Special Event – ISWA 2011 World Congress
Moving Towards Zero Waste for a Green Economy – The Role of Local Authorities

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Options to Approach Zero Waste: Management of Organic Residues

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Introduction

- Brief status
- General Alternatives
- Options for Management Organic Matter
- Conclusions
- Recommendations

Major issues currently facing us

- Global population rapidly growing and is expected to reach more than 9 billion by 2050;
- Emerging markets are becoming more affluent and demand a "higher, resource-intensive quality" of life

Major issues currently facing us

- Migration of people from rural to urban areas;
- Lack of sufficient food in some regions;
- Significant climatic events impacting agricultural productivity and the environment
- Improper final disposal of solid wastes

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Situation in many economically developing countries


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Need to Consider Global Impacts

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Generation and Characteristics of MSW

Type of Country	Avg. Generation (kg/cap-day)	Paper & Plastics (%)	Concentration of Organic Matter (%)	Moisture Content (%)
Industrialized	1.5	30 to 50	20 to 40	20 to 30
Developing				
- Middle Income	0.90	20 to 30	40 to 50	50 to 60
- Low Income	0.62	10 to 20	50 to 60	60 to 80

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Key Characteristics of MSW in Industrialized Countries

- High concentration of paper and plastics
- Low volumetric density
- Low moisture content

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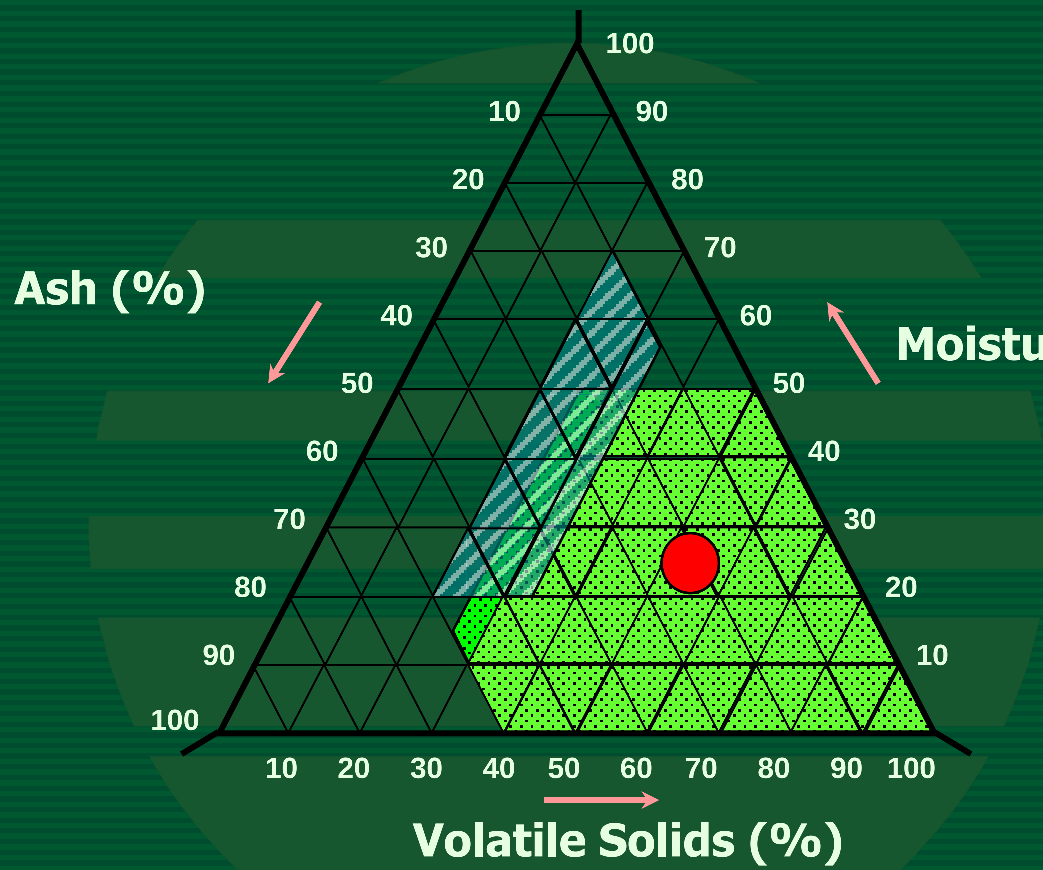
Key Characteristics of MSW in Economically Developing Countries

- High concentration of organic matter
- Relatively high volumetric density
- High moisture content

Primary Management Options for Biomass

- Thermal treatment
- Land application
- Biological treatment
  - Composting
  - Anaerobic digestion

Comparison of the Thermal Characteristics of MSW with Those Required for Auto-Combustion

