the project developer, German company AWN Umwelt GmbH (Buchen) to establish the facility as a lighthouse project for GHG mitigation funded by the government's international climate initiative. Pyöry environment delivered the engineering. In July 2009 the construction work were launched and the facility is expected to start operation in early 2011. Emission reductions of approximately 8.000-25.000 t CO_2eq per year are expected, but will not be certified since the project is financed from carbon trade overheads.

The MBT plant consists of a mechanical and a biological treatment step. The mechanical treatment aims on segregating of valuable goods (paper, synthetics) and on enrichment of the organic fraction. The waste stream is split into three fractions (fine, medium, coarse). Middle and coarse fraction are being directed to hand assorting stations. Based on the waste analysis it is expected, that the medium fraction after assorting consists mainly of organic, which are slightly clean. This portion may be converted into compost. The fine fraction will undergo biological treatment as well prior to final disposal. This fraction may be also useful as amendment for landfill cover, where it acts as methane oxidation layer. The coarse fraction will be either crushed and fed to the waste stream again or directly disposed at the landfill site.

The biological treatment will be carried out as an aerobic, actively ventilated stabilization. The process will be carried out partly under roof and partly in open air areas. The triangular windrow heaps will be frequently turned. The annual capacity of the plant amounts to 40.000 t and can be significantly increased by two shift operation. The biological treatment will generate a stabilized biomass with an expected respiration activity less than 5 mgO_2/kg. Thus, the material meets the German standards for disposal at non reactive landfill sites. The stabilized biomass (SB) can also be utilized for methane oxidation layer (special landfill cover), as soil amendment, or as fertilizer in agriculture, if possible. The economic benefits of the plant can be increased due to additional revenues from selling the SB and from related CDM-projects (landfill cover). To produce a high quality SB the waste flux management needs to be refined and permanently controlled in order to minimize pollutants and harming matters in the organic waste fraction. Additional measures can be implemented such as acquisition programs for clean biowaste. During the feasibility study it was found that residents drop biowaste at the facility when reimbursed properly. The costs for acquiring biowaste amount to 6 €/t.

1 INTRODUCTION

1.1 Background

Experts estimate that 8 to 12 % of greenhouse gas (GHG) emissions in developing and threshold countries are due to waste management activities. The major sources are methane emissions from disposal of untreated municipal solid waste, which in those countries contains a large portion of degradable organics. Biological waste treatment is an effective technology to stabilize organics and to minimize decay processes in landfills. The MBT plant in Gaobeidian (Hebei province, PR China) is a pilot waste management project to demonstrate this technology in China.

The project is administered by AWN Umwelt GmbH, a German waste management company partly public owned by AWN (Abfallwirtschaftsgesellschaft Neckar-Odenwald-Kreis) based in Buchen. AWN Umwelt has already established a joint venture for the construction of a sewage treatment plant in Gaobeidian The project was recently finalized and started operation. In the summer 2006 AWN Umwelt and the Municipality of Gaobeidian decided to prepare a similar project for the improvement of the waste disposal in Gaobeidian. The treatment facility is under construction and will open in January 2011.

FIGURE 1 Location of Gaobeidian

1.2 Objectives

The project aims on reducing emissions from waste disposal activities, particularly emissions of methane to reduce the GHG release to the atmosphere by means of biological treatment. With an annual treatment capacity of 40.000 t municipal solid waste the total emission reduction is expected to amount to 80.000 – 250.000 t CO_2equivalents during a 10 years period.

2 METHODOLOGY

In a first step the technical, economic and legal conditions were investigated in a feasibility study funded by the PPP facility of the KFW development bank, an endowment fund for the support of public private partnership projects financed by the German Ministry of Economic Cooperation and Development (BMZ). The technical and organizational execution of the study was assigned to the department of Waste and Resource Management of the Technical University Braunschweig. The study was prepared between September 2006 and February 2008. Based on the study AWN Umwelt applied for funding from the International Climate Initiative (IKI) of the German Ministry of Environment, Nature Conservation and Nuclear Safety. In June 2009 the German Government approved the grant. The implementation of the project was launched in July 2009. Detailed engineering and the approval process was finalized in December 2009. The facility is currently under construction, which is expected to be finalized by the end of 2010.

