



A SUSTAINABLE WASTE MANAGEMENT CONCEPT

FOR KHANTY-MANSIYSK MUNICIPALITY, RUSSIA

PREFACE

Since 2005, there is an intensive scientific exchange between the Ugra State University and the Technische Universität Berlin. In a bilateral project between both universities, methods for preparing a waste management concept, such as the implementation of waste analyses, were tested and developed further.

Based on this initial project, the project „A Sustainable Waste Management Concept For Khanty-Mansiysk Municipality, Russia“ was initiated in 2010 in which both universities, the local authorities of the City Khanty-Mansiysk, the High Technology Park and ARGUS e.V. worked together on an optimization of the waste management in Khanty-Mansiysk.

The Ugra State University was not only one of the initiators, but also the coordinator between the German and Russian partners in this project.

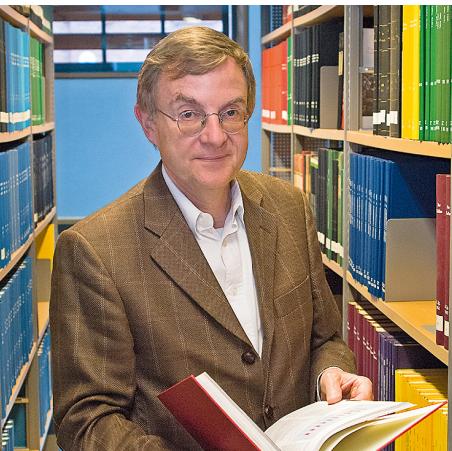
The brochure contains the essential steps for developing the waste management concept of the city Khanty-Mansiysk and the results: the concept and the educational materials that have been created in this context in order to provide scientific approaches in the field of sustainable waste management at Russian universities.

Again this background of „think global, act local“ the project emphasizes the high relevance to deal of local challenges through international cooperation.



Prof. Dr. Elena Lapshina

Director of Research and Education Centre of Environmental Dynamics and Climate Change
Ugra State University of Khanty-Mansiysk (USU)



For many years, Germany has been successfully cooperating with the Russian Federation on Environmental Protection. Waste management has a long history in Germany. In the course of time we gained valuable experience in the solution of institutional, organizational and technical challenges. We realized that orderly proper and efficient waste management is not only important for health and environmental protection, but also makes a valuable contribution to our climate objectives and to achieve the protection of natural resources. Also opportunities for the development of new technologies and industries are associated. In Russia these potentials are realized as well. Together with the city of Khanty-Mansiysk, the project partners have taken the initiative to implement an information and experience exchange in the framework of the Federal Environment Ministry's Advisory Assistance Programme to improve environmental standards and optimize investment in urban waste management under Siberian conditions. This brochure provides important insights and experiences from the project that can be used by other local authorities on their way towards a sustainable waste management.

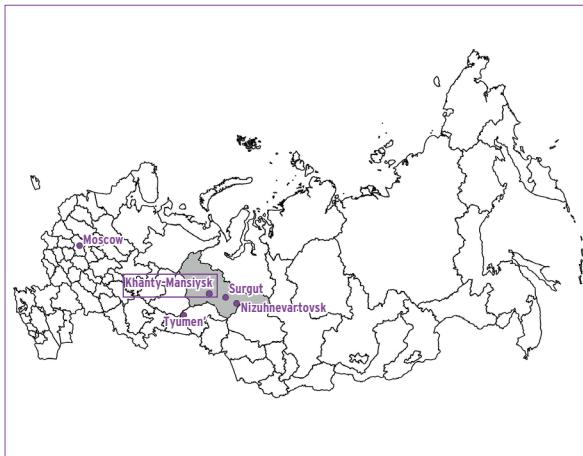


Dr. Michael Angrick

Head of the Division Sustainable Production and Products, Recycling Management
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INTRODUCTION

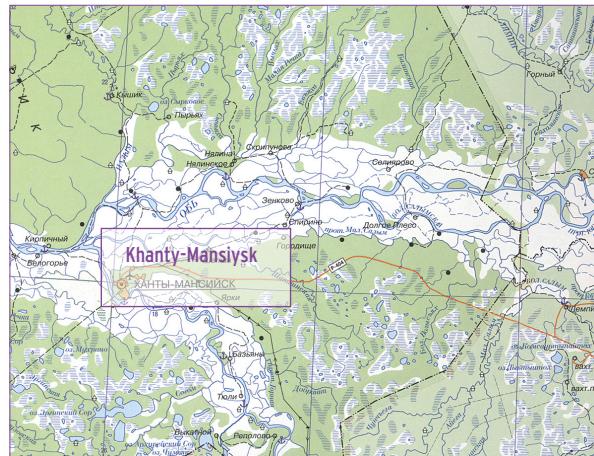
Khanty-Mansiysk is situated in a sensitive ecological setting of the West Siberian taiga near the confluence of the mighty rivers Ob and Irtysh. The wide river flood plains are surrounded by extensive pristine forests and peat lands (mires). The boundary of permafrost reaches Khanty-Mansiysk close to the River Ob.



Geographical position of Khanty-Mansiysk

Autonomous Okrug

Source: Fillipova, I., 2011, Ugra State University, Department of Ecology



Position of Khanty-Mansiysk between the rivers Ob and Irtysh

Source: Government of Khanty-Mansiysk Autonomous Okrug – Ugra, 2004, Atlas. Khanty-Mansiysk Autonomous Okrug – Ugra. Nature and Ecology. Unit II, 152 p.

Khanty-Mansiysk city covers an area of 33.7 km² and its population has increased from 39,000 in the year 2000 to about 80,000 inhabitants in 2012. It is the rapidly developing capital and administrative centre of the Khanty-Mansiysk Autonomous Okrug – Ugra (KMAO – Ugra), an economically prosperous region with extensive oil and gas exploitation.

More than 90% of KMAO-Ugra's population of 1.52 million inhabitants lives in urban centres, but with an overall average of 2.8 persons per 1 km² the region is sparsely populated.

Economic development, population increase and changes in consumption patterns within the last decades have significantly increased waste generation, but the practice of land filling this untreated waste remains unaltered. As a result, the landfill of Khanty-Mansiysk has reached its limits.

The landfill is used for deposition of all types of waste, including hazardous or problematic wastes, such as medical or specific industrial wastes. Additionally, there is an unknown quantity of waste deposited on uncontrolled dumpsites. Due to the geographic and hydrologic conditions in and around Khanty-Mansiysk, uncontrolled waste disposal poses a high risk of ground and drinking water contamination as well as environmental pollution.

Without recycling technologies to treat and minimise waste for landfill and due to low environmental standards on the existing landfill, the management of municipal solid waste has become one of the most pressing problems of the entire region.

Facing these human health risks and environmental impacts, Khanty-Mansiysk Municipality took the initiative to improve its waste management system.

As the application of modern waste treatment techniques in severe climate conditions is a technical challenge, Khanty-Mansiysk wished to be supported by German waste management know-how and to enter into a technology exchange with Germany.

PROJECT PARTNERS AND STAKEHOLDERS

Beneficiary:



The beneficiary of the project, the Department of City Household – Administration of Khanty-Mansiysk, is generally responsible for collection, transport, treatment and disposal of household and industrial waste generated in Khanty-Mansiysk as well as for preparation of tenders to improve the waste management system. This includes recycling activities as a source for commodities and economic revenues.

Role and tasks within the project: Contribution of data and information for the status-quo report, and approval and implementation of the final waste management concept since the administration had to finally approve the Waste Management Concept.

Implementing Organizations:

RUSSIAN FEDERATION:



Ugra State University of Khanty-Mansiysk (USU) was founded in 2001 and has about 10,000 students. Since 2009 it hosts the UNESCO Chair „Environmental Dynamics and Global Climate Change“.

Role and tasks within the project: Coordination of local actors and stakeholders, organization of project meetings, seminars and trainings, study tours and translation, participation in the evaluation of scenarios and the final development of the waste management concept, development and dissemination of the teaching material on the „Development of a Sustainable Waste Management Concept for Municipal Solid Waste on Local Level“.

The governmental institution **High Technology Park** was founded in 2008 by the Khanty-Mansiysk Autonomous Okrug – Ugra to promote innovation technologies, to support small and medium enterprises and to advise governmental authorities in policy and decision-making on innovative economic development.

Role and tasks within the project: Implementation of recycling market research, support of information and experience exchange between the local recycling and disposal enterprises and German waste management companies, discussion of applicable technical options and participation in the scenario evaluation.

GERMANY:



Technische Universität Berlin, Institute of Ecology, is engaged both in science and in student projects with the development and implementation of waste management concepts.

Role and tasks within the project: Project co-ordination, development of teaching material, advising and practical assistance in planning and implementation of the waste and recycling market analysis, preparation of the status quo report and the content for trainings, organisation of study tours and meetings as well as development of the Waste Management Concept.



ARGUS e.V. is a non-profit independent institute that works to provide reliable environmental data and data collection methods.

Role and tasks within the project: Guidance and assistance for the implementation of the waste analysis, the selection of appropriate technical options, the development and evaluation of scenarios and the finalization of the Waste Management Concept as well as for the establishment of contacts and facilitation of information exchange with German waste management companies.