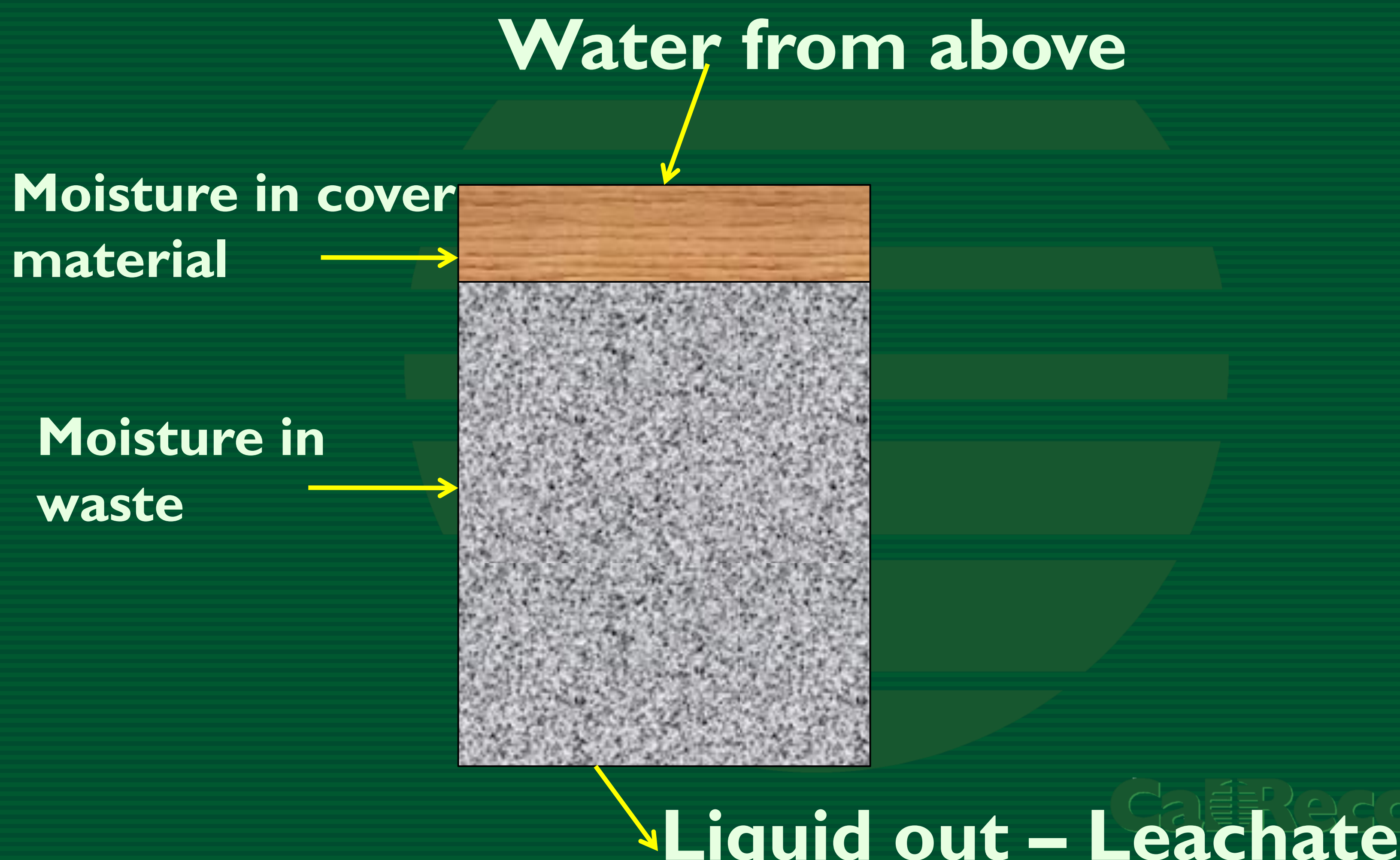


Area for auto-combustion

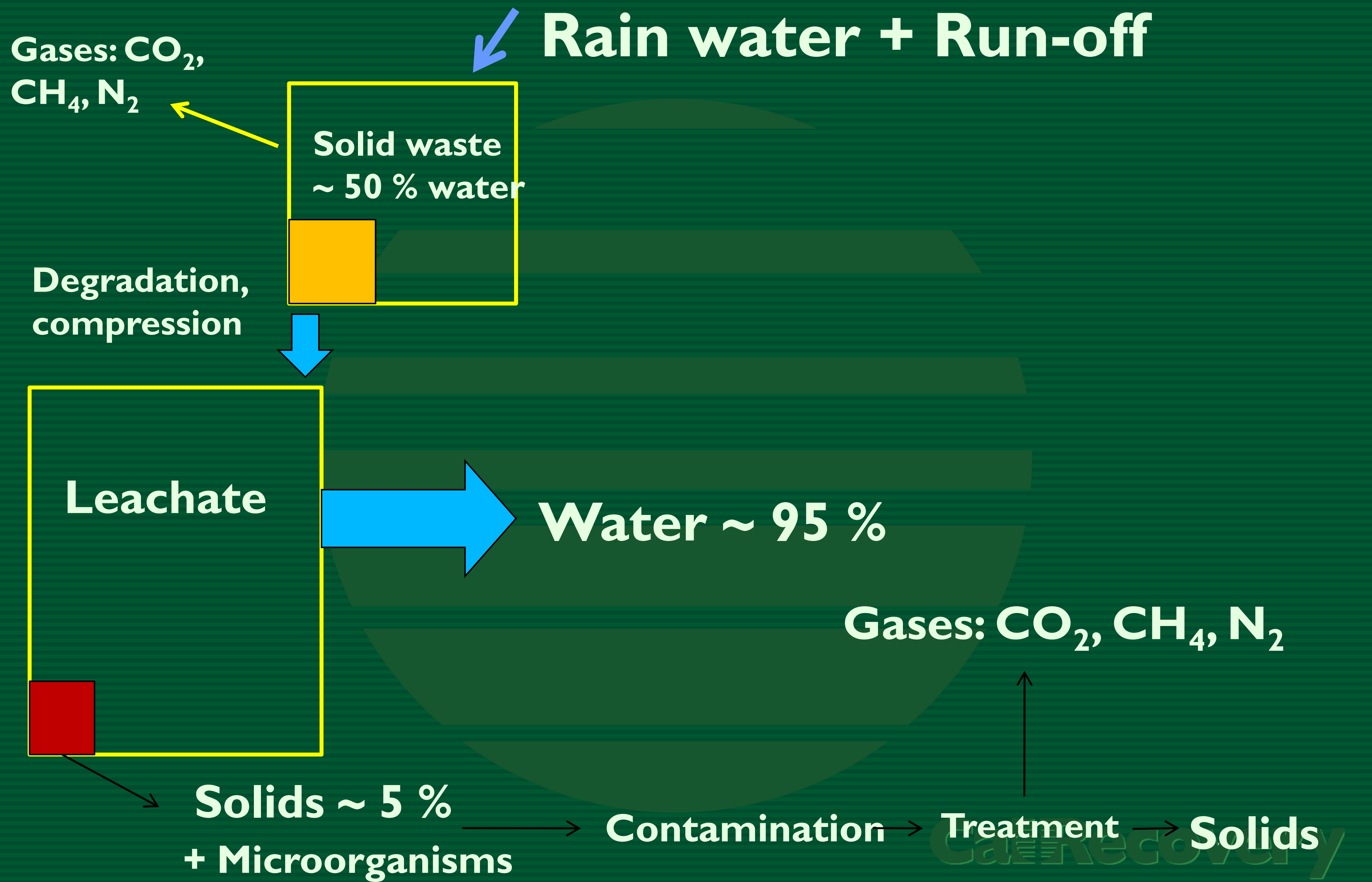
Typical values in industrialized countries

Typical values in developing countries

Leachate formation in Landfills



Schematic Diagram of a Sanitary Landfill



Potential Options to Increase Organics Diversion

- System options relevant to this presentation include:
  - composting
  - anaerobic digestion and composting

The Place of Composting in a Community System

Community as a whole:

- community support systems
- waste management
- composting of organic materials and compost production

Full Scale Composting

Objective: Reliable, cost-efficient production of quality compost and replish organic matter in the soil

- Pre-processing/feedstock preparation
- Composting
- Refinement of finished product (post-processing)
- Compost application

Potential Options to Increase Organics Diversion (cont.)

