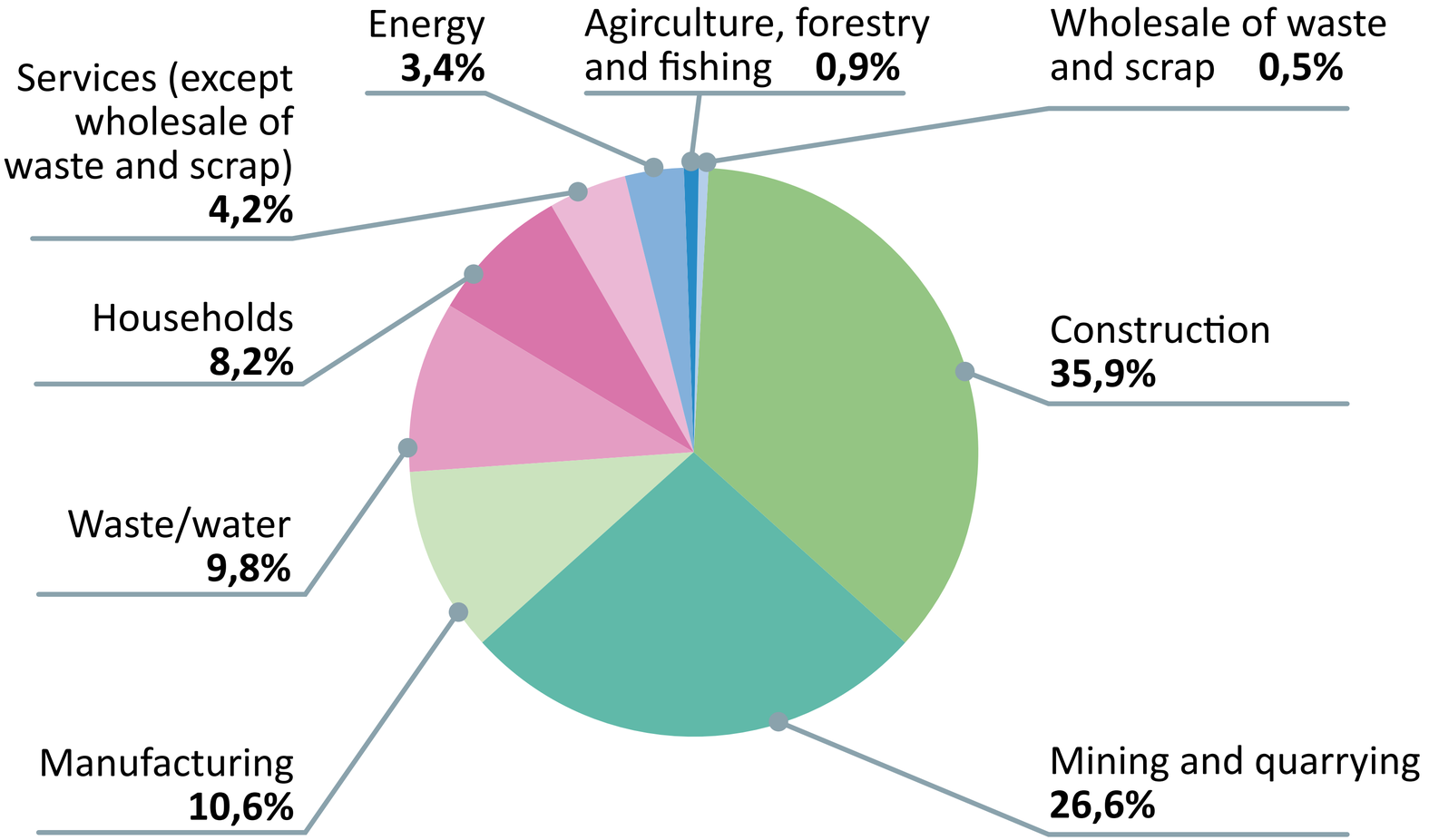
Molecular Waste Recycling

Klinotech RMO®

Waste generation



Source: Eurostat: Waste generation by economic activities and households, EU, 2018

In 2018, the total waste generated in the EU by all economic activities and households amounted to 2 337 million tonnes.

Source: Eurostat


The amount of municipal waste generated per person in the European Union (EU) in 2019 amounted to 502 kg.

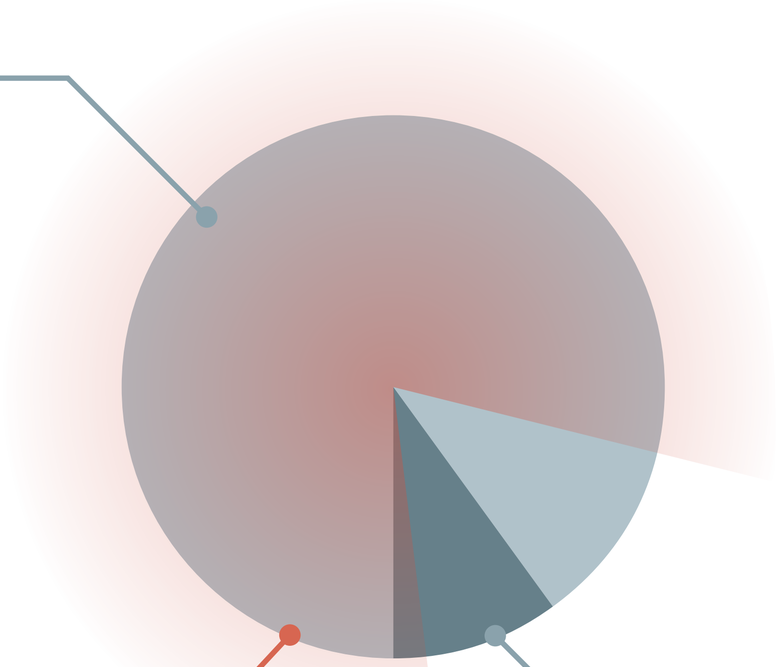
Waste

Waste is a mixture of various chemical compounds of biological and industrial origin. They are of varying degrees of moisture or hydration.

The RMO installation eliminates mixed waste when segregation is impossible or unprofitable.