3 TECHNICAL INVESTIGATIONS

During the feasibility study several technical investigations were carried out by experts from Technical University Braunschweig, AWN Umwelt and Pöyry Environment Witzenhausen. Data on waste generation and waste composition were examined. The department of waste management of Gaobeidian collects annually approximately 50.000-60.000 t municipal solid waste. The collection is carried out by different collection systems, predominantly by underground drop-off containers and multi-chamber containers that are located at the roadside. The waste disposal site is located near to the city in an exploited clay pit. The disposal site ha no technical barriers and is operated on the poorest technical level as a dumpsite. Dozens of waste pickers are irregularly active on the site (figure 2).

FIGURE 2 Waste pickers

The composition of the waste was determined by means of hand assorting a 250 kg waste sample. The sample was screened by 40 mm and 10 mm sieves. The sieve overflows were sorted by hand into groups of materials. The material that passed the 10 mm filter has been analysed in the laboratory. Table 1 shows the waste composition distinguished by material groups, which constitutes approximately 55 % of the waste weight.

Material group	**Portion [weight %]**
Organic	28 %
Plastic foils	8,5 %
Coal	8,5 %
Stones	5 %
Paper	3 %
Textiles	1,5 %
< 10 mm	45,5 %

TABLE 1 Waste composition

Plastic bottles, metals, rag paper, glass bottles and wood were not found. Regarding to a biological waste treatment there is a particular interest for the portion of the organic group as well as possible disturbing materials. In the fraction < 10 mm the organic fraction is 16%, measured as loss on ignition. Thus the entire organic portion amounts to approximately 35 % weight, significantly less than the common value for developing countries (usually: 50-70 % weight). Disturbing materials were not found in the waste. The high ash portion, which originates from burned out coal elements from simple cook places, showed up to be slight in pollutants.

The suitability of the potential biological treatment procedures under the given boundary conditions (local situation, climate, waste composition) was examined in three different pilot plants:

- Passively aerated heaps (so called chimney effect system)
- Actively aerated windrow heaps for MSW
- Actively aerated composting windrows for biowaste

FIGURE 3 Actively aerated windrow for MSW

The results of the biochemical stability of the fraction <40 mm before, during, and after the actively aerated windrow treatment are listed in table 2. The respiration activity of the input material measured as AT_4 (respiration during 4 days) amounts to 25 mg O_2 /kg, the loss on ignition lay to 18%, the TOC at 8%. Table 2 illustrates the development of the parameters over the treatment period. The respiration activity dropped significantly down to 1,9 mg O_2 /kg after two weeks of treatment reflecting the comprehensive stabilization of the organics. The output material meets the German standards for waste disposal.

	Input	after 14 days (active)	after 6 weeks (active)
	13.10.06	2.11.06	13.12.06
AT_4 [mgO_2/kg]	25,2	1,9	0,91
oDS [weight %]	18,1	14,2	14,3
TOC [weight %]	8,2	5,1	5,2
TOC in the eluate [mg/l]	639	160	270

TABLE 2 Evaluation of the biochemical stability – actively aerated window for MSW

The results were not fully satisfying. Though the quality of output material was welcomed, the total mass of converted organics was small due to low input concentration. For the large scale application it was anticipated to increase the portion of organic in the input material by either segregating non-organic waste or by separation of organic waste before treatment. Since a separate source collection is not feasible in Gaobeidian a test was carried out for hand assorting of organic materials. A biowaste acquisition campaign was launched at the dumpsite. During a period of 5 weeks biowaste was accepted against payment and has been placed immediately on the composting heap. Larger quantities of biowaste were delivered by both waste pickers and residents at a rate of 6 €/t. Thus there is an economical bench mark for the separate source collection for biowaste available.

FIGURE 4 Delivery of biowaste by local resident

Based on the technical investigations a predesign was prepared for a mechanical-biological treatment plant (MBT) by Pöyry Environment Witzenhausen.

4 DESIGN

The MBT plant consists of a mechanical and a biological treatment step. The mechanical treatment aims on segregating of valuable goods (paper, synthetics) and on enrichment of the organic fraction. The waste stream is split into three fractions (fine, medium, coarse). Middle and coarse fraction are being directed to hand assorting stations. Based on the waste analysis it is expected, that the medium fraction after assorting consists mainly of organic, which are slightly clean. This portion may be converted into compost. The fine fraction will undergo biological treatment as well prior to final disposal. This fraction may be also useful as amendment for landfill cover, where it acts as methane oxidation layer. The coarse fraction will be either crushed and fed to the waste stream again or directly disposed at the landfill site. The design of the delivery and pretreatment plant is shown in figure 5

The biological treatment will be carried out as an aerobic, actively ventilated stabilization. The process will be carried out partly under roof and partly in open air areas. The triangular windrow heaps will be frequently turned by means of mobile equipment as shown by example in figure 6.

