CODES OF PRACTICE
FOR WASTE MANAGEMENT
ON ISLANDS

MANUAL
Codes of practice for waste management on islands

Manual

Edited by:
M.E. Almeida-Teixeira, M. Onida
Waste Management Policy
ACKNOWLEDGEMENTS

The European Commission wishes to acknowledge the contribution given by RAMBØLL, Virum, Denmark to this manual. Thanks are due to Ms E. Lioliou for typesetting and to Ms J. Coleman for the proof-reading.

LEGAL NOTICE

Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of the following information.

A great deal of additional information on the European Union is available on the Internet. It can be accessed through the Europa server (http://europa.eu.int)

Cataloguing data can be found at the end of this publication.

Luxembourg: Office for Official Publications of the European Communities, 1997

ISBN 92-827-8301-4

© European Communities, 1997

Printed in Italy
# Table of Contents

1. PREFACE  
2. INTRODUCTION  
   2.1 Objectives  
   2.2 Identification of Islands  
   2.3 Scope  
   2.4 How to Use the Manual  
3. FRAMEWORK FOR WASTE MANAGEMENT  
   3.1 European Union Waste Management Policy Framework  
   3.2 European Legislation on Waste  
   3.3 National Legislation  
4. IDENTIFICATION OF WASTE MANAGEMENT PROBLEMS  
   4.1 How to Identify Main Problems on Islands  
   4.2 Data Collection  
   4.3 Identification of the Main Waste Management Related Problems  
   4.4 Identification of the Causes of Waste Management Related Problems  
   4.5 Priority Ranking of the Main Problems  
   4.6 Example of Priority Ranking  
5. CHOICE OF STRATEGY  
   5.1 General Strategies for Waste Management on Islands  
   5.2 How to Set Up Alternatives  
   5.3 Example of a Choice  
6. ORGANIZATION  
   6.1 Organization of Waste Management  
   6.2 How to Choose an Organization System  
   6.3 Example of an Organization System  
7. ECONOMY  
   7.1 EU Funding Opportunities for Waste Management Projects  
   7.2 How to Use Economic Evaluation for Screening  
   7.3 Example of a Screening  
8. COLLECTION AND TRANSPORTATION  
   8.1 Collection and Transportation Systems and Technologies  
   8.2 How to Choose a Collection and Transportation System and Technology  
   8.3 Examples of a Collection and Transportation Systems  
9. TREATMENT  
   9.1 Technology  
   9.2 How to Choose a Waste Treatment Technology  
   9.3 Example of Treatment Systems
1. PREFACE

_Waste Management on Islands_ was an issue addressed by consultants from six Member States of the European Union during 1994 and the first half of 1995, under the coordination of the Waste Management Policy Unit of the European Commission.

The main purpose of this effort was twofold: describing the current waste management practices on several islands off European coasts and proposing alternative improved solutions whenever possible.

The present Manual on Codes of Practice for Waste Management on Islands is the result of the above mentioned coordinated activities and draws contributions from all their individual reports.

In the first place, it is intended to assist the European Islands’ Local Authorities in drawing up their waste management plans, although it is expected that it will be of benefit to others working in the field of waste management.

I acknowledge the contributions given by the following consultants: Ramboll, Denmark; Byrne O‘Cleirigh, Ireland; Eratosthenes, Ltd, Greece; TPA and IGS, SA, Spain; Procesl, Lda, Portugal; Paraskevopoulos & Georgiadis, Ltd, Greece; Sociedad de Estudios P&G,SA, Spain and Lombardia Risorse, SPA, Italy.

I am confident of the usefulness of the practical tool that the present manual constitutes, and I trust that it will contribute to improving the Environment of Europe and of its islands.

Ritt Bjerregaard
Member of the Commission
(for the Environment)
2. INTRODUCTION

2.1 Objectives

The main objectives of this manual are to:

- Provide decision-makers at local (or regional) level with a practical tool to help them manage municipal and other kinds of waste (e.g. agricultural, industrial) more effectively, in accordance with the Community Strategy for Waste Management¹ and the Fifth Programme of Policy and Action in relation to the Environment and Sustainable Development².

- Give local, regional, and national authorities a better basis for understanding the essence of waste management problems on islands and archipelagos.

- Introduce good practice(s) when developing on a waste management system. This means: a) identification of the main waste management problems, b) prioritization of tasks, c) choice of strategy and treatment methods, and d) practical solutions to the identified problems.

2.2 Identification of Islands

This manual is addressed primarily to small and medium-sized islands and archipelagos which due to their location, number of inhabitants, available infrastructure, social and economic structure have to make a special effort to dispose of their waste in an environmentally acceptable way. However, some of the guidelines and suggestions contained in the manual may also be useful for waste management authorities on larger islands and on the mainland.

Among the most frequent problems are costs of transportation of recyclable waste to the mainland, lack of infrastructure, seasonal population fluctuations, climatic conditions, environmental vulnerability, lack of space and adequate infrastructure for waste disposal. At the same time, for many islands tourism is of the utmost importance for the living conditions of their inhabitants, and well-planned waste management (which is reflected in, for example, clean streets and beaches) is among the most essential parameters considered by tourists in choosing their holiday destination. Consequently, local authorities often have to make a relatively greater effort in the field of waste management than local authorities on the mainland, irrespective of the fact that islands usually have to pay more for the same result.

Uninhabited islands are not dealt with in the manual.

¹O.J. C 122, 18.5.1990, p.2.
²O.J. C 138, 17.5.1993, p. 1
2.3 Scope

This manual aims at dealing with all types of waste: from municipal solid waste, commercial and industrial waste, to some special waste streams (for example, end-of-life vehicles, health care waste, waste oils, construction and demolition waste, used batteries, used tyres).

2.4 How to Use the Manual

For the purpose of clarity and ease of use of the Manual, each chapter (except chapters 3, 4, 7 and 12) comprises three main sections:

1. The first section of each chapter provides background for the specific tasks.
2. The second section provides "guidelines on how to" carry out the specific tasks.
3. The third section provides examples which will help the user of the manual with his work.

Chapter 3 provides a description of the overall framework under which the waste management strategy is to be carried out.

Chapter 4 provides an identification of the main problems usually occurring on islands.

Several strategies may be of application. Chapter 5 presents the strategies applicable to waste management on islands. Once the main strategies are chosen by a screening procedure it is possible to select the treatment strategies necessary to meet the objectives. The illustration on the next page indicates (as an example) three management strategies for further screening.

Each of the management strategies is described with respect to organizational aspects (chapter 6), collection and transportation techniques (chapter 8) and treatment technologies (chapter 9).

The management strategies are then screened in terms of financial and environmental impact aspects (chapter 7 and chapter 10).

It is therefore possible to select the best suited solution for the specific island in question (chapter 11). Further development of this alternative will enable the elaboration of a waste management plan. Chapter 12 provides guidelines on how to set up objectives, actions, time schedules and budgets for the waste management plan as well as efforts towards waste management measures enforcement, training and information.
### HOW TO USE THE MANUAL

<table>
<thead>
<tr>
<th>Framework for waste management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of waste management problems</td>
</tr>
<tr>
<td>Strategies:</td>
</tr>
<tr>
<td>Main Strategies</td>
</tr>
<tr>
<td>Treatment Strategies</td>
</tr>
<tr>
<td>Organization</td>
</tr>
<tr>
<td>Economy</td>
</tr>
<tr>
<td>Collection and Transportation</td>
</tr>
<tr>
<td>Treatment</td>
</tr>
<tr>
<td>Environment Impact Assessment</td>
</tr>
<tr>
<td>Choice of Alternative</td>
</tr>
<tr>
<td>Waste Management Plan</td>
</tr>
</tbody>
</table>
3. FRAMEWORK FOR WASTE MANAGEMENT

3.1 European Union Waste Management Policy Framework

1. The general environmental strategy of the Community is to be found in the European Union’s Fifth Programme of Policy and Action in relation to the Environment and Sustainable Development. The strategy contains general guidelines and proposes a new approach to environmental issues, based on preventive actions and on necessary changes in the behaviour pattern of modern society. It points to the need to curb the rapid increase of quantities of waste and to the danger that waste constitutes for the environment. Among the specific sectors to be targeted, tourism is considered to be very important for the integration of the environmental dimension into development.

2. A specific "Community Strategy for Waste Management" was proposed in a Communication of the Commission to the Council and to the European Parliament of 18 September 1989\(^3\). It was endorsed by the governments of the Member States in a Council Resolution of 7 May 1990\(^4\). This strategy develops along the following lines:

   1. Prevention of the creation and of the harmfulness of waste. Prevention may take, for example, the form of the reuse of products and of development of clean technologies.

   2. Promotion of different forms of recovery, including recycling and energy recovery.

   3. Minimization and optimization of final disposal (incineration and landfilling).

---

\(^3\)SEC (89) 934 Def.

\(^4\)O.J. C 122, 18.5.1990, p. 2.
4 Minimization and control of waste transport.
5 Remedial actions (clean-up of contaminated sites).

3.2 European Legislation on Waste

Community legislation on waste takes, in most cases, the form of Directives, which need to be transposed into national law of the Member States of the Union. Therefore in most cases it is into national law that local authorities must look rather than into Community law. Nevertheless, a knowledge of Community legislation on waste is of importance since there are parts of Community Directives which are directly applicable at Member State level, not requiring the transposition into national law in order to be enforced. Furthermore, the recent Community legislation on shipments of waste within, into and out of the European Community takes the form of a Regulation, which is of direct application by all Member States and does not require national transposition measures.

It must also be underlined that there is no specific Community legislation concerning islands, since this legislation covers the entire territory of the EU. Two general Directives and the Regulation on shipments of waste constitute the basic pillars of Community waste legislation:


This Directive (known as the "framework" Directive on waste) provides the basic definitions and principles for an environmentally sound management of waste. It sets out a priority ranking of the efforts to be carried out in the area of waste and waste management. Member States are required to take appropriate measures to encourage, firstly, the reduction of waste generation and its harmfulness and secondly, the recovery of waste by means of recycling, re-use or reclamation as well as the use of waste as a source of energy.

It lays down the fundamental principle that waste must be recovered or disposed of without endangering human health and without using processes or methods which could harm the environment. The abandonment, dumping or uncontrolled disposal of waste is prohibited. This prohibition is of extreme importance in relation to the present situation in many European islands where, as the studies on which this Manual is based have shown, a relevant fraction of waste is still abandoned in nature or disposed of in an uncontrolled manner.

---

\(^5\)O.J. L 194, 25.7.1975, p. 47.

In addition, the framework Directive requires the competent authorities designated by Member States to draw up waste management plans. This Directive is completed by a Commission Decision 94/3/EC of 20 December 1993 establishing a list of wastes (so-called "European Waste Catalogue") to be used as a reference for a common definition of waste in the entire EU territory.


The Directive defines measures which, in addition to those contained in the framework Directive, have to be applied when dealing with hazardous waste. To this end, hazardous waste is defined in a list established by Council Decision 94/904/EC of 22 December 1994. A number of provisions to ensure environmentally sound management of these wastes are set up, such as the prohibition to mix hazardous waste of different categories or hazardous waste with non-hazardous waste, the requirements in relation to the authorization for establishments and undertakings dealing with hazardous waste, and provisions concerning the labelling and packaging of hazardous waste.


Based on the U.N. "Basel Convention", this Regulation provides a number of provisions applicable to the supervision and control of shipments of waste for recovery and of waste for disposal. Procedures and controls vary according to whether the destination of the waste is final disposal or recovery. As far as waste for recovery is concerned, controls and procedures also vary according to the potential harmfulness of the waste, which is classified into three main categories (Annexes II, III and IV, also known as the green, orange and red list).

In principle, all waste shipments have to be notified in advance and cannot legally be executed unless all concerned competent authorities have given their consent. Further-

---

7 An expert seminar was held in Brussels on 10-11 January 1994 in order to present the practical experiences of developing plans and to allow an exchange of experiences among Member States’ experts. The seminar proceedings are available from Waste Management Policy Unit of the European Commission (200 Rue La Loi, B-1049 Brussels).


10 O.J. L 84, 31.3.1978, p. 43.


more, the Regulation installs restrictions on exports out of and imports into the Community, mainly reflecting the requirements of the Basel Convention but sometimes even going beyond them. As such, all waste for disposal is prohibited from being exported, except to EFTA countries. Imports of waste for disposal as well as exports and imports of waste listed in Annex III and IV for recovery are also severely limited.

In addition to the above mentioned general legislation on waste, specific legislation has been adopted in the past years for a number of waste types, which for their quantity or potential harmfulness for the environment deserve special Community measures.

- Directive 76/403/EEC of 6 April 1976\(^\text{13}\) on PCBs and PCTs.

  This Directive defines the measures to be taken by Member States in order to prohibit the uncontrolled discharge, dumping and tipping of PCBs and PCTs, and make compulsory the environmentally safe disposal of PCBs and PCTs waste. Member States shall also promote, where possible, the regeneration of PCBs and PCTs contained in objects and equipment no longer capable of being used. Member States shall also set up or designate installations, establishments or undertakings which are authorized for disposing of PCBs and PCTs, on their own account and/or on behalf of third parties. The cost of disposing of PCBs and PCTs shall be borne by the holder of the PCBs and PCTs and/or the previous holders or the producer of the PCBs and PCTs or of the equipment containing them.


  These Directives provide measures to ensure that waste oils are collected and disposed of without causing any avoidable damage to man and to the environment. Priority is given to the processing of waste oils by regeneration.

  In the case of the combustion of oils in plants with a thermal input of 3 MW or more, specific emission limit values (set in the Annex to the Directive) have to be complied with.

  Combustion of waste oils in plants with a thermal input of less than 3 MW shall be subject to adequate control.

  Member States shall ensure that waste oils used as fuel do not constitute a toxic and dangerous waste and do not contain PCBs and PCTs in concentrations above 50 ppm.


\(^{14}\)O. J. L 194 25.7.75 p. 23.

\(^{15}\)O.J. L 42 12.2.87 p. 43.
Directive 86/278/EEC of 12 June 1986\textsuperscript{16} on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture.

The aim of this Directive is to protect the environment and human health while also encouraging the correct use of sewage sludge in agriculture. It fixes limit values for the concentration of heavy metals in soil and in the sludge used. It lays down conditions for the use of sewage sludge in arable land (e.g. necessity of treatments to reduce fermentability and health hazards, control of sludge and soil quality).

Directive 78/176/EEC of 20 February 1978\textsuperscript{17} aims at preventing and gradually reducing, with a view to its elimination, the pollution caused by waste produced by the titanium dioxide industry; Directive 82/883/EEC of 3 December 1982\textsuperscript{18}, fixing common measurement methods used in the protection of sites affected by titanium-dioxide pollution; Directive 92/112/EEC of 15 December 1992\textsuperscript{19}, aiming at harmonizing programmes to reduce pollution caused by titanium-dioxide waste, in order to reduce competition distortions and to protect the environment.


This Directive aims at harmonizing national measures on the recovery and controlled disposal of spent batteries and accumulators containing mercury, cadmium or lead beyond fixed limits. These batteries and accumulators must be subject to separate collection programmes. Batteries and accumulators containing dangerous substances are an important potential source of pollution when not correctly collected and recovered or disposed of. This is particularly true on islands, where soil and groundwater need special care in order to be protected against contamination.


\textsuperscript{16}O.J. L 181, 4.7.1986, p. 6.
\textsuperscript{17}O.J. L 54, 25.2.1978.
\textsuperscript{20}O.J. L 78, 26.3.1991, p. 38.
\textsuperscript{21}O.J. L 363 of 27.1.1990, p. 51.
\textsuperscript{22}O.J. L 224 of 18.8.1990, p. 29.
With the aim of protection of animal and public health, this Directive lays down requirements for the disposal and/or processing of animal waste and for placing on the market of animal waste intended for purposes other than human use.


This Directive calls for the introduction of measures in the field of prevention of waste. It encourages the establishment of re-use systems for packaging which may be refilled or re-used. It sets out quantitative targets for the recovery and recycling of waste, by requiring Member States to take the necessary measures to ensure that, by 30 June 2001, between 50 and 65% by weight of packaging waste will be recovered, and between 25 and 45% of packaging waste will be recycled (with a minimum of 15% for each packaging material)\(^{24}\). Packaging waste represents between 40 and 50% of municipal solid waste. On islands, packaging is a primary cause of pollution, as it is easily left by tourists in the environment.

- On 3 December 1981, the Council adopted a Recommendation\(^{25}\) concerning the re-use of waste paper and the use of recycled paper, which aims at encouraging the use of recycled and recyclable paper, particularly in administrative and public bodies, and at implementing programmes of consumer and manufacturer education.

In addition, Community measures have been adopted as regards treatment and disposal methods, such as:

- Incineration of municipal waste (Directives 89/369/EEC of 8 June 1989\(^{26}\) and 89/429/EEC of 21 June 1989\(^{27}\)).


These Directives aim at protecting the atmosphere from pollution from incineration emissions.


\(^{24}\) Greece, Portugal and Ireland, may decide to attain lower targets than the common ones, under the condition that a target of 25% recovery is reached. Alternatively, the same targets may be aimed at, thus allowing those countries to benefit from an extended deadline (31 December 2005).


\(^{27}\)O.J. L 203 of 15.7.1989, p. 50.

\(^{28}\)O.J. L 365 of 31.12.1994, p. 34.
In order to prevent or reduce negative effects on the environment and in particular, the pollution of surface water, groundwater, soil and air, as well as the resulting risks to human health from the landfilling of waste, a Directive on the landfill of waste was proposed by the Commission on 22 May 1991, and is being discussed by the European Parliament and the Council, at present. This proposal aims at reducing toxicity and quantity of landfill waste, in particular by encouraging pre-treatment of waste. It lays down a classification of landfills, whereby each landfill will only accept a certain kind of waste, in order to reduce waste-mixing which may increase their hazardousness to the environment. Specific procedures are envisaged for the acceptance of the delivered waste as well as for the aftercare of the landfills when they cease to be used.

3.3 National Legislation

Nearly all pieces of Community legislation on waste need to be transposed into the Member States by means of national law. Therefore a thorough knowledge of national legislation (including, where relevant, regional and local regulations) for waste management is an essential pre-requisite for the implementation of a sound waste management strategy and for the drafting of a waste management plan. Requirements, competencies and responsibilities for waste management, though covered by Community harmonization measures to a limited extend, vary greatly among the different Member States. It is therefore not possible to include in this Manual a summary of the legislation of each Member State.

In order to correctly implement a waste management strategy, national authorities should be aware at least of the following aspects contained in national legislation on waste:

- Waste management priorities.
- Responsibilities for waste management.
- Minimum environmental standards for waste collection and transport, handling, treatment and disposal.
- Health and safety regulations.
- Fees, taxes and subsidies on waste and resources.
- Possibilities for organization and financing.

Furthermore, a complete set of instructions (for households, commerce, industries, public authorities) in connection with proper handling of waste (for example: delivery of waste in the correct containers, collection schemes, transportation) is an essential part of a waste management plan.
The following aspects should be taken into consideration:

**Provisions concerning waste**

- Types of waste to be delivered to the storage systems.
- Maximum dimensions of waste subject to curbside collection.
- Where and when to deliver the waste.

**Provisions concerning collection**

- Ownership of the containers.
- Type and sizes of containers to be authorized.
- Standards of the container sites.
- Access to the containers by collection equipment/personnel.
- Collection frequency and routes.
- Maintenance of containers.

**Administrative and financial provisions**

- Taxes, fees and charges.
- Financial incentives.
- Penalties and sanctions.
- Duties of the waste producer: household, shops, hotels, industries, clinics/hospitals, public bodies (e.g., obligation of source separation, marking, cleaning).
- Duties and powers of controlling bodies.
- Possibility to complain about the service.

Where this is not already provided for by national, regional, provincial or local legislation it is useful to establish a waste registration system to correctly monitor the waste streams and provide a basis for future decisions. Data collection may be usefully effected at landfills, recycling centres and the sites to which waste is stored. The information on which the registration is based may be:

- Date of receipt and delivery.
- Place of receipt and delivery.
- Identification of source (e.g. household, industry, trade, etc.).
- Identification of transport company.
- Type of waste (e.g. glass, metals, plastics, paper, oils, batteries, etc - The European Waste Catalogue should be used as a reference).
- Classification of the waste (municipal, hazardous, etc.).
- Quantity of waste (in weight or volume).
Examples of waste management-related regulations:

* Denmark has introduced an obligatory computerized waste registration system. The system is based on weighing all waste entering waste treatment facilities (recycling, composting, incineration and landfilling). The information is compiled and sent annually to the Danish Environmental Protection Agency and distributed to local authorities. Aggregated data is sent to international authorities.

* In the municipality of Mykonos local regulations exist, for example, on construction/demolition and renovation activities, which are limited to the winter period (all construction and demolition waste must be removed before 15 March).

* The municipality of Fanø (DK) has elaborated local regulations, as regards:
  
  - Household Waste: the municipal system for waste disposal must be used, including approved stands with special 110 litres plastic bags or containers. Every dwelling must have at least one stand, and for apartment blocks, there must be at least one for every two apartments. The regulation states what must be put in the bags, and where the stands have to be placed.
  
  - Commercial waste: all enterprises have to deliver their waste at certain sites/companies listed in the regulation. They also have to separate paper, cardboard, glass and metals for recycling purposes. Enterprises which do not want to use the approved haulage contractor have to get approval from the municipality to do it themselves.
  
  - Oil and chemical waste. This indicates where and how to deliver oils, chemicals and hazardous waste.

Data: 1994/95
4. IDENTIFICATION OF WASTE MANAGEMENT PROBLEMS

HOW TO USE THE MANUAL

4.1 How to identify main problems on islands

Waste management is only one among several issues that must be faced by local authorities on islands. In order to correctly identify waste management problems, the first step to accomplish consists of listing the general and most important problems on the specific island and their interrelation. Examples of general problems are:

- Lack of infrastructure
- Dependency of the economy on tourism
- Unemployment
- Distance to mainland
- Economic structure
- Insufficient hospital care
- Lack of drinking water
- Expensive energy provision
- Pollution from waste water
- Pollution from solid waste
- Scarcity of inhabitants
- Extreme climatic conditions

Subsequently, the specific problems related to waste and waste handling must be identified.

In broad terms, waste handling related problems, are:

- Impact on air, water and soil, fauna and flora
- Nuisance for inhabitants, employees, tourists
Even if these are problems common to both islands and mainlands, the influence on groundwater can be more serious on islands with scarce water resources. Also, contamination of surface water and other nuisances for tourism will have a greater impact on islands.

An identification of problems can be made by a survey carried out by the local authorities, and/or it can be made through a public debate with participation of the citizens. A poll among a representative portion of citizens will often provide useful information on aspects ranging from technical problems to organization through treatment, disposal, etc.

4.2 Data Collection

Data collection of waste originated on an island is of great importance for the establishment of a waste management plan.

Data collection should be carried out for:

- Waste quantities (municipal, commercial, industrial, and other waste).
- Waste fractions and composition (organic, recyclable and combustible fractions).
- Problematic wastes (hazardous waste, oily waste, clinical waste, batteries, electric equipment, ship-generated waste, end-of-life cars, used tyres, fishery wastes, flotsam, distillery wastes).
- Seasonal changes in waste production due to tourism or other factors.
- Special geographical conditions (sparsely or densely populated areas, narrow streets, frequent or torrential rainfalls, low precipitation, exposure to high winds etc.)
- Infrastructure (existing and planned) for waste treatment.

4.3 Identification of the main waste management related problems

On the basis of the examination performed during the Islands’ Programme coordinated by the Commission in 1994/95 some of the major problems which must be solved in the field of waste management on islands were identified.

A summary of the most frequent environmental problems related to waste management on many European islands is presented, taking into account:

1) Impact of current collection and storage methods

* Public health hazard (e.g.: containers which cannot be mechanically washed are full of leachate, or leachate spills over onto the curbside)
* Waste dispersion (from bins and open trucks)
* Odours
* Visual impact
* Waste abandoned in nature and waste washed ashore
* Packaging littering
* Dumping of waste along the roads (particularly construction and demolition waste, abandoned cars, carcasses of white goods, tyres)
2) Impact of current disposal methods

* Contamination of groundwater and surface water from leachate
* Fire and explosion hazard (methane produced by anaerobic combustion of organic matter). Fire hazard worsens if combustible waste is present (e.g. used tyres).
* Public health hazard (rats, birds, insects, other animals)
* Visual impact
* Odours
* In the case of open-air uncontrolled incineration: air pollution (e.g. dioxines, aldehydes, hydrochloric acid); fire hazard; odours; visual impact.

