Executive Summary

Advanced solid waste management (SWM) strategies and technologies offer huge potentials to contribute to climate change mitigation. According to recent studies and experiences in Germany, 10 – 15% of the total greenhouse gas emissions can be reduced by implementing strategies and technologies which reduce, re-use and recycle waste (‘3R’) and by waste-to-energy projects. Developing and in particular emerging countries would be able not only to contribute to global climate change mitigation and improve resources recovery at comparatively low cost, but also to significantly improve health and environmental conditions in their countries if they were to put in place advanced SWM systems. However, the prevailing conditions in these countries are not suitable for the establishment of sustainable SWM systems.

If the international community wants to mobilise these SWM’s potentials to contribute to greenhouse gas GHG reduction and resource recovery the simple transfer of technologies in developing and emerging countries will not be sufficient. Besides the provision of additional funding under international climate change agreements, an enabling environment must be built up in parallel. This involves in particular establishing and strengthening professional agencies and administrations, local research and development, education and training structures as well as participation and support of relevant stakeholder groups. It requires a comprehensive and long-term support based on a strategic and coordinated approach. In the long run, developing countries (DC) should become able to generate own expertise and continuously further develop their national SWM systems. For this purpose country partnerships, agreed upon between a donor and the beneficiary country, represent a suitable organisational and possibly contractual basis. In the frame of the international
negotiations on the amendment of the United Nations Framework Convention on Climate Change such approaches are discussed as 'National Appropriate Mitigation Activities (NAMA)' or 'Sectoral Approaches'. This presentation illustrates such a sectoral approach for the solid waste sector.

INTRODUCTION

Climate change and increasing shortages of energy and material resources represent serious threats for human development. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) considers climate change to be one of the greatest global challenges of the 21st century. Solid Waste Management (SWM) is considerably interrelated with these issues. As a result of growing industrialisation and consumption the pressure on raw materials supply increases enormously. This puts the economies of many developing countries (DC), particularly those of the industrialising and transition countries, in a critical situation: Both the contamination of soils, air and water resources and the increasingly more difficult supply of raw materials and energy increasingly hamper economic development. Both aspects are closely interconnected through the SWM sector. All over the world, the consumption of fossil energy sources and raw materials is on the rise, producing steadily increasing amounts of solid waste (BMZ 2009).

While the connection between resource efficiency and SWM has meanwhile received recognition in development strategies, albeit slowly, climate change so far has hardly been associated with the solid waste sector. The huge potential of SWM to reduce greenhouse gas (GHG) emissions has up to now not received adequate attention in the international climate policy debate. Essentially, this is most likely due to the fact that the 'Intergovernmental Panel on Climate Change' (IPCC) attributes only minor significance to SWM as a source of GHG emissions. According to IPCC (2007) only 2.8% of global GHG emissions are generated by the source group 'solid waste and wastewater'. In contrast experiences in Germany and several studies recently carried out applying a life-cycle-model demonstrate that global greenhouse gas emissions could be reduced by 10 – 15% if advanced SWM strategies and technologies were implemented. The different calculation methods are analysed below.

In view of the global threats leading environmental and climate experts, e.g. the German Council of Environmental Advisers (SRU), request that advanced or even the best available technologies shall be applied as well in DC. The Institute for Global Environmental Studies (IGES) argues similarly and advises DC to take advantage of the situation and leapfrog several development stages in SWM (ADB 2007). They are advised to implement resource efficient and energy recovering SWM strategies and technologies instead of conventional solutions (i.e. landfills). In contrast to these statements development experts argue that due to the prevailing framework conditions in DC, in particular due to the lack of know-how and financial means, only so called 'appropriate technologies', meaning simple, inexpensive technologies manageable with locally available means, are sustainable. This paper discusses whether and how DC could be enabled to implement modern or advanced SWM strategies and technologies. It outlines important issues, challenges and requirements of such an ambitious venture. The components of a sustainable SWM system are presented and measures and strategies for the systematic development of a SWM system in DC proposed. This paper presents the intermediate results of a dissertation prepared at the University of Rostock, Germany.
The IPCC Fourth Assessment Report (IPCC 2007) states that SWM together with wastewater management contribute merely 2.8% to global GHG emissions. This figure, however, only relates to the end-of-pipe technologies for waste management, i.e.:

- Landfills/ Waste dumping
- Composting
- Waste incineration without energy recovery
- Sewage disposal.