The output material will be disposed at the adjacent landfill, which is under construction. On a longer view the economic benefits of the plant will be increased particularly by means of reutilization of the stabilized biomass for methane oxidation layer (special landfill cover), as soil amendment, or as fertilizer in agriculture, if possible. To achieve this goal the waste flux management needs to be refined in order to minimize pollutants and harming matters in the organic waste fraction.

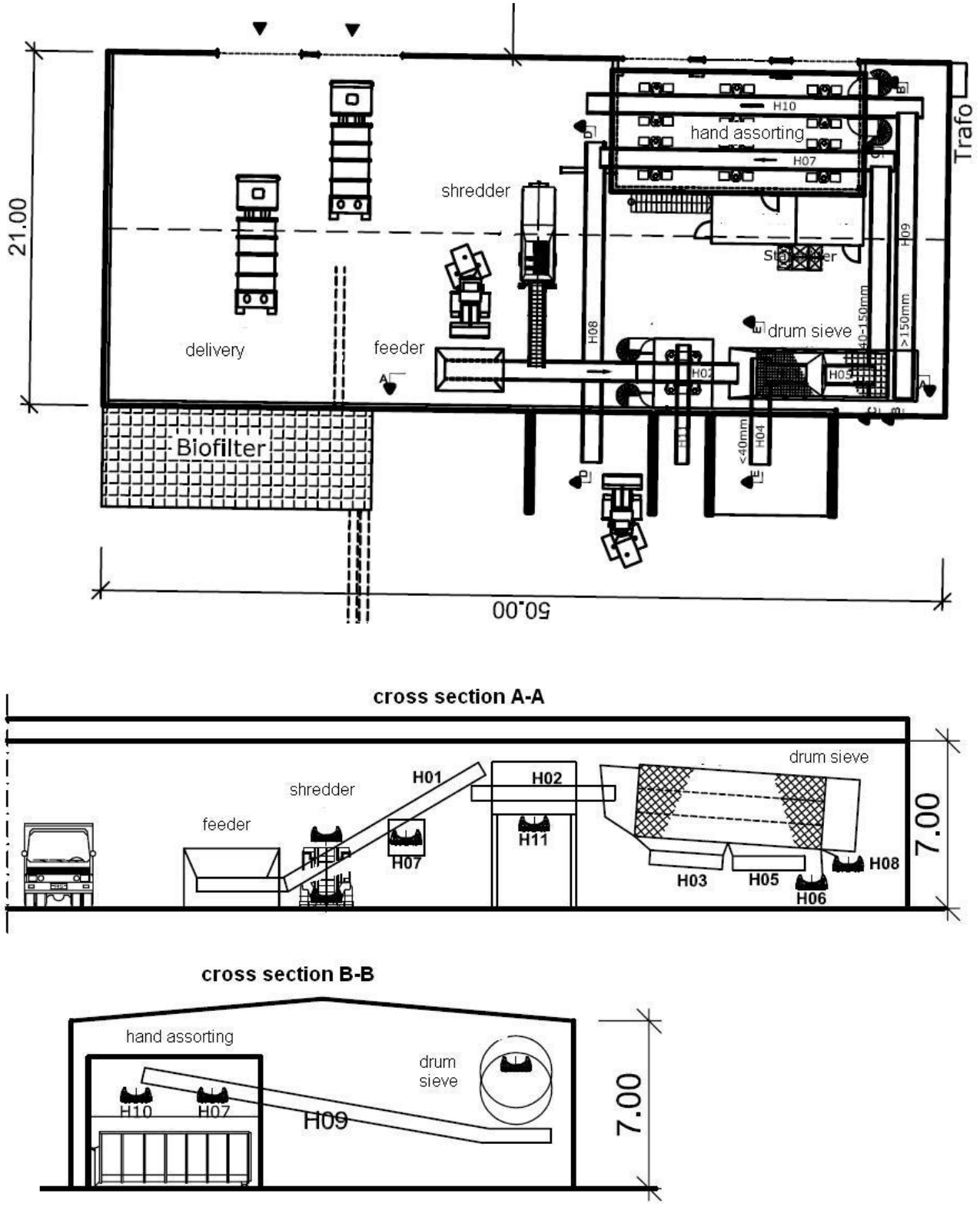

FIGURE 5 Delivery and mechanical treatment

The annual treatment capacity amounts to 40.000 t. The capacity can be significantly increased by introducing two working shifts. The location still provides contingency area for an expansion of the biological treatment. Figure 7 illustrates the lay out of the facility.

