

Environmental Science

A Study of interrelationships

Unit 9

Solid Waste Management and Disposal

Introduction

Solid Waste (固体废弃物)

Solid waste means any garbage or refuse; sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility; and other discarded material, including solid, semi-solid resulting from industrial, commercial, mining, and agricultural operations, and from community activities .

- ◆ Industrial Solid Waste
- ◆ Mining Solid Waste
- ◆ Agricultural Solid Waste
- ◆ Municipal Solid Waste

◆ Industrial Solid Waste



Approximately 635 million tons of industrial waste per year
Fig. 1 Industrial solid waste (left) and it's disposal (right)

◆ Mining Solid Waste



Waste from extraction and processing of mineral resources, which is one of the largest waste streams in many countries.

The U.S. Geological Survey: 1700 million tons of mining waste are produced each year.

Fig. 2 Mining solid waste (left) and its disposal (right)

◆ Agricultural Solid Waste



Animal health products
Vehicle and Machinery waste
Building waste
Plastic Packaging
Non-packaging plastic

Approximately 3000 million tons of agricultural waste are generated each year.

Fig. 3 Agricultural solid waste

◆ Municipal Solid Waste



Approximately 210 million tons
of waste per year



Fig. 4 Municipal solid waste (left) and its disposal (right)

Solid Waste Management



Industrial waste



Mining waste



Agricultural waste



Municipal waste

- ◆ consume a large area of land / lack of dumping land
- ◆ Potential effects on groundwater and air quality
- ◆ decreased landfill site
- ◆ increased operating cost

Need long-term solutions to reduce



The nature of the problem

'Wherever people exist, waste disposal is a problem.'

The effect of lifestyle on solid waste production

The waste generation rate of people are directly related to their economic condition. People in richer countries produce more garbage than those in poor countries.

