

# Waste management in Greenland: current situation and challenges

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## Abstract

Waste management in Greenland (56 000 inhabitants) is characterized by landfilling, incineration and export to Denmark of small quantities of metals and hazardous waste. The annual amount of waste is estimated to about 50 000 tons but actual data are scarce. Data on the waste composition is basically lacking. The scattered small towns and settlements, the climate and the long transport distances between towns and also to recycling industries abroad constitute a complex situation with respect to waste management. The landfills have no collection of gas and leachate and the incinerators are small and equipped with only moderate flue gas cleaning technology. This report summarizes the current waste management situation in Greenland and identifies important challenges in improving the waste management.

## Keywords

Greenland, waste management, remote areas, Arctic, sparse data

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## Introduction

Waste has been considered a resource for the Greenlandic Inuit population since they immigrated from east Canada to the inhospitable island of Greenland about 4000 years ago. The challenging climate made living in Greenland a struggle and everything from hunting, fishing and collecting was used as far as possible. Waste was limited to a minimum because of the harsh conditions of living.

Greenland has developed since then as a Danish colony (1721) via Home Rule Administration (1979) to modern self governmental autonomy by 2009. The traditional Inuit culture has turned into a modern society. Only few people are occupied as traditional hunters and the game and sea catches are negligible in comparison to the import of goods (Greenlandic Home Rule, 2008).

The Greenlandic consumers have the same opportunities as the northern European consumers and they have adopted the modern comfort and life-style products. About 80% of the goods in Greenland are imported from Denmark and Sweden due to the absence of production and the availability of common materials such as wood, in the arctic regions (Statistics Denmark, 2008). Greenland is today facing a waste problem as most other countries but the approaches and solutions may be different because of the scarce population and the arctic climate.

This report offers a description of the current waste management situation in Greenland and identifies the key challenges that need to be solved. The information has been collected from reports and statistics, and by interviewing many people engaged in waste management in Greenland. Remote facilities as military facilities, meteorological station, mining areas and research facilities are considered as insignificant in terms of municipal solid waste (MSW) in this context.

## Greenland

Greenland is the biggest island in the world and is situated east of Canada and north-west of Iceland. Two-thirds of the island is located north of the Arctic circle (66° 33' 39" northern latitude) (Christiansen, 1999). The length of the island is 2670 km and the widest span is 1050 km. The island is 2.2 million km<sup>2</sup> and approximately 80% is covered

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by the enormous icecap; up to 3000 m thick. The coast is traversed by countless long fiords (Gynther, 1999).

The population is sparse, only 56 000 inhabitants, primarily living on the coast line. About 83% of the population lives on the lower third of the west coast and the rest is divided between the upper two-thirds and the lower half of the east coast. No one lives in the north-eastern part of the island, which is now a national park (Greenlandic Home Rule, 2008).

Table 1 presents the distribution of the population into towns, villages and settlements. About a quarter of the population (27%) resides in Nuuk, the capital of Greenland and another quarter of the population is located in the three major towns of Sisimiut, Ilulissat and Qaqortoq (Greenlandic Home Rule, 2008). About 85% of the population lives in towns and villages with more than 500 inhabitants.

The Greenlandic society and infrastructure is rather different from other places in the world, due to the sparse population and the large distances between towns and settlements. The infrastructure is based on aeroplanes and ships, which makes transportation sensitive to the rough Arctic weather conditions.

## Waste generation

The Greenlandic waste includes residential waste, commercial waste from the markets and stores, industrial waste from the fishing industry, and construction and demolition waste.

The residential waste is a mixture of materials discarded by the households. There is no kind of source segregation, apart from hazardous waste that has to be delivered to receiving stations. The residential bulky waste is all kinds of large items ranging from furniture to bicycles. The bulky waste is collected at the kerb or via drop-off container systems.

Commercial waste is mainly expired food items and packaging materials such as cardboard, plastic and paper. Most stores and supermarkets have their own containers, but no sorting is performed. Hazardous waste must be delivered to the receiving stations. The commercial waste is a considerable part of the total amount of municipal solid waste.