Hazardous waste

Industrial organic waste
90%



Municipal organic waste
10%

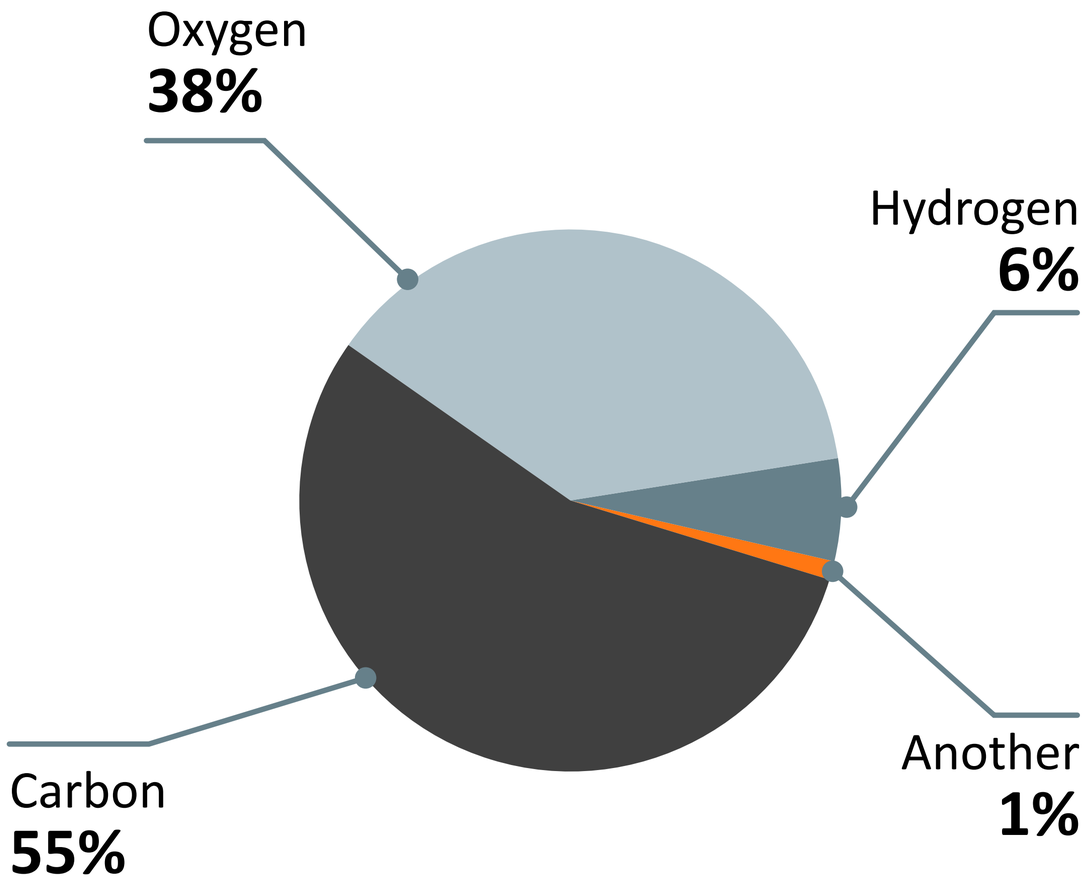
including:
80% of this share ->industrial hazardous,
and **20%** -> municipal

RMO – Operational ideas and principles

In most cases, the stranger the case is the more banal the solution.

Arthur Conan Doyle

Waste morphology



Source: Marek Pilawski (PhD)Prepared on the basis
of the verification of various groups of waste – average values.

On average, mass elemental composition of waste is:
– carbon (C): 55%,
– hydrogen (H): 6%,
– oxygen (O): 38%,
– other: 1%.

