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IDRC CRDI Canada

Municipal wastewater treatment and greenhouse gas emission reduction in Latin America and the Caribbean

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Introduction

- Wastewater treatment in Latin America is still limited; less than 20% of sewage receive some kind of treatment
- This is a clear indicator of the need to invest in this sector
- Wastewater treatment generates environmental impacts and contributes to the emission of Greenhouse gases.

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Introduction

- It is necessary to identify wastewater treatment systems with lower environmental impact.

- It is particularly important to identify technological processes that may have a low carbon footprint to help mitigate climate change in Latin America and the Caribbean.

- The evaluation of these technologies will support the process of decision making and investments that promote sustainable development.

UNAM-IDRC Project

On april 2010 we started a three year project, funded by the IDRC (International Development Research Council) of Canada

Goal (conceptual):

Evaluate the environmental impacts of the most representative water treatment technologies in Latin America and the Caribbean in order to identify mitigation strategies

Specific goals (+):

- To develop an inventory of treatment technologies in LAC
- To generate representative treatment scenarios of LAC
- To identify the technical and economic characteristics of representative scenarios
- To assess the environmental impacts of treatment scenarios with emphasis on the quantification of GHG through Life Cycle Assessment (LCA)
- To identify research topics in order to minimize environmental impact and GHG generation for the identified (improved) wastewater treatment technologies.

- WWTP inventory for six countries of LAC

Treatment technologies inventory for LAC:

Methods

✓ **The information obtained for WWTP in LAC was collected from official agencies, organizations and WWTP operators through a consultant engineer in each selected country.**

✓**WWTP Sample Inventory by country, according to:**

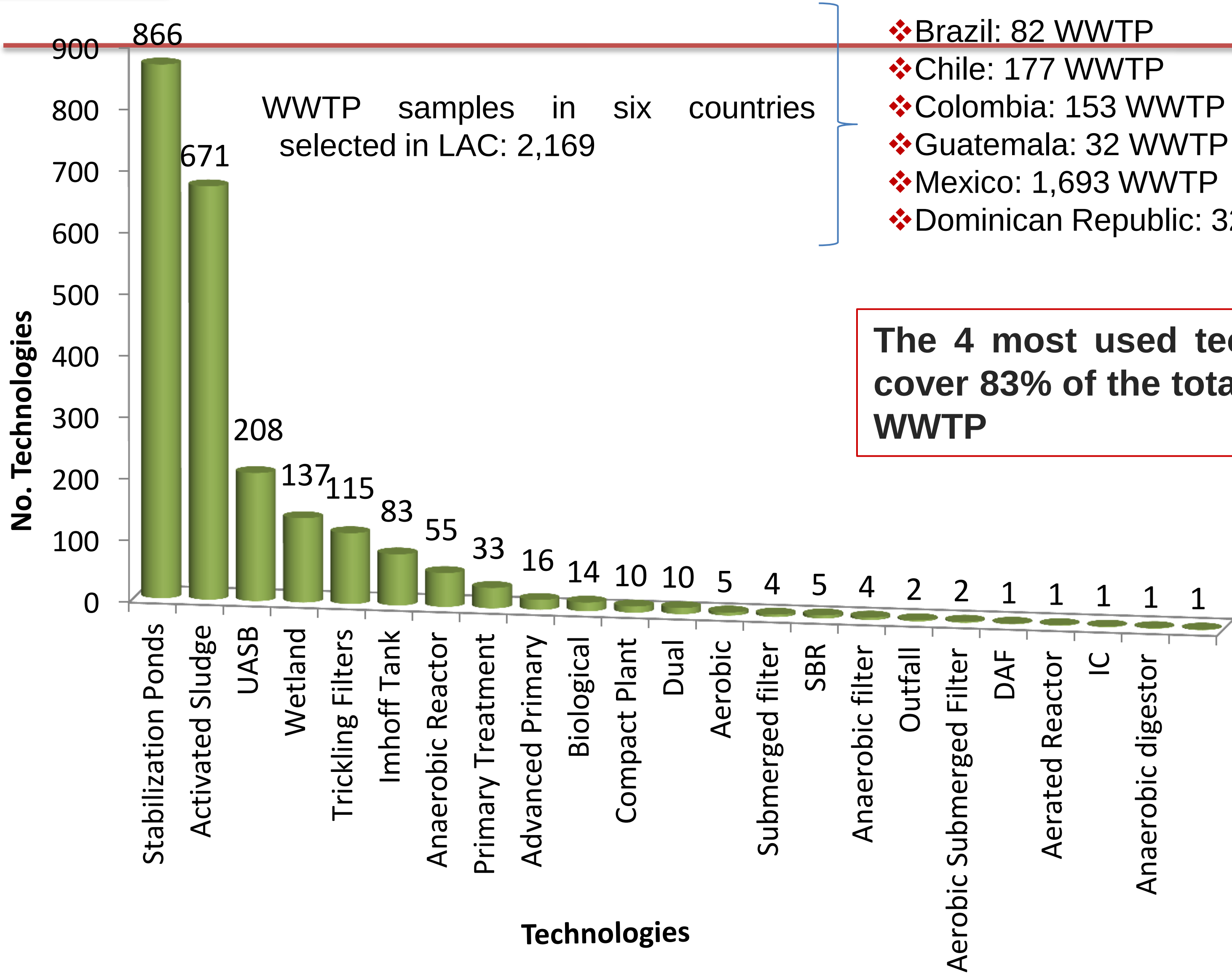
- Categorization of cities by population size.