Industrial waste is a limited category. The fishing and seafood industry discharges the organic process waste through the sewage system untreated into the sea. Industrial seafood production is the only industry in Greenland. Other kinds of industrial waste are considered similar to the commercial waste. The quantity of industrial waste is limited.

The construction and demolition waste is mostly construction waste, since very little demolition has taken place. The main fractions of construction waste are wood, cardboard and plastic collected in containers on site. The demolition waste is sparse and consists mainly of concrete, painted wood and tar paper from roof covering.

The total amount of solid waste generated in Greenland is unknown and so is the composition. The majority of the waste consists of packaging from imported goods and post-consumer waste. A rough estimate suggests that all-in-all the Greenlandic society generates approximately 50 000 tons of mixed waste per year from all sources.

## Collection of waste

In the larger towns the collection of household waste is carried out by private companies using compactor trucks or small trucks (A. Lyberth, personal communication, 2009). Private companies have found it profitable to engage in waste collection in the towns. In less densely inhabited areas the municipality performs the collection. The municipal waste collection uses small tractors or all terrain vehicles for waste collection in villages where the houses are connected by gravel paths.

It is common to let the citizens choose between one to three collections per week, which contributes to a complex administration of the waste management system. The citizen pays 10–18 € per month as an average, which in most cases only covers the expenses for collection. The treatment of the waste is paid by the municipal taxes.

The residential bulky waste such as furniture, is often collected by the municipalities even in the towns with private waste collection companies. All towns have container systems for bulky waste and the major towns with incinerations distinguish between combustible waste and

**Table 1.** Distribution of the Greenlandic inhabitants (56 000) in towns, villages and settlements, excluding staff of meteorological stations and military facilities (Greenlandic Home Rule, 2008)

	Inhabitants	Percentage of total population (%)	Number of sites	Average number of inhabitants per household
Towns	>2000	60.5	6	2.6
Villages	500–2000	24.4	12	2.6
Small villages	25–500	15.0	55	2.1
Settlements	<25	0.1	9	–

non-combustible waste. However, the users do not pay much attention to the marked purpose of the containers and often misplace the waste. The citizen can also request from the municipality a waste pick-up at the kerbside.

The commercial, industrial, construction and demolition waste is collected in 6–9 m<sup>3</sup> containers. An entrepreneur performs the collection and the unloading of the containers. The combustible waste goes to the incineration plants and the non-combustible waste is landfilled. The staff decides by visual inspection whether the waste should be incinerated or landfilled.

The hazardous waste received at the municipal receiving stations is stored until enough is collected for export.

Table 2 shows the waste types which are collected in settlements, small villages, villages and towns.

## Handling and treatment of waste

Only a few decades ago all inhabited sites in Greenland had a dump site for all kinds of waste. It was common to burn the

waste at the dumps but this practice is now illegal and waste management has improved significantly.

Combustible waste consisting of residential and commercial waste is incinerated in six small incinerators and about 30 modified straw incineration plants. Table 3 provides information about the six incinerators and the towns they serve. The annual amount of waste varies between 1300 and 9300 tons. This corresponds to 430–694 kg of waste incinerated per person, per year (W. Hansen, personal communication, 2009; M. S. Petersen, personal communication, 2008). The incineration plants in the six towns typically contain a receiving area, a treatment area and a residual area. Figure 1 shows the incineration plant in the town of Ilulissat. The receiving area consists of a ramp for unloading the trucks, a shredder for bulky waste and a pit for mixing the waste. The treatment area consists of a grab, the incineration furnace and the boiler for heat production for energy recovery. The residual area includes containers for bottom ashes, electrostatic filters for flue gas cleaning and the fly ash containers. The incinerators recover the heat for district heating. However, the willingness to buy heat from the waste

**Table 2.** Solid waste fractions in Greenlandic towns, villages and settlements

Solid waste fractions	Towns	Villages	Small villages	Settlements
Combustible waste	X	X		
Mixed waste	X	X	X	
Metal	X	X	X	
Hazardous	X	X	X	X*
batteries	X	X	X	
used oil	X	X		
chemicals	X	X		
strip lights	X			

\*There is usually no kind of segregation only the statutory collection of hazardous waste fractions.