- Sources of organics/increased diversion:
  - residential (e.g., food waste and yard waste, 5% to 35% of sector)
  - commercial/institutional (e.g., restaurant and market wastes, landscaping waste, 5% to 20% of sector)
  - industrial/C&D (e.g., wood waste)

Main Driver in Europe – EC Landfill Directive

- Stringent requirements for construction and management of landfills (e.g. liners)

- Requirement for pre-treatment of organic waste before landfilling

- **Obligation:** Reduce emissions from landfills by **diverting biodegradable components** in municipal waste that goes to landfills by
  - 25% by 2006
  - 65% by 2016

  (based on 1995 disposal figures)

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Composting in Europe (2005)

⇒ **Degradation of <u>source-separated</u> waste from households, gardens and industries**

Approximately 2,000 facilities - 40% treat only garden waste

- Annual capacity -> 18 million tons (11 M biowaste, 7 M greenwaste)
- About 800 small on-farm co-composting plants
- **Target:** production of a **MATERIAL** for market as organic fertilizers and soil amendments

Main Drivers in USA

- Some states require fixed percentages of waste diversion from landfills
- Other states have set goals
- Bans on disposal of green waste in landfills at some locations

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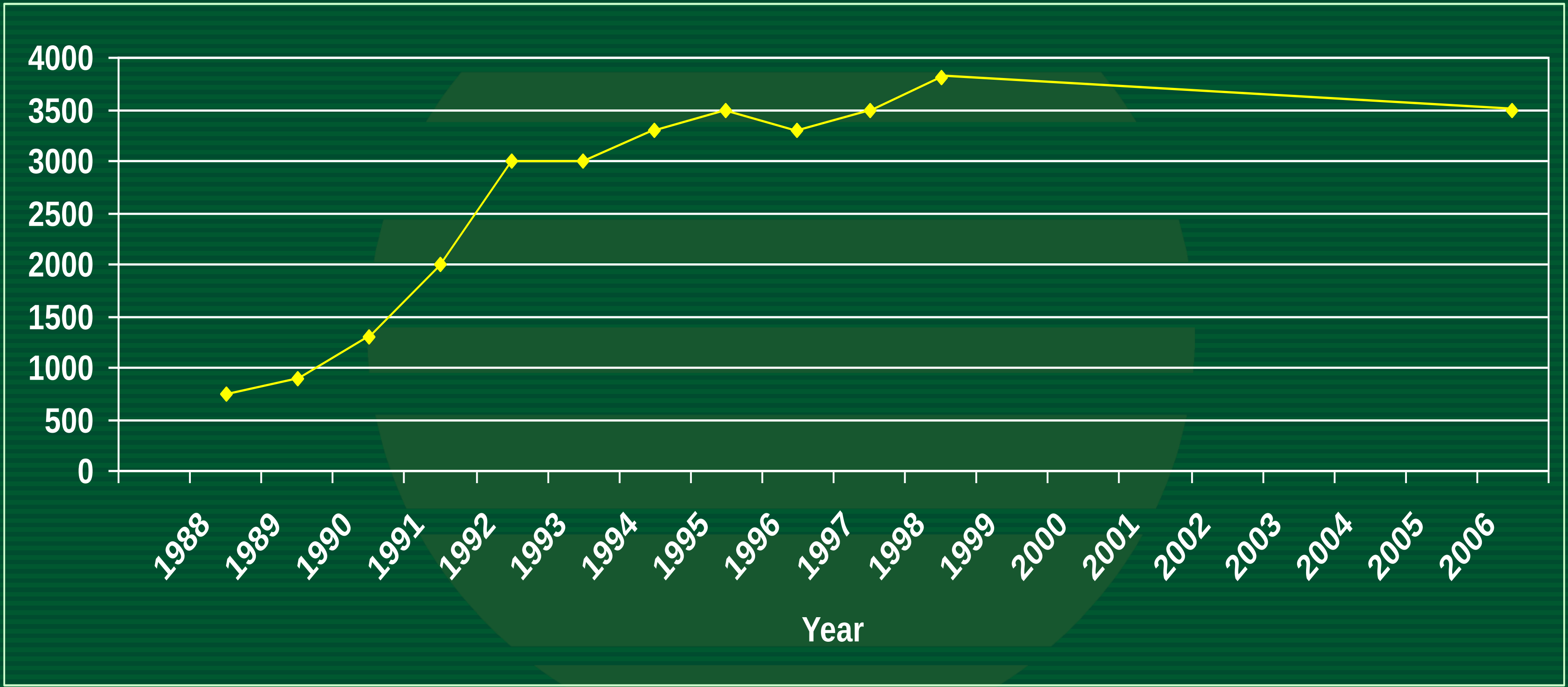
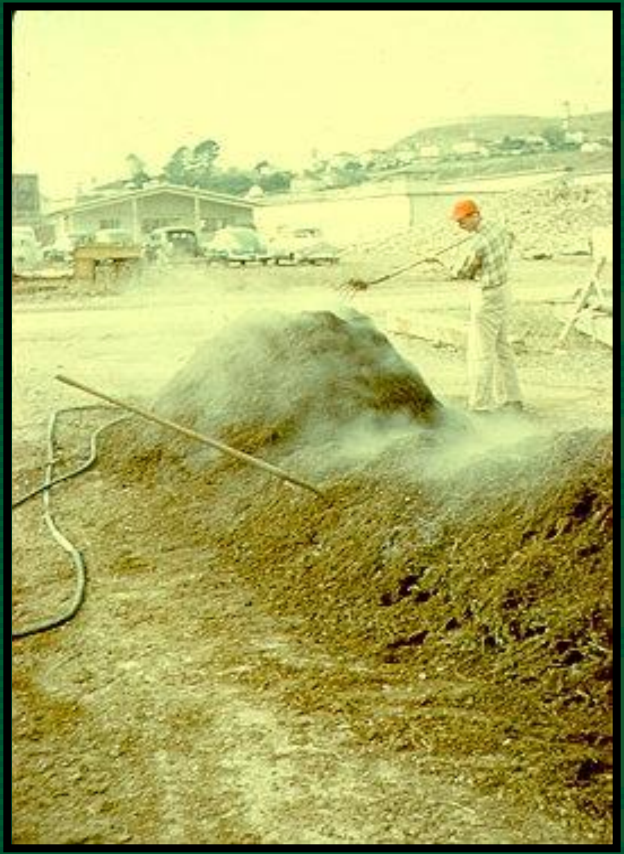
Number of Yard Waste Composting Facilities in the USA (1988-2006)