- Data base template:

a) General Format
b) Specifics Formats:
- Wastewater quality
- Sludge, biosolid and solid waste
-Emissions and Odour control
- Costs

Inventory of treatment technologies in LAC

Used technologies



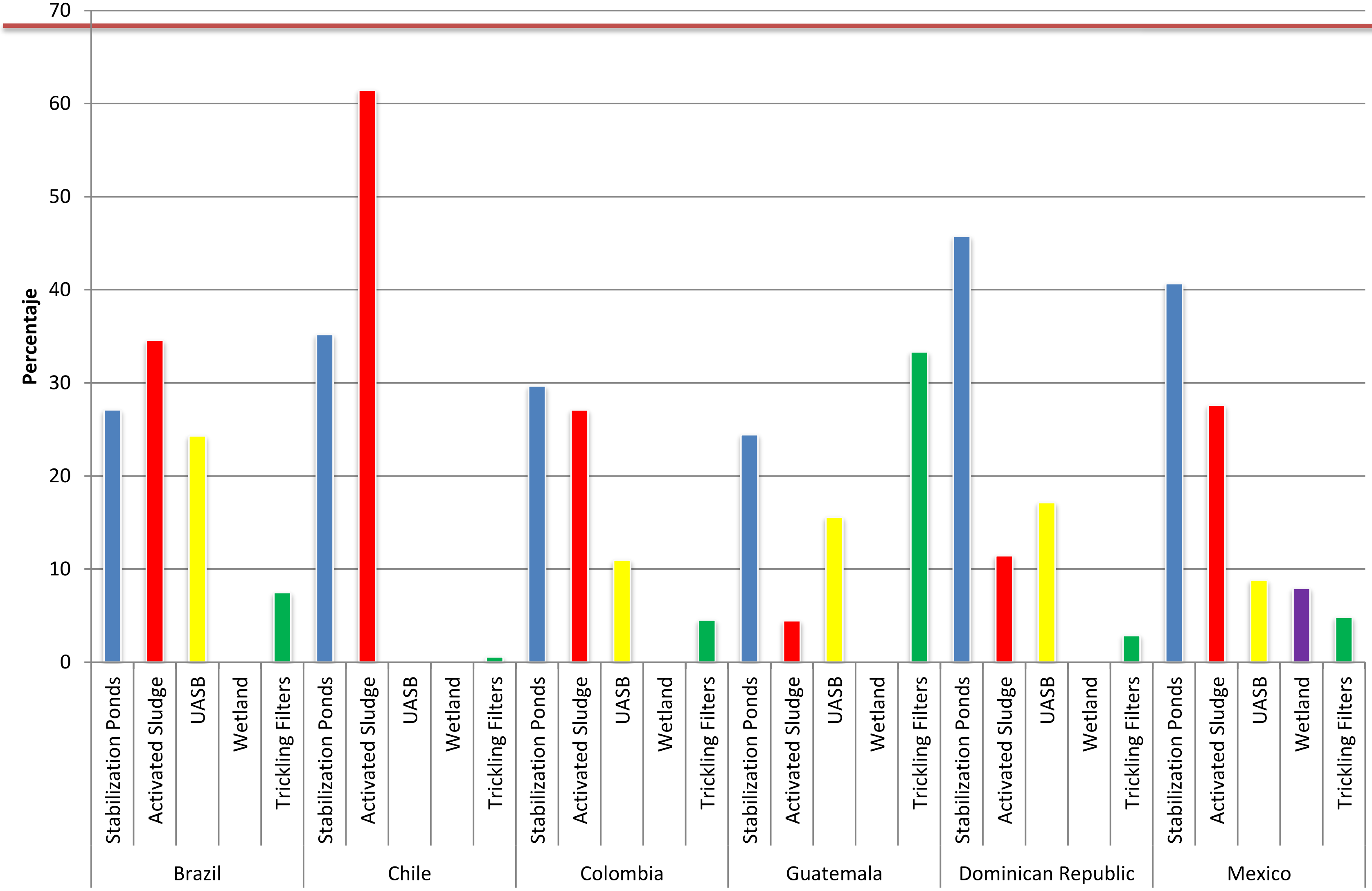
- Brazil: 82 WWTP
- Chile: 177 WWTP
- Colombia: 153 WWTP
- Guatemala: 32 WWTP
- Mexico: 1,693 WWTP
- Dominican Republic: 32 WWTP

