Development of a sustainable Waste Management Concept for Khanty-Mansiysk, Russia

Annex IV

- Feasibility Study: MBT Technology under Siberian Climate Conditions -

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1. Introduction

As part of the feasibility study, the following issues were researched:

- whether there are already experiences made operating of Mechanical-Biological Treatment plant (MBT) under climatic conditions similar to those Khanty-Mansiysk
- whether there are guarantees by manufacturers, that a biological treatment can take place at a temperature of -40°C
- whether small waste incinerators exist and what the minimum capacity (a plant size of around 30,000 - 40.000Mg / a) and the costs of the facilities are.

To answer the above questions internet researches and telephone and written inquiries to internationally operating manufacturing companies and universities were carried out.

This feasibility study is subdivided into the following parts:
Chapter 2 and 3 include the summarised results of inquiries regarding incinerators and MBT. Chapter 4 contains the result of a written questionnaire which was sent to the local administration of Anchorage, Alaska. Chapter 5 describes the results of the internet and literature research. Chapter 6 gives a summary of the results described in Chapter 2 to 5. Finally, in Chapter 7, the contact data and the original responses via e-mail are listed. As the requests were send to German and international organisations, the original responses are either in German or in English.

2. Query regarding the feasibility and practicality of waste incinerators

According to Mrs Hamatschek (telephone interview), downscaling an incinerator is too expensive, especially during flue gas treatment. She also refers to *Michaelis-Umwelttechnik GmbH & Co. KG*, which are specialised in building small incineration plants. As a rule, small incinerators should be equipped with a mechanical pre-treatment component (size, mix, moisture content, calorific value).

During a telephone interview with Mr. Grimm (Michaelis-Umwelttechnik GmbH & Co. KG, manufacturer of waste incinerators), he confirmed that the company builds environmental incineration plants in the requested size. Mr. Grimm has proposed two incineration lines with an input of 15,000 Mg of MSW per year. All system components are prefabricated in the factory in Wurzburg, Germany and delivered to the site. The company has already experiences in exporting to Russia. Due to the size of the plant and combustion technology, a mechanical pre-treatment of municipal waste (crushing, sorting unsuitable ingredients) is required. The investment cost of a plant of this size is between 5 and 6 million Euros. Mr. Grimm estimates operating costs of about 30 Euros per Mg of MSW input. Mr. Grimm also provided a proposal including a description of the plant equipment. The system is completely built in Wurzburg and can be visited.

Mr. Bette, from the company Pöyry Germany GmbH, reported that his company usually builds municipal waste incinerators with a capacity of 100,000-500,000 Mg per year. However, his company also provides facilities in the required size. They have experiences in this size particularly for waste facilities in Switzerland. (Note by Mr. Bette: The cost in Switzerland has more of a secondary role). The Pöyry Group has its headquarters in Finland (utilities) and therefore, they are familiar with extreme climatic conditions. According to a first proposal Pöyry offers a system with 9.7 MW thermal input and 5 Mg/ h of input. The turbine and generator to produce electricity will be waived for systems of this size. The capital costs of such a system are in the order of 35 - 40 million Euros. Mr. Bette has provided a cost estimate (see email below) with a rough description of the system technology.

3. Query regarding the feasibility and practicality of MBT

Following a telephone interview and an email correspondence (see below) with Mr. Bette, the company Pöyry Germany GmbH will examine the use of MBA under the given climatic conditions in KM. Pöyry is cooperating with the biological systems engineering community Witzenhausen Fricke & Turk GmbH. After an initial spontaneous assessment Mr. Bette doesn't think that a biological stage would be feasible under economic conditions. After further testing, Pöyry suggests the implementation of an MBT plant. The rough cost estimate for an MBA with extensive anaerobic stage amounts to approximately 26 million Euros. However, this would be for an annual capacity of

70,000 Mg per year. It is estimated that for an annual capacity of 40,000 Mg, the investment costs would be at around 15-20 million Euros. It should be noted that the system is a relatively high-technology (prior art) system. The realization of a simple MBA (simple mechanical treatment and aerobic biological treatment, i.e. composting) will require significantly less investment costs. If no anaerobic stage is introduced for the treatment, but an aerobic composting, the costs are significantly lower, but in this case the local conditions for an aerobic treatment have to be considered (additional water demand, the need for heating, etc.).