FIGURE 6 Windrow heap under roof with revolving machine (example)

FIGURE 7 Lay out of the MBT Gaobeidian

5 CLIMATE MITIGATION RELEVANCE

The generation of methane in the landfill will be dramatically reduced by disposing stabilized biomass instead of untreated waste. The emission reductions were calculated using the methodologies of UNFCCC, which are relevant for CDM projects. Since the facility has been financed by national revenues from carbon trade a registration as CDM project is not permitted. Nevertheless, it is anticipated to verify the emission reductions in a similar procedure. Thus, the calculation of the baseline as well as the monitoring of project emissions is required.

The methodology AMS III.F (Avoidance of methane production from decay of biomass through composting) serves as the base of the baseline study and the monitoring concept for the Gaobeidian MBT project. For calculations an appropriate separate tool is available, the „ Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".

In the greenhouse gas balance of the whole project, the emissions which result from the project itself must be considered as a negative influence. Therefore all CO_2 emissions of motor vehicles and electric machines counts by power or fuel consumption, which is reduces the CH_4-emissions. The calculation algorithms for both scenarios - baseline and project – are, as far as possible, given by the existing methodologies and tools. For the calculation of the methane emissions by the disposed waste, a biological decay of the deposited waste is modelled over several years by a layer model. With this model the highest methane emissions in a layer emerge during the first years and show in the subsequent years a regressive behaviour. Table 3 shows the provisional calculated emission for the project Goabeidian during one period of 10 years.
According to that, the projected amount of emission certificates results in 83,812 t CO2-equivalentes for the project period of 2010-2019. The calculation does not include any of the planned measures to increase the organic fraction prior to the biotreatment. These gain calculations represent only a prognosis on the basis of the emission reductions which are expected. The height of real income can diverge strongly. It depends on the plant capacity, the waste composition, the resource input, and on the commercial course of the certificates. In fact, the amount of emission reductions may even become three times higher resulting in approximately 250.000 t CO_2-equivalents reductions.
Regarding the monitoring process, all data that were used for the determination of the emissions, have to be determined ex-post, if not constant. Based on the monitored data the real emissions during the lifetime of the project will be recorded. To these data belong e.g. the power or fuel consumption, as well as the waste composition, which has to be examined several times in the year. Table 3 provides the breakdown of expected emission reductions over the first ten years of operation.

Year	**Project emissions [t CO_2eq]**	**baseline emissions [t CO_2eq]**	**Emission reductions [t CO_2eq]**
2010	497	2339	1842
2011	537	4376	3839
2012	577	6156	5579
2013	616	7714	7097
2014	655	9081	8426
2015	694	10284	9590
2016	732	11345	10613
2017	770	12283	11513
2018	807	13114	12306
2019	845	13852	13007
Total	**6729**	**90541**	**83812**

TABLE 3 Emission calculations for the MBT Gaobeidian

6 STATE OF EXECUTION

On 3rd of July 2009 the construction of the MBT was officially launched in a ceremony by laying the first stone. After the clearing of the construction site the local counterpart had turned the area into a festival zone with stage, flowers, dragons, balloons and red carpets. On a 3 x 15 m sign the future plant was visualized. German and Chinese stakeholders form the municipality, province and national government, project developers and donor joined the event. Several hundred spectators from the region gathered as audience. Finally fire works crowned the opening.