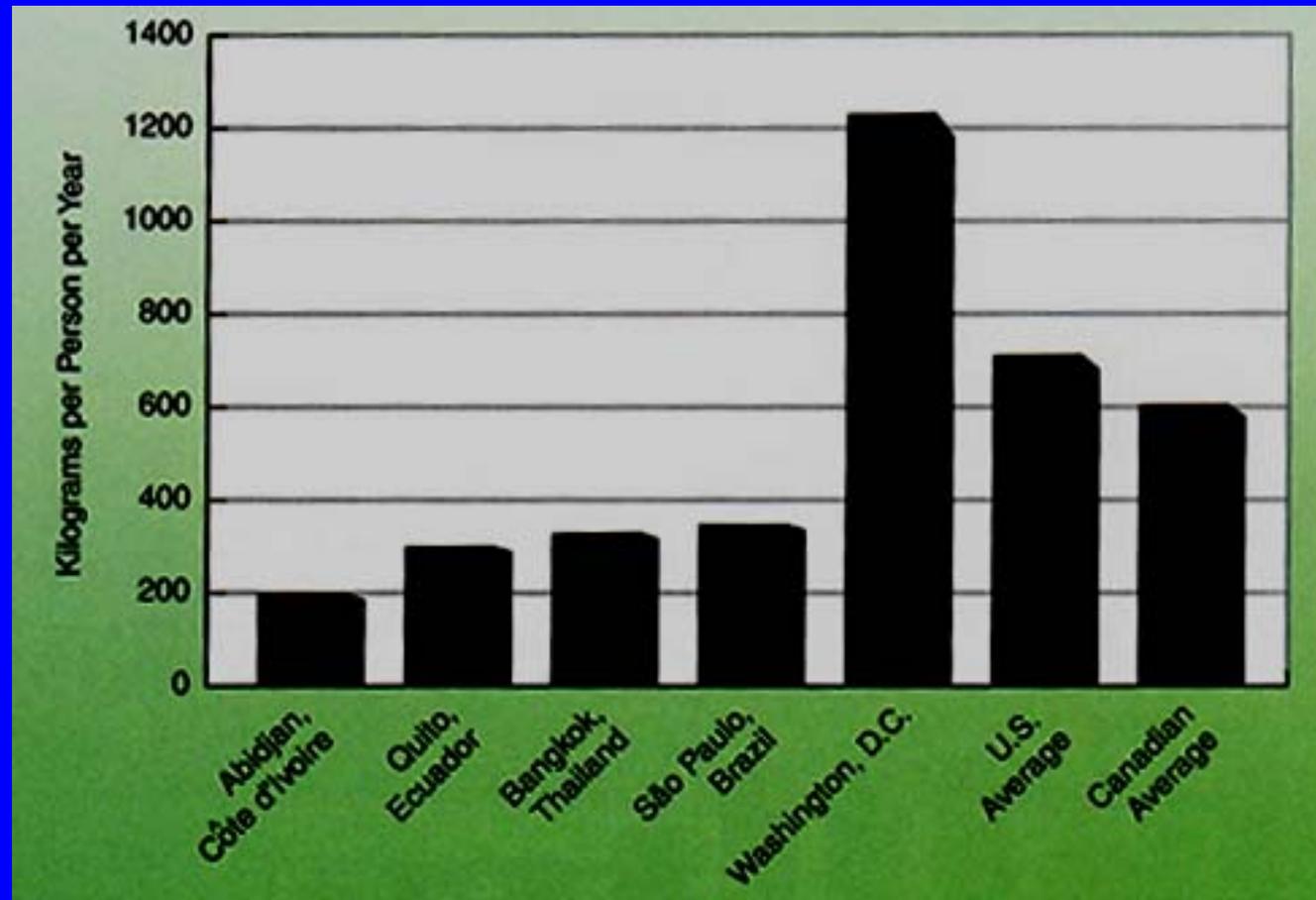


Fig. 5 Municipal solid waste generation and lifestyle

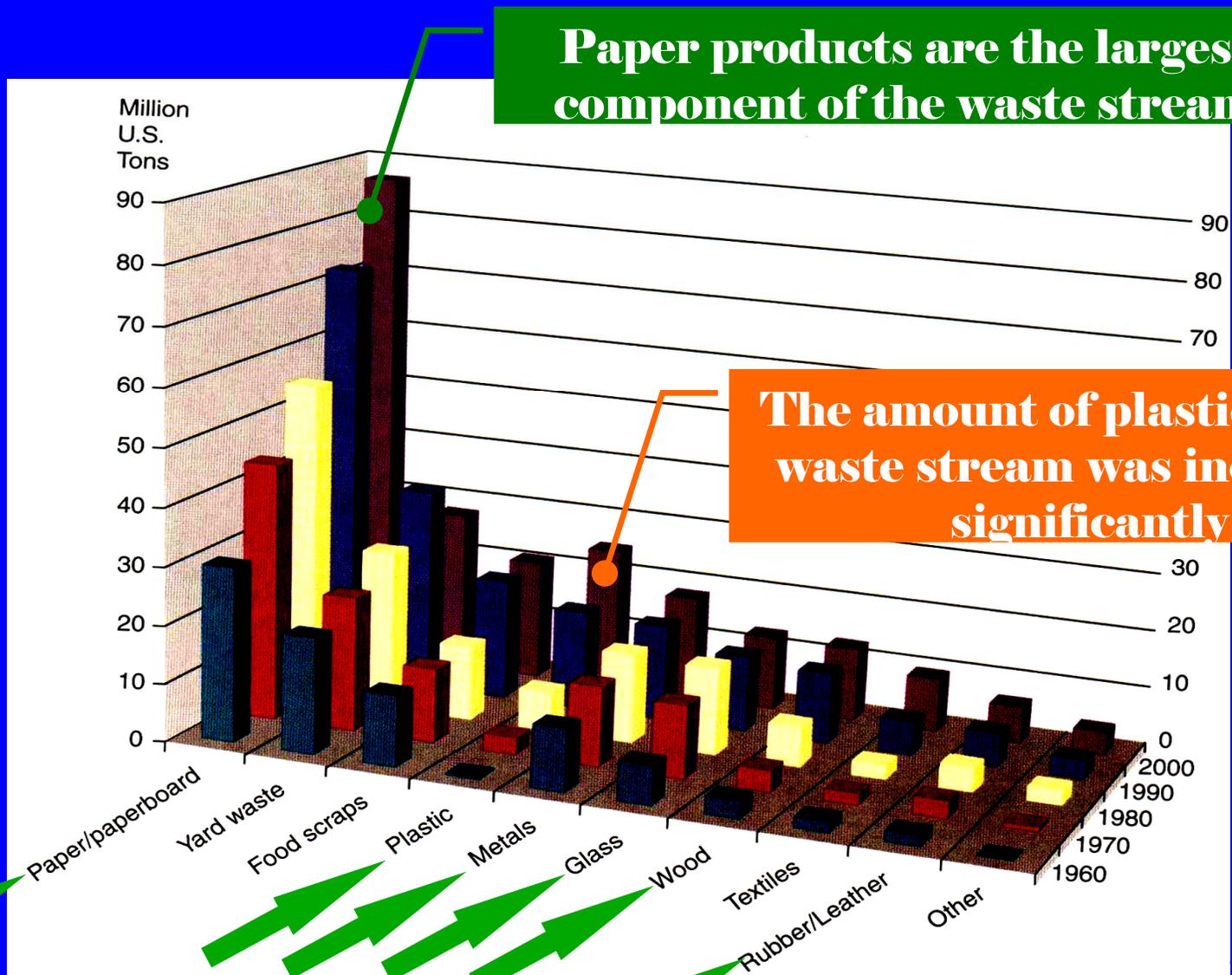


Fig. 6 The changing nature of trash

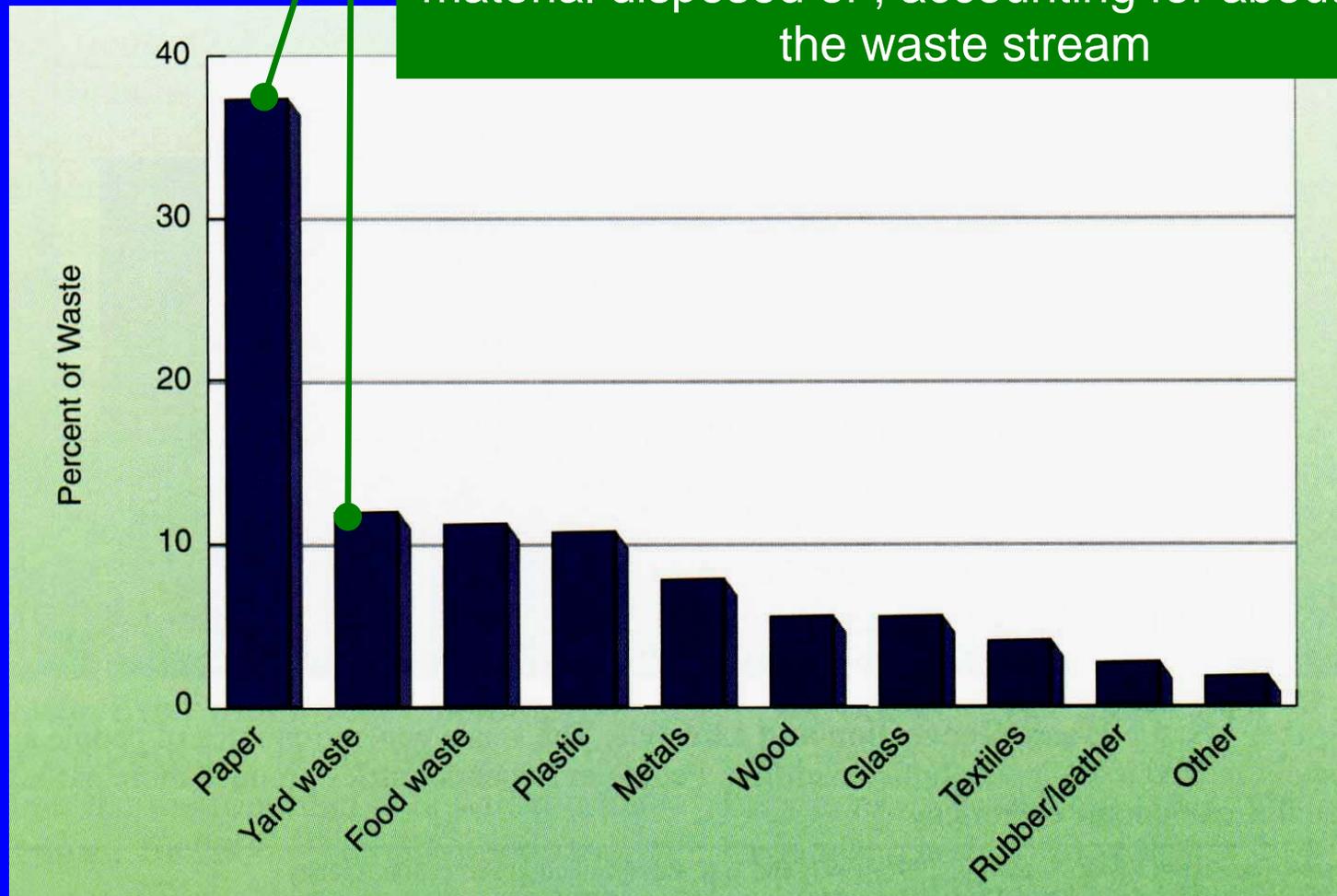
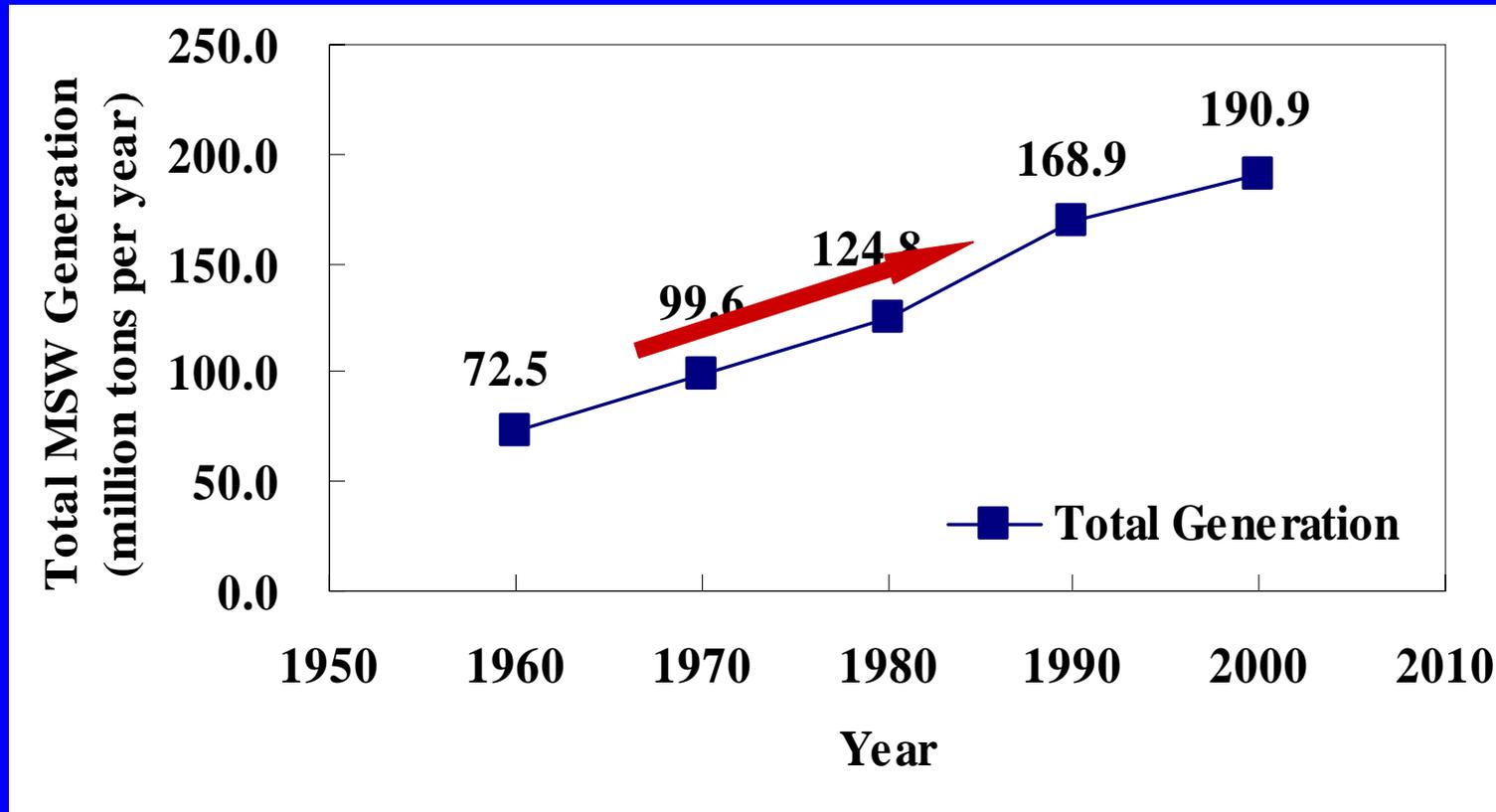


Fig. 7 Composition of trash in the United States (2000)



The generation of municipal waste in the United States has increased steadily.