Mr Kühle-Weidemeier, consulting firm - Wasteconsult international, confirmed in a telephone interview that they have experiences of biological treatment plants in Finland and Canada. Sweden and Norway do not operate biological systems. Mr Kühle-Weidemeier believes that tunnel composting is basically feasible and names two contacts in Finland and Canada.

Prof. Jukka Rintala, Finland, Tampere University of Technology, refers to current facilities in Finland which work under similar conditions (see e-mail below). He thinks that if the insulation is good and the plant well operated/ managed a biological treatment would be feasible. He stressed that the processes are easier to control at low temperatures than at high temperatures.

Dr. Felske, Waste Management Services, Edmonton, Alberta, Canada (via email), confirmed that it is feasible to operate MBT plants under severe climatic conditions similar to those in Siberia. In Edmonton, Alberta an MBA system is in operation and therefore they have practical experiences with this technology to fall back on. Interestingly, the Edmonton's (Alberta) waste management concept is very similar to our proposed recycling option (see brochure on waste plan for Edmonton.). Reliable cost estimates can only be made after thorough research of the marketing options. Mr Felske was very cooperative and can certainly provide further valuable information.

Mr Moeller (Vecoplan AG, a manufacturer of waste treatment facilities, telephone interview and email) thinks that a MBA through composting tunnel is feasible in these climatic regions. Vecoplan has experience with the export of plant technology to Russia (wood pellet plant). Vecoplan estimates the investment costs for a plant of this size at 7 to 9 million Euros. The concept of course depends on the marketability of the recycled products and the RDF. This information still has to be clarified and then forwarded to Vecoplan. (Mr Moeller sent a rough cost estimation and rough technical description of the company Vecoplan that can be refined after specifying the marketing options in KM.)

4. Inquiry regarding waste treatment and disposal in Anchorage, Alaska

According to Mr Mark G. Madden, P.E., Director, Municipality of Anchorage, Solid Waste Services, in Anchorage (Alaska), they do not have any experiences in the mechanical-biological treatment of waste. Under uncontrolled conditions (landfill) biological activity only begins 2 to 3 years after bring buried. Then the waste reaches temperatures of about 23 ° C (see answer M. Madden, Alaska).

5. Internet and literature research

The results of the literature research on the use of MBA in northern countries show that only in the European part of the world there are MBA. The USA and Canada are more likely to use landfill without prior treatment of the waste. The search on the webpage 'Elsevier' for research on MBA in northern regions didn't return any results.
The websites and literatures evaluated are summarised in *7.3 Websites and literatures.*

6. Conclusions

Based on the results of the research it was established that both waste treatment plants (incineration plant and MBT) are technically feasible, under the Siberian climatic conditions and with a plant size of 30,000-40,000 Mg/a.

7. Contact data and responses

7.1 Contact data of telephone interviews

Mrs. Eva Hamatschek
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7.2 Responses via e-mail and contact data

Response: M. Madden; Alaska
Dr. Kaazke, We landfill all of our wastes (excluding hazardous wastes) including the organic wastes from household, restaurants and other facilities. The landfill is lined and constructed with provisions for collection of leachate from the bottom of the fill as well as gas from the general waste mass.
Our landfill acts as somewhat of a biological reactor. We recirculate some of the leachate collected back into the waste to ensure there is adequate moisture for biological decomposition. The gas which is produced is rich in methane (about 50% by volume). We are currently constructing a small power plant to use the collected gas to produce electricity. The plant is designed to produce 5.2 megawatts (about 19 gigajoules) of power.
Two things to be aware of: we have found that waste which is buried in mid-winter when temperatures are around -20C will stay frozen for 2 to 3 years. In the older portions of the landfill (waste older than 5 years) the temperature of the waste is consistently around 23C except within a meter or two of the ground surface.
We do not accept hazardous wastes at our landfill. Individuals who generate these materials are required to arrange for legal processing and disposal of these wastes at other facilities. We do have a facility which collects liquid and hazardous wastes from family homes and small businesses. If the material can be reused, we make it available to the public at no charge (paints and cleaning products). If a material is non-hazardous (paint, primarily), we stabilize it, usually with bentonite clay and landfill the solidified material. If the material is hazardous, we have it disposed of at another licensed facility such as a special waste landfill or incinerator.