General Trends in Composting

- Role of organics:
  - importance of organics in reaching diversion goals
  - pretreatment of organic matter to reduce demands on land disposal and emissions from disposal sites
  - number and types of composting facilities
  - quantities of organic materials being processed

Evolution of Modern Composting



1950s

1970s

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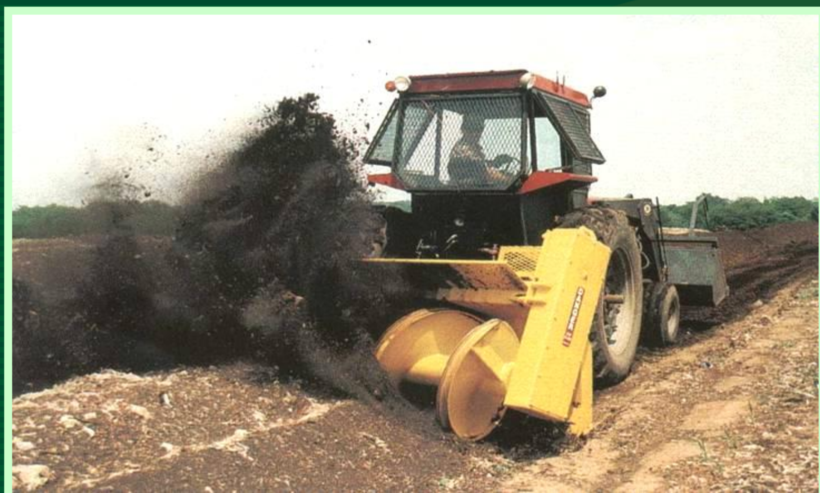
Windrow Composting

Method of providing oxygen and moisture to biomass:

- static
- forced aeration:
  - synthetic covers
  - plastic bags
- mechanically turned
- mechanically turned with forced aeration

Self-Propelled Turning Machines

Turning Machines for Small Windrows



Open Windrows

- Turned windrow, ASP, and enclosed facilities
- Air/odor emissions and control
- Strong mechanical/ civil/geotechnical/ hydrogeological experience

Forced Air Windrows with Synthetic Covers

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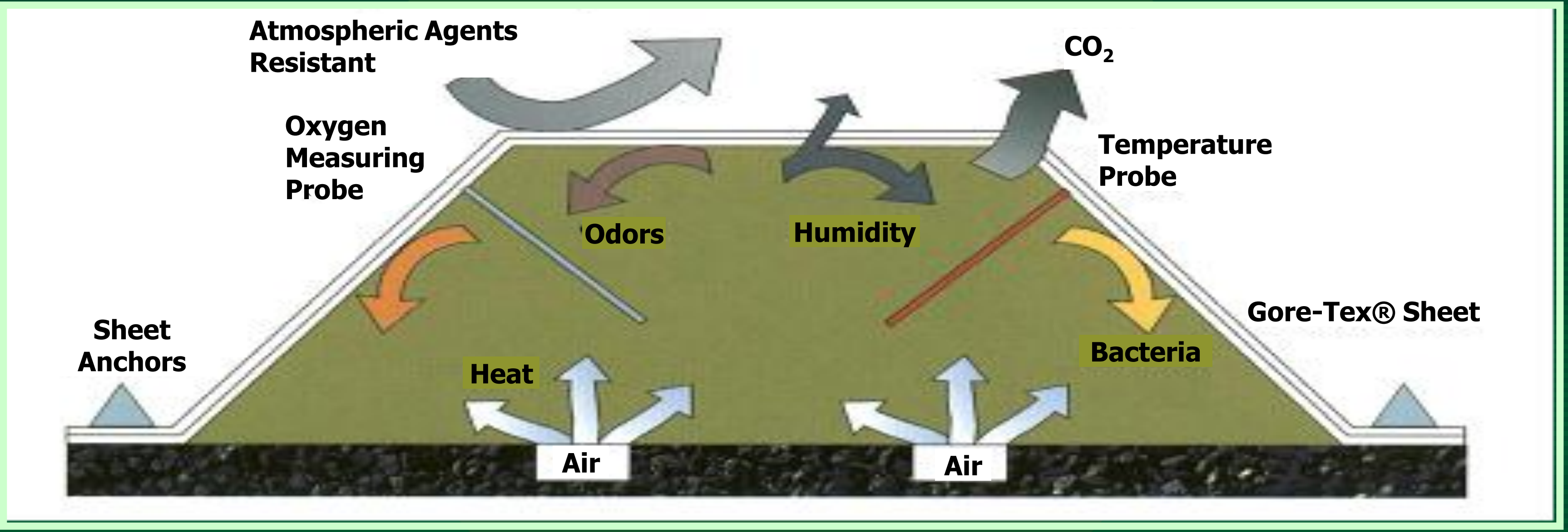
Schematic Diagram of Gas Flows in a Windrow Covered with Syntethic Material



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Close-up of Rotating Cylindrical Reactor