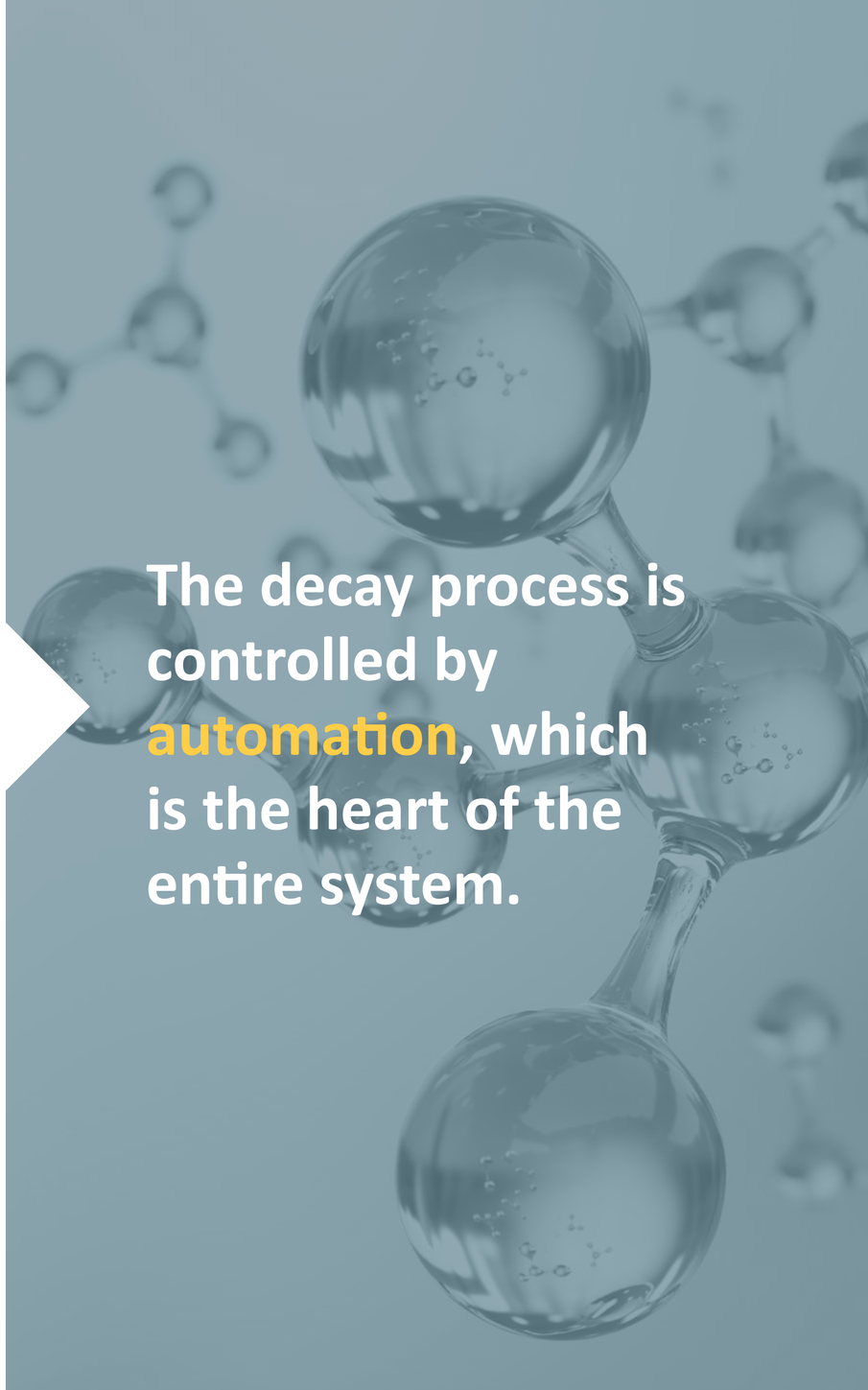
RMO installation

The basis of RMO operation is the fact that the chemical compounds of carbon, oxygen and hydrogen atoms are characterized by stability in a specific temperature range. When it is exceeded, the chemical compound is decomposed.

The RMO installation starts the process of decomposition of organic waste to its basic form, i.e. atoms, which, after leaving the reactor, create different chemical compounds than those that went into it.

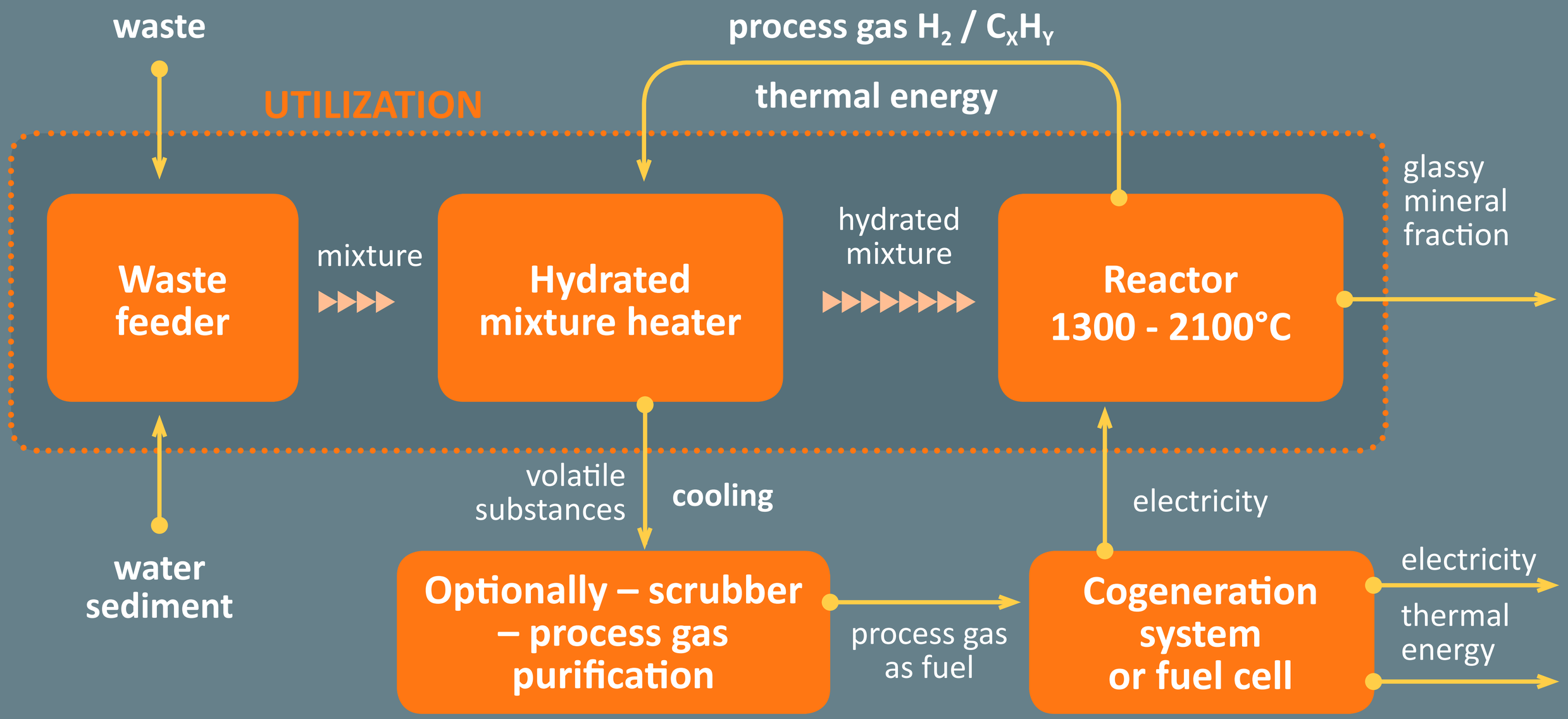
The decomposition process takes place inside the reaction chamber, called the reactor, at temperatures of 1300°C to 2100°C.

The decomposition process is effective for all organic waste, biological origin (vegetable and animal waste) and industrial origin (plastic, rubber, textiles, paint and varnishes, medicines and plant protection products, medical waste, used oils, hazardous waste, sewage, sediment sewage, etc.)



The decay process is controlled by automation, which is the heart of the entire system.