GHG-reduction impacts from reducing, re-using and recycling of waste ('3R') and waste-to-energy strategies are either accounted for in other GHG source categories or are not accounted for at all due to methodological reasons. Thus, for example, according to the Common Reporting Format (CRF) all technologies that use energy from solid waste are accounted for the energy sector (IPCC 1996):

- Waste incineration with heat recovery and/or electricity generation (without energy recovery is accounted for the waste sector) (Vol. 5, Ch. 5.1)
- Energy recovery from landfill gas (Vol. 5 Ch. 3.2)
- Energy recovery from biogas generated by solid waste fermentation (Vol. 5, Ch. 4.1);
- Energy recovery from industrial waste such as used oil, used tyres (Vol. 5, Ch. 5.1);
- Utilisation of refuse derived fuels (Vol. 5, Ch. 5.1);
- Energy recovery from residual biomass and agricultural waste (slurry, dung, harvest residue) used for biogas generation or thermal biomass conversion (Vol. 5 Ch. 2.2.4)

The wide field of material recycling is not covered by GHG inventories at all. For instance, when GHG emissions related to the extraction and processing of raw materials are avoided due to substitution of primary by secondary raw materials, these GHG reductions simply do not appear in the GHG inventories. If scrap metal, scrap paper, waste glass or other secondary raw materials separated from the waste stream are utilised instead of primary raw materials, these measures reduce the consumption of energy and resources in the manufacturing processes. But the thereby avoided GHG emissions are not accounted for as a (partial) contribution of the solid waste management sector. According to the CRF they are accounted for the sector 'Industrial processes'. Likewise, agricultural residues are classified as a contribution of the waste management sector only if they are disposed together with other waste, especially industrial waste. Otherwise they are to be reported under the sector 'agriculture, land use and forestry' (Vol. 5 Ch. 2.2.4).

All the a.m. GHG reduction effects would not be possible without modern SWM. Consequently it must be stated that the CRF conceals the real potential of SWM to reduce GHG emissions. If the total potential of SWM to GHG reduction is to be assessed, an eco-balance method must be applied which includes all relevant components of a SWM system that have an impact on the GHG balance: material recycling, substitution of primary raw materials, composting/fermentation, energy recovery, pre-treatment and landfilling of waste. The benefits from the recirculation of secondary raw materials into the production process can be calculated as credits for the substitution of primary raw materials. In the same way emissions thus avoided in extraction, processing and transport of primary raw materials have to be accounted for the SWM sector in the GHG impact balance.

In 2005 the Federal Environment Agency (UBA) drew up a GHG inventory for the waste management sector on the basis of such an eco-accounting method (Troge 2007). An up-
date of this study published in 2010 revealed that the SWM sector in Germany has contributed to GHG reductions with more than 50 million tonnes of CO2-eq. per year which is equivalent to more than 20% of the GHG reductions thus far achieved in Germany since 1990. Model calculations carried out in this study for Mexico, Turkey and Tunisia applying the same methodology revealed that by implementing advanced SWM strategies these countries could reduce their total GHG emissions by 10 – 16% (Dehoust et al. 2010).

GHG emissions generated by waste management activities in DC and emerging economies are highly relevant. In particular the large percentage of biodegradable organic waste contained represents a huge potential to generate methane, a very powerful GHG. Over and beyond this, increasing recycling could further reduce emissions, although it must be made clear that in DC the contents of recyclable materials in waste are lower than in industrialised countries.

STATE OF SOLID WASTE MANAGEMENT IN DEVELOPING COUNTRIES

Developing Countries, in particular the emerging and transition economies, are facing a disproportionate increase in produced waste quantities. At the same time waste composition and properties are changing. Besides the high population growth this is due to a considerable economic growth, accompanied by improving living conditions as well as increasing income levels, allowing product consumption for wider parts of the population. The correlation between per capita waste generation as well as waste composition and income level or living standards is significant. In particular the increasing share of end-of-life consumer products in the waste stream, there under in particular electrical and electronic scrap, accumulators etc. are noticeable. Besides these consumer wastes the generation of production waste due to the globalisation of economic relations is increasing. Last but not least residues from infrastructure facilities like sewage sludge, flue gas cleaning residues and slag are stressing the SWM systems more and more.

Most of the DC have neither the adequate facilities and technologies at their disposal nor the administrative capacities and the required know-how to cope with these challenges. The municipalities, being usually responsible for SWM, are for the most part overburdened by these tasks. Although they spend more than 20%, according to the World Bank even up to 50% of their communal budget solely on waste collection and street sweeping, often only the city centres and higher income housing districts receive regular waste collection services. Peripheral and rural areas are mostly not served. The huge effort of organising waste collection, transport, street sweeping, treatment and disposal of waste, in particular the high cost for staff, equipment and materials exceeds the financial and managerial capacities of most municipalities. Cities as centres of economic development and focal points of population growth are notably affected.