Basin Type Plant Under Construction, Depicting Forced Aeration Pipes

Anaerobic Digestion Facilities for the Recovery of Energy from Organic Matter

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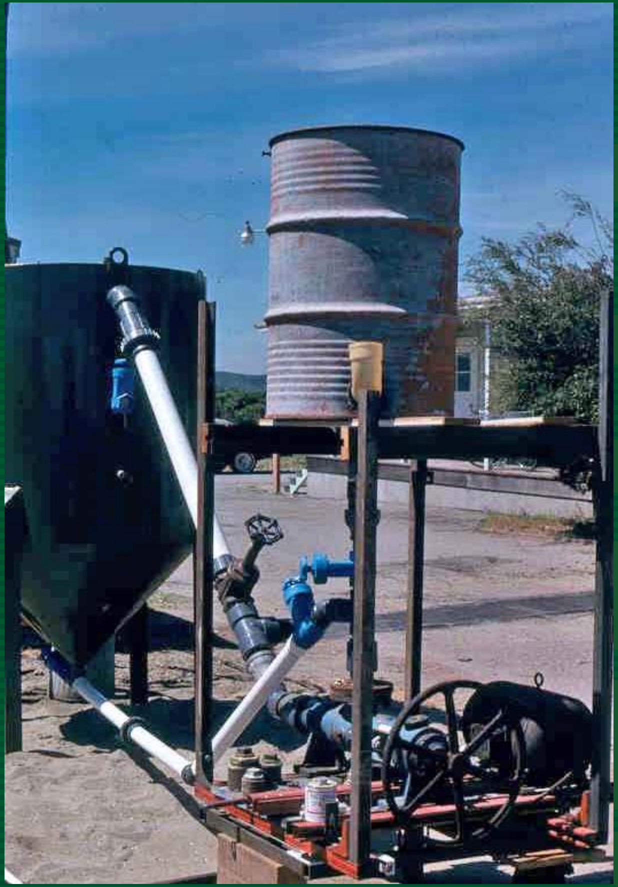
Lab-Scale Organic Fraction of MSW/Sludge Digesters in Richmond, California (1970s)

Pilot Food Waste Digester in Richmond, California (1980s)



Modern Technologies

- Essentially divided as a function of total solids content in the reactor:
  - Dry digestion: TS > 15%
  - Wet digestion: TS < 12%

Example of an installation for the treatment of organic matter

Wet Digestion

The electrical energy produced is used within the facility

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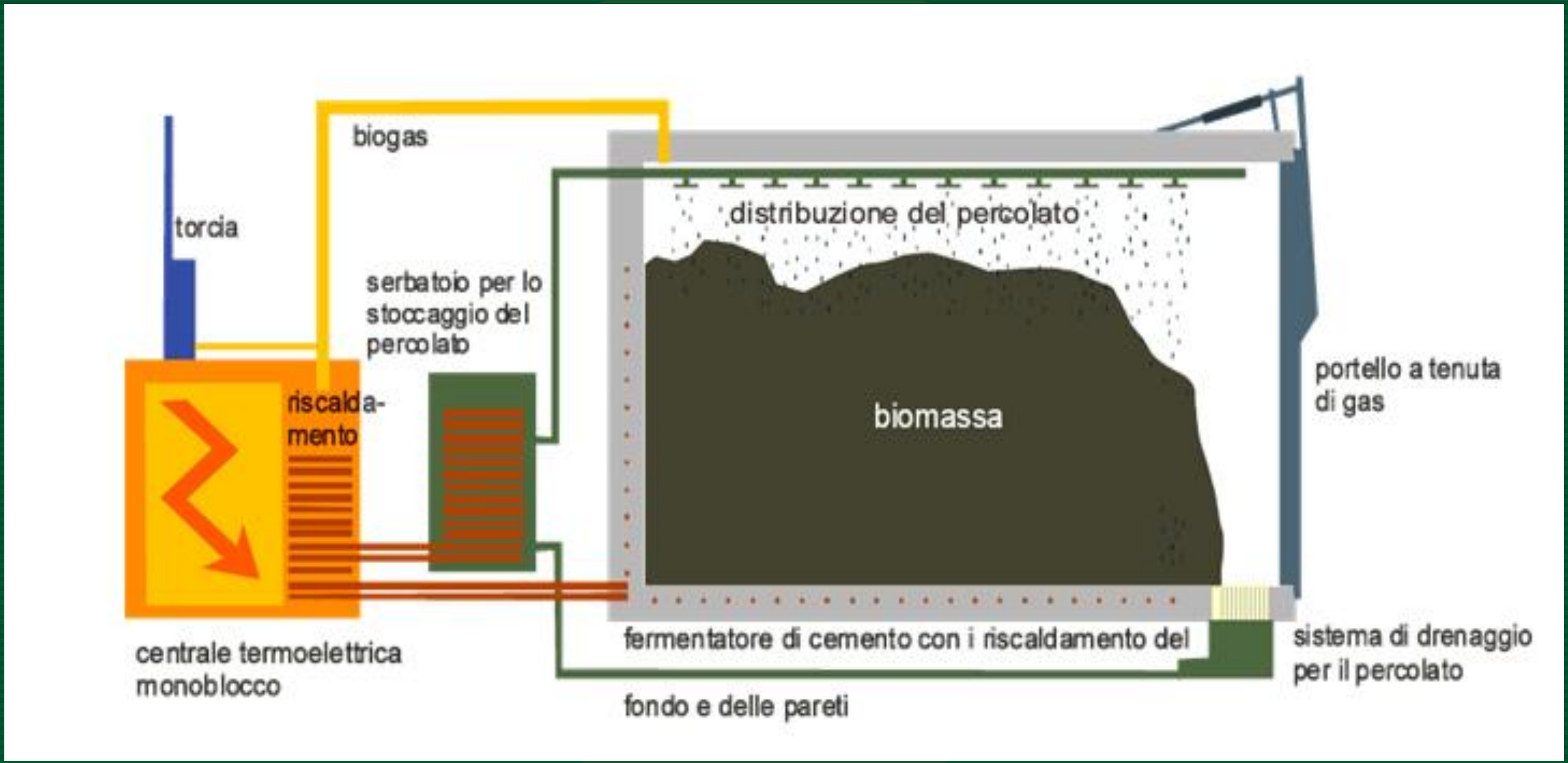
Dry Anaerobic Digestion