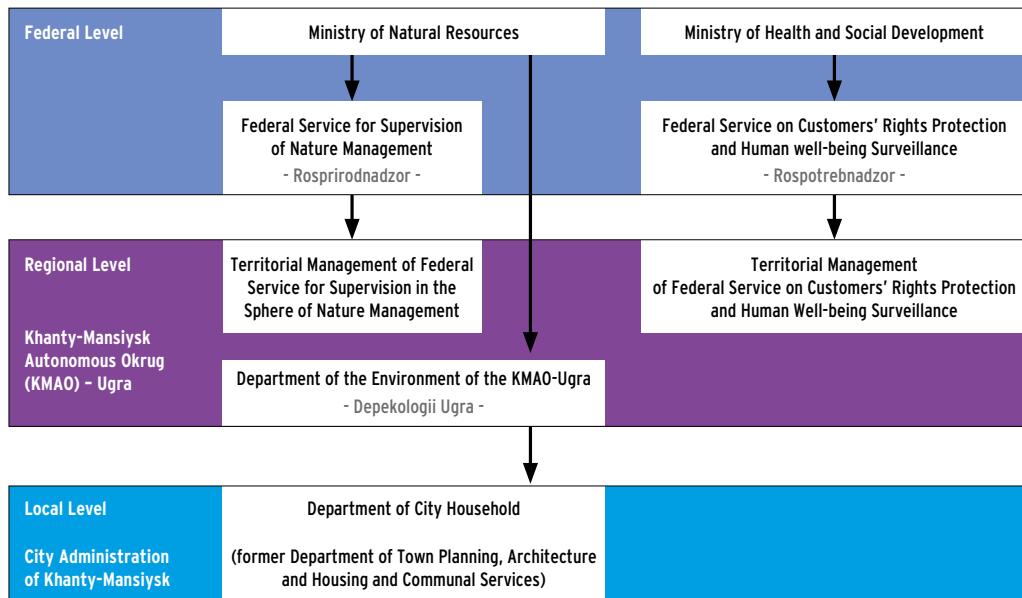
Funding, Supervision and Monitoring:



The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety funded this project through the Advisory Assistance Programme for Environmental Protection in the Countries of Central and Eastern Europe, the Caucasus and Central Asia.



The Federal Environment Agency of the Federal Republic of Germany (Umweltbundesamt, UBA) supervised the project technically.



Administration involved in Waste Management in the Russian Federation

Stakeholders:



The state-owned **Municipal Road - Operational Enterprise (M DEP)** collects and disposes about 90% of the municipal waste and operates the current landfill on behalf of Khanty-Mansiysk Municipality.

Role and tasks within the project: Data and information supply for the status-quo report, substantial support of the waste analysis, provision of experience for the applicable technical options and scenario evaluation.

Other local recycling and disposal companies participated in the data collection and recycling market research and took part in the discussion of the status quo report and final waste management concept.

The **Department of the Environment of the Khanty-Mansi Autonomous Okrug - Ugra (Depekologii Ugra)** is responsible for implementing state policy, legislation and federal and regional programs in the field of industrial and municipal waste, and distributing the necessary financial resources. It provides environmental information to the public and maintains a regional waste database.

Role and tasks within the project: Participant in the evaluation process of scenarios and the final development of the waste management concept; main actor regarding provision of a financial framework for the implementation of the waste management concept.

The **neighbouring municipalities in KMAO - Ugra** Nischnivartovsk, Neftyugansk and Surgut were actively engaged in the recycling market research, the stakeholder dialogue on the waste management concept and the exchange of information and technology with German companies.



Perm State National Research Politecnical University and National Research Irkutsk State Technical University contributed expertise to the development of teaching material on waste management to spread the knowledge gained on appropriate methods for waste analysis and development of sustainable waste management concepts in Russia. Both universities were also engaged in the recycling market research, the stakeholder dialogue on the waste management concept and the exchange of information with German companies.

German recycling and disposal companies and American and Scandinavian scientific institutes with experience in waste technology under severe climate conditions exchanged their experiences with the project partners and stakeholders.

PROJECT

Project History

First contacts between Ugra State University in Khanty-Mansiysk and Technische Universität Berlin and ARGUS e.V. were established in 2004 and resulted in a continuous cooperation. First discussions about how a sustainable Waste Management Concept for Khanty-Mansiysk could best be implemented took place within this cooperative structure.

In 2010, Ugra State University and the High Technology Park from Khanty-Mansiysk decided to apply for advisory assistance from Germany.



State University Ugra (USU), Prof. Dr. Elena Lapshina

Through international contacts, the implementation of the project was brought to a higher level ... It is recommended to seek the independent opinions of consultants, as they enrich the project and identify key aspects of developing sustainable waste management concept.



High Technology Park, Yuri Reutov

The structure and methods of the project were successfully implemented and therefore this form of project is highly recommended for the implementation of similar projects.

Project Overview and Objectives

The **German-Russian cooperation project „Development of a Sustainable Waste Management Concept (WMC) for Khanty-Mansiysk Municipality, Russia“** has been funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety with means of the Advisory Assistance Programme for Environmental Protection in the Countries of Central and Eastern Europe, the Caucasus and Central Asia. It has been technically supervised by the Federal Environment Agency of the Federal Republic of Germany (Umweltbundesamt, UBA).

The programme supports the transfer of knowledge Germany has gained from its own experiences to achieve long-term implementation of high environmental standards in the countries of the focussed region such as Russia.

The Russian project partners State University Ugra (USU) and High Technology Park, the stakeholder Municipal Road – Operational Enterprise (M DEP) and the German project partners Technische Universität Berlin and ARGUS e.V. contributed 20% to the overall budget.

The **German-Russian cooperation project „Development of a Sustainable Waste Management Concept (WMC) for Khanty-Mansiysk Municipality, Russia“** was implemented between October 2010 and May 2012.

Technische Universität Berlin, Prof. Dr. Wilke

The aim of the German project partners was to empower the staff of the city administration to independently develop and implement a waste management concept. Based on the waste analysis, possible ways of utilization of suitable waste categories were jointly identified.



The implementation of the Waste Management Concept developed within this project should achieve:

- A reduction of household and similar municipal waste to landfill;
- A minimization of uncontrolled waste disposal in unsafe conditions;
- Strengthening of the waste management systems in Khanty-Mansiysk.

The project serves as a model for other regions with similar conditions, and the knowledge gained is distributed throughout the region via teaching and information material in order to trigger similar improvements.

The German-Russian cooperation project „Development of a Sustainable Waste Management Concept (WMC) for Khanty-Mansiysk Municipality, Russia“ was implemented in two parts:

Part 1: Development of a Waste Management Concept (WMC) for Khanty-Mansiysk City

The main focus of the concept is the protection of human health and environment. It is based on a reliable state-of-the-art database on waste composition and quantity, and includes modern waste treatment techniques applicable in severe climate conditions.

Part 2: Transfer of Experience and Technology

This part was of particular added value for the local project partners and comprised of:

- Capacity building and transfer of German waste management knowledge and experience;
- Establishment of contacts between Russian and German waste management companies;
- Development and distribution of teaching material on sustainable waste management.

Timeframe

Project Phases				2010			2011						2012							
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Act 1	Development of the Waste Management Concept																			
Step 1	Information Gathering/Status Quo Report																			
Data Collection	Waste Analysis (Winter)																			
	Waste Analysis (Summer)																			
	Recycling Market Research																			
Step 3	Waste Prognosis																			
	Applicable Technical Options and Cost Estimation																			
	Development of Scenarios																			
Strategy Development	Development of Evaluation Criteria																			
	Evaluation of Scenarios																			
	Decision-making on Lead Scenario																			
Implementation Plan Development	Finalization of Waste Management Concept																			
	Approval of Waste Management Concept																			
Act 2	Transfer of Experience and Technology																			
Exchange of Experience	Exchange and Transfer of German Experience																			
	Study Tour and Meetings with German Companies																			
Dissemination	Preparation of Teaching Material																			

Technische Universität Berlin, Dr. Julia Kaazke

Time and money can be saved through integration of all relevant stakeholders. It should be taken into consideration that approximately six months to one year is necessary for the collection and summary of all required data and information.



The results of the **German-Russian cooperation project „Development of a Sustainable Waste Management Concept (WMC) for Khanty-Mansiysk Municipality, Russia“** are compiled in the following reports (available for download):

Final Report. April 2012 [1]

Annex I. Status Quo Report. June 2011 [2]

Annex II. Description of Waste Management Technologies. December 2010 [3]

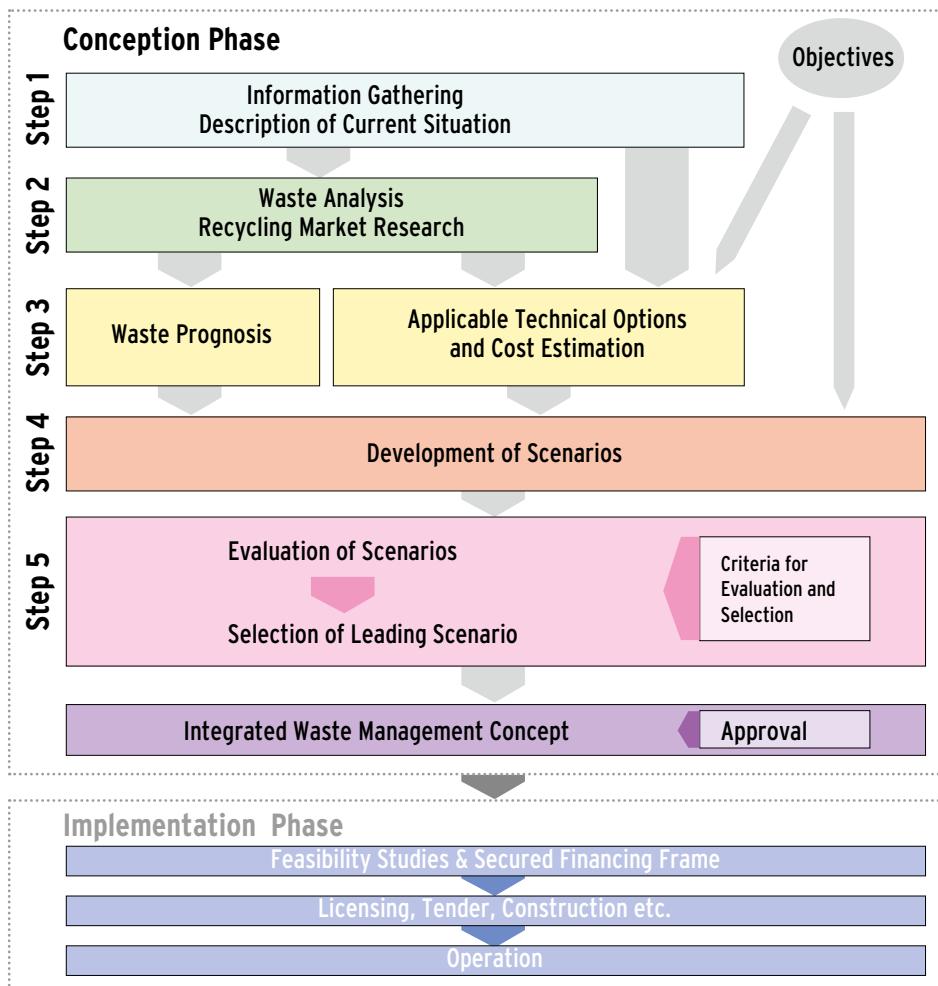
Annex III. Development of Scenarios. December 2011 [4]