I hope this is helpful. Feel free to email any other questions you might have. Regards,

Mark G. Madden, P.E.
Director
Municipality of Anchorage
Solid Waste Services
907.343.6279
maddenmg@muni.org

Response: Prof. Rintala; Finland
Dear Bertham, thanks for your mail. It sounds an interesting project. In our climate the lowest temperatures are down to -20C, sometimes -35 and -40 C. Biowastes are source separated in many municipalities, but not in all municipalities. In winter time the waste maybe frozen in collection points, on the other hand its pH doesnt start to decrease as happens in summer time.
We do have mechanical treatment systems, biogas plants as well as tunnel composting plants (plus pile maturating composting outside) for wastes. We have these systems e.g. here in Tampere, Vaasa, Oulu, Jyväskylä. All are places with quite cold winter and warm summer. The main point in reactor structures is effective insulation and good heat recovery and reasonable 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 T than at high T. Anyway, there is quite much experience of waste management systems in northern climate, but unfortunately very limited information of Finnish waste systems is available in English or German.
Anyway, the realisation of the project under those conditions is probably very much dependent on local systems, how well structures can be designed & realized. If there is anything specific information that could be useful let me know; I could try to find the information.

Tell my best regards to Matthias
br Jukka
Contact data: Prof. Dr. Jukka Rintala/ Tampere University of Technology
Jukka.rintala@tut.fi

Response: Arno Möller; Vecoplan; Germany
Hallo Herr Zwisele, die Machbarkeit einer MBA Anlage habe ich mit der Fa. WasteTec unserem Partner für die biologische Trocknung / Stabilisierung besprochen. Grundsätzlich ist die biologische Trocknung auch bei den klimatischen Bedingungen in Westsibirien möglich. Evtl. kann sich die Rottezeit bei sehr niedrigen Außentemperaturen verlängern, dies kann jedoch durch den Einsatz eines zusätzlichen Rottetunnels ausgeglichen werden.
Die gesamte mechanische wie auch biologische Behandlung sollte in einer geschlossenen Halle, die idealer Weise durch eine Heizung im frostfreien Bereich gehalten werden kann aufgebaut werden. Das von uns bevorzugte MBA Konzept ist ein Brennstoff basiertes Konzept und kann als Output Stoffstrom einen mittelkalorischen Brennstoff mit einem Heizwert von 15 - 18 MJ/kg bieten. Durch Anpassungen in der mechanischen Aufbereitung kann je nach Müllzusammensetzung vor der biologischen Behandlung recyclingfähiges Material wie z.B. PET, HDPE, Mischpapier, usw. ausgebracht werden. In diesem Fall werden die Sortierreste gemeinsam mit der organischen Fraktion der biologischen Trocknung zugeführt und nach der Trocknung zu Ersatzbrennstoff aufbereitet. Das Konzept für die Anlage wird im Wesentlichen durch die Vermarktungsmöglichkeiten für recyclingfähige Stoffe und den Ersatzbrennstoff bestimmt. Es ist deshalb wichtig im Vorfeld zu wissen ob es Möglichkeiten zur Mitverbrennung von EBS in Kohlekraftwerken oder Zementwerken in dieser Region gibt. Da das Anlagenkonzept noch nicht vorliegt können wir zu den Investkosten nur eine sehr grobe Schätzung abgeben. Unter der Berücksichtigung, dass in der mechanischen Vorbehandlung eine Kombination von automatischer und manueller Sortierung zur Ausbringung von recyclingfähigem Material erfolgt und im Anschluss die Sortierreste biologisch behandelt und in Folge in EBS weiterverarbeitet werden können Sie von einem Investitionsvolumen von ca. 7,0 - 9,0 Mio€ ausgehen. Hoffe die Angaben helfen Ihnen weiter. Sollten sie noch Fragen haben stehen wir gerne zur Verfügung.