4.4 Identification of the causes of waste management related problems

Wastes are one of the major sources of environmental pollution. Any community, not necessarily on an island, has to deal with some general waste management aspects.

Correct waste management consists of different phases:

- Data collection and waste characterisation
- Waste collection, possibly in a selective way
- Waste separation
- Waste transportation
- Temporary waste storage
- Re-use of certain waste fractions
- Recycling of certain waste fractions, including composting (organic recycling)
- Other forms of recovery, including energy recovery, of certain fractions
- Safe disposal (landfilling and incineration)

Each phase requires a good deal of organisational work, planning and financing.

In reality, current waste management systems are often incomplete or incipient. Sometimes they do not exist at all.

In fact, waste management always faces a number of difficulties, among which include:

* The lack of precise quantitative data on wastes produced and their composition
* The cost of performing proper collection operations
* The cost of building proper disposal installations
* The absence of economic value for some of the waste
* The political sensitivity of the subject (e.g. "not in my backyard" [NIMBY] syndrome, ideological differences between political parties)
* The great variety of waste produced and the need for different treatment techniques.

Apart from general aspects such as the above, additional difficulties for proper waste management can be identified in remote regions (islands, in particular).

Some examples are given hereafter (taken randomly from the Islands' Programme studies).
A) CAUSES LINKED TO INSULARITY AND LOCATION

Note: The table contains a random selection of examples.

| Geographical location | • Distance to mainland and between islands makes waste transport expensive (eg: Açores, Madeira, Canarias, Dodecanese, Bornholm, Shetland)  
|                       | • Distance between islands (eg: Açores)  
|                       | • Frequent sea storms make transport difficult |
| Climate               | • High temperatures aggravate odours and health hazard (all southern EU islands)  
|                       | • Strong winds cause waste dispersion  
|                       | • High temperature is an indirect cause of beverage packaging littering nature |
| Geological and hydrogeological aspects | • Scarcity and vulnerability of water layers  
| | • Land scarcity |
| Socioeconomic aspects | • Population increase during the tourist season. Most islands have a quite constant population throughout the year, but quite large population variations can occur in some islands, particularly the islands of the Mediterranean. To this end, the best example is that of the Canary archipelago, where the tourist season lasts for 12 months.  
| | • Economy depends very much on tourism  
| | • Concentration of commercial life in a few parts of the islands  
| | • Distribution of residential dwellings on the islands (which involves long collection trips and high costs) |
| Administrative aspects | • Autonomy statues may hinder co-operation with the mainland  
| | • Often it translates into lack of local finances which may negatively affect waste management. |
B) CAUSES LINKED TO WASTE COLLECTION

Note: The table contains a random selection of examples.

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Insufficient on-site storage equipment, especially during summer</td>
<td>• Tuscan archipelago</td>
</tr>
<tr>
<td>• Inadequate distribution of on-site storage, leading to both overcapacity and undercapacity</td>
<td>• Overcapacity: Vathi (Ithaki)</td>
</tr>
<tr>
<td></td>
<td>• Bins not properly distributed: certain areas of KOS (Asfendio, Kefalos)</td>
</tr>
<tr>
<td>• Inadequate equipment and practices for collection (non mechanically washable containers; open trucks instead of compaction vehicles; manual emptying involves health risks)</td>
<td></td>
</tr>
<tr>
<td>• Lack of (or insufficient) selective collection practices</td>
<td>• Tuscan archipelago</td>
</tr>
<tr>
<td></td>
<td>Selective collection suffers from high costs of shipping the waste to the mainland</td>
</tr>
<tr>
<td>• Almost total absence of collection services for special waste, with the consequence of filling-up landfills</td>
<td>• Great majority of islands</td>
</tr>
</tbody>
</table>

1994/95
### C) CAUSES LINKED TO WASTE RECOVERY AND DISPOSAL

Note: The table contains a random selection of examples.

<table>
<thead>
<tr>
<th><strong>PROBLEM</strong></th>
<th><strong>EXAMPLES</strong></th>
</tr>
</thead>
</table>
| - Landfills are inadequate  
  In many islands landfilling means just uncontrolled tipping into land holes; in other cases landfilling is "controlled" but the landfills are far from being sanitary (equipped in order to protect soil and groundwater); often, even the better equipped landfills need to be modernized. | - Greece, Italy (almost in entirety), Canarias (uncontrolled landfills). |
| - Incineration is inadequate | - Uncontrolled open-air incineration is still practiced on some islands (GR, IT).  
- Existing incinerators have been or will be shut down (Canarias) or modernized (Shetland, Baleares).  
- Residues from incineration are not properly treated (Bornholm).  
- The "bad reputation" of landfills, makes it difficult to find locations for new sanitary landfills (eg Kos). |
| - Absence of any infrastructure, and therefore no care, for special waste streams which, most of the time, are dangerously tipped with municipal solid waste (this practice increases the risks of contamination from oils, batteries, PCB/PCT...) | - All islands except DK, UK (part) |
| - Absence of or insufficient transfer stations | - UK |
| - Recycling is only done by private firms and on a very limited scale (aimed at large producers of waste). Municipalities are seldom involved | - Madeira/Açores: materials collected selectively are then put into landfills |
| - Too much organic waste is landfilled: composting is still very limited. This increases leachate and odours. | - Generally speaking, all islands |
D) **CAUSES LINKED TO FINANCIAL AND ORGANIZATIONAL ASPECTS**

Note: The table contains a random selection of examples.

<table>
<thead>
<tr>
<th><strong>PROBLEM</strong></th>
<th><strong>EXAMPLES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Collection is not organized on a co-operative basis (duplication of costs).</td>
<td>• Many Greek and Italian islands</td>
</tr>
<tr>
<td>• Lack of co-ordination between municipalities.</td>
<td></td>
</tr>
<tr>
<td>• Local authorities tend to consider waste management a priority only after other priorities (water, sewage, health...)</td>
<td>• Common problem</td>
</tr>
<tr>
<td>• Citizens are not sufficiently aware of risks of daily incorrect waste management nor of the potential of selective collection.</td>
<td>• This lack of awareness concerns in particular composting (Tuscany)</td>
</tr>
<tr>
<td>• But waste pollution is a slow, day by day accumulating process, often not visible.</td>
<td></td>
</tr>
<tr>
<td>• On the contrary, citizens are very aware of the risks of major disasters</td>
<td></td>
</tr>
<tr>
<td>• The lack of correct knowledge may often bring about the rejection of correct waste management plans (NIMBY syndrome).</td>
<td></td>
</tr>
<tr>
<td>• Waste management is too expensive because productivity tends to be low</td>
<td>• Common problem</td>
</tr>
<tr>
<td>• Competencies are not distributed optimally. Historically, each municipality has managed its own waste. Co-operation, which would make operations cheaper, is only just emerging</td>
<td>• Canary Islands</td>
</tr>
<tr>
<td>• No reliable information on waste generation and composition. The question of statistical monitoring (data collection on waste arisings and composition) is of major importance for any environmental policy.</td>
<td>• Common problem</td>
</tr>
<tr>
<td>• Waste management costs exceed available funds</td>
<td>• Practically everywhere</td>
</tr>
<tr>
<td>• Absence of or insufficient legislation and control</td>
<td>• In particular in countries which do not keep pace with transposing and implementing EU waste legislation.</td>
</tr>
</tbody>
</table>
4.5 Priority ranking of the main problems

In the priority ranking of the main problems an interactive coaching approach may be chosen. The basis of this procedure being that local priorities are primarily political priorities. The priority ranking can be carried out by the municipal council or the elected representatives of a community.

To facilitate the priority ranking, the following methodology could be used: The first step consists of drawing up a list of problems as described above. The second step is to group together the interrelated problems. In the third step each participant will make a list of priorities of three main problems. The seven to ten problems (depending on the number of problems listed) given priority by most of the participants will be included in the next voting round in which each participant can give priority to two main problems. Prior to the vote, a decision on the number of main problems to be worked with in the waste management plan must have been made. A limit of 3-5 main problems is recommended.
4.6 Example of priority ranking

As an illustration of how to identify main waste management problems, the results of the priority ranking of main problems for the Greek island of Mykonos and the problems identification for the Canary Islands are shown (1994/95):

<table>
<thead>
<tr>
<th>Mykonos - Example of a ranking of problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>The main industry on Mykonos is tourism.</td>
</tr>
<tr>
<td>All waste is collected as municipal solid waste and is disposed of in a central landfill.</td>
</tr>
</tbody>
</table>

The main problems identified are ranked as follows:

1. **Organisation, administration and legislation:**  
   No cooperation on waste collection or disposal exists; legislation and existing regulations are insufficient as is the controlling system.

2. **Oil and hazardous wastes are not collected:**  
   No separate public collection of oil and hazardous waste exists on the island. Hazardous waste is disposed of in landfill without control.

3. **Insufficient collection:**  
   In parts of the island waste collection is insufficient; waste washed ashore is a problem in many parts of the island, particularly considering the desire to further develop tourism; construction and demolition waste and bulky waste are dumped in nature, particularly along the roads.

4. **Insufficient recycling:**  
   Recycling is carried out on private initiative only and is not very extensive.

5. **No sanitary landfill:**  
   Landfill is uncontrolled and does not meet requirements for sanitary landfills; the fraction of organic waste is very large and results in gas emissions and odour nuisances from the landfill.
Canary Islands - Example of an identification of problems

The main problems detected in the Canary Archipelago are as follows:

- No consistent distribution of competencies at archipelago level and insufficient cooperation between islands on waste management
- No reliable information about the generation and composition of municipal waste
- No special treatment of industrial waste and no treatment infrastructure at archipelago level
- Treatment is limited to landfills
- Most landfills do not have all the necessary measures to guarantee environmental protection - no leachate catch drainage networks and no scale or control of incoming waste
- Lack of suitable land to locate landfills on all islands and high vulnerability of groundwater on all islands
- The only incineration installations do not comply with Community standards
- Only 13-14% of the waste from one island (Tenerife) is composted
- The absence of transfer plants increases transport costs
- Recycling is limited to private producers

1994/95

Other examples can be found in the study reports listed under References.
5. CHOICE OF STRATEGY

5.1 General strategies for waste management on islands

5.1.1 Waste Prevention

The main strategies for waste prevention consist of:

- Organizing production in such a way that the consumption of raw and ancillary materials is reduced, whereby waste from the production process is limited as much as possible (in particular, by using clean technologies).

- Extending, where appropriate, the lifetime of products.

- Minimizing the use of packaging to the bare necessity and encourage packaging reuse and recycling (in particular, by establishing deposit-return systems to increase collection).

- Informing consumers about the advantages of "green products" and of products packed in environmentally sound packaging.

Waste minimization and development of cleaner technologies is of special interest on islands which have industry, extensive construction activities or other production. Through cooperation between local authorities and local companies it can be ensured that companies are encouraged to use technology which generates less waste. Another more service orientated approach would be that local authorities offer companies their assistance to go through their production with a view to minimizing the amount of waste.
Consumer behaviour can be influenced in many ways. Consumers may be given information in the form of leaflets delivered door-to-door, advertisements in newspapers, local magazines and in guidebooks on the island or the municipality they inhabit, etc. Information campaigns should inform consumers exactly how they can contribute to minimizing the amounts of waste when shopping, for instance by choosing goods whose packaging can be reused or recycled.

The implementation of return systems for packaging will greatly stimulate the minimization of waste. When most of the packaging is returned by consumers to distributors or to collection centres, the amount of municipal solid waste to be collected by the municipality can be greatly reduced. Packaging waste represents between 30 and 50% of municipal solid waste. If packaging waste is reduced and separately collected, the main fraction remaining would consist of organic waste, which can be destined to central composting or biogasification. Consumers as well as distributors should hereby be stimulated to influence manufacturers and importers to minimize the amounts of packaging put on the market.

5.1.2 Main Strategies for Islands

The existing problems of waste management and future requirements for environmentally appropriate waste treatment and disposal facilities should be seen in a long-term perspective, at least 10 to 15 years. Even though local authorities, in daily waste management practice, work with several strategies and are faced with specific problems concerning different waste fractions, it is very important to decide upon a general long term strategy which could form the basis for long term investments and decision making. Decisions concerning specific sectors may then be coordinated with the long term strategy.

In the frame of a long term strategy for waste management, local trades, industries and households have the necessary time to adapt to new conditions for waste management.

To facilitate local authorities in facing the waste management challenge in the long term, three main strategies for islands and archipelagos are chosen as examples and described in this manual.

The three main strategies described in this manual are:

A) Single strategy

An island may choose to manage all or the major part of the waste on its territory. Such a strategy is typically possible for relatively large islands and isolated islands with long distances from the mainland and from other islands.

In this case the waste management alternatives depend to a large degree on the size of the island, its population and the traditions concerning cooperation between the municipalities on the island.
B) **Tandem strategy**

For islands close to a densely populated mainland or a city, the "tandem strategy" in which all waste is transported to this mainland or city, where it can be treated and disposed of in an environmentally sound way, is an advantageous possibility.

C) **Joint strategy**

In an archipelago it might be possible to establish a cooperation on waste management options making the application of high-technological solutions such as recycling, energy recovery and environmentally sound landfills (which may be too costly for small islands) feasible.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>SINGLE STRATEGY</td>
<td>TANDEM STRATEGY</td>
<td>JOINT STRATEGY</td>
</tr>
</tbody>
</table>

In practice, waste management on an island will almost always be a mix of strategies, e.g. a joint strategy for solid waste and a tandem strategy for handling of hazardous waste. Nevertheless, the existence of an overall strategy should be of use in determining waste planning and public investments in waste management in the long run.

In order to identify whether present waste management practices represent a single, a tandem or a joint strategy, the main part of the waste flows on the island must be considered. If the main part of the waste is treated on the island - e.g. by composting and sanitary landfilling - it is a single strategy although some recyclable and hazardous fractions are exported to the mainland. It must be stressed that even though the present strategy is e.g. a single strategy, this will not necessarily have to be the future strategy for the island, in view of an evolving and appropriate protection of the island's environment.

**5.1.3 Management and treatment strategies for islands**

Each of the main strategies can be divided into a number of management/treatment strategies, ranging from the simplest to the most advanced waste management methods. In table 5.1 the
Applicable management/treatment strategies within the three main strategies are shown. The list in table 5.1 is not complete - other strategies can be found due to specific local conditions - but the list represents the applicable strategies for islands which may be recommended due to technical, economical and environmental reasons.

<table>
<thead>
<tr>
<th>Main strategies</th>
<th>Management/treatment strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) Single strategy</td>
<td>A1) Sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>A2) Composting &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>A3) Biogasification &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>A4) Incineration &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>A5) Recycling &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>A6) Recycling, composting &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>A7) Recycling, biogasification &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>A8) Recycling, incineration &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>A9) Recycling, composting, incineration &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>A10) Recycling, biogas, incineration &amp; sanitary landfilling</td>
</tr>
<tr>
<td>B) Tandem strategy</td>
<td>B1) All waste to mainland</td>
</tr>
<tr>
<td></td>
<td>B2) Recycling &amp; residual waste to mainland</td>
</tr>
<tr>
<td></td>
<td>B3) Local composting &amp; residual waste to mainland</td>
</tr>
<tr>
<td></td>
<td>B4) Recycling, local composting &amp; residual waste to mainland</td>
</tr>
<tr>
<td>C) Joint strategy</td>
<td>C1) Joint sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>C2) Joint composting &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>C3) Joint biogas &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>C4) Joint incineration &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>C5) Recycling &amp; joint sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>C6) Recycling, joint composting &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>C7) Recycling, joint biogas &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>C8) Recycling, joint incineration &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>C9) Recycling, joint composting, incineration &amp; sanitary landfilling</td>
</tr>
<tr>
<td></td>
<td>C10) Recycling, joint biogas, incineration &amp; sanitary landfilling</td>
</tr>
</tbody>
</table>

Table 5.1: Waste management strategies on islands

Table 5.1 represents the alternatives which can be chosen as waste management strategy for an island in Europe. A number of them may be chosen for a screening in order to find the most suitable strategy for the island in question.
5.2 How to Set Up Alternatives

5.2.1 Choice of Waste Prevention Strategy

Initiatives for waste prevention can be taken regardless of the choice of waste treatment strategy. Efforts towards cleaner technologies will be of great interest for islands with industry or other production.

Information campaigns aimed at citizens and tourists will be a helpful tool and are recommended in all cases.

Return systems on islands can be organized by local authorities preparing a plan in cooperation with the companies and shops of the island. Return-systems, if not already established by law, should not give rise to trade and competition distortions.

Return systems can be designed in several ways. Two models are described below. The first one is more traditional, while the second is a future model for a return system which must be regarded in a 10-year perspective.

1. **Return system**

   All shops establish receivers for the various types of packaging and products (paper, cardboard, plastics, glass, aluminium, ferrous metals), which the shop commits to take back. In order to help the citizen in the efforts to duly return the packaging and products, shops ought to co-operate on joint reception, so that the consumer does not necessarily have to return used products or packaging waste to the same shop in which they were bought.

   The waste received should then be delivered to a central receiving centre for discharging. A good way of doing this is to have a number of compacting containers, which will be discharged as they are filled. The receiving centre should be placed as a terminal at the place in which a compacting container for each type of waste is installed. Signs should clearly indicate to which container the individual type of packaging should be delivered, and advisory staff should be present. The containers are picked up by a trolley as they are filled and are transported to the mainland, while a replacement container is erected at the terminal.

   For some waste types such as paper and plastics a small baling press may be advantageous.

   When establishing return systems it is very important to organize reception and treatment of the returned waste.

   The development of reusable or recyclable transport packaging will also contribute to minimizing waste.

   Return systems can also be organized as a (voluntary) agreement between local authorities and the importers and shop owners who operate on the island. The agreement should be made with the trade associations of the companies. If the companies on the
island are not already organized in trade associations, such associations should be established.

If the local authorities are interested, they may choose to establish the required facilities for a return centre themselves as an inspiration to the companies of the island. These investments could be recovered through refuse collection fees.

2. *Minimization of transport packaging and secondary packaging on the island*

This model is based on minimization of packaging waste on the islands. The key component in this model is the erection at the harbour of an unpacking terminal in which all shipped goods for industry, shops, restaurants and households are unpacked from the transport packaging and, when there is no danger of damage to the product, from secondary packaging. The terminal is based on personnel who unpack the goods and place them on the shop racks (see below). The packaging materials are separated and sent to reprocessing plants or to be reused or recycled.

A combination of the two return systems will obviously be possible.

Both for the purpose of financing and stimulating the implementation of return systems, fees or deposits on packaging can be introduced. Fees could finance the return centre and/or the unpacking terminal, while a deposit would stimulate the consumer to deliver their waste to the return centre. Any deposit or fee must be consistent with the applicable legislation.
5.2.2 Choice of the main strategy

The choice of the main strategy is influenced by the geographic, climatic, geological, cultural and political conditions of the specific island:

**Single strategy:**
- Is the island isolated from other islands or the mainland?
- Is the island large enough to contain waste treatment facilities?
- Are the waste amounts large enough to make waste treatment environmentally sustainable and economically feasible?
- Do the hydro-geological conditions allow of establishment of a landfill or other treatment plants?

**Tandem strategy:**
- Is the island located near the mainland?
- Is the island located near a large city or other densely built-up area?
- Does the nearby city/mainland operate a waste treatment system with extra capacity?
- Will co-operation with the nearby city/mainland be possible?

**Joint strategy:**
- Is the island located in an archipelago or close to other islands?
- Will co-operation with the other islands be possible?
- Is it possible to locate the waste treatment plants on one or more of the islands?
Although in some cases only one of the main strategies will be possible, for most islands, two or even all three strategies will be applicable. In this case it is recommended to set up alternatives representing two or three of the main strategies.

5.2.3 Choice of Management/Treatment Strategies

Within the main strategies one or more management/treatment strategies have to be chosen for screening. The criteria for choice of treatment strategies are:

- **The EU and national framework** - does the proposed treatment system meet the content of EU and national waste legislation?

- **The waste data** - is the proposed treatment system suitable for the amounts and composition of the waste generated on the island (cf. 4.1)?

- **The identified problems** (cf. 4.2, 4.3) - does the proposed treatment system meet the identified problems?
5.3 Example of a choice

As an illustration of how to set up alternatives, the set-up of three alternatives for the Greek island Mykonos is shown (1994/95):

Mykonos - Example of a Choice

Mykonos is located in the archipelago of "the Cyclades". It has an area of 87.4 km² and a population of 6,200 in the winter and 30,000 in the summer. The annual waste production is 6,200 tonnes of municipal waste (all landfilled) and 2,400 tonnes of construction and demolition waste (2,100 tonnes of earth and gravel are reused). The waste management can be characterized as a single strategy and the management/treatment practice landfilling.

On the basis of the existing waste management and the problems identified (see section 4.3), it has been decided to examine two management/treatment strategies within a single strategy. One is A6 - recycling, composting and sanitary landfilling and modern equipment.

A tandem strategy is not regarded as possible for Mykonos, mainly due to the geographic location and lack of co-operation with the mainland.

Joint solutions for the islands in the Cyclades may also seem difficult, but the islands have a number of joint interests, e.g. tourism, and the same basic conditions for solving the problems. It would therefore be interesting to examine a joint strategy in further detail. Treatment strategy C9 - recycling, joint composting, incineration and sanitary landfilling - is therefore examined.

Other examples can be found in the study reports listed under References.
6. ORGANIZATION

HOW TO USE THE MANUAL

<table>
<thead>
<tr>
<th>Framework for waste management</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of waste management problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collection and Transportation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact Assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice of Alternative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste Management Plan</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.1 Organization of Waste Management

Waste management on islands may be organized in the following ways:

- Separate collection and transportation carried out by different municipalities; cooperation on treatment
- Establishment of a waste association
- Establishment of an intermunicipal waste management company
- Cooperation between an association/waste management company and private contractors or waste companies for parts of or for the entire waste management

Whether a form of public or private law organization is chosen, needs careful economic and administrative examination.

Modern treatment of waste requires investment to build-up plants and landfills, which also involve high operating costs. Therefore cooperation on the waste treatment facilities will on most islands be inevitable. Local authorities on the island can choose to perform collection and transportation separately and restrict cooperation to treatment and disposal. Depending on the local geographic characteristics of the island, cooperation on collection and transportation might save costs for purchase of vehicles and reduce the transport charges through a better utilization of the vehicles.

Cooperation between local authorities can be organized as an association or as an intermunicipal waste management company.

An association of local authorities can elect a person responsible for waste management and set up a Waste Management Unit for the purpose of promoting joint waste solutions and gradually take on the tasks which have been given priority, so that planning and administra-
tion of waste management gradually takes the character of a publicly owned and managed intermunicipal waste management company.

Cooperation on waste management may involve:

- Planning of the waste management - outlining of standards for containers, collection schemes, transport scheduling, treatment objectives and monitoring
- Establishment and operation of igloos, recycling centres, selective collection centres, compaction facilities, treatment and disposal plants
- Performance of collection and transportation
- Performance of cooperation with private contractors and companies on parts of the waste management
- Levying of waste taxes and fees and payment of expenditure
- Elaboration of local regulations

Matters to be resolved by public authorities in connection with a waste association or an intermunicipal waste management company are listed below:

- Share of competences between the cooperation scheme put in place and the Waste Management Unit
- Share of responsibilities between the association/intermunicipal waste management company and the local authorities
- Allocation of revenues and expenditures between the local authorities
- Cooperation with private carriers and contractors within the waste management sector
- Responsibility for control and supervision

*Share of competences between the cooperation scheme put in place and the Waste Management Unit*

Depending on the number of local authorities participating in the cooperation scheme, it may be a disadvantage if all matters and initiatives are to be discussed and resolved unanimously. Rapid decisional procedures should be taken into account.

*Share of responsibility between the association/intermunicipal waste management company and the local authorities*

The responsibility for local waste disposal depends on national legislation. In general, it lies with the local authorities. If future tasks are allocated to the Waste Management Unit or an intermunicipal waste management company, the allocation of responsibility should be clearly defined. The inhabitants have a right to know who is responsible for a given activity. The possibilities of the local authorities to fix fees, rates and taxes for collection and disposal of waste should be investigated to elaborate clear and precise regulations applicable by the local authorities.
Allocation of revenues and expenditures between the local authorities

Small municipalities or communities with limited means should be given a guarantee that insurmountable expenditure will not be imposed on them as a consequence of majority decisions. In practice, this can be ensured by implementing joint collection and treatment systems at different rates so that municipalities or communities making a request for a slower pace can be integrated into the system without difficulty, later on.