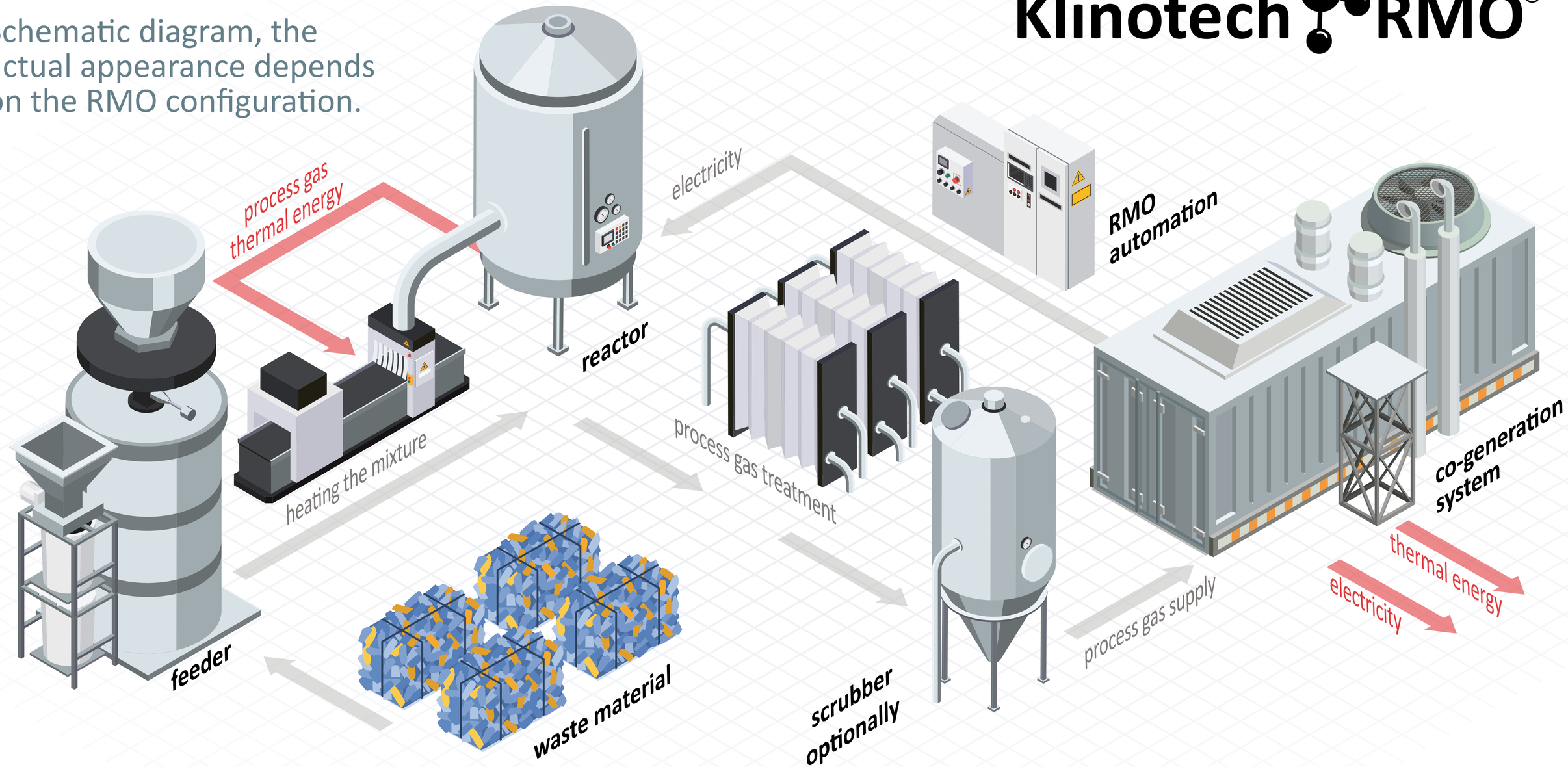
RMO process


waste
process gas H_2 / C_XH_Y
thermal energy
UTILIZATION
Waste feeder
mixture
Hydrated mixture heater
hydrated mixture
Reactor 1300 - 2100°C
glassy mineral fraction
water sediment
volatile substances
cooling
electricity
Optionally – scrubber – process gas purification
process gas as fuel
Cogeneration system or fuel cell
electricity
thermal energy

RMO installation

Schematic diagram, the actual appearance depends on the RMO configuration.