The 4 most used technologies, cover 83% of the total sample of WWTP

- The septic tank was not considered as technology for the treatment
- WWTP that reported combined processes (two technologies) were counted independently.

Inventory of treatment technologies in LAC:

Most used technologies in the selected countries



- Methane in wastewater treatment plants

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Biochemical reactions of interest in wastewater treatment

- Aerobic conditions

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

- Anoxic conditions: Nitrate reduction (Denitrification)

$$2NO_3^- + 2H^+ \rightarrow N_2 + 2.5O_2 + H_2O$$

- Anaerobic conditions: Sulfate reduction

$$CH_3COOH + SO_4^{-2} + 2H^+ \rightarrow H_2S + 2H_2O + 2CO_2$$

- Anaerobic conditions: CO_2 reduction (Hydrogenotrophic Methanogenesis)

$$4H_2 + CO_2 \rightarrow CH_4 + 2H_2O$$

- Anaerobic conditions: Acetotrophic methanogenesis

$$CH_3COOH \rightarrow CH_4 + CO_2$$

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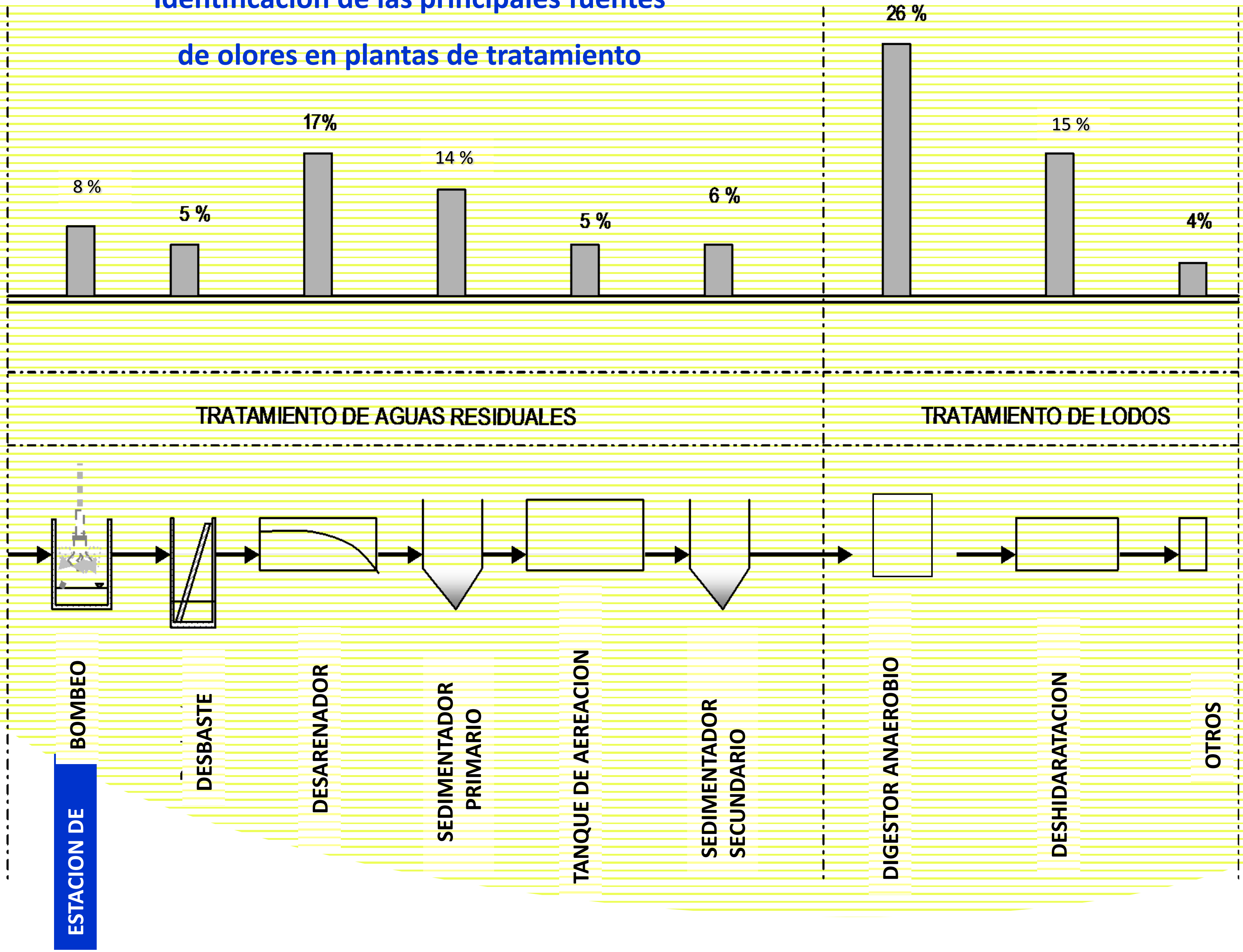
Origin of atmospheric methane