**Table 3.** Waste incinerated in six Greenlandic towns (Greenlandic Home Rule, 2008). The table contains data representing different years (2006–2009)

Name of city (year of data collection) (reference)	No. of inhabitants	No. of households	Inhabitants per household	Waste incinerated	
				Per year (tons year <sup>-1</sup> )	Per inhabitant per year (tons person <sup>-1</sup> year <sup>-1</sup> )
Aasiaat (2007) (W. Hansen, 2009) <sup>a</sup>	2977	1231	2.4	1279	0.430
Ilulissat (2007) (M. S. Petersen, 2008) <sup>a</sup>	4512	1580	2.9	3132	0.694
Maniitsoq (2007) (N. Lyberth, 2009b) <sup>a</sup>	2842	1187	2.4	1514	0.532
Nuuk (2008) (P. Nielsen, 2009) <sup>a</sup>	15083	5782*	2.5*	9371	0.621
Qaqortoq (2007) (A. Lyberth, 2009a) <sup>a</sup>	3238	1313	2.5	1755	0.542
Sisimiut (2006) (L. Kristensen, 2008) <sup>a</sup>	5399	1913	2.8	2724	0.505
Total	34051	13003	–	19775	–

\*Numbers from 2007.

<sup>a</sup>Personal communication.



**Figure 1.** Collection truck delivers waste to incineration plant in center of town of Ilulissat (Eisted, 2008).

**Table 4.** Waste incineration and energy recovery in Greenland. In smaller towns and villages the incineration is performed by modified incineration plants (MIP), which do not produce heat due to the simple construction of the plants

	Incineration plant (tons year <sup>-1</sup> )		Energy recovery	
	Capacity	Actually incinerated	Heat produced (MWh year <sup>-1</sup> )	Heat sold (%)
Aasiaat (2007) (W. Hansen, 2009) <sup>a</sup>	2000	1279	5215	75
Ilulissat (2007) (M. S. Petersen, 2008) <sup>a</sup>	3000	3132	4854	70
Maniitsoq (2007) (N. Lyberth, 2009b) <sup>a</sup>	2000	1514	2222	79
Nuuk (2008) (P. Nielsen, 2009) <sup>a</sup>	10000	9371	14511	73
Qaqortoq (2007) (A. Lyberth, 2009a) <sup>a</sup>	3000	1755	3845	71
Sisimiut (2006) (L. Kristensen, 2008) <sup>a</sup>	4000	2724	7383	62
Small towns	MIP at most places	No data available	None	–
Villages	MIP at some places	No data available	None	–
Small villages	MIP at some places	No data available	None	–

<sup>a</sup>Personal communication.

incineration plant is limited because of cheap fossil fuels and cheap electricity from hydro-power plants. The average sale of energy for district heating is approximately 70% of the production. In the summer-time the sale of energy decreases to only 10–20%. The rest of the heat is cooled off by fans (L. Kristensen, personal communication, 2008; M. S. Petersen, personal communication, 2008). Table 4 shows the energy production and recovery from the incinerators. The incineration plants in the minor towns and villages

are known as a modified Danish straw incineration plant (MIP). The MIPs are operated primarily to reduce hygienic problems of the waste. The plants are not equipped for energy utilization. The MIPs consist of a small building with a brick-lined furnace and a stack. Ashes are dumped on the local landfill and the flue gas emitted untreated. Although most of the 30 MIPs are in use, lack of maintenance and bad operational practices often put plants out of operation.



**Figure 2.** Ilulissat landfill area next to Disko Bay region. The waste is primarily non-combustible and is discreetly placed behind the town of Ilulissat. Behind the waste enormous icebergs from the famous glacier are visible (Eisted, 2008).

Mixed waste is landfilled. In the towns with incinerators mixed waste is the waste that is not being incinerated whereas in the small village the mixed waste is a blend of combustible and non-combustible waste. The landfills in Greenland are very simple and suffer from an absence of control of leachate and gas. The waste is landfilled in cliffs or on slopes, compacted and later covered with gravel or bottom ash from the incineration plant. The environment monitoring is limited and there it is likely that air, soil and water are all being contaminated. Figure 2 shows the landfill next to the town of Ilulissat. The fact that residential areas in many cases have developed close to the landfills makes the environmental issues of even more concern.