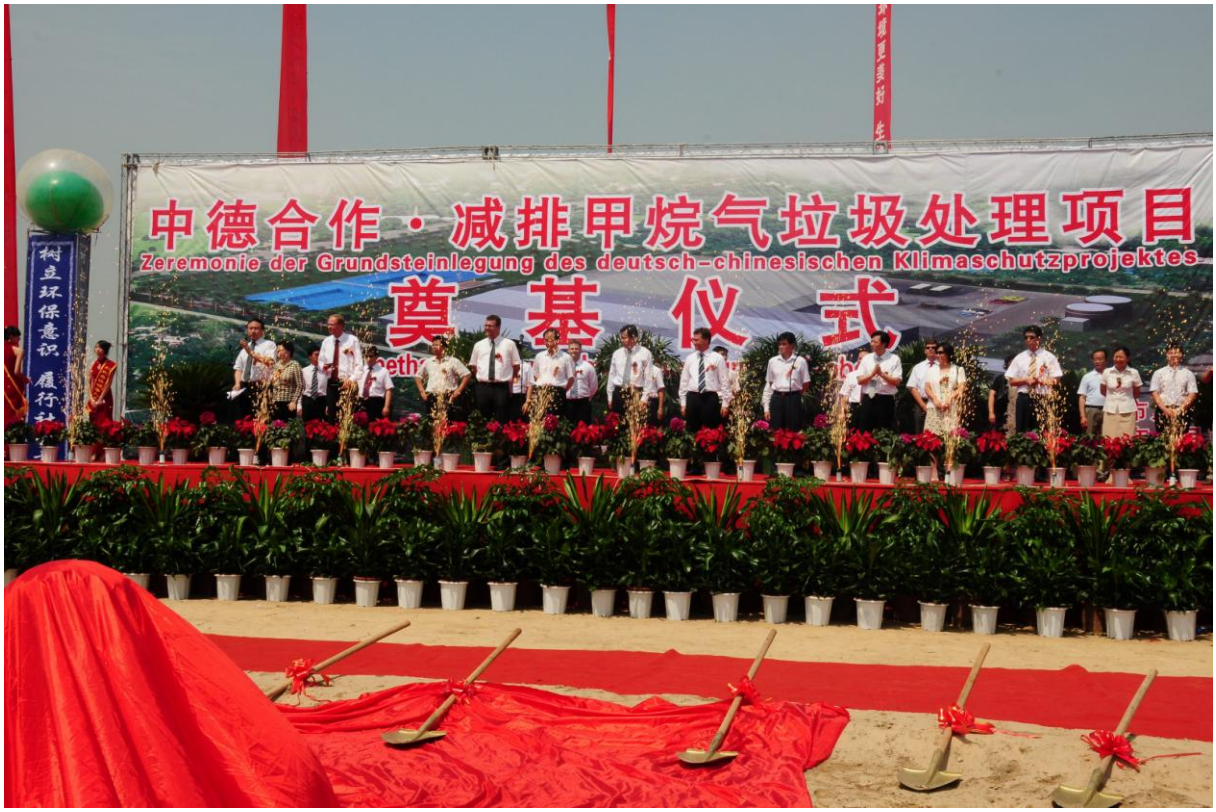

FIGURE 8 Opening ceremony for the MBT Gaobeidian

The execution of the project proceeds quickly. In accordance with the Chinese regulations a feasibility study and an environmental impact assessment was carried out and finalized by the end of October 2009. Meanwhile Pöyry Environment in cooperation with CRAES prepared the detailed engineering design. The official approval was granted by November 2009. Site clearance and construction of access and supply infrastructure was launched immediately but suffered from harsh weather conditions in January/February 2010. The main construction works of the facilities started in April 2010. The ground works and foundations are mostly completed and the administration building has been erected. Delivery and mechanical treatment compartment are under construction. Figure 9 displays the current situation on site.

FIGURE 9 Construction site by September 2010 - treatment hall (left), delivery building (right)

The construction works are expected to be finalized by December 2010, pilot operation shall start in Early 2011.

7 ACKNOWLEDGEMENTS

The project developers appreciate the funding from the International Climate Initative by German Federal Ministry of Environment, Nature Conservation and Nuclear Safety. The International Climate Initiative is financing climate protection projects in developing and newly industrialising countries and in transition countries in Central and Eastern Europe since 2008. Through this, the Federal Environment Ministry is making an effective contribution to emission reductions and adaptation to climate change. This new form of environmental cooperation complements the Government's existing development cooperation. Funding of 120 million euro per year is available for the International Climate Initiative from the revenues of the sale of emission allowances. A decision by the German Bundestag (parliament) forms the basis of this worldwide investment in climate protection.. When selecting projects, the Federal Environment Ministry attaches great importance to the development of innovative and multipliable approaches that impact beyond the individual project itself and are transferable. Through targeted cooperation with partner countries the Climate Initiative provides important momentum for negotiations on an international climate agreement for the post-2012 period. One focus of the International Climate Initiative lies in the areas of promoting a climate-friendly economy. In the field of a climate-friendly economy, the goal is to support partner countries in establishing a climate-friendly economic structure that prevents climate-damaging greenhouse gas emissions where possible. This support covers areas such as increasing energy efficiency, expanding renewable energies, reducing environmentally harmful greenhouse gases and investment-related measures, know-how transfer and policy advice in the partner country.