Fig. 8 Municipal solid waste generation rate

The lack of landfills

Landfills are the primary method of dealing with municipal solid waste in the United States. Many states in highly urbanized parts of the country have a shortage of suitable landfill space.

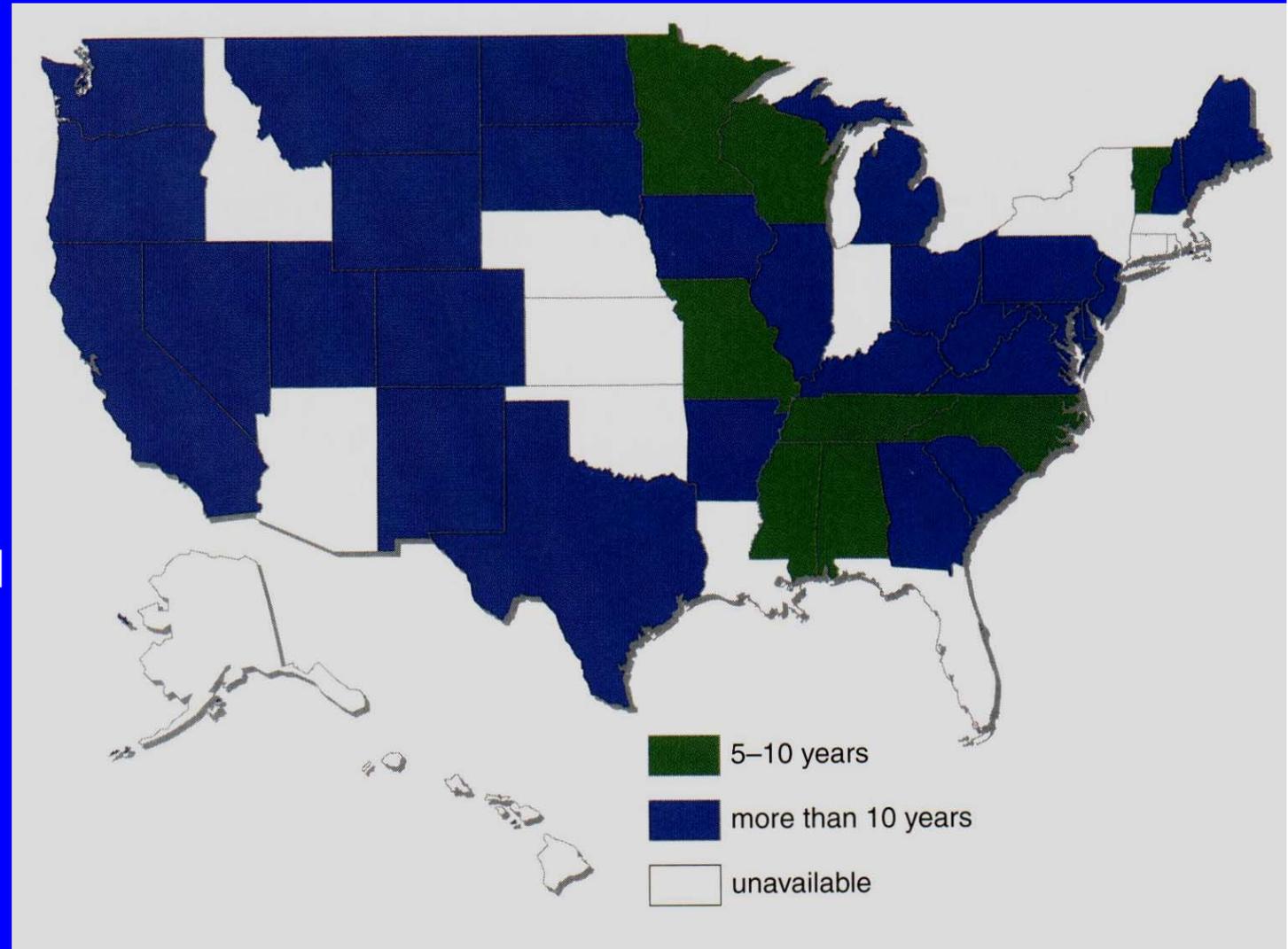


Fig. 9 Years of remaining landfill capacity

Methods of Waste Disposal

Municipal Solid Waste Management and disposal

Source reduction (including reuse)



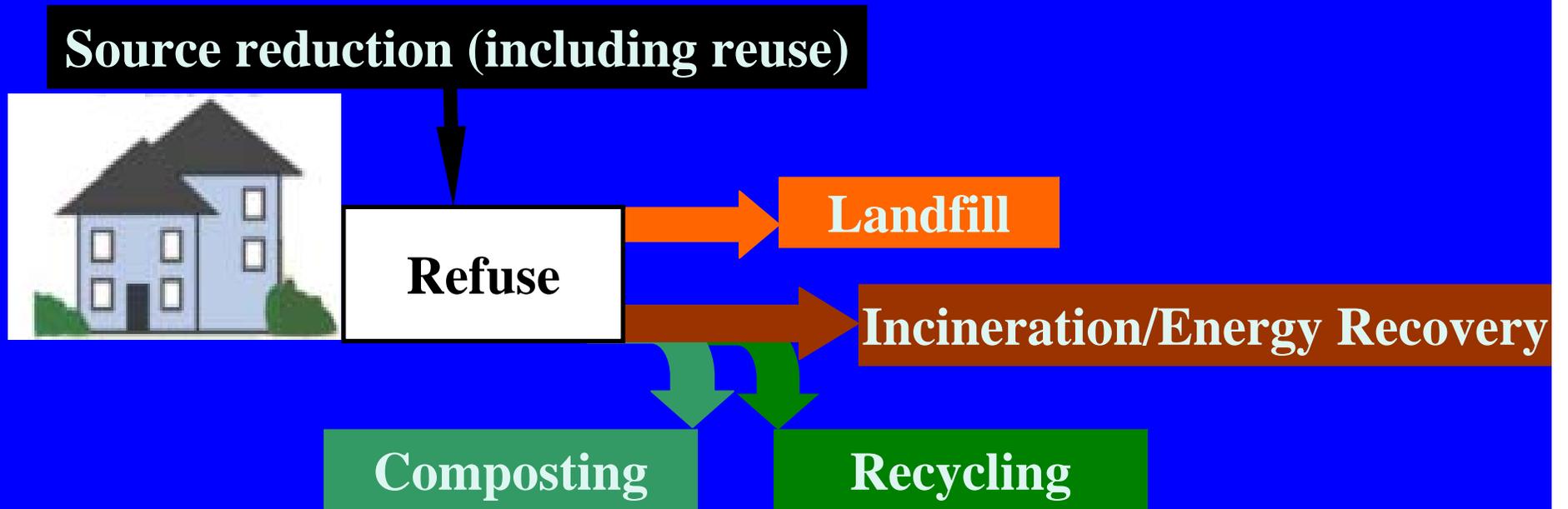
Refuse

Landfill

Incineration/Energy Recovery

Composting

Recycling



Landfills (Sanitary landfills) (填埋、卫生填埋)

◆ The role of landfills in MSW disposal

Landfill has been the cheapest methods of MSW disposal. Today, about 55% of MSW from the united States and 80% of Canadian MSW goes into landfills.