SOURCES OF METHANE EMISSIONS	CONTRIBUTION (%)
Energy production (natural gas)	26
Enteric fermentation	24
Rice agriculture	17
Landfills	11 *
Biomass burning	8
Wastes	7 *
Municipal wastewater	7 *

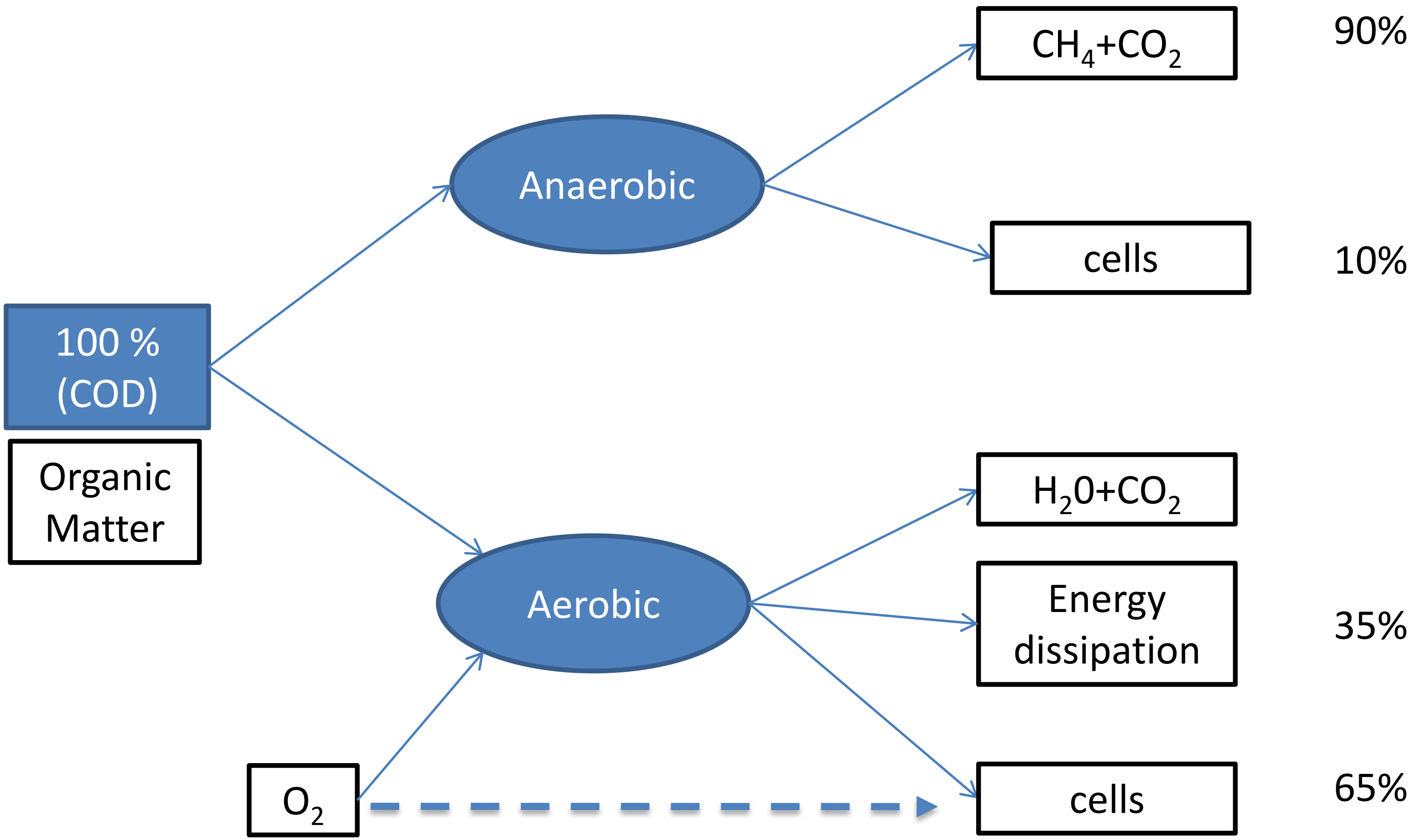
* Sum of residues: 25 %

IPCC (1994)

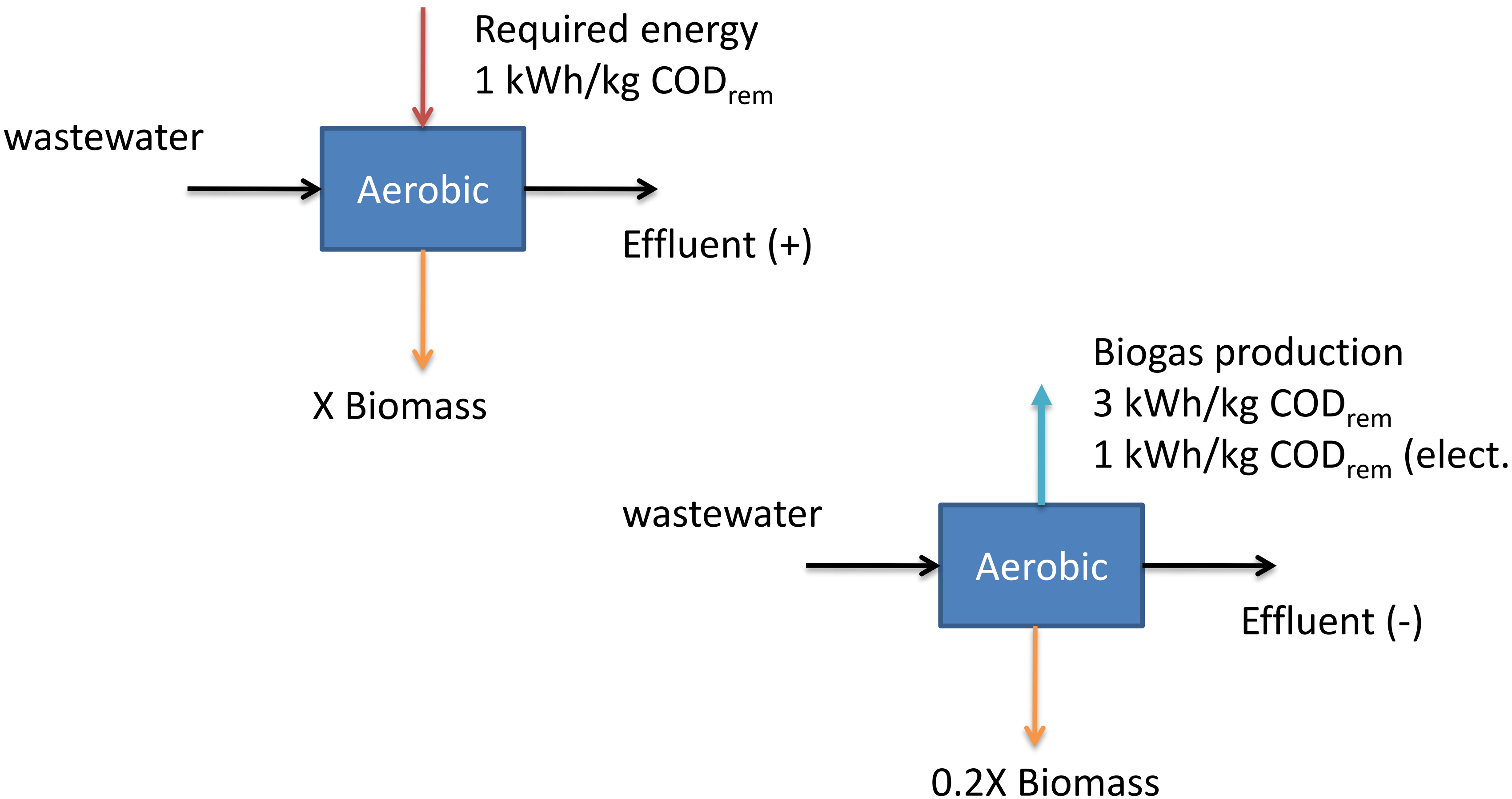
Identificación de las principales fuentes de olores en plantas de tratamiento