Cooperation with private carriers and contractors within waste management

A waste association or an intermunicipal waste management company may cooperate with private contractors or waste management companies on part or on all waste management. The association/intermunicipal waste management company may call for tenders on collection and transportation or on certain waste treatment or even on the entire waste management. Advantages and disadvantages of such a cooperation are further discussed in section 6.2.

Responsibility for independent control and supervision

On many islands the supervision by public authorities lacks efficiency. Therefore the supervision activities should be strengthened in order to ensure that new initiatives in the waste management area actually achieve the targeted results and do not create frustrations among the local population and tourists.
6.2 How to Choose an Organization System

Table 6.1 presents an overview of advantages and disadvantages of the organizational options presented in section 6.1.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate collection and transportation</td>
<td>- Local control of collection and transport standards</td>
<td>- Lack of coordination</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- More vehicles necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Often more expensive than cooperation</td>
</tr>
<tr>
<td>Waste association</td>
<td>- Cooperation allows environmentally better and more effective waste management</td>
<td>- Controlling body and contract of cooperation are required</td>
</tr>
<tr>
<td></td>
<td>- Close contact with public administrations and politicians and therefore flexible to political demands and decisions</td>
<td>- Experience of cooperation between municipalities and communities might be very limited and require a change of attitude among the politicians</td>
</tr>
<tr>
<td></td>
<td>- Experience of operation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Tradition for considerations of total systems will be combined with goal-oriented activities</td>
<td></td>
</tr>
<tr>
<td>Intermunicipal waste management company</td>
<td>- Cooperation allows environmentally better and more effective waste management</td>
<td>- Controlling body and contract of cooperation are required</td>
</tr>
<tr>
<td></td>
<td>- Close contact with public administration and politicians and therefore flexible to political demands and decisions</td>
<td>- Experience of cooperation between municipalities and communities might be very limited and require a change of attitude among the politicians</td>
</tr>
<tr>
<td></td>
<td>- Experience of operation, procurement and marketing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Incentives for economic efficiency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Risk capital for investment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Incentives for investment in new and environmentally better equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Tradition for considerations of total systems will be combined with goal-oriented activities</td>
<td></td>
</tr>
<tr>
<td>Cooperation with private contractors/companies</td>
<td>- Experience of operation, procurement and marketing</td>
<td>- Controlling body and detailed contracts are required</td>
</tr>
<tr>
<td></td>
<td>- Risk capital for investment</td>
<td>- Bankruptcy might be a threat to the daily disposal and long-term responsibility</td>
</tr>
<tr>
<td></td>
<td>- Incentives for economic efficiency</td>
<td>- Investors require long-term guarantees for prices and contracts</td>
</tr>
<tr>
<td></td>
<td>- Income will depend on technically suitable equipment and therefore lead to investment in new and environmentally better equipment</td>
<td>- Private companies might monopolize the waste management</td>
</tr>
</tbody>
</table>

Table 6.1: Advantages and disadvantages of organizational options

40
6.3 Example of an Organisation System

As examples on organisations on islands, two existing organisations - the one of the island of Zante (Greece) and the one of the island of Bornholm (Denmark) - and a recommended organisation - on the island of Kos (Greece) - are presented.

---

Zante - example of an organisation system

On the Greek island of Zante an intermunicipal association comprising the municipality and all 46 communities was formed in 1987.

The intermunicipal association employs 1 secretary and a force of 15 temporary staff employed in winter and 30 in summer for the collection and transportation of waste.

The intermunicipal association is responsible for waste collection and transportation in these municipalities/communities. In this way collection and transportation can be performed by 6 refuse collection vehicles in the communities and 3 vehicles in the municipality of Zante.

The intermunicipal association has also established collection of bulky waste biannually.

The intermunicipal association is responsible for the operation of a joint landfill which makes the performance of a sanitary landfill possible. The method actually used is semi-controlled disposal. One employee works at the landfill.

A recycling programme is carried out by the intermunicipal association. Igloos for paper and aluminium are placed in central sites and in tourist areas and a recycling centre is established in the municipality of Zante with 1 employee.

---

1994/95
**Bornholm - Example of an organisation**

Bornholm is an island with 45,000 inhabitants. The island is divided in 5 municipalities. The 5 municipalities have formed an inter-municipal waste management company called BOFA I/S. The tasks of BOFA I/S are:

- Organization of collection of household waste and hazardous waste
- Design of contracts with private contractors on collection and transportation
- Operation of municipal recycling stations and selective collection sites for hazardous wastes
- Upgrading and sale of recyclable materials
- Operation of incineration plant, composting facilities and sanitary landfill
- Current administration of the waste management
- Preparation of municipal waste management plan(s)

The organization of BOFA I/S ensures a well-functioning and economically feasible waste management system of a high standard.

**Kos - Example of a proposed organisation**

In the study, Kos is recommended to establish a waste management unit covering the entire island. The tasks of the unit should be:

- Servicing of small and remote communities which are not capable to dealing with waste management issues on their own
- Elimination of open dumping of waste
- Application of sanitary landfilling
- Optimization of collection, transport, treatment and disposal operations
- Improved planning and implementation of waste reduction initiatives such as recycling, separation and treatment of special wastes.

The waste management unit can also be involved in other activities such as cleaning service, information on waste, cooperation with other islands of the Prefecture and the seeking of funding from Government and EU programmes.

The waste management unit should be a part of a Confederation of municipalities and communities on Kos and it should refer to the board of the confederation.

1994/95

Other examples can be found in the study reports listed under References.
7. ECONOMY

7.1 EU Funding Opportunities for Waste Management Projects

Funding of waste management-related activities and projects is primarily the task of the authorities in the Member States. According to Article 130 S (4) of the EU Treaty, Member States are in principle responsible for financing and implementing environmental policies. However, besides national funding, which is of the utmost importance, some EU funding opportunities exist, and may be used to support and facilitate the implementation of environmental actions and programmes.

The main European Community sources of financial support for environmental projects and infrastructure, referring, in particular, to waste management are presented in this section.

For further detail, the document entitled "EU Financial Instruments for the Environment"\(^{29}\) should be consulted. This document contains a summary of the different budgetlines which are relevant to the environment, the amounts available, the duration of programmes, the eligibility to funding and information regarding possible contact services at the Commission.

The main financial sources for waste management projects in the Community are:

- *Structural Fund and Cohesion Fund*

Both the European Regional Development Fund and the Cohesion Fund may participate in the financing of projects which relate to the environmental sectors, including waste management (up to a relatively high percentage - 85%). These funds are not directly administered by the Commission but by the competent national authorities.

\(^{29}\) (ISBN 92-827-0144-1)
- *Sector-specific financial instruments* (e.g. LIFE, SAVE, 7th Environmental Research Programme).

These are funds which require direct administration by the Commission, often in cooperation with the Member States.

- *European Investment Bank*

EIB contributions to environmental projects mostly take the form of low interest rate loans.

There may be other possibilities, such as the co-financing of environmental projects in the frame of financial help to third countries. However, an exhaustive illustration of the financing possibilities in this field falls beyond this presentation.

**7.1.1 STRUCTURAL FUNDS AND COHESION FUND**

**7.1.1.1 Structural Funds**

Structural funds have been part of the Community action for many years, and their legal basis has been successively revised.


A total of 141,471 MECU (million ECU) is available, subdivided as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>MECU</th>
<th>Year</th>
<th>MECU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>20,135</td>
<td>1997</td>
<td>24,026</td>
</tr>
<tr>
<td>1995</td>
<td>21,480</td>
<td>1998</td>
<td>25,690</td>
</tr>
<tr>
<td>1996</td>
<td>22,740</td>
<td>1999</td>
<td>27,400</td>
</tr>
</tbody>
</table>

In order to better appreciate the amount of money available through these funds it should be reminded that the entire 1995 EU budget amounts to nearly 80,000 MECU.

In the framework of the Structural Funds, there are three main sources of finance:

* The European Social Fund (ESF),
* The European Regional Development Fund (ERDF),
* The European Agricultural Guidance and Guarantee Fund, Section Guidance (EAGGF).

In 1993 a new Financial Instrument for Fisheries Guidance (FIFG) was created.

---

\(^{30}\) O.J. L 193, 31.7.1993, p.5
All these Funds aim at strengthening economic and social cohesion and to help the poorer regions of the Community.

These financial instruments work through six objectives which, after the amendments made in 1993, include:

**Objective 1:**
Promoting the development and structural adjustment of regions whose development is lagging behind, that is, where GDP is below 75% of the EU average (ERDF, ESF, EAGGF). Funds available for Objective 1 regions (1994 to 1999): 96,346 MECU.

**Objective 2**
Restructuring of regions, frontier regions or parts of regions seriously affected by industrial decline.

Funds available for Objective 2 regions (1994 to 1999): 15,316 MECU.

**Objective 3**
Combatting long-term unemployment, facilitating the integration of young people into working life and aiding persons threatened with exclusion from the labour market (ESF).

**Objective 4**
Facilitating the adaptation of workers to industrial changes and to changes in production systems (ESF).

Funds available for Objective 3 and 4 regions (1994 to 1999): 1,584 MECU

**Objective 5**
Promoting rural development by:

a) speeding up the adjustment of agricultural structures in the framework of the reform of the Common Agricultural Policy, and aid to modernize and restructure fisheries (EAGGF and FIFG) and

b) facilitating the development and structural adjustment of rural areas (EAGGF, ESF and ERDF).

Funds available (1994 to 1999) for 5a: 6,143 MECU; and for 5b: 6,296 MECU.

Objectives 3 and 4 apply to the whole EU territory, while objectives 1, 2 and 5 only apply to specific regions.

Objective 1 concerns regions mainly in the South (Greece, Southern Italy, Corsica, Portugal and a major part of Spain) as well as several regions in the North (Ireland, Northern Ireland, Highlands and Islands, Merseyside and Islands Enterprise Area in the UK, parts of Belgium and of the Netherlands - Hainaut and Flevoland - the new German states, the French overseas departments, as well as the Madeira, Azores and Canary Archipelagos).
Concerning waste management, infrastructure may be financed mainly by the ERDF under the condition that projects are related to regional development. In other words, projects must represent a productive investment for regional development; the financing of projects for the exclusive compliance with environmental legislation is not directly eligible in the framework of the ERDF.

EU financing can go up to 75% of the total eligible cost in the case of Objective 1 regions projects.

As the funds are intended to reinforce rather than replace Member State activities, they are administered by the Member States themselves through two principal channels:

i. the Community Support Frameworks (CSF).
ii. the Community Initiative Programmes (CIP).

The objectives and priorities of both the Community Support Frameworks and the Community Initiative Programmes are implemented through Operational Programmes. The measures contained in the operational programmes are translated into action through individual projects. The regional authorities submit their proposals to the national coordinator in each country, who is finally responsible for delivery of the proposals to the Commission and subsequent financing of the accepted proposals.

Examples of current Community Initiative Programmes with a waste management component are: INTERREG II and REGIS II

**INTERREG II**
This initiative aims at assisting both internal and external border regions of the European Union in overcoming the special development problems arising from their relative isolation within national economies and within the Union as a whole, in the interests of the local population and in a manner compatible with the protection of the environment.

It must be stressed that the INTERREG II initiative considers the participation of regional and local authorities to be very important for the correct and successful implementation of the actions to be proposed.

This initiative is implemented under two distinct channels:

- cross-border cooperation
- completion of energy networks.

The first, which may be of more interest for waste management projects, includes among eligible measures the following:

* Pollution prevention and control, waste disposal, environmental conservation programmes, monitoring of environmental standards of new industries located in border areas.
* Agricultural waste disposal
Member States have already started submitting detailed proposals for Operational Programmes or amendments to existing or proposed Operational Programmes or projects in application to Community Support Frameworks. Several Operational Programmes are now in the process of being approved. All land borders of the EU are eligible, as well as certain specified maritime borders. The total budget for \textit{INTERREG II} is 2.9 BECU (billion ECU) of which 2.3 BECU are reserved for Objective 1 Regions.

\textit{REGIS II}

This initiative is a framework in which all other initiatives can be used when applied to specific "ultraperipheral" areas. Therefore the eligible regions should apply to Community Initiative Programmes via \textit{REGIS II} (except in very particular cases, where initiatives may be directly applied). This allows for a better coordination of the financial support given to such areas through the different Community Initiative Programmes.

"Ultraperipheral" areas included in \textit{REGIS II} are: the French overseas territories and departments, the Azores, Madeira and the Canary archipelagos.

Specific objectives are the promotion of economic diversity, improved links with the EU and cooperation between ultraperipheral regions and between their immediate, non-EU neighbours. The budget is equal to 0.6 BECU (billion ECU).

\textit{REGIS II} replaces the previous \textit{POSEIDOM, POSEICAN, and POSEIMA programmes.}

Eligible environmental measures include, among others:

- small scale water resources management projects;
- nature conservation.

Rates of support:
Up to 50\% of total cost for Objectives 2 to 4 and 5b and 75\% for interventions in aid of Objective 1.

In exceptional circumstances, use of the Structural Funds in Objective 1 regions of the four Member States benefitting from the cohesion financial instrument, could go up to 80\% or even to 100\% of the total cost.

\textbf{7.1.1.2 Cohesion Fund}

Article 130 d of the EC Treaty provides for a cohesion fund, since it was considered that the promotion of economic and social cohesion required supplementary action, besides that already carried out through the Structural Funds, in particular, such supplementary action was considered necessary in the fields of environment and transport infrastructures of common interest.

The Cohesion Fund is so-called in that its objective is social and economic cohesion within the Union.
The Fund applies to those Member States with GDP lower than 90% of the Community average, namely (at least until 1999) Greece, Spain, Ireland and Portugal.

Projects are evaluated individually, and the national authorities are responsible for the internal coordination and the submission of project proposals to the Commission for financing.

A total of 15.150 BECU (billion ECU) is available, subdivided as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>1.5</td>
</tr>
<tr>
<td>1994</td>
<td>1.75</td>
</tr>
<tr>
<td>1995</td>
<td>2</td>
</tr>
<tr>
<td>1996</td>
<td>2.25</td>
</tr>
<tr>
<td>1997</td>
<td>2.5</td>
</tr>
<tr>
<td>1998</td>
<td>2.55</td>
</tr>
</tbody>
</table>

Its environmental aim is to finance projects which are consistent with the goals of the Community environmental policy. Typical environmental projects include:

- water supply infrastructure;
- wastewater treatment;
- urban waste treatment;
- nature conservation.

The rates of support are:
* between 80 % and 85 % of public sector spending.
* for studies: 100 % in exceptional cases.

Eligibility: Projects are presented by the national governments and scrutinized and approved by the Commission.

7.1.2 SECTOR-SPECIFIC FINANCIAL INSTRUMENTS

7.1.2.1 Environment

Within sector-specific financial instruments, the most important environment specific financial instrument is LIFE, another possible Community source for projects concerning the management of wastes.

The general objective of LIFE is to contribute to the development and implementation of current Community environmental policy and legislation by financing demonstration projects, being given to priority environmental actions in the Community, and then to technical assistance actions involving third countries in the Mediterranean region or bordering the Baltic Sea.

The LIFE Regulation of 1992 replaced the former ACNAT, MEDSPA and NORSPA Regulations.

Financial resources available are modest, in comparison to the resources allocated by other funds.
Total finance available amounts to 400 MECU (Budget 1994 : 100.275 MECU)

Proposed solutions to environmental problems for which LIFE financing is requested, must be of an innovative character and of Community-wide interest. To make the best use of LIFE it is important to concentrate resources to allow demonstration-scale actions.

Each year the Commission chooses the priority fields within which it wishes to receive project proposals to be financed by LIFE.

For 1995, the priority fields included:
- promotion of sustainable development and the quality of the environment;
- protection of habitats and nature;
- administrative structures and environment services;
- education, training and information;
- action outside Community territories.

In particular, the priorities for LIFE in 1995 cover projects aimed at devising and developing techniques for the collection, storage, recycling and disposal of waste, particularly toxic and dangerous waste and waste water.

Projects are transmitted to the Commission by the beneficiaries via the corresponding Ministry of the Environment. As LIFE, in its present form, expired in December 1995, a new regulation was proposed for 1996, which shall allow the programme to continue essentially along the same lines.

Financial support granted by LIFE is subject to the following maximum limits:

* 30 % of the cost in the case of income-generating projects;
* 50 % of the cost of other actions and, exceptionally, 75% of the cost of actions relating to protection of nature (species, habitats, biotopes);
* Up to 100 % of the cost of technical assistance to Third countries, or for collecting information necessary for the execution of actions adopted on the pre-initiative of the Commission.

The Commission does not accept demonstration projects whose global cost is above 10 MECU or below 200.000 ECU.

LIFE is open to all "natural or legal persons". Applications are transmitted to the Commission by the Member States; however, in the field of new technologies the Commission may publish an open call for submissions in the Official Journal of the European Community. To select projects for financing, the Commission is assisted by a Committee composed of representatives of the Member States. This Committee also fixes the allocation of funding to different fields of action.

Examples of other environmental financial sources, but with a more limited budget, are:

* ENVIRONMENTAL INFORMATION AND AWARENESS-RAISING ACTIVITIES
(5 MECU)

* EUROPEAN ENVIRONMENTAL ORGANIZATIONS - FINANCIAL SUPPORT
(1 MECU)
* ENVIRONMENTAL EDUCATION (1 MECU)

7.1.2.2. Other Sectors

7.1.2.2.1 Instruments in the Energy Sector

The two most important instruments in the energy sector are SAVE and ALTENER.

SAVE aims at the promotion of energy efficiency throughout the EU thus contributing to a better use of resources as well as assisting in the realisation of the Community’s environmental objectives.

ALTENER supports specific actions which promote the establishment of renewable energy. Of the two, ALTENER, offers better possibilities in the field of waste management.

ALTENER supports specific actions which promote the establishment of renewable energy, such as:

a) Technical studies and evaluations intended to define norms and technical specifications;

b) Measures for the creation or enlargement of renewable energy infrastructures, including waste;

c) Measures to encourage the creation of information networks with a view to promoting better coordination between national, international and Community activities;

d) Studies, evaluations and actions focused on technical, economic and environmental possibilities offered by the industrial development of ‘biomass’ energy.

Finance available equals 40 MECU

Eligibility: Member States (national, regional and local bodies)

7.1.2.2.2 Instruments in the R&D Sector

7TH ENVIRONMENTAL RESEARCH PROGRAMME

Finance available : 532 MECU
Examples of areas covered by the proposed programme include, among others :

i) Research into the natural environment, environmental quality and global change

ii) Environmental technologies, among which we may recall those intended for :
* Sustainable development and technological change
* Technologies and methods to protect the environment

7.1.2.2.3 Instruments in the Consumers’ Sector

SUSTAINABLE CONSUMPTION

This instrument was created in 1993 at the initiative of the European Parliament in order to promote actions in favour of sustainable consumption. Its objective is to encourage consumers to reduce or abandon consumption habits which have negative effects on the environment and to develop more environmentally aware and sustainable consumption patterns.

Finance available: 850,000 ECU

7.1.3. THE EUROPEAN INVESTMENT BANK

The European Investment Bank (EIB) was established in 1957 by the Treaty of Rome as the "house-bank" of the European Community.

The EIB grants loans for projects contributing to the development of the less prosperous regions of the Community.

According to EIB information, 15% of its total lending is destined to environmental projects, with priority actions in the field of:
- urban environment,
- reduction of CO₂ emissions and improving air and water quality.

In 1993, 2127 MECU (50%) of the total environmental lending was directed at improving drinking water supplies and to the collection and treatment of wastewater.

The EIB, although ancillary to investment decisions, can play an important role in influencing investment decisions and by placing conditions on loans.

The main challenge faced today by the EIB is the conflict between increasing pressure to lend and unclear lending criteria vis-à-vis sustainable development.

Its method of financing is twofold:

- direct support of large projects;
- granting global loans to secondary financial institutions or banks. These intermediaries are able to extend credit to those small and medium sized operations which are too small to have direct access to the EIB.

Eligibility: public and private sector projects.
7.2 How to use economic evaluation for screening

It is advantageous to do an economic evaluation of the waste management strategy alternatives prior to the choice of a certain waste management strategy. The principle of the economic screening is to provide a picture of the annual costs of a fully implemented strategy. The costs in question comprise both those of investments and of operation.

Investments:

The investment needed for a fully implemented strategy must be drawn up. This involves (not all units will be included in all alternatives):

Collection
- Receptacles (cf. chapter 8.2)
- Igloos
- Selective collection centre(s)
- Recycling centre(s)

Transportation
- Refuse collection vehicles
- Other vehicles
- Transfer station
- Compaction equipment
- Sea transport

Recycling:
- Central sorting centre(s)
- Compaction equipment

Composting:
- Plant and buildings
- Technical equipment
- Vehicular equipment

Biogasification:
- Plant and buildings
- Composting facilities
- Technical equipment
- Vehicular equipment

Incineration:
- Plant and buildings
- Furnace and boiler system
- Turbine and generator system
- Flue gas treatment system
- Vehicular equipment
Landfilling:
  - Fences and banks
  - Leachate and cutoff drains
  - Liners
  - Gas ventilation system
  - Monitoring system
  - Weighbridge
  - Compactor
  - Other vehicular equipment
  - Buildings
  - Final covering

All investments must be specified with regards to book depreciation. This will be the expected lifetime for plants and landfills and typically 5-10 years for equipment.

Investments can then be specified annually when the interest burden is calculated. Result: annual investment expenses.

Costs of operation:

In addition to the investment expenses, the annual costs of operation must be estimated. This involves:

  - Collection and transportation of household waste
  - Collection and transportation of industrial waste
  - Collection and transportation of recyclables (from igloos)
  - Operation of recycling centre(s)
  - Operation of selective collection centre(s)
  - Transfer and compaction
  - Central sorting
  - Sea transport
  - Composting
  - Biogasification
  - Incineration
  - Landfilling
  - Administration

Income:

The annual income from sale of products from the waste management must be estimated. This involves:

  - Income from sale of recyclable materials
  - Income from sale of compost/soil improver
  - Income from sale of energy

Total costs:

The annual investment expenses, the annual costs of operation and the annual income are then assembled in a table which makes a comparison between the alternatives possible.
7.3 Example of a screening

As an example of an economic screening of three alternatives (cf. section 5.3) and the present waste management, the screening of alternatives on the Greek island of Mykonos (performed by Ramboll) is shown (calculations with interest of 7.5% annually) (1994/95):

<table>
<thead>
<tr>
<th>MYKONOS Expenses in 1000 ECU</th>
<th>Present situation</th>
<th>Alternative I</th>
<th>Alternative II</th>
<th>Alternative III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>-</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Collection and transportation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 1,100-litre containers</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>60</td>
</tr>
<tr>
<td>3 rear end loaders, 1 platform lorry, 1 tricycle</td>
<td>258</td>
<td>258</td>
<td>258</td>
<td></td>
</tr>
<tr>
<td>2 selective collection centres / recycling centres</td>
<td>93</td>
<td>93</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Baling press</td>
<td>-</td>
<td>15</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Compactor with 5 containers</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>57</td>
</tr>
<tr>
<td>Barge/vessel(^{1})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Total investments</td>
<td>-</td>
<td>409</td>
<td>424</td>
<td>473</td>
</tr>
<tr>
<td>Annual investment expenses</td>
<td>-</td>
<td>60</td>
<td>62</td>
<td>69</td>
</tr>
<tr>
<td>Annual costs of operation - collection and transport</td>
<td>211</td>
<td>150</td>
<td>100</td>
<td>160</td>
</tr>
<tr>
<td>Annual costs of operation - collection centres</td>
<td>-</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Total annual costs of operation</td>
<td>211</td>
<td>162</td>
<td>112</td>
<td>172</td>
</tr>
<tr>
<td>Recycling - income from sale of materials</td>
<td>-</td>
<td>67</td>
<td>61</td>
<td>67</td>
</tr>
<tr>
<td>Landfilling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landfill investments(^{1})</td>
<td>-</td>
<td>570</td>
<td>-</td>
<td>64</td>
</tr>
<tr>
<td>Compactor/front end loader(^{1})</td>
<td>-</td>
<td>165</td>
<td>-</td>
<td>30</td>
</tr>
<tr>
<td>Total investments</td>
<td>-</td>
<td>735</td>
<td>-</td>
<td>94</td>
</tr>
<tr>
<td>Annual investment expenses</td>
<td>-</td>
<td>83</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>Total annual costs of operation</td>
<td>-</td>
<td>140</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>Central composting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investments for plant(^{1})</td>
<td>-</td>
<td>164</td>
<td>164</td>
<td>273</td>
</tr>
<tr>
<td>Crusher, windrow tedder &amp; tractor</td>
<td>-</td>
<td>230</td>
<td>230</td>
<td>-</td>
</tr>
<tr>
<td>Drum screen</td>
<td>-</td>
<td>80</td>
<td>80</td>
<td>-</td>
</tr>
<tr>
<td>Total investments</td>
<td>-</td>
<td>474</td>
<td>474</td>
<td>273</td>
</tr>
<tr>
<td>Annual investment expenses</td>
<td>-</td>
<td>69</td>
<td>69</td>
<td>31</td>
</tr>
<tr>
<td>Total annual costs of operation</td>
<td>-</td>
<td>120</td>
<td>120</td>
<td>55</td>
</tr>
<tr>
<td>Income from sale of compost</td>
<td>-</td>
<td>50</td>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>Incineration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investments for plant and buildings(^{1})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>730</td>
</tr>
<tr>
<td>Investments for furnace and boiler system(^{1})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>820</td>
</tr>
<tr>
<td>Investments for turbine and generator system(^{1})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>450</td>
</tr>
<tr>
<td>Investments for flue gas cleaning system(^{1})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>270</td>
</tr>
<tr>
<td>Total investments(^{1})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2,270</td>
</tr>
<tr>
<td>Annual investment expenses(^{1})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>257</td>
</tr>
<tr>
<td>Total annual costs of operation(^{1})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>227</td>
</tr>
<tr>
<td>Income from sale of energy</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>200</td>
</tr>
<tr>
<td>Total annual expenses</td>
<td>211</td>
<td>537</td>
<td>272</td>
<td>563</td>
</tr>
</tbody>
</table>

\(^{1}\) Expenses in alternative III equally divided by 11 participating islands - the listed expenses are those for Mykonos.