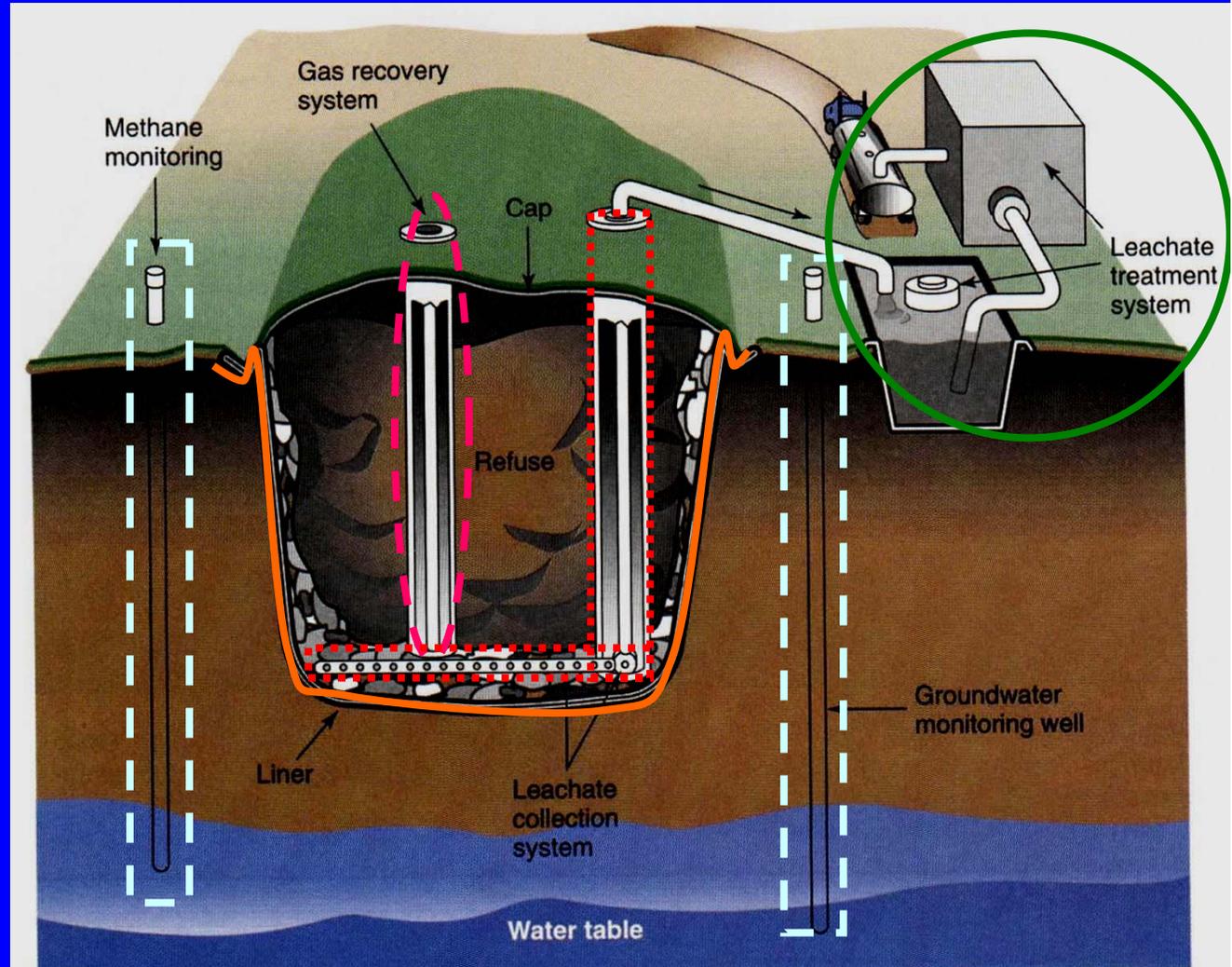


Fig. 10 Structure of landfill

◆ Difficulties in developing new landfills

- (1) The difficulty in finding a geologically suitable site;
- (2) Local opposition: 'not-in-my-backyard';
- (3) Shortage of land.