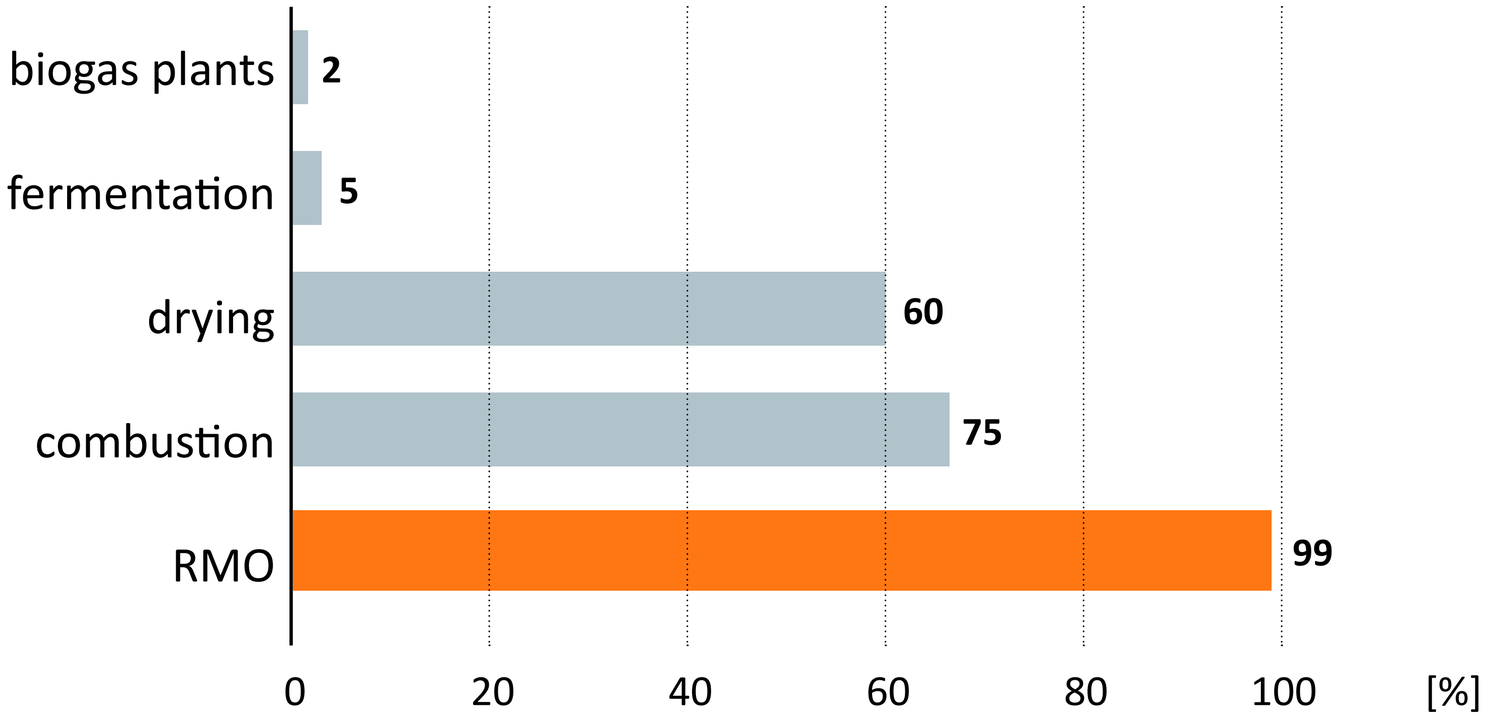
Klinotech RMO®



Reactor work effect


Waste
disposal

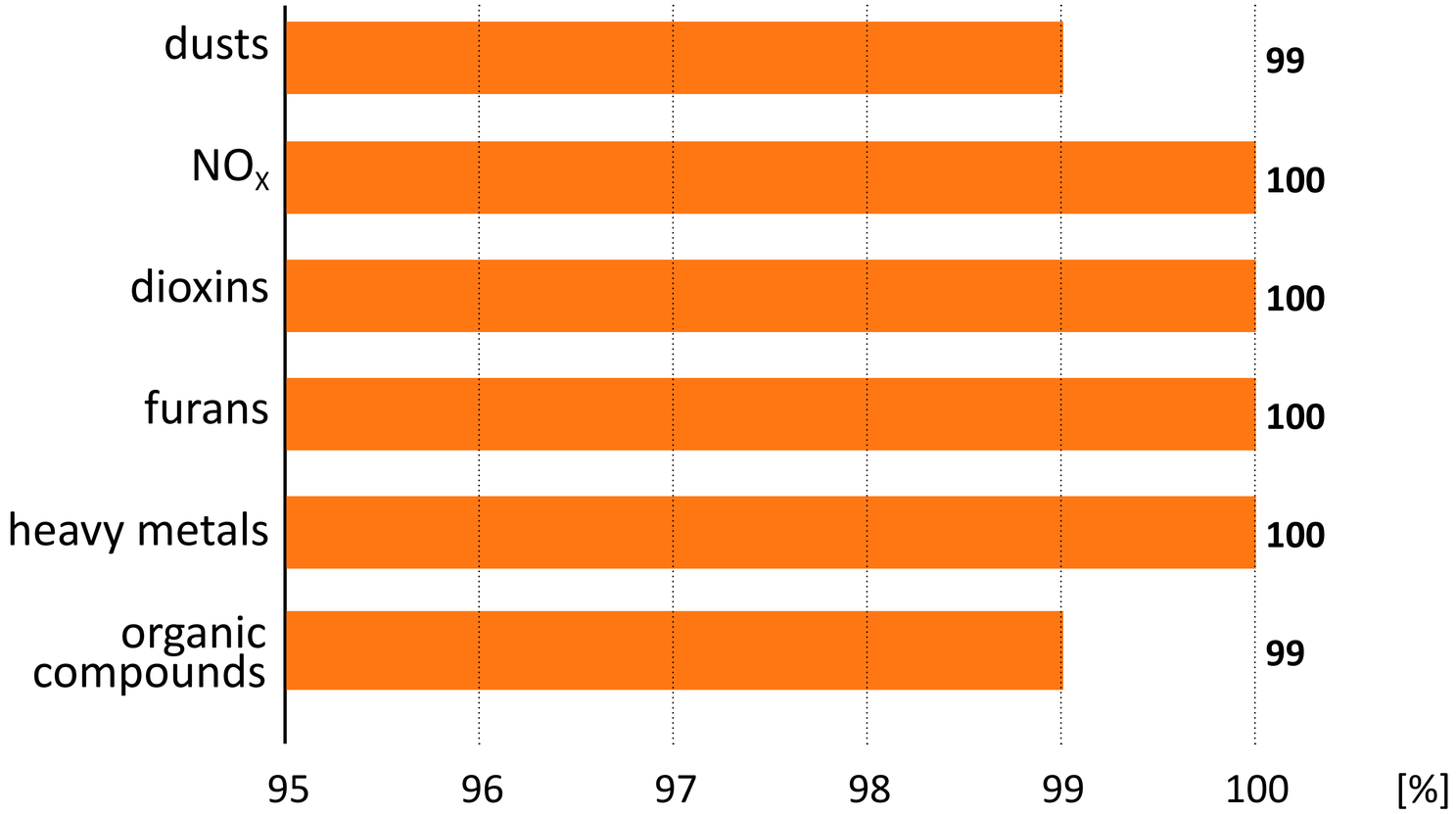
Reduction of waste mass



Source: Marek Pilawski (PhD)

RMO technology allows to almost completely reduce the weight of the waste subjected to the recycling process.