Metal waste is mostly cars, trucks and heavy machinery such as excavators and bulldozers. White goods represent a minor part of the metal fraction after CFC-gases have been removed. Furthermore, various composite items containing metals such as copper and aluminium end up in the metal waste. The metal waste is stored temporarily at the landfills in order to compile profitable amounts before export to Denmark. Only towns (typically more than 3000 inhabitants) generate profitable quantities of metal waste for export every fifth or tenth year. In villages the metal ends up at the landfill because of the unprofitable quantities and limited access for export.

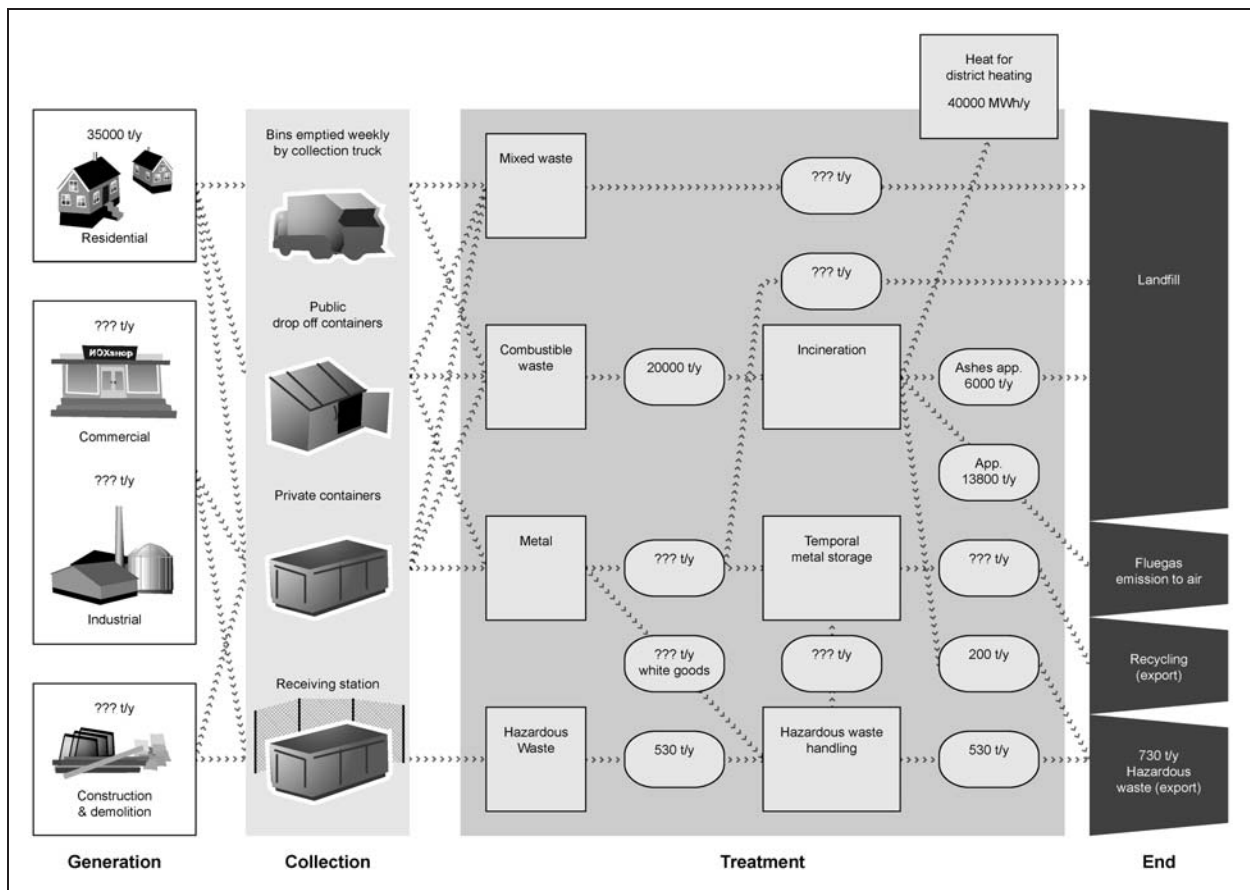
Hazardous waste is collected at the municipal receiving stations organized into CFC-gas-removed refrigerators,

batteries, chemicals and electronic waste. The hazardous waste is stored, packed and shipped for treatment to the joint municipal partnership I/S Mokana in Aalborg, Denmark (Greenlandic Home Rule Administration, 1993).