◆ Looking for alternatives to landfills

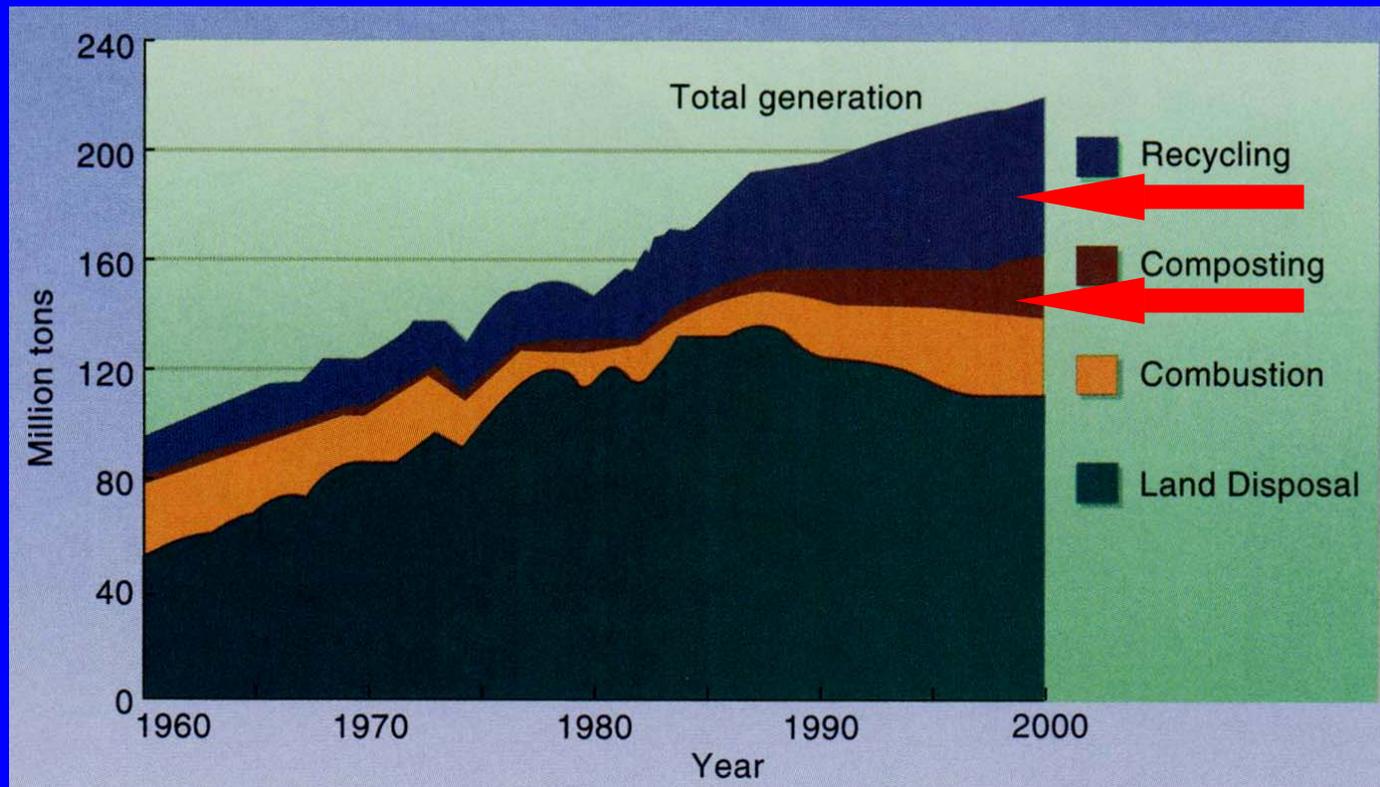


Fig. 11 Changes in MSW disposal method

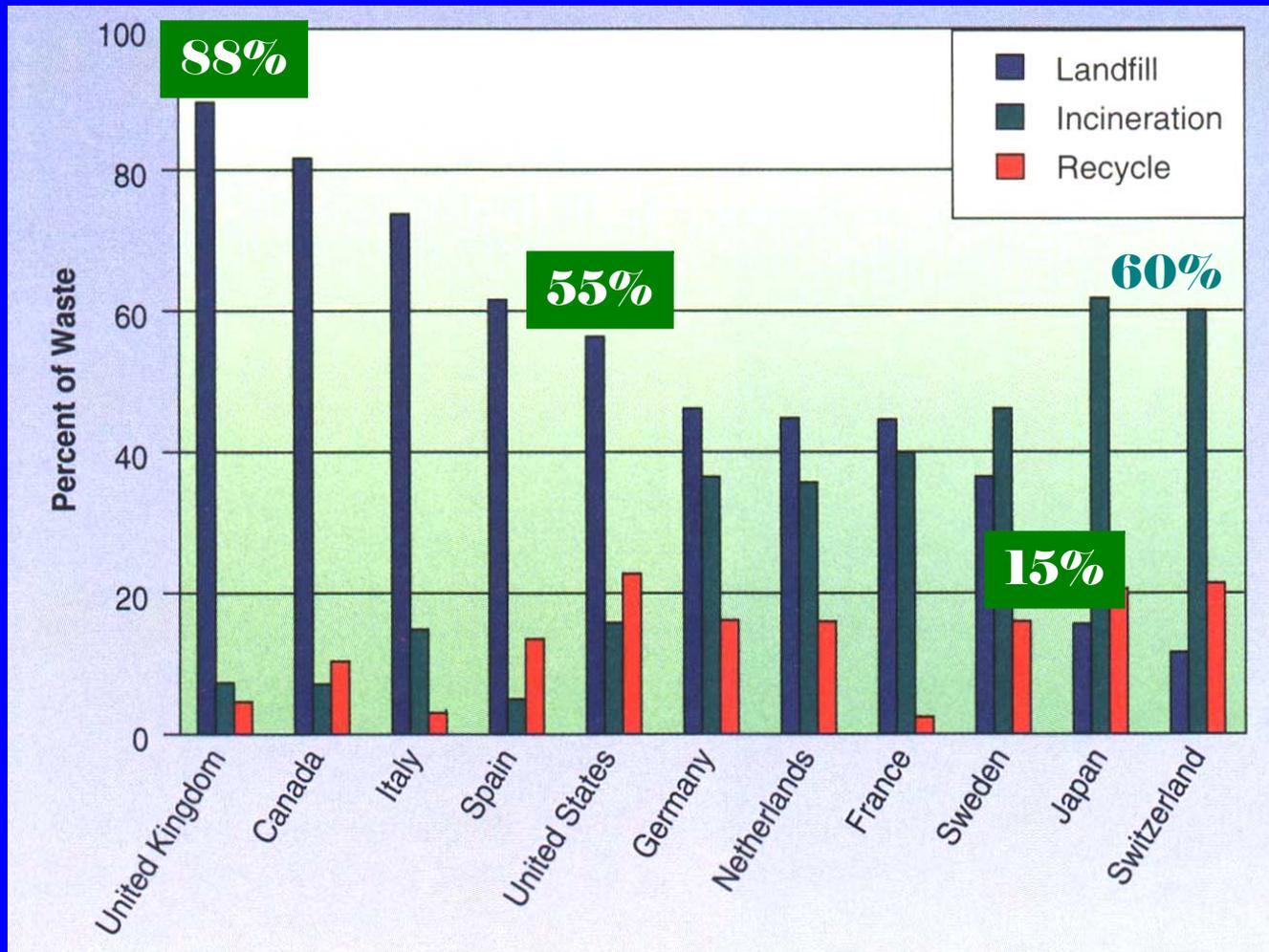


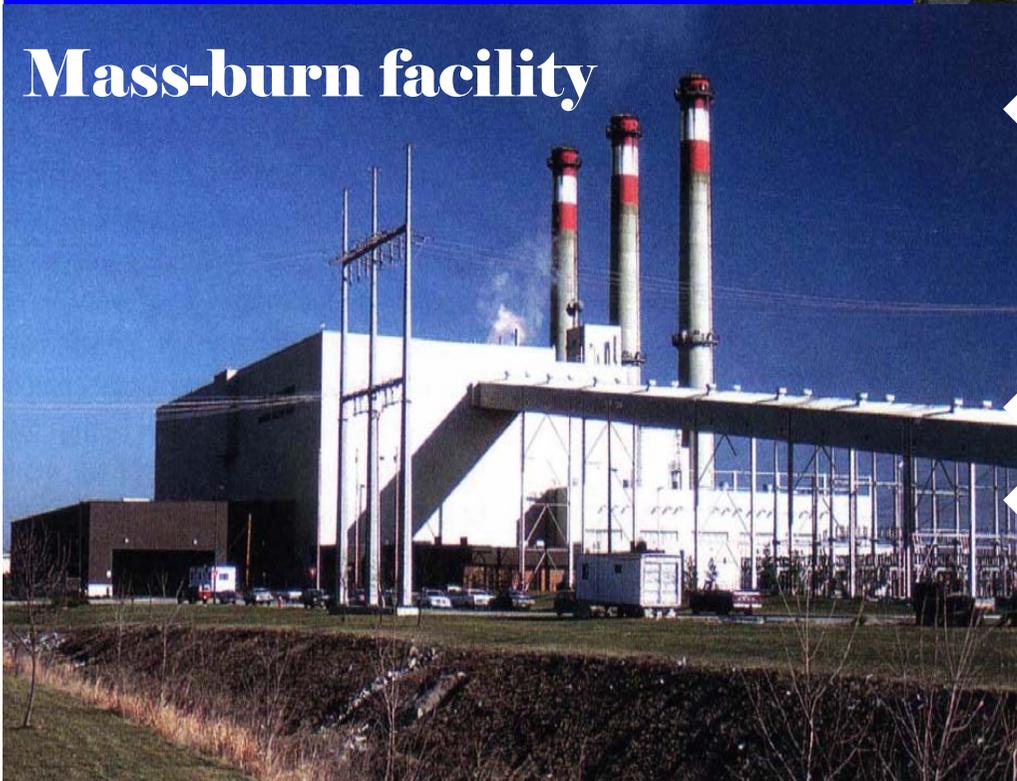
Fig. 12 Disposal methods used in various countries

Incineration (焚烧)

Incineration is the process of burning refuse in a controlled condition.



Mass-burn facility



- ◆ Energy recovery unit
(The burning waste heats water, and the steam drives the turbine to generate electricity)
- ◆ Air pollution control unit
- ◆ Incineration residues collection and process unit

◆ The role of incineration in MSW disposal

In the past, the incineration of refuse was quite common in North American and western Europe before 1940.

However, many incinerators were eliminated due to the fact it may cause potential air pollution and health risks.

Today, about 15% of MSW in the United States is incinerated; Canada incinerates about 8%; while Japan and Switzerland incinerate about 60% of their MSW.

◆ Advantages and disadvantages of incineration

Advantages:

The amount and volume of the MSW can be reduced significantly (up to 90% by volume and 75% by weight);

Waste-to-energy;

Disadvantages:

Not all waste can be burned (There will still be landfills)

Release hundreds of toxic chemicals into the atmosphere;

Disposal of the ash (The toxic substances are more concentrated in the ash);

Highly related to the economic condition;

A classic short-term solution (it destroys potentially useful (recyclable or compostable) material by turning it into toxic ash);

The cost of disposing waste by incineration is greater than that of putting it in a landfill.