Annex IV. Feasibility Study: MBT Technology under Siberian Climate Conditions. December 2011 [5]

and the teaching material „**Development of a Sustainable Waste Management Concept for Municipal Solid Waste on Local Level shown at the Example of Khanty-Mansiysk, Russia**“ by Technische Universität Berlin.

PART 1: DEVELOPMENT OF THE WASTE MANAGEMENT CONCEPT

A waste management concept is developed for a defined area and specific timeframe. It is usually prepared in various sequential work steps, some of which include stakeholder participation.



In the **first step**, all information from available sources (literature, internet etc.) are compiled and then complemented during the **second step** by fieldwork activities providing the most accurate and recent data. All data are further processed (**step 3**) to project future waste quantities and the demand for treatment and disposal capacities. In parallel, state-of-the-art waste management measures and technologies that are best applicable under local conditions have to be identified. In a **fourth work step**, scenarios to meet the local demands are developed and in work **step 5** these scenarios are discussed, evaluated and a leading scenario is selected, applying pre-defined criteria. The waste management concept is finalised based on the leading scenario, and should be finally approved by the relevant decision-makers.

For general guidance on municipal waste management planning, „Preparing a waste management plan. A methodological guidance note by the European Commission (2012)” [6] and „Developing Integrated Solid Waste Management Plan (ISWM)” [7] by the United Nations Environment Programme UNEP (2009) can be taken into account.

Step 1: Information Gathering/Description of Current Situation

General information to describe the current situation is taken from literature, Internet research and local expertise. The following information is required:

Policy, Legislation, Regional Concepts and Plans:

- Framework on waste and other relevant legislation at urban, regional and federal level;
- Definitions, objectives and responsibilities;
- Waste fees and penalty systems.

General data:

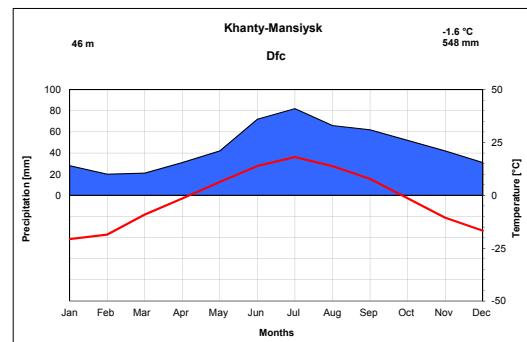
- Geography, topography, geology and hydrology, land use, climate and vegetation;
- Transportation infrastructure;
- Demography;
- Economic structure (industry, trade, tourism);
- Socio-economic aspects (gross domestic product, income);
- Housing structure (apartment blocks, small houses with garden etc.) and heating system.

Existing infrastructure and waste management facilities:

- Waste collection and transport;
- Waste treatment and disposal facilities;
- Infrastructure for wastewater.

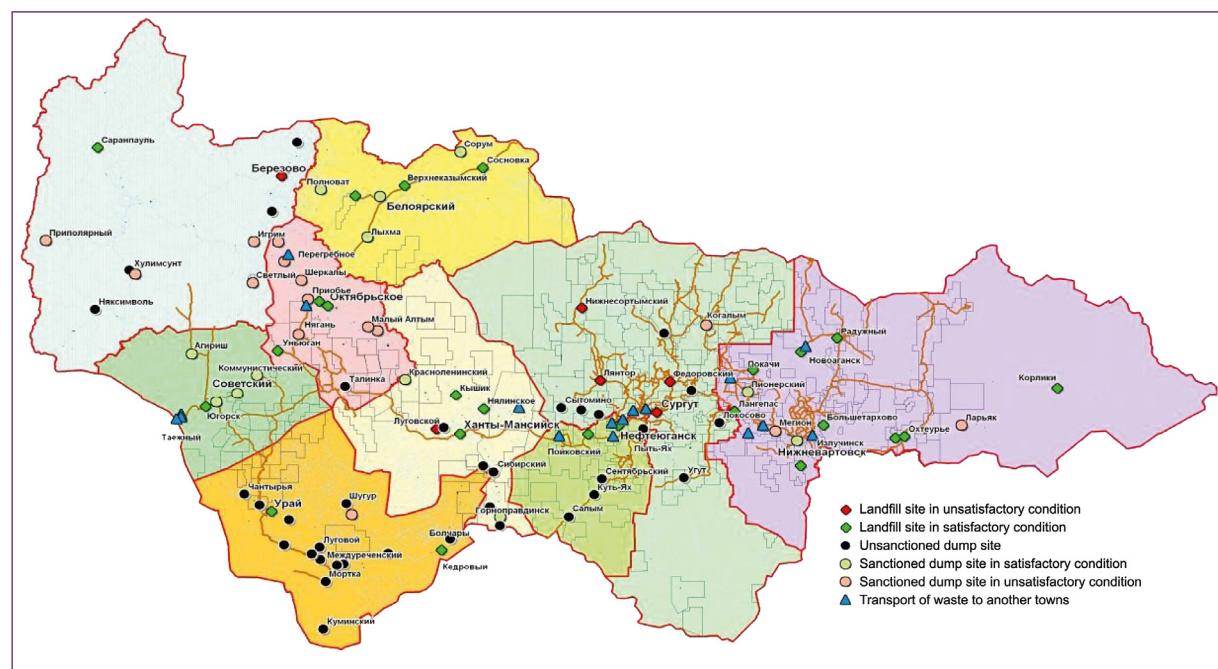
Main waste flows and their properties:

- Waste amount and composition (municipal, commercial, hazardous, industrial waste).



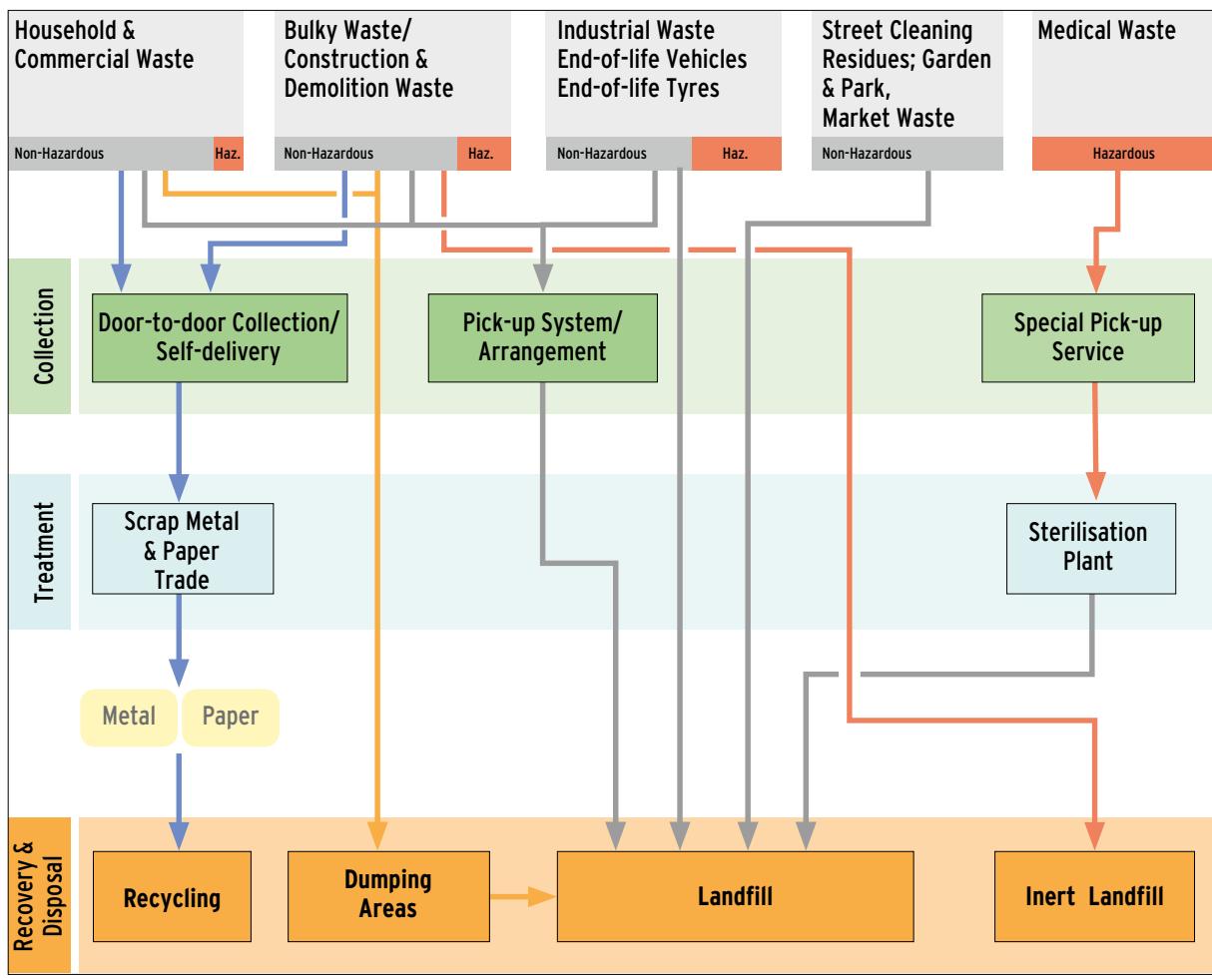
Climatic Diagram for Khanty-Mansiysk

Source: Mühr, 2007
www.klimadiagramme.de/Asien/chantymansijsk.html (04.06.2011)