Other examples can be found in the study reports under References.
8. COLLECTION AND TRANSPORTATION

8.1 Collection and Transport Systems and Technologies

8.1.1 Collection and Transport Systems

A wide variety of storage equipment is used for the collection of solid wastes. In particular, specific containers are used for hazardous wastes and/or wastes containing toxic fractions. Similarly, a large variety of transport means are used for the transportation of solid wastes. The choice of both collection and transport systems should suit the waste treatment and disposal facilities. The key factors for collection and transport systems are:

- Number of fractions
- Source separation or central separation
- Fractions covered by kerbside collection (glossary in Appendix A)
- Fractions covered by bring systems (glossary in Appendix A)
- Fractions covered by instructions (glossary in Appendix A)
- Transfer station for waste to be exported from the island
- Storage facilities

8.1.2 Collection Systems and Techniques

Table 8.1, shows the collection systems which are applicable on islands. The table is divided into 3 main parts:

1) Collection systems (collection at source),
2) Bring systems (central collection sites) and
3) Instructions (instructions of delivery directly to treatment plants)
For each collection system the applicable sources (household waste, industrial waste, construction waste and problematic wastes) and the applicable fractions are stated together with a short description of the collection method.

Table 8.2, lists and describes the characteristics of the receptacles which are of use for the above collection systems.

<table>
<thead>
<tr>
<th>System</th>
<th>Sources</th>
<th>Fractions</th>
<th>Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully mingled collection</td>
<td>household waste</td>
<td>all fractions</td>
<td>Collection of waste without source separation. Waste is collected in 100-150 litres plastic or paper sacks or in 100-300 litre containers. The waste can if desired be sorted centrally.</td>
</tr>
<tr>
<td>&quot;No container&quot; collection</td>
<td>household waste</td>
<td>paper textile</td>
<td>Collection without use of containers - usually performed by scouts, charity organizations etc.</td>
</tr>
<tr>
<td>&quot;Blue box collection&quot;</td>
<td>household waste</td>
<td>organic waste recyclables residual waste</td>
<td>Separate collection of each fraction. Municipal and organic waste in 100-150 litre paper sacks, plastic sacks or minicontainers. Recyclables in 50-100 litre containers. Special vehicles for recyclables.</td>
</tr>
<tr>
<td>&quot;Co-collection&quot;</td>
<td>household waste</td>
<td>organic waste recyclables residual waste</td>
<td>Collection of more fractions in one vehicle - i.e. a vertically split compactor vehicle or a compactor vehicle with separate lockers. Waste collected in paper sacks, plastic sacks or minicontainers.</td>
</tr>
<tr>
<td>Multifamily unit collection</td>
<td>household waste</td>
<td>organic waste recyclables residual waste</td>
<td>Collection as the &quot;blue box system&quot;, but with larger units (300 - 1,100 litre wheeled containers)</td>
</tr>
<tr>
<td>Co-mingled collection</td>
<td>household waste</td>
<td>organic waste residual waste</td>
<td>Organic waste for composting in green plastic bags and residual waste in black bags is collected from the same container in one vehicle. The bags are then sorted centrally (automatically)</td>
</tr>
</tbody>
</table>

Bring systems (used only for single fractions):

<table>
<thead>
<tr>
<th>System</th>
<th>Sources</th>
<th>Fractions</th>
<th>Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Igloo system</td>
<td>household waste</td>
<td>glass, paper aluminium cans electric batteries used oils</td>
<td>Specially designed igloo containers located at shopping centres, typically 2.5-4 m². Collection by vehicles with a crane.</td>
</tr>
<tr>
<td>Recycling centres</td>
<td>household waste</td>
<td>recyclables garden waste bulky waste</td>
<td>Maxi containers (12-20 m²) located in a centre, normally manned. Containers for paper and other light materials can be compacting containers</td>
</tr>
<tr>
<td>Collection stations</td>
<td>household waste</td>
<td>oil waste hazardous waste problematic wastes</td>
<td>Manned stations with casks of metal or plastic for reception of hazardous waste</td>
</tr>
<tr>
<td>Instructions</td>
<td>industrial waste</td>
<td>all fractions</td>
<td>Industries, constructors or possessors of problematic wastes are instructed to deliver waste directly to the waste treatment plants</td>
</tr>
</tbody>
</table>

Table 8.1: Collection systems
<table>
<thead>
<tr>
<th>Type</th>
<th>Material(s) of construction</th>
<th>Range of size</th>
<th>Wheels</th>
<th>Lid</th>
<th>Applicable for</th>
<th>Collection vehicle</th>
<th>Average lifetime (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sack ²</td>
<td>Paper, plastic</td>
<td>90-150 l</td>
<td>No</td>
<td>Yes on holder</td>
<td>All</td>
<td>All, except FEL</td>
<td>25 (holder)</td>
</tr>
<tr>
<td>Bin</td>
<td>Plastic, steel</td>
<td>50-120 l</td>
<td>No</td>
<td>Yes</td>
<td>All</td>
<td>REL, SL</td>
<td>7</td>
</tr>
<tr>
<td>Wheeled bin</td>
<td>Plastic, steel</td>
<td>120-240 l</td>
<td>Yes (2)</td>
<td>Yes</td>
<td>All</td>
<td>REL, SL - lifting device required</td>
<td>7</td>
</tr>
<tr>
<td>Mini-container</td>
<td>Plastic, glass fibre, steel</td>
<td>0.4-1.5 m³</td>
<td>Yes (4)</td>
<td>Yes</td>
<td>All</td>
<td>REL, SL - lifting device required</td>
<td>7</td>
</tr>
<tr>
<td>Midi-container</td>
<td>Steel</td>
<td>1.5-10 m³</td>
<td>No</td>
<td>Yes</td>
<td>All</td>
<td>REL, FEL - lifting device required</td>
<td>7</td>
</tr>
<tr>
<td>Maxi-container</td>
<td>Steel</td>
<td>8-30 m³</td>
<td>No</td>
<td>Yes</td>
<td>All</td>
<td>SV/R-R</td>
<td>7</td>
</tr>
<tr>
<td><strong>Source-separated materials (Bring systems):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cassette/carton</td>
<td>Cardboard, plastic</td>
<td>25-50 l</td>
<td>No</td>
<td>Yes</td>
<td>Dry components</td>
<td>Multicompart ment truck</td>
<td>1 : 5</td>
</tr>
<tr>
<td>Glass container</td>
<td>Plastic, glass fibre, steel</td>
<td>1.5-3.0 m³</td>
<td>No</td>
<td>No, one or more holes</td>
<td>Mixed or colour separated glass</td>
<td>Truck with crane</td>
<td>7</td>
</tr>
<tr>
<td>Paper container</td>
<td>Plastic, glass fibre, steel</td>
<td>1.5-3.0 m³</td>
<td>No</td>
<td>No, one or more holes</td>
<td>Recyclable paper and cardboard</td>
<td>Truck with crane</td>
<td>7</td>
</tr>
<tr>
<td>Multi-compartment container</td>
<td>Plastic, glass fibre, steel</td>
<td>1.5-3.0 m³</td>
<td>No</td>
<td>No, two or more holes</td>
<td>Recyclable dry components</td>
<td>Truck with crane and separate compartments</td>
<td>7</td>
</tr>
<tr>
<td>Multi-compartment container</td>
<td>Steel</td>
<td>8-24 m³</td>
<td>No</td>
<td>No, two or more holes</td>
<td>Recyclable dry components</td>
<td>R-R/SV</td>
<td>7</td>
</tr>
<tr>
<td>Battery container</td>
<td>Cardboard, plastic</td>
<td>25-50 l</td>
<td>No</td>
<td>No, one or more holes</td>
<td>All small batteries</td>
<td>Vehicle w. small container</td>
<td>5</td>
</tr>
<tr>
<td>Oil cask</td>
<td>Steel</td>
<td>100-600 l</td>
<td>No</td>
<td>No, one or more holes</td>
<td>Waste oil</td>
<td>Tank lorry</td>
<td>7</td>
</tr>
</tbody>
</table>

**Legend:**<br>REL: Rear End Loader  SV: Skip Vehicle  FEL: Front End Loader  R-R: Roll-on/Roll-off  SL: Side Loader

**Note:** If sacks are used for waste collection, they must be situated in a holder which will protect the sack from heavy winds, heavy precipitation and from animals. Holders are normally made of steel, but may also be made of wood.

**Table 8.2: Examples of collection receptacles**
On islands, combinations of collection systems and equipment shown in tables 8.1 and 8.2 must often be chosen. In areas of the island with difficult access - e.g. villages with steep and narrow streets and scattered settlements without proper roads - a first collection by cart or some special vehicle might be the solution, followed by a transfer to some kind of refuse collection vehicle. The transfer station may in this case be a station with mini-containers (600-1,100 litres), which can be emptied into a refuse collection vehicle, or instead to midi- or maxicontainers which can be collected by a haul vehicle (roll on/roll off principle). In both cases, the containers must be located in a way as to facilitate emptying of waste from carts or any other special vehicle. This can be done by the use of platforms.

On larger islands with greater transport distances, transfer of waste collected in refuse collection vehicles might be considered as well. Transfer is further discussed in section 8.1.4.

8.1.3 Transport Technology

Depending on local conditions such as wages, transport distances and roads and road systems, it is usually most advantageous to collect waste in modern waste collection trucks with compacting. Such trucks are equipped with a hydraulic piston, which compacts the waste, or they are equipped with a rotating propeller for the same purpose. The hydraulic piston trucks are more sturdy dealing with large items and often have a higher compaction rate (normally up to 1:6), but for some separated and elastic wastes, the rotating propeller trucks present a better compaction.

Furthermore, modern waste collection trucks are equipped with an automatic lifter/elevator for emptying the containers. In case the waste is to be treated on the island, reloading will not be necessary. Waste collection trucks of 10-16 m³ with a capacity of 3-7 tonnes of waste would be advantageous on islands.

For narrow streets and sites with difficult access, handcarts or other special vehicles may be used. Handcarts must be designed to a size which makes manual operation possible, and it must be ergonomically correct and with smooth-running wheels. Electric carts may be possible. For both carts and donkeys it is important to make sure that the waste collected is properly packed in closed sacks in order to prevent health risks.

Transportation and collection of waste for central composting or biogasification is advantageously effected in the same waste collection trucks as those used for ordinary waste. If organic waste is to be transported to another island, this could be effected either in the waste collection truck without being reloaded or by reloading into a compacting container. If an ordinary ferry is used for transportation, reloading will normally not be worthwhile, since organic waste has a high content of water and will thus compact only to a limited extent. Waste for sea-transport must be loaded into closed containers to prevent emissions of any kind.

Recyclable materials to be treated and finally disposed of on the mainland can be transported in many ways. Whole bottles, metal and baled materials can be transported as ordinary goods on a truck. Other materials such as wood, metal, broken glass, non-baled cardboard and paper as well as plastics and textiles can be transported in maxicontainers of 14-20 m³. Cardboard,
paper, plastics and textiles could advantageously be transported in compacting containers, being compressed to approximately one fourth. Containers can be transported on trolleys.

Large items such as bulky waste can be collected by means of a platform truck or by maxicontainers and a roll-on/roll-off system. The use of maxicontainers will entail a minimum of health hazards, as manual elevation to the platform is avoided, and as maxicontainers with high sides will minimize spill. Bulky waste will normally be collected at certain announced intervals throughout the year.

Table 8.3, shows examples of (road) transport equipment.

8.1.4 Compaction, Storage and Transfer

Compaction:

Prior to discharging separated recyclable materials it is usually advantageous to compact the materials. Compaction enables the reduction of transport costs which, usually, depend more on volume than on weight.

Examples of types of equipment used for the compaction of some recyclable materials are given in table 8.4.

Storage:

Temporary storage of materials for later export will often be necessary. If the materials are loaded into closed compaction containers, the waste might equally be stored in these containers, which will provide protection against the weather, and minimise emissions.

Transport trailers, which can be transported by the vehicles used for exportation, constitute another solution. Trailers are normally large (20-40 m³). The vehicles in use must be able to transport the trailers, and access must be maintained.

Baled paper or plastic and inert materials can be stored in a closed storage site or a bunker. Bunkers have three walls, typically 2 metres high, and are usually constructed of concrete with a cement floor. Bunker construction costs are minimal. Paper and cardboard will need protection against precipitation by some kind of roof. Other waste for temporary storage will need careful storage in a building (closed bunker) with air filters and dust control.
<table>
<thead>
<tr>
<th>Waste type</th>
<th>Payload (tonnes)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid wastes, liquid if contained</td>
<td>0.15-0.20</td>
<td>Limited by human effort - practical in streets with steps</td>
</tr>
<tr>
<td>Solid wastes</td>
<td>0.15-0.20</td>
<td>Limited by human effort - practical in streets with difficult access</td>
</tr>
<tr>
<td>Solid wastes, liquid if contained</td>
<td>0.15-0.40</td>
<td>Limited by human effort loading and mule power transport</td>
</tr>
<tr>
<td>Solid wastes</td>
<td>Up to 1</td>
<td>Practical for narrow streets</td>
</tr>
<tr>
<td>Solid compressible wastes</td>
<td>Up to 5</td>
<td>Limited to loader effort</td>
</tr>
<tr>
<td>Solid compressible wastes</td>
<td>6-8</td>
<td>Suitable for 5-6 m³ containers, rural areas and flat areas</td>
</tr>
<tr>
<td>Solid compressible wastes capable of being loaded into hopper</td>
<td>Up to 10 (2-axle), 10 (3-axle), 14 (4-axle)</td>
<td>Suitable for 1.5-6 m³ containers, rural areas and flat areas</td>
</tr>
<tr>
<td>Solid compressible wastes capable of being loaded into hopper</td>
<td>12-14</td>
<td>Suitable for 1.5-6 m³ containers, rural areas and flat areas</td>
</tr>
<tr>
<td>Separated paper, plastics, fins, metals, putrescible</td>
<td>Up to 10</td>
<td>Dedicated to clinical wastes, easily disinfected internally</td>
</tr>
<tr>
<td>Bottle banks, paper/cardboard bags</td>
<td>Up to 15</td>
<td>Dedicated to clinical wastes, easily disinfected internally</td>
</tr>
<tr>
<td>Clinical waste in special bags/containers only</td>
<td>Up to 15</td>
<td>Dedicated to clinical wastes, easily disinfected internally</td>
</tr>
<tr>
<td>Solid wastes including construction waste, waste liquids and sludge in containers</td>
<td>Up to 20</td>
<td>Dedicated to clinical wastes, easily disinfected internally</td>
</tr>
</tbody>
</table>

Table 8.3: Examples of transport equipment (road)

Note: Generally used for industrial wastes. Demountable container designed to solid wastes which can be liquid or semi liquid if required. Also used for metal scrap. Handles compaction of containers. Handles all kinds of maxi-containers, limited only by container design.
Transfer:

A solution for small-scale transfer stations are the mobile direct-load transfer station or the direct-load transfer station equipped with a stationary compactor. The first solution includes an open air transfer operation, which makes it difficult to control dust, noise, odours and other emissions.

The refuse collection vehicle is emptied into a hopper located directly above the container which is connected to the stationary compactor. Depending on the vehicle emptying mechanism, it can be emptied directly into the container, thus saving costs for the construction of a two-level transfer station.

The containers are collected and transported by a haul vehicle. Compacting containers can load up to 600-650 kg/m³, and 35 m³ containers will be able to load approximately 20 tonnes.

Compacting containers for transfer will involve costs of approximately 15-20 ECU/tonne which must be compared with costs of transportation.

A direct-load transfer station may be situated near a harbour or beside a recycling centre.

If the transfer is directly/automatically effected, it will not influence working conditions. However, some dust and particles may be emitted during the transfer. The most appropriate solution for a transfer station or any other dust producing activity is to keep the activities inside a closed building provided with an exhaust system, a filter and odour control in order to minimize emissions.

![Diagram of transfer station](image)

*Figure 8.1: Concept for a small-scale transfer station*
<table>
<thead>
<tr>
<th>Compaction equipment</th>
<th>Options</th>
<th>Compaction method</th>
<th>Applicable for</th>
<th>Price (ECU)(^1)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compacting container</td>
<td>Compresses materials in the container</td>
<td>Mixed waste, organic waste, residual waste, separated materials</td>
<td>6,000 (container) + 17,000 (compactor)(^2)</td>
<td>Easy to handle, can be used for several materials</td>
<td>Density: 300-600 kg/m(^3)</td>
</tr>
<tr>
<td>Baling press</td>
<td>Vertical upstroke</td>
<td>Compresses materials into dense rectangular bales - bottom platform pulled upwards hydraulically</td>
<td>Paper, cardboard, plastic, textile, other light materials</td>
<td>8-35,000</td>
<td>Easy to handle and transport</td>
</tr>
<tr>
<td></td>
<td>Vertical downstroke</td>
<td>The hydraulic ram moves downwards</td>
<td>As above</td>
<td>10-30,000</td>
<td>As above</td>
</tr>
<tr>
<td></td>
<td>Horizontal</td>
<td>Materials fall from hopper into a chamber and are compressed by a hydraulic ram</td>
<td>As above</td>
<td>30-40,000 160-300,000</td>
<td>As above</td>
</tr>
<tr>
<td>Can densifiers</td>
<td>Automated</td>
<td>Hydraulically compress cans into highly compact cubes or small cakes</td>
<td>Aluminium and ferrous cans</td>
<td>10-12,000 30-35,000</td>
<td>As above</td>
</tr>
<tr>
<td></td>
<td>Non-conventional</td>
<td>Running over the cans with a front end loader</td>
<td>As above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass crushers</td>
<td>Rotary impact</td>
<td>A rotor catches the feed and hurls it against two impact arms</td>
<td>Glass</td>
<td>16-40,000</td>
<td>Cuttle is less valuable than whole bottles</td>
</tr>
<tr>
<td></td>
<td>Chain flailer/ Rotating blades</td>
<td>The glass drops through a chute with a rotating chain or blades</td>
<td>Glass</td>
<td>5-10,000</td>
<td>As above</td>
</tr>
<tr>
<td></td>
<td>Rotor and striker plate</td>
<td>The glass is crushed between the rotor and the plate</td>
<td>Glass</td>
<td>5-10,000</td>
<td>As above</td>
</tr>
<tr>
<td>Shredders</td>
<td>Cut the materials into small pieces</td>
<td>Hard plastic, rubber (inclusive tyres), aluminium and other light metals, wood, confidential documents</td>
<td>20,000</td>
<td>Indicated price is for minor system (80-200 kg waste/hour) which will be enough on most islands</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) 1994-price, Western Europe (Paraskevopoulos & Georgiadis Ltd).

\(^2\) 1994-price (cost estimate by Ramboll)

Table 8.4: Examples of compaction equipment
8.2 How to Choose a Collection and Transportation System and Technology

Generally, the establishment of a collection and transport system and specification of the techniques to be used follows the scheme below:

1) The collection and transport system must meet the requirements of the waste treatment system (separation, export, etc.) as illustrated in table 8.5 below.

2) A collection system must be set up according to the above requirements and to the criteria shown in table 8.6 below (economy, impacts on the environment and occupational health).

3) Collection equipment (receptacles) must be set up according to the criteria shown in table 8.7 below.

4) Transport equipment must observe the criteria shown in table 8.3 above.

5) Compaction and transfer equipment must observe the criteria shown in table 8.4 above.

<table>
<thead>
<tr>
<th>Source separation</th>
<th>Municipal waste</th>
<th>Industrial waste</th>
<th>Construction waste</th>
<th>Other waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compostable</td>
<td>Recyclable</td>
<td>Recyclable</td>
<td>Glass</td>
<td></td>
</tr>
<tr>
<td>Combustible</td>
<td>Combustible</td>
<td>Combustible</td>
<td>Aluminium</td>
<td></td>
</tr>
<tr>
<td>Non-combustible</td>
<td>Non-combustible</td>
<td>Non-combustible</td>
<td>Metals</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hazardous</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Central separation</th>
<th>Municipal waste</th>
<th>Industrial waste</th>
<th>Construction waste</th>
<th>Other waste</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Metals</td>
<td></td>
<td>Metals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Collection system</th>
<th>Municipal waste</th>
<th>Industrial waste</th>
<th>Construction waste</th>
<th>Other waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>√</td>
<td></td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bring system</th>
<th>Municipal waste</th>
<th>Industrial waste</th>
<th>Construction waste</th>
<th>Other waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Municipal waste</th>
<th>Industrial waste</th>
<th>Construction waste</th>
<th>Other waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>√</td>
<td>√</td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transfer station</th>
<th>Municipal waste</th>
<th>Industrial waste</th>
<th>Construction waste</th>
<th>Other waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>√</td>
<td>√</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>

*Table 8.5: Example of a collection and transport system*

As illustrated in table 8.5, a decision on the type of collection system to be used for each of the four main categories of waste must be made: municipal waste, industrial waste, construction waste and other waste. For each category it must be decided:

- What kind of source separation will be required (which fractions)?
- Which fractions must be sorted centrally?
- Will the waste category be covered by a collection system, a bring system or by instructions?
- Will some kind of transfer be necessary?
## Table 8.6: Criteria for choice of collection systems

<table>
<thead>
<tr>
<th>System</th>
<th>Separation efficiency</th>
<th>Economy ECU/tonne⁴¹</th>
<th>Environment and occupational health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection systems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully mingled collection</td>
<td>-</td>
<td>75-100</td>
<td>Risk of impact to crew if sacks are used</td>
</tr>
<tr>
<td>&quot;No container&quot; collection</td>
<td>Medium</td>
<td>80-105</td>
<td>Low impact if clean fractions</td>
</tr>
<tr>
<td>&quot;Blue box collection&quot;</td>
<td>High</td>
<td>120-160</td>
<td>Low impact - increased recycling</td>
</tr>
<tr>
<td>&quot;Co-collection&quot;</td>
<td>High</td>
<td>85-110</td>
<td>Medium impact - increased recycling</td>
</tr>
<tr>
<td>Multifamily unit collection</td>
<td>Low</td>
<td>40-60</td>
<td>Medium impact - low recycling</td>
</tr>
<tr>
<td>Co-mingled collection</td>
<td>High</td>
<td>75-100</td>
<td>Low impact</td>
</tr>
<tr>
<td>Bring systems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Igloo system</td>
<td>Medium</td>
<td>90-120</td>
<td>Low impact - depending on design</td>
</tr>
<tr>
<td>Recycling centres</td>
<td>Medium</td>
<td>100-300</td>
<td>Low impact &amp; good separation if manned</td>
</tr>
<tr>
<td>Selective collection centres</td>
<td>Medium to high</td>
<td>Depending on amounts</td>
<td>Low impact - manning mandatory</td>
</tr>
<tr>
<td>Instructions</td>
<td>Medium to high</td>
<td>No public expenses</td>
<td>Low to medium impact</td>
</tr>
</tbody>
</table>