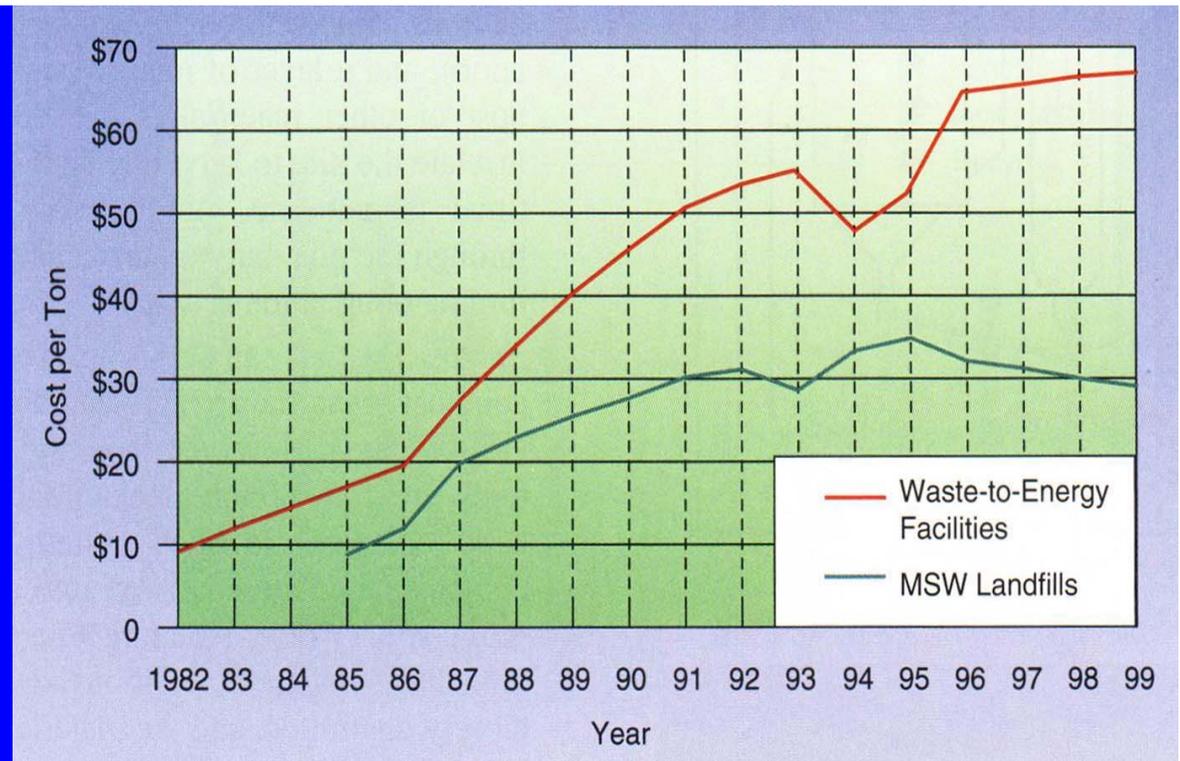


Fig. 13 Relative cost of landfills and incinerators

◆ The real choices

U.S. EPA is not interesting in developing new incinerators and has encouraged **composting, recycling and source reduction** as more effective way to reduce solid waste.

Composting (堆肥)

- ◆ Composting is the controlled biological decomposition of organic matters, such as food and yard wastes, into humus, a soil-like material.
- ◆ Composting is nature's way of transforming organic waste (such as kitchen vegetable scraps, soiled paper and yard trimmings) into new soil.



◆ The role of composting in MSW disposal

The composting methods can potential deal up to 25% of the MSW (U.S., 2000).

The suitable (such as kitchen vegetable scraps,soiled paper and yard trimmings) materials can be turned into compost in 8 to 24 weeks;



The resultant compost is organic material that can be used as a soil amendment (土壤改良剂) or as a medium to grow plants (provides nutrients to the soil);

Keeps organic wastes out of landfills.

About 3800 composting facilities are in use in the United States while 57% of yard waste were composted.

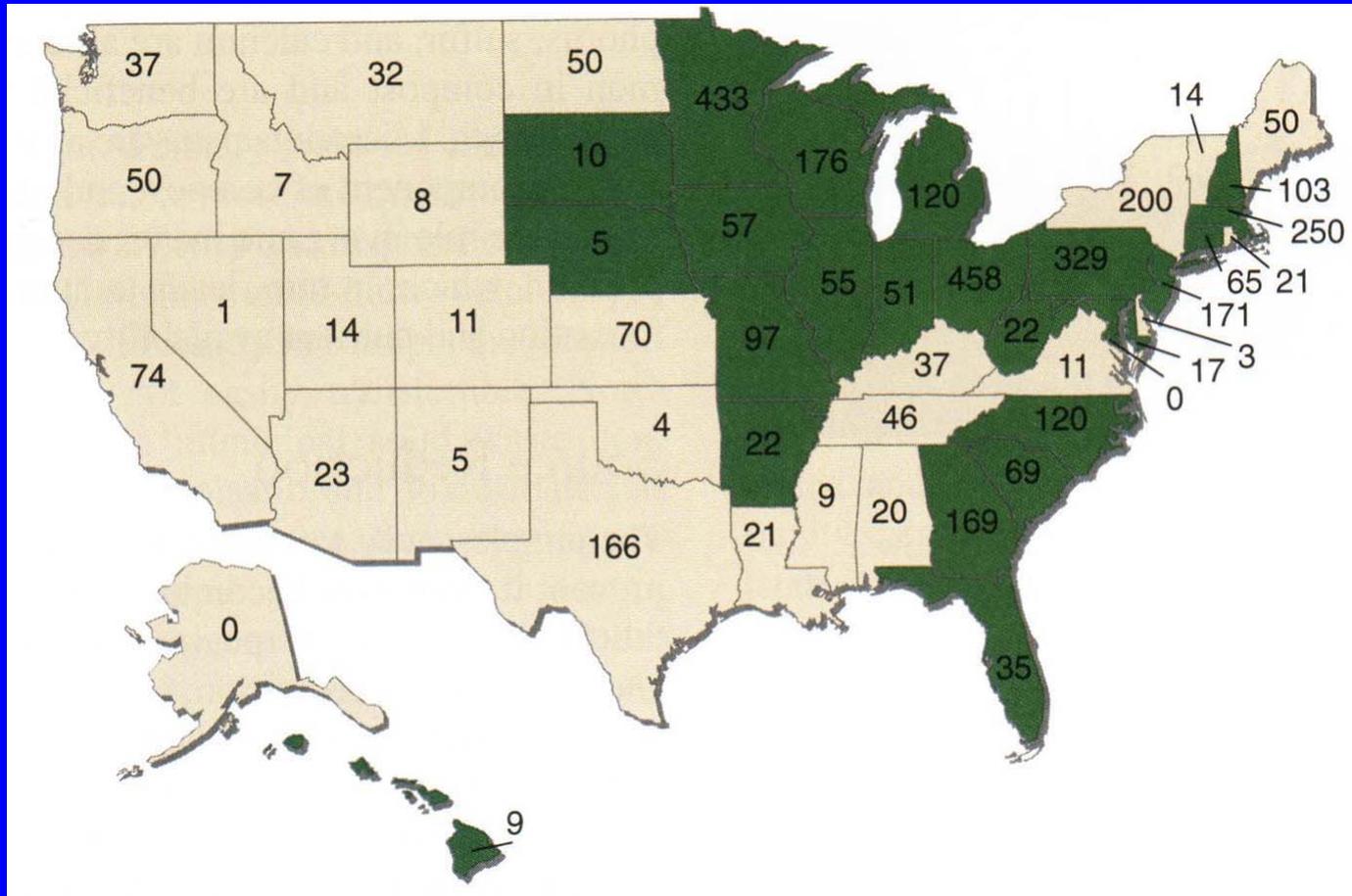


Fig. 14 States with yard waste bans and the number of composting program in each state

Source reduction (源削減)