Though recovery of recyclables like paper, cardboard, plastics, textiles, glass etc. is conducted nearly everywhere in DC mostly by informal waste pickers, the recovery rates are nevertheless limited due to the simple sorting methods applied. Moreover the quality of the recovered materials, in particular those sensitive to contamination and biological degradation like paper and cardboard, is rather poor. The recycling activities are performed by several groups of people: household servants, doorkeepers, pupils, public refuse collectors and others. They sort recyclables when the market conditions seem beneficial to them. In contrast to these occasional recyclers the informal waste pickers work continuously. They sort out recyclable materials from the waste bins and heaps in the streets. The last recovery stage takes place at the dump sites, where waste pickers work under dangerous and extreme unhealthy conditions. For the most part the whole family has to assist, making
child labour with all its negative implications a sorrowful reality. The waste pickers and their families often suffer from health problems and injuries. It is mostly marginalised population groups that can scarcely find jobs in the formal market and that have no other opportunities for income generation, mostly due to ethnic or religious reasons. Poverty, unemployment, low levels of education and the demand for cheap raw materials are the main driving forces for informal waste picking.

Facilities for the treatment, recycling and environmental friendly disposal of residues are rather few and far between. This is of particular concern where hazardous and infectious waste is disposed of together with municipal waste. The public sector does not have the required financial means for the realization and operation of environmental sound waste management facilities. Private companies mostly do not find the required framework conditions to get involved. Under the prevailing conditions they cannot take the risk for the required major investments for SWM facilities. In brief SWM in DC is characterised by

- Insufficient and not reliable SWM services
- Insufficient and inefficient performance
- Informal waste picking and recycling
- Limited use of recycling potential
- Improper hazardous waste management
- Environmental pollution by existing disposal practises
- Non-conducive framework conditions for private sector participation

For a long time, solid waste management was not high on the agenda of decision-makers in DC. Only in recent years the problems posed by uncontrolled solid waste disposal have been receiving greater attention as a result of significant increases in solid waste quantities, illegal solid waste disposal practices and increased environmental awareness. Nassour (2005) now regards the situation as more positive than some years ago 'because politicians and decision-makers are under pressure to create conditions for necessary solutions'. It is becoming increasingly more difficult to ignore the negative consequences of uncontrolled solid waste disposal.

If effective improvements are to be made here, coordinated measures will be needed to establish a sustainable framework in addition to the provision of technology and know-how. Ideally these should be coordinated in terms of scheduling and contents at all levels and will have to tackle the following challenges:

- Lack of competent utilities
- Unqualified or inadequately qualified personnel
- An inadequate legal and regulatory framework
- Lack of appropriate technical standards and environmental norms
- Lack of qualified specialist agencies
- Lack of qualified regulatory, permission and enforcement authorities
- Lack of any adequate cost covering system
- Shortfalls of appropriate education, training and research institutions
- Lacking of the civil society participation

DEVELOPMENT COOPERATION APPROACHES IN SOLID WASTE MANAGEMENT

In the past decades development cooperation has witnessed several approaches and philosophies. In the 1960's and 70's the so-called 'capital-based' approach prevailed. Its
basic assumption was that the provision of funds would induce development. Not only did this approach increase indebtedness of DC but also most of the projects in the SWM sector like in other technology based sectors failed. They were often badly managed and had high operational cost, resulting in deficient maintenance and repair, emissions (bad odours) and environmental pollution. Nassour [2005] points out deficient qualification and training, lack of understanding of the processes (in particular composting) and improper selection of technology as further reasons. Based on a critical evaluation of SWM projects financed by the World Bank Bartone et al. (1990) concluded that most of the projects had not contributed to protecting the environmental conditions and improving the performance of SWM. The projects failed to establish capable operational entities, distinct structures and competences and strategic planning.

After the numerous failures in the 80's and early 90's particular emphasis was given to 'capacity-building' and small-scale projects. Based on the conclusion that successful projects require qualified staff disposing of adequate managerial capacities, strengthening of local ownership and responsibility was placed on the top of the development cooperation agenda. The projects during this era are in particular characterised by the disposition of 'software' (JICA 2005). They focus on the establishment of service utilities and qualification and training measures to develop managerial and operational know-how. Numerous small and pilot projects, often using self-help and participatory approaches, were implemented. They were mostly low-technology projects comprising only single components of the waste management system. Despite the success of several projects, positive outcomes were at best restricted to the project area. They hardly had a significant impact on other regions or contributed to establishing sectoral structures on a national level.