¹¹ 1994 prices - cost estimates by Ramboll
<table>
<thead>
<tr>
<th>Type</th>
<th>Material(s) of construction</th>
<th>Range of size</th>
<th>Investment costs (ECU)$^1$</th>
<th>Annual costs (ECU)$^1$</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General purpose (Collection systems):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sack</td>
<td>Paper, plastic</td>
<td>110 l</td>
<td>0.27/0.17 37-49 (holder)</td>
<td>13/8</td>
<td>Exchanged at every collection - no need for cleansing</td>
<td>Uncomfortable to carry except when cart is used</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The collector makes only one trip to the storage area - fast collection</td>
<td>Risk of deterioration due to moisture, sharp or hot objects</td>
</tr>
<tr>
<td>Bin</td>
<td>Plastic, steel</td>
<td>90 l</td>
<td>24-37</td>
<td>5</td>
<td>Collectors protected against sharp objects</td>
<td>Uncomfortable to carry</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Waterproof</td>
<td>Difficult to keep clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The collector makes two trips with the bin</td>
</tr>
<tr>
<td>Wheeled bin</td>
<td>Plastic, steel</td>
<td>120 l</td>
<td>36-65</td>
<td>10-16</td>
<td>Collectors protected against sharp objects</td>
<td>Difficult to keep clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Waterproof</td>
<td>The collector makes two trips with the bin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relatively easy for the collector to move</td>
<td>Higher risk of mechanical breakdown</td>
</tr>
<tr>
<td>Mini-container</td>
<td>Plastic, glass fibre</td>
<td>240 l</td>
<td>40-50</td>
<td>12-14</td>
<td>Collectors protected against sharp objects</td>
<td>Difficult to keep clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Waterproof</td>
<td>The collector makes two trips with the bin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relatively easy for the collector to move</td>
<td>Higher risk of mechanical breakdown</td>
</tr>
<tr>
<td>Mini-container</td>
<td>Plastic, glass fibre, steel</td>
<td>1,100 l</td>
<td>220-260</td>
<td>44-52</td>
<td>As above</td>
<td>As above</td>
</tr>
<tr>
<td>Midi-container</td>
<td>Steel</td>
<td>6 m³</td>
<td>1,600-1,740</td>
<td>294-327</td>
<td>Small overall space requirement; fewer collection points</td>
<td>Difficult to keep clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mechanical loading; minimum health hazards</td>
<td>Access from road required</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Can take bulky waste</td>
<td></td>
</tr>
<tr>
<td>Maxi-container</td>
<td>Steel</td>
<td>20 m³</td>
<td>2,300-4,670</td>
<td>580-870</td>
<td>As above - very robust</td>
<td>As above</td>
</tr>
<tr>
<td><strong>Source-separated materials (Bring systems):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cassette/carton</td>
<td>Cardboard, plastic</td>
<td>25-50 l</td>
<td>2.5/6.3 57 (stand)</td>
<td>2.5/1.5 13.8 (stand)</td>
<td>Many sizes and designs available</td>
<td>Cardboard cartons easily damaged/short lifetime</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Easy to handle</td>
<td>Contents may be exposed to bad weather</td>
</tr>
<tr>
<td>Glass container</td>
<td>Plastic, glass fibre, steel</td>
<td>2.5 m³</td>
<td>940</td>
<td>195</td>
<td>Many sizes and designs available</td>
<td>Misuse can result in other materials being mixed with the glass</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relatively easy to place and handle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Highly cost efficient</td>
<td>Misuse can result in other materials being mixed with the paper</td>
</tr>
<tr>
<td>Paper container</td>
<td>Plastic, glass fibre, steel</td>
<td>2.5 m³</td>
<td>940</td>
<td>195</td>
<td>Many sizes and designs available</td>
<td>When unguarded it is vulnerable to arson</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relatively easy to place and handle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Highly cost efficient</td>
<td></td>
</tr>
<tr>
<td>Multi-compartment container</td>
<td>Plastic, glass fibre, steel</td>
<td>2.5 m³</td>
<td>915</td>
<td>195</td>
<td>Many sizes and designs available</td>
<td>Misuse can result in other materials being mixed with the separated materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relatively easy to place and handle</td>
<td>When unguarded it is vulnerable to arson</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Highly cost efficient</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Can handle several separated components</td>
<td></td>
</tr>
<tr>
<td>Multi-compartment container</td>
<td>Steel</td>
<td>16 m³</td>
<td>2,380</td>
<td>490</td>
<td>As above</td>
<td>As above</td>
</tr>
<tr>
<td>Battery container</td>
<td>Cardboard, plastic</td>
<td>50 l</td>
<td>41</td>
<td>11</td>
<td>Easy to place in shops and streets</td>
<td></td>
</tr>
<tr>
<td>Oil cask</td>
<td>Steel</td>
<td>600 l</td>
<td>240</td>
<td>52</td>
<td>Easy to place in harbours</td>
<td></td>
</tr>
</tbody>
</table>

$^1$ 1991 prices; Western Europe - annual prices are inclusive of costs for cleaning (Environmental Resources Limited & Ramboll, 1992)

Table 8.7: Criteria for choice of collection receptacles
8.3 Examples of Collection and Transportation Systems

Mykonos - Example of a collection and transportation systems

On Mykonos, a Greek island in the archipelago of the Cyclades, an examined alternative is A6: "Single strategy based on publicly organized recycling, composting and sanitary landfilling". Approximately 11,500 tonnes of waste are expected per year on Mykonos.

This alternative requires separate collection of:

- Recyclable materials
- Organic matter
- Hazardous waste
- Residual waste

The existing collection system is a fully mingled multifamily unit collection by the use of wheeled 300 l and 1,100 l plastic containers.

This is recommended to be supplemented with similar containers of another colour for organic matter and establishment of a bifurcate collection system. Bags for the waste are delivered to all households, financed by the annual waste tax: green bags for organic matter and black bags for residual waste.

The waste is collected and transported by 4 rear end loaders with hydraulic pistons and automatic emptying devices. For the narrow roads a tricycle is used. The tricycle can be emptied directly into the rear end loaders. Containers are not placed in streets without vehicle access.

Igloos for paper, glass and aluminium are located in 15 central places. These are supplemented by two recycling centres with containers for paper, cardboard, glass, aluminium, ferrous metals, wood and textiles.

Selective collection centres for hazardous waste are located at the two recycling centres.

Construction and demolition waste is instructed to be delivered directly to the recycling centres or to the landfill.
Gran Canaria - Example of a collection and transportation system

Gran Canaria is located in the archipelago of the Canary Islands. The annual waste production is approximately 460,000 tonnes/year. The proposed treatment strategy is a single strategy A8 with recycling (11%), incineration (62%) and sanitary landfilling (27%). The proposed collection and transportation system includes:

- 6 selective collection centers for problematic and hazardous wastes
- 1,000 containers for batteries
- 1,050 igloos for paper and cardboard (ratio 1 igloo/1,500 inhabitants) - these are operated on private initiative
- 1,400 igloos for glass (ratio 1 igloo/500 inhabitants) - these are operated on private initiative
- 1,050 igloos for plastic - these are operated on private initiative
- Separate collection of household waste and industrial waste for incineration
- Separate collection of construction waste for landfilling.

1994/95

Other examples can be found in the study reports as mentioned under References.
9. TREATMENT

HOW TO USE THE MANUAL

9.1 Technology

This chapter aims to outline some of the available waste management technologies which may be of application on islands. It does not intend to be exhaustive; specific reports as listed under References may be of help.

The Community strategy on waste sets as a first objective the prevention or reduction of waste production and its harmfulness.

Recovery of waste by means of re-use recycling, or use of waste as a source of energy take precedence to the disposal of waste either by landfilling or incineration without energy recovery.

9.1.1 Reprocessing and Recycling

The first task relating to reprocessing and recycling on islands is to identify materials which may be reprocessed or recycled. Reuse will often take place on a private basis, but establishment of public reuse centres, where reusable waste products are available for free or at a low price, will increase reuse considerably. A reuse centre can be established for household wastes, industrial wastes, construction wastes and some of the problematic wastes (i.e. tyres, some uncontaminated building materials). Apart from a reuse centre, it must be investigated whether local reprocessing or recycling of recyclable materials can be initiated.

Local recycling may not be economically feasible for most materials. It must therefore be investigated which materials can be collected and exported for recycling on the mainland. Export of recyclable materials involves source separation and eventually some central sorting.

The following materials will often be of interest in connection to recycling:
- **Paper and cardboard** - in most countries paper constitutes a large percentage of the waste from households and commerce, and paper is very suitable for reprocessing.
- **Glass and bottles** - glass and bottles also constitute a large percentage of the waste flow. In some countries some of the bottles are covered by a deposit, but the remaining part will also be recyclable.
- **Aluminium** - in most countries aluminium from beverage containers constitutes a significant part of the waste - especially on islands with developed tourism. Aluminium is one of the most attractive recyclable materials and often brings in the highest prices.
- **Iron and ferrous metals** - scrap from industrial waste and bulky waste (including old automobiles) are not only easily recyclable but are often valuable. Scrap is most often recycled on a private basis, but a larger percentage of the ferrous metals can be made available for recycling if the collection of the remaining materials is organized by the local authorities.
- **Plastic** - plastic constitutes another large part of the waste, and the percentage of plastic in household waste is increasing. Some of the plastic can be reprocessed for new plastic materials. This will most often be industrial waste, as clean fractions are usually needed. This means that recycling schemes for plastic will often not be of interest on islands without industry, or it will be done on the mainland.
- **Textiles** - textiles can be reused as clothes - either sold in local reuse shops or given to developing countries. Textiles can also be recycled as cloth and rags.
- **Construction and demolition materials** - sand, earth, gravel, cement, asphalt and similar materials from construction and demolition activities will, on most islands, be valuable resources for local reuse. Appropriate on-site management will contribute to reuse of contaminated material. Other wastes are often used not far from their production sites. Some of them can be used for construction activities, improvement of unpaved roads, for ground levelling, for land extraction etc.

One important factor to take into account as regards the materials collected for recycling is that of the *markets* for recyclable materials. As transportation will frequently be expensive, it is important to find a proper market for the materials. Paper, glass, plastic, aluminium, ferrous metals and textiles can be collected on all islands, but the markets on the mainland will have an influence on the materials deemed attractive for collection.

In the case of islands, the *transport expenses* for recyclable materials include those of sea transportation. Some shipping lines allow free transportation of recyclable materials in order to promote themselves as "green" shipping lines. Such arrangements will be valuable for recycling schemes on most islands.

There are several types of *central sorting systems* adapted to the fractions to be sorted. The separation of the individual fractions takes place in steps, and normally the aim is to obtain cleaner fractions. The main types of sorting techniques are:

- Preliminary sorting with grab (crane or loader tractor)
- Magnetic separation of iron and magnetic metals
- Vibrating screens and air classifiers for the separation of light materials
- Drum separation of fractions in relation to size
- Bucket screens for the separation of small and light materials
- Eddy current separator for the separation of metallic objects from non-metallic objects
- Manual sorting from conveyor belts
- Various specialized fully or semi-automatic sorting systems for example glass bottles and plastics
Experience points out that a complete central sorting station for non-source separated waste will only be economically feasible for waste amounts exceeding approximately 20,000 tonnes/year.

Preliminary sorting with grab can be used for the separation of major undesirable objects or for the separation of some of the desired fractions. Sorting with grab normally requires a second sorting.

Upgrading of the source separated fractions normally requires manual sorting, i.e. the waste passes on a conveyor belt, the necessary manipulation is undergone and then it is distributed on various side belts. When designing manual central sorting systems measures must be taken in order to protect the working environment. Good ventilation, ventilating pressure and filtration are of great importance in the sorting room. Other measures are needed in order to avoid health problems which may occur among workers manipulating organic waste not suitable for central sorting.

Upgrading of the individual fractions may, for instance, be the sorting of different metals by type; paper and cardboard can be sorted into specific kinds of paper and cardboard by central sorting; glass and bottles can be sorted into whole glasses and bottles and further sorted into coloured and uncoloured glass. For fine sorting of whole bottles by type, automatic sorting systems can be made. Fine sorting usually means that a much higher price can be obtained for recyclable materials and in many cases it may even be a condition for buying them.

The cost of the paper sorting centre on the Danish island of Bornholm was ECU 2.8 millions; ECU 1.3 millions for the building and ECU 1.5 millions for machinery.

Generally investments in central sorting systems are rather extensive, and it would generally be too expensive to establish such a system on (individual) islands considering the relatively small quantities of waste. Establishment of major central sorting systems is normally interesting only in joint waste solutions with the participation of more islands. Source separation is the optimum solution on islands.

Central upgrading of the source-separated fractions may be economically advantageous, particularly when the waste is to be compacted and transported over long distances. The fractions to be fine sorted should be evaluated taking into consideration the market for recyclable materials and transport distances.

**9.1.2 Composting**

In composting two end products are obtained: compost and strainer residues. Experience implies that one tonne of waste produces approximately 300 kg of compost and 200 kg of strainer residues.

Compost on the islands can be used as a corrective in soil - agricultural lands. Several possibilities for the use of good quality compost are available:
• Application in parks and public areas
• Application in agriculture, nurseries and orchards
• Application in private gardens, window boxes, pots, etc.

Decisive for the application possibilities is the content of heavy metals which must be controlled in order to avoid contamination of soil and aquifers. Plastic and other remains should not be present in the compost. This can be avoided by limiting the composting to source separated organic fractions from households and slaughterhouses and to garden waste.

Experience from available composting systems indicates that it is possible to produce compost which can be sold for agricultural purposes. On most islands, compost will be a valuable corrective and alternative to fertilisers.

Citizens can also be rewarded for their efforts by being offered the possibility of picking up free compost at the composting system - either continuously or on an annual "composting day".

The strainer residues will mainly consist of combustible materials, such as plastics which have to be disposed of and metal, which can be recycled.

When separating organic waste for composting the residual waste will contain waste with a low organic content and a lower water content.

Climatic conditions may influence the composting process. Open air composting will need irrigation if precipitation is too low. A very low precipitation will favour closed composting processes.

Table 9.1 shows the technologies applicable for composting on islands. The table indicates the main components of each technology and the preconditions for establishment of the technology (requirements for separation and localisation and other preconditions).
<table>
<thead>
<tr>
<th>Technology</th>
<th>Technical components</th>
<th>Preconditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garden composting</td>
<td>Low technology container</td>
<td>Separation: At source</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Localisation: Private</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other: No</td>
</tr>
<tr>
<td>Windrow composting</td>
<td>Leachate collection from windrow area</td>
<td>Separation: At source</td>
</tr>
<tr>
<td></td>
<td>Crabisher, windrow tedder &amp; drum screen</td>
<td>Localisation: &gt;500m from residential areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other: Treatment of leachate Garden waste only</td>
</tr>
<tr>
<td>Drum composting</td>
<td>Presorting</td>
<td>Separation: At source</td>
</tr>
<tr>
<td></td>
<td>Rotating drum for pre-treatment</td>
<td>Localisation: &gt;500m from residential areas</td>
</tr>
<tr>
<td></td>
<td>Leachate collection from windrow area</td>
<td>Other: Treatment of leachate</td>
</tr>
<tr>
<td></td>
<td>Crabisher, windrow tedder &amp; drum screen</td>
<td></td>
</tr>
<tr>
<td>Container composting</td>
<td>Receiving bunker ripping bags separately</td>
<td>Separation: At source</td>
</tr>
<tr>
<td></td>
<td>Drum screen for homogenization</td>
<td>Localisation: Smaller vicinity impact</td>
</tr>
<tr>
<td></td>
<td>Magnetic discarding of iron</td>
<td>Other: Treatment of leachate</td>
</tr>
<tr>
<td></td>
<td>Two-stage automatic reactor system with stirring (drum and containers)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crabisher, windrow tedder &amp; drum screen</td>
<td></td>
</tr>
</tbody>
</table>

Table 9.1: Composting technologies

9.1.3 Biogasification

The production of biogas may be achieved by treating organic waste in a biogas plant. Typically it comprises:

- A receiving section where pre-treatment and sanitary measures are applied to the waste materials
- A putrefying section where the waste materials produce gas. The retention time in the reactor is typically 20-22 days
- An after-treatment section, where the putrefied materials are treated and stored. The retention time in the sanitation tank is typically 2 days
- A gas cleaning section, where the gas is cleaned for water, hydrogen sulphide and aerosols through addition of ferric chloride
- A compression section in order to store the gas under a higher pressure level
- A gas transformation section, where the gas is used for the production of heat or heat and power
- A supplementary composting unit

Table 9.2 outlines some characteristics of technologies applicable for biogasification on islands. The table indicates the main components of each technology and the preconditions for establishment of the technology (requirements for separation, localisation and other).
<table>
<thead>
<tr>
<th>Technology</th>
<th>Technical components</th>
<th>Preconditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household waste plant</td>
<td>Reactor and equipment for household waste</td>
<td>Source separation and pre-sorting</td>
</tr>
<tr>
<td>Combined wastes plant</td>
<td>Reactor and equipment for household waste, industrial waste, sludge and manure</td>
<td>Source separation and pre-sorting, Collection of manure</td>
</tr>
</tbody>
</table>

*Table 9.2: Biogasification technologies*

The end products of the biogas will be partly biogas, partly compost and liquid manure and partly sieve residues.

On the other hand, the decomposition process undergone by organic wastes in a landfill generates biogases which are known as landfill gases. The spatial composition of these gases is heterogenous and varies depending on the composition of the wastes and the specific conditions prevailing in the site.

**Landfill gas**

Depending on the availability of oxygen, the decomposition of biodegradable matter contained in wastes involves aerobic and/or anaerobic microorganisms.

In the early stages of deposition of waste, and while oxygen is available, the aerobic process is on, producing mainly water and carbon dioxide, out of an exothermic reaction (hydrolysis stage).

As soon as a new layer of wastes covers the previously deposited wastes, the oxygen level decays and the anaerobic phase is initiated. At a first stage, wastes are hydrolysed and fermented by microorganisms breaking the complex organic molecules (acidic stage).

The breakdown of fatty acids and alcohols is undergone by means of the activity of methanogenetic bacteria. As a result, acetate converts to methane and carbon dioxide or use hydrogen and carbon dioxide to form methane and water (methanogenetic stage).

Biogas is mainly composed of methane and carbon dioxide and its rate of production depends upon many factors such as the age of the waste, the depth of the deposition site, temperature, the waste composition and its compaction rate.

Biogas produced in a waste deposition site (the production of biogas may continue for a period of up to 20 to 30 years after the site closure) should be adequately controlled, namely biogas should be collected and used either as a fuel gas or as a chemical raw material.

The controlling of biogas production and its release contributes to the stability of the landfill site and reduces fire or explosion risks.

The gas can be used in a burner or can be converted to electricity. Full internal combustion engines or gas turbines are common in smaller installations (up to 5MW), whereas in larger installations steam turbines are common.
9.1.4 Incineration

Incineration is currently used in the management of a wide range of wastes, which include municipal waste. Within the waste strategy, incineration without recovery of energy is a form of disposing of waste.

Incinerators have been developed for the destruction of different waste types, thus contributing to the reduction of volume of wastes to be landfilled and/or reducing the harmfulness or risk of certain wastes (i.e. health care wastes, certain hazardous wastes). The environmental requirements for the functioning of incinerators is covered by European legislation as well as national legislation and standards, in order to limit the environmental, impact of such installations. These requirements are to be respected by installations incinerating waste either exclusively or mixed with other input materials.

Incineration is a process in which the organic and other combustible fractions of waste are destroyed by thermal oxidation at high temperature. There are different types of incinerators available, operating at different temperatures. Operating temperatures can range from 850°C (for municipal waste) to 1400 °C for disposing of hazardous wastes. When all combustible waste is incinerated only imperishable amounts remain for landfilling. Normally, the combusted waste is reduced to approximately 5% by volume and approximately 25% by weight. If no organic waste is landfilled, there will be almost no production of landfill gas.

If incineration of waste takes place, energy should be recovered, which can also be used by other types of waste treatment plants. Steam production is possible when wastes are incinerated and vacuum evaporation takes place in a steam boiler. Fresh water is a valuable resource on many islands.

Environmentally and economically sound incineration implies that energy will have to be recovered to power and heat. For this - and in order to limit emissions - a continuous incineration process is required with 7-8,000 hours of operation per year and only 2 stops per year. It is recommended to operate the plant 24 hours a day and 7 days a week.

The main interest for energy production on southern islands may be power production, while both power and heat production will be attractive on northern islands. Power production at an incineration plant can substitute existing diesel oil or coal stoked power production.

The energy output - especially the power production - is dependent on the size of the plant and the turbine. In the planning phase, the following figures for saleable energy per tonne of waste as input may be considered (the lower calorific value of the waste is assumed to be 9,000 MJ/tonne):

Heat production:
- 7,200 MJ heat/tonne
Combined heat and power production:
• 5,400 MJ heat/tonne
• 480 kWh power/tonne

Power production:
• 760 kWh power/tonne

A simple, robust turbine of an industrial type can be installed for power production to cover the demand of the incineration plant and other nearby waste treatment plants and for sale. This can be combined with a low pressure system with vacuum evaporation producing fresh water. The steam boiler and the vacuum system can act as a desalination plant.

Water supply will be required for the boiler, the flue gas treatment system and for sanitary cleansing. However, a wet flue gas cleaning system can work on salt water, and besides, the system can in principle generate fresh water itself.

Working conditions at modern incineration plants are, by and large, complying with the relevant European Environment legislation. Combustion air is taken from the silo resulting in a low pressure in order to prevent emissions of dust, odour and endotoxins. Most of the waste is emptied directly into the waste silo, from where it is lifted into the furnace by a crane. The crane is operated from a separate control room with a window to the silo. In this way nobody is in direct contact with the waste. It is important to minimize contact with residues from incineration. Slag will be treated by complete water contact, which will prevent dust-generation to the environment.
Table 9.3 shows technologies applicable for incineration on islands. The table indicates the main components of each technology and the preconditions for establishment of the technology (requirements for separation, localisation and other).

<table>
<thead>
<tr>
<th>Technology</th>
<th>Technical components</th>
<th>Preconditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving grate</td>
<td>Automatic, individual, adjustable moving grate sections Combustion chamber Boiler</td>
<td>Industrial and construction waste must be separated in combustible and non-combustible Close to existing district heat network</td>
</tr>
<tr>
<td>Fluidized Bed</td>
<td>Sand bed for fluidisation Combustion chamber Boiler</td>
<td>For relatively homogenous and liquid waste only Close to high voltage electricity network Pre-treatment necessary to some extent</td>
</tr>
<tr>
<td>RDF</td>
<td>Combustion of waste pellets in a conventional power or district heating plant</td>
<td>Fine separation, shredding and drying of the waste &gt;500 m from residential areas Pre-treatment plant RDF-market</td>
</tr>
</tbody>
</table>

Table 9.3: Incineration technologies

Flue gas treatment:

Treatment of the flue gas will be necessary in order to reduce emissions of dust, heavy metals, dioxides and acid gases. Several technologies for flue gas cleaning exist. In order to meet the requirements of EU directives on emissions from incineration plants, a two-step cleaning system with a particle filter and a acid gas cleaning system is recommended. Table 9.4. refers to flue gas cleaning technologies.
<table>
<thead>
<tr>
<th>Technology</th>
<th>Function</th>
<th>Residue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrostatic precipitator</td>
<td>Removal of dust particles</td>
<td>Filter ash</td>
</tr>
<tr>
<td>Fabric filter</td>
<td>Removal of dust particles</td>
<td>Filter ash</td>
</tr>
<tr>
<td>Acid gas cleaning systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry</td>
<td>Adsorption with dry lime (injection)</td>
<td>Flue gas cleaning product (contaminated lime)</td>
</tr>
<tr>
<td>Semi-dry</td>
<td>Adsorption with slurry of lime and water (injection)</td>
<td>Flue gas cleaning product (contaminated lime)</td>
</tr>
<tr>
<td>Wet</td>
<td>Adsorption with liquid lime (scrubbing)</td>
<td>Waste water</td>
</tr>
</tbody>
</table>

Table 9.4: Flue gas cleaning technologies

Temporary storage:

During summer there is a large population increase on many European islands due to tourism, with the consequent increase of household waste production. However, demand for heat produced is greater in the winter thus requiring some kind of levelling of the waste.

An example of temporary storage, is that of the incineration plant of BOFA I/S on Bornholm, Denmark where a part of the waste (industrial and bulky waste) is temporarily deposited every year in the summer. Putrescible materials such as household waste and light materials such as paper, expanded polystyrene and light plastics are not deposited for later incineration. Redigging up of putrescible waste causes too great a health risk (endotoxins), and light materials can be blown away. The combustible materials, which are temporarily stored, are deposited on a special site at the landfill nearby. The site is encircled by earth banks, and the materials are left on the ground. They are compacted a little and covered by heavy materials such as wood. When they are needed in the incineration plant (in the winter), they are dug up by an excavator or a tractor loader and transported to the plant.