Mit freundlichen Grüßen / Kind Regards
i. A. Arno Möller/ Head of competence center waste Vecoplan AG
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Response: Christian Felske; Environment department Edmonton; Canada
Hi Bertram, Thanks for the email. A quick answer. Yes we have experience in these climates as winters in Alberta/ Edmonton are similar to Siberia, long and cold. We are operating an enclosed transfer and process and composting facility with an open curing operation, using either windrows or mass beds formations. We are composting two main streams: a. MSW mixed with dewatered biosolids and b. dewatered biosolids mixed with wood chips. Beside that a variety of waste processing and transfer activities are happening at our site. I have provided a brochure outlining all activities. We have done a series of testing on all our waste streams and are experienced with harsh climate conditions. I am not sure what the next step in your research is but if you have further questions I would suggest to talk over the phone to discuss this further. Let me know if that is something you would be interested in.

Christian Felske Ph.D., PEng
Technical Specialist
Environment, Research & Regulatory
Waste Management Services
Infrastructure Services Department
City of Edmonton
Fon: 780-495-9869

Response: Matthias Bette; Pöyry Deutschland GmbH (Incineration plant)
Sehr geehrter Herr Dr. Zwiesele,
bei einem Durchsatz von 40.000 Mg/a Haushaltsabfall ergibt sich bei einem Heizwert von 7.000 kJ/kg eine thermische Verbrennungsanlage mit 9.7 MW Feuerungswärmeleistung und 5 Mg/h Durchsatz. Im ersten Ansatz wurde von reiner Fernwärmeversorgung (Sommer + Winter) ausgegangen und auf Turbine und Generator verzichtet. Die Dampfparameter wurden mit 17 bar / 370 ° C angesetzt. Es ergibt sich eine Frischdampfmenge von etwa 11.6 Mg/h. Unsere Indikation für die Investitionskosten einer solchen Anlage liegt in der Größenordnung von 35 - 40 Mio EUR. Hierbei wurde allerdings ein Tiefbunker berücksichtigt. Bei dieser Größenordnung sind Flachbunker wirtschaftlicher, insbesondere auch unter dem Aspekt, dass Gründungsarbeiten in der Region wahrscheinlich sehr kostenintensiv sind. Durch weitere bauliche Vereinfachungen könnte sich der Preis am unteren Ende bewegen. Es wurde grundsätzlich europäischer Standard und europäisches Preisniveau zu Grunde gelegt. Folgendes ist in der Preisindikation enthalten:

1. Maschinentechnik:
- Krananlage
- Rostfeuerungssystem
- Verbrennungsluftversorgung
- Zusatzbrenner inkl. Heizölversorgung und -lagerung
- Entschlacker
- SNCR-System zur Entstickung
- Dampferzeuger
- System zur Ableitung und Lagerung der Kesselasche
- Kesselspeisewasseraufbereitungsanlage
- Speisewasserbehälter
- Speisewasserpumpen
- Heizkondensator zur Fernwärmeerzeugung
- Kondensatpumpen
- Balance of Plant
- Reaktor zur Eindüsung von Reaktionsmittel zur Abgasreinigung
- Gewebefilter
- System zur Ableitung und Lagerung der Filterstäube
- Saugzug
- Schornstein
- Hilfsdampferzeuger
- Verbindende Rohrleitungen inkl. Armaturen
- Druckluftversorgung
- Stahlkonstruktion, Bühnen, Treppen

2. E- und Leittechnik
- komplette Verkabelung
- Maschinentransformator 20/10,5 kV
- Trafo 20/0,7 kV
- Trafo 20/0,4 kV
- Notstromaggregat
- 220 V Batterie
- Prozessleitsystem
- Prozessvisualisierung
- MS-Schaltanlagen
- Schalträume, NS-Verteilung, -schaltanlagen

3. Bauteil
- Waage + Pförtnerhaus
- Bodenplatten, Fundamente
- Abfallbunker
- Schlackebunker
- Stahlbetontreppenhaus + Lastenaufzug
- Technische Gebäudeausrüstung (Beleuchtung, Brandmeldeanlage,
- Warmwasserheizung, Frostfreihaltung bei Anlagenstillstand, Lüftungsanlagen
- etc)
- Straßen und Außenanlagen innerhalb der Anlagengrenzen, Einzäunung
- Unterirdische Wirtschaft (Ver- und Entsorgungsleitungen) innerhalb der
- Anlagengrenzen
- Einhausung Kesselhaus
- Einhausung Abgasreinigungsanlage
- Betriebs- und Schaltanlagengebäude