Encouraged by the Rio Declaration in 1992 and the Agenda 21 so called 'integrated project approaches' have been developed since the end of the 90's. They cover the whole process chain of SWM and include strategic objectives to stimulate reduction, reuse and recycling of waste materials. Due to financial restrictions only low-cost solutions could be implemented. The strategic objective was to implement the basic structures of a modern SWM system in order to provide the basis for the development of a recycling economy (Pfaff-Simonet 2006). The projects comprised 'hardware' like technical equipment for waste collection and transport, waste treatment and disposal facilities as well as 'software' like capacity building, qualification and training measures, development and implementation of cost recovery systems, public relation and environmental education. Resource recovery measures represent core strategic elements of these projects. As much as possible the projects aim to cooperate or even integrate the informal waste pickers in the SWM systems. Thus the projects contribute to poverty reduction and associated development goals (improving health conditions, reducing child's labour etc.).

A look at the present practise of international development cooperation reveals that SWM projects financed in the framework of development cooperation rely mostly on the implementation of sanitary landfills. Although they offer only very limited potential for GHG reduction in DC they are hitherto deemed as the best compromise between that which would be desirable form an environmental point of view and that which is economically feasible. Even in the framework of the clean development mechanism (CDM) – an instrument aimed at supporting the transfer of low carbon and GHG mitigation technologies to DC - the methodologies in the SWM sector offer the wrong incentives for project developers and investors by in fact privileging landfill gas capture, treatment and utilisation strategies (Fricke et al 2009). Due to operational and technical reasons only 40 – 50% of the generated landfill gas, which consists of about 50% - 60% methane, a very powerful GHG, can be captured. This is why the contribution of sanitary landfills to GHG mitigation is very lim-
ited. Moreover even well managed landfills represent a latent risk for the environment and are at the most a second best solution regarding environmental and climate change challenges. Present project designs are still far from implementing advanced SWM systems in DC due to the limited financial means. Consequently substantial contributions to GHG reduction and resource protection can not be expected.

**CONDITIONS FOR THE IMPLEMENTATION OF SUSTAINABLE AND ADVANCED SWM PROJECTS**

Development cooperation approaches from the 60’s until the 90’s addressed merely discrete components of an SWM system. With the integrated approaches since the end of the 90’s project-inherent sustainability emerged but impacts were still confined to single projects. They hardly contributed to the development of a SWM sector and the required professional institutional and administrative structures. Albeit technical development cooperation supports the development of conducive framework condition on a 'macro-level' those supportive activities are mostly performed independently and are rarely linked with investment projects. Coordination of activities is seldom and strategic plans are mostly missing.

Besides advanced strategies and technologies modern SWM systems require clear and conducive framework conditions, specifically

- a comprehensive legal and regulatory basis
- a clear institutional organisation and distribution of competencies
- motivated service providers
- a professional administration for regulation, supervision and enforcement
- qualified staff
- education and training facilities
- research and development capacities
- encouraging framework for private sector participation
- a professional and efficient private sector (consulting, construction, service provision)
- an adequate cost recovery and reliable financing system
- an informed public with opportunities for participation

If the planned SWM systems are to be sustainable all these issues have to be addressed. Although most of them are already part of different development cooperation activities the challenge is to better coordinate and subordinate them under a strategic plan in a systems approach. This requires long-term cooperation and the reliable commitment of sufficient funds and technical support from the donor states. This goes far beyond that which was so far state of the art in development cooperation.

**NEW OPPORTUNITIES THROUGH AN INTERNATIONAL CLIMATE CHANGE MITIGATION AGREEMENT**

Under the 'United Nations Framework Convention on Climate Change (UNFCCC)' the so-called 'Annex 1 countries', which are essentially the OECD member states, have committed themselves to transfer environmentally friendly technologies and technological expertise as well as to assist the DC in building capacities and in the development, transfer and introduction of environmental and climate-friendly strategies. They have furthermore committed themselves to providing DC with "new and additional" funds to fulfil the convention which are necessary to meet the full additional costs of the activities undertaken for its implementation. These new and additional funds shall go beyond the 'Official Development Aid' (ODA) funds, which are provided in the framework of the established development cooperation. The convention concedes that DC can meet their reduction obligations only to the extent that industrialised countries meet their financial obligations and transfer environ-
mentally friendly technologies. It is also conceded that economic and social developments as well as the eradication of poverty are the highest and most urgent priorities for DC.

The implementation of advanced SWM systems would enable developing countries not only to make tangible reductions to their GHG emissions in a comparatively affordable way. It would also significantly improve health conditions and reduce environmental risks associated with improper SWM. It would furthermore create jobs and thus contribute to poverty reduction. In other words: The implementation of SWM systems would significantly contribute to the development of DC.