Temporary storage is suitable for one season only. If the waste is deposited for too long, it begins to be reduced to vegetable mould.

A supplementary solution calls for the construction of the incineration plant with extra separate reception halls. Household waste and other waste containing putrescible must be loaded into the main reception hall, whereas dry wastes (industrial, construction and bulky waste) can be loaded into another hall for temporary storage.
9.1.5 Landfilling

The proposal for a Council Directive on the landfill of waste classifies the landfills into one of the following classes: i) landfill for hazardous waste, ii) landfill for non-hazardous waste, iii) landfill for inert waste. It also states which wastes are acceptable in each of the landfills.

Not all landfills that are operational, in particular on islands, respect minimum technical and environmental conditions which are desirable for an adequate disposal of wastes. The elimination of the leachates by diffusion or percolation has to be prevented; instead, an adequate channelling of the leachates has to be done for controlling their treatment and elimination, and a lining of the site should be done depending on its geological and hydrological conditions. Similarly for the landfill gases in order to aim at the stability of the sites.

On the other hand, the characteristics of the wastes deposited on one site have to be known, and pre-treatment done, if appropriate.

The proposal for a Council Directive on the landfill of wastes foresees conditions which have to be fulfilled for ensuring that the existing landfills (both on the mainland and on islands) can be maintained in operation. Otherwise, such deposition sites have to be closed down.

The monitoring of operation as well as measures for the after-care of landfills are equally foreseen in the above mentioned proposal.

At present, a great many landfills do not fulfil the conditions foreseen in the above mentioned proposal.

Generally speaking, and taking into account the great variety of islands in the European Community, three kinds of landfills can be identified: sanitary landfills (for solid wastes from households, industries and construction and sometimes for waste water sludge), inert landfills (for inert materials only (typically construction waste, soil, some industrial wastes and bulky waste)) and special depots (mono-landfills for single waste types such as hazardous wastes, flue gas cleaning products etc.). Table 9.5 summarises some of their characteristics.

Indicatively, a new landfill may be planned with a total lifetime of 15-25 years. The lifetime of each section may be 3-5 years. Waste can be landfilled to a height of 5-15 metres depending on the location. With a height of 10 metres and compaction of the waste (to approximately 0.8 tonnes/m³), the area required will be approximately 0.125 m²/tonne waste. With a section with a lifetime of 5 years and a waste flow of 2,000 tonnes/year, the required area for the section will be approximately 1,250 m². A landfill with a lifetime of 20 years will in this case require an area of approximately 5,000 m². In addition to the area used for depositing, areas for weighbridge, buildings, equipment, water reservoir, roads, walls, and fences must be applied.
Table 9.5: Landfills

Once a site investigation has been performed, a working plan is drawn up comprising the site operational plan, the engineering plans as well as a restriction plan. Several factors are to be taken into account in order to set up a landfill as well as to secure its controlled operation.

The following are some of the factors to consider:

- The waste front should be limited to the highest extent possible
- The landfill should be manned, and all in-coming waste should be controlled
- The landfill should be fenced in order to prevent access of unauthorized persons and animals, and to catch light, wind-borne materials. The landfill should be locked outside manned opening hours
- If possible, the waste should be split up into different types of waste in order to facilitate the erection of special landfills for e.g. special hazardous waste or inert materials
- Surface water from surrounding areas should be cut off to prevent mixing with the leachate on the sanitary landfill to reducing the quantities of leachate as much as possible
- Cutoff drains should ensure that surface water does not run out
- Treatment or pre-treatment of leachate should be established
- Depending on the situation of the site and the ground water conditions, ground water control should be ensured
- The waste should be covered daily to avoid auto-ignition, to prevent light materials from blowing away and to discourage birds and vermin
- The waste should be compacted in order to reduce the volume and thus extend the lifetime of the landfill
- When the landfill is in operation, gases from the landfill should be controlled in order to avoid the risk of explosions and reduce the danger of fire
• Water should be available on the landfill in the form of a sprinkler system for dust control and to be used in the event of fire
• Access roads should be paved. Good road conditions prevent illegal dumping along the access road and put less strain on refuse collection vehicles
• Streets and roads should be kept clean
• Departing vehicles should be completely emptied and cleansed
• An operation manual defining responsibility and competence as well as guidelines for work routines should be prepared
• Final covering and after-care of the landfill should be planned, including the following elements: a) future landscape plan, b) control of surface water and possibly ground water, c) structuring of final covering, d) gas control by means of covering by gas permeable materials, which ensure evaporation and cleaning of the gas, and e) evaluation of the lifetime of the landfill
• The landfill should be divided into sections, each covering a period of approximately 5 years. This will make it possible to establish some of the installations for a sanitary landfill immediately, and others in the next sections. In this way, the landfill can be improved each time a new section is put in operation.
• The landfill should not be located in a valley or a pit as it is very difficult to control leachate and since convective rain may cause a flooding of waste into the sea.

Landfill gas is produced during the decomposition of deposited organic waste. Typically 6 to 12 months after disposal, substantial amounts of methane will start to be produced. The concentration of methane will gradually increase until it reaches about 65% of the landfill gas. 1 tonne of urban waste produces approximately 100 m³ of landfill gas in 10 years (TPA, 1994). Paragraph 9.1.3 provides for further information on landfill gas.

In some landfills it may be worth extracting the gas and using it for production of heat and power. Experience suggests that at least 500,000 tonnes of deposited waste are required in order to ensure gas amounts large enough to operate economically sound extraction (TPA, 1994). Gas production depends on the type of waste and the building-up of the landfill.

General costs for sanitary landfills in the EU (TPA, 1994):

Landfill site development: ECU 18,000-40,000 per tonne/day
Operating costs - non-hazardous landfill: ECU 20-30/tonne
Operating costs - inert waste landfill: ECU 9/tonne
Operating costs - hazardous-waste landfill: ECU 75-130/tonne
Restoration costs: ECU 125,000-250,000 per ha.

For an island with an annual production of 10,000 tonnes of waste for a non-hazardous waste landfill, this will be ECU 2,500,000-4,000,000 in 10 years or ECU 25-40/tonne.
### 9.1.5 Problematic Wastes

In table 9.6 the most common problematic wastes on islands are shown with a description of possible management.

The management of some of these wastes are covered by specific European legislation as specified in chapter 3. Other types of problematic wastes are already subject to some national regulations and/or receive increasing attention, either because of their volume or their harmfulness.

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Treatment technologies</th>
<th>Local management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oily waste</td>
<td>Separation of water and volatile products (pre-treatment)</td>
<td>Collection at service stations</td>
</tr>
<tr>
<td></td>
<td>Lubrication</td>
<td>Municipal casks in harbours</td>
</tr>
<tr>
<td></td>
<td>Incineration (fuel)</td>
<td>Selective collection centres</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local separation of water</td>
</tr>
<tr>
<td>Hazardous waste</td>
<td>Regeneration</td>
<td>Selective collection centres</td>
</tr>
<tr>
<td></td>
<td>Combustion</td>
<td>Collection in shops</td>
</tr>
<tr>
<td></td>
<td>Chemical detoxification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Controlled landfilling</td>
<td></td>
</tr>
<tr>
<td>Olive oil pressing waste</td>
<td>Disposal to accessible cultures under controlled aerobic conditions</td>
<td>Central processing plant on the island</td>
</tr>
<tr>
<td>/distillery waste</td>
<td>Co-composting with heat recovery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bio-composting</td>
<td></td>
</tr>
<tr>
<td>Batteries</td>
<td>Household batteries: encapsulation and controlled landfilling</td>
<td>Household batteries collected at collection station or by “igloos” in shops and offices</td>
</tr>
<tr>
<td></td>
<td>Car batteries: recovery</td>
<td>Car batteries collected at service stations</td>
</tr>
<tr>
<td>Electric appliances</td>
<td>Recycling of some parts</td>
<td>Return systems to shops</td>
</tr>
<tr>
<td></td>
<td>Special treatment of some parts (i.e. old capacitors) as chemical waste</td>
<td>Collection at recycling centres</td>
</tr>
<tr>
<td></td>
<td>Landfilling of the residues</td>
<td>Central sorting, emptying of fluids and demounting</td>
</tr>
<tr>
<td>Ship-generated waste</td>
<td>Oily waste - see above</td>
<td>Casks for oil waste in harbours</td>
</tr>
<tr>
<td></td>
<td>Solid waste - treated like household waste</td>
<td>Containers for solid waste in harbours</td>
</tr>
<tr>
<td>End-of-life cars</td>
<td>Private treatment (if car breakers exist) - or:</td>
<td>Municipal collection of abandoned cars</td>
</tr>
<tr>
<td></td>
<td>1. Tapping of fluids</td>
<td>Delivery to car breakers or scrap dealers</td>
</tr>
<tr>
<td></td>
<td>2. Demounting of reusable parts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Pressing and exportation of scrap</td>
<td></td>
</tr>
<tr>
<td>Tyres</td>
<td>Reuse for other purposes</td>
<td>Collection at service stations</td>
</tr>
<tr>
<td></td>
<td>Revulcanisation</td>
<td>Collection at recycling centres</td>
</tr>
<tr>
<td></td>
<td>Freezing and granulating</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shredding and incineration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shredding and landfilling</td>
<td></td>
</tr>
<tr>
<td>Sludge from septic tanks</td>
<td>Stabilization and hygienic treatment</td>
<td>Stabilization and hygienic treatment</td>
</tr>
<tr>
<td>or sewage plants</td>
<td>Co-composting, biogasification and/or use as fertilizer</td>
<td></td>
</tr>
<tr>
<td>Animal waste</td>
<td>Manure can be treated in a biogas plant and in some composting plants</td>
<td>Initial collection by farmers. Transportation in tank lorry to plant.</td>
</tr>
</tbody>
</table>

*Table 9.6: Technologies for treatment and local management of problematic wastes*
Of special interest for the collection of hazardous waste, oily waste and batteries on the islands are selective collection centres. A central selective collection centre on each island can be supplemented by small local centres.

The selective collection centre can be located at or near a recycling centre, a landfill, an incineration plant, a waste water treatment plant or other municipal activity where personnel are available. A selective collection centre can be set up as a shed with a concrete floor which inclines towards a collection well. In the shed, oil drums for waste oil and clamp lid iron casks used for other types of packaged waste can be placed. Furthermore, there must be a cabinet where delivered toxic waste can be stored under lock and key until they are put into a clamp lid cask just before the transport phase.

Turnkey local selective collection centres with tanks and toxic cabinets are available on the European market, including complete selective collection centres for hazardous waste with a 200-litre accumulation tank, a desk and a locker for poisons. They are in the range of ECU 5,000-6,000.

The size of the central selective collection centre will depend on the number of inhabitants on the island, the number of industries and the amounts of hazardous waste received. The central selective collection centre must have a locked storehouse with containers for the hazardous waste and a tank for drainage of liquid waste.

Households can deliver hazardous waste at the central selective collection centre and at the local centres.

As a supplement to the selective collection centres, a pick-up arrangement can be established. When using a pick-up arrangement, specially designed vans pass by the neighbourhood to collect hazardous waste from households a pre-announced day. Experience shows that the amount collected increases with this arrangement, as it facilitates the delivery for the households. The vans used for this are equipped as a mobile selective collection centre.

Car-repair shops are supposed to have a separate storage for solvents and liquid or viscous waste other than waste oil. However, particularly in connection with use of the oil at the place of origin or after collection for heating purposes, it seems unlikely that a strict separation of waste flows is maintained.
9.2 How to Choose a Waste Treatment Technology

9.2.1 Reprocessing and Recycling

As previously stated (cf. chapter 9.1), the European Community strategy on waste as well as most national waste strategies set as a first priority the prevention or reduction of waste and its harmfulness. Recovery of waste by means of reuse, recycling, or use of waste as a source of energy takes precedence to the disposal of waste either by landfiling or incineration without energy recovery.

In such a context, one of the objectives for local waste management on islands must be that of investigating the types of materials to be collected for recycling as well as the most appropriate methods of collection and transportation. This involves:

- Market analysis - local, national and other markets for recyclable materials
- Design of collection system (kerbside collection, igloos or recycling centres)
- Design of transport system (initial sorting, compaction, transportation)

The regional markets for recyclable materials are crucial to the feasibility of recycling schemes. As markets and prices show great differences in the different European countries and over the years, it is not possible to specify which amounts will be needed on one island in order to make possible a recycling scheme. As a very preliminary example, and as a general guideline the following amounts can be used, but local investigations are inevitable.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Amounts in tonnes/year</th>
<th>Size of island (inhabitants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous metals</td>
<td>50-100</td>
<td>2,500-5,000</td>
</tr>
<tr>
<td>Aluminium</td>
<td>20-50</td>
<td>2,000-5,000</td>
</tr>
<tr>
<td>Paper</td>
<td>500-800</td>
<td>4,000-6,000</td>
</tr>
<tr>
<td>Glass (cullet)</td>
<td>700-1,000</td>
<td>17,000-24,000</td>
</tr>
</tbody>
</table>

1) Prices for whole bottles are in several countries considerably higher. Presuming 25% of the glass can be sold as whole bottles, the required amounts will be only approximately 200-400 tonnes/year (5,000-10,000 inhabitants) (1994/95)

Table 9.7: Estimates of minimum amounts of recyclable materials and size of islands in order to make recycling schemes economically feasible

The following paragraphs summarize some indicative costs (economy) associated with different treatments or treatment technologies in line with the contents of precedent paragraphs.
### 9.2.2 Composting

<table>
<thead>
<tr>
<th>Technology</th>
<th>Economy (ECU)</th>
<th>Impact on environment and occupational health</th>
<th>Other</th>
</tr>
</thead>
</table>
| Garden composting   | E: 0 or low O: 0 or benefit[2] | Risk of odour  
Reduces energy consumption for transportation  
Meat or similar waste will cause problems with endotoxins, fungal spores, bacterial spores and vermin |                                           |
Meat or similar waste will cause problems with endotoxins, fungal spores, bacterial spores and vermin  
Leachate production | Long-time composting process - most suitable for garden waste  
Depends on precipitation |
Meat or similar waste will require extended production control  
Leachate production | Depends on precipitation |
| Container composting| E: 3,000,000 O: 4-6/tonne[5] | Closed system - air cleaning (scrubbing) possible  
No leachate production | Automatic system  
Water control |

1) E = Establishment costs; O = Operating costs  
2) Benefit due to reduced need for transportation and alternative treatment  
3) 1994-prices (cost estimate by Ramboll) - prices at capacity = 2,000 tonnes/year  
4) 1991-prices according to Environmental Resources Limited & Ramboll, 1992 - prices at capacity = 19,000 tonnes/year  
5) 1994-prices (cost estimate by Ramboll) - prices at capacity = 20,000 tonnes/year

Table 9.8: Criteria for choice of composting technologies

### 9.2.3 Biogas

<table>
<thead>
<tr>
<th>Technology</th>
<th>Economy (ECU)</th>
<th>Impact on environment and occupational health</th>
<th>Other</th>
</tr>
</thead>
</table>
| Household waste plant    | E: 3,600,000 O: 320,000 I: 500,000 | Difficult operation  
Net energy production: 2,400 MJ/tonne | Gas production: 140 Nm$^3$/tonne of waste  
Production per tonne of waste: 250 kg fibromas and 400 litres of nutrient water  
Not proven technology |
| Combined wastes plant    | E: 3,600,000 O: 320,000 I: 410,000-960,000 | Difficult operation  
Production per tonne of waste/sludge/manure: 100 kg fibromas and 800 litres of nutrient water  
Proven technology |

* 1991-prices: E = Establishment costs; O = Operating costs (annual); I = Running income (annual): (The Danish Energy Agency 1991)

Table 9.9: Criteria for choice of biogas technologies
### 9.2.4 Incineration

<table>
<thead>
<tr>
<th>Technology</th>
<th>Economy(^1)</th>
<th>Impact on environment and occupational health</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving grate</td>
<td>I: Medium O: Medium</td>
<td>High thermal &amp; destruction efficiency Flue gas cleaning needed</td>
<td>Proven technology Operates large spectre of waste types and calorific values Functions under fluctuating conditions - Robust</td>
</tr>
<tr>
<td>Fluidized bed</td>
<td>I: High O: Medium to high</td>
<td>Very high thermal and destruction efficiency Relatively low incineration temperature reduces NO(_x) Possibility for admix with additives directly to the combustion chamber Flue gas cleaning needed</td>
<td>Only for relatively homogenous wastes - needs pre-treatment up to a certain extent</td>
</tr>
<tr>
<td>RDF</td>
<td>I: High(^2) O: High(^3)</td>
<td>Combustion in coal stoked plant, normally without flue gas cleaning Occupational health problems at pre-treatment (sorting)</td>
<td>Needs pre-treatment Expensive Needs a market for RDF-products</td>
</tr>
</tbody>
</table>

\(^1\) I = Investment costs; O = Operational costs - a price example for a plant is provided below.

\(^2\) High costs if no market for RDF exists. A market will ensure some income for RDF pellets and improve the economy.

**Table 9.10: Criteria for choice of incineration technologies**

The price of an incineration plant will depend on the design of the plant and on local factors. As an example, the costs of a new moving grate incineration plant with a capacity of 6 tonnes/hour or approximately 45,000 tonnes/year (in Denmark) is (1994/95):

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost (ECU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace and boiler system</td>
<td>9 million</td>
</tr>
<tr>
<td>Turbine and generator system</td>
<td>5 million</td>
</tr>
<tr>
<td>Flue gas cleaning system</td>
<td>3 million</td>
</tr>
<tr>
<td>Buildings</td>
<td>6 million</td>
</tr>
<tr>
<td>Design etc.</td>
<td>2 million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25 million</strong>(^1)</td>
</tr>
</tbody>
</table>

\(^1\) Costs according to the specific plant in Denmark, 1994
Plants with a capacity of less than 2 tonnes/hour will often be too expensive as costs for buildings, furnace and transfer station(s) for heat and/or power will not decrease much. For plants with steam boilers, prices will be disproportionately large for plants with a capacity of less than 4-4.5 tonnes/hour.

According to some studies an incineration plant for municipal waste with a capacity of 1 tonne/hour will cost approximately ECU 4,600,000 (ECU 590/tonne/year), and with a capacity of 20 tonnes/hour it will cost approximately ECU 76,300,000 (ECU 490/tonne/year) (1994/95). Experience suggests greater economical advantages for larger plants.

**Flue gas treatment:**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Economy(^1)</th>
<th>Impact on environment and occupational health</th>
</tr>
</thead>
</table>
| Dry        | I: Moderate  
O: High | Large quantities of residues (mixture of 25 kg fly ash and 15 kg lime per tonne waste) - treatment not considered sufficient |
| Semi-dry   | I: Moderate to high  
O: Moderate to high | Large quantities of residues (mixture of 25 kg fly ash and 12 kg lime per tonne waste) |
| Wet        | I: High  
O: Low | Fly ash and lime is not mixed; 2.5 kg end product and 200-300 litre waste water per tonne waste. Full contact to lime due to dissolution in water |

\(^1\) I = Investment costs; O = Operational costs

**Table 9.11: Criteria for choice of flue gas cleaning technologies**

Dry flue gas treatment systems will hardly be able to meet future requirements of EU-directives on emissions from incineration plants, in particular the proposal for a Directive on Integrated Pollution Control.

Semi-dry and wet flue gas treatment meet the requirements of the EU-Directive on emissions from incineration plants and will also be able to meet future requirements. Of these the wet system provides the optimal cleansing of the flue gas with respect to acid gases, heavy metals, etc. The wet process ensures 100% contact between the flue gas and the treatment materials. Furthermore, the amount of solid residues from a wet process is much smaller. Depositing of flue gas residues is a great environmental problem which is not yet fully solved.
9.2.5 Landfilling

As it is very difficult to upgrade an existing landfill into a sanitary landfill, the solution to be recommended is to establish a new sanitary landfill next to the existing landfill (or another location if convenient) and to close the existing landfill, respecting the closing down measures which are needed in order to avoid further contamination of the environment. The proposed European regulation on the landfill of waste is to be taken into account. A future landfill will have to belong to one of the classes as stated in that proposed regulation.

<table>
<thead>
<tr>
<th>Landfill</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
<td>Requires a large area&lt;br&gt;Vicinity impacts&lt;br&gt;Larger environmental impacts than other treatment methods&lt;br&gt;Have last priority in the EU waste strategy</td>
</tr>
<tr>
<td>Sanitary landfill</td>
<td>All types of waste can be received and handled at the same landfill. It is possible to collect gas and use it for heat or power generation - this will require special sections for organic waste.</td>
<td>The high content of organic material causes a significant production of gas and odour. Insects, birds and vermin can exist in large numbers due to feeding and breeding opportunities. Occupational health problems may arise due to gas, odour and dust.</td>
</tr>
<tr>
<td>Inert landfill</td>
<td>Relatively cheap, as it is not necessary to take severe precautions against pollution of the environment, and as it can be located in most areas. No organic material - no gas or leachate production</td>
<td>Where hazardous compounds are deposited there is a considerable risk of severe pollution of the ground water resources, as such compounds are not expected</td>
</tr>
<tr>
<td>Special depot</td>
<td>Each depot contains only one type of waste - source location in case of pollution is easy. Limitation of landfill area with special precautions</td>
<td>The waste normally contains high concentrations of environmentally hazardous compounds. Occupational health problems may arise due to gas, odour and dust. Residues from incineration and flue gas cleaning mostly require sprinkling to deal with the emission of dust.</td>
</tr>
</tbody>
</table>

*Table 9.12: Advantages and disadvantages for the different types of landfills*
9.3 Example of Treatment Systems

**Mykonos - Example of a treatment system**

On Mykonos, a Greek island in the archipelago of the Cyclades, an examined alternative is A6: “Single strategy based on publicly organized recycling, composting and sanitary landfilling”.

This alternative requires:

- Compaction and transportation of recyclable materials to the mainland
- A composting plant
- A sanitary landfill

As most recyclables are collected in two recycling centres, compacting containers are used for compaction. As the waste is delivered directly to the compacting containers, no transfer will be necessary. The containers are transported to the mainland by a roll-on/roll-off vehicle and by ferry.

A simple drum composting facility with windrow composting is chosen. This plant will be relatively cheap and as it is a low-technology solution. The plant includes a receiving bunker with a facility which rips the green bags apart, a drum screen for sorting, a rotating drum for pretreatment and a windrow composting area with leachate collection. The plant must be located next to a waste water treatment plant in order to use cleansed water for irrigation of the compost, as the precipitation on Mykonos is low.

As the existing landfill is nearly filled, a new sanitary landfill must be established. This involves:

- Fencing
- Cutoff drains
- Equipment for covering and compaction
- Weighbridge for registration
- Consolidation of access roads
- Manning and preparation of operation manual
- Division into sections
- Plan for final covering

The landfill is located in an non-arable area far from residential areas and without rural or ground water interests.

1994/95
**Mallorca - Example of a treatment system**

The Spanish island of Mallorca in the archipelago of the Balearic Islands has an annual production of waste of approximately 329,000 tonnes. The treatment strategy proposed for Mallorca is a single strategy A8 with recycling, incineration and sanitary landfilling. This implies:

- Collection of glass and metals for recycling. Recycling will take place on the mainland. Glass and metals will be crushed and shredded before export.

- Collection of combustible waste for a new incineration plant. Combustible waste will be household waste (municipal waste) and solid fractions from the leather industry. The incineration plant will be with moving grate, power production turbine and semi-wet flue gas cleaning. Net power output of the plant is expected to be 363 kWh/tonne. After full implementation approximately 300,000 tonnes/year will be treated in the incineration plant.

- Slag from the incineration process will be used for construction activities.

- Inert materials from industry, construction waste and ash from the incineration plant will be disposed of in a sanitary landfill.

**Fano - Example of a treatment system**

On Fano, an Danish island with an annual waste production of approximately 3,000 tonnes/year, the tandem strategy B4: Public organized recycling, local composting and the remaining waste to the mainland, is chosen. This implies:

- Collection of paper, glass and aluminium in igloos and collection of paper, cardboard, glass, textiles, garden waste, aluminium and other metals at one or two recycling centres. The source separated waste fractions are upgraded and exported for recycling.

- Garden waste is shredded and composted. The compost is used for municipal gardens and for final covering of the closed landfill.

- The municipality offers subsidies for private purchase of a composting container for garden composting and a reduced waste tax if the households are doing garden composting. Approximately a third of households perform garden composting.

- The remaining household waste is collected as municipal waste and exported for incineration on the mainland.