Two pathways for biological degradation



The anaerobic difference



Carbon Balance

(aerobic *vs* anaerobic)

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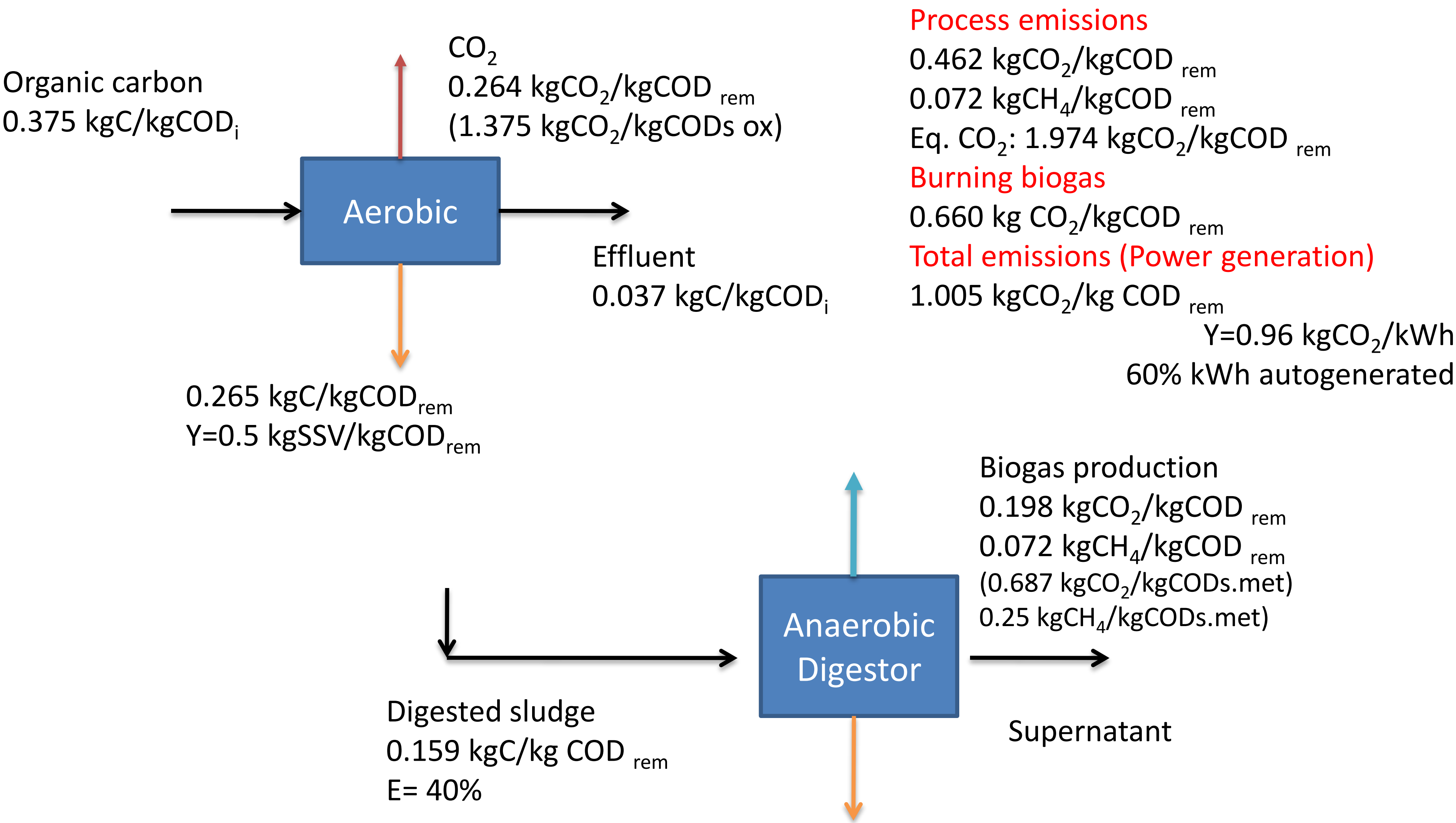
Carbon Balance (1)