The UNFCCC – if earnestly adopted – improves considerably the possibilities for the deployment of advanced technologies in DC. However, the prevailing framework conditions in DC are such that simply transferring know-how and technology would not solve the problems. In other words: The transfer of technology and know-how alone is not sufficient to substantially improve the often catastrophic waste disposal situation in DC. In the frame of the international negotiations on the amendment of the Framework Convention on Climate Change such approaches have firstly been discussed in the 'Bali Action Plan' as 'National Appropriate Mitigation Activities (NAMA)' or 'Sectoral Approaches'. The following chapter illustrates such a sectoral approach for the SWM sector.

**Outline of a Sectoral Approach in Solid Waste Management**

Sectoral approaches are 'top-down-approaches' meaning: They have to be designed, organised and managed by the governments respectively those public institutions being responsible for planning, regulating, managing and supervising a sector. The objective and the duty are to establish the sectoral structures in the whole country within a certain period of time. Relevant stakeholders and target groups are to participate. During the oral presentation of this paper a process flow diagram will be presented explaining the proposed sectoral approach.

On the vertical time line several core process steps and milestones are displayed. The sequence of this proposal is based on the respective chapter in the 'Handbook for Implementation of EU Environmental Legislation' (EU 2008). However, the EU recommendations for the implementation of a SWM system comprise merely technical, planning and implementation issues. The proposals presented in the paper at hand broadens the scope by adding all above mentioned components deemed necessary to achieve sustainability. The following core processes can be distinguished:

- Setting of a national SWM policy and a governmental programme
- Development of a sector strategy
- Development of framework conditions
- Planning of facilities and measures
- Implementation of facilities and measures
- Operation and service provision
- Monitoring and reporting

On the horizontal axis different action fields divided into three sections are presented:

- **Development of principles and infrastructure**
  - Legal basis and technical standards
  - Financing and cost recovery
  - Planning and implementation of facilities
b) Capacity development and know-how development

- Establishment of public institutions: Technical authority, authorities for licensing and permitting, supervision and enforcement
- Establishment of SWM service utilities
- Establishment of development and research institution(s)
- Establishment of education and training institution(s)

c) Participation of the private sector and civil society

- National economy (in their capacity as waste producers / clients)
- Private service providers (consulting, construction, waste management services)
- Informal sector (as owner of expertise and as service provider)
- Non-governmental organisations and civil society groups
- General public (in the sense of information and environmental education)

It is understood that the presented process flow diagram displays an idealised procedure. Depending on the initial situation and the specific objectives the processes will not be implemented in the whole country at the same time. There will be country specific key fields of action and priorities. In particular the establishment of institutions and administrations is greatly influenced by existing structures, procedures and experiences. The timeline for establishing and strengthening sectoral structures cannot be generalised. Each country has to find and decide on its own path. Nevertheless the objective of the presented process flow diagram is to better understand the whole playing field and the elements to be addressed if a sustainable SWM system is to be implemented. The systematic presentation shall widen the view on the requirements which are hitherto mostly limited to the selection of the ‘right technologies’. The diagram should guide and support decision makers and development cooperation agencies for such an ambitious venture.

CONCLUSION

If the international community wants to mobilise the potentials of SWM in developing and emerging countries to contribute to GHG reduction and resource recovery advanced or even best available technologies and strategies have to be implemented. But solely the transfer of technologies will by far not be sufficient. Besides the provision of additional funding under international climate change agreements, an enabling environment must be created. This involves in particular establishing and strengthening professional agencies and authorities, local research and development, education and training structures as well as participation and support of relevant stakeholder groups. It requires a comprehensive and long-term support based on a strategic and coordinated approach. In the long run, DC should become able to generate their own expertise and continuously further develop their national SWM systems. For this purpose country partnerships agreed upon between a donor and the beneficiary country represent a suitable organisational and possibly contractual basis.

References


Bartone, Carl, Bernstein, Janis und Wright, Frederick (1990): Investments in Solid Waste Management - Opportunities for Environmental Improvement; The World Bank, Working
Papers Urban Development 405, Washington

Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ) (2009): *Handreichung Abfallwirtschaft und Ressourcenschutz* (Draft previously not released), authors Dieter Mutz, Wolfgang Pfaff-Simoneit, Günther Wehenpohl


Giegrich, Jürgen, Vogt, Regine (2009): *Strategy Proposals for Optimising German Development Cooperation Contributions to GHG Mitigation in the Waste Management Sector*, study commissioned by GTZ, IFEU Heidelberg