- Industrial waste is source separated into recyclable materials which can be delivered to recycling centres, into combustible waste which is delivered directly to the incineration plant on the mainland, and inert waste which is delivered directly to a sanitary landfill on the mainland.

- Construction waste is reused and recycled on the island.

(1994/95); Other examples can be found in the study reports listed under References.
10. ENVIRONMENTAL IMPACT ASSESSMENT

10.1 Introduction

10.1.1 Background Information

In order to judge the benefits and/or inconveniences of a project, such as a waste incinerator or a landfill, the environmental aspects are to be taken into consideration, together with those related to technical and economic aspects.

The Council Directive 85/337/EEC of 27 June 1995 on the assessment of the effects of certain public and private projects on the environment sets the grounds for Environmental Impact Assessment (EIA). Its annexes list those projects which must under all circumstances, be the subject of an environmental impact assessment - amongst others installations for the treatment or the disposal of hazardous waste - and those, for which Member States have discretion whether to require an environmental impact assessment. Since Article 13 of the Directive recognizes the right of Member States also to subject projects to an environmental impact assessment prior to its authorisation which is not on the EC-lists, care should be taken that such an assessment is always made where it is required. Often it is even advisable to make an environmental impact assessment even where it is not mandatory. This may be important for insurers or creditors/financiers in particular.

The transposition of Directive 85/337/EEC into Member States national law makes it possible that the EIA process objectives are the same throughout the Union, though Member States may decide differently on the means of achieving the objectives of the Directive.
Strategic Environmental Assessment should be associated to land use planning, ensuring that a preliminary environmental impact analysis had been performed, thus leaving a more specific project environmental impact assessment to be performed later.

However, legislative, administrative and practical aspects of policy, plan and programme assessments are still at early stages, thus often leaving an environmental assessment to be performed at project planning.

By and large, when a project is notified to the competent authorities, it is reasonably developed from the technical and economic viewpoints, but developers tend to neglect the environmental evaluation.

The environmental impact assessment report should not be seen as another annex to attach to the file seeking authorization, but as an essential part of an integrated approach, enabling the setting up of alternatives.

Among the reasons for such a situation is that developers focus on "one solution", tending to justify it mostly from economic and technical viewpoints. The environmental impacts are either not being taken into account or are being largely neglected. In other words, the project planning is sometimes quite advanced before notification is made to competent authorities.

Waste management facilities are among the undertakings that local authorities are asked to give precise advice on. Some of them fall in Annex I of Directive 85/337/EEC making an environmental evaluation compulsory prior to development consent. The relevant environmental considerations should be well formulated in order to identify alternatives and enable a selection.

Local authorities, as developers of such undertakings, are bound to follow the same requirements as any private developer not exempting themselves of compliance with clear and objective criteria which have been set for assessment, including environmental criteria.

Commonly, an Environmental Assessment comprises different phases which, far from being isolated, are interconnected: i) screening; ii) scoping; iii) investigations and data acquisition; iv) environmental impact statement; v) post project analysis.

Several actors may be identified, perceiving the need and requirements for an environmental assessment in different ways.

The main actors are the developer of a project, the EIA competent authorities, the public and other (including regional and local (municipality) authorities).

Whereas in the i) screening phase, the developer may question the need for an EIA, the authorities require it in order to award or deny authorization. The public may wonder about the (direct) impacts of the project while "others" may wonder where responsibility for such a procedure lies.
Procedures for an environmental assessment may differ from one Member State to another. Art 5 of the Directive 85/337/EEC does not determine the form under which the information should be submitted to the competent authorities.

However, in order to let the procedure benefit from the contributions of the different actors on the one hand, and distinguish between the adoption of a statement of the environmental impacts and that of the project itself on the other, some clear guidelines should be provided.

The reliability of the final decision will depend on the quality of the procedure.

At the initial phase, such a quality is translated by the precision of the project’s description by its submitters, not only on the design but on the information on the impacts.

Once the competent authorities have announced the project, the public which is affected by the project should be able to put forward precise questions on the project, its impacts and observancy of legal requirements, in accordance with Art 6 of the above mentioned Directive.

The environmental impact assessment relies on the technical data and on their critical examination as expressed in the environmental impact statement.

Once the authorities have taken a decision, the different interested actors should have access to information and mutual discussion, giving the opportunity for further input to the statement.

The decision should reflect the findings and information brought in throughout the assessment procedure. (cf. Art 8).

The procedure benefits from an interaction among all interested actors which in the end have some responsibility on the solution adopted.

Deviations from the general procedure outlined above as well as the weight of participation of the different actors has been registered in the past, in case of projects which are considered of a national interest.

However, it should be pointed out that increasing environmental awareness has also contributed to an increasing public participation (individuals, NGOs, etc) and taking of responsibilities.

In practice, adequate development of the different phases may be achieved by trying to formulate relevant questions and giving answers to them.

The formulation of the environmental impact statement has received particular attention and checklists are developed in order to help developers in submitting adequate environmental information to the competent authorities.
The checklists aim at assisting the evaluation of the completeness and suitability of the information from technical and decision making viewpoints, as well as providing the necessary information to the public.

A checklist does not follow only one model, as specific national legislation on the one hand, and local circumstances and practical experience on the other, may determine different approaches.

The competent authorities develop their review by:

1) deciding on the relevant information for a specific context of the project;

2) determining whether there are omissions or shortcomings in the information presented;

3) in case there are omissions and/or shortcomings, deciding on which are crucial for the decision making process;

4) specifying which additional information is required and recommending the method of obtaining it.

Once stages 2) and 3) are complete, the environmental information required for a particular project or part of a project may be considered:

- complete - no need for additional information

- acceptable - not complete but not preventing the decision making process

- inadequate - additional information is necessary before the decision making process

As regards stage 4), the relevancy and adequacy of the information may depend upon:

- the legal background

- the level of decision making: i.e. the initial project stages, or detailed engineering aspects, or further environmental issues are to be considered

- particular characteristics of the projects. Could a precedent be set?

- particular characteristics of the environment i.e. particularity sensitive location

- public attitude to type of project or the particular project.

A checklist may comprise the following areas:

Figure 10.1 shows an example of questions identifying the items which may need to be provided to the competent authorities in the area of "description of impacts".
**Fig. 10.1 - Example of questions in the area of "description of impacts".**

**Impact Identification**

1. Have direct and indirect/secondary effects on construction, operating and, where relevant, after use or decommissioning of the project been considered (including both positive and negative effects)?
2. Does the information include consideration of whether effects will arise as a result of "consequential" development, i.e. whether additional development, which would be difficult to resist, will be induced in the area, leading to further environmental effects?
3. Have the above types of impacts been investigated in so far as they affect the following:
   - air and climate;
   - water and soils;
   - noise;
   - landscape;
   - historic and cultural heritage;
   - land use;
   - impacts on people and communities.
4. If any of the above are not of concern in relation to the specific project and its location, is this clearly stated in the information?
5. Is the investigation of each type of impact appropriate to its importance for the decision, avoiding unnecessary information and concentrating on the key issues?
6. Are impacts which may not themselves be significant, but which may contribute incrementally to a significant effect, considered?
7. Does information include a description of the methods/approaches used to identify impacts and the rationale for using them?
8. Has consideration been given to impacts which might arise from non-standard operating conditions, (for example equipment failure or unusual environmental conditions such as flooding), accidents and emergencies?
9. If the nature of the project is such that accidents are possible which might cause severe damage within the surrounding environment, has an assessment of the probability and likely consequences of such events been carried out and the main findings reported?

**Magnitude of Impacts**

10. Are impacts described in terms of the nature and magnitude of the change occurring and the nature (location, number, value, sensitivity) of the affected receptors?
11. Has the timescale over which the effects will occur been predicted such that it is clear whether impacts are short, medium or long term, temporary or permanent, reversible or irreversible?
12. Where possible, have predictions of impacts been expressed in quantitative terms? Otherwise, have qualitative description been defined?
13. Where quantitative predictions have been provided is the level of uncertainty attached to the results described?

**Data and Methods**

14. Have the methods used to predict the nature, size and scale of impacts been described and are they appropriate to the importance of each projected impact?
15. Are the data used to estimate the size and scale of the main impacts sufficient for the task, are they clearly described and have their sources been clearly identified?

**Evaluation of Impact Significance**

16. Has the significance of effects been discussed in terms of the impact on the local community and on the protection of environmental resources?
17. Has the significance of effects been discussed taking account of appropriate national and international standards or norms, where these are available. Otherwise, have the magnitude, location and duration of the effect been discussed in conjunction with the value, sensitivity and rarity of the resource?
18. Have the available standards, assumptions and value systems which can be used to evaluate significance been discussed?
19. Where there are no generally accepted standards or criteria for the evaluation of significance, have alternative approaches been discussed and, if so, is a clear distinction made between fact, assumption and professional judgement?
20. Does the information include a clear indication of which impacts may be significant and which may not?

**Other Relevant Criteria**

21.
22.

* Insert other criteria which are considered relevant in the specific circumstances of the proposed project/development.
10.1.2 Assessment of the Selected Alternatives

At the screening stage, the full evaluation of the environmental impact of the envisaged project may not be completed, though preliminary assessments are made in order to enable a choice among several alternatives of waste management systems.

Once the "description of impact" is done, it is necessary to quantify such impacts by taking into account local conditions. The general objectives of an activity as well as possible sub-activities are assumed to be known.

Methods for EIA have been developing for the past two decades, being available not only in the specified literature but also, on the market by means of ready-to-use packages. Some of the most common methods for environmental impact assessment are multiple criteria decision methods.

A series of criteria relating to each of the relevant parameters are listed, ranked and weighted in order to reflect the specific local conditions. Aspects which are of relevancy in the mainland, may have a different ranking in an island’s environment. That is certainly the case as regards ground water resources, and land availability, for example.

The evaluation of the environmental impacts should be based on a series of objective criteria. In case some subjective assessments are included they should be well justified in order to allow local waste managers an appropriate judgement on the preconditions.

In the sequence, examples are given of EIA methods, which may be used for the assessment of alternative waste management systems on islands. These were partly developed during the coordinated EU activity on waste management on islands, and aim at obtaining a tool which should be relatively handy to use.
Figure 10.2 illustrates in a simplified manner a waste management system, which in terms of specific alternatives may be combined in different ways. An EIA method has to be capable of comparing impacts from all parts of the system.

10.1.3 Three EIA Models

Environmental impacts from waste management systems are manifold and complex, and in order to be able to evaluate the impacts in relation to elements such as soil, water, air, human beings etc. (cf. section 10.1.1), the majority of EIA methods use systematic procedure.
EIA on islands will not diverge considerably from EIA on the mainland, as the common methods are useful on islands as well. However, the detailed elaboration of the EIA should reflect the specific conditions of the island in question. The availability of appropriate environmental data is crucial for performing the assessment of the impacts associated with all the possible alternative systems and activities.

Typically an EIA process comprises the following steps (fig. 10.3), whereas the scoping activities may be illustrated by (fig. 10.4) The three examples of EIA models given below are of the type of multiple criteria decision. Further references are included under the corresponding list at the end of this publication.

10.1.4 Model A

Paraskevopoulos-Georgiadis, Ltd, (for reference see at the end of this book) presents a version of a multiple criteria decision model, called Framework of Environmental Evaluation (FEE). The FEE includes four steps:

1. Objectives. The first task is to define the objectives of the model, that is to define what should be learnt from the evaluation, e.g. location of a landfill or a comparison between two or more treatment methods.

2. Evaluation criteria. The next step is to define the criteria for decision making. If the objective is location of a landfill, criteria can be depth of aquifers, water supply, area use, distance to residential areas, traffic conditions, etc. The criteria must be defined and quantified on a scale, e.g. from -10 to 10 or from 0 to 3.

3. Aggregation - formation of an overall index. The criteria scales must be aggregated in a kind of matrix, which combines the total of values. The combination function is usually a sum or a product or a combination of these. Most aggregation functions require the determination of relative weights by which the criteria are combined. The relative weights can be determined by:
   a) Direct specification by experts
   b) Specification by a comparative analysis of the criteria. In this procedure, the criteria are compared by pairs.

4. Evaluation. The criteria are calculated for a final score, and the scores are listed by ranking.

The FEE procedure can be applied for environmental impact assessment alone or for an evaluation with more parameters, e.g. a combination of practicability, economy and environmental impact.
Review of project and location to identify potential impacts

Review of Alternatives

Consultations with outside organisations

Deciding on Most Significant Impacts

Preparation of Draft Scope for EIA

Consultation on Draft

Finalisation of Scope and Continuing Review
Project Preparation

Notification to Competent Authority

Screening to determine need for environmental impact assessment

Scoping

Environmental Studies: Preparation and submission of environmental information to the competent authority

Consideration of environmental information

Decision by competent authorities

Post decision monitoring
10.1.5 Model B

Eratosthenes, Ltd. (for reference see at the end of this book) also presents a version of a multiple criteria decision model. This model has been elaborated for evaluation of alternative waste management schemes. The alternatives are evaluated according to 4 basic parameters, which are divided into subparameters:

1: Promotion of environmentally sound management
2: Optimization of technology applied
3: Optimization of economic parameters
4: Political aspects

The parameters are weighted from 1 to 3, where 3 is applied to the most important criteria. The alternatives are then evaluated according to these criteria on a scale from 1 to 5, where 5 is applied to the best performance. Figure 10.5 illustrates the criteria considered in the model of Eratosthenes, Ltd.

The ranking of the applied scores is based on the method of "minimum distance from the ideal point" using a mathematical formula.

10.1.6 Model C

Ramboll (for reference see at the end of this book) has developed an expert-based score model for evaluation of alternative waste management systems. The treatment systems included are: Recycling, garden composting, central composting, biogasification, incineration and direct landfilling. The model consists of 5 levels:

1. Basic scores. For each kind of waste treatment, a basic score is calculated for a number of environmental impacts (greenhouse gases, acid gases, heavy metals, dioxins, ground water, surface water, soil, occupational health, vicinity impact, resource consumption and risks). The basic scores are calculated by an expert team and the scores are based on "standard plants". The scores range from -10 to +10 with +10 as the maximum impact.

2. On the specific island, the basic score is adjusted with an additional score. The additional scores take into account any variants of the standard plants and any particular conditions on the island. The additional score is calculated as a fixed score by means of a questionnaire to the local authorities.

3. In order to compare the different impact scores, the next step is an environmental ranking. This ranking is not necessarily technical but shows the priorities of the local authorities, thus reflecting that it is a political matter. The impacts should be ranked as percentages, giving a total of 100%. The ranking is limited to certain intervals.

4. Combining the adjusted score (basic score plus additional score) and the environmental ranking, a priority score is calculated for each treatment process.
Criteria of evaluation for alternative waste management schemes

Environmental values
- Releases to air: Source separation, composting, sanitary landfilling and improvement of treatment facilities reduces emissions
- Releases to surface water: Improved treatment reduces emissions
- Releases to ground water: Improved treatment, especially sanitary landfilling, reduces emissions
- Aesthetics & odours: Improved waste treatment with less demand for space is positive

Technical aspects
- Reliability: The reliability of the treatment system in daily operation
- Overall efficiency: To evaluate the contribution to the treatment system to environmental protection, waste minimization and recovery
- Duration of construction: Short duration is considered positive

Financial aspects
- Investment costs: The cost of land acquisition, site development and mechanical equipment
- Operational costs: Cost of daily operation

Social/Political values
- Promotion of envir. policy: To give positive weight to alternatives that promote the environmental policy
- Recovery of resources: High degree of recovery is positive
- Recovery of energy: Net energy consumption or recovery - a high degree of recovery is positive
- Employment: Ability of creating jobs
- Land requirement: Treatment plants with large area use is considered negative
- Social acceptance: How will new treatment plants and methods affect local people
5. The priority scores are then combined with the relative waste flow, resulting in a number of *system scores*, which are aggregated in a *final score*.

The result of the procedure - the final score - is a number which can be compared to the numbers from evaluation of alternative systems.

A key element of this score model is the distinction between the scientific/technical and the political factors of the decision-making process.

This score model is restricted to the assessment of environmental impact. Other relevant aspects for evaluation such as economy, political aspects etc. should be evaluated respectively and included in an overall evaluation comparing all aspects.

10.1.7 Discussion of the Three Models

In any of the three models the decisive factors are:

- Assure that all relevant criteria are considered.

- Attribute the relative weights to the criteria. The comparison and consequent weighting of the different types of impacts is crucial to all EIA models. Most often, some kind of expert-based comparisons are used, but no absolute comparison between the pollution of ground water and emissions to the air can be made.

- When the criteria to be compared are a mix of practical, technical, economic and environmental aspects, it is obvious that the scaling is a political matter and not a technical one (some of the criteria are less objective than others). If the model is based on expert ranking only, some of the political choices are hidden within the model, thus passing the political factors off as technical factors.

- Integration of technical, economic and political factors in the EIA provides a more simplified tool for decision making, but on the other hand the integration and ranking of the different elements may suppress important requisites and consequences and an adequate background for a sound decision-making may not be established. As an example a very cheap waste management system may get the best score even though it has a high environmental impact.

- To ensure that criteria and scaling is not biased towards certain decisions. If the model is not set up in an objective way, it will only act as a justification of a choice already made - the output equals the input!

The (less objective) preconditions should be made clear to the decision-makers at any time.
A way to ensure a professional scaling of the parameters can be the use of a score model such as:

<table>
<thead>
<tr>
<th>Assessment parameters</th>
<th>Scores</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>External environment</td>
<td>Trace</td>
<td>Small</td>
</tr>
<tr>
<td>Dispersion</td>
<td>Little</td>
<td>Some</td>
</tr>
<tr>
<td>Effect</td>
<td>Natural</td>
<td>Reversible</td>
</tr>
<tr>
<td>Working Environment</td>
<td>Duration</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td>Exposure</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td>Effect</td>
<td>Nuisance</td>
</tr>
</tbody>
</table>

This assessment score gives 10 possible problem levels (1,2,3,4,6,8,9,12,18 and 27). Generally, assessment scores below 9-12 indicate that attention should be paid to the performance of the treatment process, while scores above 9-12 generally indicate a treatment method which should be avoided or minimized.

As indicated in the three models, different kinds of aggregation of the sub-scores exist. Some methods for aggregation are based on addition, some on product formulas, some on a combination of these and others on more complex mathematical formulas. The simple models may be less mathematically correct than the more advanced mathematical models, but they have the advantage of being more easily understandable.

An important element in the EIA is to end up with a result which will facilitate the comparison of alternatives for the local decision makers.

Also important is to elaborate a clear description of the model, the preconditions and the subjective choices made in the EIA.

### 10.1.8 Checklist of Environmental Impacts

In most methods, the choice of environmental parameters depends on the purpose for which a method is to be applied, and varies from situation to situation, whereas other methods apply fixed environmental parameters, e.g. those related with sustainable development.

In section 11.1.1 an example of a checklist is given. It may help the description of the impacts. In the sequence, further specification of parameters is given per area to be investigated.

**Climate:**
- Greenhouse gases (CO₂, CH₄)
- Clearing of vegetation
- Changing of land-water relations (land reclamations, reservoirs)
Air:
- Acid gases (HCl, SO₂, NOₓ, and NH₃)
- Heavy metals
- Dioxins

Ground water:
- Contamination of ground water
- Change of ground water level

Surface water:
- Thermal pollution
- Filling and dredging

Soil:
- Change in nutrient status of soil
- Heavy metals which may reach the human ecosystem via crops
- Erosion

Occupational health:
- Exposure to endotoxins or other toxic substances
- Manoeuvring heavy lifts/weights
- Noise

Waste
- Production of waste (different types)
- Treatment of wastes
- Disposal

Vicinity impact (the local environment):
- Noise and vibration
- Odour

Resource consumption:
- Materials
- Energy

Ecological impacts:
- Flora and fauna
- Change of landscape

Risks:
- Fires and explosions
- Floods

10.2 How to Use Environmental Impact Assessment

Independent to the specific EIA method chosen, the EIA procedure should include the following steps:
- **Objectives.** The first step of an EIA procedure is the definition of the objectives of the waste management and of the EIA. Objectives of the waste management are discussed in chapter 3. The level at which the EIA is being carried out should also be specified. Is it a comparison between alternative scenarios or does it relate to the location of treatment plants and disposal sites?

- **Data collection.** Data collection includes both mapping and measurement of future waste flows. Data collection, which is considered in chapter 4, should include:
  - Waste amounts and composition
  - Existing collection and transport equipment
  - Existing treatment facilities
  - Geographical and geological data on possible locations for plants and landfills

- **Alternatives.** It is important to include alternative scenarios in the EIA. A description of alternative strategies for waste management on islands is provided in chapter 5.

- **Criteria.** Local authorities should set up a number of criteria for evaluation of the alternatives. The criteria should be clustered as main criteria divided into sub-criteria. Criteria can be restricted to environmental impacts, but other parameters such as feasibility, economy, etc. can also be included. Three examples of setting up criteria are included in section 11.1.

- **Ranking.** The criteria or types of impact must be ranked or given relative weight in order to enable comparison. Ranking should be made as a priority to the most important criteria or parameters. Sometimes, non-objective parameters are considered and ranking becomes not strictly technical, but may introduce some political aspects to the decision.

- **Score.** The criteria or parameters must be evaluated and given a score. The score can be the quantified impact or a score on a scale (index). The use of a scale will facilitate the comparison between parameters. If a scale is used, it is important to elaborate an objective and consistent method for the calculation of scores.

- **Aggregation.** The scores of the sub-criteria or parameters should be aggregated into a form, which will make a simple comparison possible. Different types of mathematical tools for such multiple criteria decision making exist. Examples of aggregations are discussed in section 11.1.

- **Comparison of alternatives.** It should now be possible to compare the alternatives and to find the waste management system with the lowest environmental impact. The results and a description of the differences in the impact of the alternatives should be elaborated and presented to the local authorities.
10.3 Examples
Three examples of EIA are presented in the following sequence. They follow the description of three EIA models described in section 10.1.

**Kos - Example of an EIA**

Paraskevopoulos-Georgiadis, Ltd. performed a comparative analysis of four waste treatment methods on Kos:

A: Landfilling  
B: Incineration  
C: Composting  
D: Recycling

The treatment methods are evaluated according to five main criteria, which are given relative weights:

1. Practicability - 10%  
2. Relevance for the island - 20%  
3. Technical feasibility - 15%  
4. Economic aspects - 25%  
5. Environmental impact - 30%

The subcriteria for each of these main criteria are scaled in a 4-point system:

0: No desirability/acceptability for the method  
1: Low desirability/acceptability for the method  
2: Medium desirability/acceptability for the method  
3: High desirability/acceptability for the method

When the scores for the criteria have been calculated and they have been given relative weights, the scores can be totalled into final scores:

A: Landfilling - 61 points  
B: Incineration - 52 points  
C: Composting - 50 points  
D: Recycling - 79 points

From this, it appears, that the treatment methods can be ranked as follows: Recycling - landfilling - incineration - composting.
Zante - Example of an EIA

In the evaluation of alternative waste management schemes on the Greek island of Zante, Erasthotenes, Ltd. has used the multiple criteria model described above. Each of the subparameters is taken in turn, in order to attribute a score (1-5) and a weight of importance.

The four alternatives to be evaluated are:

A: Recycling of paper and aluminium and landfilling of the residual waste

B: Recycling of paper and aluminium, composting of putrescible (source separation) and landfilling of the residual waste

C: Recycling of paper and aluminium, composting of putrescible (central mechanical separation), separate landfilling of household batteries and landfilling of the residual waste

D: Recycling of paper and aluminium, composting of putrescible and production of RDF (based on central mechanical separation), separate landfilling of household batteries and landfilling of the residual waste

The result of the assessment is:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>1.1</th>
<th>1.2</th>
<th>1.3</th>
<th>1.4</th>
<th>2.1</th>
<th>2.2</th>
<th>2.3</th>
<th>3.1</th>
<th>3.2</th>
<th>4.1</th>
<th>4.2</th>
<th>4.3</th>
<th>4.4</th>
<th>4.5</th>
<th>4.6</th>
<th>d^k</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td></td>
<td>0.2033</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Notes: The numbers 1.1 to 4.6 refer to the subcriteria illustrated in figure 11.2 from the top of the figure. The formula for calculation of d^k is provided below, where W_i^k represents the relative importance of each criterion i for each scenario k and g_i^k represents a grade of the criterion i.

d^k is the distance to the "ideal point", thus showing alternative C to be the optimum alternative.

\[ d^k = \sqrt{\sum_i W_i^k \times (g_i^k - g_i^k)^2 / (g_i^k - g_{i+})^2} \]
Andros - Example of an EIA

In the analysis of alternative waste management systems on the Greek island of Andros, three alternatives (cf. chapter 5) were evaluated by Ramboll:

I: Single strategy A5: Recycling and sanitary landfilling
II: Single strategy A6: Recycling, composting and sanitary landfilling
III: Joint strategy C6: Recycling, composting and sanitary landfilling

As the first step, the waste flow was estimated for each strategy. The additional score was added according to the conditions on Andros. In this way the adjusted score was calculated.