Map of registered landfills in KMAO-Ugra/Administration of KMAO-Ugra, 2011

Administration of Khanty-Mansiysk Autonomous Okrug, www.admhmao.ru/sport/2010/news/news_1.htm (20.06.2011)



Current Waste Management System

Results for Khanty-Mansiysk in 2011

The current waste management system is characterized by the following findings:

- 94% of the annually collected 560,000 tonnes of waste is snow.
- Apart from snow, household and commercial waste is the main waste stream with about 29,000 tonnes per year collected and disposed on the landfill.
- Uncontrolled waste dumping is not unusual in Khanty-Mansiysk. The municipality has to clean these dumping areas at regular intervals and remove the waste to the landfill. It is estimated that cleaning of dumping areas contributes about 5,000 to 10,000 tonnes of waste for landfill per year.
- Waste from 1,785 waste containers is collected by six waste disposal companies in Khanty-Mansiysk every day.
- An unknown quantity of waste is directly delivered to the landfill by private enterprises and individuals.
- The landfill site has a size of 20 ha, which includes all infrastructure and buildings as well as the landfill body. One landfill cell of 8 ha is almost filled and a second cell is in preparation.
- There is no separate collection scheme in place. Hazardous waste, special types of waste (e.g. spent batteries, waste electronics etc.), recyclables (paper, plastics, glass etc.) or bio-waste are disposed on the landfill.
- Annually 180 tonnes of medical waste are sterilised at the hospitals and afterwards disposed on the landfill.
- About 3,000 tonnes of mainly bulky waste and street cleaning residues are disposed on the landfill.
- About 710 tonnes of construction and demolition waste is collected by the public waste management authorities each year and deposited close to the riverbanks.

Step 2: Recycling Market Research

A recycling market analysis shows if and to what extent the sales from waste materials can contribute to the implementation and finance of a sustainable waste management concept.

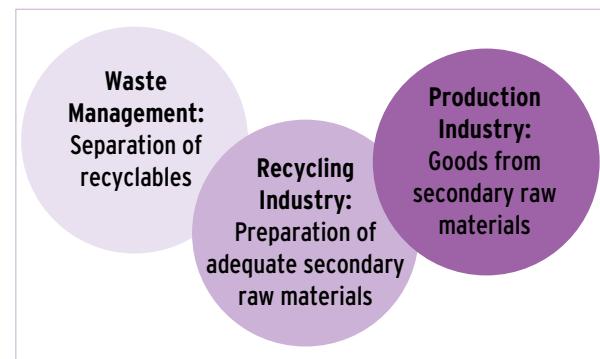
Field work complements the information from literature, interviews and the Internet regarding:

- Local market for recyclable materials:
 - Quantity and quality of recyclable materials;
 - Current recycling market structure in the city and in the region.

Experiences from Khanty-Mansiysk

For the market analysis, three types of companies are important:

- Companies that collect or treat materials recovered from municipal waste;
- Factories using secondary raw materials for production, e.g. glass manufacturers;
- Transportation companies for recyclables and waste.



High Technology Park, Director Yuri Reutov

In order to analyse the recycling market the following activities were performed in KMAO-Ugra:

- Contact data of recycling companies were identified in cooperation with „German Trade and Invest”, „Russian Chamber of Commercial and Industry”, „Territorial institution of the Federal Office for State Statistic in KMAO-Ugra” and „Territorial Management of Federal Service for Supervision in the Sphere of Nature Management in KMAO-Ugra (Rosprirodnazor)” and from the internet;
- The identified recycling companies were contacted by phone;
- Then the necessary recycling market information was collected by questionnaire.

The same procedure was applied to recycling companies in Irkutsk, Perm and Yekaterinburg. Contact data of companies in Irkutsk were acquired from the „calendar of waste” [8] developed within the project „Development of a Waste Management Concept for the Tourist Regions of Lake Baikal”.

In KMAO-Ugra only a few and usually small enterprises are collecting and separating recyclables from waste. They specialize in cardboard, metal and end-of-life tyres. The town of Surgut, a distance of 250 km from Khanty-Mansiysk, is a kind of recycling centre in the region KMAO-Ugra. In Khanty-Mansiysk itself, only three enterprises collect and treat recyclables, however, these companies were interested in further development. The regional administration and the High Technology Park make efforts to establish more recycling companies, especially for paper, cardboard, glass and plastics, because a functioning market is a crucial prerequisite to implementing recycling strategies in Khanty-Mansiysk Municipality.

A metal treatment enterprise in Surgut is the only factory in the region which uses secondary raw material for production.

Companies from Yekaterinburg receive recyclables but do not actively collect material in KMAO-Ugra.

A market for compost or fertilizers is hardly existent in and around Khanty-Mansiysk because the climate and geography does not permit the intensive agriculture or landscaping which could absorb a larger quantity of compost on a regular basis.

Step 2: Waste Analysis

The analysis of waste forms the basis for waste management concepts and design of recycling, treatment and disposal facilities. Successful waste management planning depends on reliable data on current waste amounts and compositions, including relevant physico-chemical properties, and on the accurate prediction of solid waste generation for the relevant planning period.

The composition and amount of waste from households and commerce are subject to seasonal fluctuations. To take them into account, waste analyses are conducted in at least two seasons (winter and summer).

Methodology and Standards

Globally more than 20 tools to determine solid waste amount and composition are available, e.g. „Standard Test Method for Determination of Composition of Unprocessed Municipal Waste” [9] by the American Society for Testing and Materials International. For the purpose of this project the „Methodology for the Analysis of Solid Waste (SWA-Tool)” [10] by the European Commission (2004) was applied.

Besides the composition, physico-chemical waste properties such as water content, heating value or further contaminants are of importance and should be analysed by a laboratory. The water content of waste is essential because it influences the biodegradability and combustibility of waste. „ISO 11465: Soil quality – determination of dry matter and water content on a mass basis” [11] is an applicable analytic standard. The calorific value of the waste indicates the amount of energy that can be produced per kilogram of waste through incineration. This factor is important to estimate the potential for waste incineration and may be determined using „DIN 51900-3: Testing of solid and liquid fuels – determination of gross calorific value by the bomb calorimeter and calculation of net calorific value – part 3“ [12] as an analytic standard.

Implementation

Waste analyses usually comprise of three phases: preparation, sampling and sorting, assessment and reporting.

Preparation phase

Firstly, the methodology for waste analysis and the sorting categories and fractions are defined. In order to achieve representative results, each analysis campaign needs a minimum number of sample units depending on the variance of the interesting properties. The SWA-tool recommends at least 36 sample units with a volume of 1 m³.

Information and maps obtained from the description of the current situation are used to:

- Select representative sampling areas (strata) in accordance with the housing, heating and socio-economic structure and determination of statistically representative sampling volumes;
- Define sampling plan and schedule.

It is important that the sorting and sampling campaign is planned and organised carefully. This includes the coordination and organisation of staff, vehicles, location, equipment, and the laboratory for the physico-chemical analysis.

Sampling and sorting phase

Waste samples of a specific volume are collected by truck from the selected sampling locations in accordance with the sampling plan and the collection schedule. The samples are manually sorted into different waste categories, and each category is weighted and recorded. Sub-samples from defined categories are prepared for laboratory analysis of physico-chemical properties.



ARGUS e.V., Managing Director Dr. Bertram Zwisele

The application of an appropriate tool for waste analysis is significant for a reliable result. Special attention has to be paid to the selection of waste samples and during sampling.

In order to guarantee that the waste samples taken are representative and undisturbed:

- Sampling volumes have to be standardized and a minimum overall volume has to be observed;
- Sampling locations have to feature the main characteristics of the area and be chosen randomly;
- Routines and behaviour of the waste generators have to be maintained:
 - Sampling campaigns should not be announced;
 - Sampling should take place in line with the normal waste collection routine.