Dry Anaerobic Digestion

Dry Anaerobic Digestion

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Current performance of facilities

Biowaste

DIGESTER

Biogas

Green Energy

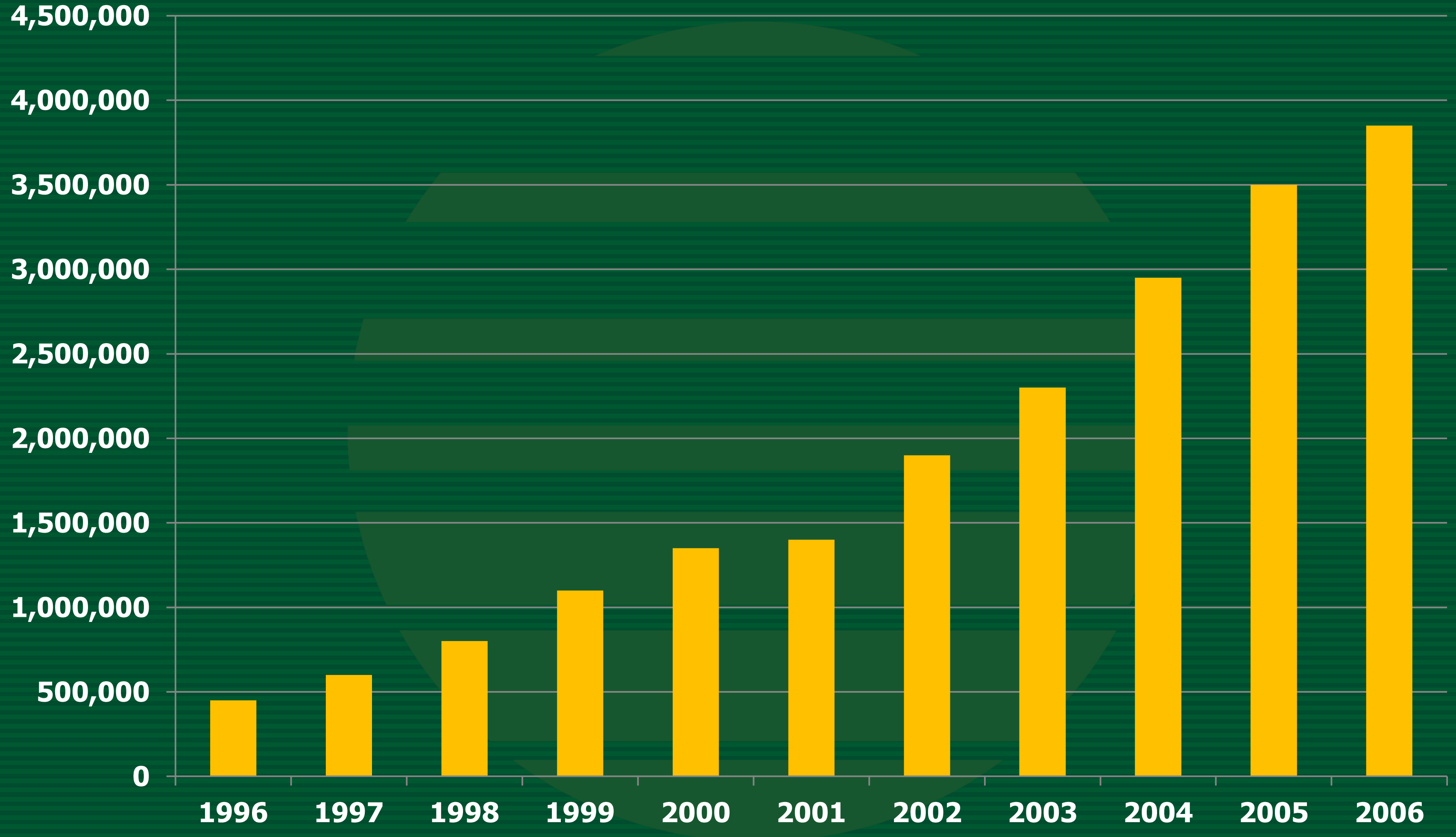
Soil Conditioner

1 m3 of Biogas at 60% CH_4

6 kWh

600 kg CO_2 emissions savings

Installed Capacity of AD in the EU (tons per year)



Relevant Financial Incentives

- Award "Green Certificates" (CG):
  - European Directive 2001/77/CE
  - promotes production of energy from renewable sources
  - provides financial incentive to producer (time period and amount vary from country to country)
  - one GC = 50 MWh of energy
  - in Italy, financial incentive is 0.115 €/kWhe per year (~.138 US$/kWhe year)
  - in Italy, incentive is valid for 8 years from startup of plant – can be extended 4 more years (financial incentive reduced to 60%)
  - in Germany, incentives last over 20 years

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Financial Incentives in Germany

Output (kW)	Incentive (€/kWhe)
< 150	0.115
150 to 500	0.099
500 to 5,000	0.089
5,000 to 20,000	0.084

Additional revenue may be obtained through co-digestion (from 0.04€ to 0.06 €/kWhe)