◆ Definition

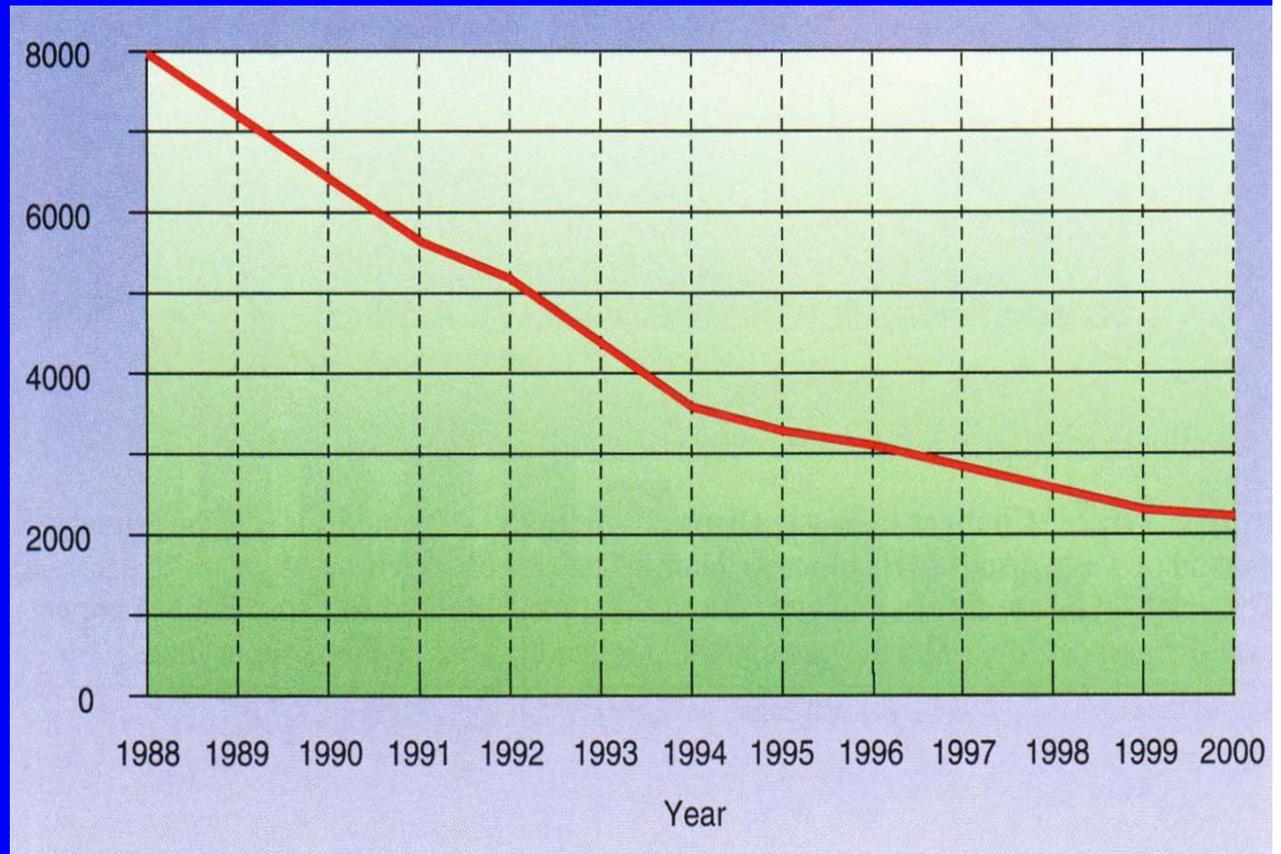
Source reduction, also known as waste prevention or pollution prevention, is the elimination or reduction of waste before it is created. It involves the design, manufacture, purchase or use of materials and products to reduce the amount or toxicity of what is thrown away.

◆ The need of source reduction

(1) Shortage of suitable landfill space; In many areas, no suitable land is available for landfills development.

(2) The development of new landfill site is expensive; New landfills often resisted due to public concerns over groundwater contamination, odors, and truck traffic;

(3) The amount of waste each person creates has almost doubled from 1.2 to 2 kilograms per day in American



(4) The number of landfill site has decreased by nearly 70%;

The most effective way to solve the problem is by reducing waste in the first place, i.e. Stopping waste before it happens.

Source reduction first, recycling and composting second, and disposal in landfills or waste combustors last.

◆ The practice in source reduction

- (1) Purchasing long-lasting goods;
- (2) Seeking products and packaging that are as free of toxics as possible;
- (3) Redesigning products to use less raw material in production, have a longer life, or be used again after its original use;
- (4) Reusing items is another way to stop waste at the source;

◆ Benefits of source reduction and reuse (再用)

Saving natural resources;

Reducing toxicity of waste;

Reducing costs;

Communities: More than 6,000 communities have instituted "**pay-as-you-throw**" programs where citizens pay for each can or bag of trash they set out for disposal;

Business: When businesses manufacture their products with less packaging, they are buying less raw material;

Consumers: Buying products with less packaging, or that are reusable (not single-use) frequently means a cost savings;

Recycling (回收)

◆ Recycling process

Put the recyclables out on the curb.

Step 1. Collection and Processing

The recyclable materials are collected at the curb or from a drop-off centre, than transported into a recovery facility where they were cleaned, separated, and baled.

Step 2. Manufacturing

Recyclables are processed into new products.

Step 3. Purchasing Recycled Products

Purchasing recycled products completes the recycling loop.



◆ The practice in recycling

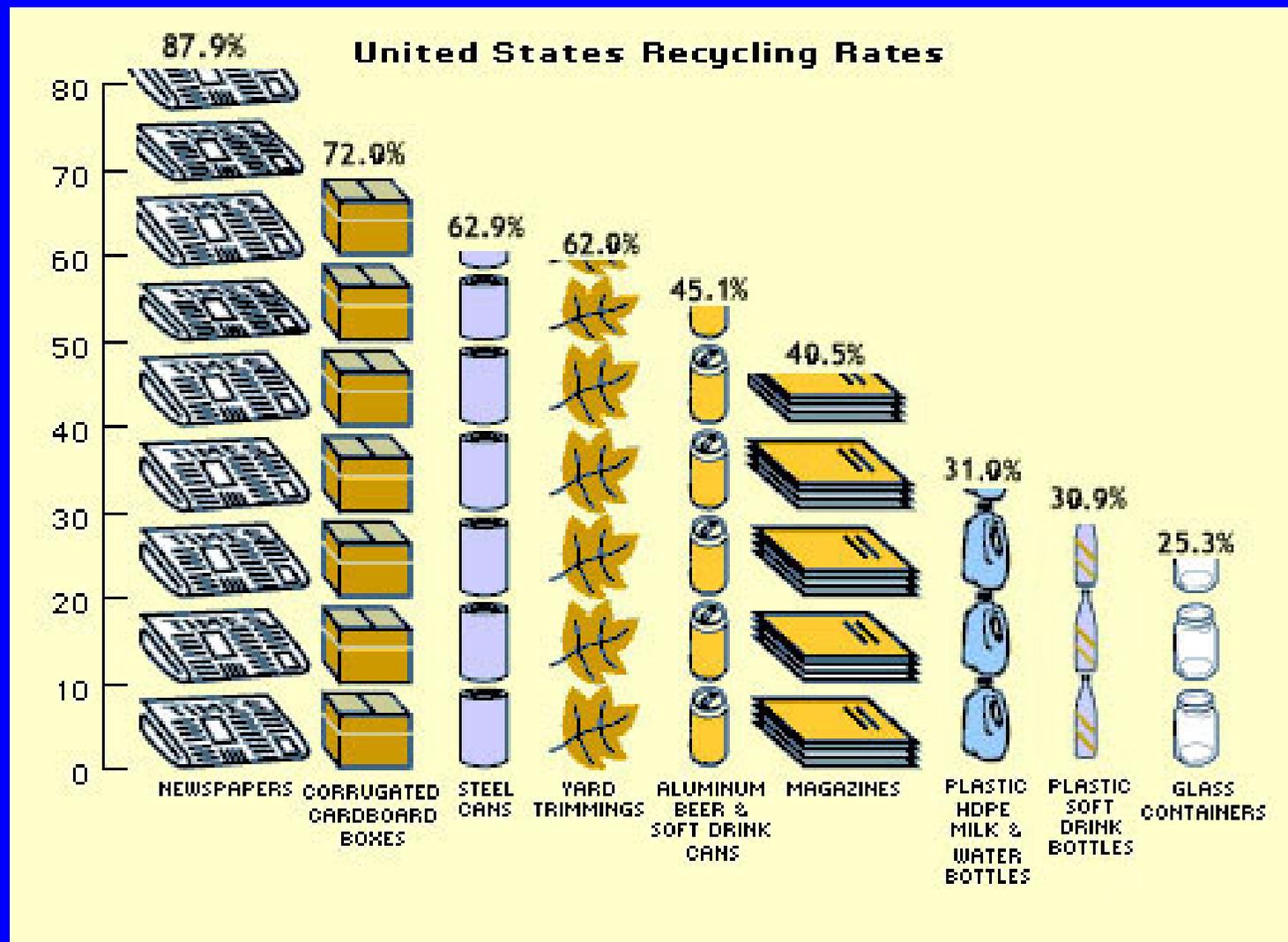


Fig. 15 Recycling rates for various materials

◆ Benefits of Recycling

- (1) Conserves resources for our children's future;
- (2) Prevents emissions of many greenhouse gases and water pollutants;
- (3) Supplies valuable raw materials to industry;
- (4) Creates jobs;
- (5) Stimulates the development of greener technologies;
- (6) Reduces the need for new landfills and incinerators (about 30% of the MSW is disposed through recycling);

- (7) Saves energy;

Recycling is an excellent way of saving energy and conserving the environment. Did you know that:

1 recycled tin can would save enough energy to power a television for 3 hours;

1 recycled glass bottle would save enough energy to power a computer for 25 minutes;

1 recycled plastic bottle would save enough energy to power a 60-watt lights for 3 hours;

70% less energy is required to recycle paper compared with making it from raw materials.