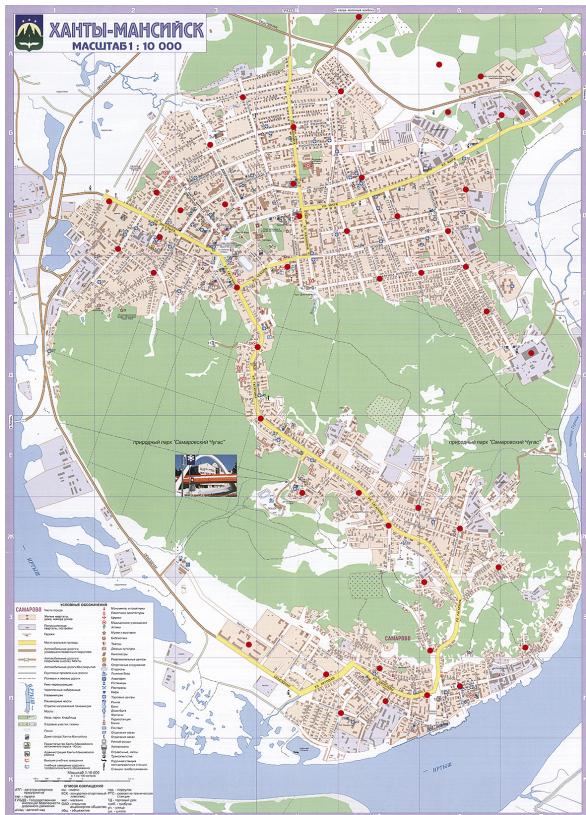
Assessment and reporting phase

The results of the sampling and sorting campaigns and from the laboratory analysis are compiled, verified and processed to meet the demands for reporting, planning or scenario development.

Experiences from Khanty-Mansiysk

The Technische Universität Berlin, in close cooperation with M DEP, implemented two extensive analyses of waste from households and commerce in Khanty-Mansiysk in February 2011 and in June 2011.

The methodology applied is based on the SWA-Tool of the EU including its definition of sorting categories.



Sampling plan for winter and summer waste analyses in Khanty-Mansiysk

M DEP, Director Tatjana Fadina

During the project, experiences in the implementation of waste analysis and detailed knowledge of the negative environmental impacts of simple landfilling were obtained. It was recognized that a separate collection including recycling reduces the residual waste, and that this is a better solution than simple landfilling. In addition, there is now a very clear idea about the composition of municipal waste as well as its potential for recycling.



Based on the description of the current situation and additional information from M DEP, the sampling plan was prepared by Technische Universität Berlin and ARGUS e.V.

For Khanty-Mansiysk, four representative sampling areas (strata) were selected:

- Residential area: Small houses with a garden;
- Residential area: Apartment blocks;
- Residential and commercial area: Apartment blocks;
- Commercial centre: Businesses and institutions.

For both waste analysis campaigns (summer and winter) a total of 72 waste samples of 1 m³ were collected and sorted, resulting in 36 m² of waste per campaign. Each sampling and sorting campaign lasted 6 days.



Sampling location in Khanty-Mansiysk



Waste sampling

Sorting station

City Administration Khanty-Mansiysk, former Head of Department A.S. Chvanov

The implementation of the waste analysis was especially impressive in terms of the selection of container locations for sampling and the sorting into 34 categories.



In accordance with the sampling plan, a specific number of waste containers of 0.5 m² and 1 m² was collected and transferred to the sorting location every day. Two trucks, one support car and three staff of M DEP were used for the collection of the containers.

Each waste sampling unit, either one 1 m³ container or two 0.5 m³ containers, was manually sorted into 34 sorting categories by 10 personnel from M DEP. All sorting categories were weighed and recorded in a weighing report. Sub-samples were taken and sent for laboratory analysis for the determination of physico-chemical properties. M DEP provided the location, the necessary equipment (Sorting tables, sacks, buckets, containers, weighing scales etc.) and a wheel loader.



Sorting into waste categories

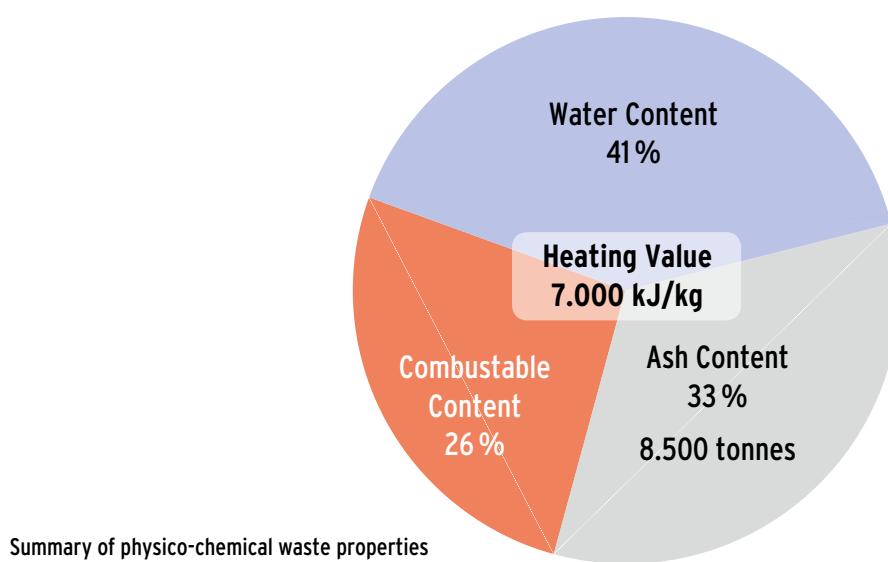
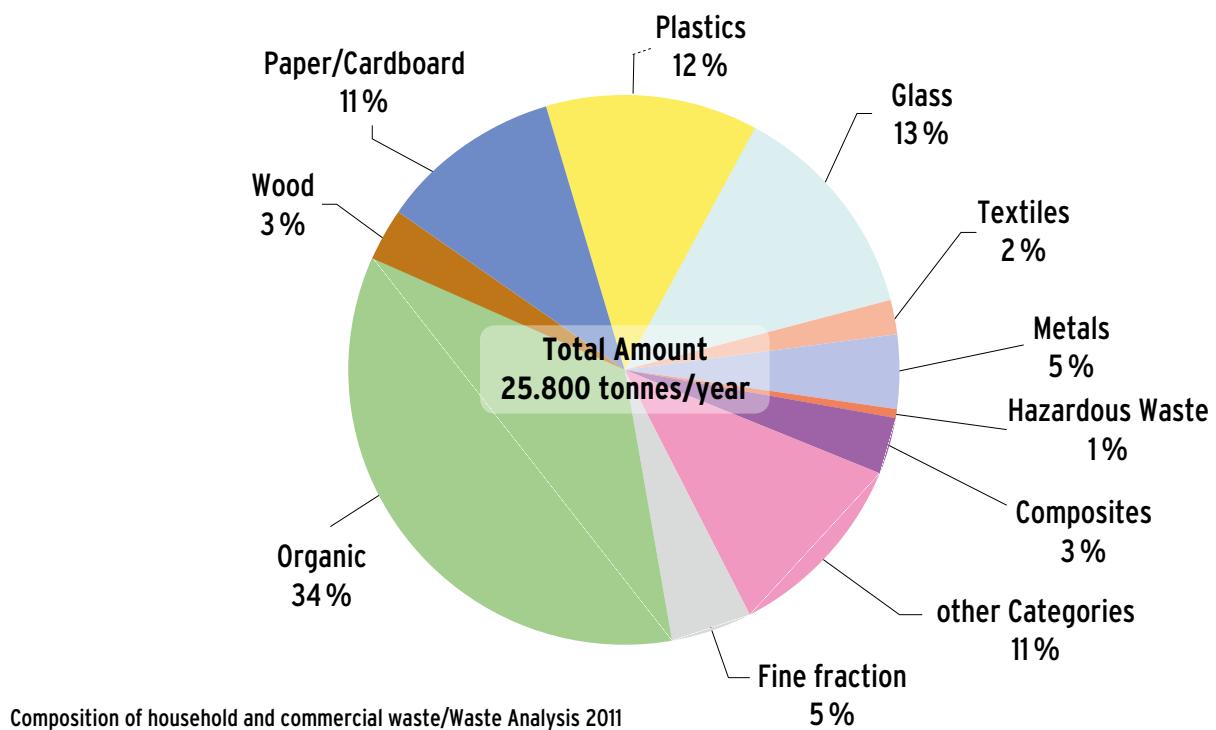


Determination of water content:
Drying of plastic waste in a drying oven

The waste analysis 2011 conducted by the **German-Russian cooperation project „Development of a Sustainable Waste Management Concept (WMC) for Khanty-Mansiysk Municipality, Russia“** yielded detailed data on the composition of household and commercial waste, the main waste stream in Khanty-Mansiysk.

Data analysis by Technische Universität Berlin and ARGUS e.V. showed the main results for household and commercial waste:

- The largest category is organic, comprising 34 % of the total weight;
- The waste is combustible without supplementary firing due to its calorific content of about 7.000 kJ per kg;
- 36 % of the waste is suitable for refuse derived fuel (RDF) production (heating value of 16.200 kJ per kg);
- 46 % of the waste from households and commerce is recyclable;
- 47 % of the waste from households and commerce is biodegradable.



Step 3: Waste Prognosis

A waste prognosis, which forecasts waste production and its material composition and properties within a defined period of time, based on empirical data. This forecast is essential to determine a suitable type and size for future waste disposal systems or waste treatment plants, and to decide on the potential for utilisation of waste, e.g. by recycling.

Several factors influence the waste amount and quality (population growth, economic development, employment, environmental awareness, policies etc.).