Revenue from sale of electricity ~ 0.175 €/kWhe

Additional bonuses for co-generation and for use of innovative technologies

Potential Solutions: Energy-Agro-Waste Systems for Maximum Efficiency

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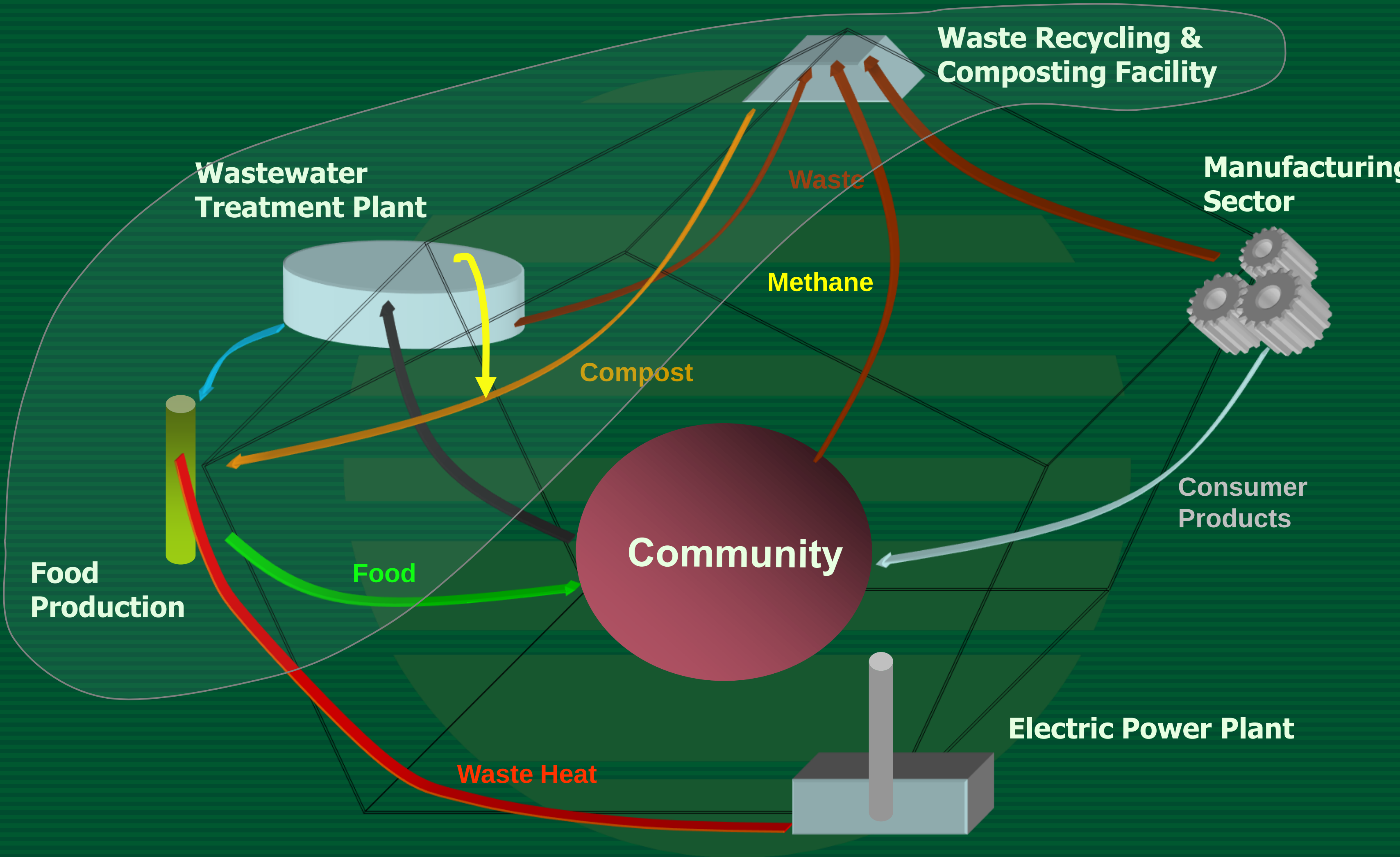
Introduction

- Communities are not planned from the outset for optimal utilization of materials and energy
- Community systems are composed of a number of individual subsystems, e.g.:
  - food production
  - wastewater treatment
  - electricity supply
  - Solid waste processing

Community Support Subsystems



Community Support Subsystems

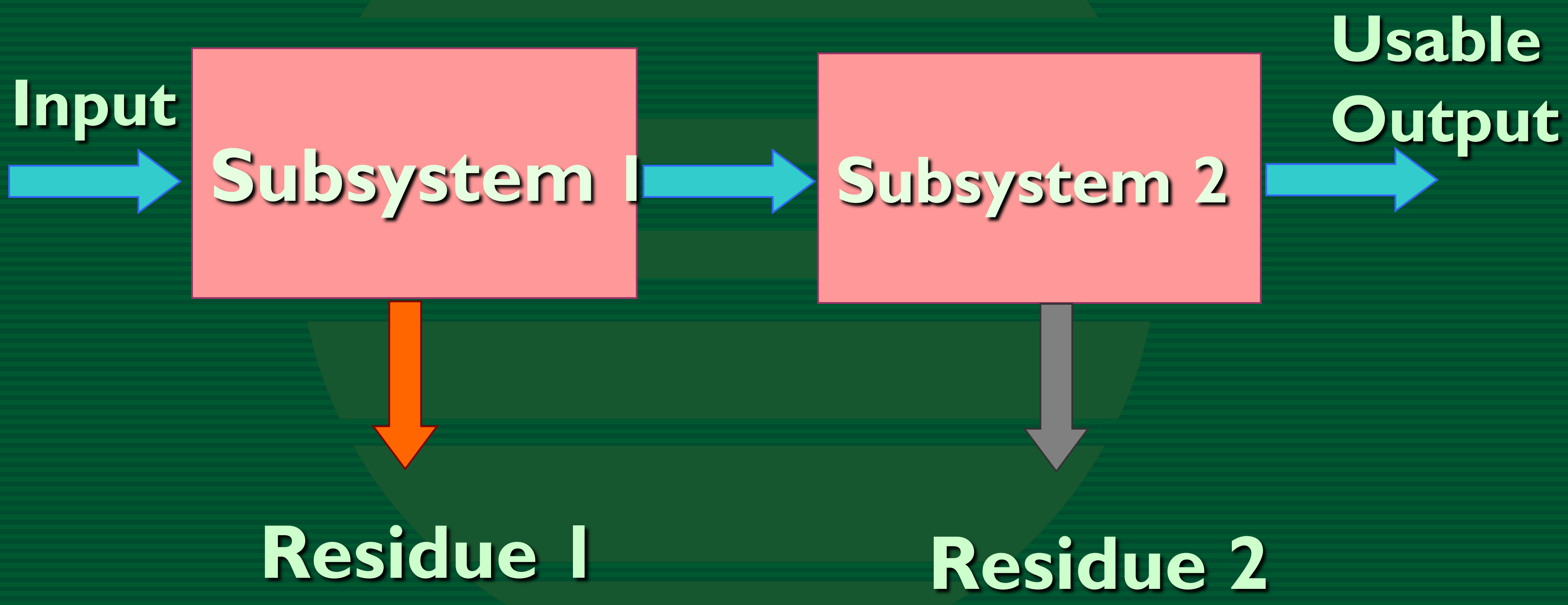
- Design of any one subsystem does not take into account impact on all of the other subsystems
- Planned development of community systems needs to account for mass and energy balances among subsystems -- result:
  - high overall system efficiency
  - reduced net waste production
  - conservation of energy
  - overall optimum use of resources