◆ Recycling concerns

Technical questions:

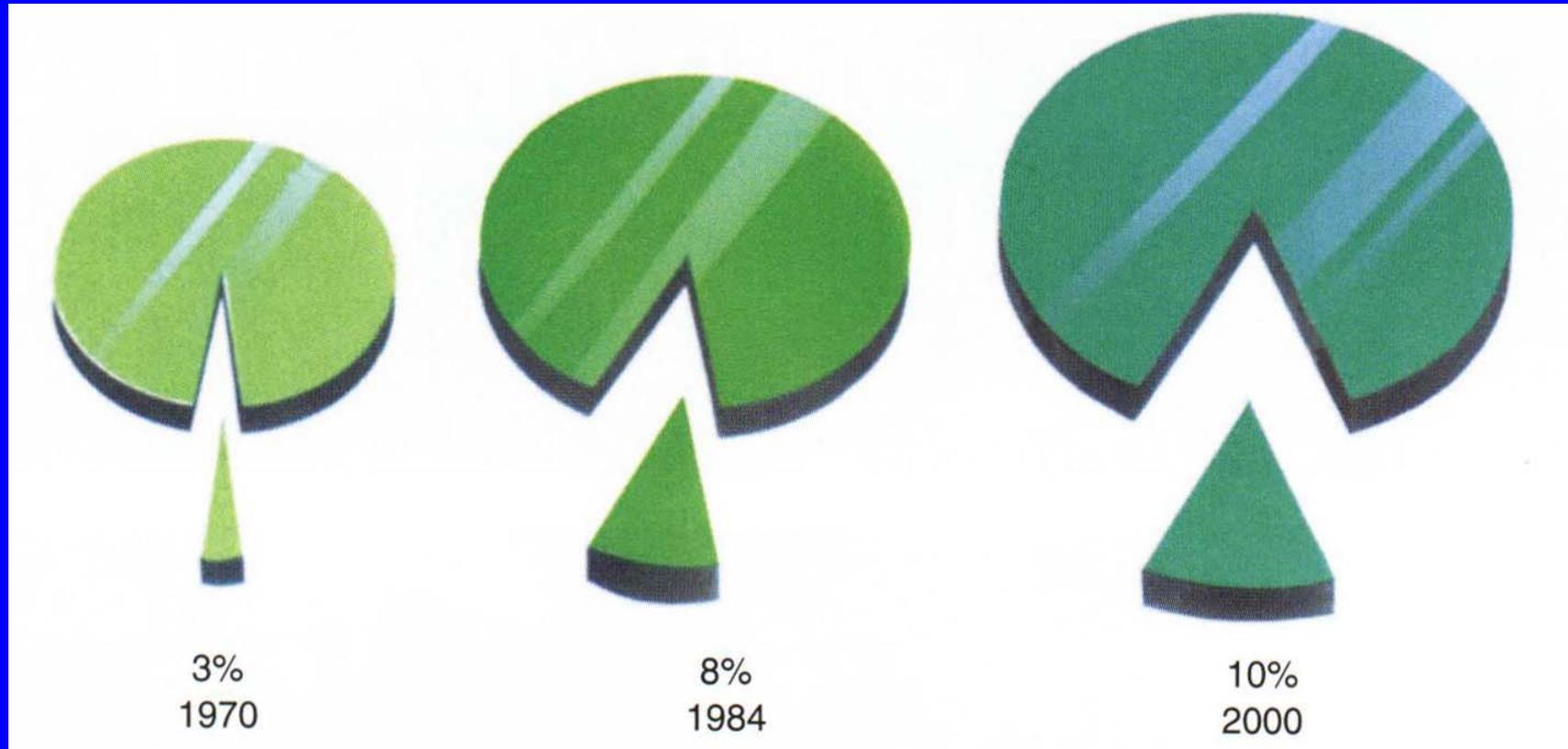


Fig. 16 Increasing amount of plastics in trash

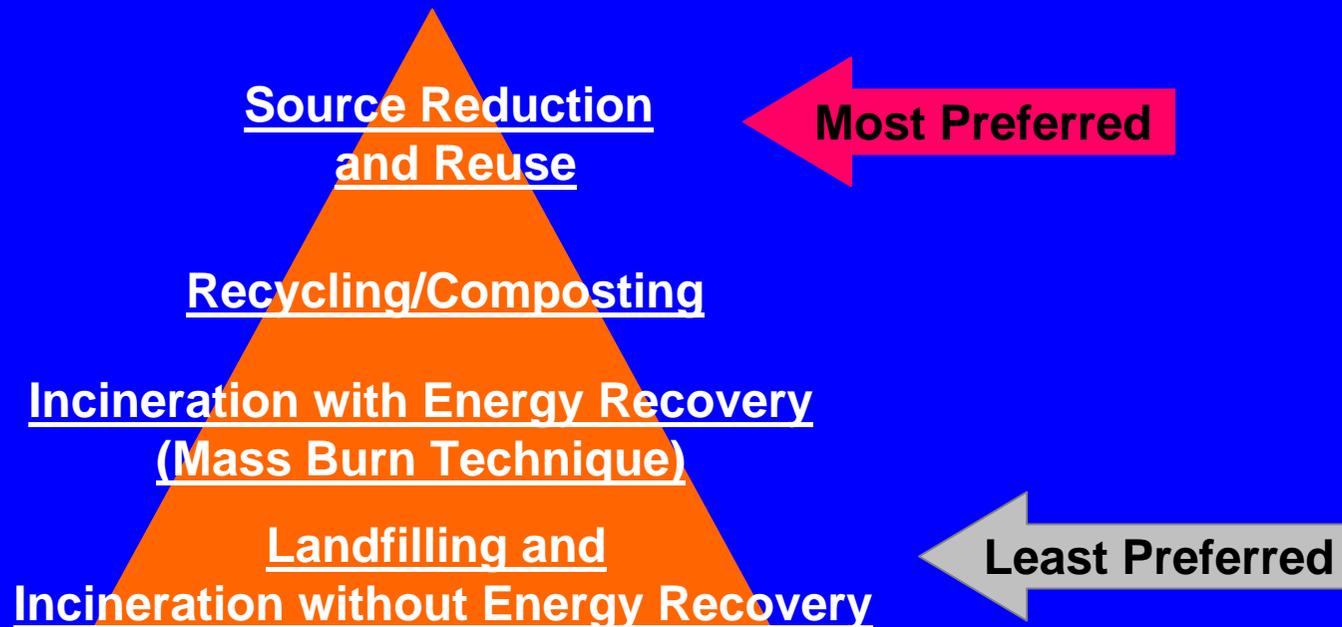
Economic questions:

Prices for recycled material can vary widely from year to year, depending on demand;

The demand for recycled products doesn't keep pace with the growing supply.

Summary

- The lifestyle should be changed;
- Five techniques are used for municipal solid waste disposal;



- The degree to which any method will be use will depend on economics, changes in technology, and citizen awareness and involvement.

Key terms

- Municipal solid waste
- Municipal solid waste landfill
- Leachate
- Incineration / Mass burn
- Composting
- Recycling
- Reuse
- Source reduction

Review Questions

- How is lifestyle related to our growing municipal solid waste problem?
- Describe some of the problems associated with modern landfills?
- What are four concerns associated with incineration?
- Name several strategies that would help to encourage the growth of recycling?
- Describe examples of source reduction.