In order to compare the adjusted scores, an environmental rating was effected. The rating is not necessarily technical but shows the priorities of the local authorities. All impacts must be rated in the interval of 0-100% with a total of 100%. The rating was in this case effected by RH&H Consult with regard to the priorities of the local authorities on Andros. The ratings were:

<table>
<thead>
<tr>
<th>Impact Island</th>
<th>Greenhouse gases</th>
<th>Acids</th>
<th>Heavy metals</th>
<th>Dioxins</th>
<th>Ground water</th>
<th>Surface water</th>
<th>Soil</th>
<th>Occupational health</th>
<th>Vicinity impact</th>
<th>Resource consumption</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andros</td>
<td>10%</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
<td>10%</td>
<td>15%</td>
<td>5%</td>
<td>5%</td>
<td>15%</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>

By multiplying the adjusted scores with the environmental ratings the priority scores were calculated. Then the priority scores were multiplied with the share of amount, i.e. the part of the waste, which is treated in the specific treatment system in that particular alternative. The result is a sub-score, which can be summed up to a total score for each treatment system (right column) or for each impact (bottom row). The total of these scores is the final system score, which is the value of the environmental impact analysis for the specific alternative.

For Andros the final system scores for the present waste management and the three alternative strategies are illustrated in figure 10.6.

As can be seen from the figure, all three alternatives represent considerable improvements compared to the present situation and the alternative with the lowest environmental impact is alternative III: Joint strategy with recycling and treatment of source separated organic waste in a joint high-technology composting plant and disposal of the residual waste on a joint sanitary landfill.
Figure 10.6: EIA scores for Andros
At this stage, both an economic evaluation and an EIA of the waste management strategy alternatives were performed. It is therefore possible to select the alternative most suitable for the island in question and prepare a report which will serve as a basis for a decision at political level.

Such a report should comprise the following main aspects:

- Description of the waste management alternatives as precisely as possible, including the requirements for achieving the objectives.
- Description of the preconditions for the success of each alternative.
- Description of the advantages and disadvantages of each alternative.

The report should weigh the different factors regarding technical aspects and/or standards, financial resources and environmental impact.

The local decision-makers may have been involved in some of the initial phases of the waste management planning, e.g. selection of treatment strategies and alternative strategies, but the situation might also be that they have not been asked for an opinion until this stage of the planning procedure. At any rate, at this point of waste management planning a decision at political level has be taken the main strategy, treatment solution, technical, legal and organisational aspects.
The choice between alternatives and a decision on one solution for waste management and waste management planning for, say, the next decade results from the consideration of many local interests and will be weighted in relation to other technical sectors (water supply, waste water treatment, facilities at the harbour, etc.) which also have to be taken into account when the alternatives are described.

One of the purposes of the present Manual is that of helping local authorities select waste management alternative(s) in order to fulfil the requirements set down in the Council Directive 75/442/EEC on waste, in particular, article 7 relating to waste management plans.
12. IMPLEMENTATION OF THE CHOSEN STRATEGY

12.1 Establishing a Waste Management Plan

When a waste management strategy has been chosen, (a) waste management plan(s) is/are prepared. The waste management plan(s) is(are) adopted by the national, regional or local (competent) authorities as determined by the national law on waste (cf. Council Directive 75/442/EEC on waste).

By and large, a waste management plan shall cover:
- the natural or legal persons empowered to carry out the management of waste,
- the estimated costs of the recovery and disposal operation,
- appropriate measures to encourage rationalization of the collection, sorting and treatment of waste.

More specifically, a plan may contain sections focusing on: framework and actual conditions, objectives, actions, time schedules, budget, monitoring, enforcement, training and information.

12.2 Framework and actual conditions

An adequate waste management strategy for an island is only possible to be draw up when a survey has been carried out on the actual conditions on the island.

This includes a collection of data on the waste flows and will look into all the aspects discussed in this manual e.g. collection of data on waste flows, infrastructure, geographic, geological and climatic conditions, legal and administrative framework, existing equipment and treatment facilities, equipment (available and needed), treatment facilities (available and possible to develop) and markets for recyclable materials, compost and energy.
It is important to ensure the link between local planning on the island and regional, national and more generally, EU planning on waste management.

12.3 Objectives

The objectives of the waste management plan should be set up on the basis of the identified problems (cf. section 4). Both the legislative requirements (cf. section 3) and the main problems identified are to be met by the objectives of the plan. At this stage qualitative objectives are set. The objectives of the waste management plan must be in accordance with the chosen strategy.

Examples of (qualitative) objectives are:

- Avoid and/or prohibit illegal dumping of waste
- Increased efforts towards waste prevention
- Increased recovery, including recycling
- Improvement of landfill conditions - establishment of a sanitary landfill
- Establishment of biological treatment of the organic fraction
- Improvement of collection standards and occupational health
- Better organization of waste management and increased cooperation
- Establishment of incineration with energy recovery

The objectives must also be specific and quantified - as an example: 60% of the waste for recovery (including recycling), 20% for incineration with energy recovery and 20% for landfilling. Objectives can be requirements for collection and transportation, establishment of treatment plants, improvement of an existing landfill and targets for recycling of specific materials.

12.4 Actions

Based on the objectives of the plan and the existing waste management system a set of actions are set in order to meet the objectives.

Depending on the specific conditions, actions may be:

- Characterisation of present waste flows and future trends
- Establishment of a monitoring system
- Reorganization of the collection and transport system (including roads)
- Purchase of new equipment for collection and transportation (receptacles, vehicles)
- Selection and purchasing of collection, transportation and compaction equipment.
- Establishment of a selective collection system (including information to the public, implementation)
- Establishment of recycling centres
- Organization of hazardous waste treatment
• Establishment of a composting plant
• Establishment of a sanitary landfill or improvement of existing landfill
• Establishment of a biogas plant
• Establishment of an incineration plant
• Establishment of the overall required organization

12.5 Time Schedules

Once the required actions are identified, they are given an order of priority and a time schedule. Time schedules enable a clear and unambiguous implementation of the actions as well as an allocation of relevant staff and economic resources.

The exact time schedule depends on the type of plan being drawn up. In a short-term plan (i.e. 3-5 years), specific time schedules are to be indicated, whereas a long-term plan (i.e. 10-12 years) is often described as a strategy where the objectives and actions are clearly set but the time schedules are not so exactly stated.

As an example taken from a study performed on the island of Andros, a time schedule may be set as follows:

| Waste Management Plan for Andros (Archipelago of the Cyclades, Greece) |
|-------------------------------------------------|--------|--------|--------|--------|
| Establishment of a waste management unit covering the entire island |        |        |        |        |
| Improvement of existing landfill                |        |        |        |        |
| Establishment of a joint collection and transportation system |        |        |        |        |
| New containers for municipal waste               |        |        |        |        |
| New refuse collection vehicles                   |        |        |        |        |
| Transfer stations for remote residents           |        |        |        |        |
| Establishment of selective collection sites for hazardous wastes |        |        |        |        |
| Establishment of recycling centres and igloos    |        |        |        |        |
| Establishment of a cooperation on waste management in the archipelago |        |        |        |        |
| Establishment of shipment facilities             |        |        |        |        |
| Establishment of joint treatment facilities      |        |        |        |        |

Table 12.1: Example of time schedule for a waste management plan

12.6 Budget

A budget can be elaborated for all actions in the waste management plan, for all actions in the short-term plan and for each year.
A budget for the entire waste management plan must contain estimates of the need for investments for each action and the operating costs. This will provide information on the possible need for funding, loans and taxes/fees. It must be specified which part of the investments and expenses will be met by taxes and fees, and which part will be raised by loans and other funding. Reasoning and decisions are to be taken in the context of the relevant national law.

In the short-term plan the estimates of investments and expenses must be quite specific, and investments considered per year covered by the plan. Based on the overall budget for 3-5 years a budget can be elaborated for each year. These annual budgets must be audited and revised every year.

12.7 Monitoring

A continuous monitoring system providing information on the development of amounts and composition of the waste and on the distribution on treatment systems will reveal much of help for identifying future trends or changes.

The monitoring task will be facilitated if all waste treatment plants or disposal sites register the waste inputs (ie. overall quantities by means of a weighbridge at the reception).

In countries, where such registration does not take place, other measurements must be carried out. In most countries national studies have been carried out for municipal or household waste, indicating the average annual waste production per inhabitant and waste composition. Another possibility is to check the amount of waste collected in the municipal collection scheme every week.

In the case of more specific waste flows, such as industrial waste or some priority waste streams, monitoring of waste may be more difficult. However, interviews or questionnaires answered by the relevant industries, or waste streams producers, service stations, retailers, importers, as well as other actors may provide an estimation of those wastes characterisation.

12.8 Enforcement

Enforcement measures must be foreseen and established in order to ensure a proper execution of the waste management plan. Enforcement measures may be:

- **Legal and administrative measures:**
  - Enforcement of national and EU regulations
  - Local regulations
  - Control activities
• **Economic measures:**
  - Taxes and charges to influence consumer behaviour
  - Penalties for non-separated waste or waste not delivered as required in the local regulations

• **Agreements:**
  - Voluntary agreements between local authorities and industry and commerce on e.g. source separation and delivery of certain waste materials
  - Sanctions for breaching of agreements or free-riders.

**12.9 Training**

Training of staff is of great importance for the implementation of new waste management activities. All members of staff must be involved in the training activities. Moreover, it is important to ensure good timing of the training, so that the employees have acquired the necessary skills before a new plant or activity is taken into use.

Training programmes on waste management may address:

1. Decision makers in municipalities, communities and in possible waste association(s) have an immediate need for knowledge of modern waste treatment methods and forms of organization complying with future solutions.

2. Employees, who are to develop a waste management administration, would profit from the same kind of courses.

3. Staff employed in collection and operation of a waste management plant would benefit from technical courses.

Moreover, the local authorities on the island or the waste association(s) may cooperate with municipalities and waste associations having already developed modern waste management systems and waste management companies. In Europe, many associations of this kind exist and exchange visits and study tours are often natural elements of such cooperations.

**12.10 Information**

Information to citizens and tourists is crucial for the proper implementation of a new waste management plan. In order to ensure e.g. the required source separation and/or the right delivery of waste, it is important to inform both citizens and tourists about waste management on the island.

Besides, the success of a strategy under implementation will depend upon regular information provided to inhabitants as well as visitors to the island.

Examples of information to be provided are:
· Information on the need to avoid and prohibit illegal dumping and similar activities
· Information on how to separate and when and where to deliver the waste
· Information on the importance of proper source separation
· Information on new initiatives within source separation
· Information on new treatment facilities

Information campaigns should be prepared and initiated well in advance of the implementation of new initiatives, and campaigns promoting e.g. source separation should be repeated at regular intervals. Similarly, for other specific campaigns.

The way in which the information is imparted is decisive for the success of the campaign. In this context, it is important to collect and make appropriate use of feedback the public may give to the campaign. This will contribute to the gradual closing of the gap between the administration/politicians and the public.
13. CONCLUSION

This manual for waste management on islands does not pretend to be exhaustive. Instead, it aims at providing a tool which may be used by waste managers at local level in order to develop a proper sequence for a waste strategy and choice of waste management alternatives.

For this reason, the structure of the manual is that of a step-by-step approach to the development of waste management strategy for an island.

Chapters 3 and 4 provide the background for establishing a waste management strategy.

Chapter 3 provides an overview of the legislative framework for waste management in Europe. It refers to national legislation and local regulations as well.
Chapter 4 provides an identification of the main waste management problems on European islands, together with some of their causes. It puts the emphasis on the need for data collection on all aspects covered by the management of waste.

Chapter 5 focuses on the main strategies for islands: from single to tandem and joint strategy. When the possibilities for treatment of waste are brought in, some treatment strategies are devised which depend on the situation on the specific island.

The screening of the different strategies is then performed in terms of organizational aspects. The options available for the local authorities depend upon the particular island.

An economic evaluation and the opportunities for funding of waste management facilities is then taken into account.
Chapter 8 focuses on **collection and transportation** aspects required for a good performance of any waste management system. Considerations are made on collection methods and equipment and transport requirements, including temporary storage.

Chapter 9 focuses on the screening of the strategies in terms of **treatment and disposal**. Chapter 9 provides a summary of the most relevant aspects associated with a series of available technologies for composting, biogasification, incineration and sanitary landfilling.

Chapter 10 is an introduction to the objectives of **environmental impact assessment**. It then briefly mentions three different models of impact assessment which were partially developed for the sake of the Islands’ Programme.

The **choice of an alternative** is the object of chapter 11.
Considerations related to the establishment of a waste management plan which will be the object of a decision by the competent authorities (political level) are made in chapter 12.
### Appendix A : DEFINITIONS AND GLOSSARY

**Definitions contained in EU legislation:**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste</td>
<td>Any substance or object which the holder discards or intends or is required to discard.</td>
</tr>
<tr>
<td>Waste prevention</td>
<td>Any effort aimed at minimization of waste, including reduction of production and consumption of goods which cause waste (including packaging), development of cleaner technology and good housekeeping within the production units.</td>
</tr>
<tr>
<td>Producer/generator</td>
<td>Anyone whose activities produce waste and/or anyone who carries out pre-processing, mixing or other operations resulting in a change in the nature or composition of this waste.</td>
</tr>
<tr>
<td>Holder</td>
<td>The producer of the waste or the natural or legal person who is in possession of it.</td>
</tr>
<tr>
<td>Waste management</td>
<td>Collection, transportation, recovery and disposal of waste, including the supervision of such operations and aftercare of disposal sites.</td>
</tr>
<tr>
<td>Disposal</td>
<td>Disposal of waste by any of the following operations: tipping above or underground, land treatment, injection into deep repositories, surface impoundment, disposal at specially designed landfill, discharge of solid waste into a water body except into seas and oceans, dumping including insertion in the sea bed, biological or physicochemical treatment, incineration on land or at sea, permanent storage, blending, mixing or repacking or any kind of treatment prior to the above-mentioned methods of treatment.</td>
</tr>
<tr>
<td>Recycling</td>
<td>Reprocessing of waste materials for the original or other purposes, including organic recycling but excluding energy recovery.</td>
</tr>
<tr>
<td>Recovery</td>
<td>Any of the following operations performed on various substances to recover waste: reclamation/regeneration, recycling, refining (of oil), energy recovery, spreading on land.</td>
</tr>
</tbody>
</table>
Other definitions and glossary:

Acid gases: A group of gases, mainly $\text{SO}_2$, $\text{NO}_x$ and $\text{HCl}$ which after emission to the atmosphere react and cause generation of acid rain.

Agricultural waste: Animal waste and natural, non dangerous substances used in farming.

Animal waste: Manure, carcasses etc.

Bring system: Collection system where the waste holder brings the waste to the waste collection points (containers) situated within the vicinity of the source of generation.

Bulky waste: Large or relatively large objects from households, trade, commerce, industry and institutions.

Central composting: Composting at a central plant of organic solid waste and garden waste and any waste water sludge after prior collection hereof.

Central sorting: Manual or mechanical sorting of waste materials in a central sorting centre.

Commercial waste: Waste from trade, commerce, institutions, hotels and restaurants.

Compactor: Any power-driven mechanical equipment designed to compress and reduce the volume of waste materials.

Construction waste: Waste from construction, building, demolition and renovation of houses, plants, roads, etc.

Container composting: Composting based on a closed container system.

Dioxins: Group of chlorinated tricyclic compounds including PCDD (polychlorinated dibenzo dioxins) and PCDF (polychlorinated dibenzo-furans) produced as chemical by-products. Ubiquitous in the environment, being found in trace quantities in soil, milk, human and animal fat and other biological tissues. Toxicity varies with the number and configuration of chlorine atoms in the molecule.

Drum composting: Composting system based on pre-treatment in a rotating drum followed by windrow composting.
Electric/electronic appliances: Any appliance from households, commerce, industry or fixed installation which functions by means of a source of external or internal current.

Flue gas residues: The residues from cleaning of the flue gas from an incineration plant.

Garden composting: Composting in private gardens of organic household and garden waste either in open piles or in small receptacles.

Garden waste: Vegetation waste from private gardens and public parks and areas.

Greenhouse gases: A group of gases, including CO₂ and CH₄, whose accumulation in the upper zones of the troposphere causes an increase of the atmospheric temperature and a change of the Earth climate.

Heavy metals: Group of metals such as mercury, cadmium, lead and nickel which can have a toxic impact on human beings and animals.

Hospital waste: Wastes from hospitals and similar establishments, which include clinical wastes from wards and operating rooms, surgical wastes from operating rooms and food wastes.

Household waste: Waste generated by households.

Igloo: A container used for the disposal of recyclable materials.

Industrial waste: Waste from industrial production.

Landfill: Waste disposal site for the deposit of waste on or underground. Includes internal waste disposal sites and excludes facilities where waste is unloaded in preparation for further recovery, treatment or disposal elsewhere and temporary deposit of waste prior to recovery, treatment or disposal.

Inert landfill: Landfill for inert materials only.

Intermunicipal waste company: A waste management company formed by a group of municipalities/communities.

Kerbside collection: The collection of household wastes from a kerbside collection point.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multifamily unit:</td>
<td>Container(s) placed at the kerbside in residential areas covering several houses/flats.</td>
</tr>
<tr>
<td>Municipal Solid Waste:</td>
<td>Waste collected through municipal collection schemes.</td>
</tr>
<tr>
<td>Oil waste:</td>
<td>Any mineral lubricant or industrial oil which has become unfit for its original use.</td>
</tr>
<tr>
<td>Organic fraction:</td>
<td>Fraction of waste containing hydrocarbons, often their components with other elements, e.g. vegetable matter and paper.</td>
</tr>
<tr>
<td>Pellet:</td>
<td>A densified fuel form, usually cylindrical, die-formed, usually by extrusion, with random lengths and open broken ends. Generally of high density.</td>
</tr>
<tr>
<td>Physical planning:</td>
<td>Area planning - planning for construction activities, urban and rural development, infrastructure and natural resources.</td>
</tr>
<tr>
<td>Putrescible fraction:</td>
<td>The portion of household waste, often food and vegetable matter, which will decompose most readily and which is often responsible for offensive odours.</td>
</tr>
<tr>
<td>Pyrolysis:</td>
<td>The chemical decomposition of complex molecules by heating in the absence of oxygen, producing solid, liquid and gaseous substances.</td>
</tr>
<tr>
<td>Recyclable:</td>
<td>Waste able to be reprocessed and recycled either for the original or other purposes.</td>
</tr>
<tr>
<td>Recycling centre:</td>
<td>A centre with a number of maxi-containers for the dumping of recyclable material.</td>
</tr>
<tr>
<td>Refuse derived fuel (RDF):</td>
<td>A fuel made from the combustible fraction of refuse after prior separation in a process plant.</td>
</tr>
<tr>
<td>Sanitary landfill:</td>
<td>Controlled landfill with facilities for protection of the environment and which complies with the EU project of directive on landfills.</td>
</tr>
<tr>
<td>Sea ballast:</td>
<td>Oily waste from ships, including ballast water containing oil.</td>
</tr>
<tr>
<td>Selective collection centre:</td>
<td>Collection centre for selective wastes.</td>
</tr>
<tr>
<td>Source separation:</td>
<td>Separation of waste into certain components (can be paper, glass and aluminium for recycling, hazardous wastes and batteries for special treatment, organic waste for composting or</td>
</tr>
</tbody>
</table>
biogasification or combustible waste for incineration) performed by the waste holder.

Special depot: Controlled sanitary landfill for one waste type only or with sections for specific wastes. Mostly used for hazardous wastes, batteries, residues from flue gas cleaning, etc.

Vicinity impact: Impact to neighbours from any plant or treatment process. Impacts can be the sight, dust, noise and odours.

Windrow composting: Composting method where waste is composted in piles in the open air. The piles are turned over at certain intervals and are irrigated when necessary.
Appendix B : REFERENCES

As stated in the Preface to this Manual, the Islands’ Programme, gathering eight consultants from six Member States of the European Union, addressed the theme of "Codes of Practice for Waste Management on Islands". Detailed surveys were performed on the following islands/archipelagos:

- The Shetland Islands
- The Orkney Islands
- The Outer Hebrides
- The Inner Hebrides (Argyll and Bute District)
- Aran Isles
- Isle of Wight
- Bornholms
- Fanø
- Andros (Archipelago of the Cyclades)
- Mykonos (Archipelago of the Cyclades)
- Madeira Archipelago (Madeira and Porto Santo)
- Açores Archipelago (Santa Maria, São Miguel, Terceira, Pico, Faial, São Jorge, Graciosa, Flores, Corvo)
- Canary Islands (Gran Canaria, Tenerife, Lanzarote, La Palma, Fuerteventura, El Hierro, La Gomera)
- Balearic Islands (Mallorca, Menorca, Ibiza and Formentera)
- Tuscan Archipelago (Elba, Capraia, Gorgona, Montecristo, Pianosa, Giannutri, Giglio)
- Dodecanese Archipelago (Rodos, Karpathos, Kassos, Symi, Halki, Tilos, Nisyros, Astypalea, Kalymnos, Lipsi, Leros, Patmos, Megisti, Agathonisi)
- Kos
- Zante
- Cefalonia
- Ithaki
- Lefkas

128
The references to the reports on which the data contained in this Manual is based are:

- **BYRNE O’ CLEIRIGH Ltd.**
  30a Westland Square
  Pearse Street
  Dublin 2
  Ireland

  "Study of waste management on islands off Great Britain & Ireland"
  Volume 1: study findings.
  Volume 2: guideline for waste management on islands off Great Britain & Ireland
  "Technical and Economic Note on Incineration and Pyrolysis of Wastes"

- **RAMBOLL**
  Bredevej, 2
  DK - 2830 Virum
  Denmark

  "Waste management on Bornholm, Fano, Andros and Mykonos"
  "Problematic waste streams on Bornholm, Fano, Andros and Mykonos"
  "Alternative waste management systems on Bornholm, Fano, Andros and Mykonos and environmental analysis"
  "Concepts for waste minimization and recycling on Bornholm, Fano, Andros and Mykonos"
  "Concepts for incineration and for sanitary landfilling on Bornholm, Fano, Andros and Mykonos"
  "Concepts for the management of problematic waste streams on Bornholm, Fano, Andros and Mykonos"
  "Waste management plan and recommendations for Bornholm, Fano, Andros and Mykonos"
  (one volume for each island)

- **PROCESL**
  Rua Castilho, 67, 4°
  P-1200 Lisboa
  Portugal

  "Codes of practice for waste management on islands".
  "Preliminary study".
  "Practical cards"."Biogas production and utilization".

- **TPA S.A.**
  C/ Federico Salmon, 13
  28016 Madrid
  Spain

  "Waste management on islands".
  "Special waste streams".
  "Alternative handling systems".
  "Concepts for waste minimization and recycling".
"Concepts for waste incineration and disposal".

"Concepts for collection, transportation and treatment of problematic waste streams on islands".
"Concepts for disposal".
"analysis and recommendations of alternative waste management methods for the canary islands".

SOCIEDAD DE ESTUDIOS P&G, SA
C/ Castello, 24
E - 28001 Madrid
Spain

"Codes of conduct for waste management on islands - the case of the balearic islands" (interim report).
"Survey on different techniques of source separation/central sorting".

LOMBARDIA RISORSE s.p.a
Via A. Costa, 31
I - 20131 Milan
Italy

"Codes of conduct for waste management on islands" (interim report).
"Collection of technical data on source separation, collection, transportation and treatment systems (composting plants)"

PARASKEVOPOULOS & GEORGIADES, Ltd
58 Pontou Street
GR - 11527 Athens
Greece

"Kos island, model waste management plan".
"Recycling methods/plants".

ERATOSTHENES, Ltd
17a Stournara
GR - 10683 Athens
Greece

"Waste Management for the Islands of Zante, Cefalonia, Ithaki and Lefkas" (2 volumes).
"Practical cards: Collection & Transportation".
European Commission

**EUR 16995 — Codes of practice for waste management on islands**

Luxembourg: Office for Official Publications of the European Communities

1997 — iv, 130 pp. — 21 x 29.7 cm

ISBN 92-827-8301-4

Price (excluding VAT) in Luxembourg: ECU 13.50