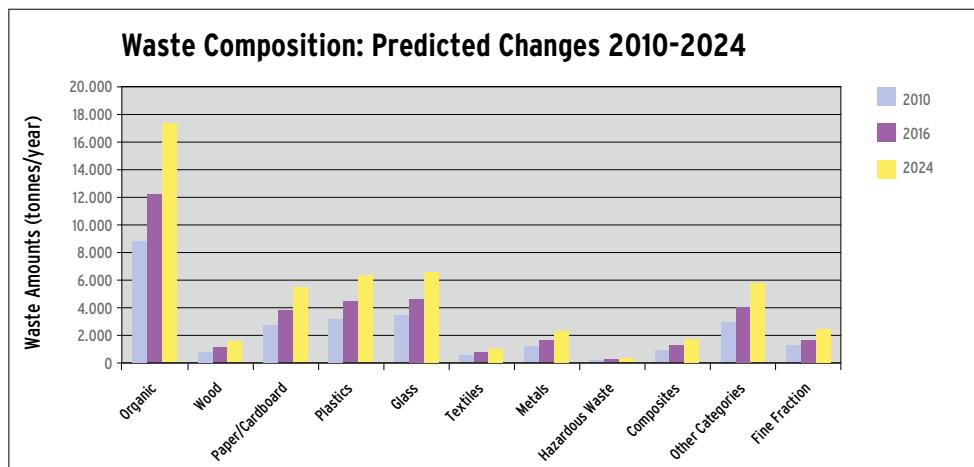
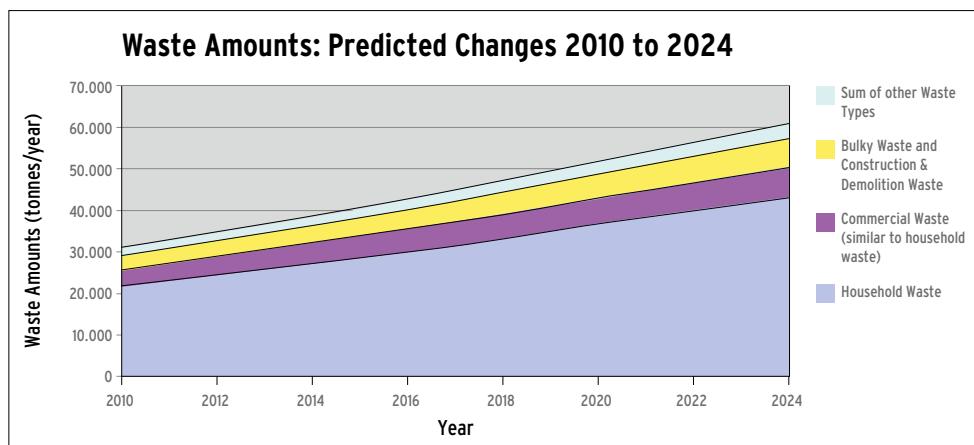
Forecast for Khanty-Mansiysk

The data provided by the local authorities, and the results of the waste analyses, are the basis for this waste prognosis. The waste forecast for Khanty-Mansiysk considered the following factors:

- Waste amount and waste composition in 2011;
- Predicted changes of population until 2024;
- Gross Domestic Product (GDP) of KMAO-Ugra;
- Average income of inhabitants in Khanty-Mansiysk until 2024.

The prognosis shows that without any waste management measures:

- The total amount of municipal solid waste, including bulky waste and construction and demolition waste, will increase to about 57,000 tonnes per year in 2024;
- The specific amount per person will increase from 0.38 to 0.49 tonnes per year in 2024.



Step 3: Selection of Appropriate Technical Options

This part of a Waste Management Concept describes the applicable state-of-the-art technologies and the costs for waste collection and transport, waste treatment and recovery and disposal.

Waste collection can be implemented by a pick-up system (waste is collected at each property) or by a drop-off system (citizens will bring the waste to a certain location, e.g. bring banks or recycling centres).

Waste treatment means that the waste is processed mechanically, biologically or thermally before recycling or landfill.

Waste treatment serves several purposes, amongst others:

- Reduction of waste for landfill and minimization of landfill space;
- Reduction of negative effects on human health or the environment;
- Reduction of carbon emissions and climate change effects;
- Production of recyclables and/or production of energy.

A functioning recycling market is important to absorb secondary raw material (metals, glass, paper and plastics derived from waste).

Conclusions for Khanty-Mansiysk

The challenge for the **German-Russian cooperation project**

„Development of a Sustainable Waste Management Concept (WMC) for Khanty-Mansiysk Municipality, Russia“ was to find waste treatment solutions that fit the climatic conditions of Western Siberia. This is particularly important for the introduction of modern waste treatment and recovery techniques in areas with severe and permafrost climate conditions.

For this reason, specific recommendations and experiences from German and European companies that build or operate incineration and/or bio-mechanical treatment plants in similar climate conditions, and research and knowledge from Canadian and US institutions and Scandinavian Universities, were compiled to select the applicable technical solutions for scenario development.

City Administration Khanty-Mansiysk, former Head of Department A.S. Chvanov

For the city administration of Khanty-Mansiysk, a major objective of the project was to acquire detailed knowledge and experience on environmentally sound waste treatment technologies from Germany.

Tampere University of Technology/Finland, Prof. Dr. Jukka Rintala

In Finland, we do have mechanical treatment systems, biogas plants as well as tunnel composting plants (plus pile maturing composting outdoors) for wastes ... The main requirement in reactor structures is effective insulation and good heat recovery as well as reasonably good management of the whole system. Of course, low temperature may affect the energy balances etc., but to my understanding individual failures in operation of the plants in Finland are not due to low temperatures. Some things maybe even easier to manage at low temperatures than at high temperatures.

Modern waste treatment technologies, such as incineration and bio-mechanical treatment, with capacities between 30,000 to 40,000 tonnes per year are technically feasible and operational under Siberian climatic conditions.

Step 4: Development of Scenarios

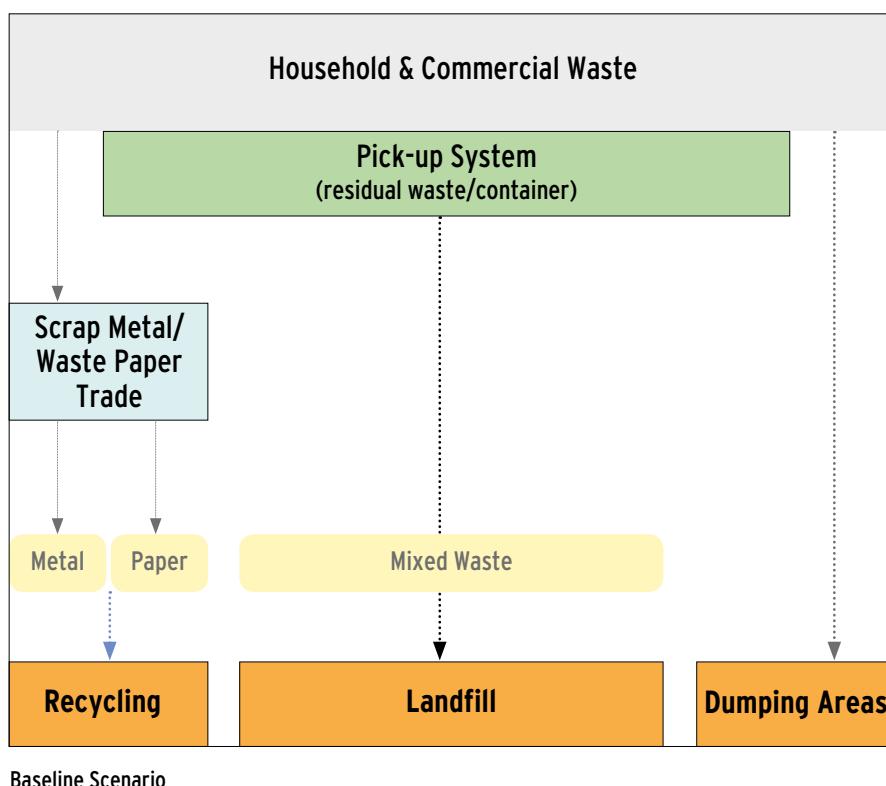
The main task within the development of a sustainable waste management concept is the design and identification of technically feasible scenarios considering the given waste management infrastructure, quantity and quality of future waste streams, state-of-the-art technology, superior policy frameworks as well as ecological, social and economic limits.

The identified scenarios should reflect the full range of technically possible disposal options for the investigation area.

Scenarios for Khanty-Mansiysk

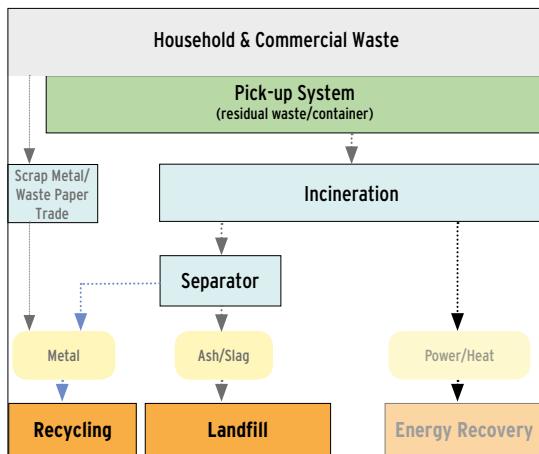
The scenarios and the treatment, recycling and disposal options are developed for household and commercial waste as the main waste stream.

The baseline scenario shows the continuation of the current practice to landfill untreated waste. Without any waste management measures, the amount of household and commercial waste will increase to about 50,000 tonnes by 2024.