Reduction of harmful emissions in RMO



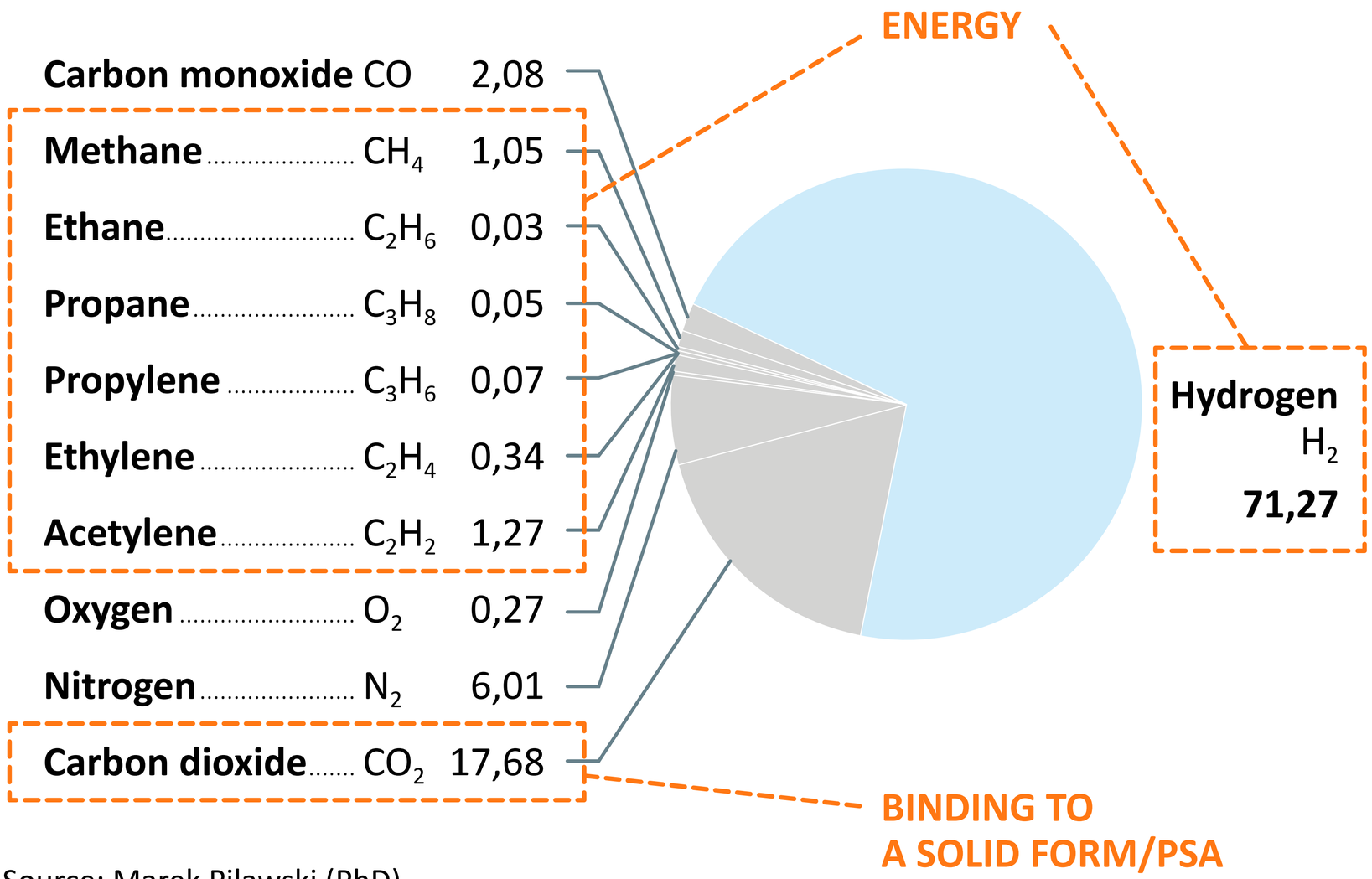
Source: Marek Pilawski (PhD),
Emission of secondary waste in relation to landfills.

RMO technology makes it possible to almost completely reduce harmful emissions occurring during waste disposal.


Process
Gas

Process gas composition [%]

(Sample 1)



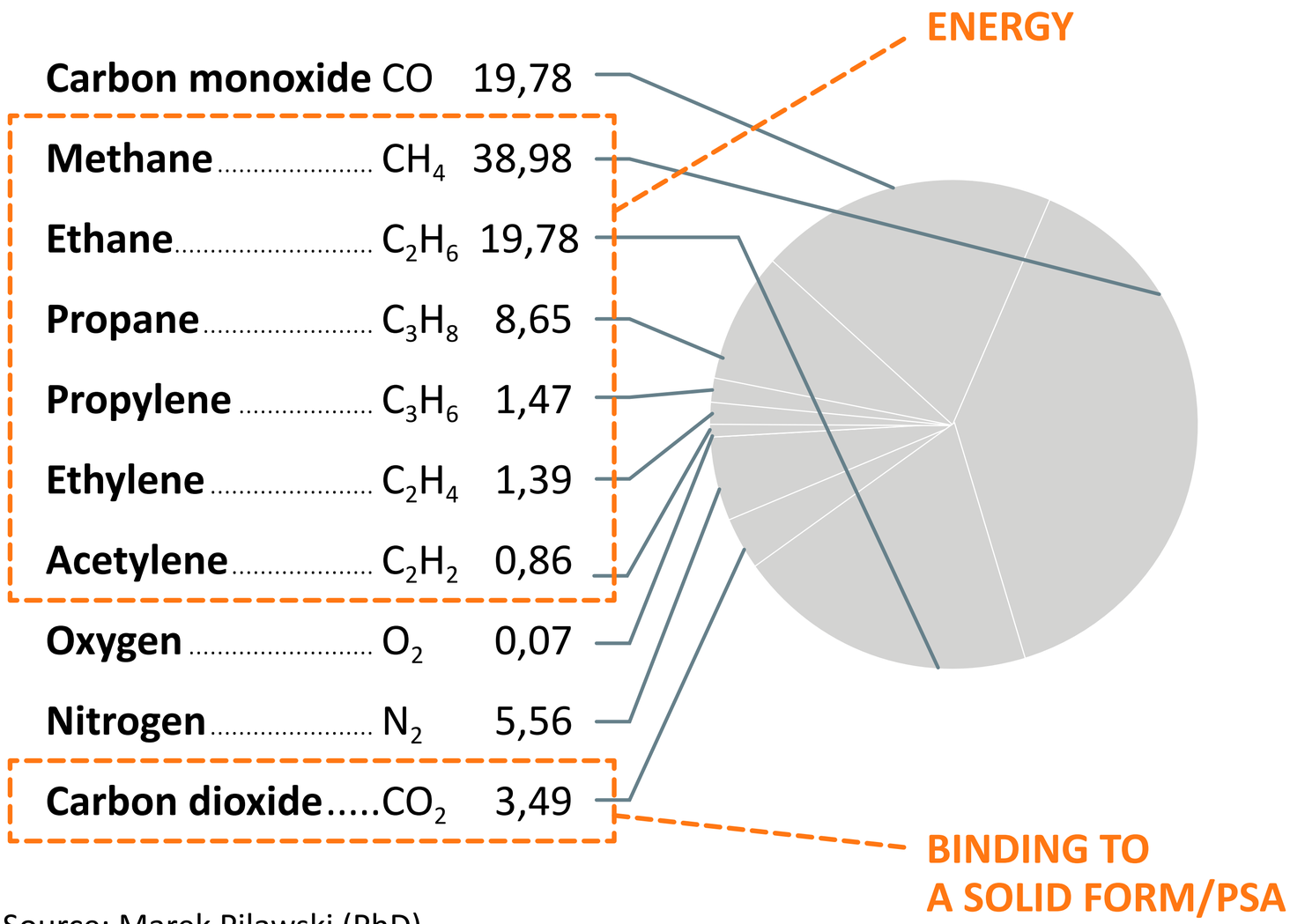
Source: Marek Pilawski (PhD)