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Carbon Balance (2)

Anaerobic **industrial** wastewater treatment

Process emissions

Eq. CO2: 3.918 kg CO2/kgCOD $_{rem}$

Burning biogas

0.906 kg CO_2/kgCOD $_{rem}$

With power generation

-0.054 kg CO_2/kgCOD $_{rem}$

Y=0.96 kgCO_2/kWh

E=0.33

Organic Carbon

0.375 kgC/kgCOD

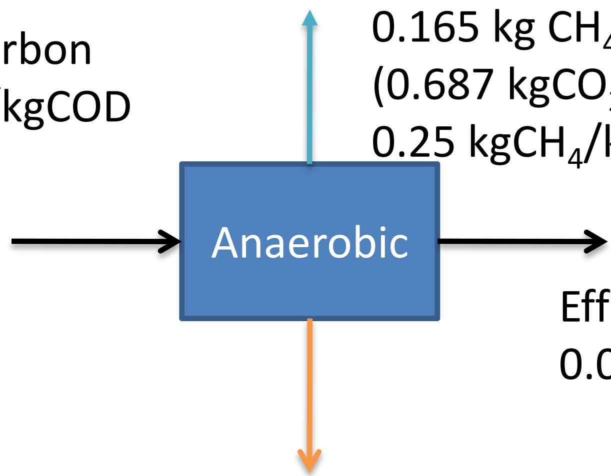
Biogas Production

0.453 kgCO_2/kgCOD $_{rem}$

0.165 kg CH_4/kgCOD $_{rem}$

(0.687 kgCO_2/kgCOD$_{s\ met}$)

0.25 kgCH_4/kgCOD$_{s\ met}$)



Effluent

0.075 kgC/kgCOD

0.053 kgC/kgCOD$_{rem}$

Y=0.1 kgSSV/kgCOD$_{rem}$

Summary table for Carbon balance

Process	Process emissions $kgCO_2/kgCOD_{rem}$ $kgCH_4/kgCOD_{rem}$	Total process emissions (Eq. CO_2) $kgCO_2/kgCOD_{rem}$	Burning Biogas $kgCO_2/kgCOD_{rem}$	Total emissions (Power Generation) $kgCO_2/kgCOD_{rem}$
LA+DA	0.462 0.072	1.974	0.660	1.005
DA	0.453 0.165	3.918	0.906	-0.054

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Considerations for wastewater with low COD concentration