Models of Unit Processes

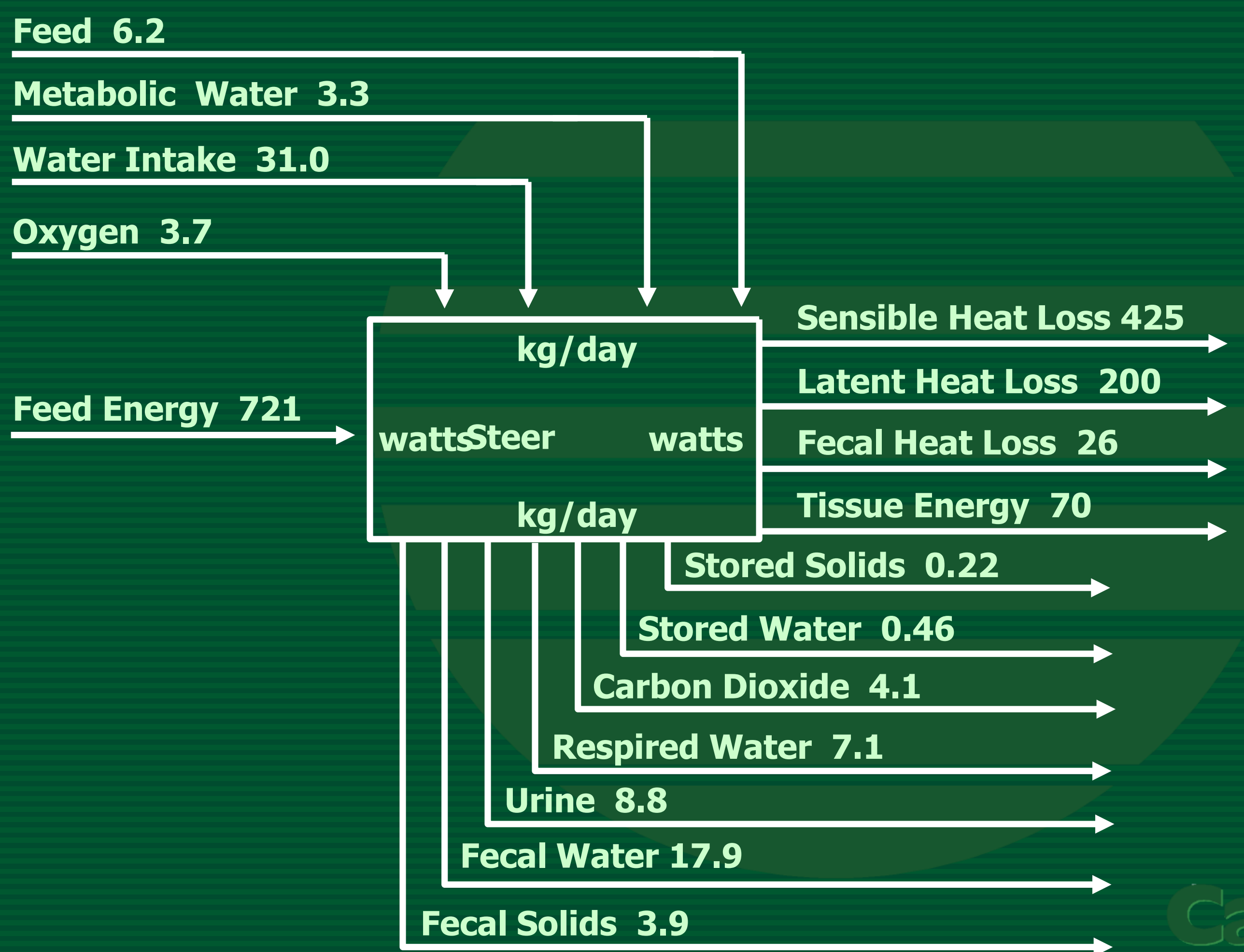
- Requirements for modeling unit processes:
  - identification of fundamental variables
  - governing relations among variables (inputs and outputs)
  - reliable scientific data
  - foresight to identify common inputs and outputs among different types of unit processes

➤ **INTEGRATION**

Models of Unit Processes (cont.)



Mass and Energy Balance Diagram for Beef Production



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Concluding Remarks

Status of our Industry

Many improvements have taken place in waste management practices during the last 70 years

Status of our Industry (cont.)

- However, society still consumes large quantities of items each day
- As an example, in the EU each person produced:
  - 460 kg of solid waste per year in 1995
  - 520 kg of solid waste per year in 2004
  - 680 kg of solid waste per year (projected in 2020)

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Conclusions/Recommendations

- Limited or conflicting information to make important management decisions
  - Need reliable, scientifically based information
- Veracity in reporting results of programs
- Strategies used by most industrialized countries:
  - Waste minimization
  - Recycling (including bio treatment)
  - Waste diversion from landfill

Conclusions/Recommendations

- Strategies used by most economically developing countries:
  - Informal recycling
  - Final disposal in the land
- Following are some specific suggestions for economically developing countries

Keys to Success

- Political will to solve the problem of waste management
- Development of 3R and "zero waste" strategies:
  - appropriate technology (site selection, facility design)
  - available resources (financial and human) for sustainable operations
  - availability of uses/markets (product quality)
- Establishment of sound final disposal sites

Keys to Success

- Review and modernize pertinent laws
- Develop policies related to resource management and resource recovery
- Ensure continuity of staff in Environmental Management
- Following are three additional requirements for success:

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Keys to Success

- Education
- Education
- Education

- AND

“Life Style“ California, USA

example food (source: Menzel, So isst der Mensch, 2005)

Food for one week

“Lifestyle” Germany

example food (source: Menzel, So isst der Mensch, 2005)

Food for one week

"Lifestyle" Rural Area - Ecuador

example food (source: Menzel, So isst der Mensch, 2005)

Food for one week