The composition of the process gas may vary depending on the waste batch, its hydration and the settings of the control system.

Source: Klinotech

Process gas composition [%]

(Sample 2)



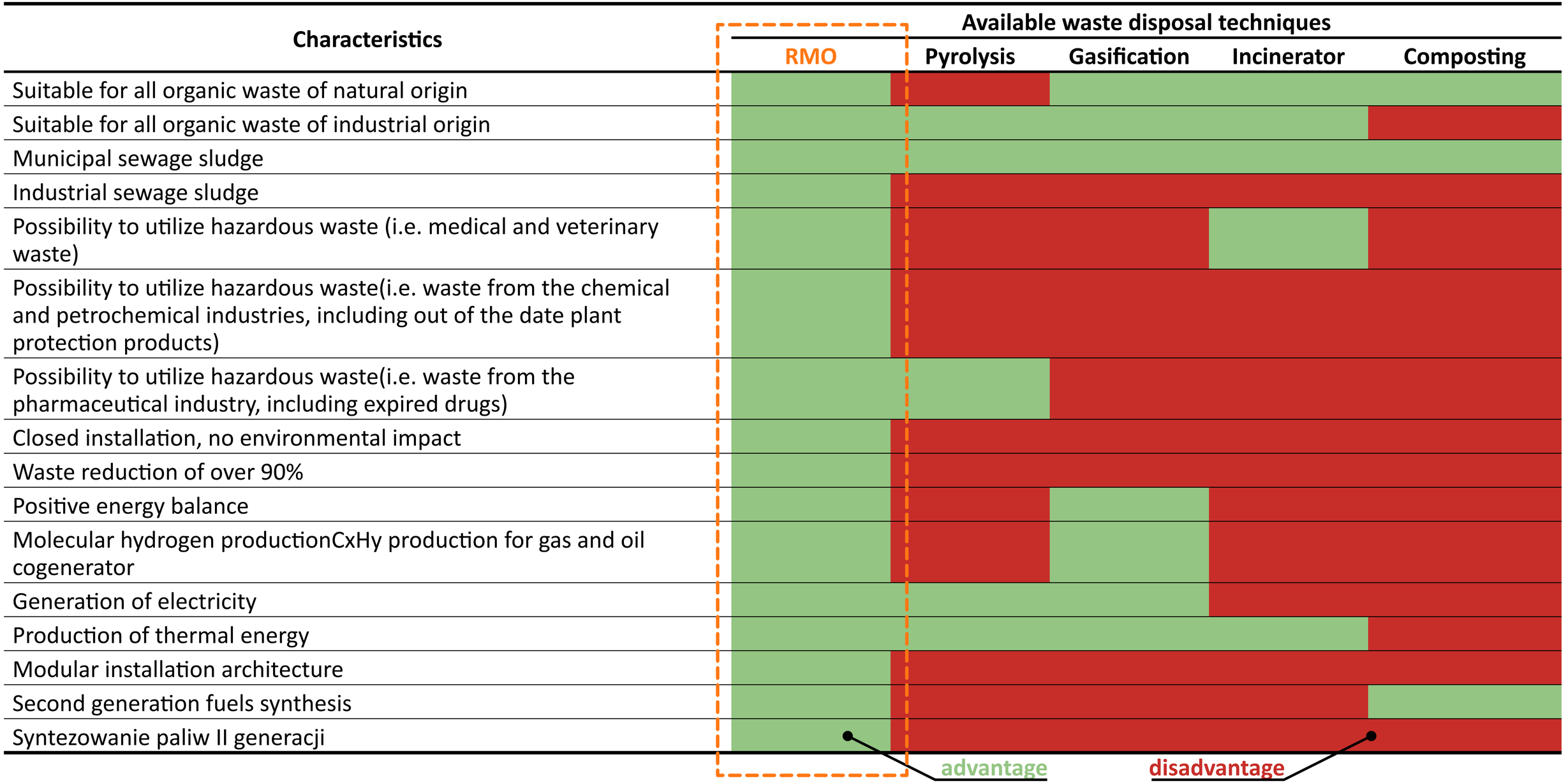
Source: Marek Pilawski (PhD)

The composition of the process gas may vary depending on the waste batch, its hydration and the settings of the control system.

Source: Klinotech


What distinguishes RMO from others
waste disposal processes?