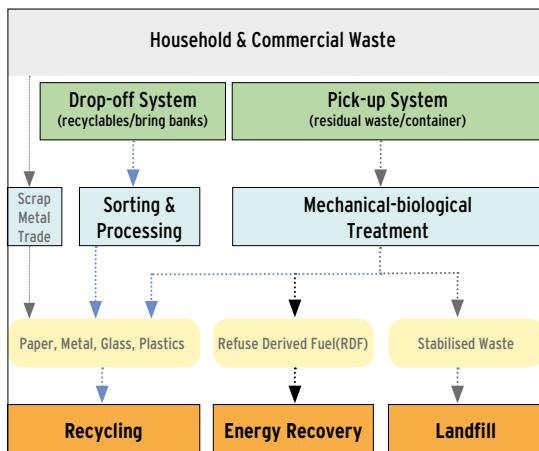


Taking the baseline scenario as a starting point, different scenarios are developed to serve specific waste management purposes:

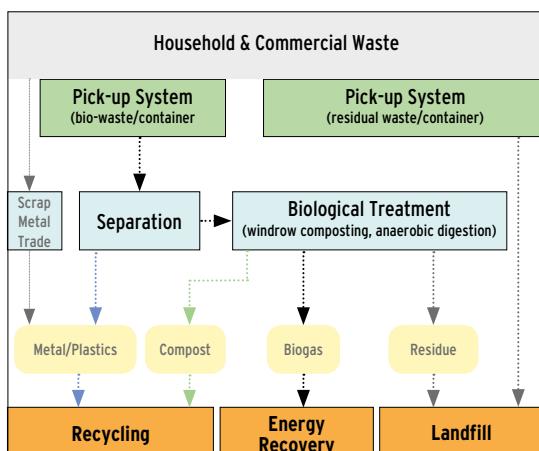
- Reduction of waste for landfill = Scenario 1 Incineration;
- Production of recyclables and/or energy = Scenario 2 Recycling;
- Reduction of landfill gas and stabilization of waste = Scenario 3 Biological Treatment.



Scenario 1 Incineration

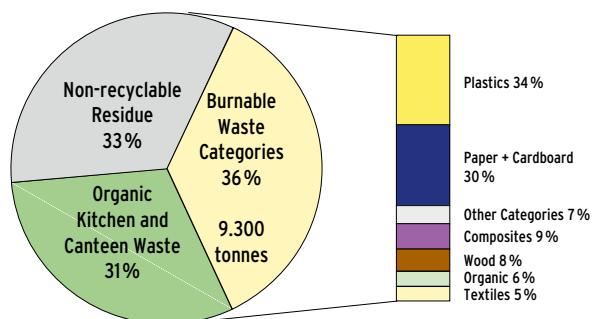


Scenario 2 Recycling

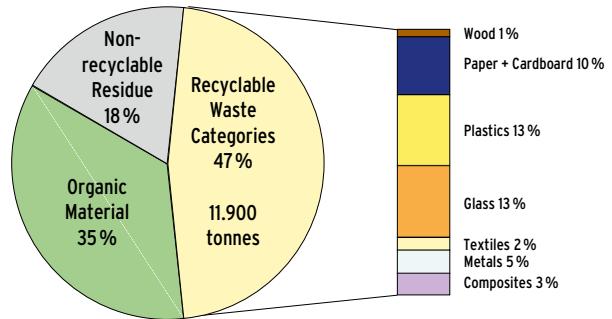


Scenario 3 Biological Treatment

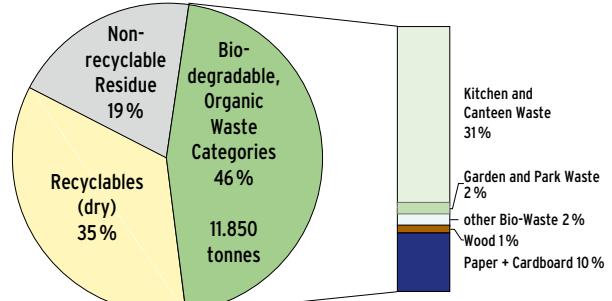
Based on the waste analysis data, the waste categories are grouped to display their potential for incineration, recycling and biological treatment:



Potential for Incineration



Potential for Recycling



Potential for Biological Treatment

For Khanty-Mansiysk all three scenarios are potentially applicable. Also combinations of the scenarios are generally possible, but there are also restrictions. For example the incineration scenario is hardly compatible with recycling. The separation of high calorific wastes such as paper, cardboard or plastics for recycling or recovery reduces the combustibility of the remaining waste to below a technically feasible level. Therefore only inert materials such as glass or metals may be separated and recycled in the incineration model.

Step 5: Decision-making – Development of Evaluation Criteria and Evaluation of Scenarios



High Technology Park, Yuri Reutov

Already during the implementation of this advisory project, the sustainable impacts of the project became visible. Implementation of the Waste Management Plan under preparation was regularly and jointly discussed at regional as well as urban level. Within the project, a lot of information on environmental issues was received from the Technical University of Berlin and ARGUS e.V..

Example of Khanty-Mansiysk

Waste treatment technologies, and combinations of these, have specific environmental impacts. In order to describe these impacts for the criteria „environmental impact“ in the evaluation, the German project partners defined indicators in accordance with the waste management objectives (reduction of waste for landfill, production of energy or recyclables, and minimization of landfill gas) and quantified these by specific indicator values. It must be noted that this indicator scheme is generally applicable, but the values given in the table are specific for the situation in Khanty-Mansiysk and not directly applicable to other projects.

As each of the technically feasible scenarios has its advantages and disadvantages, a set of environmental, technical, and socio-economic criteria were compiled to support decision-making about the leading scenario. Each of the three scenarios (incineration, recycling, biological treatment) and the baseline scenario were discussed and evaluated on a scale of 1 to 5 (–, -, 0, +,++) at a meeting of the project partners, the beneficiary and the stakeholders M DEP and KMAO – Ugra region.

Waste treatment options	Deposition rate	Energy recovery rate	Recycling rate	Carbon emissions ⁸
Deposition	100 %	-	-	17.879 t CO ₂ Eq
Incineration ¹	29 %	-	-	7.735 t CO ₂ Eq
RDF, co-incineration ²	64 %	36 %	-	2.396 t CO ₂ Eq
Composting ³	71 %	-	29 %	-
Anaerobic digestion ⁴	71 %	-	29 %	-
Mechanical-biological Treatment ⁵	53 %	16 %	32 %	1.227 t CO ₂ Eq
Separate collection ⁶	77 %	-	23 %	-
Separate collection + Mechanical-biological treatment ⁷	46 %	8 %	46 %	613 t CO ₂ Eq

¹ 80 % of metals recycled from slag

² 80 % of burnable fractions are separated for RDF, 80 % of metals recycled

³ 60 % of organic is separately collected, 55 % are recycled

⁴ 60 % of organic is separately collected, 55 % are recycled

⁵ 80 % of metals and glass are recycled, 75 % of burnable fractions are recovered

⁶ 60 % of recyclables are separately collected, 50 % are recycled

⁷ 60 % of recyclables are separately collected, 50 % are recycled, 80 % of remaining metals and glass are recycled, 75 % of remaining burnable fractions are recovered

⁸ Emission factor for incineration of municipal waste: 0,3 t CO₂ Eq/Mg waste; substitution effects not considered

Environmental indicators and values specific for Khanty-Mansiysk

Criteria	Scenario 0	Scenario 1	Scenario 2	Scenario 3
	Baseline	Recycling	Biological treatment	Incineration
Costs & financing	++	0	+	-
Environmental impact	--	+	+	0
Carbon emission reduction	--	++	+	0
Resource efficiency	--	++	0	-
Reduction of deposition	--	+	0	++
Disposal of hazardous residues from waste treatment	0	0	+	-
Accordance with regional waste management concept	0	++	-	-
Flexibility	-	++	0	--
Waste disposal security (includes the risks of a functioning recycling industry)	+	+	+	++
Social impact (health, public acceptance, impact on local employment)	0	+	+	-

Evaluation without weighting factors applied

The evaluation shows that:

- The recycling scenario is the best performer. However, for the recycling scenario an effective recycling industry and a functioning recycling market is a pre-condition, which is not yet a reality for Khanty-Mansiysk.
- Incineration is more expensive, but has the advantage of the highest reduction of waste for landfill. On the other hand, incineration seems less accepted by the population, and the emission standards to be met are higher than for other waste treatment technologies and therefore more costly.
- Mechanical biological treatment is less expensive and more environmentally friendly in total.

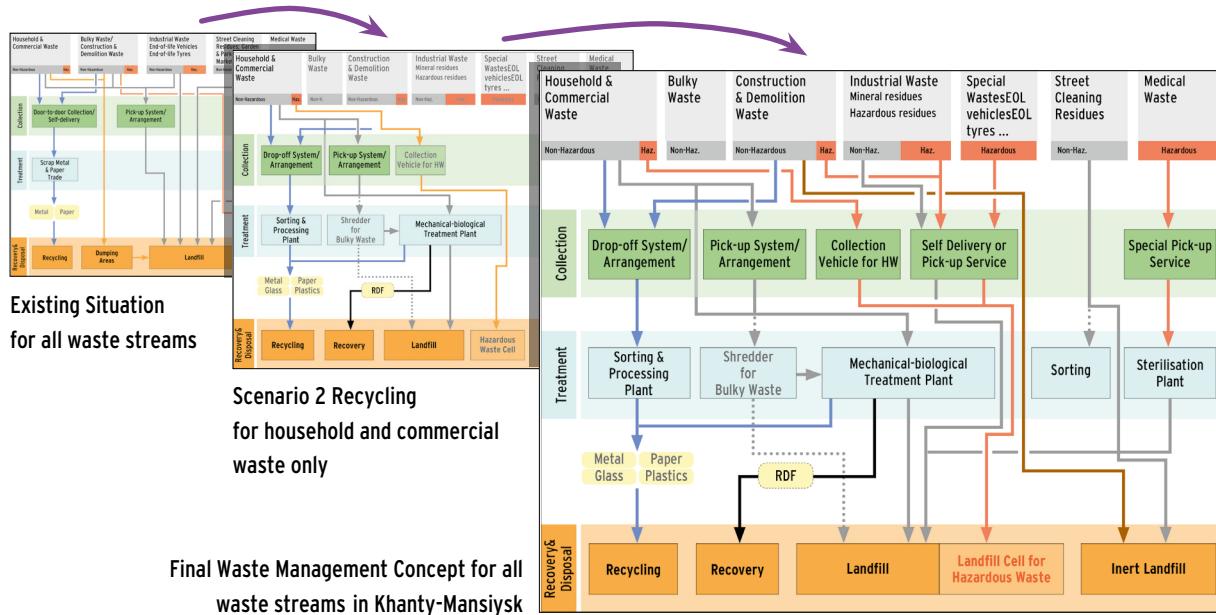
ARGUS e.V., Anja Schwetje

Transparency is very important in evaluation and selection processes. Naturally not all evaluation criteria are of equal priority for each actor, so that each criteria was also assigned with a weighting factor to demonstrate its importance.