### Flows of the Greenlandic waste management system

The information collected on the Greenlandic waste management system has been aggregated into a flow diagram which is shown in Figure 3. This figure shows the waste generation, the waste collection, the handling and treatment system, and the final destination of the waste. Some flows are unknown due to lack of data. The quantity of residential waste has been estimated to be 35 000 tons year<sup>-1</sup> (Carl Bro, 1996). The total quantity of MSW is estimated to approach 50 000 tons year<sup>-1</sup>.

- About 20 000 tons of waste is annually incinerated. The incineration emits about 14 000 tons to the air as flue gases and produces about 6000 tons of bottom ash, which is landfilled, and about 200 tons of fly ash, which is exported as hazardous waste. The incineration produces 53 000 MWh year<sup>-1</sup> for district heating of which about 70% is sold according to Table 4.
- About 30 000 to 35 000 tons of waste including the bottom ashes are landfilled annually. The amounts of leachate



**Figure 3.** An overview of waste management in Greenland. The figure shows only a few numbers because of the limited data available in Greenland.

and gas generated are unknown, but no leachate or gas is collected.

- About 1000 tons of metals are exported for recycling each year. This estimate is an extrapolation of data available from the town of Sisimiut, which exports about 30 kg of metal waste inhabitant<sup>-1</sup> year<sup>-1</sup> (L. Kristensen, personal communication, 2008).
- About 730 tons of hazardous waste per year (12 kg person<sup>-1</sup> year<sup>-1</sup>) is exported (C. Espersen, personal communication, 2008). This is 530 tons of hazardous waste collected at the municipal receiving stations and 200 tons of fly ash. The town of Nuuk alone produces 150 tons of fly ashes per year (P. Nielsen, personal communication, 2009).

**Future challenges**

Greenland likely generates about 50 000 tons of waste per year corresponding to just less than 1 tonne person<sup>-1</sup> year<sup>-1</sup>. However, actual data on waste flows are few and uncertain. The mapping of the current waste management in Greenland has identified several challenges that could be addressed.

- The lack of data on quantities and especially the composition of the MSW prevents any assessment of alternative waste management schemes, for example, including the introduction of recycling schemes for other fractions than metals. Detailed data on the amounts and composition is the basis for identifying specific fractions that potentially could be sorted out and managed separately.
- Long distances and small amounts of waste are challenges in the assessment of increased recycling or introduction of more centralized treatment facilities with higher emission controls. This applies to transport of waste within Greenland as well as the transport of recyclables to industries in Europe and North America. The distances may make recycling less attractive, but this must be balanced against the potential impacts from managing the waste locally with technologies suited to the amounts and the climate.
- Incineration plants are small with limited flue gas cleaning and moderate energy recovery. Considering the fact that many of these plants are located close to housing areas it might be important to perform a closer examination of the actual emissions from these plants. Scrutiny of the operational procedures may also improve the performance of the incinerator. Likewise, it would be useful to closer

examine the possibility of recovering and using more heat from the incinerators thereby avoiding the use of fossil fuels for heating.

- Landfills will always be a part of the Greenlandic waste management system, since municipal waste quantities are small and land plentiful. A closer assessment paying attention to local conditions may suggest how the environmental load from the landfills can be reduced without incurring excessive cost. Part of this may also be to assess the possibility to use the landfill for temporary storage of materials that can be recovered when sufficient quantities have been accumulated.
- The hazardous waste is the source of emission of several environmental harmful substances. In view of the vulnerable Arctic nature it is important to keep good track of the collection of hazardous waste and limit any emission of problematic substances to the environment.

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