Comparative analysis of the waste utilization technology



Effectiveness of RMO technology in individual waste groups

waste catalog*	RMO		
	waste reduction	emission	energy balance
	%		
01 – Waste from exploration, extraction, physical and chemical processing of ores and other minerals	10-30	Zero	Negative or zero
02 – Waste from agriculture, horticulture, aquaculture, fisheries, forestry, hunting and food processing	99	Zero	Positive
03 – Waste from wood processing and the production of panels and furniture, pulp, paper and cardboard	99	Zero	Positive
04 – Waste from the leather, fur and textile industries	60-99	Zero	Negative or zero
05 – Wastes from petroleum processing, natural gas purification and pyrolyticprocessing of coal	70-99	Zero	Positive
06 – Waste from the production, preparation, traiding and use of products of the inorganic chemistry industry	20-99	Zero	Negative or zero
07 – Waste from the production, preparation, traiding and use of products of the organic chemistry industry	70-99	Zero	Positive
08 – Waste from the production, preparation, traiding and application of protective coatings (paints, varnishes, ceramic enamels), putty, adhesives, sealants and printing inks	40-60	Zero	Negative or zero
09 – Waste from the photographic industry and photographic services	40-60	Zero	Negative or zero
10 – Waste from thermal processes	10-30	Zero	Negative or zero

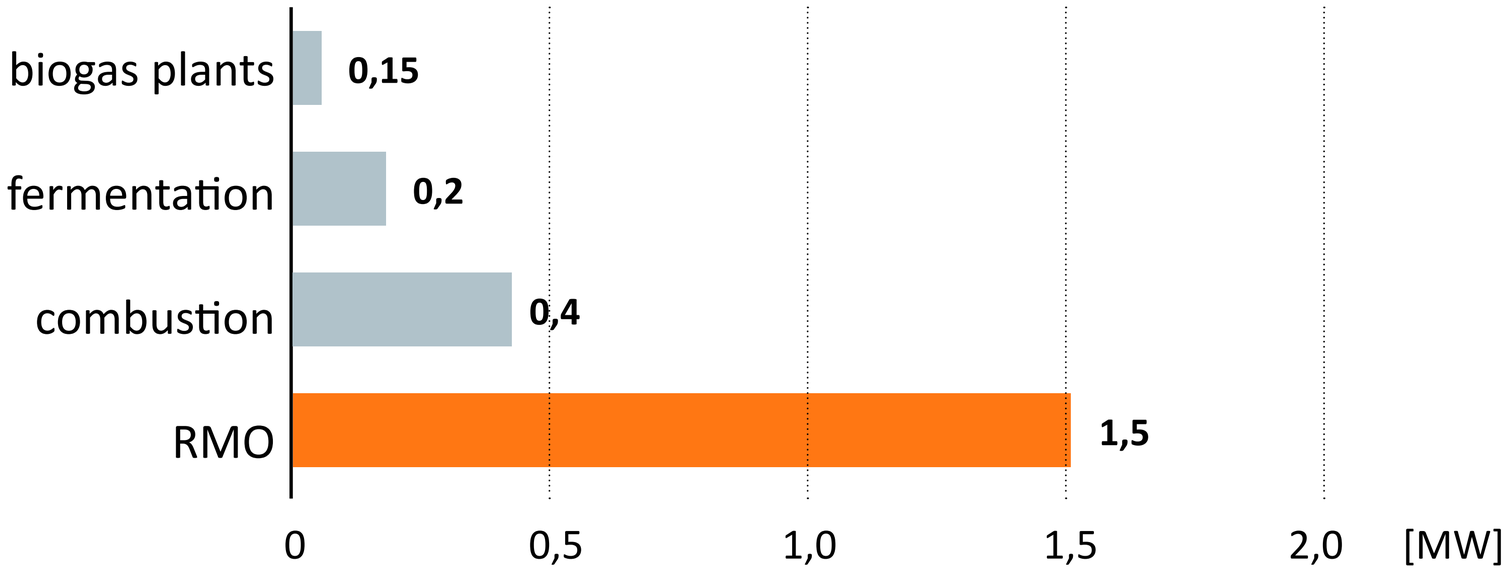
Source: Regulation of the Minister of Climate of 3 January 2020 and Commission Decision EU 2014/955 / EU on the list of waste

Effectiveness of RMO technology in individual waste groups

waste catalog*	RMO		
	waste reduction	emission	energy balance
	%		
11 – Waste from chemical surface treatment and coating of metals and other materials as well as from hydrometallurgical processes of non-ferrous metals	10-30	Zero	Negative or zero
12 – Waste from shaping as well as physical and mechanical surface treatment of metals and plastics	10-30	Zero	Negative or zero
13 – Waste oils and waste liquid fuels (excluding edible oils and groups 05, 12 i 19)	80-99	Zero	Positive
14 – Waste organic solvents, refrigerants and propellants (excluding grups 07 i 08)	80-99	Zero	Positive
15 – Packaging waste; absorbents, wiping cloths, filter materials and protective clothing not included in other groups	80-99	Zero	Positive
16 – Waste not included in other groups	10-99	Zero	Positive /Negative
17 – Waste from the construction, renovation and dismantling of buildings and road infrastructure (including soil and soil from contaminated areas)	10-30	Zero	Negative or zero
18 – Medical and veterinary waste	80-99	Zero	Positive
19 – Waste from installations and devices for waste management, from sewage treatment plants and from the treatment of drinking water and water for industrial purposes	80-99	Zero	Positive
20 – Municipal waste, including selectively collected fractions	70-99	Zero	Positive

Source: Regulation of the Minister of Climate of 3 January 2020 and Commission Decision EU 2014/955 / EU on the list of waste

Energy production in RMO technology



NOTE: Waste with calorific value was selected for the calculations
15 GJ/Mg = 4 kWh/Mg

Source: Marek Pilawski (PhD) on the basis of industry literature

Analytical data

Assumptions

RMO operation time
8000 h/year

Batch size (capacity installation)
500 kg/h

Configuration (2 opitions):
1. with H_2 production
2. without H_2 production

Operation period
10 years

Configuration 1 with H_2 production

H_2 generated over 10 years:
65 kg H_2/h x 80000h
= **5200 tons**.

Thermal energy generated over 10 years:
0,37 GJ/h x 80000h
= **29 600 GJ**

Estimated values calculated for the carbon content of the waste **at 40%**

Configuration 2 without H_2 production

Electricity generated over 10 years:
0,2 MW x 80000h
= **16 000 MWh**

Disposed of waste generated over 10 years:
500 kg x 80000h
= **40 000 tons**

Thermal energy generated over 10 years:
0,732 GJ/h x 80000 h
= **58 560 GJ**

Where are we

05

01

scientific competences of the creators of the RMO idea, patents, scientific achievements

02

creating the assumptions of the RMO project

03

scientific verification

04

team building

05

construction of financial assumptions

06

analysis of needs for a specific user, performance of tests and calculations for the declared groups of waste

07

development of detailed designs

08

start-up (COD)

Verification and scaling of activities

Klinotech RMO®