The beneficiary and the stakeholders selected the best performing „recycling scenario”, which includes separate collection of recyclables at source, as the leading scenario for the waste management concept. The selected scenario is in line with the regional waste management plan of KMAO-Ugra, which emphasises increased recycling activities as the main objective for Khanty-Mansiysk.

Waste Management Concept for Khanty-Mansiysk



Measures to implement the Waste Management Concept for Khanty-Mansiysk

The waste management concept developed by the [German-Russian cooperation project „Development of a Sustainable Waste Management Concept \(WMC\) for Khanty-Mansiysk Municipality, Russia“](#) proposes the following measures:

- Uncontrolled waste dumping will be prohibited and the dumping sites will be ultimately closed through efficient control by the authorities.
- Hazardous waste will be separated from non-hazardous waste in all waste streams by all waste generators.
- Separate collection of recyclables from households and commerce will be introduced via a drop-off system.
- The collected recyclables will be treated in a sorting and processing plant with an estimated capacity of 5,000 tonnes per year in 2016 rising to 10,000 tonnes per year in 2024.
- A recycling industry and market will need to be established with the support of the High Technology Park and KMAO-Ugra region.
- The remaining household and commercial waste will be collected via a pick-up system using the existing containers and treated in a mechanical biological treatment plant with a capacity of 30 – 40,000 tonnes per year.
- Bulky waste will be shredded.
- The current landfill will be extended and up-graded with service buildings, landfill cover and a basal sealing system to meet the demands for an inter-communal landfill site as planned by KMAO-Ugra region. The implementation of a collection and treatment system for leachate and gas is foreseen by the Waste Management Concept.
- The landfill will be supplemented with a separate landfill cell for hazardous wastes, which will be constructed and operated with higher safety standards.
- The operation of the landfill will be improved with respect to, for example, waste reception procedures and waste record system and application of daily cover.
- Public information campaigns will improve awareness on waste separation at source and on recycling.

Both the mechanical-biological treatment plant and the sorting and processing plant will be completely enclosed. Wastewater from the degradation process will be re-circulated and excess wastewater will be treated. Emissions will be cleaned by respective exhaust air purification systems (most probably bio filter).

Compliance with the objectives and measures of KMAO-Ugra's regional waste management plan secures maximum financial contributions from the regional budget for the implementation of measures proposed by the Waste Management Concept.

Costs and Timeframe

The specific costs per inhabitant are estimated between 28 and 38 Euros per year.

In order to implement the Waste Management Concept, the region KMAO-Ugra and Khanty-Mansiysk Municipality have to invest 10 – 16 Million Euros within the next 5 years:

Waste Management in Khanty-Mansiysk Conceptual and Implementation Phase	Year					
	2011	2012	2013	2014	2015	2016 - 2024
Administrative and Organisational Measures						
Awareness-raising & Public Relations		Yellow				
Separation of Hazardous & Non-hazardous Waste						
Waste Prevention Measures						
Waste Collection						
Improvement of the current Pick-up System:						
• Introduction of Source Separation of Recyclables, Bring-banks for Recyclables;		PP				
• Separate Collection of Municipal Hazardous Waste, Special Wastes and Spent Tyres.						
Waste Treatment						
Sorting and Processing Plant		Yellow	Yellow			
Mechanical-biological Treatment Plant		FS				
Recycling/Recovery/Disposal						
Support of logistical Network for Recycling		Yellow	Yellow			
Improvement and Extension of the Landfill Site			Yellow			
Separate Landfill Cell for Hazardous Waste						
	Concept	Feasibility Studies (FS) Pilot Projects (PP)		Implementation		Operation
						Implementation Plan

The exact technical specifications for all waste management equipment and facilities will be defined during the implementation phase of the Waste Management Concept. This includes:

- Selection of plant locations, detailed design, preparation of the necessary documents for permits and environmental impact assessment as well as the construction of the mechanical-biological treatment plant and the sorting and processing plant should be commissioned from experienced consultants and enterprises;
- For the detailed design, preparation of tender and other documents the information compiled in the **German-Russian cooperation project „Development of a Sustainable Waste Management Concept (WMC) for Khanty-Mansiysk Municipality, Russia“**, e.g. status-quo report, waste analysis and prognosis and final concept, is an up-to-date basis.

Achievements and Advantages

The implementation of the proposed Waste Management Concept will

- Reduce the amount of waste for landfill in 2024 to 26 %.
- Reduce the greenhouse gas emission by about 90 % (related to the reference year 2012).
- Reduce persistent organic compounds and heavy metals infiltration into soil and groundwater
 - by the strict separation of hazardous substances and separate disposal with higher safety standards;
 - through closure of uncontrolled dumping areas and dumpsites.
- Increase the recycling and recovery rates significantly, because up to 12,000 tonnes of secondary raw materials and a maximum 12,000 tonnes of refuse derived fuels (RDF) may be produced.
- Demonstrate the feasible application of modern waste treatment technologies in Siberian climate conditions.
- Create additional jobs in the waste management and recycling sector.

M DEP, Director Tatjana Fadina

The long-term impact of the project will be demonstrated by the reduction of waste for landfill, due to the introduction of separate collection. Thus the life span of the landfill is extended and, possibly, a profit can be gained through the sale of secondary raw materials. Already private investors have prepared proposals for the implementation of separate collection: for example, the High Technology Park would like to start a pilot project in a district of the city of Khanty-Mansiysk and introduce a separate collection scheme for household waste.



PART 2: TRANSFER OF EXPERIENCE AND TECHNOLOGY

Study Tour

A delegation from the administration, various organizations and the university of Khanty-Mansiysk, and from Perm State National Research Polytechnical University visited Germany between 16th and 22nd of October 2011 to exchange knowledge and share experience.

The delegation met with Berlin's environmental administration, amongst others, and got an insight into systems for municipal waste incineration, mechanical-biological treatment and biogas production, municipal solid waste landfilling, the sorting and processing of separately collected packaging waste and the recycling of tyres in Berlin and Brandenburg.

They also met with the German project partners to discuss the applicability of technical options for waste treatment in Khanty-Mansiysk and the shaping of the waste management concept.

Information Exchange and Technology Transfer with German Companies

Several German companies with proven expertise in mechanical-biological treatment, biogas, incineration and degasification of landfills were consulted during development of the scenario. Information on innovative technologies, and practical experience concerning planning, building and operating waste treatment plants, was exchanged with the Russian project participants during the site visits in Germany, and at the closing meeting in Khanty-Mansiysk in April 2012. German companies and European institutions contributed to the deliberations on the technical feasibility of waste treatment under Siberian climatic conditions.

Teaching Material

The Technische Universität Berlin prepared reference lists and teaching material on the „Development of a Sustainable Waste Management Concept for Municipal Solid Waste on Local Level shown at the Example of Khanty-Mansiysk, Russia“ [13] in both Russian and English language.

State University Ugra (USU), Prof. Dr. Elena Lapshina

In addition to the main objective, the development of the waste management concept, education material regarding the development of a sustainable waste management concept at a local level has been created in cooperation with the Technische Universität Berlin ... The aim of USU is to improve the educational work of the University, to broaden the knowledge of students and to provide international scientific approaches on waste through the use of internationally elaborated materials.



The teaching material is applied in regular university courses to disseminate experiences gained with the **German-Russian cooperation project „Development of a Sustainable Waste Management Concept (WMC) for Khanty-Mansiysk Municipality, Russia“** and to enhance knowledge about appropriate methods for waste analysis, and methodologies for the development of a sustainable waste management concept.

These lectures are part of university courses at Ugra State University, Perm State National Research Polytechnical University and National Research Irkutsk State Technical University.

The teaching material is also applicable for stakeholders' trainings and seminars in other regions with similar conditions.

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<http://www.umweltbundesamt.de/ius/35-53-A-RU.pdf>

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[12] Deutsches Institut für Normung e.V., DIN 51900-3: 2005-01: Testing of solid and liquid fuels; Determination of gross calorific value by the bomb calorimeter and calculation of net calorific value – Part 3: Method using adiabatic jacket

[13] PowerPoint presentation „Development of a Sustainable Waste Management Concept for Municipal Solid Waste on Local Level shown at the Example of Khanty-Mansiysk, Russia“ in English and Russian language.
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The following German recycling and disposal companies and American and Scandinavian scientific institutes with experience in waste technology under severe climate conditions exchanged their experiences with the project partners and stakeholders during the project:

Mechanical-biological treatment and composting:

 **Vecoplan**  **Vecoplan AG** • Arno Möller
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Biogas and landfill gas:

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Waste incineration:

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<http://www.michaelis-umwelttechnik.de/en/index.php>

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