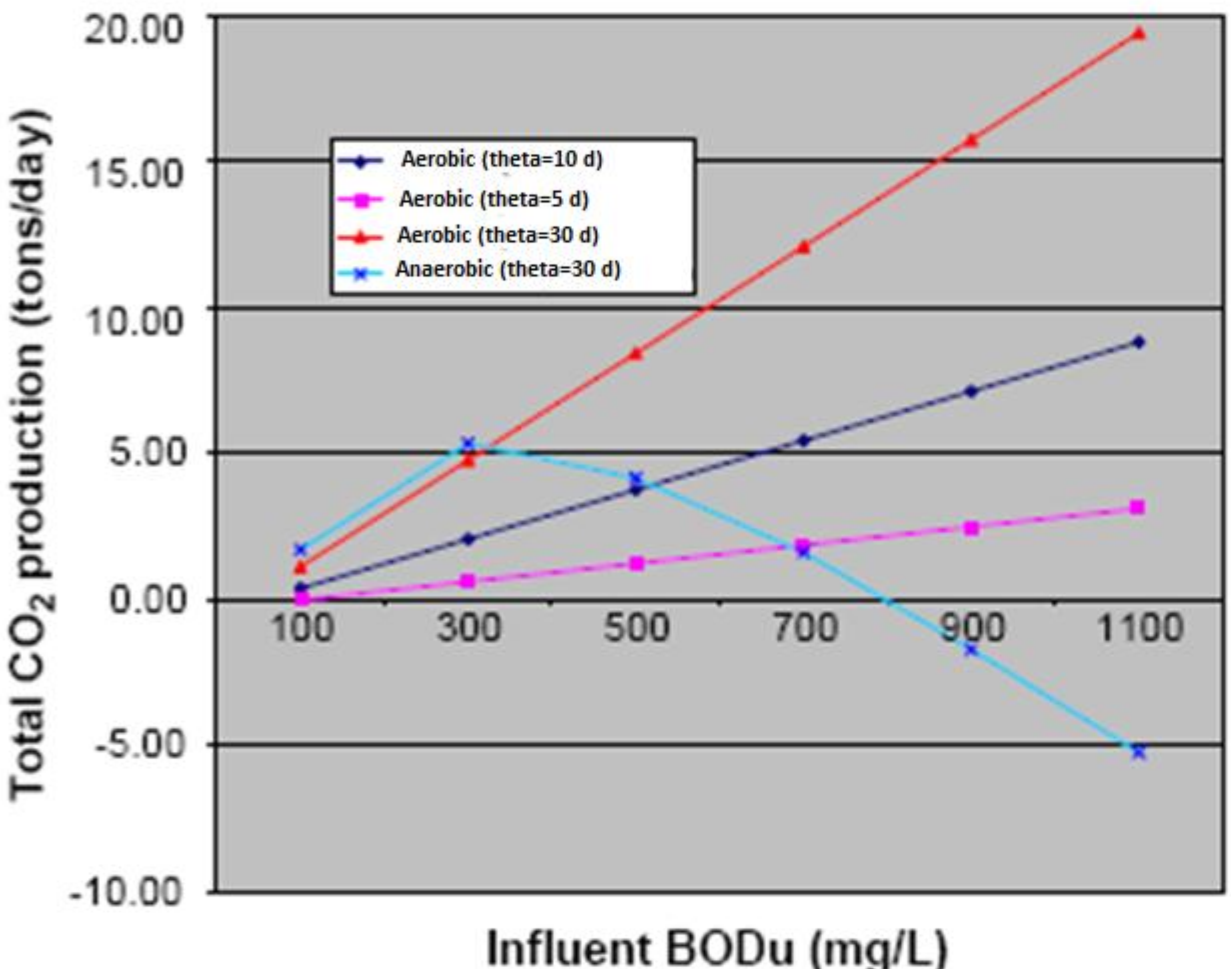
- Municipal wastewater (COD below 1000 mg/L)

  - The net production of methane is limited
    (0.1 a 0.22 m^3CH_4/kg COD rem *vs 0.35*m^3CH_4*/kg COD rem)*

  - Approximately 30 to 50% of methane is dissolved in the effluent

  - Loss of energy and emission of GHG with significant global warming potential (21 times that of CO_2)

CO_2 emissions based on influent BOD concentration



Cakir y Stenstrom, 2005)

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Final comments

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Final comments

- In Latin America and the Caribbean, stabilization ponds, activated sludge, UASB reactors and trickling filters are the most widely used wastewater treatment processes
- The tool for the Environmental Life Cycle Analysis will allow to suggest region's own data to international LCA databases as well as GHG emission factors consistent with our technological reality in the field
- The anaerobic path is a sustainable option for the treatment and use of organic waste
  - Low Energy consumption
  - Net energy production
  - Less GHG emission factors (when biogas is used)

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Final comments

- The main disadvantage in anaerobic treatment is the methane fraction that leaves as dissolved gas and it is released to the atmosphere

- There is still a long way to go for this option to be accepted

- The Kyoto Protocol and CDM can promote the acceptance of this technology