Mit freundlichen Grüßen / With kind regards
ppa. Matthias Bette
Leiter Vertrieb / Vice President Sales

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Response: Matthias Bette; Pöyry Deutschland GmbH (MBT plant)
Sehr geehrter Dr. Zwisele,
anbei eine grobe Kostenschätzung für ein umfängliche MBA mit anaerober Stufe. Die Kosten für eine einfache Kompostierung dürften deutlich niedriger liegen, doch sind hier die lokalen Bedingungen für eine aerobe Behandlung immer zu berücksichtigen (Zusatzwasserbedarf, Notwendigkeit der Beheizung, usw.)
Ich hoffe, dass Ihnen diese Angaben für das genannte Projekt hilfreich sind.

Die Anlage verfügt über folgende Ausstattung:

- Mechanische Aufbereitung der Abfälle
- Zerkleinerer
- Fe- und NE-Abscheidung
- Trommelsieb
- Ballistikseparator
- Ballenpresse/Containerstation für heizwertreiches Material
- Staubfilter

- Biologische Behandlung
- Mixer
- Abscheidung von Leicht- und Schwerstoffen
- Nachzerkleinerer
- Gärbehälter (zweistufig inkl. Hydrolyse)
- Nachbehandlung der Gärreste (Aerobisierung und Entwässerung)
- Blockheizkraftwerk inkl. Gasspeicher und Gasfackel
- Überdachtet Lagerfläche für Zwischenlagerung der Gärreste
- Abluftbehandlung

- Bauteil
- Halle für Annahmebereich, mechanische Aufbereitung, Kontrollraum,
- Sozialräume
- Fundamente für Vergärungsanlage
- Befestigte Wege für Anlieferverkehr und Transportvorgänge im
- Anlagenbereich
- Waage

Die Kosten für diese Anlage beliefen sich auf ca. 26 Mio. Euro, allerdings für einen Jahresdurchsatz von 70.000 Mg/a. Wir schätzen, dass bei einem Jahresdurchsatz von 40.000 Mg die Investkosten zwischen 15 und 20 Mio. Euro liegen würden. Allerdings handelt es sich bei dieser Anlage um eine vergleichsweise hoch technisierte (Stand der Technik), so dass bei Realisierung einer einfachen MBA (einfache mechanische Aufbereitung und aerobe biologische Behandlung (Kompostierung)) deutlich weniger Investkosten anfallen würden.

Mit freundlichen Grüßen / With kind regards

ppa. Matthias Bette
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7.3 Websites and literatures

Canada
Webpages
Department of Environment Canada:
http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=EF0FC6A9-1
Region Yukon – Norden Kandas – Government of Yukon, Environment:
http://www.env.gov.yk.ca/

Publication:
Mechanical Biological Treatment (MBT) -- Part 1: A European perspective, relevant to Canada:
http://www.solidwastemag.com/news/mechanical-biological-treatment-mbt---part-1/1000213617/
Mechanical-Biological Treatment - Part II - The future is bright for MBT in Canada:
http://www.solidwastemag.com/news/mechanical-biological-treatment--part-ii/1000215205/

U.S. – Alaska:
Municipality of Anchorage, Solid Waste Service:
http://www.muni.org/departments/sws/pages/default.aspx

Norwegian:
State of the Environment Norway:
http://www.environment.no/Topics/Waste/
Veolia in Oslo:
http://www.veolia.com/en/group/case-studies/oslo-norway.htm

Sweden:
Publication – main ephasis is on incineration plant in Sweden
http://www.andrew.cmu.edu/user/kmeister/Temp/Eriksson_MSW_SystemsPerp_05.pdf
Avfall Sverige – Swedish Waste Management:
http://www.avfallsverige.se/topmenu/in-english/

Finland:
Helsinki Region Environmental Services Authority:
http://www.hsy.fi/en/wastemanagement/instructionsandbrochures/sortingofwastes/Pages/default.aspx